Cheltenham Borough Council

Annual Status Report 2022

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CHELTENHAM
BOROUGH COUNCIL

2022 Air Quality Annual Status Report (ASR)

In fulfilment of Part IV of the Environment Act 1995

Local Air Quality Management

Date: September 2022

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Executive Summary: Air Quality in Our Area

Air Quality in Cheltenham Borough Council

Air pollution is associated with a number of adverse health impacts. It is recognised as a contributing factor in the onset of heart disease and cancer. Additionally, air pollution particularly affects the most vulnerable in society: children, the elderly, and those with existing heart and lung conditions. There is also often a strong correlation with equalities issues because areas with poor air quality are also often less affluent areas[1,2].

The mortality burden of air pollution within the UK is equivalent to 28,000 to 36,000 deaths at typical ages[3], with a total estimated healthcare cost to the NHS and social care of £157 million in 2017[4].

Road traffic emissions are the main source of air pollution in the Borough of Cheltenham, mainly from the A40 (Gloucester Road), A4013 (Princess Elizabeth Way), A4019 (Swindon Road/Tewkesbury Road), A435 (London Road), A46 (High Street), and A46 (Bath Road). These roads, among others, form the main arterial highway network within Cheltenham, and carry high volumes of road traffic. As a result, these roads tend to become congested, in particular through Cheltenham Town Centre, resulting in increased pollutant concentrations.

In response to these increased concentrations, Cheltenham Borough Council has one AQMA that was declared in September 2020. This AQMA was declared (following the revocation of the borough-wide AQMA) for exceedances of the NO_2 annual mean AQS objective of 40 µg/m^3, and can be viewed on the UK-Air website.

During 2021, concentrations of NO_2 were monitored at 39 diffusion tube sites. One of these was a triplicate site co-located with the automatic analyser (located on St Georges Street), which also measured NO_2.

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[1] Public Health England. Air Quality: A Briefing for Directors of Public Health, 2017

[2] Defra. Air quality and social deprivation in the UK: an environmental inequalities analysis, 2006

[3] Defra. Air quality appraisal: damage cost guidance, July 2021

[4] Public Health England. Estimation of costs to the NHS and social care due to the health impacts of air pollution: summary report, May 2018

In 2021, the maximum NO_2 annual mean concentration within the AQMA was 34.5 µg/m^3 (Site ID: 5). Outside the AQMA boundary, the highest recorded annual concentration was 31.3 µg/m^3 (Site ID: 28). Although the maximum concentration was higher in the AQMA, it is evident that the NO_2 annual mean AQS objective was not exceeded within the AQMA in 2021. This is a trend that has been observed over the past two years, with the NO_2 annual mean limit last being breached within the AQMA in 2019, when a concentration of 46.5 µg/m^3 was recorded (Site ID: 5). Outside of the AQMA, the annual mean limit of 40 µg/m^3 has not been exceeded in the last five years, suggesting that there is no need to amend the current AQMA boundary.

During 2021, the annual mean NO_2 concentration was not greater than 60 µg/m^3 at any diffusion tube site and, therefore, an exceedance of the 1-hour mean objective at any location with the borough is considered unlikely. The automatic monitoring station did not record any hourly concentrations above 200 µg/m^3 during 2021.

Actions to Improve Air Quality

Whilst air quality has improved significantly in recent decades, and will continue to improve due to national policy decisions, there are some areas where local action is needed to improve air quality further.

The 2019 Clean Air Strategy[5] sets out the case for action, with goals to reduce exposure to harmful pollutants. The Road to Zero[6] sets out the approach to reduce exhaust emissions from road transport through a number of mechanisms; this is extremely important given that the majority of Air Quality Management Areas (AQMAs) are designated due to elevated concentrations heavily influenced by transport emissions.

Cheltenham Borough Council's Air Quality Action Plan (AQAP) is under preparation but has not yet been published. The intention of the AQAP is to focus on a number of key actions that are being taken to tackle sources of air pollution. As road traffic is the main source of air pollution, especially within the AQMA, the actions within the AQAP primarily target transport emissions. These actions can be categorised into five key priorities:

[5] Defra. Clean Air Strategy, 2019

[6] DfT. The Road to Zero: Next steps towards cleaner road transport and delivering our Industrial Strategy, July 2018

Priority 1 – Transport: Focusing on areas that Cheltenham Borough Council have direct control over (e.g. planning and procurement of outsourced functions) and areas where measures can be implemented via partnerships with Gloucestershire County Council and others.

Priority 2 – Planning and Infrastructure: Cheltenham Borough Council will work with both developers and partner organisations to ensure that infrastructure, services and community facilities are delivered in a sustainable manner, with the least potential negative impact on air quality.

Priority 3 – Policy Guidance: Existing strategies/policies adopted by Cheltenham Borough Council and Gloucestershire County Councils are key mechanisms to reducing emissions across the borough. To effectively reduce NO_2 concentration, especially within the AQMA, the existing Transport Plans, Freight Strategies, Climate Change Strategies and Cycle Strategies should be revised, taking into account the impact on air quality.

Priority 4 – Public Health and Wellbeing Behavioural Change: The most effective way to achieve a reduction in vehicle numbers is to change the attitudes and behaviour of people towards travel. This ranges from education/raising awareness to schemes which incentivise change.

Priority 5 – Air Quality Monitoring: Cheltenham Borough Council currently monitoring air quality passively via a diffusion tube network and automatically via a continuous analyser. Recently, Cheltenham Borough Council have also introduced nine AQ Mesh Pods to help measure air quality and identify any areas of likely exceedance. This monitoring also assists with determining the success of the measures outlined in the AQAP.

These actions are primarily directed towards reducing vehicle emissions. In a source appointment exercise carried out in 2022 during the preparation of the draft AQAP, vehicles were responsible for 70.4% of the total NO_x concentrations within the AQMA. The majority of this was accounted for by cars (39.4%) and LGVs (20.1%).

Conclusions and Priorities

During 2021, no exceedances of the NO_2 annual mean objective were recorded within or outside of the AQMA boundary. This is the same as in the previous reporting year, meaning that the NO_2 annual mean objective has not been exceeded at any site within Cheltenham Borough Council during both 2020 and 2021. This is likely in part due to changes in travel behaviour as a result of the COVID-19 pandemic. Across the entire diffusion tube network

(to which four new sites were added in 2021), the maximum NO_2 annual mean concentration in 2021 was recorded within the AQMA. The site where this maximum concentration was recorded (Site ID: 5) has also recorded the maximum NO_2 annual mean concentration for the last five years. For the 35 diffusion tube sites that were part of the network in 2020, the annual mean concentration increased at 26 sites in 2021, meaning that compared to 2020, the concentration of NO_2 was higher at 74% of sites in 2021.

As highlighted above, Cheltenham Borough Council are in the process of updating the 2014 AQAP which highlights the priorities for the coming years. These measures primarily relate to reducing vehicle emissions as road transport is the predominant contributor to air pollution within the borough, especially within the AQMA.

Local Engagement and How to get Involved

Cheltenham Borough Council's website provides an opportunity to engage with the public on air quality issues. The website includes information on multiple aspects of air quality, such as current air quality monitoring, declared AQMAs, previous annual status reports, smoke control areas, and open fires/wood burning stoves.

Information on sustainable transport is provided to the public via the Think Works website, which outlines options available across the county of Gloucestershire. These range from local walking maps, cycle routes, public transport journey planners, park and ride facilities, eco driving, car sharing, to information on electrical vehicles.

Local Responsibilities and Commitment

This ASR was prepared by Bureau Veritas on behalf of Cheltenham Borough Council, with the support and agreement of the following officers and departments:

Gareth Jones, Senior Environmental Health Officer

Bernadette Reed, Acting Team Leader, Public Protection

This ASR been provided to the Director of Public Health as a copy for their information and comments.

If you have any comments on this ASR please send them to Environmental Protection at:

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envhealth@cheltenham.gov.uk

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1 Local Air Quality Management

This report provides an overview of air quality in Cheltenham Borough Council during 2021. It fulfils the requirements of Local Air Quality Management (LAQM) as set out in Part IV of the Environment Act (1995) and the relevant Policy and Technical Guidance documents.

The LAQM process places an obligation on all local authorities to regularly review and assess air quality in their areas, and to determine whether or not the air quality objectives are likely to be achieved. Where an exceedance is considered likely the local authority must declare an Air Quality Management Area (AQMA) and prepare an Air Quality Action Plan (AQAP) setting out the measures it intends to put in place in pursuit of the objectives. This Annual Status Report (ASR) is an annual requirement showing the strategies employed by Cheltenham Borough Council to improve air quality and any progress that has been made.

The statutory air quality objectives applicable to LAQM in England are presented in Table E.1.

2 Actions to Improve Air Quality

2.1 Air Quality Management Areas

Air Quality Management Areas (AQMAs) are declared when there is an exceedance or likely exceedance of an air quality objective. After declaration, the authority should prepare an Air Quality Action Plan (AQAP) within 12 months setting out measures it intends to put in place in pursuit of compliance with the objectives.

A summary of AQMAs declared by Cheltenham Borough Council can be found in Table 2.1. The table presents a description of the single AQMA that is currently designated within Cheltenham Borough Council. This AQMA was declared in September 2020 in response to a detailed assessment undertaken during 2019, replacing the now revoked borough-wide AQMA. Appendix D provides a map of the AQMA and also the air quality monitoring locations in relation to the AQMA. The current AQMA has been declared in response to localised exceedances of the NO_2 annual mean objective north of the town centre.

Table 2.1 – Declared Air Quality Management Areas

AQMA Name	Date of Declaration	Pollutants and Air Quality Objectives	One Line Description	Is air quality in the AQMA influenced by roads controlled by National Highways?	Level of Exceedance: Declaration	Level of Exceedance: Current Year	Name and Date of AQAP Publication	Web Link to AQAP
Cheltenham Borough Council AQMA 2020	15/09/2020	NO_2 Annual Mean	Includes properties with a façade fronting onto: High Street from junction of Gloucester Road and Tewkesbury Road to junction of Burton Street; Poole Way; and Swindon Road from junction of Poole Way to St Georges Street	No	46.5 µg/m^3	34.5 µg/m^3	Cheltenham Air Quality Action Plan 2014 (Under Revision)	Cheltenham Air Quality Action Plan 2014 (Under Revision)

☒ **Cheltenham Borough Council confirm the information on UK-Air regarding their AQMA is up to date.**

☒ **Cheltenham Borough Council confirm that all current AQAPs have been submitted to Defra.**

Notes: The 2014 AQAP is currently being revised but was not published at the time of writing this report. Once available, the updated 2022 AQAP will be accessible on the AQAP available downloads section of Cheltenham Borough Council's website.

2.2 Progress and Impact of Measures to address Air Quality in Cheltenham Borough Council

Defra's appraisal of last year's ASR concluded that the report was well structured, detailed and provided the information specified in the guidance. Additionally, the following comments were made:

"The Council continue to review and expand their monitoring network, with the addition of 9 new AQ Mesh monitors and extra diffusion tube locations. This is supported and the Council are encouraged to continue reviewing their monitoring networks and make amendments where they deem appropriate".

- During 2021, Cheltenham Borough Council continued to deploy the AQ Mesh Pods at nine sites around the town and undertook cross-referencing/co-location studies to improve the reliability of data. The diffusion tube network was increased further by four sites in 2021, bringing the total size of the network to 39 sites.

"Currently the Council anticipates that measures in place to tackle NO_2 will inherently tackle $PM_{2.5}$. It is advised that the Council utilise their new AQ Mesh monitors to help inform new measures that will specifically address particulate matter".

- Cheltenham Borough Council have actively used the data from the AQ Mesh Pods to identify the most successful measures to reduce pollutant concentrations at specific locations. For example, a short air quality study was undertaken previously, which identified that borough-wide measures would be more successful than school specific measures. Once the data for this year is corrected, this will be published on Cheltenham Borough Council's website, and any necessary action will be taken.

"In Table 2.1, the level of exceedance for both the declaration and current year are set to 30-33. They should be a real number based on the highest measurement in the AQMA and not a range".

- In the 2021 ASR, the level of exceedance at declaration has been amended to the 2019 maximum value of 46.5 µg/m^3, as although the AQMA was declared in 2020, the AQMA boundary was decided based on a 2019 report. The level of exceedance for the current year has also been corrected to be the maximum value at a single diffusion tube site that is within the AQMA boundary (34.5 µg/m^3, Site ID: 5).

"Trends are well presented in graphs but aside from a review of the AQMA the trends are not discussed a lot. It would be beneficial for the Council to investigate trends further and try to understand the cause of any changes in concentrations".

- The 2021 ASR discusses trends in pollutant concentrations in relation to those within the AQMA and those outside of the AQMA. Trends are discussed with respect to both the previous year and last five years (2017-2021).

Cheltenham Borough Council has taken forward a number of direct measures during the current reporting year of 2021 in pursuit of improving local air quality. Details of all measures completed, in progress or planned are set out in Table 2.2. 17 measures are included within Table 2.2, with the type of measure and the progress Cheltenham Borough Council have made during the reporting year of 2021 presented. Where there have been, or continue to be, barriers restricting the implementation of the measure, these are also presented within Table 2.2. More detail on these measures can be found in their respective Action Plans (see Cheltenham Borough Council 2014 AQAP). Although not available at the time of writing this report, an updated version of the AQAP will be uploaded to the AQAP available downloads section of Cheltenham Borough Council's website once published.

