Norwich City Council

Annual Status Report 2022

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NORWICH
City 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 Norwich

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].

Norwich, located in the heart of Norfolk, covers approximately 39 km^2 and a population of roughly 142,000 people. The population of the Norwich 'Travel to Work Area' (i.e. the area of Norwich in which most people both live and work) is approximately 381,200. Norwich is the fourth most densely populated local authority district in the eastern region with 3,480 people per km^2.

Norwich City Council permits 29 'Part B' processes which includes a road stone coating plant, a sawmill & timber treatment process, a cement batching installation, aircraft/vehicle resprays and a crematorium. The Environment Agency permits larger 'Part A' processes which comprises just Briar Chemicals (an agrochemical company). However, no Part A or Part B processes are considered to contribute with any significance to air pollution levels in the city. The University of East Anglia operates a 20 MW natural gas boiler and three natural gas combined heat and power (CHP) engines that produce 5.7 MW of electricity and 6 MW of heat. This energy is used within the neighbouring Eaton School. The CHP stack height

[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

has been designed to provide good dispersion and, hence, this source of NO_2 is not considered to contribute with any significance to pollution levels in Norwich.

Road traffic is a major source of air pollution in Norwich. Completed source appointment exercises have identified emissions road traffic to be the most significant source of NO_2. As a result, an Air Quality Management Area (AQMA) covering an area around the centre of Norwich was declared in 2012 due to exceedances of the NO_2 annual mean objective. In 2021, the annual mean objective was still exceeded within the AQMA, with a concentration of 40.2 µg/m^3 being recorded at site DT11. Therefore, it is evident that there are still areas within the AQMA where the Air Quality Strategy (AQS) objective is breached.

In order to tackle the exceedances within the AQMA, Norwich City Council produced an updated Air Quality Action Plan (AQAP) in 2021 (accessible here). So that the any pollution hotspots can be identified (i.e. those areas where action is needed), Norwich City Council proposes to maintain and continue with the passive diffusion tube monitoring network. Diffusion tube locations are reviewed annually, with locations determined by any anticipated pollution hotspots, such as where changes to the road network may have had an impact on NO_2 levels.

During 2021, the maximum NO_2 annual mean concentration recorded at a single diffusion tube site inside the AQMA was 40.2 µg/m^3 (DT11). Outside of the AQMA the maximum concentration was 21.3 µg/m^3 (DT40). These concentrations are comparable to that recorded in the previous reporting year, with a maximum NO_2 concentration of 39.4 µg/m^3 and 21.5 µg/m^3 being recorded within and outside of the AQMA. Therefore, it is evident that during 2021 there has not been a significant increase in NO_2 concentrations in Norwich. There remains an exceedance of the NO_2 annual mean AQS objective within the AQMA, therefore the AQMA designation shall remain. However, as the AQS objective is only exceeded at one site in 2021, the size of the current AQMA is to be reviewed during the current reporting year to see if the AQMA boundary can be amended.

A new raft of changes are due to take place as a result of the successful Transforming Cities Fund bid. This will see £32 million spent on infrastructure changes aimed at:

- Reducing levels of cross-city traffic by directing traffic onto the inner ring road.
- Alleviating congestion by installing smart traffic signalling.
- Facilitating bus upgrades to cleaner engines (Euro 6 specification/zero emission) and providing bus priority in the form of additional lengths of bus lane and priority for buses through traffic signals.

- Enabling more direct, connected and safer cycle/pedestrian routes into and across the city.

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 areas where local action is needed to improve local air quality.

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 AQMAs are designated due to elevated concentrations heavily influenced by transport emissions.

The 2021 AQAP focuses on road infrastructure changes that are designed to divert traffic away from the congested city centre and re-allocated more road space for active forms of travel (i.e. walking/cycling). The main focus is on enhancing the road network as factors such as vehicle emission standards are beyond the control of Norwich City Council. In addition the plan promotes the use of public transport by prioritising bus routes, improving bus frequency on key routes and providing easy access to Park & Ride facilities. Cycle infrastructure is also a key focus for Norwich City Council by lengthening and linking up cycle routes as well as providing segregated and safer routes (i.e. at major junctions).

Norwich City Council's main priorities are to reduce emissions from public transport and promote alternative modes of travel. To achieve this, Norwich City Council are working in conjunction with Norfolk County Council to implement the following measures over the course of the next five years:

- Expansion of the Low Emission Zone (LEZ).
- Restricting vehicles that can travel through the LEZ to a much tougher Euro emission standard by the end of 2023 (following discussions with transport operators).
- Extending engine switch off powers to accommodate the extended LEZ.

[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

- Promote low and zero emission public transport through the use of external grant schemes and private investment.
- Reviewing traffic light junctions to reduce congestion and improve traffic flow.
- Make road junctions safer and easier for cyclists/pedestrians to navigate.
- Expand the cycle networks and create safe, connected corridors for pedestrians and cyclists.
- Build upon School Travel Plans to introduce School Streets, and encourage schools to participate in air quality initiatives such as Clean Air Day.
- Engage the public through a behaviour change programme, including the use of social media to increase awareness of taking personal responsibility for reducing air pollution, such as engine switch off, walking/cycling, car sharing and using an open fire responsibly.

Norwich City Council believe that the implementation of these measures will reduce NO_2 levels to below the annual mean AQS objective, so that the current AQMA designation can be eventually revoked.

To date, significant works have been completed in much of the city centre area of Norwich, including the creation of more pedestrian areas, the removal of traffic lights and kerbside barriers at a number of junctions. On some of these streets, this also includes the removal of private motorised vehicles giving access only to buses, coaches, taxis, delivery vehicles and bikes. These changes are designed to support the vitality of the city centre by reducing conflict between vehicles, pedestrians and cyclists. With respect to public transport, in 2020 First Bus pledged to make an £18 million investment in its fleet and purchase 55 new Euro 6 buses, although it should be noted that discussions are currently underway for this investment to focus on zero emission vehicles and not just on cleaner diesel buses. This will result in all Euro 3 & 4 buses being removed from the fleet. This is significant as First Bus are responsible for over 75% of the public transport network in Norwich. The Norwich Park & Ride contract is due for renewal in 2022/23, which provides an opportunity to introduce low tailpipe emission buses. Ticket pricing will however been a key component that determines the use of the Park & Ride. A new bus passenger charter for Norfolk has been launched as part of the Norfolk Bus Service Investment Plan (BSIP) launched in October 2021. This outlines the commitment of Norfolk County Council and bus operators to improve bus services in Norwich and across Norfolk by rebuilding and increasing passenger confidence, having a green and sustainable transport offer, simple and affordable fares and

making buses the primary mode of transport for most journeys. The aim is for 90% of buses in Norfolk to be Euro 5, 6 or zero emission by 2027.

In terms of alternatives to private vehicle use, the cycle network for the greater Norwich area has been significantly upgraded over recent years. It comprises five radial and two orbital pedalway routes and a number of cycle routes connecting those pedalway routes. In addition, the Beryl micromobility scheme was launched in 2020, which now includes 470 standard bikes, 115 electric bikes and 250 electric scooters available to hire. Overall, there has been a 40% increase in cycling since 2012.

Norwich City Council have also promoted the uptake and use of electrical vehicles. There are now 57 electrical vehicle (EV) charging points within the Norwich City Council. Seven of these EV charging points are owned by Norwich City Council and are located in Rose Lane Car Park. Norwich City Council will continue to encourage the installation of EV charging points, and for significant planning projects, a relevant condition is added where applicable.

A good relationship has been developed with the Environmental Science Department at the University of East Anglia (UEA) and collaborative research projects have already been undertaken. It is hoped further collaborations with the UEA, and other partner authorities, will nurture research projects into air pollution. For example, one such project currently being investigated is the speciation of $PM_{2.5}$ in Norwich. These collaborations with the UEA are important as the provide a more holistic approach to project when applying for funding.

Conclusions and Priorities

The 2021 AQAP presents a comprehensive review of Norwich air quality, the problem areas and the additional measures that will be required to combat this.

Norwich City Council intend to continue with automatic and passive NO_2 monitoring within the city area. As completion of road changes are implemented, Norwich City Council will keep the locations of passive monitoring under continuous review so that any resulting impacts from these changes can be determined. Prior to the next phase of road changes, Norfolk County Council will be embarking on a program of passive monitoring to acquire baseline information so that the full impact of the proposed road schemes can be assessed.

During 2021, there were no exceedances of the NO_2 annual mean AQS objective at sites outside of the AQMA. Within the AQMA, the 40 µg/m^3 objective was only exceeded at one site (DT11: 40.2 µg/m^3). All automatic monitoring stations reported concentrations of NO_2, PM_{10} and $PM_{2.5}$ to be below the relevant objectives.

Norwich City Council own and run the Castle Meadow automatic monitoring station. Funding has been made available to replace this 25-year old station with more up to data technology. The opportunity will be taken to replace this station with more up to date technology and relocate the new station to a roadside location, midway along Castle Meadow and close to relevant receptors. The new monitoring station is expected to be commissioned in Autumn 2022 and the current monitoring station will continue to be operated in tandem for a short period of time so any discrepancies in data can be identified. With the strive to replace ageing, polluting buses with those using a cleaner technology, the engine switch off enforcement and the development of the BSIP, it is hoped improvements in air quality in the LEZ along Castle Meadow will follow. Therefore, as it is hoped these changes will result in a measurable reduction in NO_2, the Castle Meadow monitoring station has a useful purpose.

As well as maintaining the automatic and passive monitoring network, Norwich City Council will also continue to support initiatives that contribute positive to improving air quality. These cover a range of actions, such as:

- Encouraging car sharing in partnership with companies such as Liftshare.
- Encouraging schools to develop travel plans, including using the Modeshift Stars software.
- Support the Enterprise Car Club (formerly Norfolk Car Club).
- Support walking and cycling schemes such as Mobi-Mix, Beryl Bikes and the LCWIP (Local Cycling & Walking Infrastructure Plan).
- Inform citizens on health concerns when using an open fire/wood burner through a program of social media and website campaigns.

Local Engagement and How to get Involved

Norwich City Council are aware that air quality is a subject that has become an increasing area of interest and concern for more and more people year on year. As a result, information about air quality in general and actions that can be taken to improve air quality, can be found at the following:

- UK-AIR (the government's air information resource).
- Norwich City Council (air quality reporting website).
- Enterprise Car Club ('connecting Norfolk').
- Norfolk Liftshare (car journey sharing).
- Modeshift Stars (national schools award for schools promoting sustainable travel).

- Mobi Mix Project (mobility hubs and e-scooters).
- Cycle City Ambition Programme (report for Department for Transport).
- Transforming Cities Overview (funding application to Department for Transport).

Please note Norwich City Council does not have control over third party websites and, hence, may not necessarily endorse its content.

Norwich City Council promote initiatives such as 'Clean Air Day', which allow the public to raise any air quality issues or concerns and learn more about how to help themselves with improving the air which they breathe in (both indoors and outdoors). This is done with aid from the Norfolk Environmental Protection Group, who promote issues such as:

- Encouraging children to walk or cycle to school and find routes away from busy roads. Poster competitions have been used to engage teachers and pupils.
- Encouraging citizens to abandon the car on Clean Air Day and use an alternative mode of transport such as car share, public transport, cycle or walk.
- Raising awareness of the safest way to use a wood-burner/open fire, walking on side streets instead of the main road, and switching off engines when idling.
- Promoting 'Clean Air Day' on social media sites, with the main focus on the younger generation. Norwich City Council hope that initiatives such as 'Clean Air Day' would be a catalyst for behavioural changes that will continue beyond the day itself.

Local Responsibilities and Commitment

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

This ASR has been approved by:

Jeremy Wiggin Bsc (Hons) MSc MCIHT, Transport for Norwich Manager – Norfolk County Council

Cllr Hampton – Cabinet Change & Digital Inclusion – Norwich City Council

Cllr Jones - Cabinet Safer Stronger Neighbourhoods – Norwich City Council

If you have any comments on this ASR please send them to Sally Nicholson at:

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Table of Contents

List of Figures

List of Tables

1 Local Air Quality Management

This report provides an overview of air quality in Norwich 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 Norwich City 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

AQMAs are declared when there is an exceedance or likely exceedance of an air quality objective. After declaration, the authority should prepare an 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 Norwich City Council can be found in Table 2.1. The table presents a description of the one AQMA that is currently designated within Norwich. Appendix D: Maps of Monitoring Locations and AQMAs provides maps of AQMA and also the air quality monitoring locations in relation to the AQMA. The air quality objective pertinent to the current AQMA is designation is for the NO_2 annual mean.

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
Central Norwich AQMA	November 2012	NO_2 Annual Mean	An area encompassing Norwich City Centre, broadly following the inner link road.	No	52 µg/m^3	40.2 µg/m^3	AQAP June 2021	AQAP June 2021

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

☒ **Norwich City Council confirm that all current AQAPs have been submitted to Defra.**

2.2 Progress and Impact of Measures to address Air Quality in Norwich

Defra's appraisal of last year's ASR concluded that the report is well structured, detailed, and provides the information specified in the Guidance. The appraisal also stated:

"Robust and accurate QA/QC procedures were applied. Calculations for bias adjustment, annualisation and distance-correction factors were outlined in detail".

