NORWICH City Council

2021 Air Quality Annual Status Report (ASR)

In fulfilment of Part IV of the Environment Act 1995

Local Air Quality Management

Date: December 2021

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Report Reference Number	NCC/ASR/2021
Date	January 2022

Executive Summary: Air Quality in Our Area

Air Quality in Norwich City 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].

Norwich covers approximately 39 square kilometres in the heart of Norfolk with a population of circa 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 circa 381,200. Norwich is the fourth most densely populated local authority district in the eastern region with approximately 3480 people per square kilometre.

Norwich City Council (also referred to as 'the council') permits 29 'Part B' processes which includes a road stone coating plant, a sawmill & timber treatment process, a cement batching installation, aircraft & vehicle re-sprayers and a crematorium. The Environment Agency permits larger 'Part A' processes which comprises just Briar Chemicals, an agrochemical company. 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 20MW natural gas boiler and 3 natural gas combined heat and power engines that produce a combined 5.7MW of electricity and

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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 2020

[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

6MW of heat. The neighbouring Eaton School feeds off this boiler. Stack height has been designed to provide good dispersion and hence this source of NO_2 is again not considered to contribute with any significance to pollution levels in Norwich.

The major pollutant source in the city is road traffic. Source apportionment exercises identify oxides of nitrogen from road traffic to be the most significant source of nitrogen dioxide (NO_2). In Norwich, the main contributor is buses with diesel engines, oxides of nitrogen are a by-product of incomplete combustion. An Air Quality Management Area (AQMA) covering an area around the centre of Norwich was declared in 2012 due to exceedances of the annual mean NO_2 objective (See Appendix E).

In 2021 the council produced an updated Air Quality Action Plan (AQAP) that sets out measures which should work towards achieving the national air quality objectives. The action plan can be accessed on the council website by following this link:

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The 2021 Annual Status Report (ASR) refers to measures proposed in the new 2021 Air Quality Action Plan.

Norwich City Council proposes to continue with both automatic continuous NO_2 monitoring in tandem with passive diffusion tube monitoring.

Diffusion tube locations are reviewed annually. Locations are determined where pollution hotspots are anticipated and include sites where road changes may have had an impact on NO_2 levels, such as where higher traffic loading has resulted on alternative routes. In 2020, diffusion tube locations were also chosen in response to the submission of a planning application for a large development at Anglia Square. This was so baseline pollutant levels could be determined prior to any potential development.

As a result, at the start of 2020:

- 1 NO_2 diffusion tube was removed from a triplicate of diffusion tubes
- 29 diffusion tube locations were retained
- 1 new diffusion tube location was added
- 2 diffusion tubes were added for a small 3 month survey outside a school

It is believed the data presented in this report, when assessed against the national annual mean objective levels, only provides an indicative assessment of pollution levels as the data has been substantially affected by the impact the Covid-19 pandemic has had on traffic levels. The continuous analysers do however provide some very interesting results when monthly means are evaluated. As a result, no adjustments will be made to passive diffusion tube (DT) monitoring positions for the following year as limited confidence can be given to the results for 2020 but monitoring positions will be added to as further road infrastructure changes are implemented.

The requirement for a detailed assessment has not been identified for any pollutants and the council will progress to the 2022 Annual Status Report (ASR).

A new raft of road changes is programmed as a result of the successful Transforming Cities Fund bid. This will see £32m spent mostly on infrastructure changes aimed principally at:

- reducing levels of cross-city through traffic and directing more of the city centre traffic directly onto the inner ring road,
- alleviating congestion by installing smart traffic signalling,
- facilitating bus upgrades to cleaner engines (Euro 6 specification/zero emission), and
- enabling more direct, connected and safer cycle and pedestrian routes into and across the city.

This report has been undertaken in accordance with the Local Air Quality Management Technical Guidance (TG16) and associated tools (updated 2018).

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 even more ambitious than EU requirements 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

[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

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.

Air pollution has risen up the corporate agenda at Norwich City Council since the first round of Review & Assessment. For example, the Transport Planning Officer must consider air quality issues for all new developments and Norfolk County Council has incorporated a local air quality strategy into its Local Transport Plan.

The 2021 Air Quality Action Plan (AQAP) proposes new measures with bold deadlines, strengthening the strategies that are believed to have had the greatest impact on improving air quality. As a result, the AQAP focuses principally on road infrastructure changes designed to further divert general traffic away from the congested city centre and re-allocate more road space to walking and cycling. In addition, the policy has been to encourage the use of public transport by prioritising bus routes, improving bus frequency on key routes and providing easy access to Park & Ride facilities. The policy has also been to encourage cycling by lengthening and linking up cycle routes as well as providing segregated and safer routes, paying particular attention to major junctions.

Most of the road changes reported in the 2015 Action Plan have been implemented but the bus and taxi only roads remain some of the most polluted in Norwich. Norfolk County Council are continuing to encourage bus companies to upgrade or replace their older more polluting vehicles. The ultimate aim is to minimise emissions from traffic as much as possible and, although an application by Norfolk County Council to government in 2020 to become an all-electric bus city was not successful, every opportunity will continue to be taken to achieve this.

Significant works have now been completed in much of the city centre area of Norwich and includes the creation of more pedestrian areas and 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 be another step forward in supporting the vitality of the city centre by reducing conflict between vehicles, pedestrians and cyclists while maintaining access for all modes of travel. It is strongly believed this will contribute to improvement in air quality in the surrounding areas.

A key proposal in the 2015 AQAP was to work with local bus companies to encourage updating of bus fleets. The 2021 Action Plan is considerably bolder in this respect and reaffirms the commitment to agreeing with bus operators a date for Euro 6, and ultimately zero emission, compliance. It goes further still and proposes geographical extensions to the LEZ by including the bus and taxi only streets adjoining Castle Meadow i.e. Red Lion Street, St Stephens Street & Rampant Horse Street.

In 2020, First Bus pledged to make an £18m investment in its fleet and purchase 55 new Euro 6 buses. This will enable the operator to remove all Euro 3 & 4 diesels from its fleet, leaving only a few Euro 5 buses. This is a huge achievement for collaborative working between County Council and bus operators. As First Bus are the main bus operator in Norwich, accounting for 75% of the public transport network, this upgrade will convert directly into quantifiable improvements in air quality when fully implemented in 2023. Discussions are underway with First Bus regarding the opportunity for their £18m investment to be redirected towards zero emission vehicles instead.

The Norwich Park & Ride contract is due for renewal 2022/23. This provides an opportunity for Norfolk County Council to introduce low/zero emission vehicles. Ticket price will however also be a crucial driver and establishing a sustainable balance between these two requirements will be key.

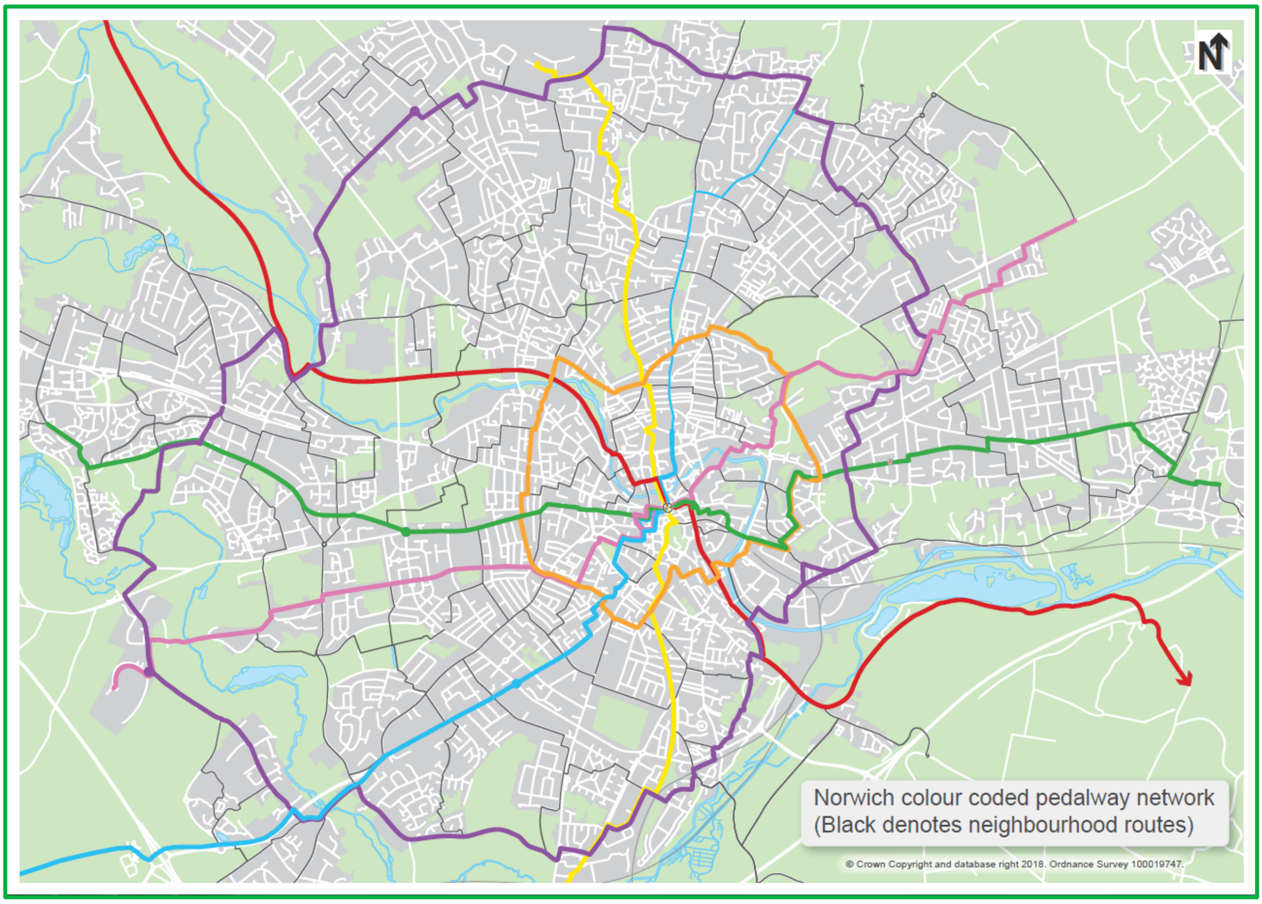
The transport strategy for Norwich was reviewed in 2020/21. It considers what interventions are needed to address issues of air quality and carbon emissions. Interventions considered include restricting certain types of vehicles within specific areas of Greater Norwich, the number and pricing of city centre car parking spaces and a levy being raised based on parking provision. This review considers the impacts of a behaviour change strategy, the integration of different transport modes and the adoption of a corridor-based approach with emphasis on different corridors being prioritised for different modes. The new Transport Strategy for Norwich was adopted in Winter 2021.

A further approach undertaken by the council to improve air quality was engine switch off enforcement. Enforcement commenced in the autumn 2018 on bus and taxi only roads i.e. Castle Meadow and St Stephens Street. The 2021 Action Plan recommends this policy be rolled out across the proposed extended Low Emission Zone (LEZ) and ultimately throughout the AQMA. To date all drivers have been compliant and no Fixed Penalty Notices have been issued but further work with bus operators may be required to ensure the message is fully embraced.

The Norwich Bus Charter is a voluntary agreement between councils and bus operators and is due a comprehensive review as part of the Norfolk Bus Service Investment Plan (BSIP) launched in October 2021. This sets out a 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 first choice mode of transport for most journeys. There is the aim for 90% of buses in Norfolk being Euro V, VI or zero emission by 2027.

The cycle network for the greater Norwich area commenced in 2012 and was completed in 2020. It comprises 5 radial and 2 orbital pedalway routes and a number of neighbourhood cycle routes connecting those pedalway routes. Each of the 7 pedalways is colour coded as shown on the map below.

City Schematic of Norwich Pedalways



Both the council and Norfolk County Council have made a concerted effort to increase cycle connectivity, improve cycle paths at major road junctions, install bus & cycle priority lanes and promote cycling as a mode of transport. This has paid off as cycling has increased by >40% over this time, albeit enhanced by increasing student numbers.

This increase in cycling is only expected to escalate further now that Norwich has a bike/scooter share scheme in place with over 80 bays across the city. There are currently 470 standard bikes, 115 electric bikes and 250 electric scooters.

Another key action, completed in April 2018, was the construction of the Norwich Northern Distributor Road (NDR), now renamed 'Broadland Northway'. The Broadland Northway provides a dual carriageway link from the national road network to Norwich International Airport and beyond, serving a large area of Broadland and North Norfolk including existing and planned business and housing areas.

Traffic monitoring has shown that the Broadland Northway has:

- Reduced traffic flows & congestion on the northern sections of the Outer Ring Road, key northern radial routes and on unsuitable residential and rural roads – equating to about 40,000 vehicles/day
- Reduced general traffic travelling through the city centre
- Significantly improved access for north Norwich and north & northeast Norfolk, the wider road network and to Norwich International Airport
- Provided the transport infrastructure needed to allow planned and proposed growth
- Increased the opportunities for improving public transport and the provision for pedestrians and cyclists.

Plans to construct the Western Link, which will connect the western end of the Broadland Northway with the A47 to the west of Norwich, are being developed. The Strategic Outline Business Case (SOBC) for the Western Link was approved by government in May 2020 and work to develop the Outline Business Case (OBC) is ongoing. A construction date of 2023-2025 is forecast.

More information on the Broadland Northway is available on the county council website here:

https://www.norfolk.gov.uk/roads-and-transport/major-projects-and-improvement-plans/norwich/northern-distributor-road.

More information on the Western Link can be found here: https://www.norfolk.gov.uk/roads-and-transport/major-projects-and-improvement-plans/norwich/norwich-western-link.

More information on transport projects within Norwich can be found on the County Council website here:

https://www.norfolk.gov.uk/roads-and-transport/major-projects-and-improvement-plans/norwich/city-centre-improvements

Norwich City and Norfolk County Council are invested in trialling the implementation of "School Streets"[7], i.e. unpolluted and safe roads outside schools where traffic restrictions apply at school times. It is hoped this will encourage children to walk and cycle to school. The trial is scheduled to commence in 2022 with air quality monitoring outside of schools being conducted using low-cost mobile monitors and diffusion tubes.

In a further attempt to aid a modal shift, County are releasing an online Road Cycling Safety course aimed specifically for schools.

Electric vehicle charging points within the Norwich City Council district boundary now total 57 x 7kW or above. Seven of these EV points are owned by the council and are located in Rose Lane Car Park plus 1 x 50kW rapid charger in Earlham Park Car Park next to the University of East Anglia Enterprise Centre. The council will continue to encourage the installation of electric charging points, and for significant planning projects, it has been made an imperative of the application.

The council works with 6 other Local Authorities to form a Norfolk Environmental Protection Group (NEPG) - Air Quality sub-group. The purpose is to ensure consistency of approach throughout the county and to share experience and success stories. Another benefit of the group is it gives a forum for engagement with representatives of Highways at Norfolk County Council and Public Health Norfolk. Both Highways and Public Health representatives participate regularly in the NEPG sub-group meetings and play an important role at feeding information into the group, participating in collaborative events such as Clean Air Day and identifying potential funding initiatives. In 2020, these meetings were mostly conducted online due to Covid-19 restrictions but will resume once workload and constraints resulting from the pandemic are eased.

In early 2018, a working group of representatives from Norwich City Council, Broadland District Council, South Norfolk Council and Norfolk County Council (Highways) was set up specifically to develop a multi-authority approach to tackling poor air quality from transport within the Greater Norwich Area. The aims of the group are:

- To produce a positive change to air quality resulting from transport.
- To develop better education of all road users as to the effect of transport emissions on human health and the wider environment.

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http://schoolstreets.org.uk/[7]

- Commit to working as a team to consider air quality as a cross boundary issue.
- Commit to working with stakeholders to develop and implement projects.
- Identify joint funding opportunities for delivering air quality projects.
- Collate data on air quality before, during and after projects.
- Evaluate the impact of air quality improvement projects and determine if they have been effective and are appropriate for adoption elsewhere.
- Share findings of projects with interested third parties.

These meetings were also curtailed during the Covid-19 pandemic but will be resumed as soon as is possible.

A good working relationship has been developed with the Environmental Science Department at 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. One such project currently being investigated is the speciation of $PM_{2.5}$ in Norwich. Collaborations with the UEA may also provide a more holistic approach to projects when applying for government funding.

Conclusions and Priorities

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

The council proposes to continue with automatic and passive NO_2 monitoring within the city area. As completion of road changes are implemented, City Council will review the locations of passive monitoring positions so 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. In this way the full impact of the proposed road schemes can be assessed.

No excursions of the NO_2 objective were measured outside of the central AQMA. In 2020, Covid-19 lockdown and restrictions resulted in severely reduced vehicle activity. No monitoring locations, automatic or passive, exceeded the NO_2 objective level. Even if traffic volumes fail to return to pre-pandemic levels, 2020 NO_2 measured levels are not considered to be representative. The boundaries of the current AQMA will not be reconsidered until all proposed road changes are complete and sufficient monitoring data has been acquired to give full confidence to any changes.

Norwich is a compact city with a medieval street layout and trying to maintain the historic plan of the city whilst catering for modern society and transport can create a conflict of interests. This conflict will be a key consideration on all Planning Development schemes.

The automatic monitoring station on Castle Meadow is owned and run by the council. Funding has been made available to replace this 25 year old station with more up to date technology. The opportunity will be taken to re-site 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 Spring 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, engine switch off enforcement and the development of the BSIP, it is hoped improvements in air quality in the LEZ along Castle Meadow will naturally follow. Air quality monitoring on Castle Meadow therefore still has a useful purpose as it is hoped these changes will translate into measurable reductions in NO_2 levels.

The council will continue to engage with suppliers of mobile AQ sensors and co-location studies will continue to be undertaken with the council’s automatic AQ station so the accuracy and reliability of these units can be confidently assessed for future application.

The council will also continue to support initiatives that contribute positively to improving air quality, 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 Norfolk Car Club:
- support walking and cycle schemes such as Pushing Ahead, Mobi-Mix, Beryl Bikes and the LCWIP (Local Cycling & Walking Infrastructure Plan).
- Inform citizens on health concerns when using an open fire/woodburner through a program of social media and website campaigns.

Local Engagement and How to get Involved

Air quality is a subject that has reached the interest and concern of more and more people year on year. If anyone would like to find out more about air quality and how they can contribute to improving it in their area, these links can provide further information:

- UK Air – The Govt's Air Information Resource: https://uk-air.defra.gov.uk/
- Norwich City Council's air quality reporting website: https://www.norwich.gov.uk/downloads/download/1917/air_quality_monitoring_reports_and_assessments
- Norfolk Car Club – 'Connecting Norfolk': http://www.norfolkcarclub.com/
- Norfolk Liftshare - https://liftshare.com/uk/community/norfolk
- Modeshift Stars (a national schools awards scheme that has been established to recognise schools that have demonstrated excellence in supporting cycling, walking and other forms of sustainable travel**)** https://modeshiftstars.org/
- Mobi Mix project - mobility hubs and e-scooter - https://www.interreg2seas.eu/fr/MOBI-MIX
- Pushing Ahead - https://www.pushingaheadnorfolk.co.uk/
- CCAG report for DfT https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/851558/Cycle_City_Ambition_Programme_interim_report_extended_summary.pdf
- Transforming Cities Overview https://www.norfolk.gov.uk/roads-and-transport/major-projects-and-improvement-plans/norwich/city-centre-improvements/improvement-projects/transforming-cities-application

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

On Clean Air Day the Norfolk Environmental Protection Group along with Public Health Norfolk and Highways organise events which allow the public to raise any air quality issues or concerns and learn more about how to help themselves improve the air they breathe both indoors as well as outdoors. The Group intends to promote issues which apply to both city and rural living 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 & 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:
- Self-help - such as being aware of the safest way to use a wood-burner/open fire, walking side streets rather than main roads, engine switch off when idling, eco-driving etc:
- Clean Air Day to be promoted on social media with a particular goal to reach the younger generation.

It is hoped that Clean Air Day would be used as a catalyst to encourage a change in behaviour which will be continued beyond the actual day itself. In 2020, these events were cancelled due to the pandemic but will be re-instated going forward.