Key completed measures are:

- *Highways Improvements:* A range of highways amendments have taken place, such as the 2-way junction priority changes at Albion Street and Imperial Square, which allows traffic easier access to town centre car parks. Upgrades have also taken place to the traffic signals on St Margaret's Road/A4019 area. These are now running on the new scoot system which is helping to keep traffic moving in the area.
- *Low Emission Bus Fleet:* The current fleet of stagecoach buses now have a black box system, which promotes fuel-efficient driving and anti-idling.
- *Workplace Travel Plans:* A scoping exercise was carried out in 2021 with LiftShare to explore different opportunities for staff to use more sustainable modes of travel for their commute – a Cycle2Work scheme was introduced in 2021.

The following measures outline Cheltenham Borough Council's priorities for the coming years. These measures are predominantly derived from the updated AQAP, which is to be published during 2022, and include the following:

- *Promoting Low Emission Transport:* Working with companies such as Royal Mail to encourage the uptake of low emission vehicles. This is significant as the main access road to the Royal Mail depot (Swindon Road) passes through the AQMA. The uptake

of low emission vehicles is also to be encouraged by offering discounts for parking permits to residents who have an electrical vehicle (EV) within/around the AQMA. Cheltenham Borough Council therefore intend to install more EV charging points.

- *Increasing Public Awareness:* Raise the awareness of the importance of air quality mitigation by working with Gloucestershire County Council's 'behavioural experts' and marketing teams. Cheltenham Borough Council also plan to work with local NHS trusts to raise awareness amongst the most vulnerable groups (i.e. children/elderly).
- *Develop Understanding of Vehicle Movements:* Cheltenham Borough Council are to commission a study to understand the reasoning for vehicle trips through the AQMA.

These measures listed in the updated AQAP can be categorised under 5 priorities:

Priority 1 – Transport: Focusing on areas that Cheltenham Borough Council have direct control over (e.g. planning and procurement of outsourced functions) and areas where measures can be implemented via partnerships with Gloucestershire County Council and others.

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Table 2.2 – Progress on Measures to Improve Air Quality

Measure No.	Measure	Category	Classification	Year Measure Introduced	Estimated / Actual Completion Year	Organisations Involved	Funding Source	Defra AQ Grant Funding	Funding Status	Estimated Cost of Measure	Measure Status	Reduction in Pollutant / Emission from Measure	Key Performance Indicator	Progress to Date	Comments / Barriers to Implementation
1	Highways Improvements	Transport Planning and Infrastructure	Other	2016-18	2018	Gloucestershire County Council / Local Sustainable Transport Fund	GCC	TBC by GCC	TBC by GCC	TBC by GCC	Completed	1 – 2%	Reduction in through traffic and improved access to car parks. Reduced congestion at key junctions.	Phase 3 completed Autumn 2017. 2-way junction priority changes at Albion Street and Imperial Square allowing traffic easier access to town centre car parks.	-
2	Low Emission Bus Fleet	Vehicle Fleet Efficiency	Promoting Low Emission Public Transport	2014-16	Ongoing	Cheltenham Borough Council	Bus Operators	No	TBC by GCC	TBC by GCC	TBC by GCC	0.005%	Bus fleet data.	All Stagecoach vehicles are powered by Euro V and increasingly Euro V1 engines. The current fleet of Stagecoach buses now have a black box system which monitors driving behaviour and promotes more fuel efficient driving and anti-idling.	The main bus fleet company in Cheltenham and Gloucester has the most modern fleet in any area of the UK. Many buses are now Euro 6 compliant.
3	Promotion of Park & Ride	Alternatives to Private Vehicle Use	Bus Based Park & Ride	2014-16	2018	Gloucestershire County Council	GCC	TBC by GCC	TBC by GCC	TBC by GCC	TBC by GCC	0.1 – 1%	Reduced car travel into and out of Cheltenham.	Arle Court Park & Ride has been redesigned, and is currently undergoing a major expansion project to meet increased demand.	-
4	Promotion of Greener Vehicles	Promoting Low Emission Transport	Promoting Alternative Refuelling Infrastructure to Promote Low Emission Vehicles EV Recharging Gas Fuel Recharging	2013-15	Ongoing	Gloucestershire County Council	GCC	TBC by GCC	TBC by GCC	TBC by GCC	TBC by GCC	<0.5%	Charge point usage data.	Roll-out of further electric charging points to continue in liaison with Climate Change team.	The Borough and County Councils continue to encourage EV usage through the installation of charging points in car parks or on-street. Cheltenham and Gloucestershire County Councils will also investigate the potential for differential parking charges for electric and hybrid vehicles in both car parks and on-street. The Borough currently provide free EV charging at its car park charging points.
5	Twenty is Plenty	Promoting Low Emission Transport	Other	2015-17	Ongoing	Cheltenham Borough Council	CBC	No	Not Funded	£100k - £500k	Planning	<0.5%	Traffic count / speed data.	The Cabinet working group are awaiting better guidance on the benefits and implementation.	Assessed in the “Connecting Cheltenham” report (2020). The report was also issued to GCC to help inform their LTP as: “Introduce speed limits in accordance with their current national guidelines and prioritise them based on available evidence – including 20mph zones”.

Measure No.	Measure	Category	Classification	Year Measure Introduced	Estimated / Actual Completion Year	Organisations Involved	Funding Source	Defra AQ Grant Funding	Funding Status	Estimated Cost of Measure	Measure Status	Reduction in Pollutant / Emission from Measure	Key Performance Indicator	Progress to Date	Comments / Barriers to Implementation
6	Increased Car Sharing	Alternatives to Private Vehicle Use	Car & Lift Sharing Schemes	2015	2016	Gloucestershire County Council	GCC	TBC by GCC	TBC by GCC	TBC by GCC	TBC by GCC	0.001%	Traffic data count.	Parish Lift, Carshare Gloucestershire, available via Gloucestershire County Council.	'Parish Lift' a new community car sharing scheme was developed in 2016 to help support social inclusivity and rural accessibility across the Cotswolds Area of Outstanding Natural Beauty (AONB). The scheme compliments the current Carshare Gloucestershire initiative and is being funded by Communities Connected, a Community Interest Company (CIC). Parish Lift is an online platform designed to help match registered users, whether they be drivers of people seeking a 'lift'.
7	Air Quality Information	Public Information	Via the Internet	2015-16	Ongoing	Cheltenham Borough Council	CBC	No	Not Funded	£10k - £50k	Planning	<0.1%	Hit counter on webpage.	Gloucestershire County Council have created a county-wide interactive air quality monitoring data webpage, to be optionally hosted on each Council website.	Currently going through approval, expected to be live in Autumn 2022.
8	Business Travel Grants	Promoting Low Emission Transport	Other	2014-15	2018	Gloucestershire County Council	GCC	TBC by GCC	TBC by GCC	TBC by GCC	Completed	<0.1%	Uptake of grants.	Grants no longer available under this scheme.	In 2016/17, 132 businesses (representing 2,205 staff) were contacted in the Cheltenham parking zone areas to raise awareness of parking enforcement and encourage a shift towards more sustainable modes of travel. 13 businesses (representing 14,865 staff) were engaged in a more intensive site assessment and awareness raising events promoting Thinktravel and sustainable modes.
9	Wayfinding Initiative	Promoting Travel Alternatives	Promotion of Cycling & Walking	2014-15	2017	Gloucestershire County Council	GCC	TBC by GCC	TBC by GCC	TBC by GCC	Completed	<0.1%	-	No further work since completion of this project.	Signage installed.
10	Promotion of Workplace Travel Plans	Promoting Travel Alternatives	Workplace Travel Planning	2015	Unknown	Cheltenham Borough Council	CBC	No	Funded	£10k - £50k	Planning	<0.1%	Whether or not a plan is implemented.	CBC carried out a scoping exercise in 2021 with LiftShare to explore opportunities for staff to use more sustainable modes of travel for their commute. The Cycle2Work scheme was introduced in 2021. A staff travel survey will be conducted in September 2022 to get baseline data.	These will be used to encourage businesses in Cheltenham to develop and implement similar plans.

Measure No.	Measure	Category	Classification	Year Measure Introduced	Estimated / Actual Completion Year	Organisations Involved	Funding Source	Defra AQ Grant Funding	Funding Status	Estimated Cost of Measure	Measure Status	Reduction in Pollutant / Emission from Measure	Key Performance Indicator	Progress to Date	Comments / Barriers to Implementation
11	Air Quality Planning Policy	Policy Guidance and Development Control	Air Quality Planning and Policy Guidance	2015	Unknown	Cheltenham Borough Council	CBC	No	Funded	<£10k	Completed	Unknown but potentially significant	Air Quality Planning Policy adopted.	Air quality is still a material consideration with planning and air quality impacts of all significant developments will be properly assessed and mitigation actions taken where necessary.	Although no specific policy on air quality is adopted as part of the Cheltenham Local Plan (2017-18), air quality is still a material consideration with planning.
12	Traffic Light Appraisal	Traffic Management	Strategic Highway Improvements, Re-prioritising Road Space away from Cars, including Access Management, Selective Vehicle Priority, Bus Priority, and High Vehicle Occupancy Lanes	2015-17	Ongoing	Gloucestershire County Council	GCC	TBC by GCC	TBC by GCC	TBC by GCC	TBC by GCC	Potentially significant in current areas of poor air quality.	Number of traffic lights removed and traffic count/ speed data.	Upgrades of some of the traffic signals have taken place on St Margaret's Road/ A4019 area. These are now running on the new scoot system which is helping to keep traffic moving in the area. GCC are also looking at air quality sensors in the locations, but there has been contractor delays on this.	MOVA is an intelligent traffic signal system, which over time can optimise traffic signals reducing queues and congestion. These are currently being installed following routine upgrades to signal systems in Cheltenham.
13	Bus and Taxi Quality Partnership	Promoting Low Emission Transport	Public Vehicle Procurement – Prioritising Uptake of Low Emission Vehicles.	2016	Ongoing	Gloucestershire County Council	GCC	TBC by GCC	TBC by GCC	TBC by GCC	TBC by GCC	Unknown	Anecdotal.	Gradual uptake as there has been recent requirement for taxis to be updated for accessibility, rather than air quality issues.	No specific partnership but buses and taxis are not allowed to idle at bus stops and taxi ranks in town.
14	Green Planting	Traffic Management	Other	2014-16	Ongoing	Cheltenham Borough Council	CBC	No	Partially Funded	£50k - £100k	Implementation	<0.1%	Number of urban planning applications with green planting schemes adopted.	In 2021, works completed in High Street. Further work required due to planting not thriving.	CBC are delivering the Habitat Cheltenham biodiversity projects.
15	Vehicle Management Signage	Traffic Management	Other	2014-18	Unknown	Cheltenham Borough Council	CBC	No	Not Funded	£50k - £100k	Aborted	<0.1%	Traffic count data.	Bids for funding have been aimed at other projects, so this has not been pursued.	-
16	Cycle Safety Improvements	Transport Planning and Infrastructure	Cycle Network	2014-16	Ongoing	Cheltenham Borough Council	CBC	No	Funded	£50k - £100k	Completed	<0.1%	Number of cyclists / accident & injury statistics.	Barriers to Cycling project completed Autumn 2017 with installation of contraflow cycle lane on Sandford Mill Road.	-
17	Installation of AQ Mesh Pods	Monitoring	Other	2020	Ongoing	Cheltenham Borough Council	CBC	No	Funded	£10k - £50k	Completed	-	Monitoring of $PM_{2.5}$ and NO_x at 9 sites within the borough, which will lead to a greater understanding of the distribution of pollutants, allowing more effective and targeted measures.	Results up to end of 2021 available on CBC website. An "upgrade" in winter 21-22 resulted in a software error that has compromised result accuracy.	Corrected results should be published shortly.

2.3 $PM_{2.5}$ – Local Authority Approach to Reducing Emissions and/or Concentrations

As detailed in Policy Guidance LAQM.PG22 (Chapter 7), local authorities are expected to work towards reducing emissions and/or concentrations of $PM_{2.5}$ (particulate matter with an aerodynamic diameter of 2.5µm or less). There is clear evidence that $PM_{2.5}$ has a significant impact on human health, including premature mortality, allergic reactions, and cardiovascular diseases.

Efforts within the borough are being concentration on monitoring NO_2 levels, with a particular focus on the established AQMA. As primary emissions of both NO_2 and particulates predominantly originate from the same sources, measures implemented to reduce NO_2 levels will also reduce levels of PM_{10} and $PM_{2.5}$.

During 2021, Cheltenham Borough Council continue to deploy the nine AQ Mesh Pods that were installed in August 2020 to monitor real-time localised NO_x, PM_{10} and $PM_{2.5}$. However, due to issues with reliability/accuracy, caused by a software error, the results are not yet available. Once corrected, the data is to be published on Cheltenham Borough Council's website. The monitored results for 2022 are expected to be included in next year's Annual Status Report to provide indicative localised levels of these pollutants.