- QA/QC procedures of the automatic monitoring stations have been described in the 2022 ASR, as well as a comparison of the national and local bias adjustment factor.

"The Council has included discussion and review of its AQMAs and monitoring strategy. Additionally, the Council have reviewed their monitoring network and made necessary changes through removal and additional tubes in place to provide data. This demonstrates the Council's proactive and dedicated approach to improving air quality across the area".

- Norwich City Council will review the concentrations reported in the 2022 ASR and amend the monitoring network towards any identified hotspots, if required.

"Small discrepancy between concentrations reported for DT42 in Table A.4 (21.4 µg/m^3), which differs from the concentration for the same diffusion tube in Table B.1 (21.2 µg/m^3). This appears to be a typing error and as such, Council should take care to report results accurately in future ASRs".

- Reported concentrations have been double checked in the 2022 ASR to ensure consistency between tables.

"The Council have incorrectly written that they have 40 monitoring locations, when in fact there are 40 diffusion tubes spread across 30 monitoring locations which include five triplicate sites".

- In the 2022 ASR, the total number of sites has been updated to reflect any duplicate or triplicate sites. During 2021, there were 28 sites with one duplicate and four triplicates resulting in a total of 37 diffusion tubes being deployed each month.

"Comments from last year's ASR have been mentioned and addressed. This is welcomed, and we encourage this to continue in future ASRs".

- Reference to the appraisal of the 2021 ASR has been included in the 2022 ASR, with the suggested improvements acted upon.

Both Norwich City Council and Norfolk County Council have 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. 24 measures are included within Table 2.2, with the type of measure and the progress Norwich City 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 the 2021 Air Quality Action Plan published by Norwich City Council:

Key completed measures are:

- *Traffic Management:* Thorpe Road bus/cycle contraflow, which provides an improved and more direct route for buses and cyclists travelling into the city centre along this key arterial route. It is hoped that this infrastructure improvement will encourage behavioural change to limit car use.
- *Travel Alternatives:* Cycling encouraged by extending cycling routes and making the existing ones more joined up. Green pedalway crossing from the west to east through the city which completes the five radial and two orbital pedalways.

Norwich City Council's priorities for the coming years are:

- *Low Emission Transport:* Continue to review the existing Low Emission Zone (LEZ), including considering plans to extend the geographical scope of the LEZ. Norwich City Council will continue to work with bus operators to agree dates for Euro 5 & 6, and ultimately zero emission compliance.
- *Transport Planning & Infrastructure:* Transport hubs being developed at key transport interchanges, such as Norwich Rail Station, Norwich Bus Station, Norfolk & Norwich University Hospital and Bowthorpe. Improvements are also to be made to the bus route infrastructure with the provision of priority for buses along key transport corridors including Dereham Road, Wroxham Road and Cromer Road.
- *Travel Alternatives:* Extension to Thickthorn Park and Ride site. Outline of the design has been completed and planning application submitted, but issues that have been raised are currently being addressed. This extension will provide a sustainable travel option into the city centre as well as the Norwich Research Park. School travel plans are also to be highlighted as part of the Clean Air Day campaign.

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	Castle Meadow Low Emission Zone	Promoting Low Emission Transport	Low Emission Zone (LEZ)	2006/09	Ongoing	Norwich City Council	Norwich City Council		Funded	<£10k	Planning	Approx. 10-15 µg/m^3 NO_2	Reduction in NO_2 levels in Castle Meadow.	Erratic decline in NO_2 but probably would have been worse without LEZ.	Ongoing review of LEZ and the requirement to further reduce vehicle emissions. We are committed to agreeing with bus operators firm agreed dates for Euro 5, Euro 6 and ultimately zero emission compliance. Engine switch off enforcement commenced in autumn 2018 on Castle Meadow & St Stephens St where there is bus & taxi only traffic. Plans being considered to extend the geographical scope of the LEZ.
2	Review of traffic light times & synchronisation to optimise traffic flow for all new road layout schemes	Traffic Management	UTC, Congestion management, traffic reduction	2016 +	Ongoing	Norfolk County Council	Norfolk County Council		Funded	£10k - £50k	Implementation	Specific value not known but will contribute to overall reduction in NO_2 levels in city centre and surrounds. NO_2 levels at CM1 reduced by >10 µg/m^3 in 2019. Reason unknown but smart traffic lights installed at end on Castle Meadow close to CM1. To date this is considered to be one explanation.	Reduced city centre congestion as well as wider network.	Ongoing. Traffic signals along Koblenz Avenue in Norwich are being optimized following highway improvement works around Norwich station.	Congestion should be minimised, but this needs to be monitored and where applicable diffusion tube sites reviewed. In addition, the work on ring road junction improvements will aid this. Latest generation traffic signal control software is now in use. In 2019 this was implemented on Agricultural Plain (at end of Castle Meadow) to improve traffic flow on this complicated 5-way junction.
3	Ring road junction improvements	Traffic Management	UTC, Congestion management, traffic reduction	2020/23	2023/24	Norwich City Council / Norfolk County Council	Norwich City Council / Norfolk County Council		Funded	£1m - £10m	Completed (Grapes Hill) / Planning (Heartsease)	Specific value not known but will contribute to overall reduction in NO_2 levels in city centre and surrounds.	Reduced city centre congestion as well as wider network / increased numbers of people walking and cycling.	Grapes Hill roundabout was completed Nov 2021 and initial evidence shows reduced congestion/smoother traffic flows. An options appraisal has been completed for the Heartsease Fiveways junction and has identified improvements to take forward for design to address key concerns around pedestrian and cyclist safety. The Foundry Bridge junction near Norwich Rail Station was completed July 2022 with the aim of improving flow for general traffic, buses, cycles and pedestrians.	The current design of the Heartsease roundabout is a significant barrier to walking and cycling along this corridor, which leads to a dominance of car traffic into the city. This is also a key bus corridor, which sees considerable delays.
4	Engine switch-off enforcement	Public Information	Other	2018	Completed August 2018	Norwich City Council	Norwich City Council		Funded	< £10k	Ongoing on Castle Meadow & St Stephens St. Reach extended if LEZ extended as proposed.	Complimentary to other measures; in particular Castle Meadow LEZ. NO_2 levels at CM1 reduced	Reduction in NO_2 levels in city centre and surrounds	Engine switch off enforcement in place with issue of Fixed penalty Notices for drivers who fail to comply when requested. To date no non-compliance.	Use of powers to enforce engine switch-off via issue of fixed penalty notices. Enforcement commenced specifically on Castle Meadow & St Stephens where bus & taxi only traffic. Any

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
												by >10 µg/m^3 in 2019. Reason unknown but smart traffic lights installed at end of Castle Meadow close to CM1. To date this is considered to be one explanation and engine switch off may be another.			extension of the LEZ would mean extension of engine switch off enforcement area.
5	Signage informing engine switch-off enforcement. Electronic displays at traffic lights giving waiting times.	Public Information	Other	2017 – trial on Riverside Road.	Ongoing but October 2018 for switch off enforcement on Castle Meadow	Norwich City Council / Norfolk County Council	Norwich City Council / Norfolk County Council		Not Funded	£100k - £500k	Planning	Specific value not known but will contribute to overall reduction in NO_2 levels in city centre and surrounds.	Reduction in NO_2 levels in AQMA.	Ongoing	New signage associated with enforcement of engine switch off educates road users and reinforces AQMA. The option to display waiting times at traffic lights is being considered.
6	Low NO_x Buses	Promoting Low Emission Transport	Public Vehicle Procurement - Prioritising uptake of low emission vehicles	N/A	Ongoing. 15 zero emission buses to be introduced by March 2024.	Norwich City Council / Norfolk County Council	Norwich City Council / Norfolk County Council		Funded	£1m - £10m	Planning	The introduction of 15 zero emission buses is forecast to reduce air quality related emissions (NO_x and $PM_{2.5}$) by 9.2 tonnes per annum.	Reduction in NO_2 levels in city centre and surrounds.	24 buses retrofitted with exhaust gas treatment equipment by June 2018. First Bus has committed to £18m investment as part of the Transforming Cities Fund in new and refurbished vehicles to provide low and zero emission buses. Funding has been secured through the Zero Emission Bus Regional Area (ZEBRA) programme for 15 zero emission buses to be introduced by First by March 2024.	Aim is to work in partnership with bus operators on funding opportunities relating to low NO_x emission vehicles. An unsuccessful application to the All-Electric Bus Town Fund was made in 2020.
7	Assess opportunity for a zero-emission bus fleet to operate the Norwich Park & Ride service when the contract is renewed in 2023	Promoting Low Emission Transport	Other		2023/24	Norfolk County Council	Norfolk County Council		Not Funded	£1m - £10m	Planning	Specific value not known but will contribute to overall reduction in NO_2 levels in city centre and surrounds.	Reduction in NO_2 levels in city centre and on busy feeder roads.	See comment to the right.	The performance of Park & Ride is being reviewed as the service has struggled to recover post-COVID. This will help to determine whether the requirement for zero emission buses is appropriate regarding the level of subsidy support that may be required for a future service.
8	School Travel Plans	Promoting Travel Alternatives	School Travel Plans	Ongoing	Ongoing	Norfolk County Council	Norfolk County Council		Funded	£10k - £50k	Implementation	Specific value not known but will contribute to overall reduction in NO_2 levels in city centre and surrounds.	Reduction in NO_2 levels in city centre and surrounds. Passive NO_2 monitoring to be installed outside key schools.	Schools within Greater Norwich that are served by a development site covered by the AtoBetter travel planning programme have engagement in terms of their travel plan. There are 3 schools in Greater Norwich that have formed part of the School Streets trial.	County Council already promotes Modeshift Stars software with schools so they can generate and manage their own travel plans. Consideration will be given to whether school bus contracts can be amended on their renewal to utilise low emission vehicles. School travel plans to be highlighted as part of Clean Air Day campaign – led by County & Public Health Norfolk.
9	West to East traffic restriction in Norwich City Centre	Traffic Management	UTC, Congestion management, traffic reduction	2020/23	2022/23	Norfolk County Council	Norfolk County Council (TCF		Funded	£1m - £10m	Planning	Specific value not known but will contribute to overall	Reduction in NO_2 levels in city centre and surrounds.	Has been approved for construction in 2023.	Provides substantially improved conditions for pedestrians and reduces congestion with buses.