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1 Local Air Quality Management

This report provides an overview of air quality in Norwich during 2020. 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 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 Norwich City Council can be found in Table 2.1. The table presents a description of the single city centre AQMA that is currently designated within Norwich City Council. Appendix D: Map(s) of Monitoring Locations and AQMAs provides maps of the AQMA and the air quality monitoring locations in relation to the AQMA. The air quality objectives pertinent to the current AQMA designation are as follows:

- NO_2 annual mean;

Figure 2.1 – Map of the Declared Air Quality Management Area

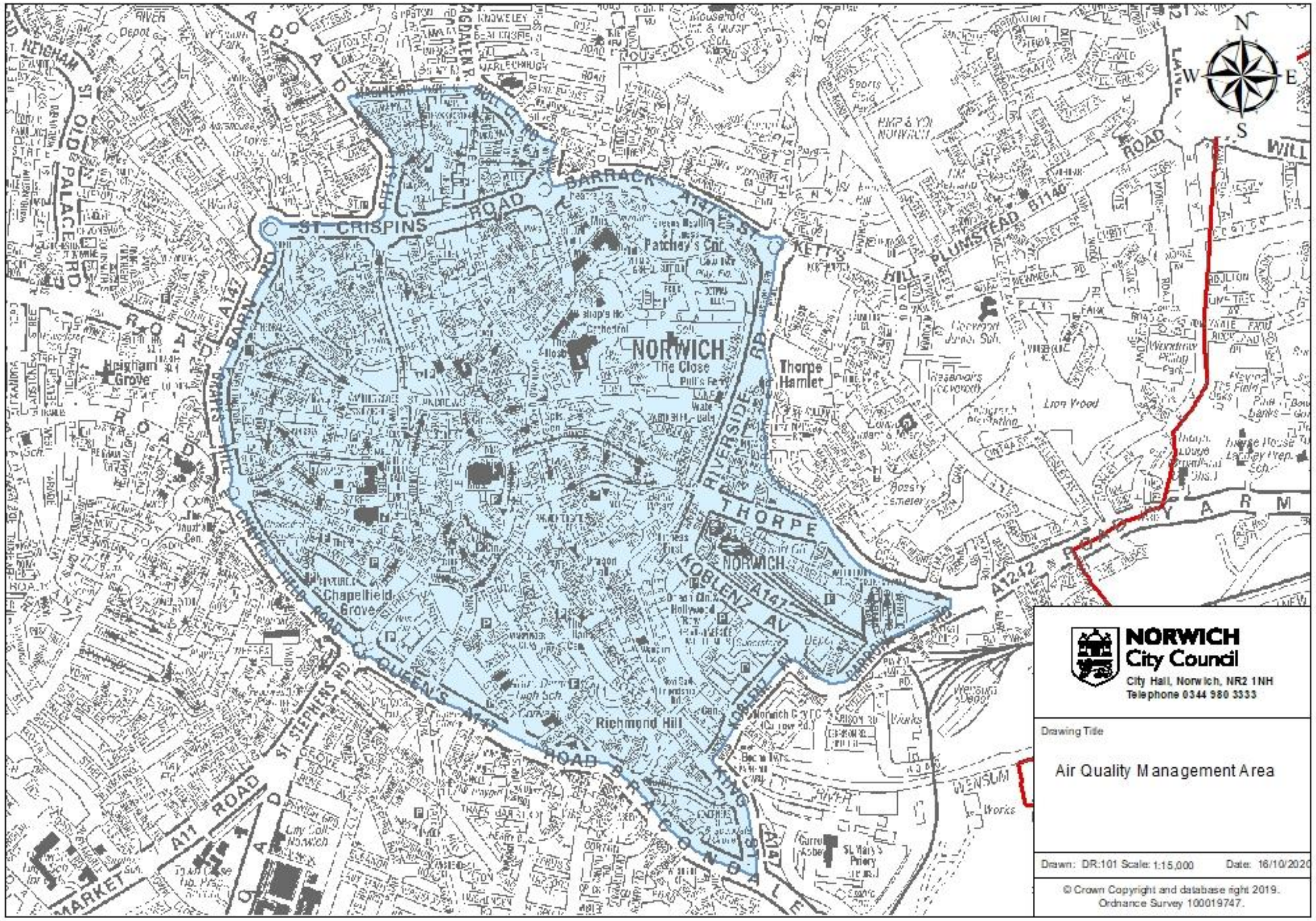

Table 2.1 – Declared Air Quality Management Areas

AQMA Name	Date of Declaration	Pollutants and Air Quality Objectives	One Line Description	Is air quality in the AQMA influenced by roads controlled by Highways England?	Level of Exceedance: Declaration	Level of Exceedance: Current Year	Name and Date of AQAP Publication	Web Link to AQAP
Central AQMA	Nov-12	NO_2 Annual Mean	An area encompassing Norwich city centre, broadly following the inner link road	NO	52 µg/m3 (at 52 St Augustines Street)	39	AQAP June 2021	Air quality monitoring reports and assessments | Norwich City Council

☒ **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 City Council

Defra's appraisal of last year's ASR concluded:

The report is well structured, detailed, and provides the information specified in the Guidance. The following comments are designed to help inform future reports.

1. It is very encouraging to see that the Council have continued to review the locations of their monitoring sites in relation to recent changes to the roads and relevant exposure. The removal of sites with continuously low concentrations and introducing new sites is supported.
2. The Council have provided a very detailed ASR, with pollutant trends, measures and activity within Norwich discussed extensively. In particular the Council's discussion of NO_2 concentrations within the city is to be commended. Not only are trends discussed but the Council attempt to find potential causes for the changes in NO_2 concentrations. This demonstrates the Council's active engagement in trying to understand and tackle air quality issues within their city. The level of detail provided within the ASR is welcomed, and the Council are encouraged to continue their good work in future ASRs.
3. The Council complete a co-location study at CM2 and state that this site is not representative of the majority of diffusion tube locations within the city and therefore have used the national factor. As the Council have other continuous monitoring locations within the city, such as CM1, it is recommended for a co-location study to also be conducted here so that bias factors for both roadside and urban background locations will be available.

Outstanding comments from last year's appraisal:

1. The Council has a number of measures in place to address $PM_{2.5}$ which demonstrates their commitment to working with Public Health England to address this pollutant. It would be useful if the Council could make reference to the Public Health Outcomes Framework and their relevant local indicator for $PM_{2.5}$ in this section of the report.
2. Distance corrections were conducted for sites not representative of relevant exposure using the "NO_2 fall off with distance calculator" available on the LAQM website. Calculations could be provided in future reports.

In response to the comments made in last years appraisal, it can be confirmed:

- Norwich City Council will take up the recommendation of conducting a diffusion tube co-location study at their Castle Meadow roadside location. This will commence January 2022.
- Use of the Diffusion Tube Data Processing Tool has identified that this year no distance corrections are required. As and when the calculation is required, the calculations will be included in the ASR.
- Public Health Outcomes Framework and their relevant local indicator for $PM_{2.5}$ will be reviewed with Public Health Norfolk and how this should be included in the ASR.

Both Norwich City Council and Norfolk County Council have taken forward a number of direct measures during the current reporting year of 2020/21 in pursuit of improving local air quality. Details of all measures completed, in progress or planned are set out in

Table 2..

24 measures are included within

Table 2., with the type of measure and the progress Norwich City Council have made during the reporting year of 2020/21 presented. Where there have been, or continue to be, barriers restricting the implementation of the measure, these are also presented within

Table 2.. Table 2.2 has been ordered in terms of perceived importance to reduce air pollution.

More detail on these measures can be found in their respective Action Plans, the latest Action Plan being reported in July 2021. All Action Plans can be found by clicking on the following link:

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Key measures completed in 2020/21 are:

- Tombland redesign, which has provided a high-quality public space that is attractive to walk through and has improved links to cycle networks
- Thorpe Road bus/cycle contraflow which is hoped will encourage behavioural change to limit car use.

- Green pedalway crossing from west to east through the city which completes the 5 radial and 2 orbital pedalways.
- Roll-out and expansion of the bike and scooter hire scheme operated by Beryl.

Norwich City Council expects the following measures to be completed over the course of the next reporting year although all the financial and resource implications associated with Covid-19 will almost certainly have a detrimental effect on the progress of these projects:

- First Bus to commence upgrade of bus fleet. (In total 55 new Euro 6 buses being purchased over next 3 years leaving only a few Euro 5 buses remaining from current fleet – note, discussions are ongoing with First Bus regarding vehicle investment being directed at zero emission buses).
- Implementation of smart traffic light technology. This should reduce journey times for buses and increase journey time reliability for public transport users.
- King Street redesign which improves the environment for walking and cycling.

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

- Encourage lower emission buses.
- Encourage behavioural changes to more sustainable modes of transport.
- Encourage greater use of distribution hubs outside the city allowing only cleaner vehicles into the city.

The principal challenges and barriers to implementation that Norwich City Council anticipates facing are resourcing and funding issues and for this reason the installation of some measures, such as the larger road schemes, have been slower than desired.

Whilst the measures stated above and in

Table 2. will help to contribute towards compliance, Norwich City Council anticipates that further additional measures not yet prescribed may well be required in subsequent years to achieve compliance and enable the revocation of the City Centre AQMA.

Optimistically, given the Transforming Cities funding, plus the natural progression of vehicle electrification and bus upgrades, the evolving behavioural change from car to other more sustainable modes of transport and schools encouraging students to do likewise, it is expected that our goal is achievable and within an acceptable timeframe. It may be that Norwich returns to localised pollution hotspots where road bottle necks or street canyons provide more targeted challenges.

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 (NCC)	Norwich City Council (NCC)		Funded	<£10k	Planning	Circa 10-15 µg/m3 NO2	Reduction in NO2 levels in Castle Meadow	Erratic decline in NO2 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 +	2021/22	Norfolk County Council (NorCC)	Norfolk County Council (NorCC)		Funded	£10k - £50k	Implementation	Specific value not known but will contribute to overall reduction in NO2 levels in city centre and surrounds. (NO2 levels at CM1 reduced by >10 µg/m3 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	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	2021/22	NCC + (NorCC)	NCC + (NorCC)		Funded	£1m - £10m	Completed (Grapes Hill) / Planning (Heartsease)	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 / increased numbers of people walking and cycling	Grapes Hill roundabout was completed Nov 2021. An options appraisal has been completed for the Heartsease Fiveways junction and has identified improvements to take forward for design	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	Commenced August 2018	NCC	NCC		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. (NO2 levels at CM1 reduced by >10 µg/m3 in 2019. Reason unknown but smart traffic lights installed at end	Reduction in NO2 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
												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 Rd	Ongoing but October 2018 for switch off enforcement on Castle Meadow	NCC + NorCC	NCC + NorCC		Not Funded	/£100k - £500k	Planning	Specific value not known but will contribute to overall reduction in NO2 levels in city centre and surrounds	Reduction in NO2 levels in AQMA	Ongoing	New signage associated with enforcement of engine switch off educates road users and reinforces AQMA. The option to display waiting time at traffic lights is being considered.
6	Low NOx Buses	Promoting Low Emission Transport	Public Vehicle Procurement - Prioritising uptake of low emission vehicles	N/A	Ongoing	NCC + NorCC	NCC + NorCC		Not Funded	£1m - £10m	Planning	Specific value not known but will contribute to overall reduction in NO2 levels in city centre and surrounds	Reduction in NO2 levels in city centre and surrounds	24 buses retrofitted by June 2018. First Bus has committed to £18m investment in new and refurbished vehicles to make their entire fleet Euro 5/6. A Full Business Case is being prepared for the Zero Emission Bus Regional Area (ZEBRA) funding for submission in Jan 2022 for 15 zero emission buses for First.	Aim is to work in partnership with bus operators on funding opportunities relating to low NOx 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		2022/23	NorCC	NorCC		Not Funded	£1m - £10m	Planning	Specific value not known but will contribute to overall reduction in NO2 levels in city centre and surrounds	Reduction in NO2 levels in city centre and on busy feeder roads		Park & Ride Bus contract due for renewal giving opportunity for a zero emission fleet. A successful grant application may be required. Policy decision would be needed as to whether the County Council continues to aim to operate the Park & Ride service as a zero subsidy contract.
8	School Travel Plans	Promoting Travel Alternatives	School Travel Plans	Implemented but requires updating	Ongoing	NorCC	NorCC		Funded	£10k - £50k	Implementation	Specific value not known but will contribute to overall reduction in NO2 levels in city centre and surrounds	Reduction in NO2 levels in city centre and surrounds. Passive NO2 monitoring to be installed outside key schools.	Ongoing	County to request updated travel plans - prioritising schools inside AQMA. Travel Plan to focus on using buses, cycling and walking to school to ensure travel by private car is minimised. 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

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
															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	NorCC	NorCC (TCF funding)		Funded	£1m - £10m	Planning	Specific value not known but will contribute to overall reduction in NO2 levels in city centre	Reduction in NO2 levels in city centre and surrounds	Outline design underway. Consultation completed. Will go to Joint Committee for consideration Jan 2022	Provides substantially improved conditions for pedestrians and reduces congestion with buses
10	Revised layout in St Stephens Street / Red Lion Street	Traffic Management	UTC, Congestion management, traffic reduction	2020/23	2022/23	NorCC	NorCC (TCF funding)		Funded	£1m - £10m	Implementation	Specific value not known but will contribute to overall reduction in NO2 levels in city centre	Reduction in NO2 levels in city centre and surrounds	Outline design underway	Provides substantially improved conditions for pedestrians and reduces congestion with buses
11	Mobility hubs at key transport interchanges	Transport Planning and Infrastructure	Public transport improvements-interchanges stations and services	2020/23	2022/23	NorCC	NorCC (TCF funding)		Funded	£1m - £10m	Planning	Specific value not known but will contribute to overall reduction in NO2 levels in city centre	Reduction in NO2 levels in city centre and surrounds	Outline design underway. Public consultation for hospital interchange completed. Rail station works to commence Jan 2022. Norwich Bus Station works to commence Summer 2022	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	NCC + NorCC	NCC + NorCC		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 early-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	Strategic highway improvements, Re-prioritising road space away from cars, including Access management, Selective vehicle priority, bus priority, high vehicle occupancy lane	Long term	2019	NCC + NorCC	NCC + NorCC		Not funded	> £10m	Planning	Specific value not known but will contribute to overall reduction in NO2 levels in city centre and surrounds	Reduced city centre congestion	Approval to construct given at June 2018 Highways Committee	Works underway to reduce congestion and encourage greater levels of sustainable modes on this important link between the rail station and city centre.
14	Extension to Thickthorn Park and Ride site	Promoting Travel Alternatives	Other	2020/23	2022/23	NorCC	NorCC (TCF funding)		Funded	£1m - £10m	Planning	Specific value not known but will contribute to overall reduction in NO2 levels in city centre	Reduced city centre congestion as well as wider network	Outline design underway. Scheme out to consultation Dec 2021. Aim to submit planning application Summer 2022.	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	NorCC	NorCC		Not Funded	£1m - £10m	Planning	Specific value not known but will contribute to overall reduction in NO2 levels in city centre	Reduced city centre congestion as well as wider network	Project suspended	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.	NCC + NorCC	NCC + NorCC		Funded	£100k - £500k	Implementation	Studies are showing that 15% of all journeys taken by bike or scooter would otherwise have been taken by car.	As of October 2020, 51,200 journeys have been taken and 223,000km have been covered by users of the service.	Public bike share launched in March with E-scooters added in September as part of 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	2022/23	NCC / NorCC	NCC / NorCC		Funded	£50k - £100k	Implementation	Specific value not known but will encourage green corridors to be utilised by students/pupils	Reduction in traffic levels, improved air quality and greater numbers of pupils walking	Introduction of School Streets. Two of the six schools included in the School Streets trial are in Greater Norwich. Trial to	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
													and cycling to school	begin Dec 2021 and run to Oct/Nov 2022	
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	NorCC)	NorCC (TCF funding)		Funded	£100k - £500k	Implementation	Specific value not known but will contribute to overall reduction in NO2 levels in city centre	Reduction in NO2 levels in city centre and surrounds	Outline design underway	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	NorCC	NorCC		Partially Funded	> £10m	Planning	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	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.	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	NCC + NorCC	NCC + NorCC		Not Funded	/£1m - £10m	Planning	Specific value not known but will contribute to overall reduction in NO2 levels in city centre and surrounds	Reduced city centre congestion	Not started	Long term goal. Will be considered in light of emerging Transport for Norwich Strategy Review
21	Education & information campaigns to encourage more responsible driving and the use of alternative modes	Promoting Travel Alternatives	Other	Ongoing	Ongoing	NCC + NorCC	NCC + NorCC		Funded	£1m - £10m	Implementation	Specific value not known but will contribute to overall reduction in NO2 levels in city centre and surrounds	Reduction in NO2 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	NorCC	NorCC			£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	NorCC	NorCC (TCF funding)		Funded	£1m - £10m	Completed	Specific value not known but will contribute to overall reduction in NO2 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	NCC, NorCC	NCC, NorCC & DfT		Funded	£1m - £10m	Completed	Specific value not known but will contribute to overall reduction in NO2 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.

Measures with shaded background = completed

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

As detailed in Policy Guidance LAQM.PG16 (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 $PM_{2.5}$:

1. Real-time monitoring of $PM_{2.5}$ is carried out at the AURN station at Lakenfields in the Norwich suburbs. This is an urban background site fitted with a Fidas $PM_{2.5}$ analyser. For many years Norwich City Council has also operated a $PM_{2.5}$ TEOM analyser at its automatic monitoring station (roadside). The Council therefore holds a large amount of historic data for $PM_{2.5}$ and will use this to inform any trends in the ambient concentration of $PM_{2.5}$ across the city as a whole.

2. Norwich City Council is currently in the process of replacing it's 25 year old roadside air quality station at Castle Meadow with more up to date monitors to be housed in a more compact enclosure. The siting of the new station will be moved to a more central roadside position on Castle Meadow closer to relevant receptors.

3. The council is 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;

   https://fingertips.p0he.org.uk/profile/public-health-outcomes-framework/data#page/3/gid/1000043/pat/102/par/E10000020/ati/101/are/E07000148/iid/30101/age/230/sex/4

4. Measures described 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 primarily aimed at reducing 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 $PM_{2.5}$ pollution. It is however understood that, at least in Norwich, $PM_{2.5}$ is primarily a

transboundary pollutant. Figure A6 shows that the urban background monitoring station is just as likely to have elevated levels of $PM_{2.5}$ as the urban kerbside site thus indicating traffic pollution is not the primary source of $PM_{2.5}$. (This was also strongly highlighted during Covid-19 lockdown when NOx levels decreased by around 30% whilst PM levels stayed the same as pre-lockdown).

5. The Defra derived data shown in Figure A.8 illustrates that in 2015 the primary contributor of $PM_{2.5}$ in Norwich was residual particulates and salt. Norwich has a rural hinterland with a large agricultural industry and it is activities associated with this that are expected to be a significant contributor. Due to the city's proximity to the coast, salt is also a significant component of $PM_{2.5}$ pollution. An up to date $PM_{2.5}$ source apportionment study is currently being discussed with research graduates at the UEA. It is hoped that this study will be conducted during the course of the upcoming year.
6. The minimisation of airbourne 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.
7. Norwich has 3 Smoke Free Zones, although these have a historical origin rather than any real present day significance. The Council is currently promoting advice on the new Air Quality (Domestic Solid Fuels Standards) (England) Regulations 2020 and the importance to health, as well as the legal requirement, to only burn material on woodburners and open fires which does not produce smoke or fume. This message goes out to the hospitality sector as well as Norwich citizens and emphasises the fact that pollutants emitted when burning wood and coal are harmful to everyone, but particulary the very young, the elderly and the most vulnerable. This message is primarily broadcast through social media; the Council's monthly magazine, Citizen; educational days such as Clean Air Day and the Norwich City Council website. This issue has also been debated at Council Scrutiny meetings.
8. The Council will be working collaboratively 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. This means that emissions from domestic chimneys have increased and, potentially, indoor air pollution. Pollutants associated with wood burners and open fires can cause breathing problems such as asthma attacks and contribute to other health conditions.

The Department for Environment Food & Rural Affairs (DEFRA) has provided a leaflet aimed at owners of wood burning stoves or open fires with simple steps on how to reduce their environmental and health impacts. This leaflet is available on the council's website:

Guide to open fires and wood burning stoves

The Council has made it their 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 will work towards installing an alternative method of heating. A total of 65 local authority houses have been identified. This 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 2020 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 2016 and 2020 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, Castle Meadow, during 2020. Also within its district is an automatic continuous monitoring site (Norwich Lakenfields) run by DEFRA which forms part of the AURN (Automatic Urban & Rural Network). Table A.1 in Appendix A shows the details of the automatic monitoring sites. The Envista - Air Resources Manager (norfolkairquality.net) page presents automatic monitoring results for Norwich City Council, with automatic monitoring results also available through the Defra UK-Air website https://uk-air.defra.gov.uk/data/.

3.1.2 Non-Automatic Monitoring Sites

Norwich City Council undertook non- automatic (i.e. passive) monitoring of NO_2 at 40 sites during 2020. 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. 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).

For diffusion tubes, the full 2020 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.

Table 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 annual mean concentration at the Castle Meadow automatic monitoring site (CM1) was recorded as 30µg/m^3 for 2020. This is sigificantly lower than all preceeding years and 25% lower than 2019. This result is clearly driven by the impact of Covid-19. Castle Meadow is a bus and taxi only street and during the Covid-19 pandemic approximately 25-40% fewer buses were operating, some routes are still operating at a frequency less than pre-Covid due, in part, to driver shortages.