The current Defra 2021 background maps for Cheltenham Borough Council (2018 based)[7] show that all background concentrations of $PM_{2.5}$ are far below the annual mean AQS objective of 25 µg/m^3. The highest concentration is predicted to be 9.8 µg/m^3 within the grid square (1 x 1 km) with the centroid grid reference of 395500, 222500. This grid square encompasses the north-east of Cheltenham city centre including part of the A46, which is a key arterial route, where the PM secondary fraction (formed from gaseous pollutants) constitutes as the key contributor to $PM_{2.5}$.

The Public Health Outcomes Framework[8] data tool compiled by Public Health England quantifies the mortality burden of $PM_{2.5}$ within England on a county and local authority scale. The fraction of mortality attributable to $PM_{2.5}$ pollution in Cheltenham is 5.6%. This is equivalent to the national average, but higher than the South West average of 5.2%.

[7] Defra Background Mapping (2018 Based). Available at: https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2018

[8] Public Health Outcomes Framework – PHE. Available at: https://fingertips.phe.org.uk/profile/public-health-outcomes-framework/data#page/1/gid/1000043/pat/6/par/E12000009/ati/401/are/E07000078/yrr/1/cid/4/tbm/1

3 Air Quality Monitoring Data and Comparison with Air Quality Objectives and National Compliance

This section sets out the monitoring undertaken within 2021 by Cheltenham Borough Council and how it compares with the relevant air quality objectives. In addition, monitoring results are presented for a five-year period between 2017 and 2021 to allow monitoring trends to be identified and discussed.

3.1 Summary of Monitoring Undertaken

3.1.1 Automatic Monitoring Sites

Cheltenham Borough Council undertook automatic (continuous) monitoring at one site during 2021. Table A.1 in Appendix A shows the details of the automatic monitoring site. This automatic monitor is co-located with three diffusion tubes, allowing a local bias adjustment factor to be derived through a triplicate co-location study. A map showing the location of the monitoring site is provided in Appendix D. Further details on how the monitors are calibrated and how the data has been adjusted are included in Appendix C.

3.1.2 Non-Automatic Monitoring Sites

Cheltenham Borough Council undertook non-automatic (i.e. passive) monitoring of NO_2 at 39 sites during 2021, including one triplicate site, resulting in a total of 41 diffusion tubes being deployed each month. This is an increase of four sites from the 35 that made up the diffusion tube network in the previous reporting year. Table A.2 in Appendix A presents the details of the non-automatic sites.

Maps showing the location of the monitoring sites are provided in Appendix D, with an interactive monitoring map also available of Cheltenham Borough Council's website. Further details on Quality Assurance/Quality Control (QA/QC) for the diffusion tubes, including bias adjustments and any other adjustments applied (e.g. annualisation and/or distance correction), are included in Appendix C.

During 2021, the diffusion tube network was well maintained, with the average data capture being approximately 95%. Across all 39 sites, there was only a total of 20 months data lost, with no site losing more than three months data.

3.2 Individual Pollutants

The air quality monitoring results presented in this section are, where relevant, adjusted for bias, annualisation (where the annual mean data capture is below 75% and greater than 25%), and distance correction. Further details on adjustments are provided in Appendix C.

3.2.1 Nitrogen Dioxide (NO_2)

Table A.3 and Table A.4 in Appendix A compare the ratified and adjusted monitored NO_2 annual mean concentrations for the past five years with the air quality objective of 40µg/m^3. Note that the concentration data presented represents the concentration at the location of the monitoring site, following the application of bias adjustment and annualisation, as required (i.e. the values are exclusive of any consideration to fall-off with distance adjustment).

When compared to the 35 sites that made up the diffusion tube network in 2020, the NO_2 annual mean concentration increased at 26 sites. Therefore, the concentration was higher in 2021 than in 2020 at 74% of sites. During 2021, the maximum NO_2 annual mean concentration was recorded as 34.5 µg/m^3 (Site ID: 5), which is an increase from the maximum NO_2 concentration recorded at the same site in 2020 (32.9 µg/m^3) – this site is within the current AQMA designation. Across the four diffusion tube sites that are located inside the AQMA, the average NO_2 annual mean concentration in 2021 was 29.8 µg/m^3. The NO_2 annual mean AQS objective of 40 µg/m^3 has not been exceeded at any diffusion tube site within the AQMA boundary over the last two years. Across the 35 diffusion tube sites that are located outside of the AQMA, the average NO_2 annual mean concentration in 2021 was 23.0 µg/m^3, with the maximum concentration being 31.3 µg/m^3 (Site ID: 28). Over the last five years, the AQS annual mean objective for NO_2 has not been exceeded at any site outside of the AQMA, therefore there is no need to amend the current AQMA boundary.

For diffusion tubes, the full 2021 dataset of monthly mean values is provided in Appendix B. Note that the concentration data presented in Table B.1 includes distance corrected values, only where relevant.

The automatic monitoring site located on St Georges Street (CM1) recorded an NO_2 annual mean concentration of 25.3 µg/m^3. As the data capture at this automatic monitoring site was 98.6%, the results are highly reflective of the NO_2 concentration during 2021. This is an increase of 0.6 µg/m^3 from the 24.7 µg/m^3 recorded in the previous reporting year.

Figure A.2 – Trends in Annual Mean NO_2 Concentrations (Sites 3-14)

Figure A.3 – Trends in Annual Mean NO_2 Concentrations (Sites 15-25)

Figure A.4 – Trends in Annual Mean NO_2 Concentrations (Sites 26-32)

Figure A.5 – Trends in Annual Mean NO_2 Concentrations (Sites 34-40)

Figure A.6 – Trends in Annual Mean NO_2 Concentrations (Sites 41-47)

Table A.5 in Appendix A compares the ratified continuous monitored NO_2 hourly mean concentrations for the past five years with the air quality objective of 200 µg/m^3, not to be exceeded more than 18 times per year.

In 2021, the NO_2 hourly mean objective of 200 µg/m^3 was not exceeded on any occasion, with the maximum hourly concentration recorded at the automatic monitoring site (CM1) being 101 µg/m^3. Furthermore, as no single diffusion tube site recorded an annual mean concentration above 60 µg/m^3, it can be suggested that the 1-hour mean objective was not likely to be breached at any other site.

With respect to data processing, the data presented within the following sections has been bias adjusted using the local bias adjustment factor calculated at the automatic monitoring site (CM1), where three diffusion tubes (Site ID: 7/8/9) are co-located. In terms of data capture, all diffusion tube sites had sufficient data capture to not require annualisation in 2021. This is in contrast to the previous year, where the annual mean concentration from one site required annualisation.

Appendix A: Monitoring Results

Table A.1 – Details of Automatic Monitoring Sites

Site ID	Site Name	Site Type	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Pollutants Monitored	In AQMA? Which AQMA?	Monitoring Technique	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Inlet Height (m)
CM1	St Georges Street	Kerbside	394760	222878	NO_2	YES; Cheltenham Borough Council Air Quality Management Area 2020	Chemiluminescent	0	2.4	1.3

Notes:

(1) 0m if the monitoring site is at a location of exposure (e.g. installed on the façade of a residential property).

(2) N/A if not applicable

Table A.2 – Details of Non-Automatic Monitoring Sites

Diffusion Tube ID	Site Name	Site Type	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Pollutants Monitored	In AQMA? Which AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube Co-located with a Continuous Analyser?	Tube Height (m)
3	Ladies College	Roadside	394621	222215	NO_2	No	0.0	5.7	No	2.9
4	2 Gloucester Road	Roadside	394237	223006	NO_2	Yes	2.0	0.5	No	2.9
5	422 High St	Roadside	394350	222923	NO_2	Yes	0.0	1.8	No	2.9
6	New Rutland Court	Roadside	394738	222888	NO_2	Yes	0.0	1.9	No	2.9
7, 8, 9	Co-location	Roadside	394760	222878	NO_2	No	1.0	2.4	Yes	1.3
10	2 Swindon Road	Kerbside	394830	222845	NO_2	No	1.0	2.1	No	2.9
11	Portland Street	Roadside	395110	222670	NO_2	No	1.0	1.6	No	3.1
12	Winchcombe St./Fairview	Roadside	395210	222618	NO_2	No	1.0	3.2	No	3.1
13	54 Albion Street	Kerbside	395207	222465	NO_2	No	2.0	1.2	No	2.8
14	2 London Road	Roadside	395362	222000	NO_2	No	1.0	3.0	No	2.9
15	YMCA - High St	Roadside	395182	222183	NO_2	No	5.0	1.9	No	3.0
16	8a Bath Road	Roadside	395146	222149	NO_2	No	0.0	2.0	No	3.0
18	81 London Road	Roadside	395660	221670	NO_2	No	0.0	4.7	No	2.7
19	264 Gloucester Road	Roadside	393296	222170	NO_2	No	0.0	0.8	No	2.5
20	340 Gloucester Road	Roadside	392912	221862	NO_2	No	0.0	3.6	No	2.8
22	Hatherley Lane	Roadside	391178	221641	NO_2	No	0.0	3.7	No	2.8
25	50 St Georges Street	Roadside	394708	222763	NO_2	No	2.3	0.4	No	3.0
26	22 St Pauls Road	Roadside	394902	223004	NO_2	No	1.5	1.1	No	2.9
27	St Lukes College Road	Roadside	395156	221866	NO_2	No	2.3	0.6	No	2.9
28	Princess Elizabeth Way North	Roadside	393081	223643	NO_2	No	1.0	1.2	No	2.9
29	Princess Elizabeth Way South	Roadside	392066	222540	NO_2	No	9.5	1.3	No	2.8
30	Clarence Parade Alternative	Roadside	394810	222439	NO_2	No	1.0	0.4	No	2.8

Diffusion Tube ID	Site Name	Site Type	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Pollutants Monitored	In AQMA? Which AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube Co-located with a Continuous Analyser?	Tube Height (m)
31	Gloucester Rd School	Kerbside	393906	222873	NO_2	No	12.5	0.3	No	2.9
32	Gloucester Rd / Stoneville St	Roadside	394180	222982	NO_2	No	1.6	1.9	No	2.9
33	48 Swindon Road	Roadside	394635	222928	NO_2	Yes	2.0	2.2	No	3.3
34	Elvis Villas	Roadside	394980	222735	NO_2	No	0.0	2.2	No	2.9
35	Berkeley Place	Roadside	395340	222071	NO_2	No	2.8	1.9	No	3.2
36	Sandford Park Alehouse	Roadside	395300	222027	NO_2	No	6.5	1.9	No	3.4
37	A40 PE Way Roundabout	Roadside	391869	222084	NO_2	No	19.3	6.0	No	2.9
38	Gloucester Rd (Benhall)	Roadside	392267	222009	NO_2	No	22.0	4.0	No	2.0
39	Norwood / Gratton Rd	Roadside	394473	220935	NO_2	No	5.8	1.5	No	3.0
40	Opp. Wokswagon London Rd	Roadside	395862	221424	NO_2	No	8.4	2.2	No	2.8
41	170 Prestbury Rd	Roadside	395980	223322	NO_2	No	1.3	1.7	No	2.9
42	Prestbury Rd / Portland Square	Kerbside	395394	222875	NO_2	No	2.7	0.8	No	2.8
43	Boots Corner	Urban Centre	394954	222511	NO_2	No	2.1	3.3	No	2.8
44	Warden Hill School	Suburban	393262	220358	NO_2	No	6.1	1.6	No	2.9
45	Farmfield Road	Suburban	393010	220348	NO_2	No	6.7	2.1	No	2.8
46	Telstar Way	Kerbside	391507	221978	NO_2	No	7.8	1.0	No	2.6
47	Prestbury High Street	Roadside	397010	223887	NO_2	No	0.0	1.8	No	2.8

Notes:

(1) 0m if the monitoring site is at a location of exposure (e.g. installed on the façade of a residential property).

(2) N/A if not applicable.

Table A.3 – Annual Mean NO_2 Monitoring Results: Automatic Monitoring (µg/m^3)

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2021 (%) (2)	2017	2018	2019	2020	2021
CM1	394760	222878	Kerbside	98.6	98.6	36.0	32.7	36.0	24.7	25.3

☒ **Annualisation has been conducted where data capture is <75% and >25% in line with LAQM.TG16.**

☒ **Reported concentrations are those at the location of the monitoring site (annualised, as required), i.e. prior to any fall-off with distance correction.**

Notes:

The annual mean concentrations are presented as µg/m^3.

Exceedances of the NO_2 annual mean objective of 40µg/m^3 are shown in **bold**.

All means have been "annualised" as per LAQM.TG16 if valid data capture for the full calendar year is less than 75%. See Appendix C for details.

Concentrations are those at the location of monitoring and not those following any fall-off with distance adjustment.

(1) Data capture for the monitoring period, in cases where monitoring was only carried out for part of the year.

(2) Data capture for the full calendar year (e.g. if monitoring was carried out for 6 months, the maximum data capture for the full calendar year is 50%).