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
							funding)					reduction in NO_2 levels in city centre.			
10	Revised layout in St Stephens Street / Red Lion Street	Traffic Management	UTC, Congestion management, traffic reduction	2020/23	2022/23	Norfolk County Council	Norfolk County Council (TCF funding)		Funded	£1m - £10m	Implementation	Specific value not known but will contribute to overall reduction in NO_2 levels in city centre.	Reduction in NO_2 levels in city centre and surrounds.	In construction. Should be substantially complete Sep 2022.	Provides substantially improved conditions for pedestrians and reduces congestion with buses
11	Transport hubs at key transport interchanges	Transport Planning and Infrastructure	Public transport improvements- interchanges stations and services	2020/23	2022/23	Norfolk County Council	Norfolk County Council (TCF funding)		Funded	£1m - £10m	Implementation	Specific value not known but will contribute to overall reduction in NO_2 levels in city centre.	Reduction in NO_2 levels in city centre and surrounds.	Rail station works were completed July 2022. Norwich Bus Station works to commence Spring 2023. Bowthorpe interchange will be consulted on Autumn 2022. Discussions ongoing regarding the Norfolk & Norwich University Hospital scheme.	Key hubs being developed are at Norwich Rail Station, Norwich Bus Station, Norfolk & Norwich University Hospital and Bowthorpe.
12	Bus rapid transit	Transport Planning and Infrastructure	Bus route improvements	Ongoing	Ongoing	Norwich City Council / Norfolk County Council	Norwich City Council / Norfolk County Council		Funded	> £10m	Implementation	Specific value not known but will contribute to overall reduction in NO2 levels in city centre and surrounds	Reduced city centre congestion as well as wider network.	Cromer Road and Aylsham Road bus lanes are complete. Dereham Road bus lanes to go to consultation late 2022.	Transforming Cities will see substantial provision of priority for buses along key transport corridors including Dereham Road, Wroxham Road and Cromer Road.
13	Rationalising and simplifying of traffic on Prince of Wales Road	Traffic Management	UTC, Congestion management, traffic reduction	Long term	2023/24	Norwich City Council / Norfolk County Council	Norwich City Council / Norfolk County Council		Funded	> £10m	Planning	Specific value not known but will contribute to overall reduction in NO_2 levels in city centre and surrounds	Reduced city centre congestion.	Scheme to restrict eastbound traffic movement on St Andrews Street has been approved and will be constructed 2023. This will reduce traffic levels down Prince of Wales Road, easing congestion at the Foundry Bridge junction.	This scheme also supports the transport mobility hub completed at Norwich Rail Station.
14	Extension to Thickthorn Park and Ride site	Promoting Travel Alternatives	Other	2020/23	2023/24	Norfolk County Council	Norfolk County Council (TCF funding)		Funded	£1m - £10m	Planning	Specific value not known but will contribute to overall reduction in NO_2 levels in city centre.	Reduced city centre congestion as well as wider network.	Outline design completed. Planning application submitted and issues raised are being addressed.	This will provide a sustainable travel option into the city centre as well as the Norwich Research Park.
15	Extension of Postwick Park and Ride site	Promoting Travel Alternatives	Other	TBC	TBC	Norfolk County Council	Norfolk County Council		Not Funded	£1m - £10m	Planning	Specific value not known but will contribute to overall reduction in NO_2 levels in city centre.	Reduced city centre congestion as well as wider Network.	Site was used throughout 2020-2022 as a COVID testing facility. Will not be reopened for Park & Ride use until Park & Ride patronage improves.	While spare capacity remains at the existing site, expansion of the site will remain on hold.
16	Installation of Beryl Bikes, E-Bikes and E-scooters across the greater Norwich area	Promoting Travel Alternatives	Other	2020	Scheme largely installed by end of 2020. Contract with Beryl runs until 2025 with option to extend.	Norwich City Council / Norfolk County Council	Norwich City Council / Norfolk County Council		Funded	£100k - £500k	Implementation	Studies are showing that 30% of all journeys taken by bike or scooter would otherwise have been taken by car.	Over 1million km have been travelled on Beryl bikes and scooters since launch.	Public bike share launched in March 2020 with E-scooters added in September 2021 (DfT trials).	Finding suitable space for bays to achieve optimal bay network density to drive up ridership.
17	Introduction of School Streets	Transport Planning and Infrastructure	Congestion management, traffic reduction	2021/22	Ongoing	Norwich City Council / Norfolk County Council	Norwich City Council / Norfolk County Council		Funded	£50k - £100k	Implementation	Specific value not known but will encourage green	Reduction in traffic levels, improved air quality and greater numbers	Introduction of School Streets. Two of the six schools included in the School Streets trial are in Greater Norwich. A review	The County Council will work with Sustrans and a wide range of stakeholders to implement.

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
												corridors to be utilised by students/pupils.	of pupils walking.	paper will be considered by Cllrs in Jan/Feb 2023.	
18	Wayfinding. Investment in new and transformative infrastructure to encourage more sustainable modes of transport for commuting and leisure journeys	Transport Planning and Infrastructure	Other	2020/23	2022/23	Norfolk County Council	Norfolk County Council (TCF funding)		Funded	£100k - £500k	Implementation	Specific value not known but will contribute to overall reduction in NO_2 levels in city centre.	Reduction in NO_2 levels in city centre and surrounds	Contractor appointed for the provision and installation of wayfinding signage. Project completion Spring 2023.	Provides substantially improved conditions for pedestrians and cyclists
19	Construction of final link of Northern Distributor Road (NDR) over River Wensum joining up with A47 West	Transport Planning and Infrastructure	Other	2023-2025	2025	Norfolk County Council	Norfolk County Council		Partially Funded	> £10m	Planning	Specific value not known but will contribute to overall reduction in NO_2 levels in city centre and surround.	Reduced city centre congestion as well as wider network.	Preferred route confirmed (July 2019). Strategic Outline Business Case approved May 2020. Contract for Design and Build awarded June 2021. Outline Business Case submitted to DfT.	Major scheme promoted by the County Council which the City Council is not currently supporting pending preparation of a Transport for Norwich Strategy and Action Plan to address congestion and air quality issues. Post construction monitoring will be undertaken.
20	Removal of private vehicle traffic from Tombland	Traffic Management	Strategic highway improvements, Re-prioritising road space away from cars, including Access management, Selective vehicle priority, bus priority, high vehicle occupancy lane	Long term	TBC	Norwich City Council / Norfolk County Council	Norwich City Council / Norfolk County Council		Not Funded	/£1m - £10m	Planning	Specific value not known but will contribute to overall reduction in NO_2 levels in city centre and surrounds.	Reduced city centre congestion.	Not started	Long term goal. Will be considered as part of the development of the Transport for Norwich Implementation Plan.
21	Education & information campaigns to encourage more responsible driving and the use of alternative modes	Promoting Travel Alternatives	Other	Ongoing	Ongoing	Norwich City Council / Norfolk County Council	Norwich City Council / Norfolk County Council		Funded	£1m - £10m	Implementation	Specific value not known but will contribute to overall reduction in NO_2 levels in city centre and surrounds.	Reduction in NO_2 levels in city centre and surrounds.	Ongoing	Continuation of work to promote Transport for Norwich objectives utilising funding from DfT through Access fund.
22	Installation of new Air Quality Monitoring Station		Other	20021	2022	Norfolk County Council	Norfolk County Council			£50k	At tender stage	Replaces ageing AQ station with more up to date technology implementation of measures more reliably quantified.		In progress	None
23	Thorpe Road bus/cycle contraflow	Traffic Management	Strategic highway improvements, Re-prioritising road space away from cars, including Access management, Selective vehicle priority, bus priority, high vehicle occupancy lane	2020/21	2021/22	Norfolk County Council	Norfolk County Council (TCF funding)		Funded	£1m - £10m	Completed	Specific value not known but will contribute to overall reduction in NO_2 levels in city centre.	Reduction in NO2 levels in city centre and surrounds.	Completed	Provides a substantially improved and more direct route for buses and cyclists travelling into the city centre along a key radial route.
24	CCAG programmes	Promoting Travel Alternatives	Promotion of cycling	2014-2019	2019/20	Norwich City Council / Norfolk County Council	Norwich City Council / Norfolk County Council / DfT		Funded	£1m - £10m	Completed	Specific value not known but will contribute to overall reduction in NO_2 levels in city centre and surrounds.	Reduction in vehicle use in city centre. Increased no. people cycling.	Complete	Cycle routes have been extended and more joined up. All 2 orbital and 5 radial pedal ways now substantially complete.

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.

Norwich City Council is taking the following measures to address $PM_{2.5}$:

- **Real-Time Monitoring:** Automatic monitoring of $PM_{2.5}$ is carried out at the Automatic Urban and Rural Network (AURN) station (Norwich Lakenfields), which is an urban background site fitted with a FIDAS $PM_{2.5}$ analyser. Norwich City Council also operate a $PM_{2.5}$ TEOM analyser at the locally managed automatic monitoring station (Castle Meadows). Therefore, there is a large amount of historic data for $PM_{2.5}$, at background and roadside locations, that can be used to inform any trends in the ambient $PM_{2.5}$ concentration across the city.
- **Air Quality Partnerships:** Norwich City Council are working with partners within the Norfolk Environmental Protection Group's (NEPG) Air Quality sub-group to ensure regular two-way engagement with representatives of Public Health Norfolk. This allows for an exchange of information and data, including that referenced in the Public Health Outcomes Framework.
- **Strategy Measures:** The measures listed within Table 2.2 ('Progress on Measures to Improve Air Quality') will have a positive contribution towards reducing $PM_{2.5}$ emissions and/or exposure, despite being primary orientated to NO_2. For example, reducing the volume of road traffic, increasing pedestrian only areas and promoting walk and cycle routes will also reduce vehicle brake and tyre wear – a contributor to $PM_{2.5}$ emissions. It is however understood that, at least in Norwich, $PM_{2.5}$ is primarily a transboundary pollutant. This is highlighted by the urban background monitoring station recording the same level of $PM_{2.5}$ in 2021 as the urban kerbside site, thus indicating that traffic pollution is not the primary source of $PM_{2.5}$ in Norwich.
- **Planning Applications:** The minimisation of airborne particulates will continue to be an important factor in all planning application considerations. Developers are

encouraged to be part of the Considerate Contractors Scheme and have a fully adhered to onsite Environmental Policy which includes dust suppression.

- **Smoke Control Areas:** Norwich City Council has currently declared three smoke free zones and are promoting advice on the Air Quality (Domestic Solid Fuels Standards) (England) Regulations 2020 and the importance of health, as well as the legal requirement to material on wood burners and open fires which does not produce smoke or fumes. This message is given not only to the general public, but also to the hospitality sector to emphasise the fact that pollutants emissions when burning wood and coal are harmful to everyone (especially the young, elderly and most vulnerable). Social media, Norwich City Council's monthly magazine and educational days such as Clean Air Day are all used as ways of broadcasting such message.
- **Trading Standards:** Norwich City Council are working with Trading Standards to ensure retailers of wood and coal are complying with the new Air Quality (Domestic Solid Fuels Standards) (England) Regulations 2020.

2.3.1 Open Fires and Wood Burning Stoves

The use of open fires and wood-burning stoves has risen in popularity, particularly over recent years, causing emissions from domestic chimneys to increase. As a result, there is the potential for indoor air pollution to also increase. This is significant as pollutants such as $PM_{2.5}$ which are associated with wood burners and open fires can cause breathing problems such as asthma attacks and contribute to other health conditions.

Norwich City Council have made it a priority to identify all houses which have open fires as their primary source of heating, and especially those pertaining to their own housing stock, and are working towards installing an alternative method of heating. A total of 65 local authority houses have been identified, which could potentially feed into the Public Health Outcomes Framework for the Norwich area.

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

This section sets out the monitoring undertaken within 2021 by Norwich City 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

Norwich City Council undertook automatic (continuous) monitoring at one site during 2021; Castle Meadow. There is also an AURN monitoring station within Norwich; Norwich Lakenfields. Table A.1 in Appendix A shows the details of the two automatic monitoring sites. The Envista – Air Resources Manager page presents automatic monitoring results for Norwich City Council, with automatic monitoring results also available through the UK-Air website.

Maps showing the location of the monitoring sites are 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

Norwich City Council undertook non-automatic (i.e. passive) monitoring of NO_2 at 28 sites during 2021. However, one diffusion tube site is a duplicate site (DT1) and four sites are triplicate sites (DT4, DT26, DT29, DT31) resulting in a total of 37 diffusion tubes being deployed each month. This is a reduction of three sites from that in the previous reporting year, with diffusion tubes not being deployed at Jessop Road E, Jessop Road W and Edward Street in 2021. 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: Maps of Monitoring Locations and AQMAs. 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.

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).

During 2021, the maximum NO_2 annual mean concentration recorded at a diffusion tube site within the Central Norwich AQMA was 40.2 µg/m^3 (DT11). Over the last five years, the NO_2 annual mean AQS objective (40 µg/m^3) has been exceeded at this site for every year, except 2020. There was only one further diffusion tube site within the AQMA that recorded an NO_2 annual mean concentration within 10% of the AQS objective (DT13: 36.4 µg/m^3). However, it is important to note that this diffusion tube is not located at a point of relevant exposure.

The maximum NO_2 annual mean concentration is relatively comparable to that recorded within the AQMA in 2020 (39.4 µg/m^3), indicating that there has not been a significant increase in NO_2 concentrations during 2021 in Norwich. For the two diffusion tube sites that are located outside of the AQMA (DT4 and DT40), the maximum NO_2 annual mean concentration was 21.3 µg/m^3 in 2021. Again, this is comparable to that recorded in the previous reporting year (21.5 µg/m^3), indicating that there has been no major increase in NO_2 outside of the AQMA.

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 annual mean NO_2 concentration recorded at the Castle Meadow automatic monitoring site (CM1) was 29.9 µg/m^3, which is the same as that recorded in the previous reporting year. At the Norwich Lakenfields urban background AURN monitoring site (CM2), the annual mean NO_2 concentration (10.2 µg/m^3) was also comparable to the NO_2 concentration recorded in 2020 (10.0 µg/m^3).

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 200µg/m^3, not to be exceeded more than 18 times per year.

The AQS objective for the NO_2 hourly mean concentration was not exceeded at either of the two automatic monitoring stations during 2021. A maximum NO_2 hourly mean concentration of 124.0 µg/m^3 and 73.2 µg/m^3 were recorded at CM1 and CM2, respectively. This is especially relevant for the Castle Meadow (CM1) automatic monitoring analyser as this site is located in a place where pedestrians typically stay for one hour or more. No single diffusion tube site recorded an annual mean NO_2 concentration greater than 60 µg/m^3, indicating that it is unlikely that the NO_2 hourly mean was to be exceeded at these sites.

3.2.2 Particulate Matter (PM_{10})

Table A.6 in Appendix A: Monitoring Results compares the ratified and adjusted monitored PM_{10} annual mean concentrations for the past five years with the air quality objective of 40µg/m^3.

The annual mean PM_{10} concentration at the Castle Meadow (CM1) automatic monitoring site was 18.9 µg/m^3, which is comparable to that recorded in both 2020 and 2019 (19 µg/m^3). For the AURN Norwich Lakenfields (CM2) monitoring site, the annual mean PM_{10} concentration was measured to be 13.0 µg/m^3 which, as with the CM1 site, is comparable to that of 2020 (13.0 µg/m^3).