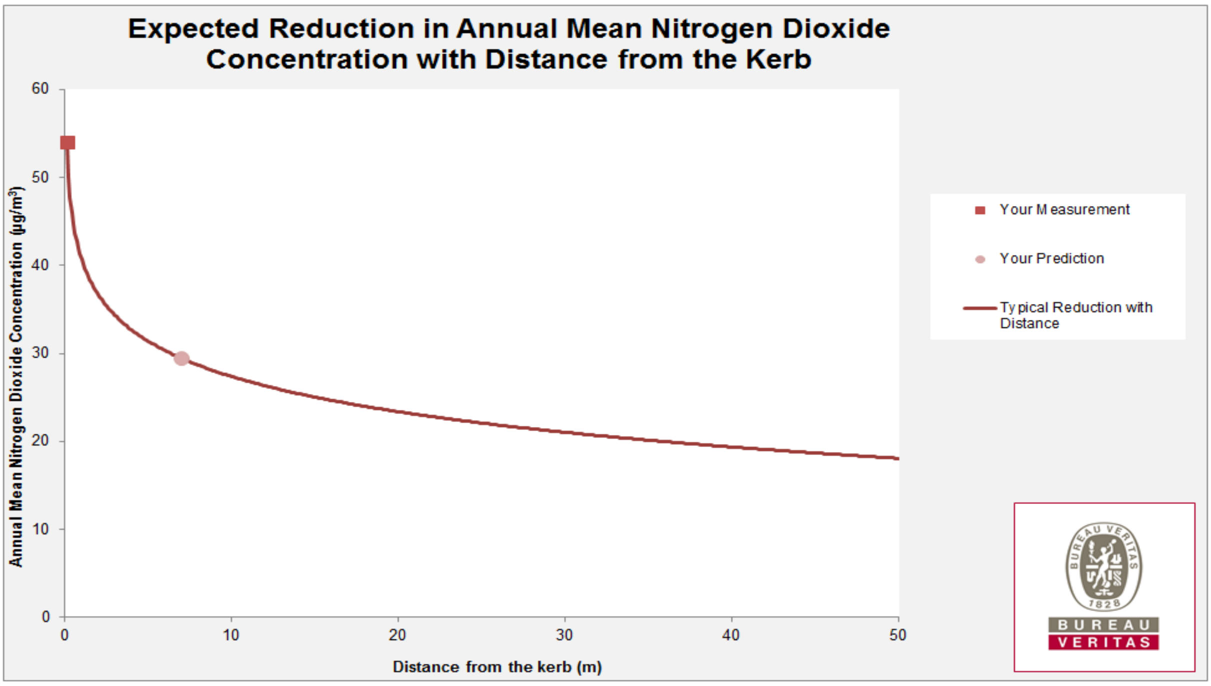
A reduction in pollution levels would not only result from a reduction in buses per se but significantly less general traffic would enhance traffic flow through Castle Meadow as there would be little to no queueing at the traffic lights on Agricultural Plain to the south. Last year there was a noticeable lowering in NO_2 levels relative to previous years which was thought to result from road changes to the Agricultural Plain junction and the installation of up-to-date traffic signalling. Engine switch-off enforcement was also believed to be a contributing factor. Traffic volumes may still be lower than pre-Covid levels, mostly due to the extension, and likely permanency in some form or another, of the “working from home” policy. This will all have an effect on damping pollution levels but, when considered in conjunction with the programmed bus fleet upgrades and the general move towards cleaner buses, post-Covid pollution levels from road traffic are expected to continue on a downward trend.

Historically the CM1 site, which lies at the heart of the AQMA, has always had the highest levels of NO_2 but, for the second year running, this was exceeded by the diffusion tube locations on St Augustines St, Riverside Road & Castle Meadow Mid. Zipfel House (a busy, narrow junction at the top of Magdalen Steet), Chapel Field North and St Stephens Street all measure about the same as CM1 at around 30µg/m^3.

As always, it must be noted that the Castle Meadow automatic analyser site is not representative of relevent exposure for the annual mean for NO_2. The closest residence is sufficiently far enough away that the NO_2 levels would not only be well below the objective level but other factors would come into play which would make any corrections for distance not applicable. Figure 3.1 illustrates the Defra NO_2 Fall Off with Distance Correction (https://laqm.defra.gov.uk/tools-monitoring-data/no2-falloff.html) for a roadside mean annual NO_2 level of 54 µg/m^3. The purpose of this graph is to illustrate how rapidly levels diminish with distance.

The Castle Meadow automatic analyser site is relevant for the 1 hour mean for NO_2 as pedestrians may be expected to spend one hour or more at this location. There was no breach of the 1 hour objective.

Figure 3. 1 Example of NO2 Fall Off With Distance



The Norwich Lakenfields urban background automatic monitoring site (CM2) measured an annual mean concentration of 10 µg/m^3. As with CM1, there is no exceedence of the annual mean nor the 1-hour mean. Figure A.1(a) shows that the seasonal trends in NO_2 levels at the urban background site can be observed even in roadside sites outside the county possibly indicating the meterological effect on pollution levels.

Table A.4 in Appendix A shows the diffusion tube results for 2020, corrected for bias using a locally derived bias adjustment factor of 0.88 using the 50% TEA in Acetone method.

The precision and accuracy spreadsheet used to calculate the local bias correction is shown in Appendix C.

The national bias spreadsheet is also shown in Appendix C and is available online here:

National Bias Adjustment Factors | LAQM (defra.gov.uk)

No diffusion tube (DT) sites exceeded the NO_2 annual mean objective of 40µg/m^3 for 2020. Again this is a result of Covid-19 lockdowns delivering the circumstances already described above. However the DT 52 St Augustines annual mean was 39µg/m^3. The next DT location closest to the objective level was Castle Meadow Mid at 36µg/m^3. The 2 sites with the highest levels of NO_2 are no surprise but nonetheless the levels are considered to be unrealistic of normal circumstances and hence no weight will be given to the results.

In 2020, 7 new DT locations were added whilst 4 were removed; the latter due to NO_2 levels being consistently below the objective level. These 4 revoked DT locations had originally been chosen as either queuing traffic was known to exist or for the purpose of establishing the lateral extent of a known pollution hotspot.

4 of the new locations were in response to the submission of a large planning application at Anglia Square to the north of the city centre (DT44, DT45, DT46, DT47). 2 more of the new locations were where queuing traffic was known to exist on Queens Road (DT49 & DT50) and 1 to determine the extent of pollution into side streets off Riverside Road (DT48).

2 further diffusion tubes were installed adjacent to a school on Jessop Rd in response to a complaint about fume from coaches serving the schools (DTS1 & DTS2). These were only installed over a period of 3 months and measured very low levels (10 µg/m^3) which we can have confidence in as the monitoring was conducted pre-Covid.

Figure A.1 presents the results of the NO_2 (a) continuous and (b) continuous plus passive annual means from 2016 -2020. The trends on both graphs illustrate a slow but principally steady reduction in levels. The steep decline in 2020 clearly being the result of Covid-19 lockdowns and the ensuing circumstances.

The greatest drop in NO_2 levels were observed within the bus & taxi only streets (all 3 locations recording a decrease in 11mg/m^3 when compared with 2019). The highest drop was seen at Chapelfield North, 13mg/m^3, which lies on the edge of the LEZ and where buses make up the majoirty of vehicles. The smallest decline in levels was observed at both monitoring locations on St Augustines and Zipfel House, dropping 7mg/m^3 and 5mg/m^3 respectively. Both relate to narrow streets with fairly tall building frontages close to kerbside and feeding into busy traffic light junctions. This reinforces the fact that the physical environment can have an effect on pollution levels by disrupting dispersion.

The 2020 data will be treated as anomalous and no great weight given to the results in terms of whether previously identified pollution hot spots can be re-assessed. The reader is therefore recommended to refer also to the 2019 ASR and 2021 Action Plan.

On the whole, it is felt that the upgrade to buses with cleaner engines will have a significant impact on pollution levels. However, smarter traffic lights, the move to reduce general traffic from the city centre and thus reducing congestion, engine switch off enforcement and the promotion of alternative modes of transport are, in particular, all also expected to aid the reduction in pollution levels within the AQMA. A comprehensive monitoring network that is being reviewed and revised annually will plot the progress of these measures.

3.2.2 Particulate Matter (PM_{10})

Table A.6 & Figure A.4 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.

Table A.7 and Figure A.5 in Appendix A compares the ratified continuous monitored PM10 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.

The annual mean concentration of PM_{10} at the Castle Meadow automatic monitoring site was recorded as 19µg/m^3 (85% data capture), the same as the previous year, and well below the annual mean objective of 40µg/m^3. There were 0 exceedances of the 24-hour mean of 50µg/m^3 (35 allowed). Since the station does not incorporate an FDMS device, the data was corrected using the Volatile Correction Method (VCM). This is discussed further in Appendix C.

For the Norwich Lakenfields monitoring site, the annual mean concentration was 13µg/m^3 (99% data capture) and hence also lies well below the annual mean objective of 40µg/m^3. There were 0 exceedances of the 24-hour mean.

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.

It should be noted that the $PM_{2.5}$ TEOM analyser at Castle Meadow is not fitted with an FDMS device. The analyser is therefore not considered to be equivalent to the reference measurement method and as such it is not detecting some of the peaks which are used for real-time public dissemination. 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.

Figure A.6 in Appendix A shows the trend in the monthly mean concentrations at both Castle Meadow and Lakenfield sites and demonstrates that both Norwich sites already comfortably meet the annual average EU limit value of 25µg/m^3 and that the peaks and troughs in the levels are present at both sites. The plot of Sandy Roadside site in Cambridgeshire is included to illustrate the regional influence of $PM_{2.5}$ pollution as it also mimics, in particular, the peaks and troughs of the Norwich Lakenfields site. This reinforces the fact that $PM_{2.5}$ is mostly a transboundary pollutant and influenced by atmospherics.

Figure A.7 shows that the World Health Organisation recommended guideline value of 10µg/m^3 has been met at both Lakenfields and Castle Meadow for the last 3 consecutive years.

It must be noted that the meeting of $PM_{2.5}$ target levels is not in regulatory standards for local authorities.

It is considered that in seeking to reduce the concentration levels of other pollutants, namely NO_2 from road traffic, a beneficial impact on $PM_{2.5}$ concentrations will also likely occur due, in part, to brake and tyre wear contributing to $PM_{2.5}$ levels. Our historic monitoring data will be of assistance in assessing such impacts. However Figure A.8 demonstrates that salt and residual particulates are the main source of $PM_{2.5}$ in Norwich.

3.2.4 Ozone

Ozone monitoring is carried out at the Norwich Lakenfields site. There are no regulatory objective levels for ozone. The following statistics were recorded for 2020;

- Annual Mean 53µg/m^3, 100% data capture (50µg/m^3, 99% data capture in 2019)
- O3 High – on 3 days (3 days in 2019)
- Air Quality Strategy Objective for 2005 (O3) Daily maximum 8-hour running mean > 100 µg/m^3 on more than 10 days – 27 exceedances (17 in 2019)
- EC Population Information Threshold (O3) 1-hour mean > 180 µg/m^3 – 6 exceedances. (8 in 2019)
- EC Health Protection Target Value (O3) daily maximum 8-hour running mean > 120 µg/m^3 on more than 25 days – 0 exceedances (0 in 2019)
- Air Quality Standard (O3) 8-hour running mean > 100 µg/m^3 – 168 exceedances (113 exceedances in 2019)
- EC Health Protection long-term objective (O3) daily maximum 8-hour running mean > 120 µg/m^3 – 10 (11 exceedances in 2019).

Overall, 2020 showed slightly higher levels of O_3 when compared with the previous year which could be explained by differences in weather systems between the 2 years but, on the whole, the levels are fairly consistent.

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 potentially be 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	PM10, NOx, NO2, PM2.5	Y	Chemiluminescent (Ambirak); TEOM	N/A	1	2.5
CM2	Lakenfields	Urban Background	623637	306940	O3, PM10, NOx, NO2, PM2.5	N	Chemiluminescent (Thermo); FDMS	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, DT1C	256 King St	Roadside	623863.04	307678.6	NO2	Yes. Norwich.	0.0	3.5	No	2.5
DT4A, DT4B, DT4C	Lakenfields AQS	Urban Background	623681.24	307015.82	NO2	No	20.0	1.5	Yes	2.5
DT6	130 Magdalen St	Roadside	623160.89	309550.43	NO2	Yes. Norwich.	0.0	4.0	No	2.5
DT9	13 St Augustine's St	Kerbside	622905.81	309496.11	NO2	Yes. Norwich.	1.0	1.5	No	2.5
DT11	52 St Augustine's St	Kerbside	622825.87	309573.17	NO2	Yes. Norwich.	0.0	1.0	No	2.5
DT13	Castle Meadow (Middle)	Roadside	623141.06	308606.69	NO2	Yes. Norwich.	N/A	2.5	No	2.5
DT16	Zipfel House	Roadside	623185.69	309649.68	NO2	Yes. Norwich.	0.0	3.0	No	1.5
DT19	27 Cattle Market St	Roadside	623320.58	308430.88	NO2	Yes. Norwich.	0.0	2.0	No	1.5
DT21	Rotary House	Roadside	623879.53	307658.91	NO2	Yes. Norwich.	3.0	2.0	No	2.5
DT22	Carrow Bridge House	Roadside	623900.96	307709.56	NO2	Yes. Norwich.	0.0	5.0	No	3.0
DT25	Bargate Court	Roadside	623422.42	309388.23	NO2	Yes. Norwich.	0.0	4.0	No	3.0
DT26A, DT26B, DT26C	3 Riverside Rd	Roadside	623870.26	308515.77	NO2	Yes. Norwich.	0.0	3.0	No	3.0
DT29A, DT29B, DT29C	Chapelfield North	Kerbside	622532.23	308490.36	NO2	Yes. Norwich.	1.5	1.0	No	2.5

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)
DT31A, DT31B, DT31C	Quantrell House	Kerbside	623380	307700	NO2	Yes. Norwich.	0.0	3.0	No	3.0
DT34	41 St Stephens Street	Kerbside	622898	308114	NO2	Yes. Norwich.	6.0	0.5	No	3.0
DT37	7a Gunns Court	Kerbside	622492	308520	NO2	Yes. Norwich.	3.0	2.5	No	3.0
DT39	49 Duke St	Kerbside	622884	309082	NO2	Yes. Norwich.	0.0	1.0	No	3.0
DT40	St Stephens Rd (Kingsley Rd)	Roadside	622695	307855	NO2	No	1.5	2.0	No	2.2
DT41	Magdalen St (RSPCA)	Roadside	623148	309277	NO2	Yes. Norwich.	1.5	3.5	No	2.5
DT42	Magdalen St (Bus Stop)	Roadside	623151	309326	NO2	Yes. Norwich.	20.0	2.5	No	3.0
DT43	Edward St	Roadside	623037	309487	NO2	Yes. Norwich.	2.0	1.0	No	2.2
DT44	Botolph/Edwards St	Roadside	622910	309391	NO2	Yes. Norwich.	20.0	2.0	No	2.1
DT45	Pitt St W	Roadside	622904	309418	NO2	Yes. Norwich.	>20 n/a	2.2	No	2.2
DT46	Pitt St E	Roadside	622987	309486	NO2	Yes. Norwich.	>20 n/a	2.1	No	2.1
DT47	Duke St/St Crispins	Roadside	622869	309187	NO2	Yes. Norwich.	>20 n/a	2.5	No	2.2
DT48	Riverside/Aspland	Roadside	623878	308532	NO2	Yes. Norwich.	0.0	1.2	No	2.2
DT49	Queens Rd N	Roadside	623480	307679	NO2	Yes. Norwich.	0.0	2.0	No	2.2
DT50	Queens Rd S	Roadside	623474	307692	NO2	Yes. Norwich.	0.0	1.1	No	2.1

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)
S1	Jessop Road E	Roadside	621104	307935	NO2	No	9.0	1.1	No	2.1
S2	Jessop Road W	Roadside	621083	307924	NO2	No	9.0	0.3	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 NO2 Monitoring Results: Automatic Monitoring (µg/m3)

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2020 (%) (2)	2016	2017	2018	2019	2020
CM1	623202	308615	Kerbside	93	93	**56**	**51**	**54**	**41**	30
CM2	623637	306940	Urban Background	94	94	14	13	12	13	10

☒ **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 NO2 Monitoring Results: Non-Automatic Monitoring (µg/m3)

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 2020 (%) (2)	2016	2017	2018	2019	2020
DT1A, DT1B, DT1C	623863.04	307678.6	Roadside	100	100.0	37.7	36.3	33.3	34.2	25.6
DT4A, DT4B, DT4C	623681.24	307015.82	Urban Background	100	100.0	12.9	13.9	11.8	12.0	10.0
DT6	623160.89	309550.43	Roadside	100	100.0	29.6	31.2	27.1	29.8	21.7
DT9	622905.81	309496.11	Kerbside	100	100.0	**40.2**	**41.5**	37.4	**40.1**	33.0
DT11	622825.87	309573.17	Kerbside	100	100.0	**50.7**	**53.6**	**44.4**	**46.0**	39.4
DT13	623141.06	308606.69	Roadside	92.3	92.3	**45.9**	**48.5**	**44.9**	**46.9**	35.5
DT16	623185.69	309649.68	Roadside	100	100.0	38.6	39.9	33.4	36.1	30.5
DT19	623320.58	308430.88	Roadside	92.3	92.3	39.1	37.7	36.1	34.8	22.9
DT21	623879.53	307658.91	Roadside	100	100.0	32.9	32.5	29.1	30.9	24.9
DT22	623900.96	307709.56	Roadside	100	100.0	23.3	25.3	31.1	29.4	21.7
DT25	623422.42	309388.23	Roadside	100	100.0	35.0	32.7	29.6	32.4	25.9
DT26A, DT26B, DT26C	623870.26	308515.77	Roadside	100	100.0	**46.7**	**44.2**	39.3	**43.3**	32.6
DT29A, DT29B, DT29C	622532.23	308490.36	Kerbside	100	100.0	**45.8**	37.1	**41.3**	**43.4**	29.8
DT31A, DT31B, DT31C	623380	307700	Kerbside	100	100.0			37.2	38.6	29.9
DT34	622898	308114	Kerbside	100	100.0			**41.2**	**40.3**	29.2
DT37	622492	308520	Kerbside	92.3	92.3			29.9	30.3	24.6
DT39	622884	309082	Kerbside	100	100.0			30.0	31.9	20.2
DT40	622695	307855	Roadside	100	100.0				32.6	21.5
DT41	623148	309277	Roadside	100	100.0				34.2	27.4
DT42	623151	309326	Roadside	55.8	55.8				33.0	21.4
DT43	623037	309487	Roadside	92.3	92.3				22.5	17.4
DT44	622910	309391	Roadside	100	100.0					22.5

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 2020 (%) (2)	2016	2017	2018	2019	2020
DT45	622904	309418	Roadside	92.3	92.3					25.4
DT46	622987	309486	Roadside	100	100.0					25.4
DT47	622869	309187	Roadside	100	100.0					19.8
DT48	623878	308532	Roadside	100	100.0					27.3
DT49	623480	307679	Roadside	100	100.0					24.9
DT50	623474	307692	Roadside	100	100.0					25.3
S1	621104	307935	Roadside	66	15.4					-
S2	621083	307924	Roadside	100	23.1					10.4

☒ **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(a) – Trends in NO2 Monthly Mean Concentrations

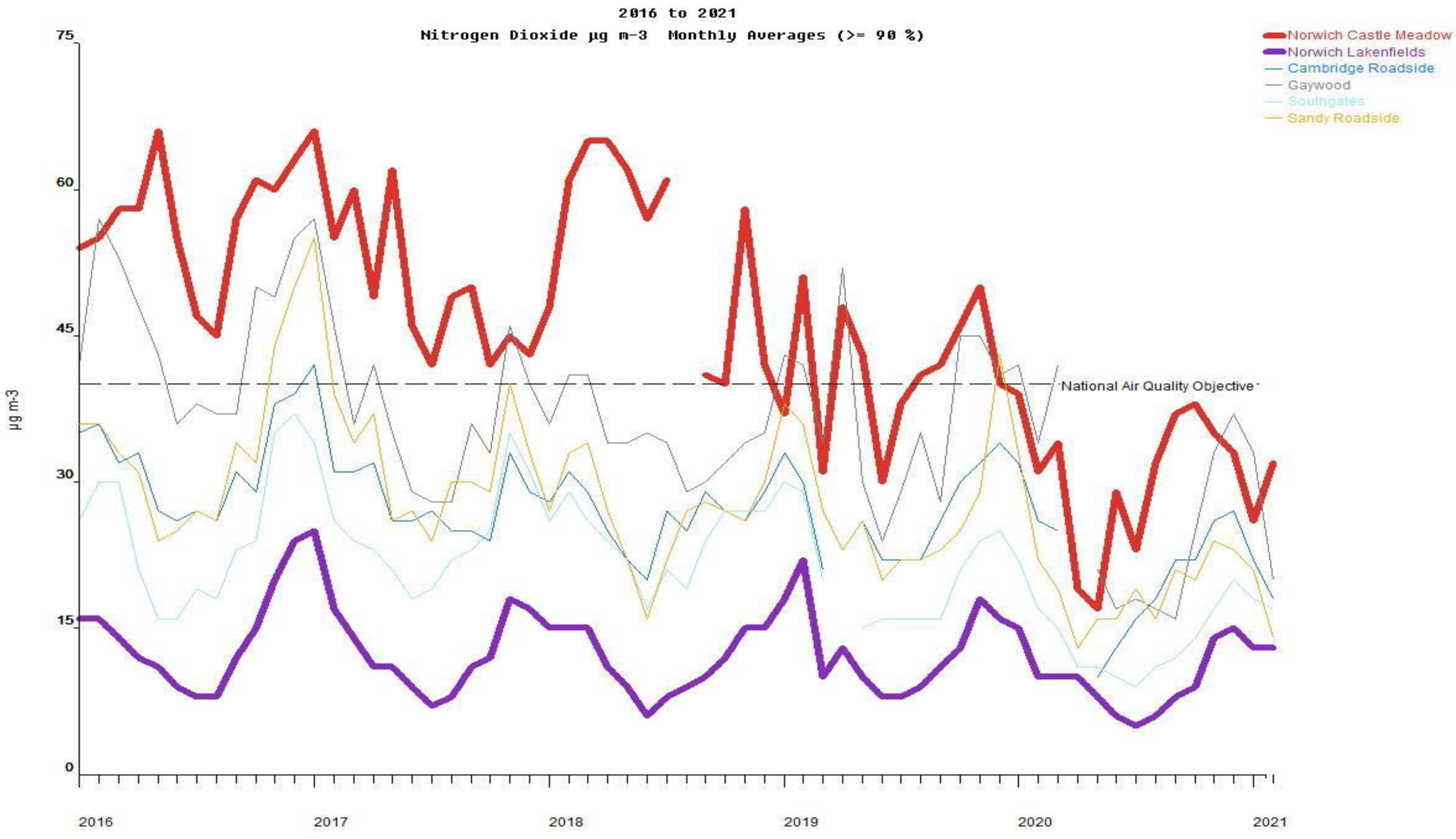


Figure A.1(b) – Trends in NO2 Annual Mean Concentrations for Continuous Analysers and Diffusion Tubes