Table A.4 – Annual Mean NO_2 Monitoring Results: Non-Automatic Monitoring (µg/m^3)

Diffusion Tube ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) [1]	Valid Data Capture 2021 (%) [2]	2017	2018	2019	2020	2021
3	394621	222215	Roadside	98.1	98.1	32.8	27.5	29.6	20.8	21.8
4	394237	223006	Roadside	88.5	88.5	**45.4**	**41.2**	**43.1**	32.3	31.5
5	394350	222923	Roadside	98.1	98.1	**49.9**	**45.2**	**46.5**	32.9	34.5
6	394738	222888	Roadside	98.1	98.1	**41.6**	37.9	**40.3**	30.3	30.0
7, 8, 9	394760	222878	Roadside	98.1	98.1	36.4	32.9	35.1	24.8	25.3
10	394830	222845	Kerbside	90.4	90.4	39.4	35.6	39.2	26.6	27.0
11	395110	222670	Roadside	88.5	88.5	35.9	32.6	34.1	24.1	24.6
12	395210	222618	Roadside	98.1	98.1	32.8	31.8	34.4	24.5	26.1
13	395207	222465	Kerbside	90.4	90.4	34.8	31.3	30.4	22.3	22.0
14	395362	222000	Roadside	98.1	98.1	37.1	37.4	37.4	27.5	28.5
15	395182	222183	Roadside	98.1	98.1	31.9	29.1	28.5	20.3	23.1
16	395146	222149	Roadside	98.1	98.1	38.0	34.5	34.4	25.1	27.0
18	395660	221670	Roadside	98.1	98.1	38.4	37.3	37.6	28.4	29.0
19	393296	222170	Roadside	90.4	90.4	34.4	30.6	33.4	23.6	23.9
20	392912	221862	Roadside	98.1	98.1	38.6	35.3	36.2	25.5	24.7
22	391178	221641	Roadside	71.2	71.2	-	34.9	33.4	25.2	25.0
25	394708	222763	Roadside	98.1	98.1	-	31.9	31.6	21.5	22.4
26	394902	223004	Roadside	98.1	98.1	-	29.0	31.3	22.7	22.6
27	395156	221866	Roadside	98.1	98.1	-	24.8	27.6	17.7	18.7
28	393081	223643	Roadside	98.1	98.1	-	38.4	38.2	31.2	31.3
29	392066	222540	Roadside	98.1	98.1	-	31.2	33.7	24.7	25.3
30	394810	222439	Roadside	98.1	98.1	-	-	31.6	22.1	22.8
31	393906	222873	Kerbside	98.1	98.1	-	-	-	24.3	24.5
32	394180	222982	Roadside	98.1	98.1	-	-	-	25.3	26.8
33	394635	222928	Roadside	82.7	82.7	-	-	-	21.5	23.1
34	394980	222735	Roadside	98.1	98.1	-	-	-	24.5	25.0
35	395340	222071	Roadside	98.1	98.1	-	-	-	19.1	20.2
36	395300	222027	Roadside	98.1	98.1	-	-	-	27.7	28.2
37	391869	222084	Roadside	98.1	98.1	-	-	-	23.9	22.2

Diffusion Tube ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) [1]	Valid Data Capture 2021 (%) [2]	2017	2018	2019	2020	2021
38	392267	222009	Roadside	98.1	98.1	-	-	-	21.6	22.1
39	394473	220935	Roadside	98.1	98.1	-	-	-	16.9	17.8
40	395862	221424	Roadside	82.7	82.7	-	-	-	21.7	21.7
41	395980	223322	Roadside	98.1	98.1	-	-	-	14.8	15.8
42	395394	222875	Kerbside	98.1	98.1	-	-	-	23.6	22.8
43	394954	222511	Urban Centre	98.1	98.1	-	-	-	20.3	23.5
44	393262	220358	Suburban	98.1	98.1	-	-	-	-	10.3
45	393010	220348	Suburban	98.1	98.1	-	-	-	-	10.0
46	391507	221978	Kerbside	84.6	84.6	-	-	-	-	18.3
47	397010	223887	Roadside	76.9	76.9	-	-	-	-	22.9

☒ **Annualisation has been conducted where data capture is <75% and >25% in line with LAQM.TG16.**

☒ **Diffusion tube data has been bias adjusted.**

☒ **Reported concentrations are those at the location of the monitoring site (bias adjusted and annualised, as required), i.e. prior to any fall-off with distance correction.**

Notes:

The annual mean concentrations are presented as µg/m^3.

Exceedances of the NO_2 annual mean objective of 40µg/m^3 are shown in **bold**.

NO_2 annual means exceeding 60µg/m^3, indicating a potential exceedance of the NO_2 1-hour mean objective are shown in **bold and underlined**.

Means for diffusion tubes have been corrected for bias. All means have been "annualised" as per LAQM.TG16 if valid data capture for the full calendar year is less than 75%. See Appendix C for details.

Concentrations are those at the location of monitoring and not those following any fall-off with distance adjustment.

(1) Data capture for the monitoring period, in cases where monitoring was only carried out for part of the year.

(2) Data capture for the full calendar year (e.g. if monitoring was carried out for 6 months, the maximum data capture for the full calendar year is 50%).

Figure A.1 – Trends in Annual Mean NO_2 Concentrations (Within AQMA)

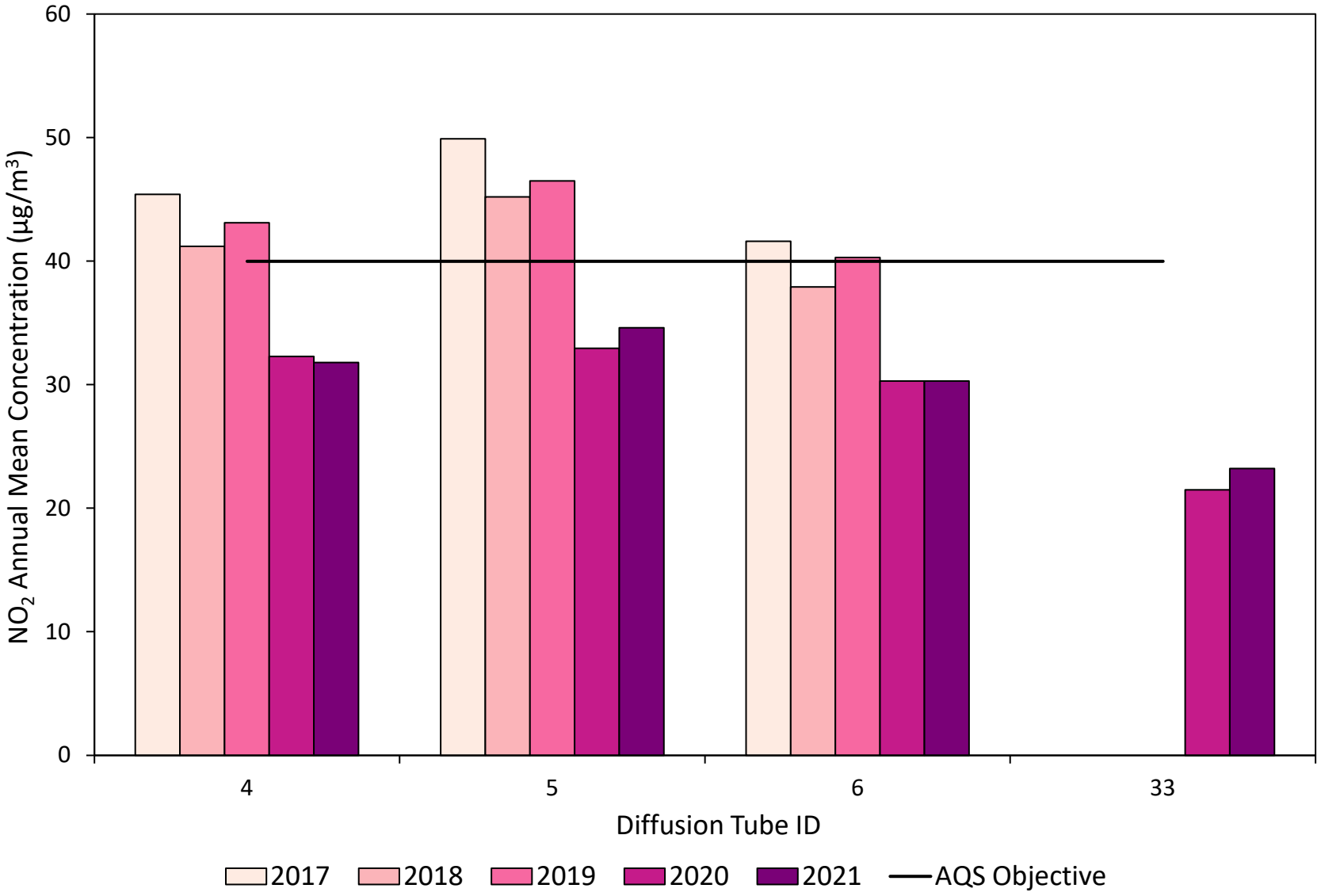


Figure A.2 – Trends in Annual Mean NO_2 Concentrations (Sites 3-14)

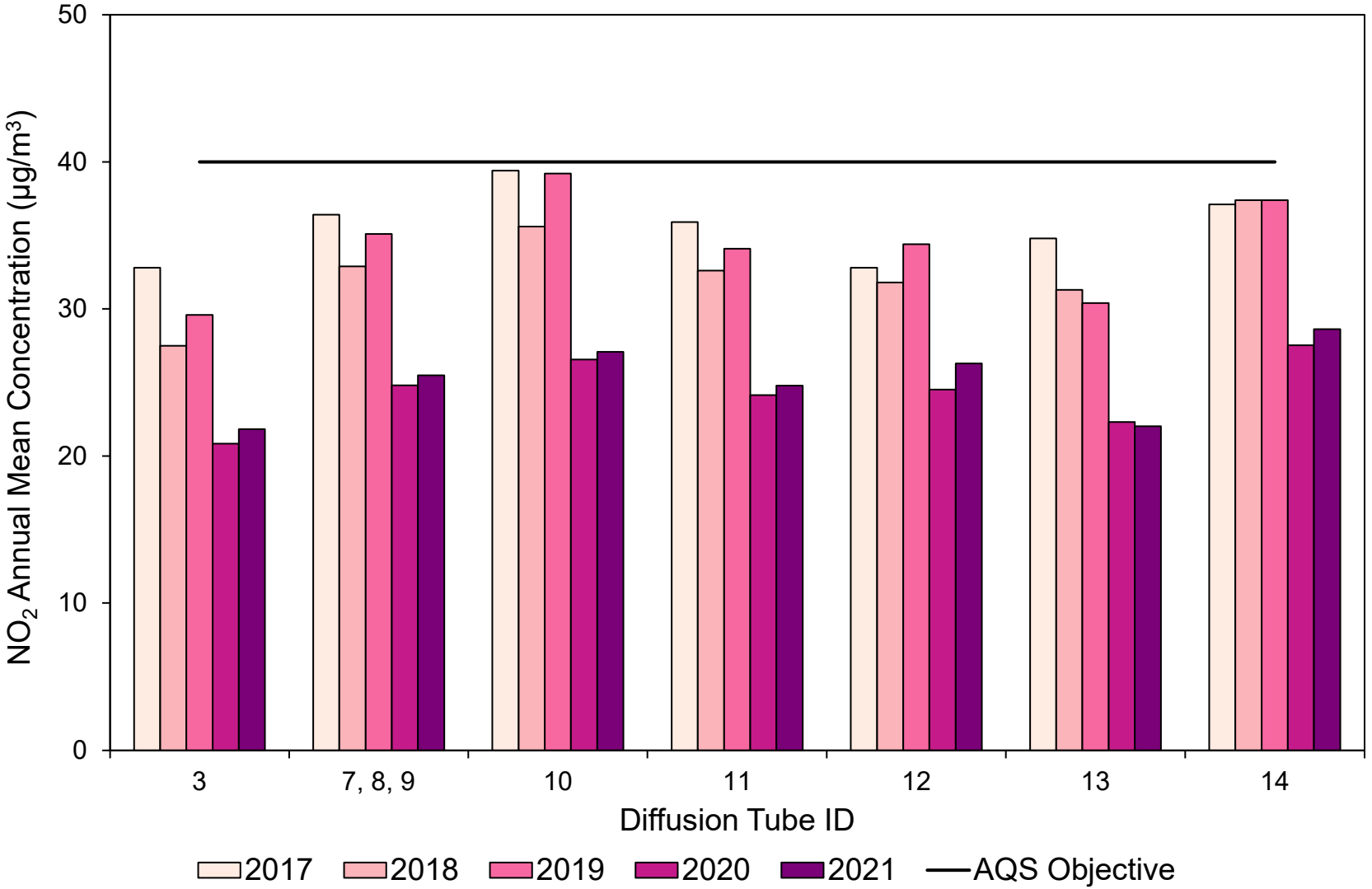


Figure A.3 – Trends in Annual Mean NO_2 Concentrations (Sites 15-25)