Table A.7 in Appendix A compares the ratified continuous monitored PM_{10} daily mean concentrations for the past five years with the air quality objective of 50µg/m^3, not to be exceeded more than 35 times per year.

At the Castle Meadow (CM1) monitoring station, there were no PM_{10} 24-hour mean concentrations greater than 50 µg/m^3, with the maximum 24-hour mean being 46 µg/m^3. This concentration was exceeded once at the Norwich Lakenfields AURN site (CM2), with a daily concentration of 57.7 µg/m^3 being recorded. This is however well below the annual limit of exceedance limit of 35 days that the AQS objective allows the PM_{10} daily concentration to reach 50 µg/m^3.

The PM_{10} concentration recorded at both automatic monitoring stations demonstrates the compliance with both the annual mean and daily objective within Norwich during 2021.

3.2.3 Particulate Matter ($PM_{2.5}$)

Table A.8 in Appendix A presents the ratified and adjusted monitored $PM_{2.5}$ annual mean concentrations for the past five years.

The $PM_{2.5}$ annual mean concentration recorded at the Castle Meadow (CM1) automatic montiring site was 8.6 µg/m^3, whilst at the AURN Norwich Lakenfields (CM2) monitoring site, a $PM_{2.5}$ annual mean concentration of 8.5 µg/m^3 was recorded. It should however be noted that the $PM_{2.5}$ TEOM analyser at the Castle Meadow site is not considered to be equivalent to the reference measurement method. There is, however, a long history of $PM_{2.5}$ measurements in Norwich and the TEOM measurements can be used to track any reduction of the $PM_{2.5}$ annual mean. For example, relative to 2020, it can be seen that the $PM_{2.5}$ concentration has reduced from that in 2020 at the Castle Meadows site (10 µg/m^3), whilst there has been a marginal increase at the AURN Norwich Lakenfields site from the $PM_{2.5}$ that was measured in 2020 (8 µg/m^3).

3.2.4 Ozone (O_3)

Ozone monitoring is carried out at the Norwich Lakenfields site (CM2). There are no regulatory objectives for ozone, but the following statistics were recorded in 2021:

- Annual Mean 50.0 µg/m^3, 97% data capture (53.0 µg/m^3, 100% data capture in 2020).
- Air Quality Strategy Objective for 2005 (O3) daily maximum 8-hour running mean > 100 µg/m^3 on more than 10 days – 5 exceedances (27 in 2020).
- EC Population Information Threshold (O3) 1-hour mean > 180 µg/m^3 – 0 exceedances (6 in 2020).
- EC Health Protection Target Value (O3) daily maximum 8-hour running mean > 120 µg/m^3 on more than 25 days – 1 exceedance (0 in 2020).

Ozone is harmful to humans when inhaled and to plants when they respire. Urban pollutants such as NO_2 mop up ozone and hence, as NO_2 levels change, ground level ozone trends will be useful to capture. It could also be potentially used to provide public health alerts.

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	Castle Meadow	Kerbside	623202	308615	NO_x, NO_2, PM_{10}, $PM_{2.5}$	YES	Chemiluminescent; TEOM	N/A	1	2.5
CM2	Norwich Lakenfields (AURN – UKA00549)	Urban Background	623637	306940	O_3, NO_x, NO_2, PM_{10}, $PM_{2.5}$	NO	Chemiluminescent; FIDAS	20	N/A	2.5

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)
DT1A, DT1B	256 King St	Roadside	623863	307679	NO_2	YES (Central Norwich AQMA).	0.0	3.5	No	2.5
DT4A, DT4B, DT4C	Lakenfields AQS	Urban Background	623681	307016	NO_2	NO	20.0	1.5	Yes	2.5
DT6	130 Magdalen St	Roadside	623161	309550	NO_2	YES (Central Norwich AQMA).	0.0	4.0	No	2.5
DT9	13 St Augustine's Street	Kerbside	622906	309496	NO_2	YES (Central Norwich AQMA).	1.0	1.5	No	2.5
DT11	52 St Augustine's Street	Kerbside	622826	309573	NO_2	YES (Central Norwich AQMA).	0.0	1.0	No	2.5
DT13	Castle Meadow (Middle)	Roadside	623141	308607	NO_2	YES (Central Norwich AQMA).	N/A	2.5	No	2.5
DT16	Zipfel House	Roadside	623186	309650	NO_2	YES (Central Norwich AQMA).	0.0	3.0	No	1.5
DT19	27 Cattle Market Street	Roadside	623321	308431	NO_2	YES (Central Norwich AQMA).	0.0	2.0	No	1.5
DT21	Rotary House	Roadside	623880	307659	NO_2	YES (Central Norwich AQMA).	3.0	2.0	No	2.5
BT22	Carrow Bridge House	Roadside	623901	307710	NO_2	YES (Central Norwich AQMA).	0.0	5.0	No	3.0
DT25	Bargate Court	Roadside	623422	309388	NO_2	YES (Central Norwich AQMA).	0.0	4.0	No	3.0
DT26A, DT26B, DT26c	3 Riverside Rd	Roadside	623870	308516	NO_2	YES (Central Norwich AQMA).	0.0	3.0	No	3.0
DT29A, DT29B, DT29C	Chapel Field North	Kerbside	622532	308490	NO_2	YES (Central Norwich AQMA).	1.5	1.0	No	2.5
DT31A, DT31B, DT31C	Quantrell House	Kerbside	623380	307700	NO_2	YES (Central Norwich AQMA).	0.0	3.0	No	3.0

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)
DT34	41 St Stephens Street	Kerbside	622898	308114	NO_2	YES (Central Norwich AQMA).	6.0	0.5	No	3.0
DT37	7a Gunns Court	Kerbside	622492	308520	NO_2	YES (Central Norwich AQMA).	3.0	2.5	No	3.0
DT39	49 Duke St	Kerbside	622884	309082	NO_2	YES (Central Norwich AQMA).	0.0	1.0	No	3.0
DT40	St Stephens Rd (Kingsley Rd)	Roadside	622695	307855	NO_2	NO	1.5	2.0	No	2.2
DT41	Magdalen St (RSPCA)	Roadside	623148	309277	NO_2	YES (Central Norwich AQMA).	1.5	3.5	No	2.5
DT42	Magdalen St (Bus Stop)	Roadside	623151	309326	NO_2	YES (Central Norwich AQMA).	20.0	2.5	No	3.0
DT44	Botolph/Edwards St	Roadside	622910	309391	NO_2	YES (Central Norwich AQMA).	20.0	2.0	No	2.2
DT45	Pitt St W	Roadside	622904	309418	NO_2	YES (Central Norwich AQMA).	>20 n/a	2.2	No	2.1
DT46	Pitt St E	Roadside	622987	309486	NO_2	YES (Central Norwich AQMA).	>20 n/a	2.1	No	2.2
DT47	Duke St/St Crispins	Roadside	622869	309187	NO_2	YES (Central Norwich AQMA).	>20 n/a	2.5	No	2.1
DT48	Riverside/Aspland	Roadside	623878	308532	NO_2	YES (Central Norwich AQMA).	0.0	1.2	No	2.2
DT49	Queens Rd N	Roadside	623480	307679	NO_2	YES (Central Norwich AQMA).	0.0	2.0	No	2.2
DT50	Queens Rd S	Roadside	623474	307692	NO_2	YES (Central Norwich AQMA).	0.0	1.1	No	2.2
DT51	70 Bracondale	Roadside	624028	307323	NO_2	YES (Central Norwich AQMA).	0.0	2.5	No	2.1

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	623202	308615	Kerbside	91.6	91.6	**51**	**54**	**41**	30	29.9
CM2	623637	306940	Urban Background	87.8	87.8	13	12	13	10	10.2

☒ **Annualisation has been conducted where data capture is <75% and >25% in line with LAQM.TG22.**

☒ **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.TG22 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
DT1A, DT1B	623863	307679	Roadside	100.0	100.0	36.3	33.3	34.2	25.6	25.7
DT4A, DT4B, DT4C	623681	307016	Urban Background	100.0	100.0	13.9	11.8	12.0	10.0	9.8
DT6	623161	309550	Roadside	90.8	90.8	31.2	27.1	29.8	21.7	21.8
DT9	622906	309496	Kerbside	100.0	100.0	**41.5**	37.4	**40.1**	33.0	32.8
DT11	622826	309573	Kerbside	100.0	100.0	**53.6**	**44.4**	**46.0**	39.4	**40.2**
DT13	623141	308607	Roadside	100.0	100.0	**48.5**	**44.9**	**46.9**	35.5	36.4
DT16	623186	309650	Roadside	91.1	91.1	39.9	33.4	36.1	30.5	28.6
DT19	623321	308431	Roadside	100.0	100.0	37.7	36.1	34.8	22.9	23.7
DT21	623880	307659	Roadside	90.8	90.8	32.5	29.1	30.9	24.9	22.9
BT22	623901	307710	Roadside	100.0	100.0	25.3	31.1	29.4	21.7	21.6
DT25	623422	309388	Roadside	100.0	100.0	32.7	29.6	32.4	25.9	25.9
DT26A, DT26B, DT26c	623870	308516	Roadside	100.0	100.0	**44.2**	39.3	**43.3**	32.6	30.6
DT29A, DT29B, DT29C	622532	308490	Kerbside	100.0	100.0	37.1	**41.3**	**43.4**	29.8	29.4
DT31A, DT31B, DT31C	623380	307700	Kerbside	100.0	100.0	-	37.2	38.6	29.9	28.0
DT34	622898	308114	Kerbside	89.5	89.5	-	**41.2**	**40.3**	29.2	26.4
DT37	622492	308520	Kerbside	100.0	100.0	-	29.9	30.3	24.6	22.6
DT39	622884	309082	Kerbside	90.8	90.8	-	30.0	31.9	20.2	19.5
DT40	622695	307855	Roadside	100.0	100.0	-	-	32.6	21.5	21.3
DT41	623148	309277	Roadside	100.0	100.0	-	-	34.2	27.4	29.4

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
DT42	623151	309326	Roadside	91.4	91.4	-	-	33.0	21.4	27.4
DT44	622910	309391	Roadside	100.0	100.0	-	-	-	22.5	21.3
DT45	622904	309418	Roadside	90.8	90.8	-	-	-	25.4	22.7
DT46	622987	309486	Roadside	100.0	100.0	-	-	-	25.4	23.9
DT47	622869	309187	Roadside	100.0	100.0	-	-	-	19.8	22.1
DT48	623878	308532	Roadside	100.0	100.0	-	-	-	27.3	26.8
DT49	623480	307679	Roadside	100.0	100.0	-	-	-	24.9	24.7
DT50	623474	307692	Roadside	82.2	82.2	-	-	-	25.3	24.2
DT51	624028	307323	Roadside	100.0	100.0	-	-	-	-	27.2

☒ **Annualisation has been conducted where data capture is <75% and >25% in line with LAQM.TG22.**

☒ **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.TG22 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 (1)