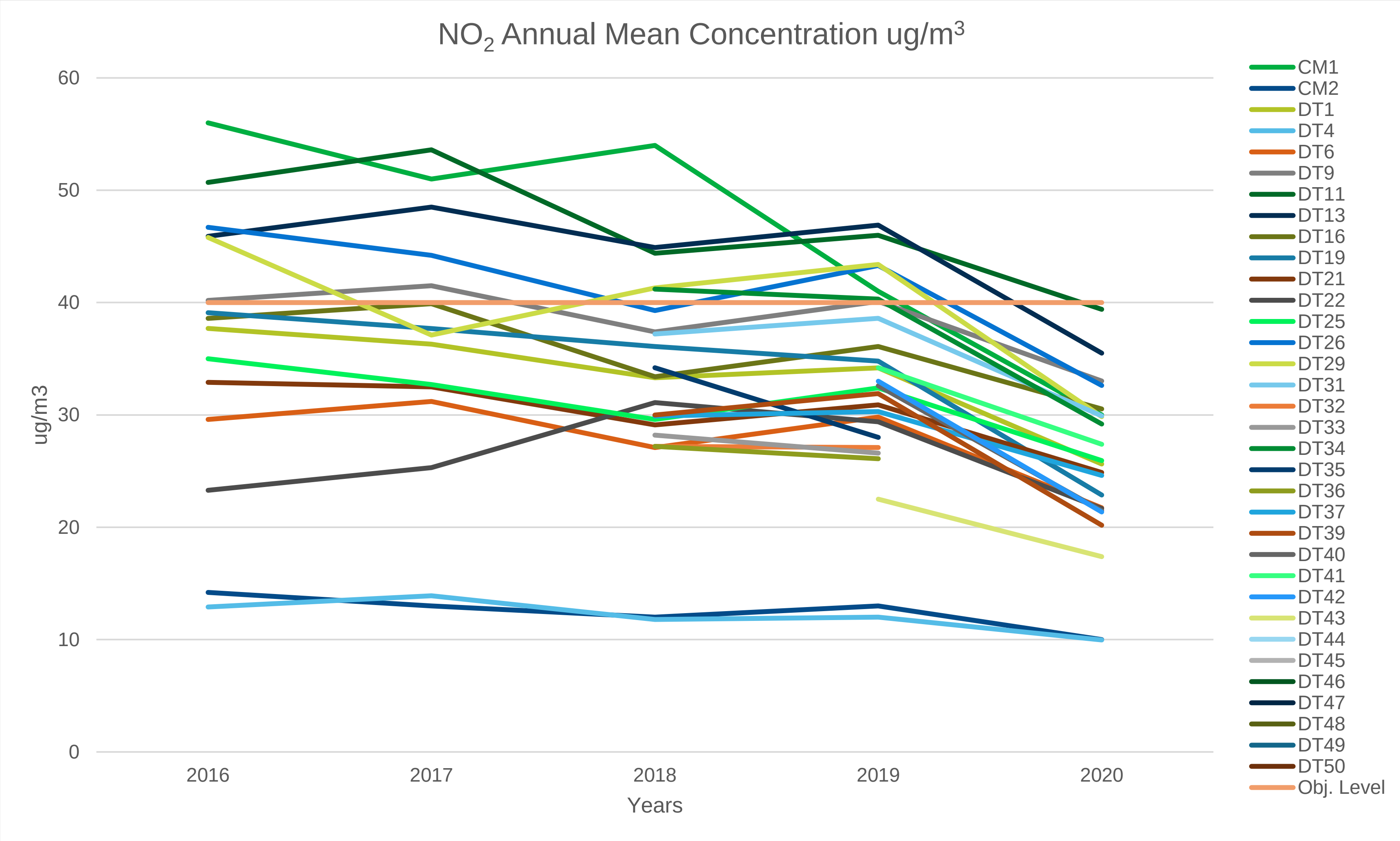


Table A.5 – 1-Hour Mean NO2 Monitoring Results, Number of 1-Hour Means > 200µg/m3

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2020 (%) (2)	2016	2017	2018	2019	2020
CM1	623202	308615	Kerbside	93	93	4	1	**19**	1	0
CM2	623637	306940	Urban Background	94	94	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%).

Figure A.2 – Trends in Number of Exceedances of NO_2 1hr Mean

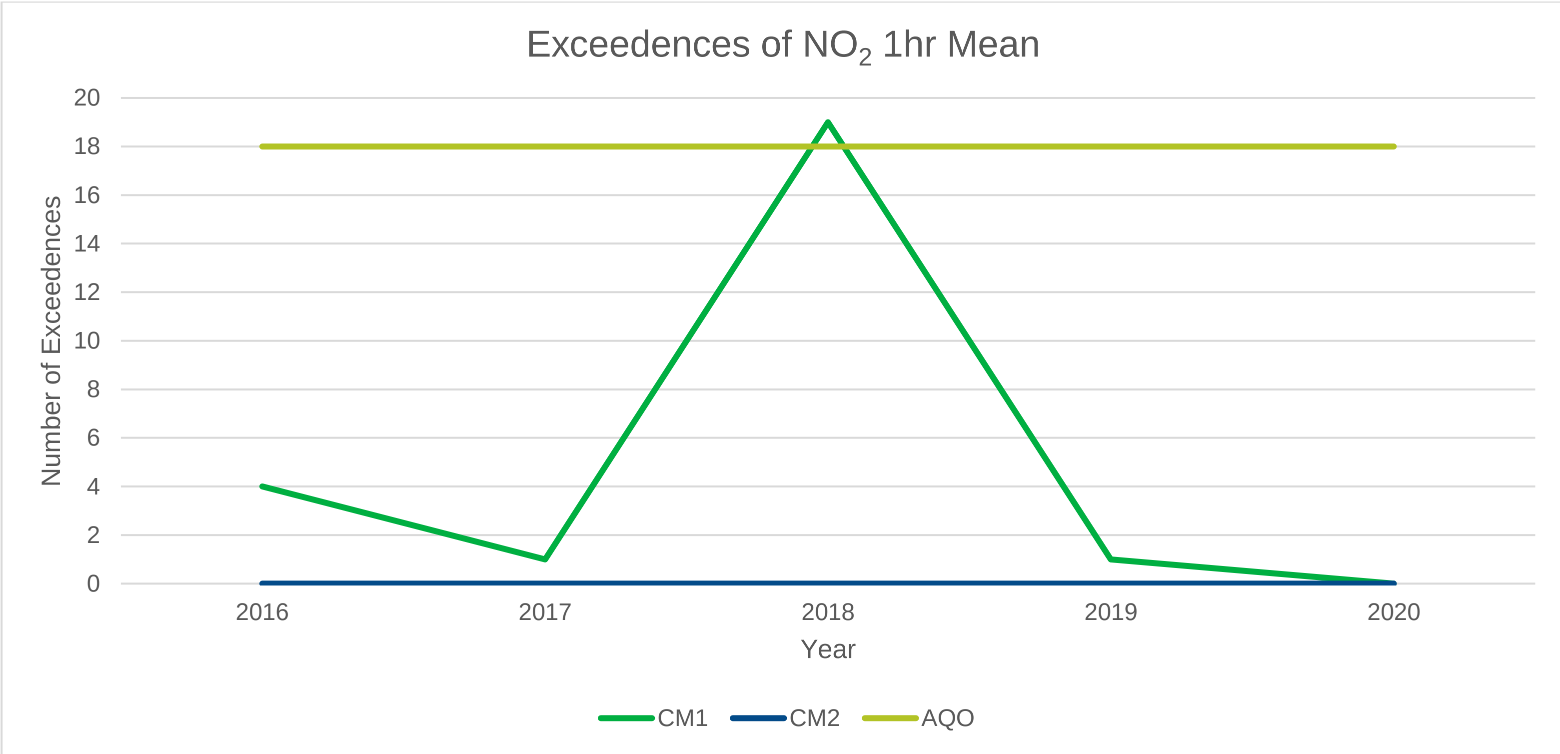


Table A.6 – Annual Mean PM10 Monitoring Results (µg/m3)

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2020 (%) (2)	2016	2017	2018	2019	2020
CM1	623202	308615	Kerbside	85	85	20	23	27	19	19
CM2	623637	306940	Urban Background	99	99	16	16	16	14	13

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

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.TG16 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.2 – Trends in PM10 Monthly Mean Concentrations

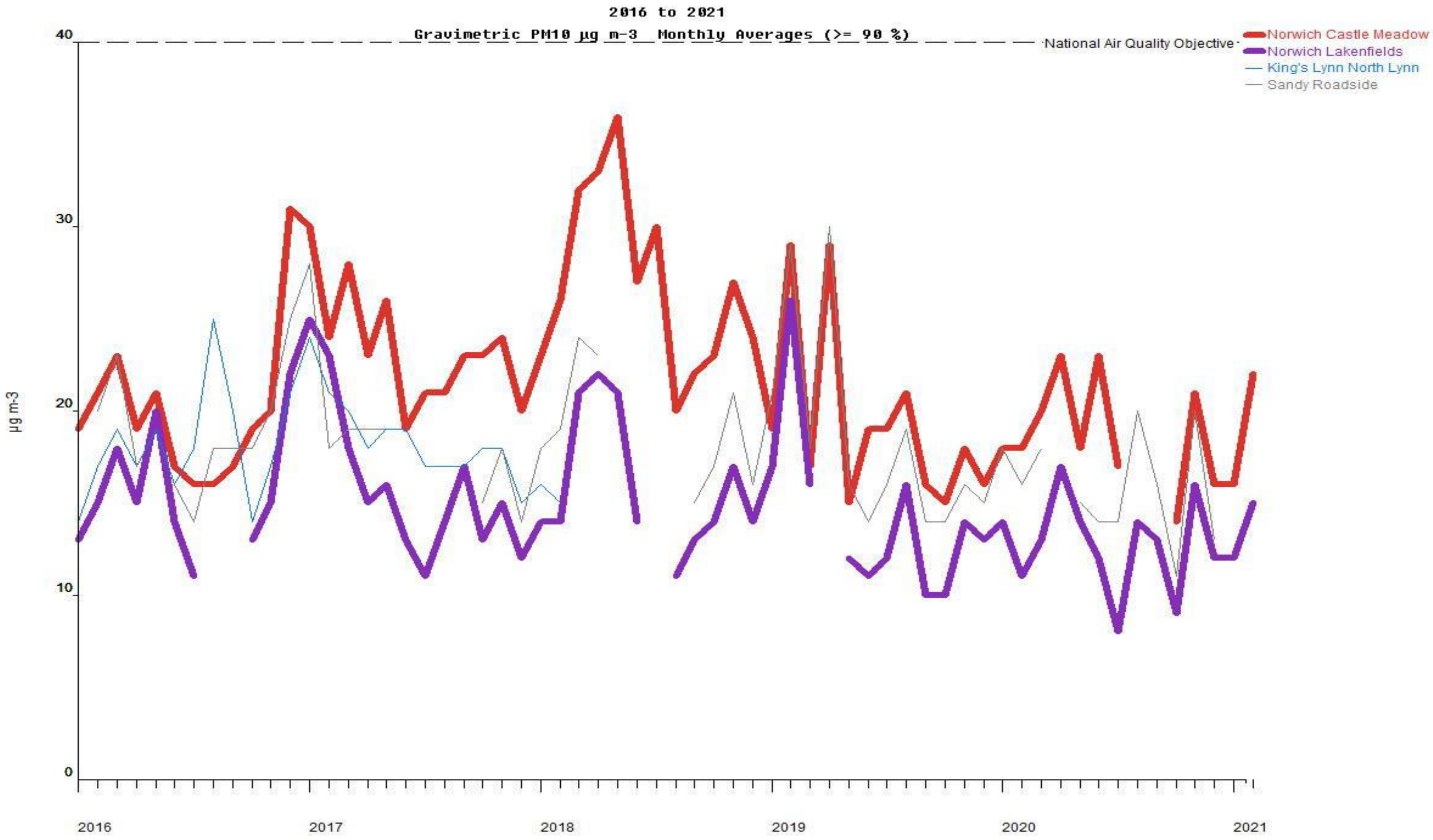


Figure A.4 – Annual Mean PM_{10} Concentrations

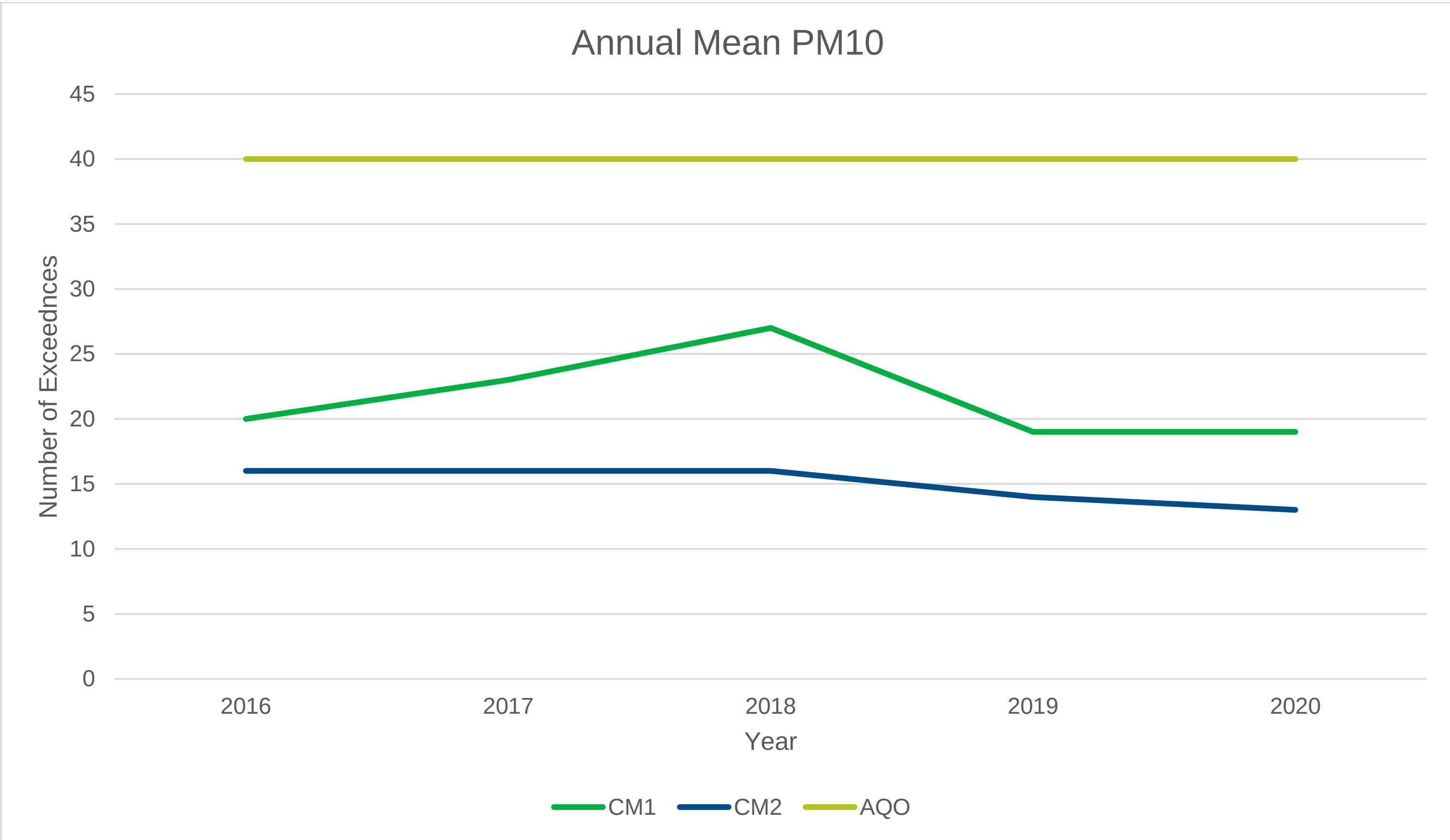


Table A.7 – 24-Hour Mean PM10 Monitoring Results, Number of PM10 24-Hour Means > 50µg/m3

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2020 (%) (2)	2016	2017	2018	2019	2020
CM1	623202	308615	Kerbside	85	85	4	4	8	5	0
CM2	623637	306940	Urban Background	99	99	**1 (27)**	5	1	4	0

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%).

Figure A.5 – Number of Exceedances of 24hr PM_{10} Concentrations

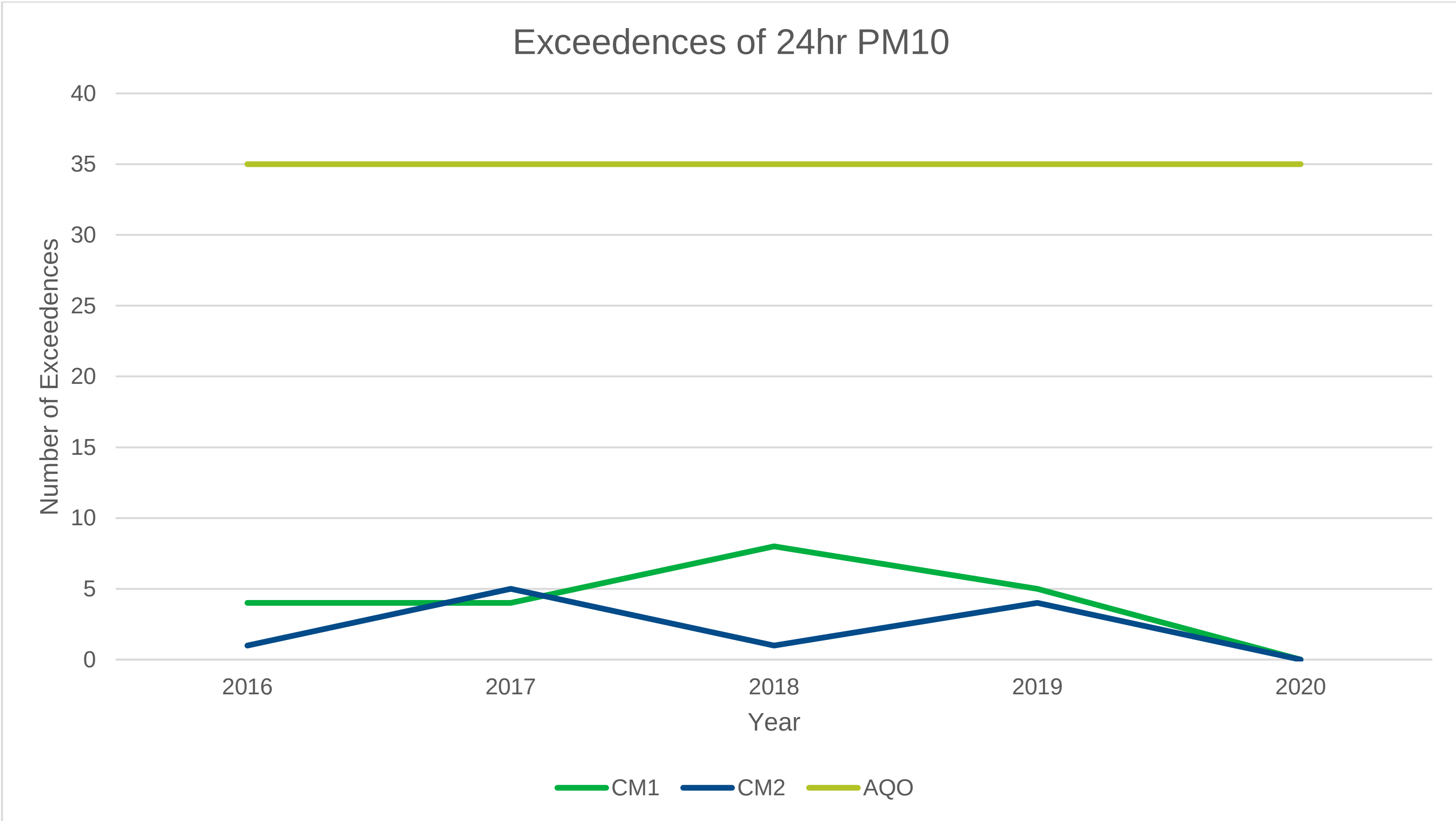


Table A.8 – Annual Mean PM2.5 Monitoring Results (µg/m3)

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2020 (%) (2)	2016	2017	2018	2019	2020
CM1	623202	308615	Kerbside	94	94	11	15	10	10	10
CM2	623637	306940	Urban Background	99	99	11	12	10	10	8

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

Notes:

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

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.