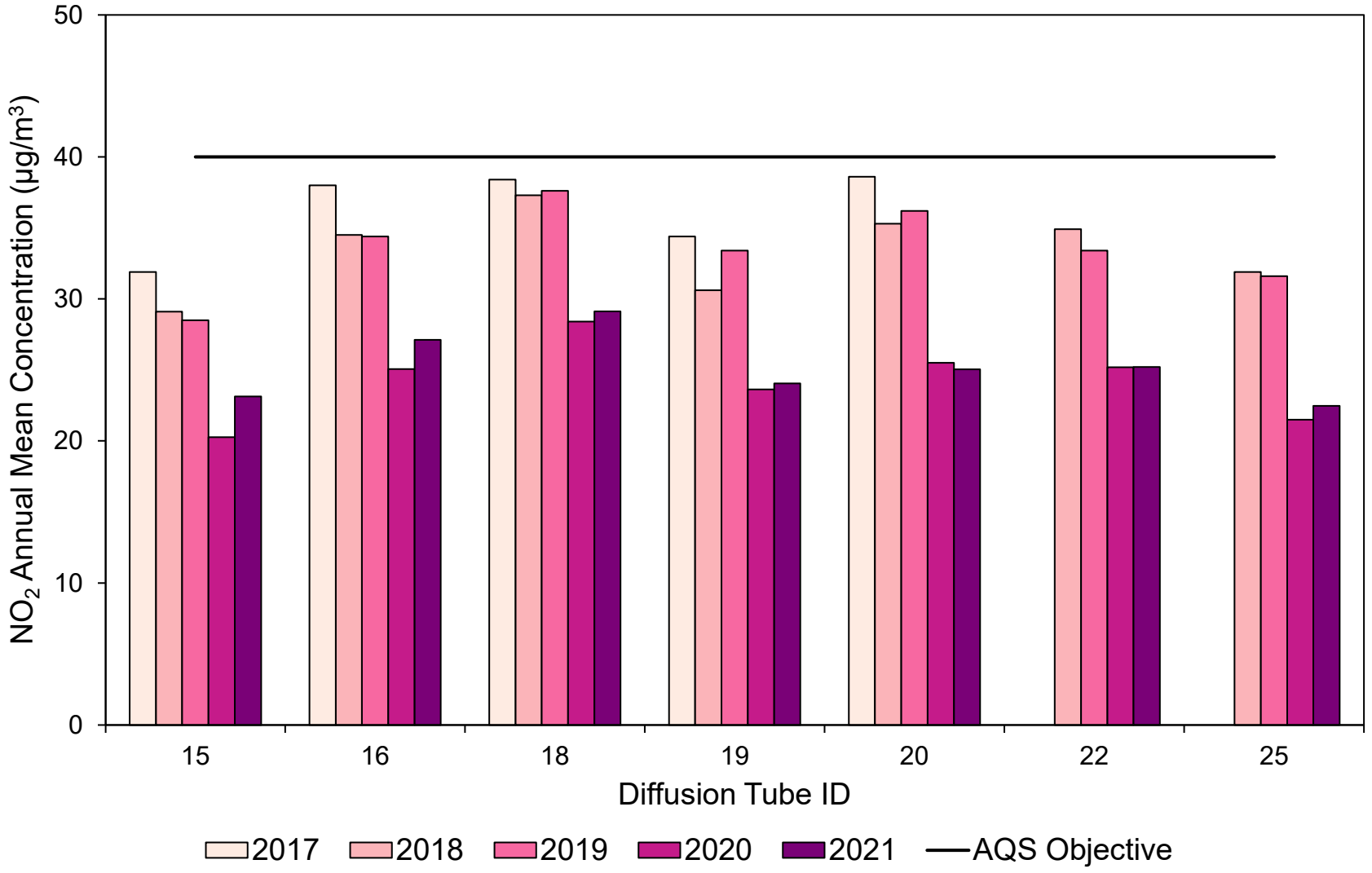


Figure A.4 – Trends in Annual Mean NO_2 Concentrations (Sites 26-32)

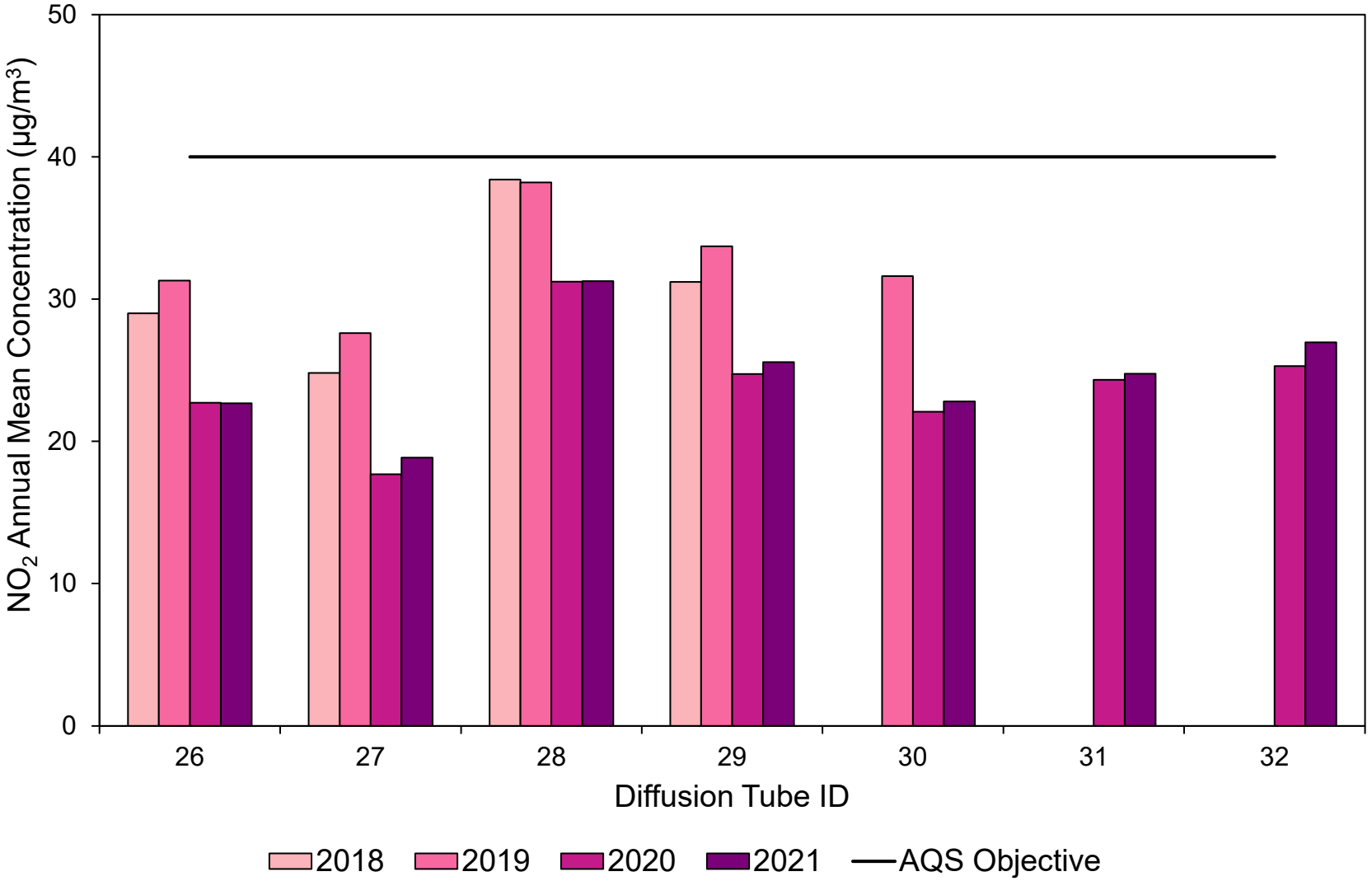


Figure A.5 – Trends in Annual Mean NO_2 Concentrations (Sites 34-40)

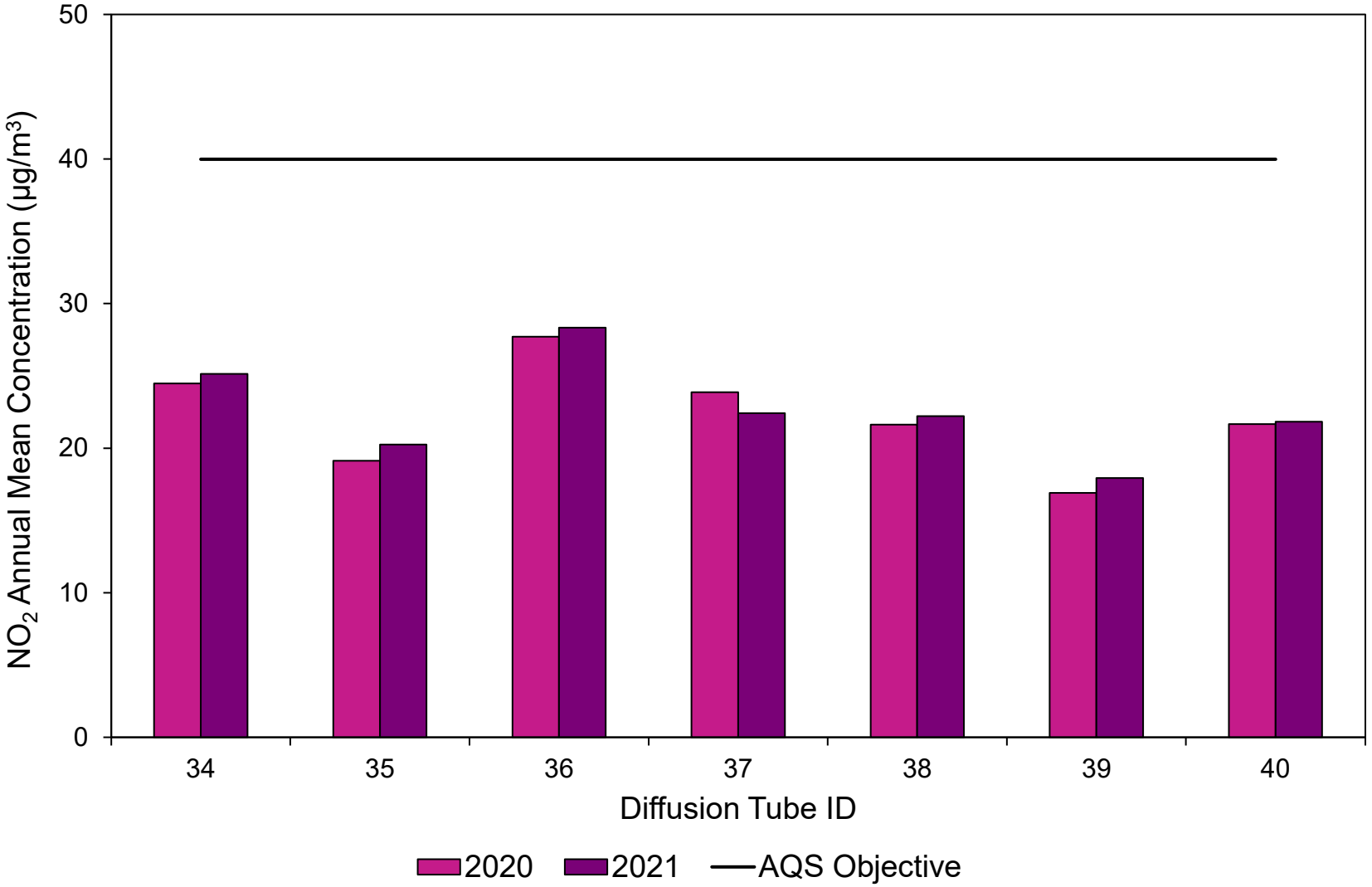


Figure A.6 – Trends in Annual Mean NO_2 Concentrations (Sites 41-47)

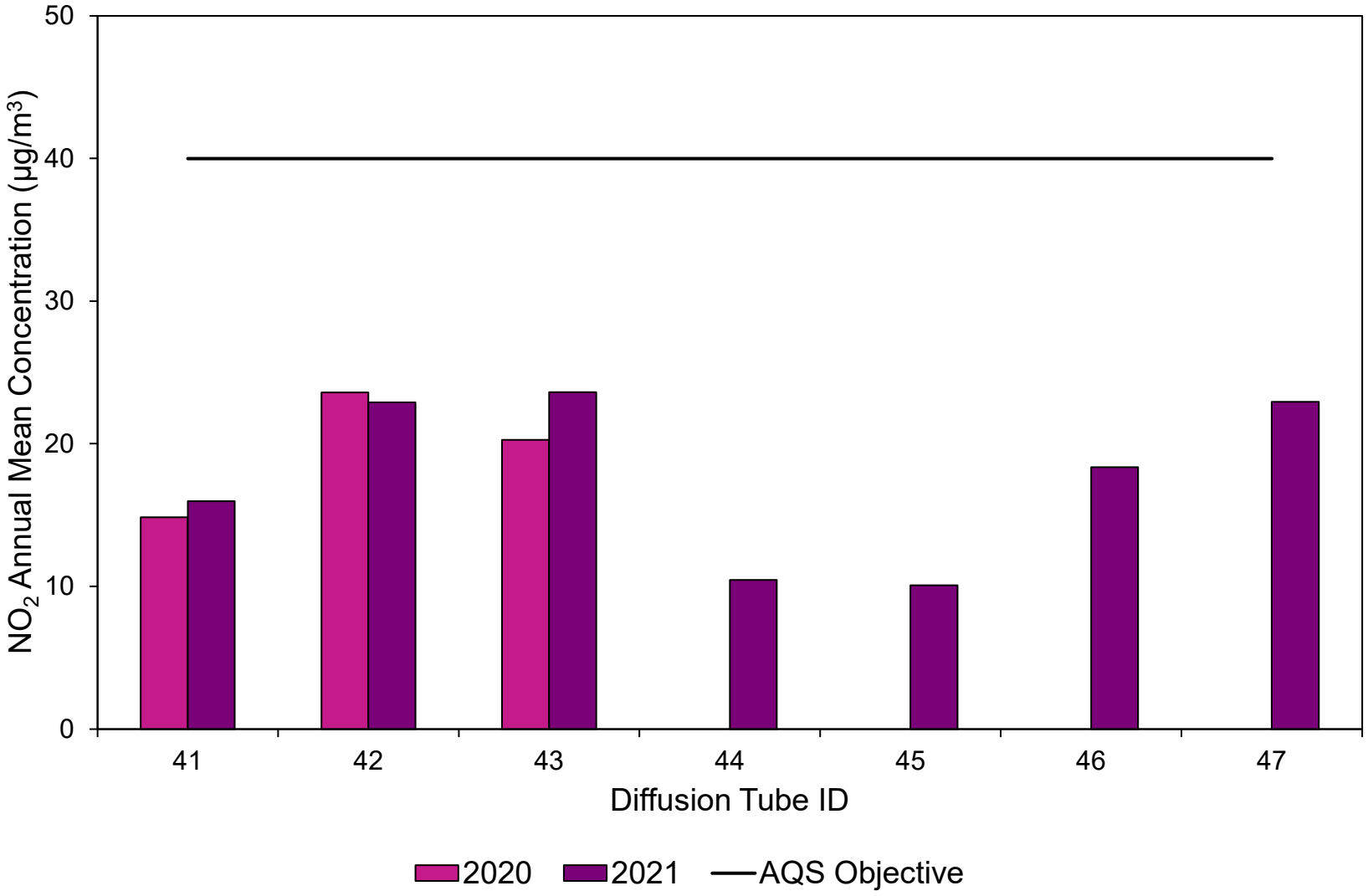


Table A.5 – 1-Hour Mean NO_2 Monitoring Results, Number of 1-Hour Means > 200µg/m^3

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2021 (%) (2)	2017	2018	2019	2020	2021
CM1	394760	222878	Kerbside	98.6	98.6	0	0	0	0	0

Notes:

Results are presented as the number of 1-hour periods where concentrations greater than 200µg/m^3 have been recorded.