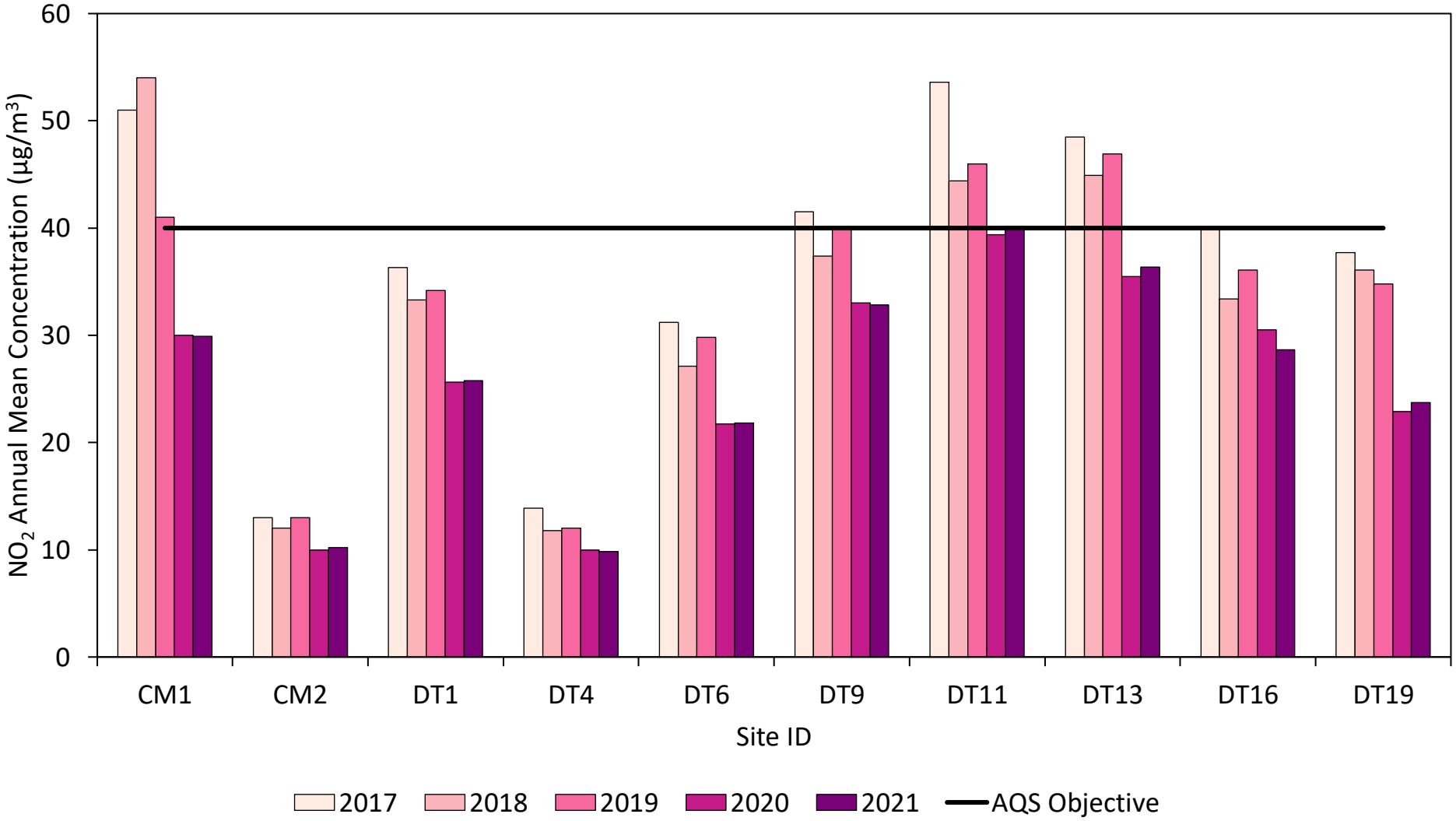


Figure A.2 – Trends in Annual Mean NO_2 Concentrations (2)

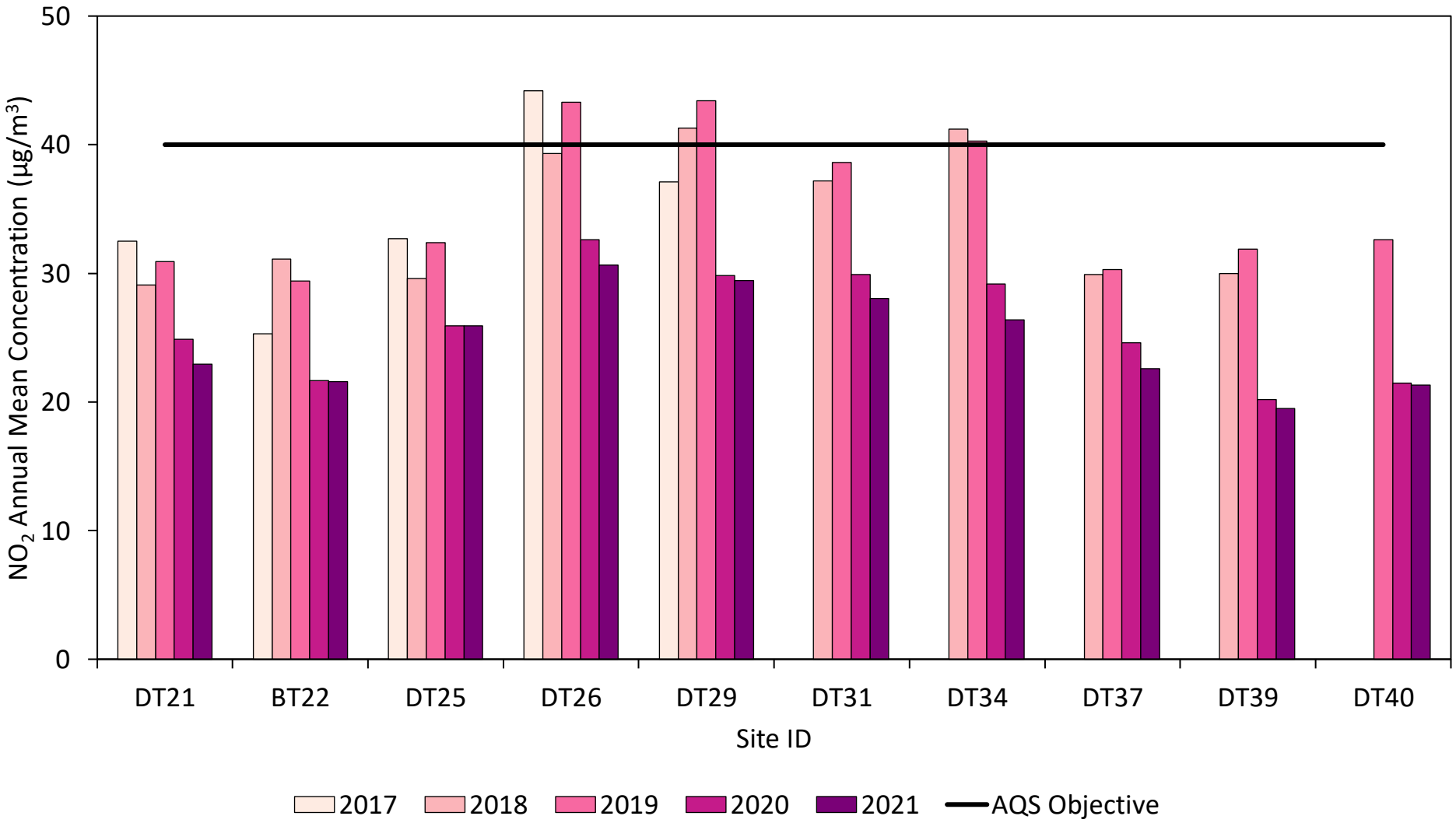


Figure A.3 – Trends in Annual Mean NO_2 Concentrations (3)

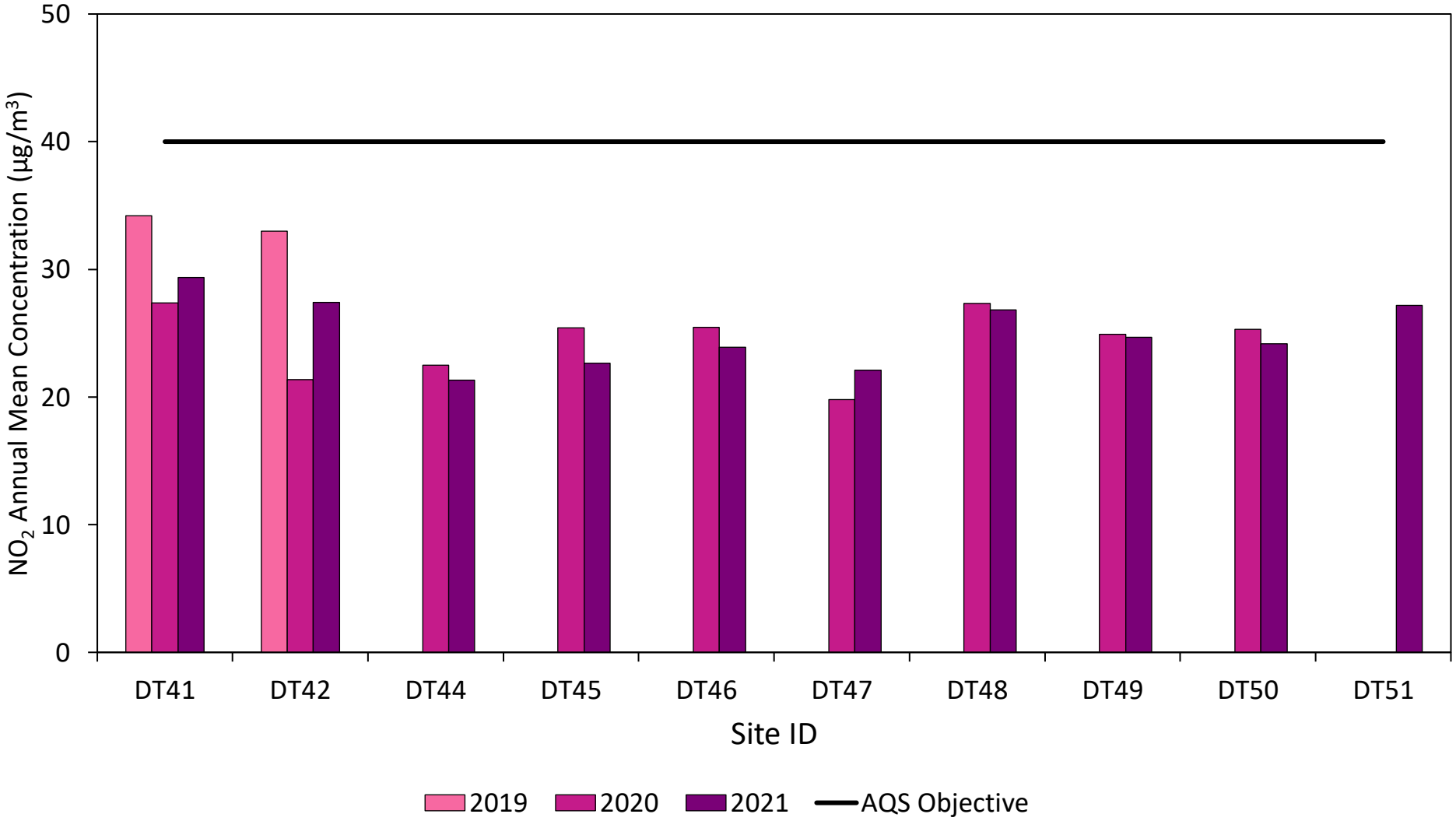


Table A.5 – 1-Hour Mean NO_2 Monitoring Results, Number of 1-Hour Means > 200µg/m^3

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	623202	308615	Kerbside	91.6	91.6	1	**19**	1	0	0
CM2	623637	306940	Urban Background	87.8	87.8	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%).

Table A.6 – Annual Mean PM_{10} Monitoring Results (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	623202	308615	Kerbside	92.3	92.3	23	27	19	19	18.9
CM2	623637	306940	Urban Background	97.4	97.4	16	16	14	13	13.0

☒ **Annualisation has been conducted where data capture is <75% and >25% in line with LAQM.TG22.**

Notes:

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

Exceedances of the PM_{10} annual mean objective of 40µg/m^3 are shown in **bold**.

All means have been "annualised" as per LAQM.TG22 if valid data capture for the full calendar year is less than 75%. See Appendix C for details.

(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.4 – Trends in Annual Mean PM_{10} Concentrations

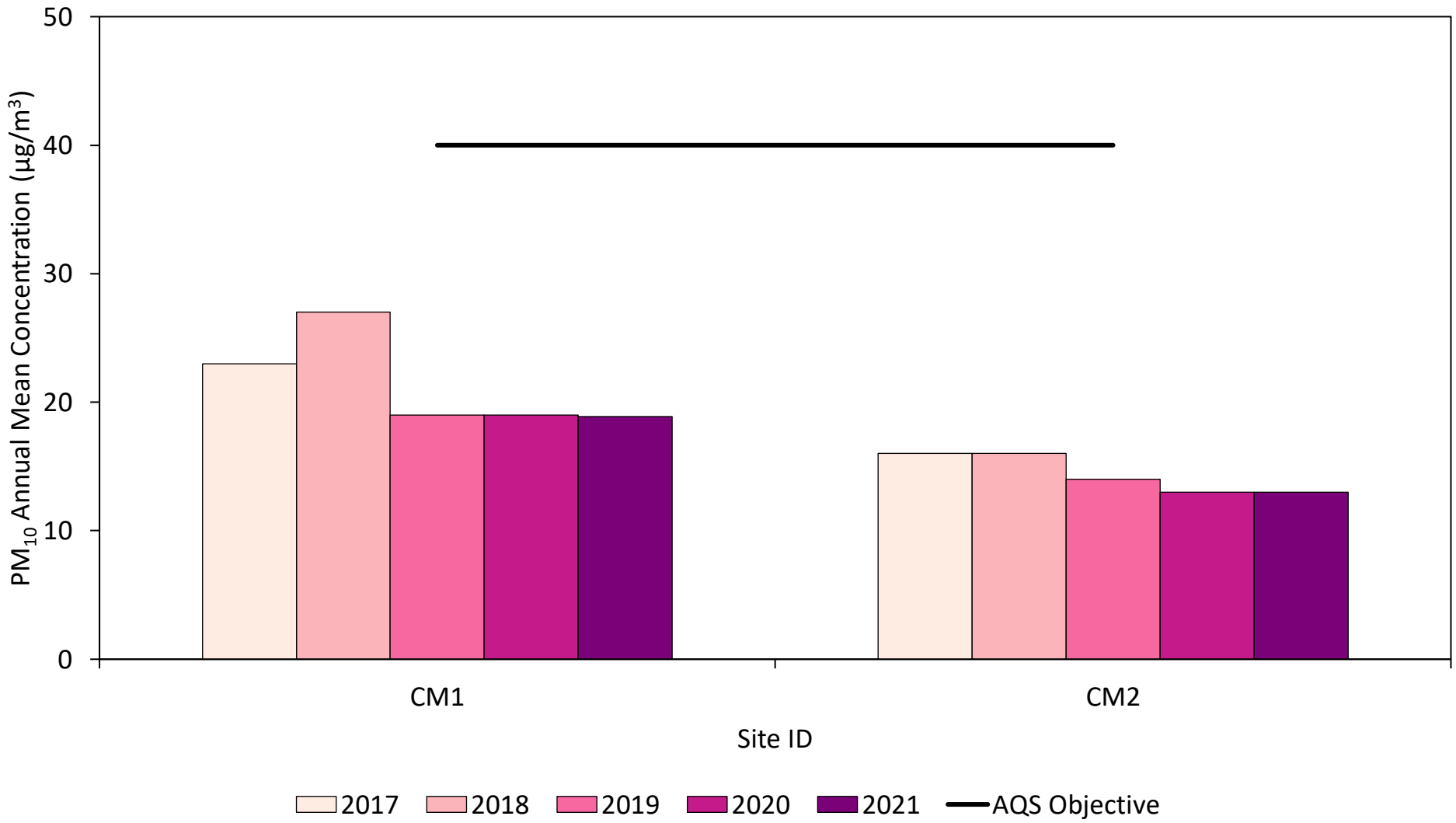


Table A.7 – 24-Hour Mean PM_{10} Monitoring Results, Number of PM_{10} 24-Hour Means > 50µg/m^3