(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.6 – Trends in $PM_{2.5}$ Monthly Mean Concentrations

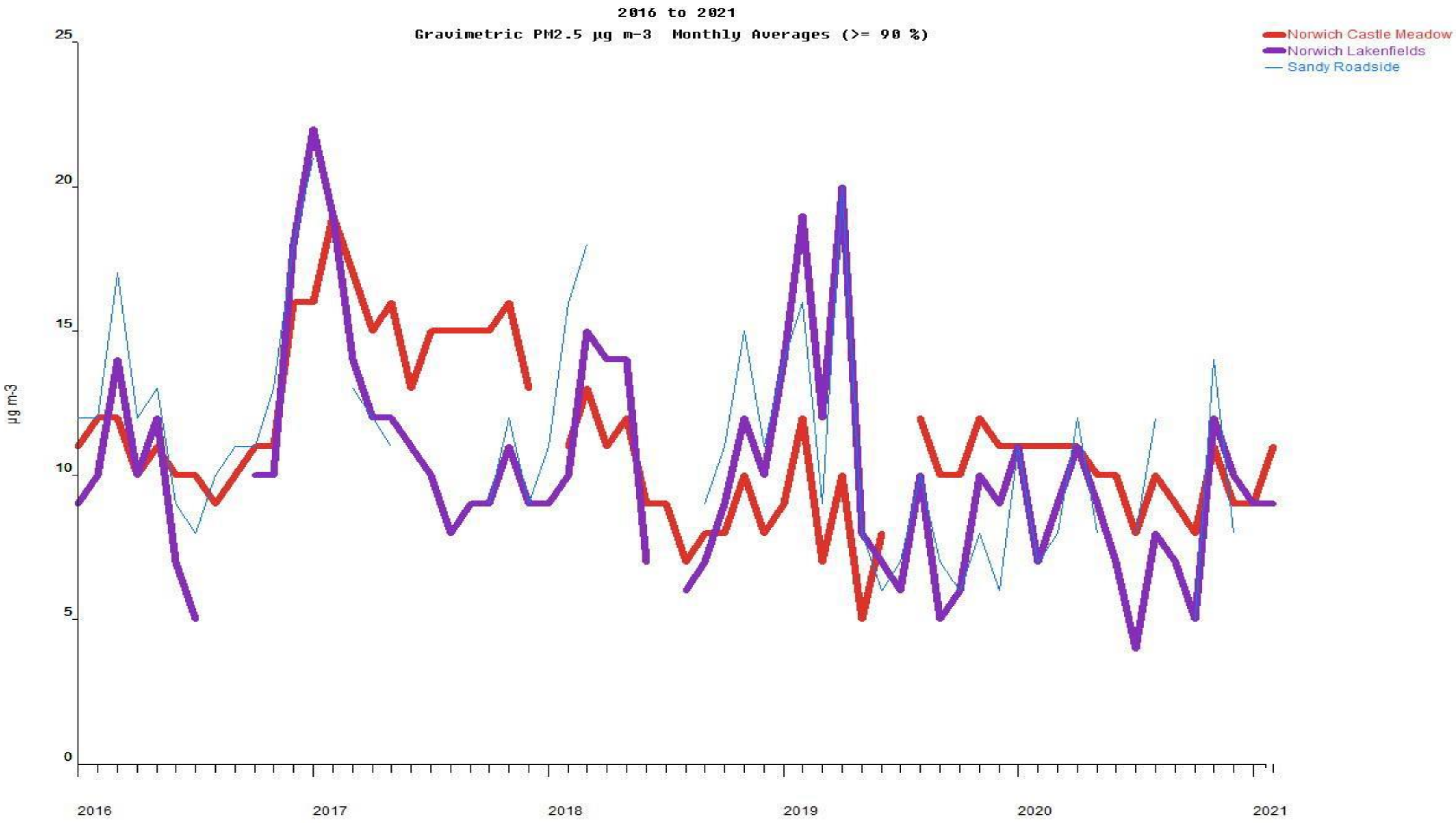


Figure A.7 – Annual Mean PM2.5 Concentrations

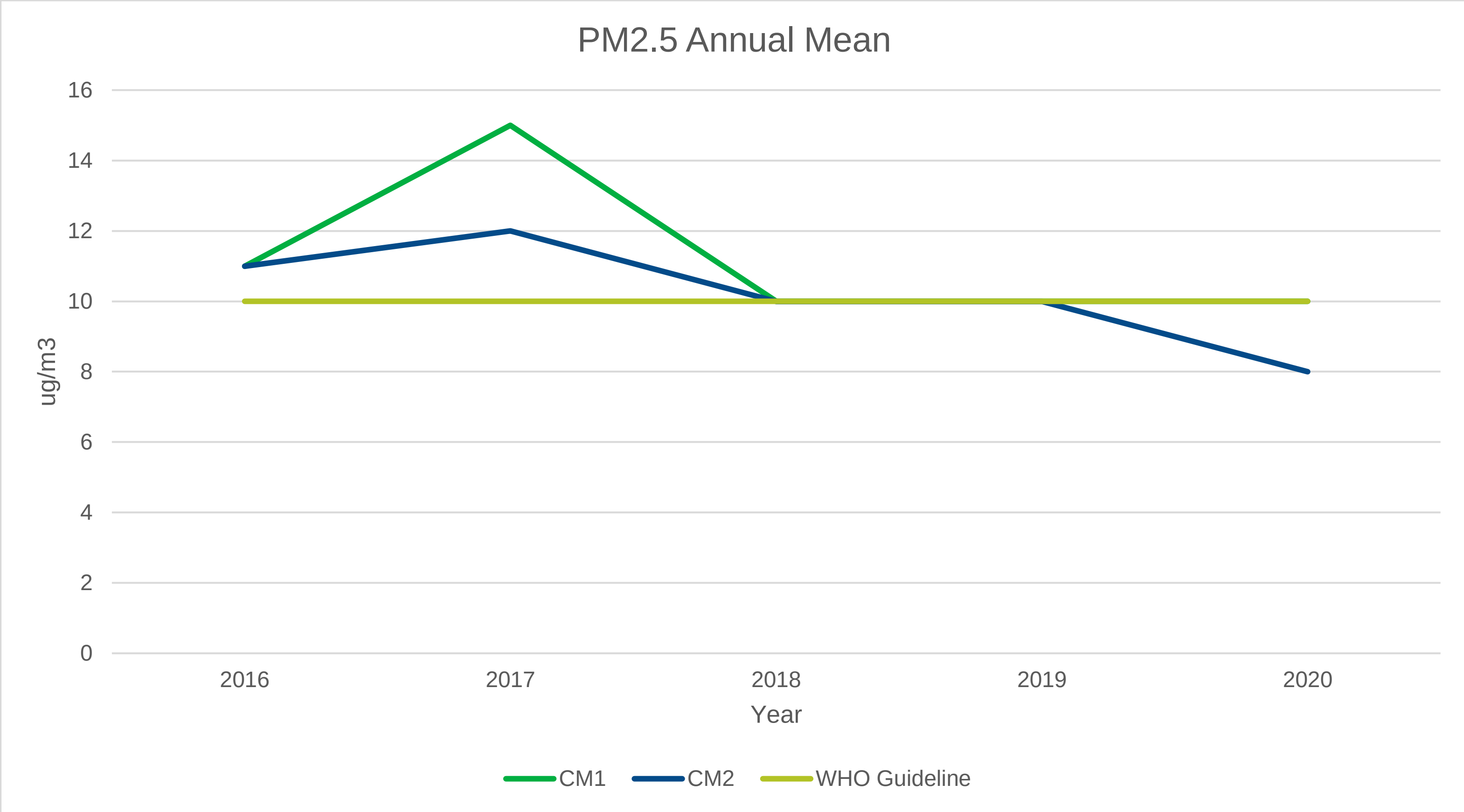
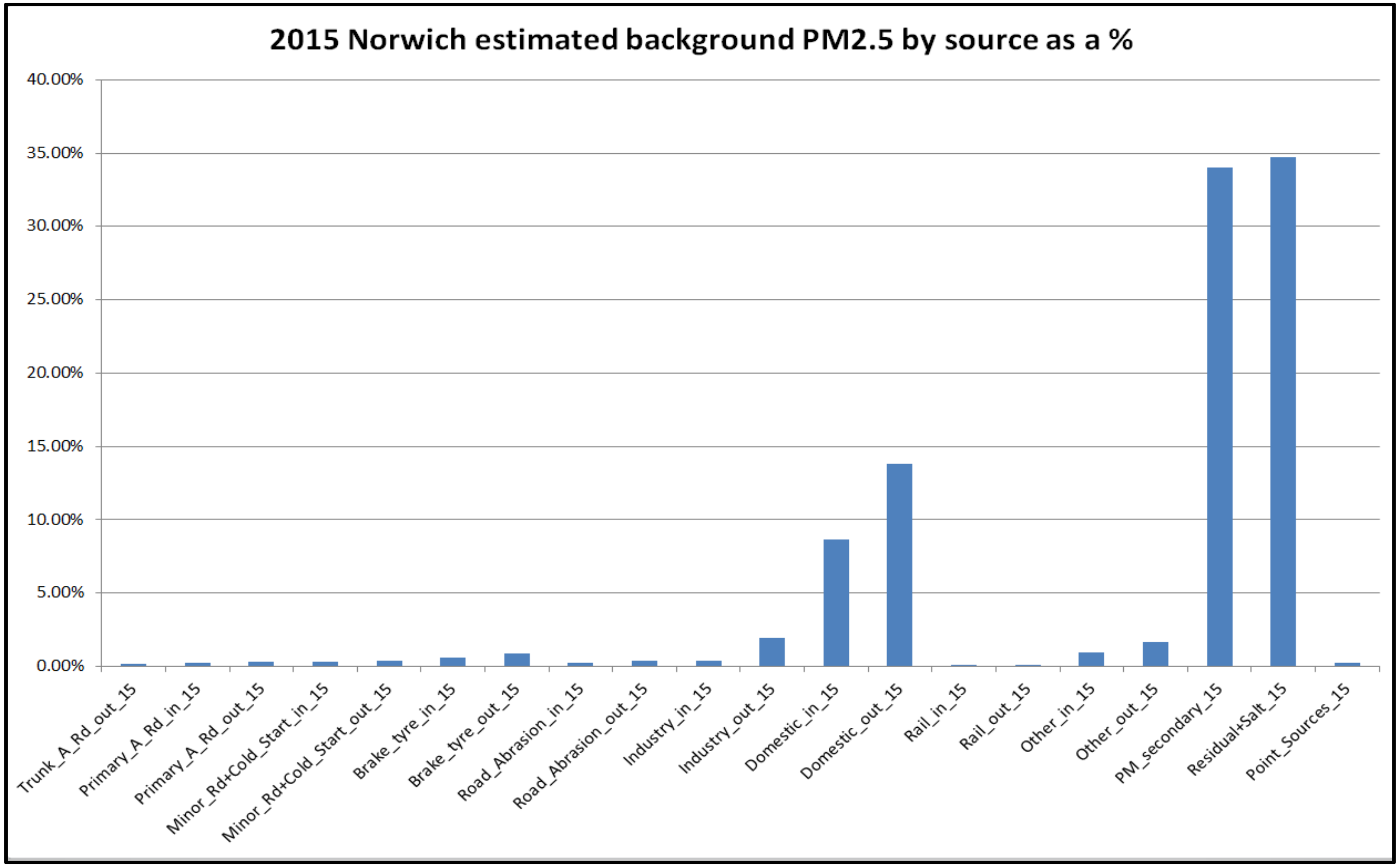


Figure A.8 – Background $PM_{2.5}$ by Source



Appendix B: Full Monthly Diffusion Tube Results for 2020

Table B.1 – NO2 2020 Diffusion Tube Results (µg/m3)

DT ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Easting)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean: Raw Data	Annual Mean: Annualised and Bias Adjusted (0.88)	Annual Mean: Distance Corrected to Nearest Exposure	Comment
DT1A	623863	307679	**41.2**	29.9	29.7	18.0	15.8	27.3	23.2	30.6	30.7	31.7	35.9	36.2	-	-		Triplicate Site with DT1A, DT1B and DT1C - Annual data provided for DT1C only
DT1B	623863	307679	**41.5**	38.2	28.2	18.2	16.6	24.9	21.6	32.2	27.2	31.6	33.8	39.3	-	-		Triplicate Site with DT1A, DT1B and DT1C - Annual data provided for DT1C only
DT1C	623863	307679	**42.4**	34.2	30.6	18.5	17.9	25.1	22.9	27.6	28.9	34.6	37.1	28.6	29.2	25.6		Triplicate Site with DT1A, DT1B and DT1C - Annual data provided for DT1C only
DT4A	623681	307016	18.4	11.4	10.9	7.3	7.2	8.6	6.9	8.0	10.2	9.9	17.9	17.3	-	-		Triplicate Site with DT4A, DT4B and DT4C - Annual data provided for DT4C only
DT4B	623681	307016		13.2	11.6	9.5	7.2	8.8	6.8	8.9	9.4	11.1	19.3	16.2	-	-		Triplicate Site with DT4A, DT4B and DT4C - Annual data provided for DT4C only
DT4C	623681	307016		13.2	10.9		7.2	7.9	7.0	8.2	10.0	10.2	18.1	15.4	11.4	10.0		Triplicate Site with DT4A, DT4B and DT4C - Annual data provided for DT4C only
DT6	623161	309550	33.3	31.2	24.4	13.3	16.9	18.1	20.0	25.7	26.3	24.9	31.4	31.9	24.8	21.7		
DT9	622906	309496	**43.2**	33.6	37.9	28.5	31.1	35.6	30.5	42.8	40.5	38.7	47.2	42.0	37.6	33.0		
DT11	622826	309573	**63.4**	34.6	**40.7**	24.4	35.0	**40.0**	**47.6**	**50.5**	**47.5**	**50.0**	**57.2**	**48.0**	**44.9**	39.4		
DT13	623141	308607	**48.8**		**40.5**	23.7	25.8	35.0	38.1	**48.2**	**47.4**	**44.5**	**48.0**	**45.2**	**40.5**	35.5		
DT16	623186	309650	**50.9**	**47.5**	31.6	19.0	17.9	28.1	31.3	30.8	32.5	39.8	**45.2**	**43.1**	34.8	30.5		
DT19	623321	308431		32.1	29.1	20.8	19.7	26.8	19.4	31.0	24.7	26.3	38.3	18.7	26.1	22.9		
DT21	623880	307659	37.4	35.2	28.2	18.4	20.8	26.8	23.0	30.4	28.3	33.8	30.1	28.1	28.4	24.9		
DT22	623901	307710	36.2	28.4	25.8	17.3	19.1	19.8	20.7	21.9	26.5	25.1	29.1	26.4	24.7	21.7		
DT25	623422	309388	38.5	33.7	28.8	18.8	24.4	22.6	27.4	30.7	34.0	28.4	36.4	30.9	29.6	25.9		
DT26 A	623870	308516	**47.7**		34.4	25.7	24.7	35.8	29.2	**45.1**	**40.7**	**42.2**	**44.2**	**42.1**	-	-		Triplicate Site with DT26A, DT26B and DT26C - Annual data provided for DT26C only
DT26 B	623870	308516	**44.7**	37.9	34.7	26.4	25.2	32.3	30.3	**45.6**	**40.3**	**40.3**	**40.9**	**41.9**	-	-		Triplicate Site with DT26A, DT26B and DT26C - Annual data provided for DT26C only
DT26 C	623870	308516	**46.9**	**43.0**	36.2	24.2	18.1	34.2	29.4	39.7	39.9	**42.0**	**44.7**	**48.0**	37.2	32.6		Triplicate Site with DT26A, DT26B and DT26C - Annual data provided for DT26C only
DT29 A	622532	308490	**47.0**	31.7	29.2	15.1	11.0	26.4	30.7	39.1	**41.4**	38.0	37.1	39.7	-	-		Triplicate Site with DT29A, DT29B and DT29C - Annual data provided for DT29C only
DT29 B	622532	308490	**45.3**	**42.4**	31.9	38.2	18.7	24.7	31.8	**40.4**	39.7	39.3	**40.1**	**42.7**	-	-		Triplicate Site with DT29A, DT29B and DT29C - Annual data provided for DT29C only
DT29 C	622532	308490	**44.6**	38.1		13.7	19.0	31.7	33.2	36.5	**41.4**	**45.1**	34.0	35.4	34.0	29.8		Triplicate Site with DT29A, DT29B and DT29C - Annual data provided for DT29C only
DT31 A	623380	307700	**45.6**	**44.4**	34.1	28.3	20.9	32.5	30.3	32.9	33.9	35.6	**41.2**	**42.9**	-	-		Triplicate Site with DT31A, DT31B and DT31C - Annual data provided for DT31C only
DT31 B	623380	307700	**45.8**	**40.2**	32.8	18.1	19.7	30.3	29.0	32.9	34.2	38.1	38.5	38.3	-	-		Triplicate Site with DT31A, DT31B and DT31C - Annual data provided for DT31C only

DT ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Easting)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean: Raw Data	Annual Mean: Annualised and Bias Adjusted (0.88)	Annual Mean: Distance Corrected to Nearest Exposure	Comment
DT31C	623380	307700	**46.8**		34.5	18.7	20.5	29.9	29.7	33.8	32.0	38.1	**40.8**	**40.1**	34.1	29.9		Triplicate Site with DT31A, DT31B and DT31C - Annual data provided for DT31C only
DT34	622898	308114	**47.1**	**40.2**	36.9	17.2	18.3	30.8	27.0	32.9	34.1	37.1	**40.9**	36.7	33.3	29.2		
DT37	622492	308520	**40.0**	32.9	28.8	10.9	15.4		21.8	28.6	28.6	30.4	33.3	37.9	28.1	24.6		
DT39	622884	309082	32.5	23.2	24.1	14.0	14.7	20.5	15.0	24.6	24.2	25.6	29.8	27.9	23.0	20.2		
DT40	622695	307855	33.6	30.6	26.9	13.8	14.3	18.7	18.0	21.7	26.5	25.9	33.8	29.9	24.5	21.5		
DT41	623148	309277	**42.6**	36.2	32.0	19.8	23.1	26.1	26.6	32.2	31.4	29.9	39.6	35.3	31.2	27.4		
DT42	623151	309326	38.2	29.1	29.8	19.5					25.2		**41.6**	34.5	31.1	21.2		
DT43	623037	309487		21.9	21.3	13.3	13.4	18.0	15.9	17.3	18.9	20.5	29.0	28.6	19.8	17.4		
DT44	622910	309391	35.7	31.2	22.6	14.1	15.2	20.7	18.3	26.0	28.2	30.2	35.1	30.3	25.6	22.5		
DT45	622904	309418	37.0	30.6	28.1	16.2	17.1	25.6	21.9	34.0		37.0	36.6	34.5	29.0	25.4		
DT46	622987	309486	36.8	29.7	21.1	17.7	19.7	23.9	22.2	37.3	37.2	37.5	32.7	32.4	29.0	25.4		
DT47	622869	309187	27.4	24.7	21.7	16.2	16.8	18.4	16.1	27.4	22.9	23.3	29.7	26.6	22.6	19.8		
DT48	623878	308532	**43.5**	32.9	30.2	19.5	19.2	24.9	22.5	37.1	35.8	37.5	35.4	35.1	31.1	27.3		
DT49	623480	307679	31.8	23.0	27.2	22.3	23.7	27.3	24.2	34.6	31.6	30.6	31.2	33.4	28.4	24.9		
DT50	623474	307692	39.9	33.6	27.5	17.3	19.6	22.7	25.4	27.5	28.6	31.2	38.9	34.0	28.8	25.3		
S1	621104	307935		14.9	13.0										-	-		
S2	621083	307924	17.3	14.8	13.3										15.1	10.4		

☒ **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.**

☒ **Norwich City Council confirm that all 2020 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 City Council During 2020

Norwich City Council has not identified any new sources relating to air quality within the reporting year of 2020.

Additional Air Quality Works Undertaken by Norwich City Council During 2020

Norwich City Council completed its Action Plan within the reporting year of 2021.

In addition, a business case was submitted to the council for a new air quality station to replace the 25 year old automatic monitoring station on Castle Meadow. The business case was accepted.

QA/QC of Diffusion Tube Monitoring

National Diffusion Tube Bias Adjustment Factors

Supplier/ Analyst: Gradko

Preparation Method: 50% TEA in Acetone

National Bias Adjustment Factor (from spreadsheet v09/21): **0.84** (22 studies)

National Diffusion Tube Bias Adjustment Factor Spreadsheet

Spreadsheet Version Number: 09/21

Follow the steps below **in the correct order** to show the results of **relevant** co-location studies

Data only apply to tubes exposed monthly and are not suitable for correcting individual short-term monitoring periods

Whenever presenting adjusted data, you should state the adjustment factor used and the version of the spreadsheet

This spreadhseet will be updated every few months: the factors may therefore be subject to change. This should not discourage their immediate use.

This spreadsheet will be updated at the end of March 2022

LAQM Helpdesk Website

The LAQM Helpdesk is operated on behalf of Defra and the Devolved Administrations by Bureau Veritas, in conjunction with contract partners AECOM and the National Physical Laboratory.

Spreadsheet maintained by the National Physical Laboratory. Original compiled by Air Quality Consultants Ltd.

Step 1: Select the Laboratory that Analyses Your Tubes from the Drop-Down List. If a laboratory is not shown, we have no data for this laboratory.

Step 2: Select a Preparation Method from the Drop-Down List. If a preparation method is not shown, we have no data for this method at this laboratory.