Exceedances of the NO_2 1-hour mean objective (200µg/m^3 not to be exceeded more than 18 times/year) are shown in **bold**.

If the period of valid data is less than 85%, the 99.8th percentile of 1-hour means is provided in brackets.

(1) Data capture for the monitoring period, in cases where monitoring was only carried out for part of the year.

(2) Data capture for the full calendar year (e.g. if monitoring was carried out for 6 months, the maximum data capture for the full calendar year is 50%.

Appendix B: Full Monthly Diffusion Tube Results for 2021

Table B.1 – NO_2 2021 Diffusion Tube Results (µg/m^3)

DT ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean: Raw Data	Annual Mean: Annualised and Bias Adjusted (0.89)	Annual Mean: Distance Corrected to Nearest Exposure	Comment
3	394621	222215	24.8	21.8	24.3	20.8	24.8	20.7	23.6	20.9	27.9	26.6	32.7	25.6	24.5	21.8		
4	394237	223006	45.1	36.5	39.0		33.3	27.2	33.0	27.8	40.2	34.5	42.0	34.4	35.7	31.8		
5	394350	222923	42.1	38.8	37.2	36.8	36.7	29.1	39.7	32.4	45.8	41.0	48.8	38.3	38.9	34.6		
6	394738	222888	40.2	36.8	35.8	29.8	33.8	28.0	32.0	27.2	35.8	33.2	41.9	34.1	34.0	30.3		
7	394760	222878	29.6	29.7	28.4	27.1	30.1	24.9	-	21.6	33.1	28.3	34.1	27.3	-	-		Triplicate Site with 7, 8 and 9 - Annual data provided for 9 only
8	394760	222878	31.8	30.6	30.0	27.2	29.6	21.8	-	22.8	33.2	28.7	37.1	27.4	-	-		Triplicate Site with 7, 8 and 9 - Annual data provided for 9 only
9	394760	222878	31.7	30.3	-	27.4	31.4	21.9	26.9	25.0	31.0	27.8	32.0	28.0	28.6	25.5		Triplicate Site with 7, 8 and 9 - Annual data provided for 9 only
10	394830	222845	28.5	34.2	-	29.4	29.7	25.3	30.1	25.0	36.1	29.8	36.9	29.9	30.4	27.1		
11	395110	222670	32.3	31.5	29.2	-	26.0	20.3	27.8	23.3	31.2	25.9	31.6	27.2	27.8	24.8		
12	395210	222618	33.8	31.4	28.6	24.8	28.3	21.6	27.5	21.8	34.2	33.9	39.0	29.7	29.5	26.3		
13	395207	222465	24.4	-	25.5	25.5	22.7	21.8	23.3	20.6	26.1	24.0	33.1	25.2	24.7	22.0		
14	395362	222000	33.8	32.2	33.3	34.3	32.5	29.6	30.3	31.3	39.3	30.0	28.0	31.2	32.2	28.6		
15	395182	222183	25.8	25.2	25.2	25.2	24.7	21.0	26.1	22.9	31.5	25.9	32.1	26.4	26.0	23.1		
16	395146	222149	33.1	29.2	28.8	27.3	30.9	25.6	28.0	26.9	37.8	31.3	36.8	29.8	30.5	27.1		
18	395660	221670	36.7	35.6	33.4	31.0	30.9	25.6	30.4	27.3	35.8	34.7	37.7	33.4	32.7	29.1		
19	393296	222170	30.9	24.9	29.8	24.7	23.3	21.2	25.3	-	28.1	26.7	34.4	27.9	27.0	24.1		
20	392912	221862	33.9	31.5	30.3	28.6	23.2	23.4	25.9	24.3	33.4	30.4	35.6	17.2	28.1	25.0		
22	391178	221641	32.3	33.1	-	-	21.5	25.3	24.7	23.2	28.4	-	37.4	29.0	28.3	25.2		
25	394708	222763	25.5	26.8	24.4	25.7	26.0	19.3	25.0	20.9	26.6	25.4	31.3	25.9	25.2	22.5		
26	394902	223004	28.8	26.1	26.4	24.4	24.0	21.0	22.4	18.9	26.1	25.8	35.3	26.5	25.5	22.7		
27	395156	221866	26.3	22.3	21.8	20.2	20.4	15.8	18.8	15.9	21.6	21.3	28.7	21.1	21.2	18.9		
28	393081	223643	32.0	38.9	37.3	39.3	32.0	31.3	35.7	30.1	40.3	34.4	37.8	32.4	35.1	31.3		

DT ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean: Raw Data	Annual Mean: Annualised and Bias Adjusted (0.89)	Annual Mean: Distance Corrected to Nearest Exposure	Comment
29	392066	222540	38.7	32.2	30.5	30.6	22.1	23.3	24.8	24.2	30.4	26.4	34.8	26.8	28.7	25.6		
30	394810	222439	26.5	23.0	25.8	22.8	22.6	21.4	24.9	22.0	26.4	27.8	36.9	27.2	25.6	22.8		
31	393906	222873	33.2	28.6	32.2	26.9	27.3	20.8	23.2	22.7	27.3	26.5	36.7	28.1	27.8	24.7		
32	394180	222982	34.0	31.8	32.3	29.4	23.6	25.7	29.1	27.1	31.3	29.7	38.5	31.0	30.3	27.0		
33	394635	222928	28.6	-	27.7	26.0	-	22.1	23.6	19.5	28.6	27.1	31.4	26.2	26.1	23.2		
34	394980	222735	31.6	28.4	30.1	25.0	26.5	21.9	27.6	23.4	30.2	29.4	36.0	28.7	28.2	25.1		
35	395340	222071	26.1	24.5	25.1	23.2	20.3	16.6	20.2	17.6	21.5	21.7	31.6	24.6	22.8	20.3		
36	395300	222027	37.1	30.5	32.2	29.0	26.8	23.9	29.5	28.5	35.3	33.3	43.5	32.4	31.8	28.3		
37	391869	222084	31.3	29.5	26.7	22.3	22.9	18.8	21.7	21.1	28.7	24.0	31.0	24.4	25.2	22.4		
38	392267	222009	29.3	25.4	26.6	22.1	21.3	18.6	23.3	19.6	28.4	27.0	32.7	25.1	25.0	22.2		
39	394473	220935	21.0	22.4	23.1	21.8	17.1	17.0	15.0	18.7	19.6	18.3	27.6	20.2	20.1	17.9		
40	395862	221424	27.3	26.1	27.7	25.4	-	20.2	18.1	22.4	29.7	23.7	-	24.9	24.5	21.8		
41	395980	223322	22.2	17.5	19.4	15.8	12.7	12.4	13.3	21.4	15.7	17.5	28.6	18.9	17.9	16.0		
42	395394	222875	32.5	27.8	28.9	25.9	20.8	16.5	22.4	12.6	28.4	27.4	36.8	28.8	25.7	22.9		
43	394954	222511	27.6	26.6	28.4	25.6	21.9	22.8	27.5	25.6	26.0	23.8	35.9	26.7	26.5	23.6		
44	393262	220358	14.9	13.1	14.4	11.3	7.8	8.0	8.6	7.7	10.0	11.0	20.9	13.1	11.7	10.4		
45	393010	220348	13.4	13.1	13.7	10.7	8.3	8.8	8.5	8.1	10.3	10.2	18.5	12.2	11.3	10.1		
46	391507	221978	-	-	25.9	20.5	16.4	13.8	17.2	15.5	21.8	23.0	29.6	22.5	20.6	18.3		
47	397010	223887	-	-	-	23.2	23.9	21.0	23.6	21.4	30.8	29.0	33.4	25.7	25.8	22.9		

☒ **All erroneous data has been removed from the NO_2 diffusion tube dataset presented in Table B.1.**

☒ **Annualisation has been conducted where data capture is <75% and >25% in line with LAQM.TG16.**

☒ **Local bias adjustment factor used.**

☐ **National bias adjustment factor used.**

☒ **Where applicable, data has been distance corrected for relevant exposure in the final column.**

☒ **Cheltenham Borough Council confirm that all 2021 diffusion tube data has been uploaded to the Diffusion Tube Data Entry System.**

Notes:

Exceedances of the NO_2 annual mean objective of 40µg/m^3 are shown in **bold**.

NO_2 annual means exceeding 60µg/m^3, indicating a potential exceedance of the NO_2 1-hour mean objective are shown in **bold and underlined**.

See Appendix C for details on bias adjustment and annualisation.

Appendix C: Supporting Technical Information / Air Quality Monitoring Data QA/QC

New or Changed Sources Identified Within Cheltenham Borough Council During 2021

Cheltenham Borough Council has not identified any new sources relating to air quality within the reporting year of 2021.

Additional Air Quality Works Undertaken by Cheltenham Borough Council During 2021

During 2021, Cheltenham Borough Council continued to work with Bureau Veritas to formalise the update to the 2014 AQAP. This new action plan identifies five key areas for action, ranging from transport, planning and infrastructure, policy guidance, behavioural change, to air quality monitoring. These actions outline the measures that are to be put in place by Cheltenham Borough Council over the next five years.

As in the previous reporting year, AQ Mesh Pods were continued to be deployed during 2021 at nine sites around the town. In spring, Cheltenham Borough Council underwent a cross-referencing and co-locating study of each AQ Mesh site to improve the reliability of the data. However, shortly after the sensors were reaching the end of their reliable life, and started to fail. Cheltenham Borough Council therefore changed the servicing and data handling contracts to the original manufactures of the pods, who replaced numerous failed and failing sensors. Whilst this got the units working consistently, they were providing results of dubious accuracy over the first few months of use. Cheltenham Borough Council are now carrying out more co-locating and cross-referencing to other data sources and, as a result, an error was found in the supplier's software which was skewing the results. The supplier is now fixing this problem across their network, with the roll out of the fixed software expected in the next month. Once corrected, the results of the AQ Mesh Pods will be published on Cheltenham Borough Council's website. These AQ Mesh Pods highlight that Cheltenham Borough Council are continuously looking to expand the monitoring network, so that any exceedances, or likely exceedances, can be identified and acted upon.

QA/QC of Diffusion Tube Monitoring

During 2021, the diffusion tubes used by Cheltenham Borough Council were supplied and analysed by Gradko International, using the 20% TEA in water preparation method. Gradko International, a UKAS accredited laboratory, participate in the AIR-PT scheme for NO_2 diffusion tube analysis and Annual Field Intercomparison Exercise. These provide strict criteria relating to performance that participating laboratories must meet, thereby ensuring that the reported NO_2 concentrations are of a high calibre. During 2021, the AIR-PT results were from the rounds AIR-PT AR042 (January – February), AIR-PT AR043 (May – June), AIR-PT AR045 (July – August) and AIR-PT AR046 (September – October). For all of these rounds, Gradko International were awarded a score of 100% – the percentage score is an indication of the results deemed satisfactory based upon the z-score of < ±2.

For all observations in 2021, the precision of NO_2 diffusion tubes that were supplied by Gradko International (using the 20% TEA in water preparation method) was classified as 'good', with no observation recording 'bad' precision. The precision is an indication of the laboratory's performance and consistency in both the preparation, analysis and handling of diffusion tubes. Full details of the precision summary results are available here.

The diffusion tubes deployed during 2021 were done so in line with the national monitoring calendar (±2 days). However, the first tube on date was slightly later from when that of the suggested calendar, with the January diffusion tubes being deployed on the 13th, instead of the 6th. After the January deployment, the national monitoring calendar was followed for the rest of the monitoring year.