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	623202	308615	Kerbside	92.3	92.3	4	8	5	0	0
CM2	623637	306940	Urban Background	97.4	97.4	5	1	4	0	1

Notes:

Results are presented as the number of 24-hour periods where daily mean concentrations greater than 50µg/m^3 have been recorded.

Exceedances of the PM_{10} 24-hour mean objective (50µg/m^3 not to be exceeded more than 35 times/year) are shown in **bold**.

If the period of valid data is less than 85%, the 90.4th percentile of 24-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%).

Table A.8 – Annual Mean $PM_{2.5}$ Monitoring Results ($\mu g/m^3$)

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	623202	308615	Kerbside	90.4	90.4	15	10	10	10	8.6
CM2	623637	306940	Urban Background	97.4	97.4	12	10	10	8	8.5

☒ **Annualisation has been conducted where data capture is <75% and >25% in line with LAQM.TG22.**

Notes:

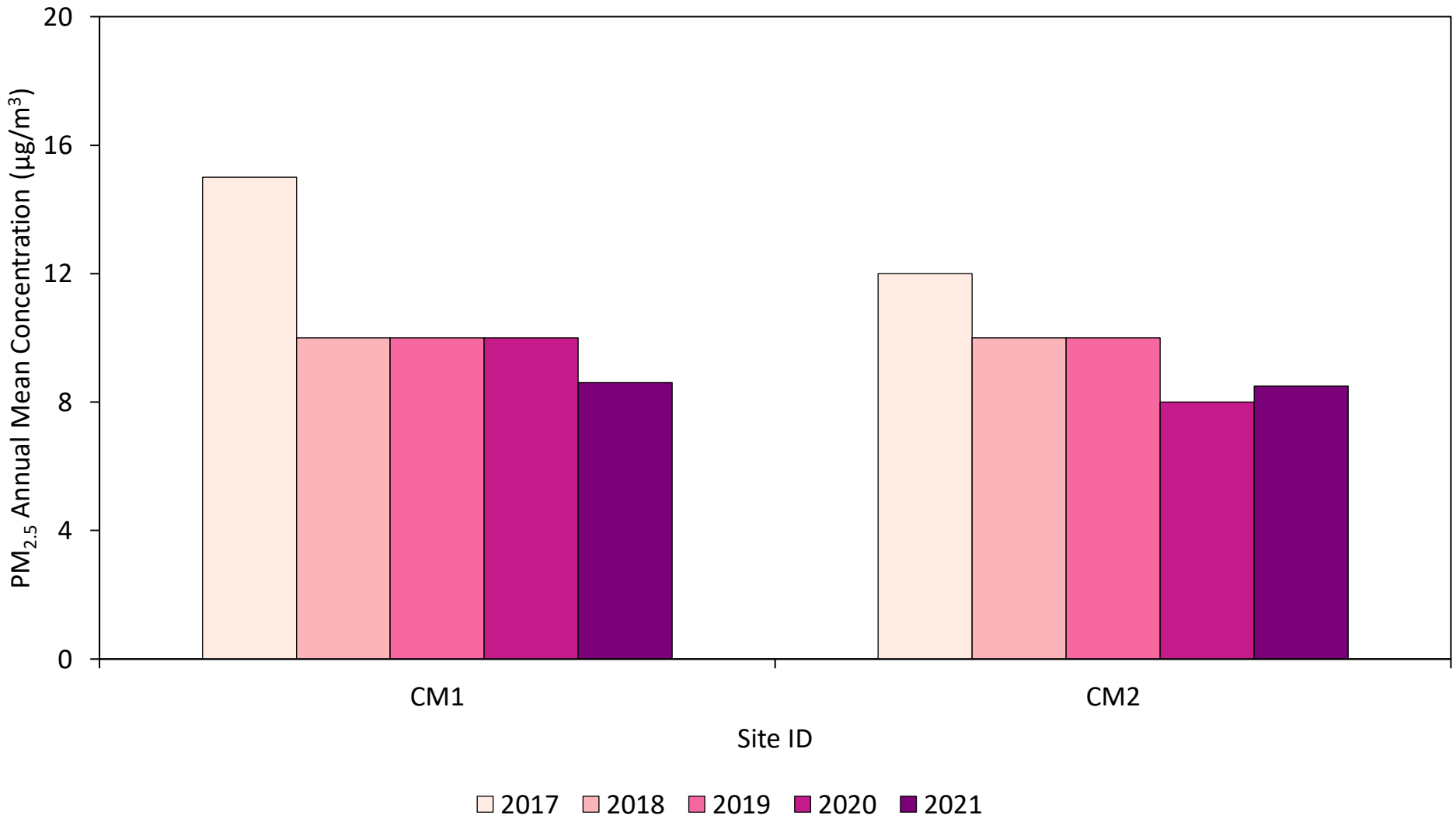
The annual mean concentrations are presented as $\mu g/m^3$.

All means have been “annualised” as per LAQM.TG22 if valid data capture for the full calendar year is less than 75%. See Appendix C for details.

(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.5 – Trends in Annual Mean $PM_{2.5}$ Concentrations



Appendix B: Full Monthly Diffusion Tube Results for 2021

Table B.1 – NO_2 2021 Diffusion Tube Results ($\mu g/m^3$)

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 (0.83)	Annual Mean: Distance Corrected to Nearest Exposure	Comment
DT1A	623863	307679	29.8	32.7	24.5	22.9	32.0	28.8	29.0	23.0	35.2	37.2	34.7	37.6	-	-		Duplicate Site with DT1A and DT1B - Annual data provided for DT1B only
DT1B	623863	307679	30.2	35.8	28.1	24.0	32.2	29.6	28.6	23.0	36.8	39.2	34.1	35.6	31.0	25.7		Duplicate Site with DT1A and DT1B - Annual data provided for DT1B only
DT4A	623681	307016	17.6	13.4	18.4	8.6	9.9	8.3	7.9	7.0	10.7	12.8	17.6	15.5	-	-		Triplicate Site with DT4A, DT4B and DT4C - Annual data provided for DT4C only
DT4B	623681	307016	17.3	12.2	11.3	8.1	8.8	8.2	7.9	6.2	9.7	13.3	20.1	14.6	-	-		Triplicate Site with DT4A, DT4B and DT4C - Annual data provided for DT4C only
DT4C	623681	307016	17.4	12.6	12.5	8.9	9.4	7.9	7.5	6.5	9.8	13.6	19.1	16.0	11.9	9.8		Triplicate Site with DT4A, DT4B and DT4C - Annual data provided for DT4C only
DT6	623161	309550	27.1	26.2	28.5	22.2	25.1	24.7	21.6	22.5	-	31.1	31.3	28.9	26.3	21.8		
DT9	622906	309496	40.0	38.9	39.1	41.4	41.7	41.8	40.4	36.7	38.2	36.2	42.0	38.1	39.5	32.8		
DT11	622826	309573	44.8	40.0	47.5	36.5	51.4	49.4	48.8	36.6	59.9	56.4	58.6	51.1	48.4	**40.2**		
DT13	623141	308607	40.5	40.3	42.7	43.8	47.4	45.5	45.1	36.6	49.1	45.5	49.6	39.9	43.8	36.4		
DT16	623186	309650	39.4	34.7	20.7	-	34.9	31.0	29.6	26.9	39.3	40.9	40.2	41.9	34.5	28.6		
DT19	623321	308431	12.2	32.1	25.1	23.9	30.9	28.2	31.5	22.8	38.8	38.2	27.2	32.1	28.6	23.7		
DT21	623880	307659	26.6	30.2	27.9	22.8	29.3	26.3	25.5	20.9	-	34.5	31.2	28.9	27.6	22.9		
BT22	623901	307710	31.6	22.4	26.6	23.5	24.1	25.3	20.5	22.3	23.9	26.8	36.1	28.8	26.0	21.6		
DT25	623422	309388	34.9	29.7	31.5	31.5	27.6	30.5	26.8	26.2	32.9	33.5	38.7	30.9	31.2	25.9		
DT26A	623870	308516	33.9	40.9	32.8	25.9	41.4	43.1	41.0	26.7	48.7	37.2	31.5	39.8	-	-		Triplicate Site with DT26A, DT26B and DT26c - Annual data provided for DT26c only
DT26B	623870	308516	33.6	40.6	33.3	27.0	42.6	44.9	39.1	29.8	46.5	37.3	30.7	38.9	-	-		Triplicate Site with DT26A, DT26B and DT26c - Annual data provided for DT26c only
DT26c	623870	308516	35.7	39.7	33.9	-	42.4	44.7	40.6	28.6	46.9	38.6	27.8	37.0	36.9	30.6		Triplicate Site with DT26A, DT26B and DT26c - Annual data provided for DT26c only
DT29A	622532	308490	35.5	30.0	36.2	39.4	37.6	38.6	39.1	40.1	34.0	33.3	34.4	35.9	-	-		Triplicate Site with DT29A, DT29B and DT29C - Annual data provided for DT29C only
DT29B	622532	308490	38.2	32.2	35.5	34.5	38.2	40.3	39.6	34.4	32.3	29.3	33.6	34.5	-	-		Triplicate Site with DT29A, DT29B and DT29C - Annual data provided for DT29C only

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 (0.83)	Annual Mean: Distance Corrected to Nearest Exposure	Comment
DT29C	622532	308490	37.2	32.9	35.9	37.4	38.9	-	29.9	35.2	33.8	30.1	36.3	32.8	35.5	29.4		Triplicate Site with DT29A, DT29B and DT29C - Annual data provided for DT29C only
DT31A	623380	307700	31.6	33.0	20.9	28.0	32.1	33.0	31.4	24.8	41.1	41.7	36.9	38.4	-	-		Triplicate Site with DT31A, DT31B and DT31C - Annual data provided for DT31C only
DT31B	623380	307700	35.3	33.4	34.8	24.1	33.8	29.9	31.6	24.1	36.8	43.2	40.4	39.1	-	-		Triplicate Site with DT31A, DT31B and DT31C - Annual data provided for DT31C only
DT31C	623380	307700	34.0	30.3	35.8	24.9	34.3	31.4	33.8	29.2	39.0	44.9	41.7	37.7	33.8	28.0		Triplicate Site with DT31A, DT31B and DT31C - Annual data provided for DT31C only
DT34	622898	308114	33.6	32.1	32.4	28.2	29.3	33.1	31.2	23.9	36.4	38.8	30.9		31.8	26.4		
DT37	622492	308520	30.2	28.3	30.1	22.6	25.5	25.1	22.6	21.0	26.2	32.0	30.5	32.4	27.2	22.6		
DT39	622884	309082	24.9	24.7	21.2	22.5	24.8	22.8	24.1	19.5	-	28.0	28.4	17.6	23.5	19.5		
DT40	622695	307855	24.9	27.8	26.0	23.4	23.0	25.8	22.7	18.6	28.1	30.5	30.7	26.5	25.7	21.3		
DT41	623148	309277	37.0	33.4	33.6	32.0	34.6	36.8	33.5	30.7	38.9	39.2	40.9	34.2	35.4	29.4		
DT42	623151	309326	37.4	33.3	31.3	24.8	30.5	-	27.6	26.4	36.7	40.5	39.5	35.0	33.0	27.4		
DT44	622910	309391	30.8	30.0	22.2	20.7	21.0	21.9	21.9	19.0	28.1	31.7	31.6	29.4	25.7	21.3		
DT45	622904	309418	26.5	32.7	26.5	22.2	28.2	26.8	25.0	23.1	-	33.2	27.9	28.2	27.3	22.7		
DT46	622987	309486	31.2	29.7	25.4	23.4	31.0	24.7	27.0	23.0	33.1	35.0	30.5	31.8	28.8	23.9		
DT47	622869	309187	29.3	27.5	23.7	26.7	27.1	23.9	23.3	19.6	29.6	27.4	33.7	27.6	26.6	22.1		
DT48	623878	308532	32.6	34.6	29.6	24.7	31.0	36.8	33.3	27.3	35.9	38.1	32.0	32.1	32.3	26.8		
DT49	623480	307679	29.5	32.0	25.4	31.8	28.9	29.8	28.3	26.1	30.7	30.5	31.3	32.3	29.7	24.7		
DT50	623474	307692	31.5		30.7	21.9	28.4	26.8	28.7	23.6	-	35.3	36.3	28.2	29.1	24.2		
DT51	624028	307323	33.0	34.7	31.5	39.3	35.9	32.7	34.6	25.1	32.7	27.8	31.8	33.8	32.7	27.2		

☒ **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.TG22.**

☐ **Local bias adjustment factor used.**

☒ **National bias adjustment factor used.**

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

☒ **Norwich City 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 Norwich During 2021

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

Additional Air Quality Works Undertaken by Norwich City Council During 2021

Norwich City Council has not completed any additional works within the reporting year of 2021.