Step 3: Select a Year from the Drop-Down List. If a year is not shown, we have no data[2]

Step 4: **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 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	2020	KS	Marylebone Road Intercomparison	12	57	43	33.0%	G	**0.75**
Gradko	50% TEA in acetone	2020	R	London Borough of Richmond upon Thames	12	22	20	9.4%	G	**0.91**
Gradko	50% TEA in acetone	2020	B	London Borough of Richmond upon Thames	9	19	16	20.3%	G	**0.83**
Gradko	50% TEA in acetone	2020	UB	Reading Borough Council	12	14	15	-7.7%	G	**1.08**
Gradko	50% TEA in acetone	2020	R	Reading Borough Council	12	30	25	20.2%	G	**0.83**
Gradko	50% TEA in acetone	2020	UB	Norwich City Council	10	12	10	14.4%	G	**0.87**
Gradko	50% TEA in acetone	2020	SU	Reigate and Banstead BC (RG1)	10	19	14	33.3%	G	**0.75**
Gradko	50% Tea in Acetone	2020	KS	Slough Borough Council	12	34	27	23.5%	G	**0.81**
Gradko	50% TEA in Acetone	2020	SU	Slough Borough Council	11	21	17	29.2%	G	**0.77**
Gradko	50% TEA in Acetone	2020	KS	Slough Borough Council	12	29	25	17.9%	G	**0.85**
Gradko	50% TEA in acetone	2020	R	East Herts District Council	11	25	26	-4.2%	G	**1.04**
Gradko	50% TEA in acetone	2020		**Overall Factor[3] (22 studies)**				**Use**		**0.84**

Checking Precision and Accuracy of Triplicate Tubes

Diffusion Tubes Measurements

Period	Start Date dd/mm/yyyy	End Date dd/mm/yyyy	Tube 1 μgm^{-3}	Tube 2 μgm^{-3}	Tube 3 μgm^{-3}	Triplicate Mean	Standard Deviation	Coefficient of Variation (CV)	95% CI of mean
1	08/01/2020	05/02/2020	18.4						
2	05/02/2020	04/03/2020	11.5	13.2	13.2	13	1.0	8	2.5
3	04/03/2020	02/04/2020	10.9	11.6	10.9	11	0.4	3	0.9
4	02/04/2020	12/05/2020	7.3	9.5		8	1.5	18	13.8
5	12/05/2020	05/06/2020	7.2	7.2	7.2	7	0.0	1	0.1
6	05/06/2020	01/07/2020	8.6	8.8	7.9	8	0.5	5	1.1
7	01/07/2020	06/08/2020	6.9	6.8	7.0	7	0.1	1	0.2
8	06/08/2020	03/09/2020	8.1	8.9	8.2	8	0.5	5	1.1
9	03/09/2020	01/10/2020	10.2	9.4	10.0	10	0.4	4	1.1
10	01/10/2020	04/11/2020	9.9	11.1	10.2	10	0.6	6	1.6
11	04/11/2020	02/12/2020	17.9	19.3	18.1	18	0.7	4	1.9
12	02/12/2020	05/01/2021	17.3	16.2	15.4	16	0.9	6	2.3
13									

It is necessary to have results for at least two tubes in order to calculate the precision of the measurements

Site Name/ ID:

Precision 11 out of 11 periods have a

Accuracy (with 95% confidence interval)
without periods with CV larger than 20%
Bias calculated using 9 periods of data
Bias factor A 0.88 (0.81 - 0.98)
Bias B 13% (2% - 24%)
Diffusion Tubes Mean: 11 μgm^{-3}
Mean CV (**Precision**): 6
Automatic Mean: 10 μgm^{-3}
Data Capture for periods used: 99%
Adjusted Tubes Mean: 10 (9 - 11) μgm^{-3}

Accuracy (with 95% confidenc
WITH ALL DATA
Bias calculated using 9 periods of data
Bias factor A 0.88 (0.81
Bias B 13% (2%
Diffusion Tubes Mean: 11 µgm
Mean CV (**Precision**): 6
Automatic Mean: 10 µgm
Data Capture for periods used: 99%
Adjusted Tubes Mean: 10 (9 - 11)

Diffusion Tube Annualisation

With the exception of the bus stop on Magdalen Street (DT42) where the diffusion tube is subject to repeated vandalism, all diffusion tube monitoring locations within Norwich City Council recorded data capture of >75% and therefore it was not required to annualise any monitoring data. The Data Processing Toolkit was utilised and performed an annualisation using a factor of 0.7829 for Norwich Lakenfields. Only Norwich Lakenfields was used as all other background sites are considered too far away as to be relevant. Castle Meadow was not utilised as, being on a bus and taxi only street, this was also not considered relevant to a background site. This annualisation factor was however considered to be low.

In addition, any sites with a data capture below 25% do not require annualisation.

Diffusion Tube Bias Adjustment Factors

The diffusion tube data presented within the 2020 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.TG16 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 local bias adjustment factor of 0.88 to the 2020 monitoring data. A summary of bias adjustment factors used by Norwich City Council over the past five years is presented in Table C.1.

Historically, the national bias adjustment factor has been applied - with the exception of the 2018 data when only 8 studies had been submitted to the national spreadsheet and some of these submissions showed a significant variation in bias. The local bias was therefore applied as it showed good data precision.

The reporting of the 2019 data in the 2020 ASR was delayed by Covid work commitments and hence, at the time of writing, the September national dataset was available. This comprised 29 studies and, although some submissions were again showing poor bias, in aggregate the data was considered to be sufficiently robust and hence acceptable to use.

TG16 Box 7.11 identifies the justification for the choice of bias, local vs national. It suggests the local factor should always be used in preference to the national. In Norwich, the automatic station used for co-location is an urban background site which does not represent the roadside hotspots of the AQMA diffusion tube locations. Hence Norwich tends to preference the national database as opposed to the locally derived one unless there is good reason to choose otherwise.

This year due to the pandemic creating significantly less traffic on the roads, DT NO_2 levels are atypically low. In addition, the national bias factor for the 09/21 database, despite comprising 22 studies, was also low at 0.84. The precision readings for the local study were good and hence it was decided to err on the side of caution and use the local bias of 0.88.

The locally derived bias adjustment factor of 0.88 has therefore been applied.

Table C.1 – Bias Adjustment Factor

Year	Local or National	If National, Version of National Spreadsheet	Adjustment Factor
2020	Local	-	0.88
2019	National	09/20 (29 studies)	0.89
2018	Local		0.86
2017	National	03/18 (22 studies)	0.97
2016	National	06/17 (18 studies)	1.01

NO_2 Fall-off with Distance from the Road

Wherever possible, local authorities should ensure that monitoring locations are representative of exposure. However, where this is not possible, the NO_2 concentration at the nearest location relevant for exposure should be 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 Norwich City Council required distance correction during 2020.

QA/QC of Automatic Monitoring

In order to satisfy the requirements outlined in LAQM (TG16), the following QA/QC procedures were implemented at the Norwich City Council owned automatic monitoring station at Castle Meadow:

- 2-weekly calibrations of the analysers at Castle Meadow roadside station carried out by a member of the Public Protection team at Norwich City Council
- 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 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 another standard gas to confirm the gas concentration. Any identified faults were forwarded on to the service unit for repair.

The final stage of the QA/QC process is data ratification. During ratification, all calibration, audit and service data are collated, and the data is appropriately scaled.

Any suspect data identified are deleted, thereby ensuring that the data sets are of a high quality. The Castle Meadow data was ratified by Air Quality Data Management (AQDM). Public access to the live and historic data is via the AQDM website:

Air Quality Data Management (aqdm.co.uk)

Norwich Lakenfields is part of the AURN network operated by Bureau Veritas. The AURN network have appointed LSO's and servicing is conducted by Acoem UK on a 6 monthly basis. Audits are conducted by Ricardo-AEA Ltd annually. Live and historic data is available through the Defra website:

Home - Defra, UK

All data presented in the ASR is ratified.

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

The Volatile Correction Method (VCM) allows corrections to be made to 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 Equivalent PM_{10} for the annual mean and 24-hour mean readings.

The Norwich Lakenfields site has a Fidas analyser to monitor for PM_{10} and $PM_{2.5}$.

Automatic Monitoring Annualisation

All automatic monitoring locations within Norwich City Council recorded data capture of greater than 75% therefore it was not required to annualise any automatic monitoring data. In addition, any sites with a data capture below 25% do not require annualisation.

NO_2 Fall-off with Distance from the Road

Wherever possible, local authorities should ensure that monitoring locations are representative of exposure. However, where this is not possible, the NO_2 concentration at the nearest location relevant for exposure should be 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 City Council required distance correction during 2020.

Table C.2 – Annualisation Summary (concentrations presented in µg/m3)

Site ID	Annualisation Factor Lakenfields	Annualisation Factor Lakenfields	Annualisation Factor Site 3 Name	Annualisation Factor Site 4 Name	Average Annualisation Factor	Raw Data Annual Mean	Annualised Annual Mean	Comments
DT42	0.7828	0.7828			0.7828	31.1	24.4	
S2	0.7829	0.7829			0.7829	15.1	11.8	

Table C.3 – Local Bias Adjustment Calculation

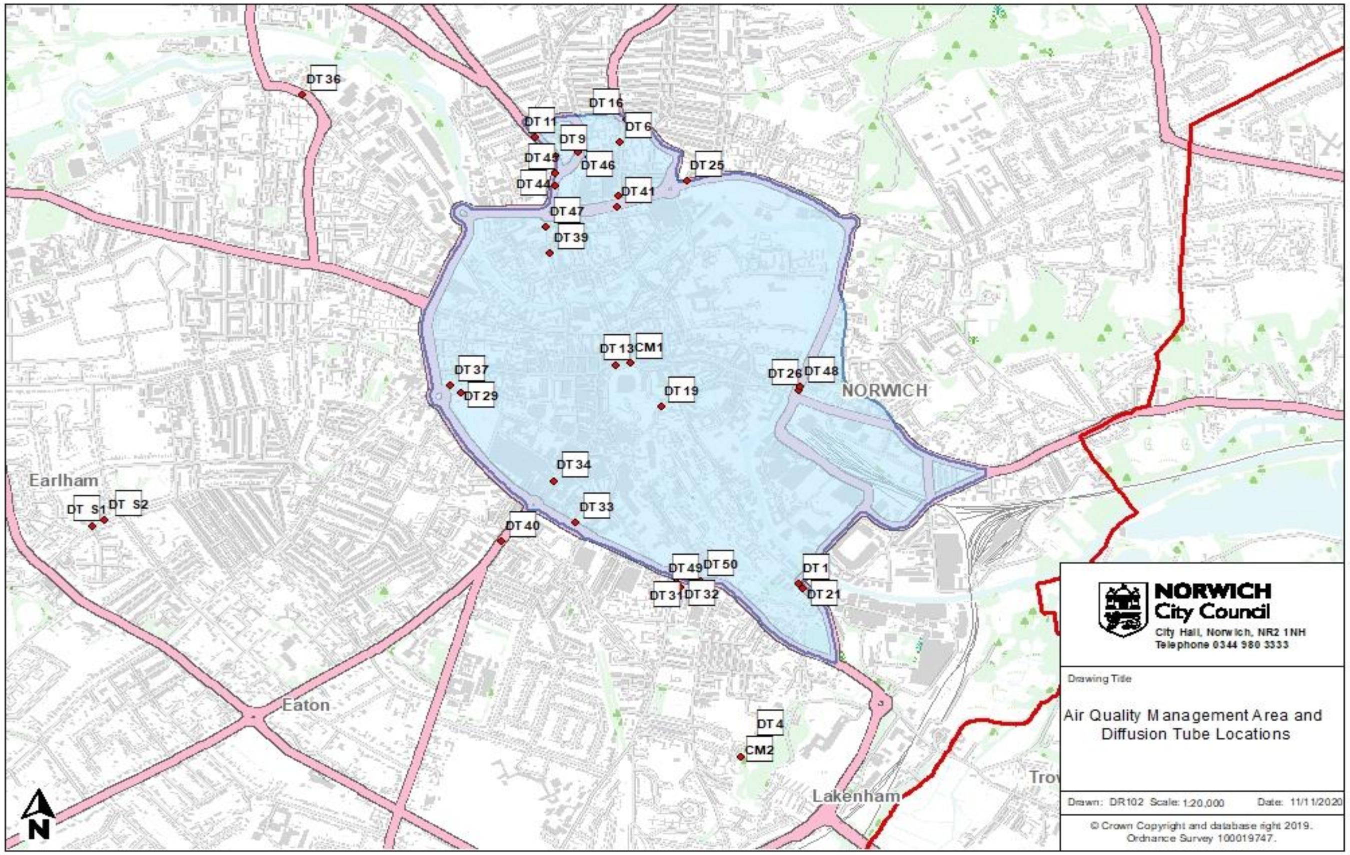
	Local Bias Adjustment Input 1	Local Bias Adjustment Input 2	Local Bias Adjustment Input 3	Local Bias Adjustment Input 4	Local Bias Adjustment Input 5
Periods used to calculate bias	9				
Bias Adjustment Factor A	0.88 (0.79 - 0.99)				
Diffusion Tube Bias B	14% (1% - 27%)				
	14				
Diffusion Tube Mean (µg/m^3)	11.2				
Mean CV (Precision)	5.7%				
Automatic Mean (µg/m^3)	9.9				

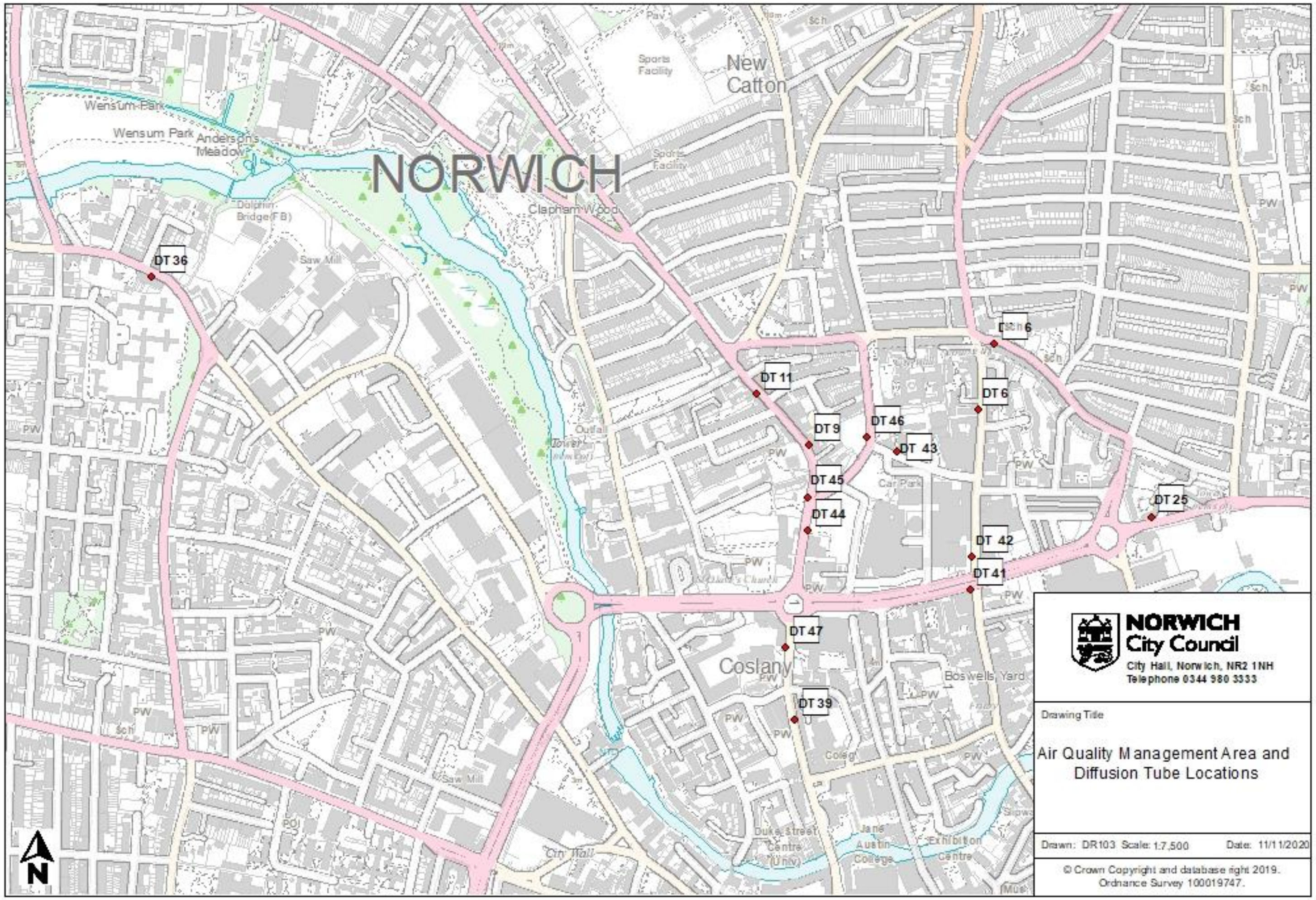
Notes:

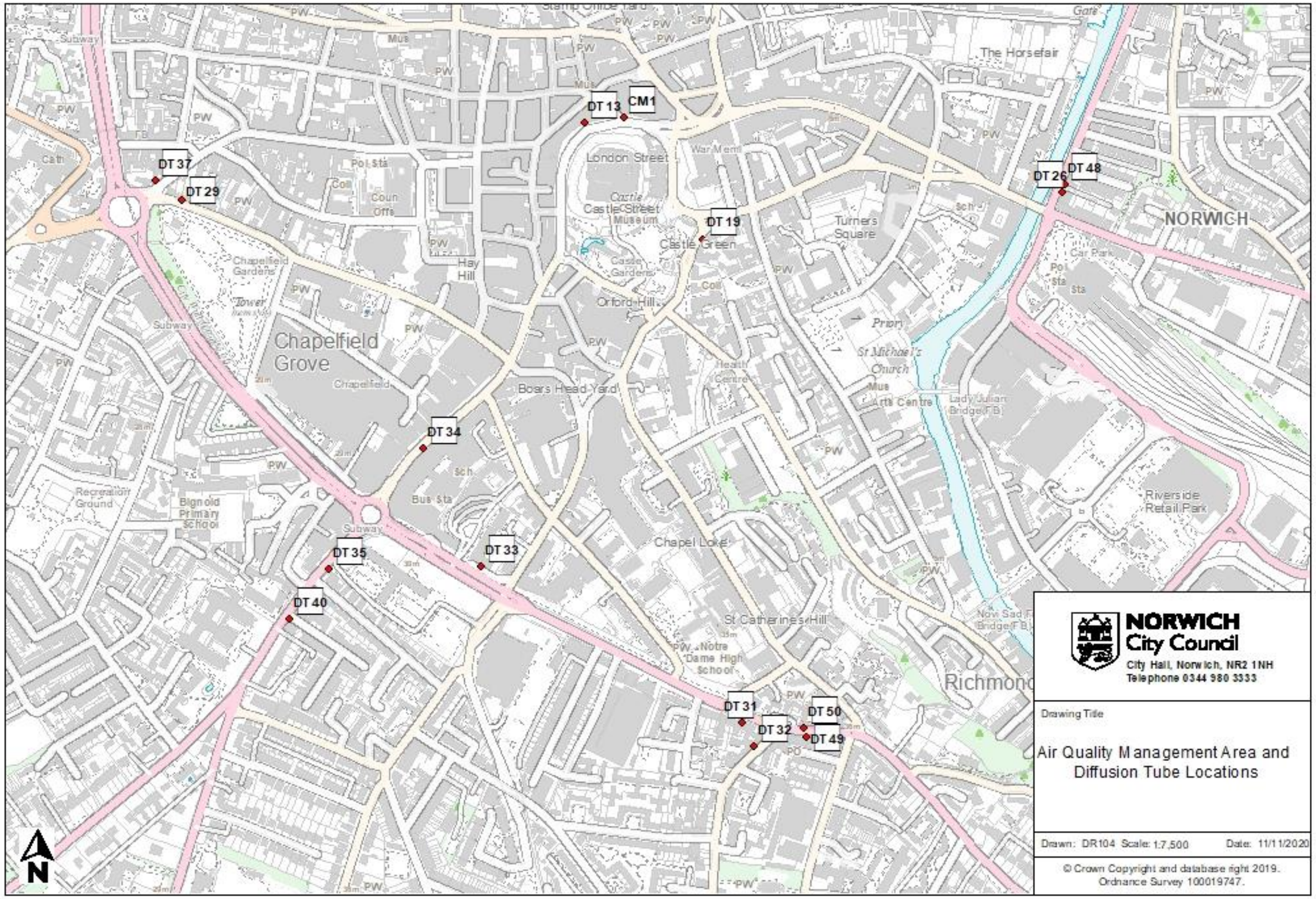
A single local bias adjustment factor has been used to bias adjust the 2020 diffusion tube results.