Diffusion Tube Annualisation

No single diffusion tube site required annualisation during 2021, with no site missing more than three months of data. This is because the LAQM technical guidance states that:

"For any monitoring sites with fewer than nine months' worth of data, it is necessary to perform annualisation".

It should however be noted that although diffusion tube Site 22 had a data capture of 71.2%, the data has not been annualised. This is because this percentage is the amount of data captured for the annual monitoring period calendar carried out in line with the LAQM calendar, not the number of months that data is available for. As shown in Table B.1, there was still nine months of data available, therefore annualisation was not required despite having a data capture of 71.2%.

Diffusion Tube Bias Adjustment Factors

The diffusion tube data presented within the 2021 ASR have been corrected for bias using an adjustment factor. Bias represents the overall tendency of the diffusion tubes to under or over-read relative to the reference chemiluminescence analyser. LAQM.TG22 provides guidance with regard to the application of a bias adjustment factor to correct diffusion tube monitoring. Triplicate co-location studies can be used to determine a local bias factor based on the comparison of diffusion tube results with data taken from NO_x/NO_2 continuous analysers. Alternatively, the national database of diffusion tube co-location surveys provides bias factors for the relevant laboratory and preparation method.

Cheltenham Borough Council have applied a local bias adjustment factor of 0.89 to the 2021 monitoring data. This value is derived from the co-located study at the automatic monitoring site on St Georges Street, where the triplicate diffusion tube site (7/8/9) is co-located. The output of this local bias adjustment calculation is summarised in Table C.2. The local factor was used to bias adjust the 2021 diffusion tube data as it was more conservative than using the national factor. In 2021, the national bias adjustment factor for diffusion tubes supplied by Gradko International using the 20% TEA in water preparation method was 0.84.

Table C.1 – Bias Adjustment Factor

Monitoring Year	Local or National	If National, Version of National Spreadsheet	Adjustment Factor
2021	Local	-	0.89
2020	Local	-	0.89
2019	Local	-	0.99
2018	Local	-	0.97
2017	Local	-	1.03

NO_2 Fall-off with Distance from the Road

Wherever possible, monitoring locations are representative of exposure. However, where this is not possible, the NO_2 concentration at the nearest location relevant for exposure has been estimated using the Diffusion Tube Data Processing Tool/NO_2 fall-off with distance calculator available on the LAQM Support website. Where appropriate, non-automatic annual mean NO_2 concentrations corrected for distance are presented in Table B.1.

No diffusion tube NO_2 monitoring locations within Cheltenham Borough Council required distance correction during 2021.

QA/QC of Automatic Monitoring

Cheltenham Borough Council's automatic monitoring site CM1, located on St Georges Street/Swindon Road Junction, is operated and managed by Enviro Technology Services plc. The M200E NO_x analyser is MCERTS approved, mirroring compliance with the European Committee for Standardisation (CEN) standard EN1421:2012, and measures NO_x, NO_2 and NO. The unit was installed in August 2011 and Enviro Technology Services undertake routine monthly calibration visits and data download services. Data received is ratified by Geoff Broughton from Air Quality Data Management (AQDM), with concentration data provided every quarter.

Automatic Monitoring Annualisation

The automatic monitoring station within Cheltenham Borough Council (CM1) recorded data capture greater than 75% during 2021 (98.6%) and, therefore, annualisation was not required.

NO_2 Fall-off with Distance from the Road

No automatic NO_2 monitoring locations within Cheltenham Borough Council required distance correction during 2021.

Table C.2 – Annualisation Summary (concentrations presented in µg/m^3)

	Local Bias Adjustment Input 1
Periods used to calculate bias	11
Bias Factor A	0.89 (0.84 – 0.95)
Bias Factor B	12% (5% – 20%)
Diffusion Tube Mean (µg/m^3)	28.8
Mean CV (Precision)	3.9%
Automatic Mean (µg/m^3)	25.6
Data Capture	98%
Adjusted Tube Mean (µg/m^3)	26 (24 – 27)

Notes:

A single local bias adjustment factor has been used to bias adjust the 2021 diffusion tube results.

Appendix D: Maps of Monitoring Locations and AQMAs

Figure D.1 – Map of Non-Automatic & Automatic Monitoring Sites (AQMA/Cheltenham Centre)

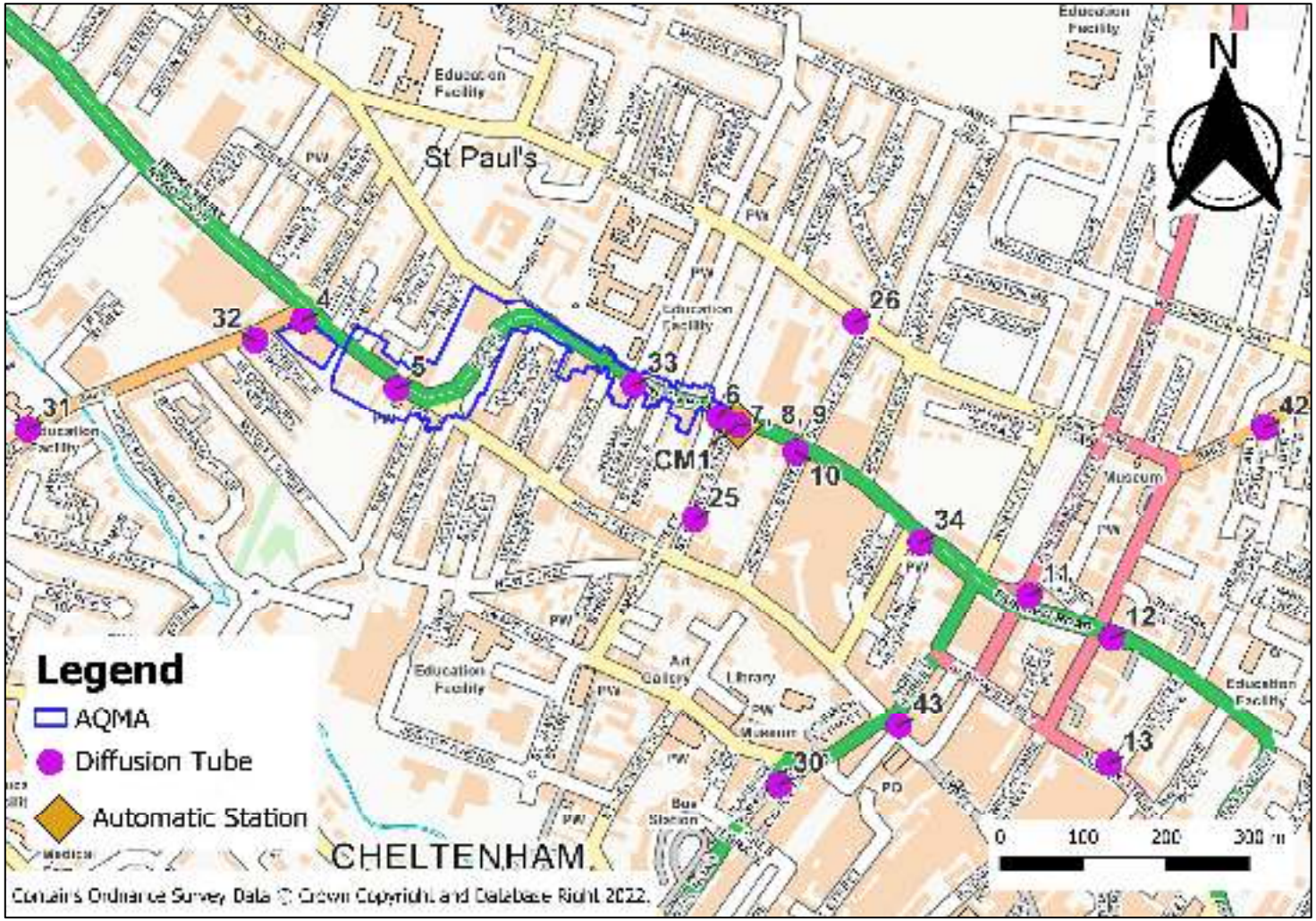


Figure D.2 – Map of Non-Automatic Monitoring Sites (Cheltenham Centre)

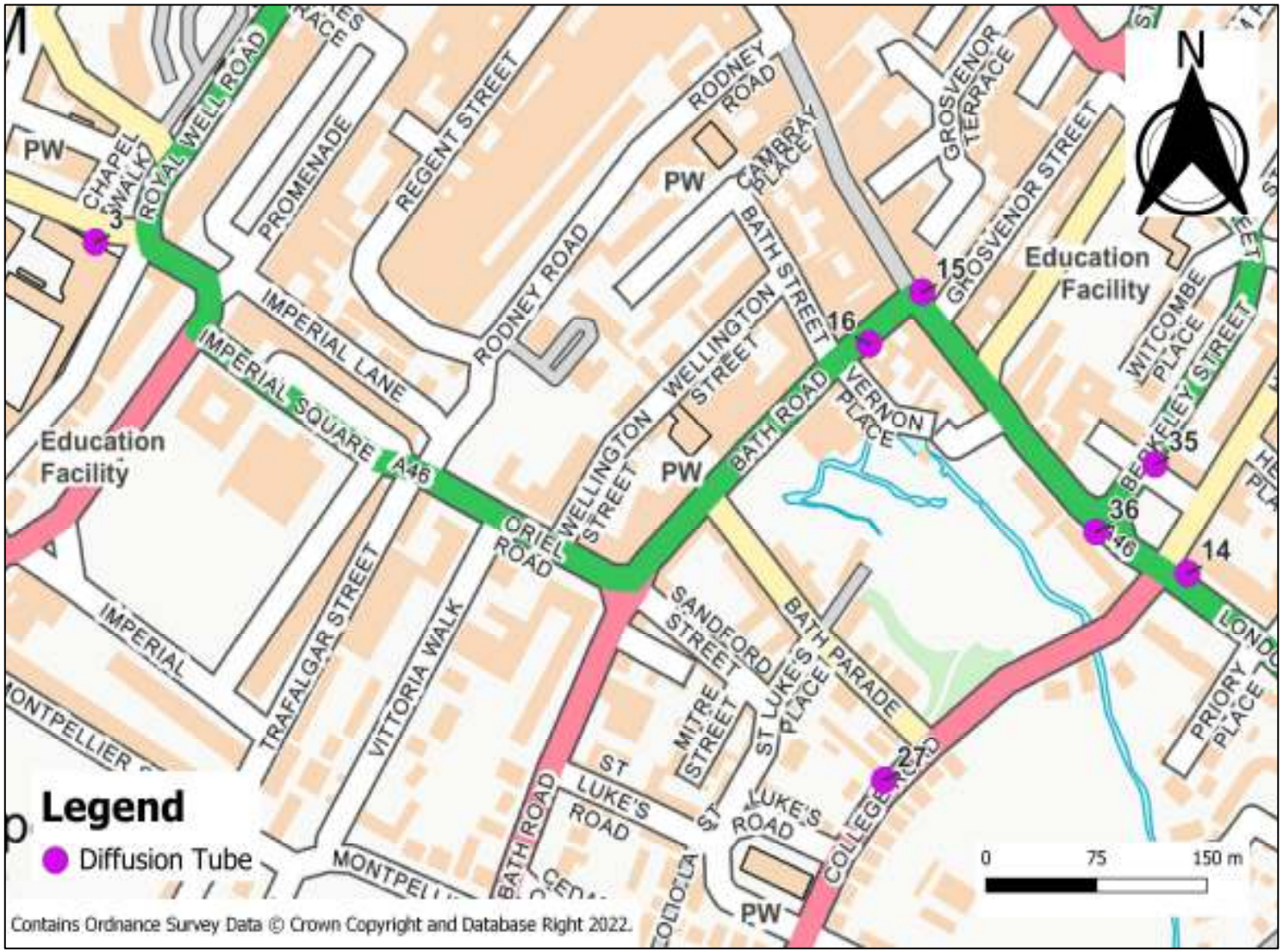


Figure D.3 – Map of Non-Automatic Monitoring Sites (London Road)

Figure D.4 – Map of Non-Automatic Monitoring Sites (Leckhampton/Warden Hill)