QA/QC of Diffusion Tube Monitoring

The diffusion tubes deployed in 2021 were supplied and analysed by Gradko International using the 50% TEA in acetone preparation method. Gradko International are a UKAS accredited laboratory, partaking in the AIR-PT scheme for NO_2 diffusion tube analysis and Annual Field Intercomparison Exercise. These provide strict criteria relating to the performance that participating laboratories must meet, thereby ensuring that the reported NO_2 concentrations are of a high calibre. In the first round of results during 2021, running from January – March (AIR-PT AR042), Gradko International were awarded a score of 25%. The percentage is an indication of the results deemed satisfactory based upon the z-score of < ±2. At the time of writing this report, the AIR-PT results for April – December 2021 were not available. For all 14 observations in 2021, the precision of NO_2 diffusion tubes supplied by Gradko International were classified as ‘good’. The precision is an indication of the laboratory’s performance and consistency in both the preparation, analysis and handling of the diffusion tubes. Full details of the precision summary results are available here.

During 2021, the diffusion tubes were not deployed in line with the monitoring calendar, with some changes occurring four or five days after the specified date. However, no diffusion tube was left out beyond the recommended four to five weeks of TG(22). As a result, data has not had to be removed for any month, and all data has been used in the annual results.

Diffusion Tube Annualisation

All diffusion tube monitoring locations within Norwich recorded data capture greater than 75%, therefore it was not required to annualise any monitoring data. In addition, any sites with a data capture below 25% do not require annualisation. During 2021, the data capture across the diffusion tube network ranged from a minimum of 82% to a maximum of 100%. Indeed, 20 of the 28 diffusion tube sites recorded a data capture of 100% in 2021, indicating that the diffusion tube network was well maintained, with minimal loss of data occurring.

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.

Norwich City Council have applied a national bias adjustment factor of 0.83 to the 2021 monitoring data (Figure C.1 – spreadsheet 03/22). A summary of bias adjustment factors used by Norwich City Council over the past five years is presented in Table C.1.

A triplicate co-location study is carried out by Norwich City Council at the AURN monitoring site (Norwich Lakenfields). During 2021, the local bias adjustment factor was calculated to be 0.81 (Table C.2). However, it should be noted that this automatic monitoring station is an urban background site and, therefore, does not represent the roadside characteristics of the AQMA diffusion tube locations. Hence, the national bias adjustment factor has usually been used by Norwich City Council. For this reason, combined with taking the more conservative approach, the national bias adjustment factor has been applied to the 2021 monitoring data.

Figure C.1 – National Bias Adjustment Factor Spreadsheet 03/22

Step 1:	Step 2:	Step 3:	Step 4:								
Select the Laboratory that Analyses Your Tubes from the Drop-Down List	Select a Preparation Method from the Drop-Down List	Select a Year from the Drop-Down List	Where there is only one study for a chosen combination, you should use the adjustment factor shown with caution. Where there is more than one study, use the overall factor[3] shown in blue at the foot of the final column.								
If a laboratory is not shown, we have no data for this laboratory.	If a preparation method is not shown, we have no data for this method at this laboratory.	If a year is not shown, we have no data[2]	If you have your own co-location study then see footnote[4]. If uncertain what to do then contact the Local Air Quality Management Helpdesk at LAQMHelpdesk@bureauveritas.com or 0800 0327953								
Analysed By[1]	Method To undo your selection, choose (All) from the pop-up list	Year[5] To undo your selection, choose (All)	Site Type	Local Authority	Length of Study (months)	Diffusion Tube Mean Conc. (Dm) (µg/m³)	Automatic Monitor Mean Conc. (Cm) (µg/m³)	Bias (B)	Tube Precision[6]	Bias Adjustment Factor (A) (Cm/Dm)	
Gradko	50% TEA in acetone	2021		Overall Factor[3] (14 studies)				Use		0.83	

Table C.1 – Bias Adjustment Factor

Monitoring Year	Local or National	If National, Version of National Spreadsheet	Adjustment Factor
2021	National	03/22 (14 studies)	0.83
2020	Local	-	0.88
2019	National	09/20 (29 studies)	0.89
2018	Local	-	0.86
2017	National	03/18 (18 studies)	0.97

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.

The NO_2 annual mean concentration at site DT13 required distance correction. This site was subject to such calculation as the annual mean concentration (36.4 µg/m^3) was within 10% of the AQS objective and the monitoring site is not located at a point of relevant exposure. However, this site was not distance corrected as the diffusion tube is a significant distance from a point of relevant exposure, therefore an accurate estimation could not be obtained.

QA/QC of Automatic Monitoring

In order to satisfy the requirements outlined in LAQM TG(22), at the Norwich City Council owned automatic monitoring station (Castle Meadow), the following QA/QC procedures were implemented:

- 2-weekly calibrations of the analysers, carried out by a member of the Norwich City Council Public Protection team.
- Annual audits.
- 6-monthly servicing of the monitoring sites.
- Data ratification.

Calibration of the analysers was carried out using certified compressed gas standards (ISO17025). This ensured that the calibration gas was traceable to the national and international standards. In addition to the calibration, sample filters were changed for both

gaseous and TEOM analysers and any faults were identified, thus minimising data loss. Audits of the monitoring sites were carried out by Ricardo-AEA Ltd and consisted of a number of performance checks to identify any faults with the equipment. The calibration cylinders were also checked against other standard gas to confirm the gas concentration. Any identified faults were forwarded on to the service unit for repair.

Both the validation and ratification of data from the Castle Meadow automatic monitoring station is provided by Air Quality Data Management (AQDM) to the standards described in LAQM TG(22). Validation is the process that operates on data during the collection stage; all data is continually screened algorithmically and manually for anomalies. The anomalies may occur due to equipment failure, human error, power failure, interferences or other disturbances. Ratification is the process that finalises the data to produce the measurements suitable for reporting. All available data is critically assessed so that the best data scaling is applied and all anomalies are appropriately edited; generally, this occurs at three, six or twelve month intervals. Public access to live/historic data is available on the AQDM website.

The Norwich Lakenfields automatic monitoring station is part of the AURN operated by Bureau Veritas. The AURN have appointed LSO's and servicing is conducted by Acoem UK on a six monthly basis. Audits are conducted by Ricardo-AEA Ltd annually. Live and historic data is available through the Defra website.

PM_{10} and $PM_{2.5}$ Monitoring Adjustment

The Volatile Correction Method (VCM) allows corrections to be applied to the TEOM measurements for the loss of volatile components of particulate matter that occur due to the high sampling temperatures employed by these instruments. The resulting corrected measurements have been demonstrated as equivalent to the gravimetric reference equivalent. The VCM works by using the volatile particulate matter measurements provided by nearby FDMS instruments (within 130 km) to assess the loss of PM_{10} from the TEOM; this value is then added back onto the TEOM measurements. The VCM model was applied to the Castle Meadow TEOM data to calculate the indicative gravimetric equivalence PM_{10} for the annual mean and 24-hour mean readings. The Norwich Lakenfields AURN site has a FIDAS analyser to monitor PM_{10} and $PM_{2.5}$.

Automatic Monitoring Annualisation

All automatic monitoring locations within Norwich recorded data capture of greater than 75% therefore it was not required to annualise any monitoring data.

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 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 automatic NO_2 monitoring locations within Norwich required distance correction during 2021.

Table C.2 – Local Bias Adjustment Calculation

	Local Bias Adjustment Input 1
Periods used to calculate bias	10
Bias Factor A	0.81 (0.72 – 0.93)
Bias Factor B	23% (7% – 38%)
Diffusion Tube Mean (µg/m^3)	11.3
Mean CV (Precision)	4.2%
Automatic Mean (µg/m^3)	9.2
Data Capture	100%
Adjusted Tube Mean (µg/m^3)	9 (8 – 10)

Notes:

Although not used to bias adjust the 2021 data, the results of the co-location study are presented for transparency.

Appendix D: Maps of Monitoring Locations and AQMAs

Figure D.1 – Map of Automatic & Non-Automatic Monitoring Sites (Overview)

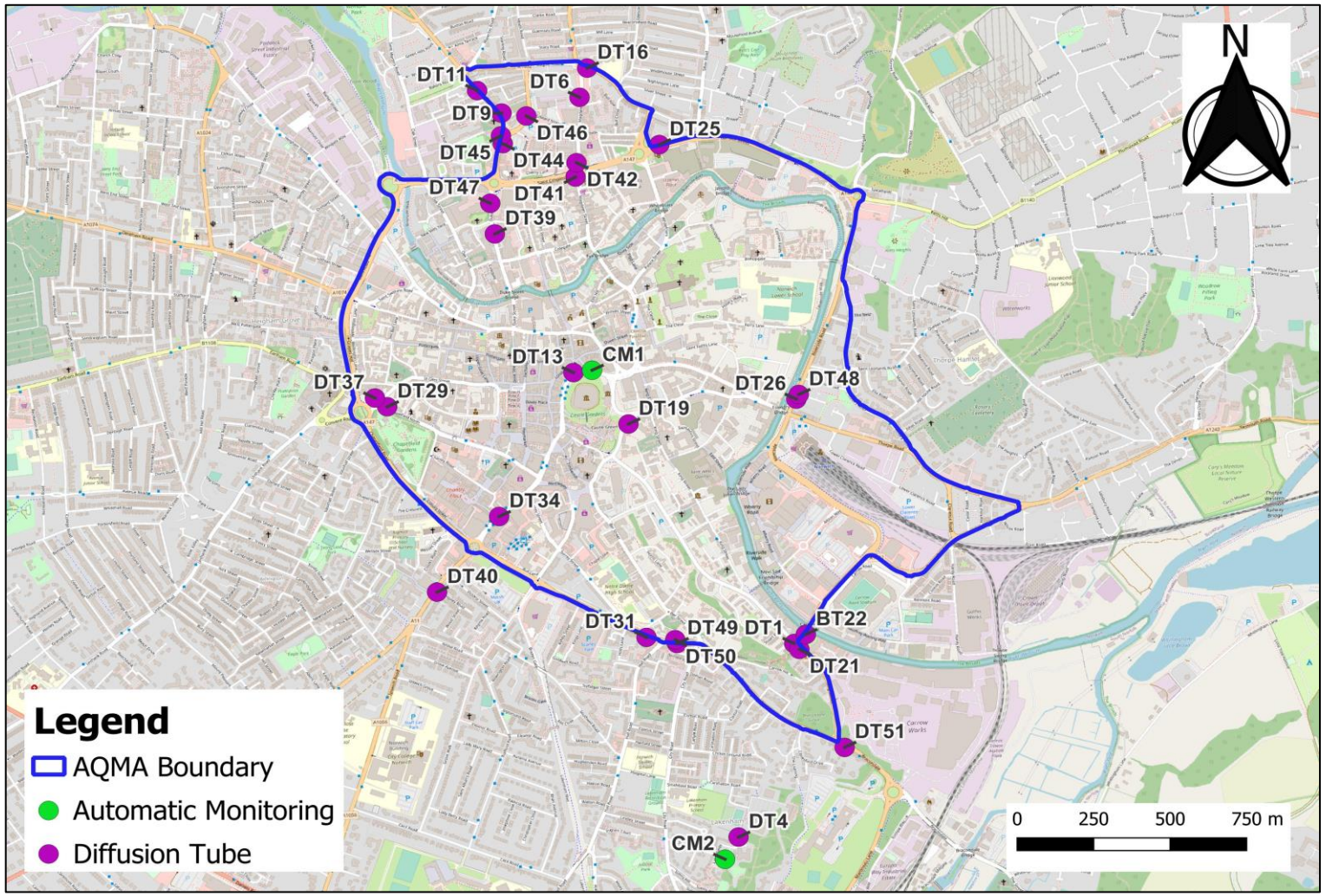


Figure D.2 – Map of Non-Automatic Monitoring Sites (North of AQMA)