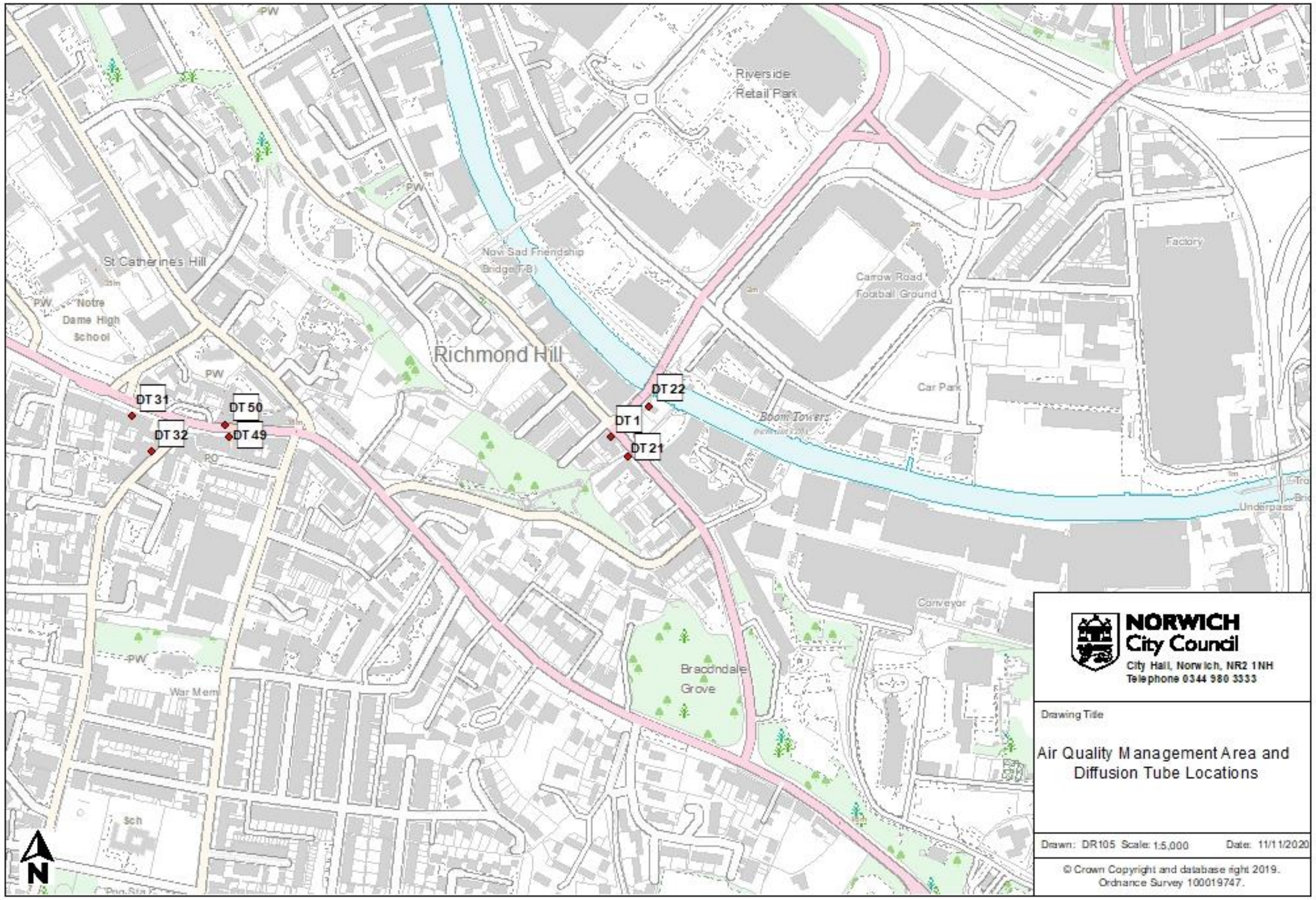
Appendix D: Map(s) of Monitoring Locations and AQMAs

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




NORWICH
New Catton
Wensum Park
Andersons Meadow
Clapham Wood
Coslany
DT 36
DT 11
DT 9
DT 46
DT 43
DT 45
DT 44
DT 6
DT 25
DT 42
DT 41
DT 47
DT 39
NORWICH City Council
City Hall, Norwich, NR2 1NH
Telephone 0344 980 3333
Drawing Title
Air Quality Management Area and Diffusion Tube Locations
Drawn: DR103 Scale: 1:7,500
Date: 11/11/2020
© Crown Copyright and database right 2019. Ordnance Survey 100019747.


DT 13
CM1
DT 37
DT 29
DT 19
DT 26
DT 48
DT 34
DT 35
DT 33
DT 40
DT 31
DT 32
DT 50
DT 49
NORWICH City Council
City Hall, Norwich, NR2 1NH
Telephone 0344 980 3333
Drawing Title
Air Quality Management Area and Diffusion Tube Locations
Drawn: DR104 Scale: 1:7,500 Date: 11/11/2020
© Crown Copyright and database right 2019. Ordnance Survey 100019747.
N


Riverside
Retail Park
St Catherines Hill
Notre
Dame High
School
Novi Sad Friendship
Bridge (FB)
Carrow Road
Football Ground
Richmond Hill
Factory
Car Park
Boom Towers
DT 31
DT 50
DT 32
DT 49
DT 22
DT 1
DT 21
Underpass
Conveyor
Bracondale
Grove
War Mem
Sch
N
NORWICH
City Council
City Hall, Norwich, NR2 1NH
Telephone 0344 980 3333
Drawing Title
Air Quality Management Area and
Diffusion Tube Locations
Drawn: DR105 Scale: 1:5,000
Date: 11/11/2020
© Crown Copyright and database right 2019.
Ordnance Survey 100019747.


Lakenham
DT4
CM2
Smithfield Road
Cristchurch Road
City Road
Meadowbrook Close
Stafford Drive
Long John Hill
Surrey Hill
PW
NORWICH
City Council
City Hall, Norwich, NR2 1NH
Telephone 0344 980 3333
Drawing Title
Air Quality Management Area and
Diffusion Tube Locations
Drawn: DR106 Scale: 1:2,500
Date: 11/11/2020
© Crown Copyright and database right 2019.
Ordnance Survey 100019747.
N

Appendix E: Summary of Air Quality Objectives in England

Table E.1 – Air Quality Objectives in England[8]

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

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

Appendix F: Impact of COVID-19 upon LAQM

COVID-19 has had a significant impact on society. Inevitably, COVID-19 has also had an impact on the environment, with implications to air quality at local, regional and national scales.

COVID-19 has presented various challenges for Local Authorities with respect to undertaking their statutory LAQM duties in the 2021 reporting year. Recognising this, Defra provided various advice updates throughout 2020 to English authorities, particularly concerning the potential disruption to air quality monitoring programmes, implementation of Air Quality Action Plans (AQAPs) and LAQM statutory reporting requirements. Defra has also issued supplementary guidance for LAQM reporting in 2021 to assist local authorities in preparing their 2021 ASR. Where applicable, this advice has been followed.

Despite the challenges that the pandemic has given rise to, the events of 2020 have also provided Local Authorities with an opportunity to quantify the air quality impacts associated with wide-scale and extreme intervention, most notably in relation to emissions of air pollutants arising from road traffic. The vast majority (>95%) of AQMAs declared within the UK are related to road traffic emissions, where attainment of the annual mean objective for nitrogen dioxide (NO_2) is considered unlikely. On 23rd March 2020, the UK Government released official guidance advising all members of public to stay at home, with work-related travel only permitted when absolutely necessary. During this initial national lockdown (and to a lesser extent other national and regional lockdowns that followed), marked reductions in vehicle traffic were observed; Department for Transport (DfT) data[9] suggests reductions in vehicle traffic of up to 70% were experienced across the UK by mid-April, relative to pre COVID-19 levels.

This reduction in travel in turn gave rise to a change of air pollutant emissions associated with road traffic, i.e., nitrous oxides (NO_x), and exhaust and non-exhaust particulates (PM). The Air Quality Expert Group (AQEG)[10] has estimated that during the initial lockdown period in 2020, within urbanised areas of the UK reductions in NO_2 annual mean concentrations were between 20 and 30% relative to pre-pandemic levels, which

[9] Prime Minister's Office, COVID-19 briefing on the 31st of May 2020

[10] Air Quality Expert Group, Estimation of changes in air pollution emissions, concentrations and exposure during the COVID-19 outbreak in the UK, June 2020

represents an absolute reduction of between 10 to 20µg/m^3 if expressed relative to annual mean averages. During this period, changes in $PM_{2.5}$ concentrations were less marked than those of NO_2. $PM_{2.5}$ concentrations are affected by both local sources and the transport of pollution from wider regions, often from well beyond the UK. Through analysis of AURN monitoring data for 2018-2020, AQEG have detailed that $PM_{2.5}$ concentrations during the initial lockdown period are of the order 2 to 5µg/m^3 lower relative to those that would be expected under business-as-usual conditions.

As restrictions are gradually lifted, the challenge is to understand how these air quality improvements can benefit the long-term health of the population.

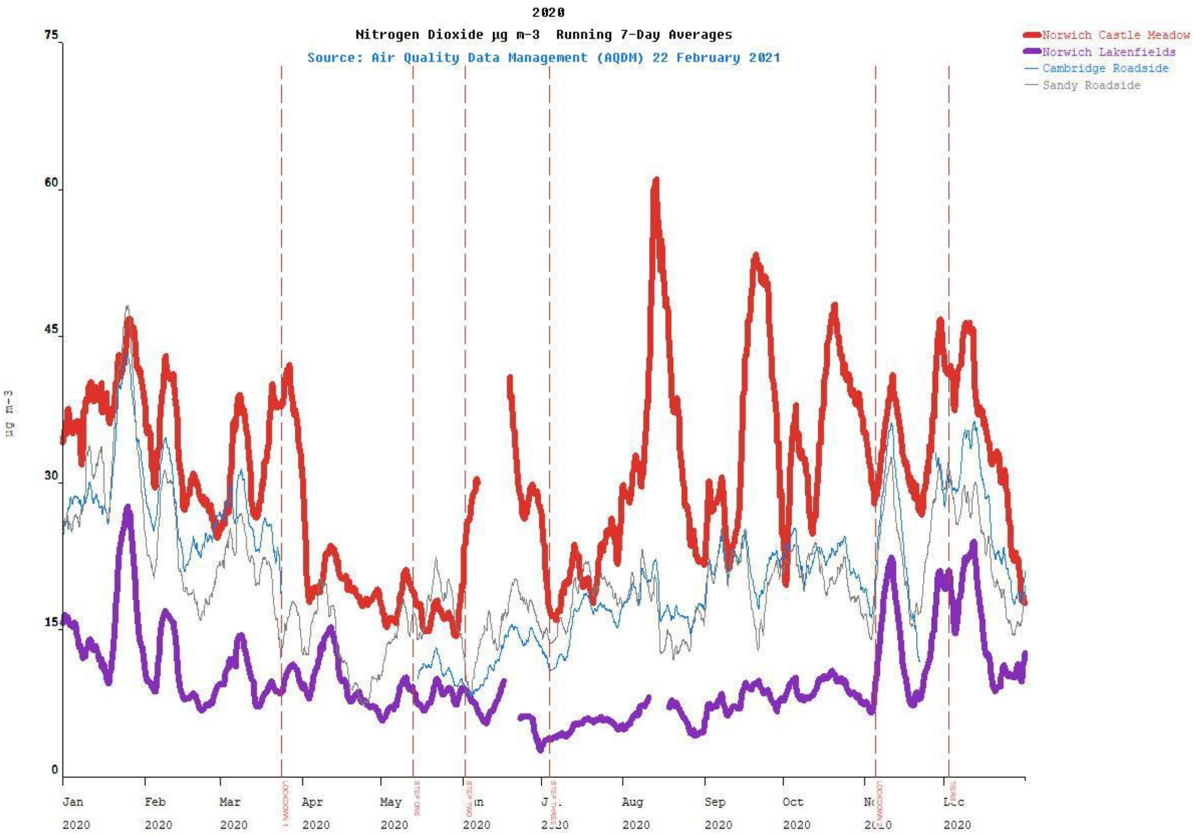
Impacts of COVID-19 on Air Quality within Norwich City Council

Nitrogen Dioxide

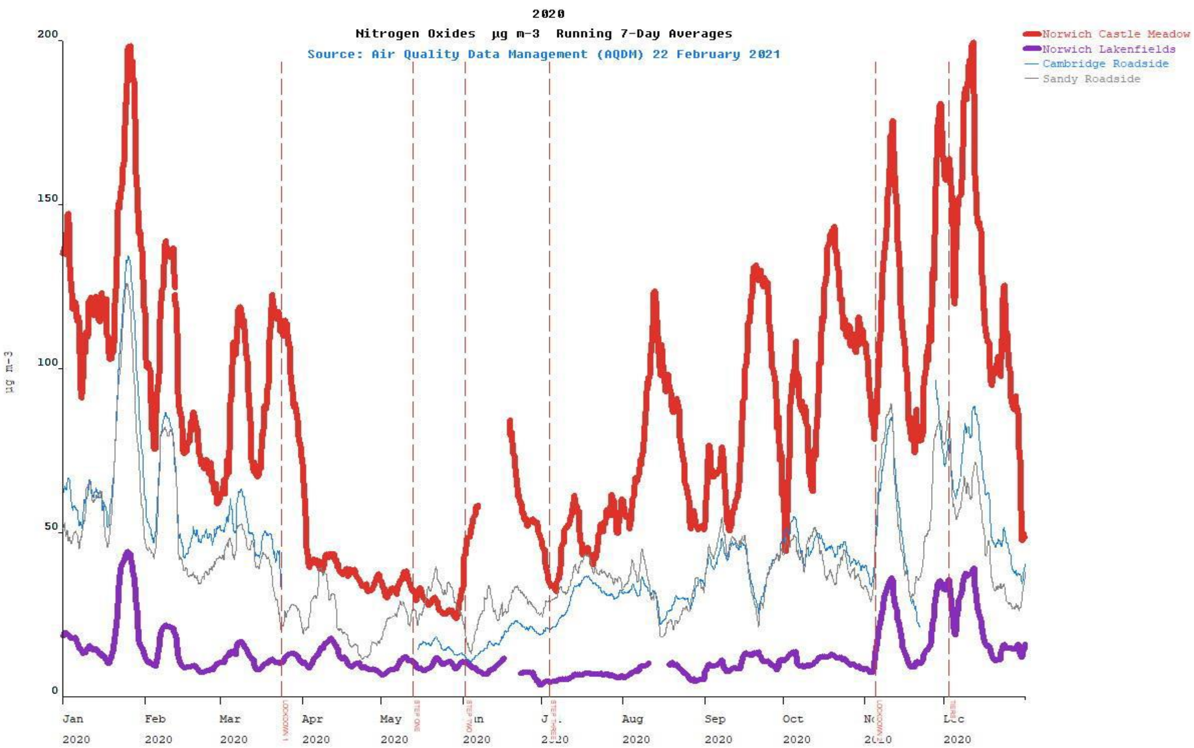
The following plots illustrate that within just a few days, the Castle Meadow automatic monitoring site showed NO_2 pollution levels at the roadside had dropped to levels similar to the urban background station at Lakenfields. As lockdown progressed, the range of NO_2 concentrations during the lockdown period were also dampened.

Directly comparing 2020 lockdown with the equivalent period in 2019 is not practical because lockdown coincided with the start of spring and finer weather. In fact, February 2020 was the wettest on record in England and the spring was the sunniest.

The plot below compares the Norwich running 7-day NO_2 concentration during 2020 (thick lines) with nearby stations. The first lockdown began on 23rd March 2020 and was most effective during April 2020. The effect of the first lockdown can be estimated by comparing the change between March and April 2020.



The plot below compares the Norwich running 7-day NOx concentration during 2020 (thick lines) with nearby stations.



There was a large decrease in NO_2 and NOx concentrations at Norwich due to the March 2020 lockdown when comparing March and April 2020 pollution levels. However, it should be noted that there is usually a noticeable decrease between March and April at the start of spring.

Estimated change due to the March 2020 lockdown

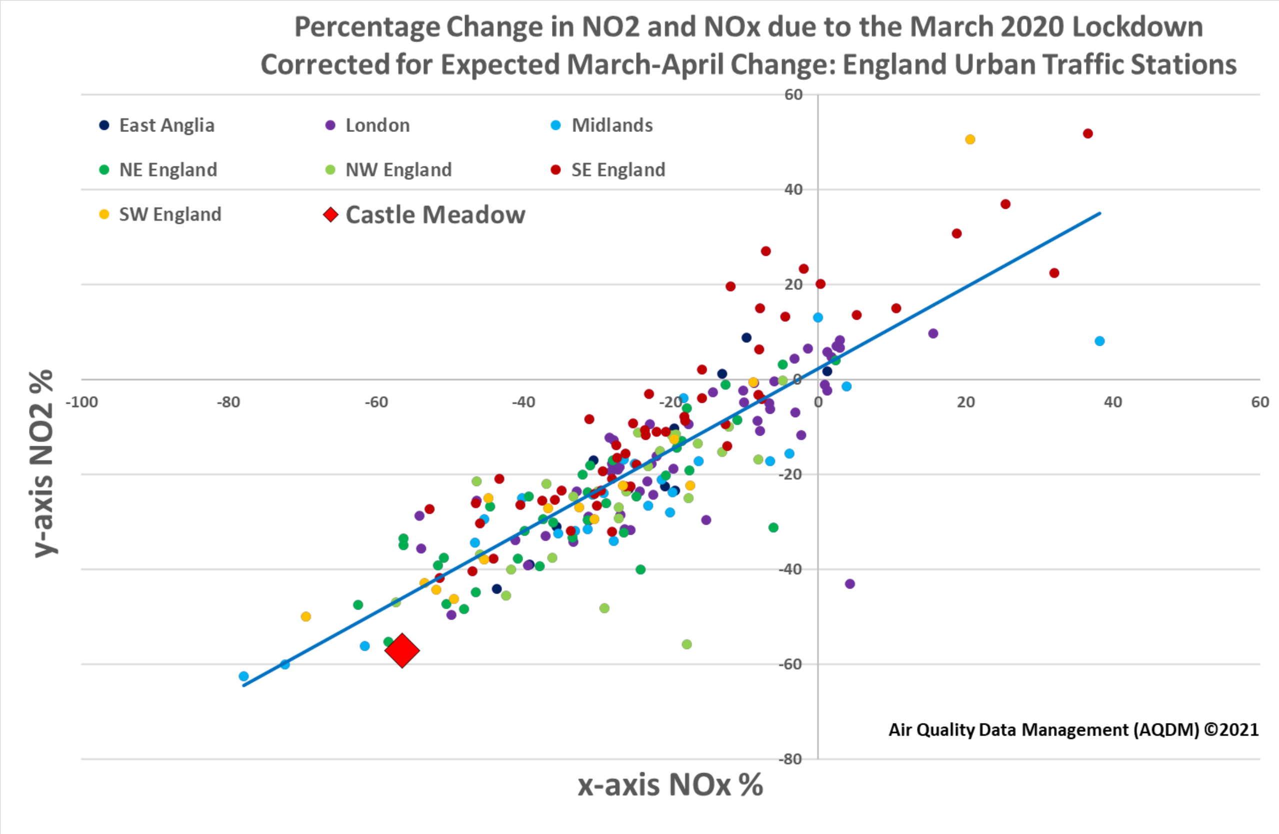
Station(s)	Pollutant	µg m^{-3}	%
Castle Meadow	NO_2 NOx	- 15 µg m^{-3} - 61 µg m^{-3}	- 43 % - 62 %

After correcting for the expected change between March and April by comparing with 2015-2019 levels, the percentage decreases in concentrations at Castle Meadow were much greater than the average for the region and England.

Estimated change due to the March 2020 lockdown compared to 2015-2019 at Urban Traffic Stations

Station(s)	Pollutant	µg m^{-3}	%
Castle Meadow	NO_2 NOx	- 19 µg m^{-3} - 55 µg m^{-3}	- 57 % - 56 %
East Anglia	NO_2 NOx	- 6 µg m^{-3} - 13 µg m^{-3}	- 37 % - 39 %
England	NO_2 NOx	- 5 µg m^{-3} - 13 µg m^{-3}	- 20 % - 25 %

The plot below compares the changes due to the March 2020 lockdown at Norwich with other stations (Urban Traffic). The plot has the NOx percentage change along the x-axis and NO_2 percentage change along the y-axis. Most stations are in the bottom left quarter which measured a decrease in NO_2 and NOx concentrations. There were some stations that measured a negligible change (around the central origin) while a few measured increases (top right quarter). Norwich shows a marked decrease.