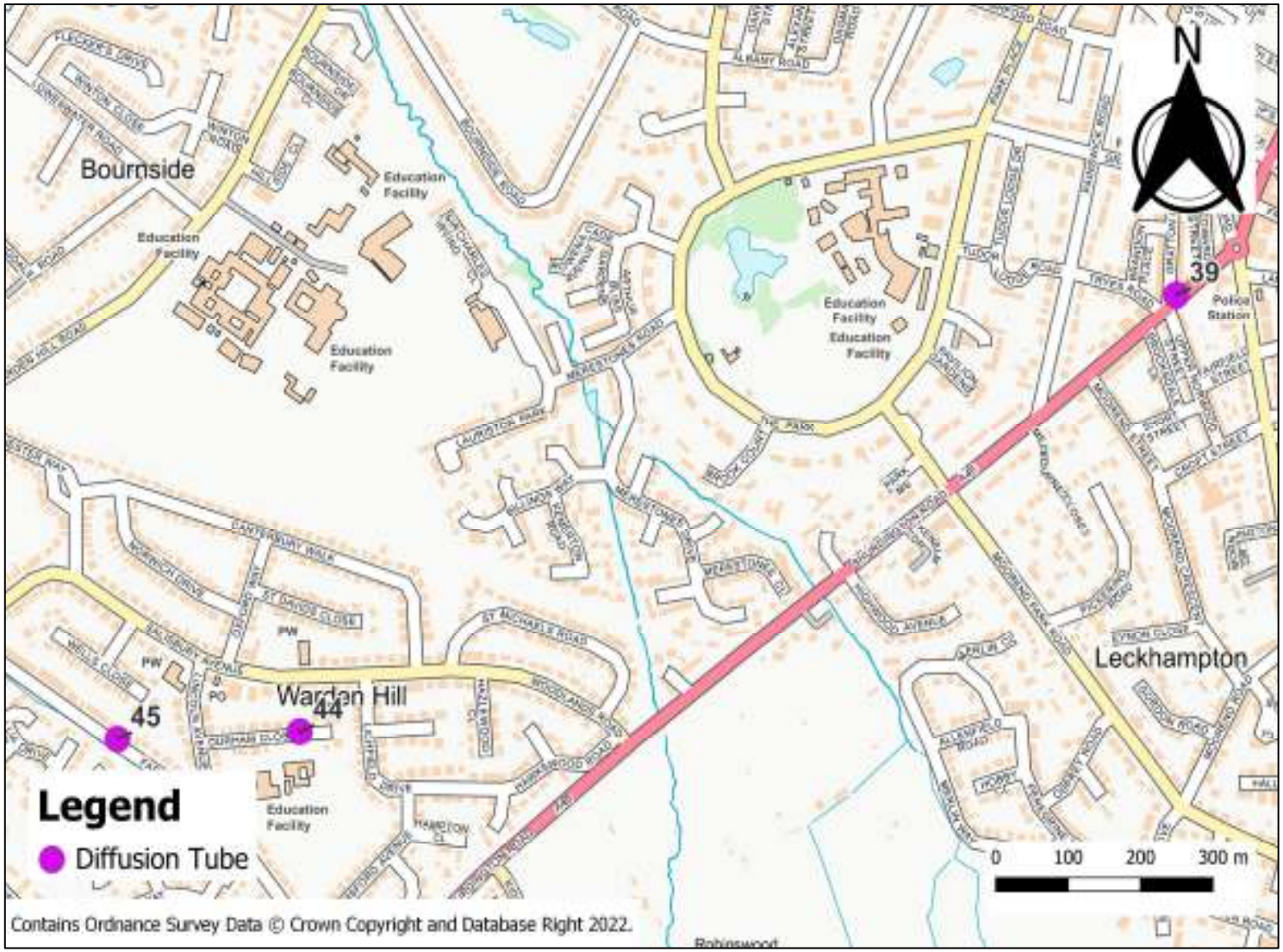


Figure D.5 – Map of Non-Automatic Monitoring Sites (Benhall/St Marks)

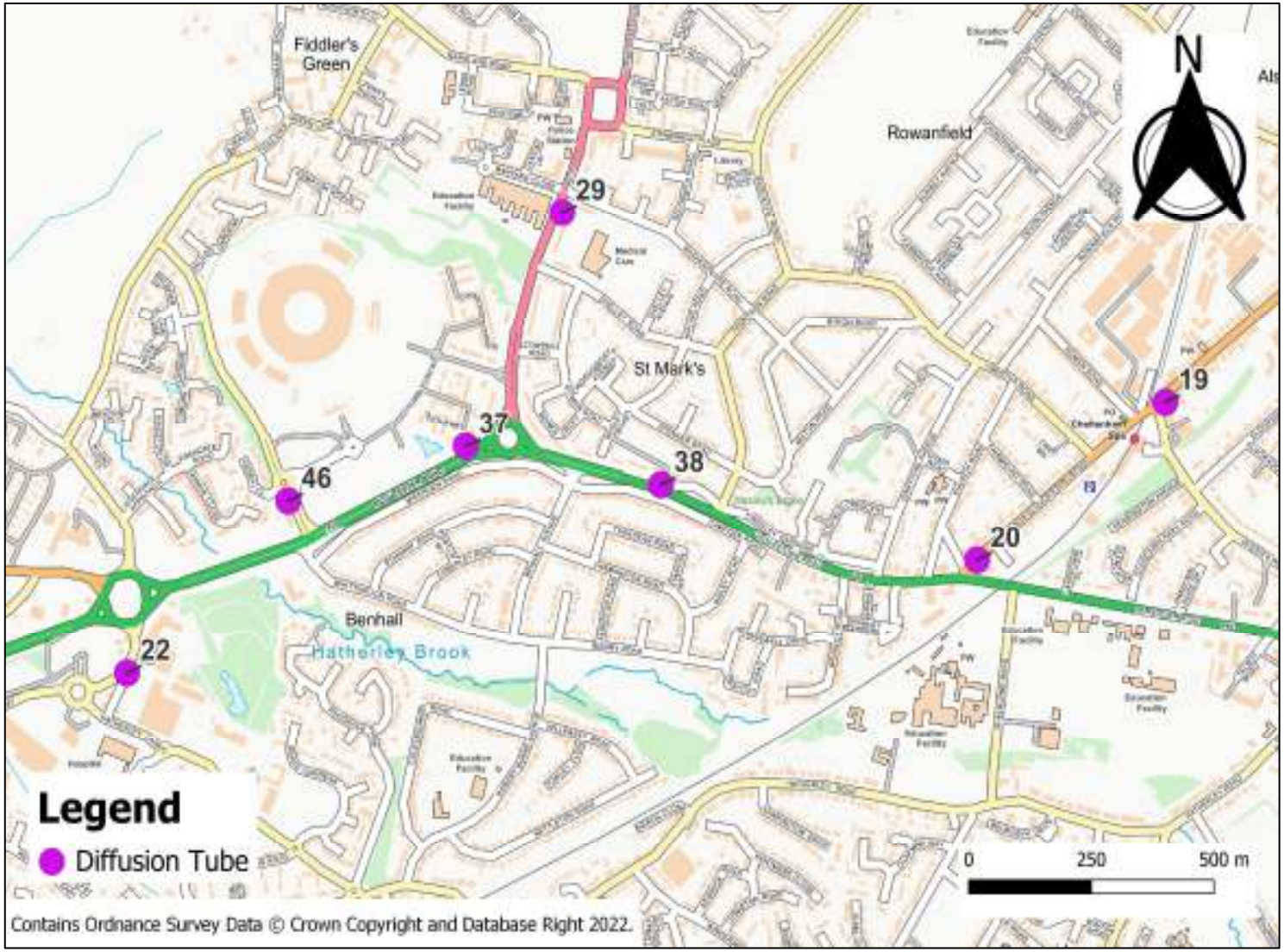
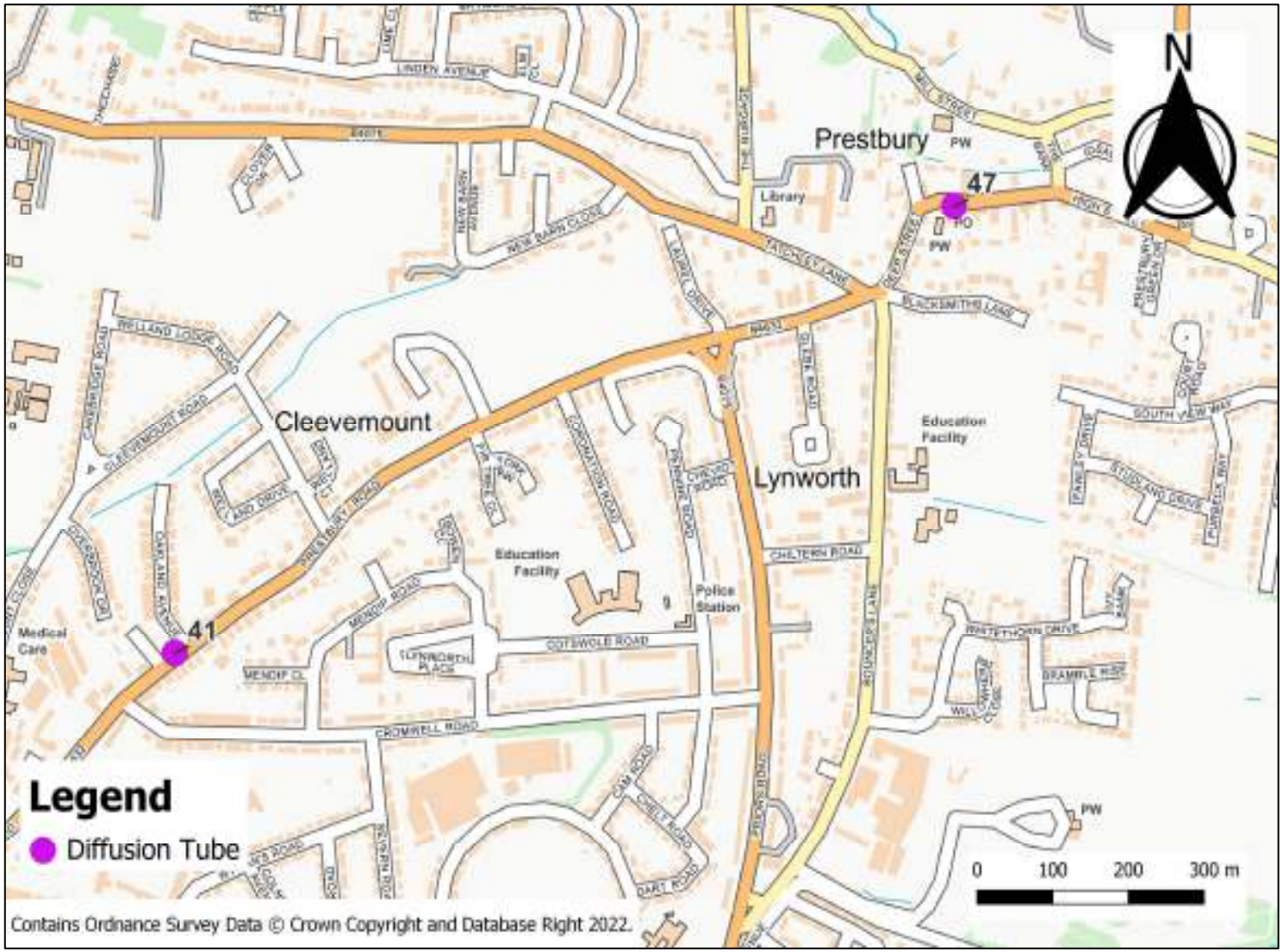


Figure D.6 – Map of Non-Automatic Monitoring Sites (Princess Elizabeth Way)

Figure D.7 – Map of Non-Automatic Monitoring Sites (Prestbury Road/High Street)



Appendix E: Summary of Air Quality Objectives in England

Table E.1 – Air Quality Objectives in England[9]

Pollutant	Air Quality Objective: Concentration	Air Quality Objective: Measured as
Nitrogen Dioxide (NO_2)	200µg/m^3 not to be exceeded more than 18 times a year	1-hour mean
Nitrogen Dioxide (NO_2)	40µg/m^3	Annual mean
Particulate Matter (PM_{10})	50µg/m^3, not to be exceeded more than 35 times a year	24-hour mean
Particulate Matter (PM_{10})	40µg/m^3	Annual mean
Sulphur Dioxide (SO_2)	350µg/m^3, not to be exceeded more than 24 times a year	1-hour mean
Sulphur Dioxide (SO_2)	125µg/m^3, not to be exceeded more than 3 times a year	24-hour mean
Sulphur Dioxide (SO_2)	266µg/m^3, not to be exceeded more than 35 times a year	15-minute mean

[9] The units are in microgrammes of pollutant per cubic metre of air (µg/m^3).

Glossary of Terms

Abbreviation	Description
AQAP	Air Quality Action Plan - A detailed description of measures, outcomes, achievement dates and implementation methods, showing how the local authority intends to achieve air quality limit values'
AQMA	Air Quality Management Area – An area where air pollutant concentrations exceed / are likely to exceed the relevant air quality objectives. AQMAs are declared for specific pollutants and objectives
ASR	Annual Status Report
Defra	Department for Environment, Food and Rural Affairs
DMRB	Design Manual for Roads and Bridges – Air quality screening tool produced by National Highways
EU	European Union
FDMS	Filter Dynamics Measurement System
LAQM	Local Air Quality Management
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
PM_{10}	Airborne particulate matter with an aerodynamic diameter of 10µm or less
$PM_{2.5}$	Airborne particulate matter with an aerodynamic diameter of 2.5µm or less
QA/QC	Quality Assurance and Quality Control
SO_2	Sulphur Dioxide

References

- Cheltenham Borough Council AQAP 2014.
- Defra Background Mapping Data for Local Authorities – 2018 Based.
- Local Air Quality Management Technical Guidance LAQM.TG16. April 2021. Published by Defra in partnership with the Scottish Government, Welsh Assembly Government and Department of the Environment Northern Ireland.
- Local Air Quality Management Policy Guidance LAQM.PG16. May 2016. Published by Defra in partnership with the Scottish Government, Welsh Assembly Government and Department of the Environment Northern Ireland.
- National Diffusion Tube Bias Adjustment Spreadsheet. Version 06/22. Published June 2022.
- Public Health Outcomes Framework, Public Health England.