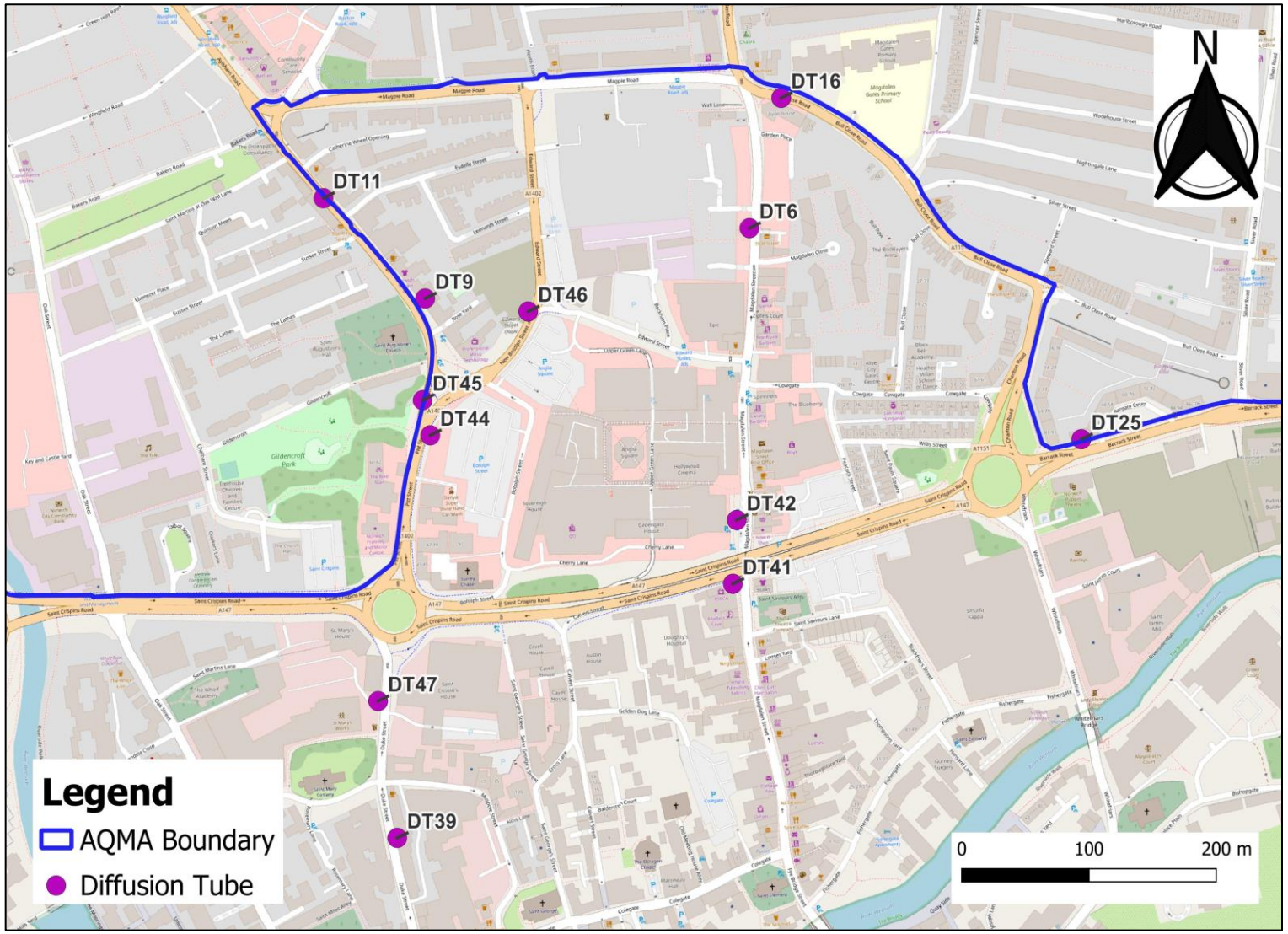


Figure D.3 – Map of Automatic & Non-Automatic Monitoring Sites (Centre of AQMA)

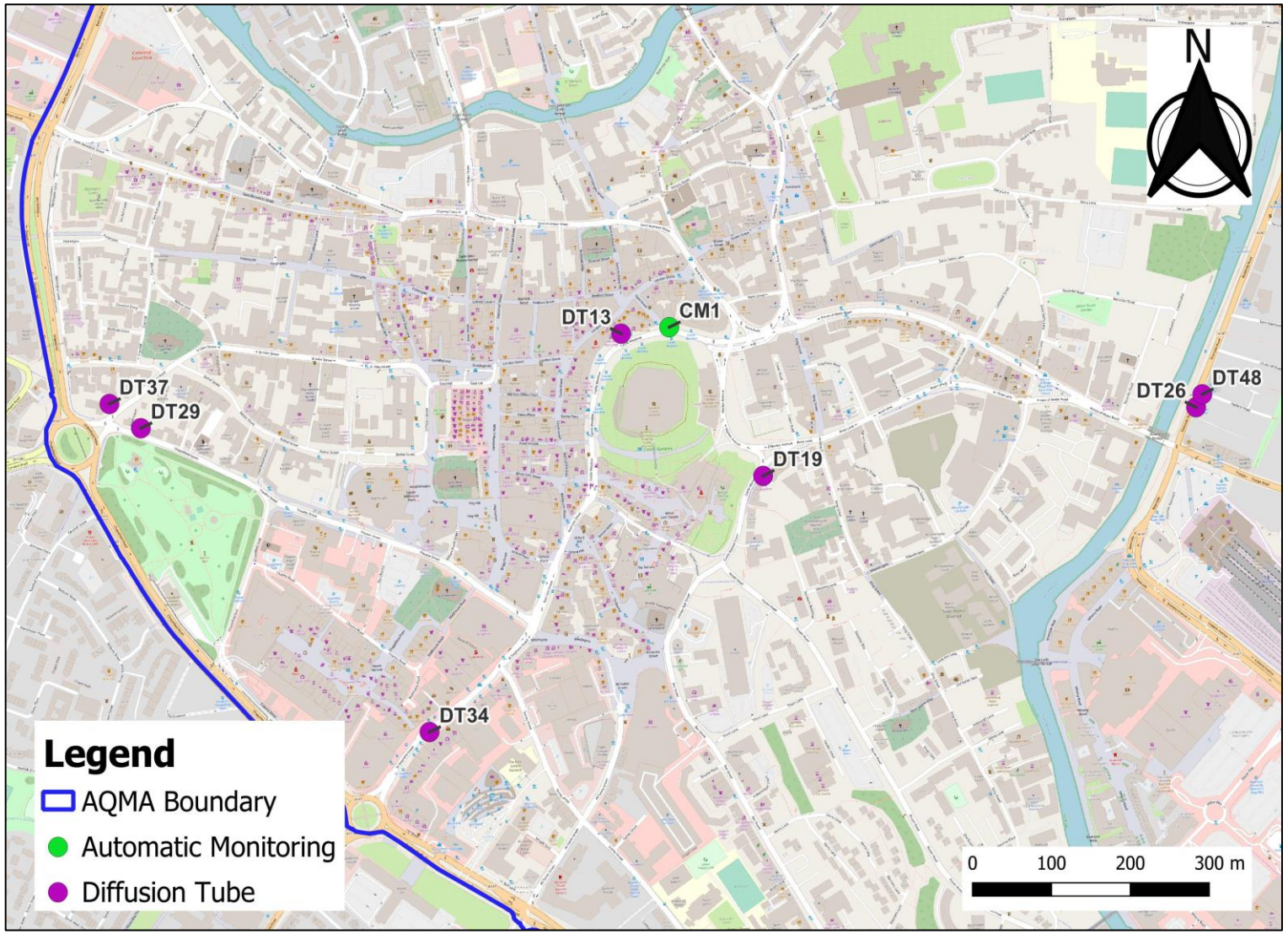
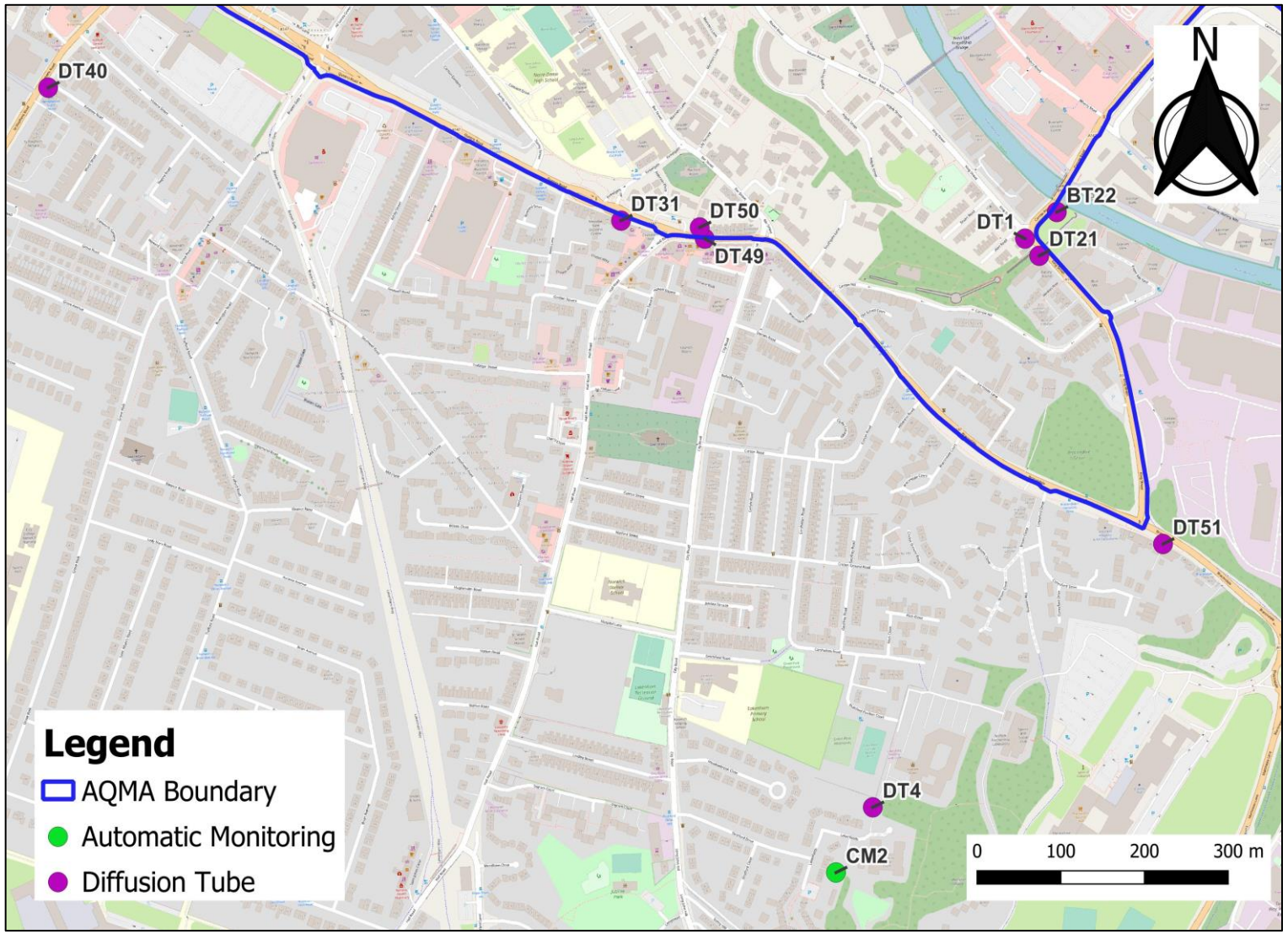


Figure D.4 – Map of Automatic & Non-Automatic Monitoring Sites (South of AQMA)



Appendix E: Summary of Air Quality Objectives in England

Table E.1 – Air Quality Objectives in England[7]

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

[7] 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
AURN	Automatic Urban and Rural Network
Defra	Department for Environment, Food and Rural Affairs
EU	European Union
FDMS	Filter Dynamics Measurement System
LAQM	Local Air Quality Management
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
O_3	Ozone
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
TEOM	Tapered Element Oscillating Microbalances

References

- Local Air Quality Management Technical Guidance LAQM.TG22. 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.PG22. May 2016. Published by Defra in partnership with the Scottish Government, Welsh Assembly Government and Department of the Environment Northern Ireland.