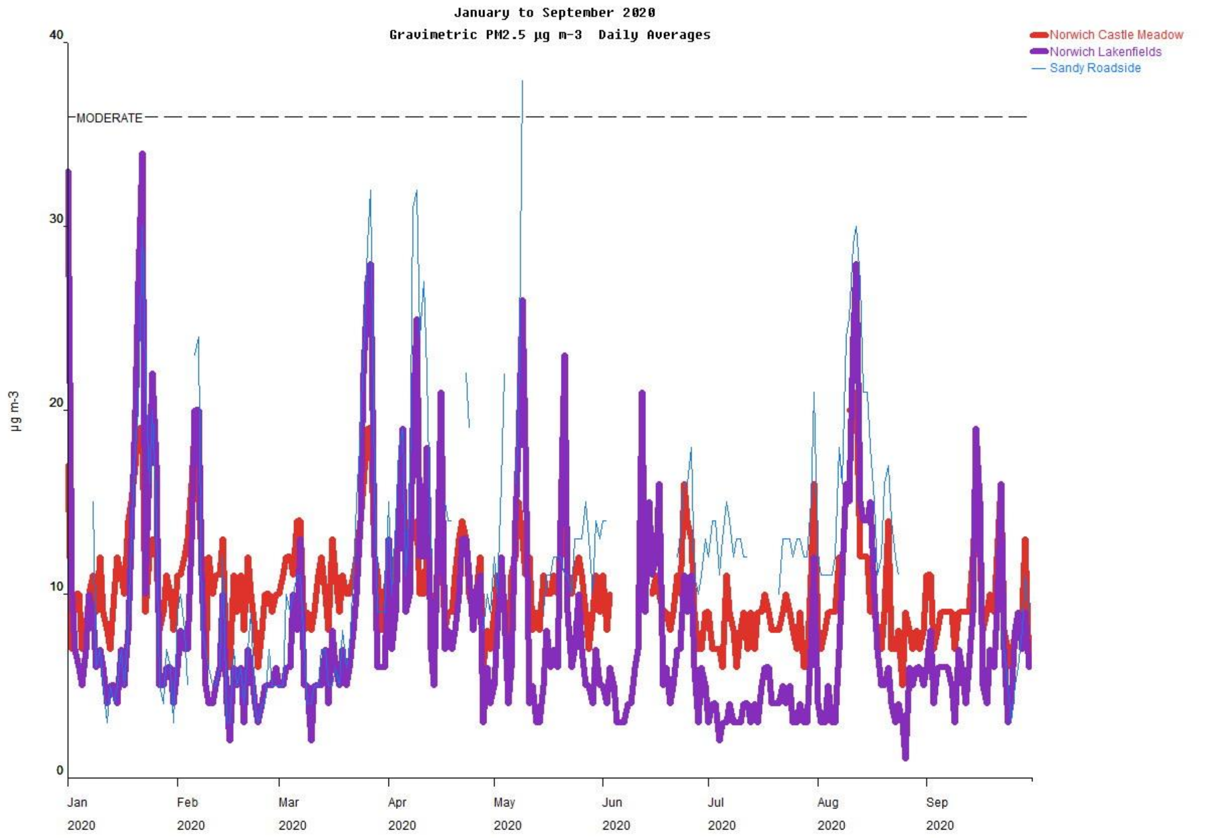


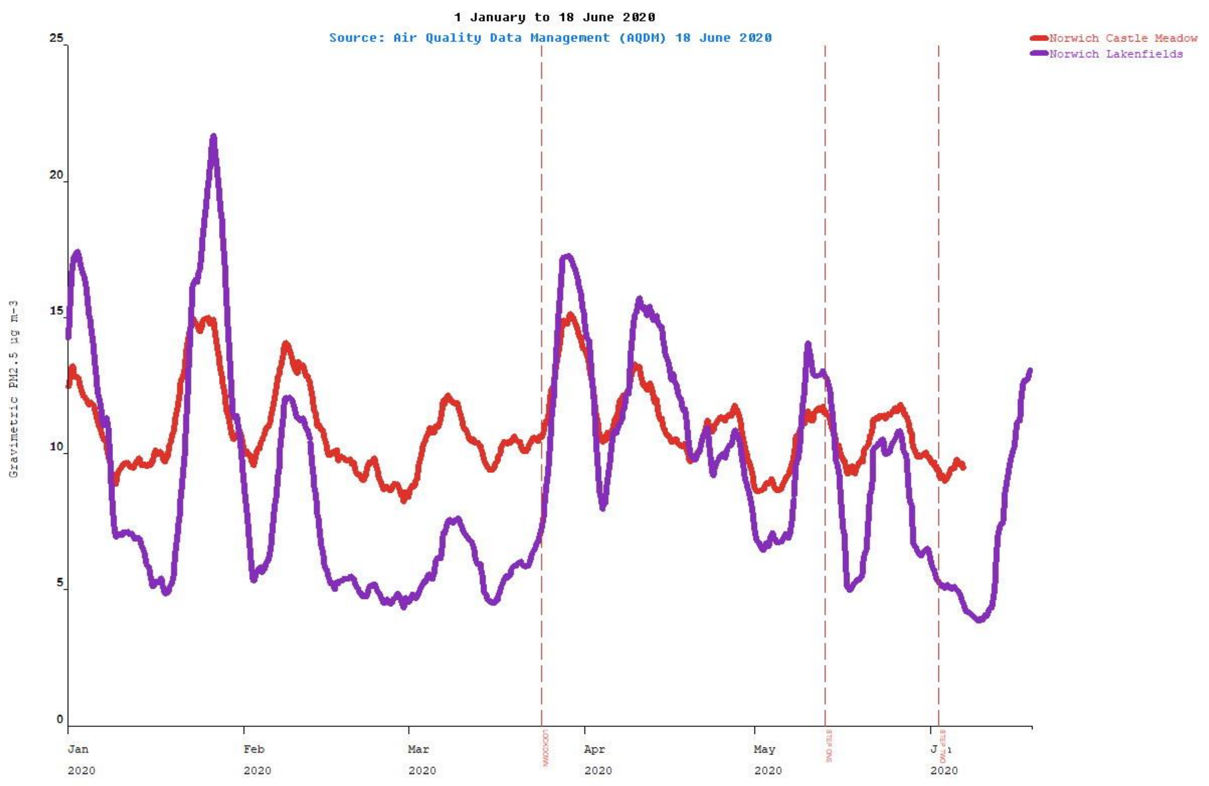
The diffusion tube data showed similar changes in pollution levels. When considered as an annual mean, comparisons of 2019 to 2020 diffusion tube data showed reductions over a range of 11 - 40%. The highest reductions i.e., 40% were observed on bus and taxi only streets or those where the majority of the vehicle movements are buses i.e. St Stephens and Chapel Field North. The lowest reductions were observed on normally busy, congested junctions and street canyons i.e. St Augustine's (15-20%) & Zipfel House 11%.

Particulates - $PM_{2.5}$

In April 2020 there was a major PM episode affecting East of England which can be seen in the data. However, this aside, the following plots clearly illustrate that lockdown and the associated significant reduction in vehicle activity had no perceivable effect on $PM_{2.5}$ levels at either the roadside or urban background sites.

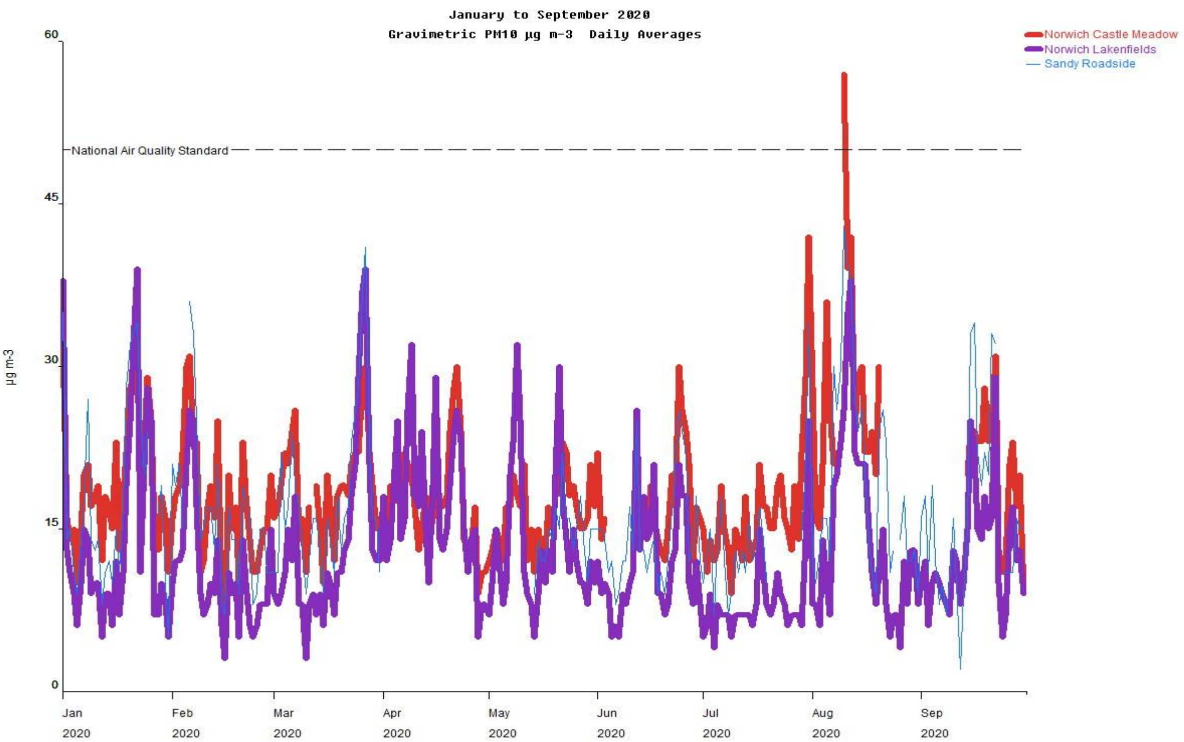
(The first plot shows pollution levels January to September. On the 2nd plot the data is expanded to show Jan-June pollution levels with significant lockdown dates highlighted).

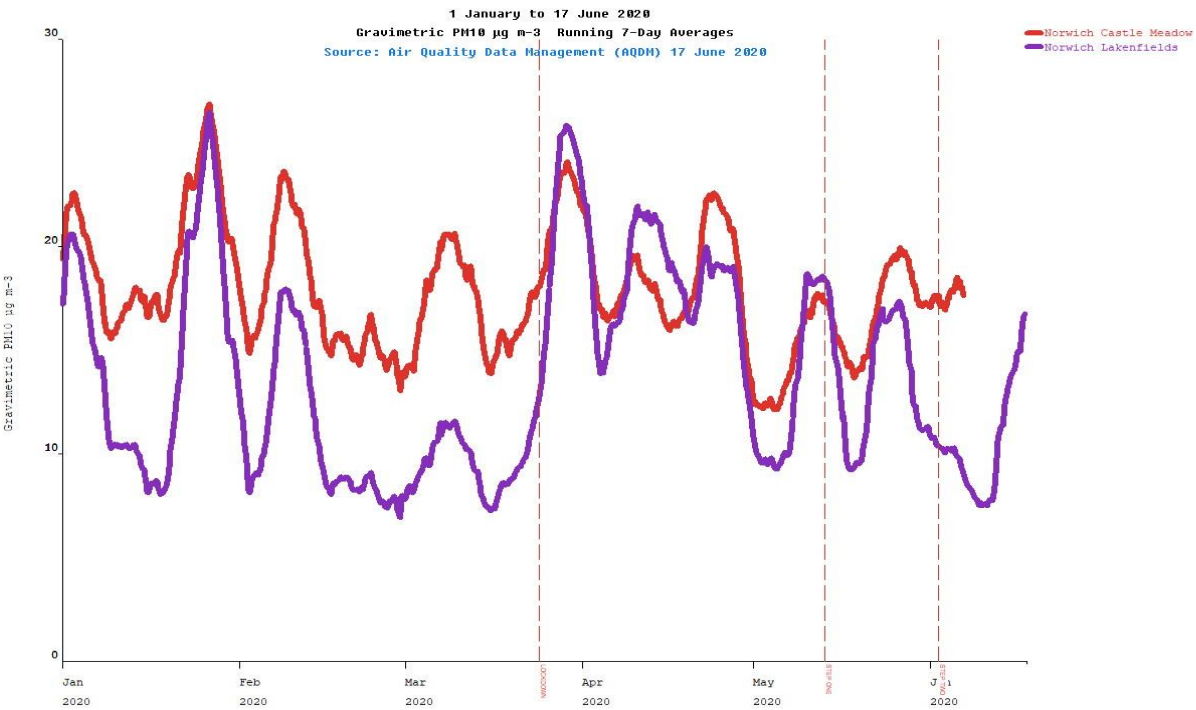

January to September 2020
Gravimetric PM2.5 µg m-3 Daily Averages
Norwich Castle Meadow
Norwich Lakenfields
Sandy Roadside
MODERATE
µg m-3
Jan 2020
Feb 2020
Mar 2020
Apr 2020
May 2020
Jun 2020
Jul 2020
Aug 2020
Sep 2020


1 January to 18 June 2020
Source: Air Quality Data Management (AQDM) 18 June 2020
Norwich Castle Meadow
Norwich Lakenfields
Gravimetric PM2.5 µg m-3
Jan 2020
Feb 2020
Mar 2020
Apr 2020
May 2020

PM_{10}

The same plots for PM_{10} again show that there is no perceivable difference in PM_{10} levels pre, during or post lockdown.





In summary, the following tables and plot show the very significant decrease in NO_2 levels at the Castle Meadow site and the insignificant effect of lockdown at the roadside site on particulate levels.

These data show that there is strong evidence to suggest that NO_2 levels could be significantly reduced, and probably to below the objective level, by replacing the bus fleet with cleaner buses, or preferably zero emission buses. This change will however still give challenges on streets which, because of their physical nature, will create traffic bottle necks and inhibit pollution dispersion.

With regards to particulates, it is clear that vehicle activity is not the main source of pollution and hence pollution is most likely to be transboundary.

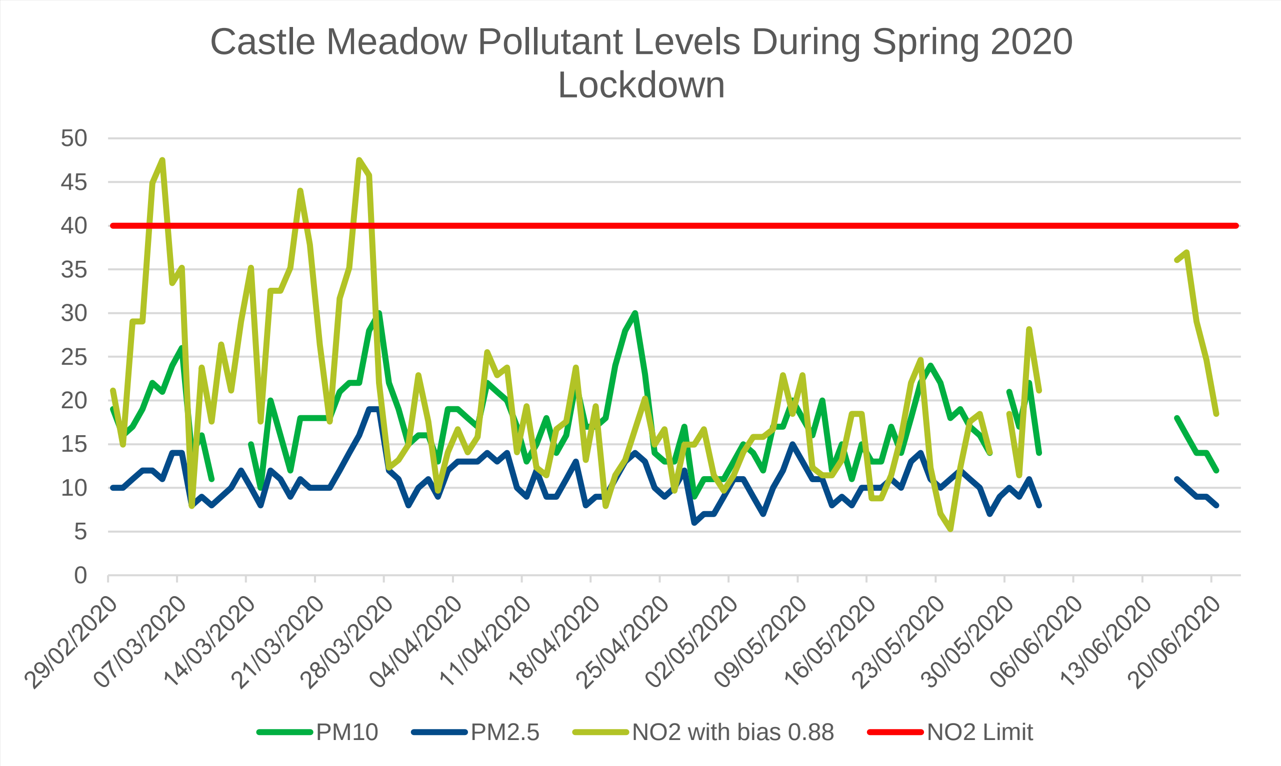
NORWICH CASTLE MEADOW January to September 2020

Monthly Data Captures %

Pollutant	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
PM_{10}	99.2	93.7	92.6	99.2	98.5	55.3	91.9	47.8	49.7
$PM_{2.5}$	99.5	95.7	99.5	99.3	98.7	57.2	94.5	89.9	94.9
Nitrogen Dioxide	96.5	93.4	97.0	99.9	97.8	59.3	98.5	89.7	95.0

Monthly Means

Pollutant	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
PM_{10} µg m^{-3}	19	17	19	18	16	18	17	27	21
$PM_{2.5}$ µg m^{-3}	11	11	11	11	10	10	8	10	9
Nitrogen Dioxide µg m^{-3}	39	31	34	19	17	29	23	32	37



Opportunities Presented by COVID-19 upon LAQM within Norwich City Council

With regards to opportunities Covid-19 has presented in terms of LAQM, businesses as well as Councils will probably continue to offer greater work flexibility and greater opportunities to work from home. This would maintain traffic levels at a more depressed rate when compared to pre-Covid levels and will dampen peak traffic times.

It was well documented during the pandemic that people generally were enjoying the less polluted and quieter streets brought about by the significant reductions in vehicle activity. On the whole people walked and cycled more and it is considered that this trend may continue beyond the time influenced by Covid-19.

During Covid-19 there was a behaviour change to shop locally but also to shop online. If this behaviour is adopted long term, fewer domestic vehicle movements are anticipated but a greater number of distribution vehicles. This will mean distribution hubs outside the city will be important and an opportunity will arise to make all delivery vehicles low or zero emission. Adequate parking for delivery vehicles will also need to be considered on all new housing developments.

Challenges and Constraints Imposed by COVID-19 upon LAQM within Norwich City Council

The pandemic stretched the ability of the Public Protection team to perform it's appointed tasks as the team were significantly involved in the enforcement of the Covid-19 legislation. Nevertheless, the Public Protection team managed to carry out the majority of its duties regarding air quality monitoring and reporting:

- Automatic Monitoring - Data capture was over 75% (Impact Rating – None)
- Automatic Monitoring - QA/QC regime adhered to as defined in LAQM.TG16 (Impact Rating – None)
- Passive monitoring – Data capture was over 75% (Impact Rating – None)
- Passive monitoring – Bias adjustment undertaken as normal (Impact Rating – None)
- Passive Monitoring - Changeover dates mostly adhered to (Impact Rating – Small)
- Passive Monitoring – Tubes stored in accordance with laboratory guidance (Impact Rating – None)
- AQAP – Measure Implementation – Mostly Unaffected (Impact Rating – Small)
- AQAP – New AQAP reporting – Delayed due to constrained officer time (Impact Rating – Medium)
- ASR Reporting - Delayed due to constrained officer time (Impact Rating – Medium)

Table F 1 – Impact Matrix

Category	Impact Rating: None	Impact Rating: Small	Impact Rating: Medium	Impact Rating: Large
Automatic Monitoring – Data Capture (%)	More than 75% data capture	50 to 75% data capture	25 to 50% data capture	Less than 25% data capture
Automatic Monitoring – QA/QC Regime	Adherence to requirements as defined in LAQM.TG16	Routine calibrations taken place frequently but not to normal regime. Audits undertaken alongside service and maintenance programmes	Routine calibrations taken place infrequently and service and maintenance regimes adhered to. No audit achieved	Routine calibrations not undertaken within extended period (e.g. 3 to 4 months). Interruption to service and maintenance regime and no audit achieved
Passive Monitoring – Data Capture (%)	More than 75% data capture	50 to 75% data capture	25 to 50% data capture	Less than 25% data capture
Passive Monitoring – Bias Adjustment Factor	Bias adjustment undertaken as normal	<25% impact on normal number of available bias adjustment colocation studies (2020 vs 2019)	25-50% impact on normal number of available bias adjustment studies (2020 vs 2019)	>50% impact on normal number of available bias adjustment studies (2020 vs 2019) and/or applied bias adjustment factor studies not considered representative of local regime
Passive Monitoring – Adherence to Changeover Dates	Defra diffusion tube exposure calendar adhered to	Tubes left out for two exposure periods	Tubes left out for three exposure periods	Tubes left out for more than three exposure periods
Passive Monitoring – Storage of Tubes	Tubes stored in accordance with laboratory guidance and analysed promptly.	Tubes stored for longer than normal but adhering to laboratory guidance	Tubes unable to be stored according to be laboratory guidance but analysed prior to expiry date	Tubes stored for so long that they were unable to be analysed prior to expiry date. Data unable to be used
AQAP – Measure Implementation	Unaffected	Short delay (<6 months) in development of a new AQAP, but is on-going	Long delay (>6 months) in development of a new AQAP, but is on-going	No progression in development of a new AQAP
AQAP – New AQAP Development	Unaffected	Short delay (<6 months) in development of a new AQAP, but is on-going	Long delay (>6 months) in development of a new AQAP, but is on-going	No progression in development of a new AQAP

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 Highways England
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

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- 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.
- DEFRA (2007) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, Department of the Environment, Food and Rural Affairs, Cm 7169, NIA 61/06-07
- Air Quality Action Plan 2021, Norwich City Council
- Annual Status Report 2016, Norwich City Council
- Annual Status Report 2017, Norwich City Council
- Annual Status Report 2018, Norwich City Council
- Annual Status Report 2019, Norwich City Council
- Annual Status Report 2020, Norwich City Council
- Norfolk County Council website – major projects and improvement plans - Norwich https://www.norfolk.gov.uk/roads-and-transport/major-projects-and-improvement-plans/norwich
- DEFRA LAQM website – Air Quality Information Resource;

  http://uk-air.defra.gov.uk
- Defra Fall-Off with Distance Calculator;

  https://laqm.defra.gov.uk/tools-monitoring-data/no2-falloff.html
- Public Health Outcomes Framework;

  https://fingertips.phe.org.uk/profile/public-health-outcomes-framework/data#page/3/gid/1000043/pat/102/par/E10000020/ati/101/are/E07000148/iid/30101/age/230/sex/4
- Estimated Background Air Pollution Maps (base year 2015), downloaded from https://uk-air.defra.gov.uk/data/laqm-background-home
- Diffusion Tube Laboratory QA/QC;

  http://laqm.defra.gov.uk/diffusion-tubes/qa-qc-framework.html
- Defra Bias Adjustment Spreadsheets;

  https://laqm.defra.gov.uk/bias-adjustment-factors/bias-adjustment.html

AQDM Report on Norwich Analysis of the March 2020 Lockdown on Local Air Quality-Feb 2021