2020 Air Quality Annual Status Report (ASR)

In fulfilment of Part IV of the Environment Act 1995 Local Air Quality Management

November 2020

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Executive Summary: Air Quality in Our Area

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 34 '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, for Norwich, comprises just Briar Chemicals, an agrochemical company. No Part A or Part B processes are considered to contribute significantly to air quality 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 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 not considered to contribute significantly 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 in engines. 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 2015 the council produced an updated Air Quality Action Plan (AQAP) that set out measures to be taken in order to work towards achievement of the air quality objectives. The action plan can be accessed on the council website by following this link: https://www.norwich.gov.uk/downloads/file/3020/2015_air_quailty_action_plan. This Plan will however be superseded by the 2020 Action Plan which is to be released later this year. This Annual Status Report (ASR) refers to measures proposed in the new 2020 Action Plan.

Norwich City Council proposes to continue with both automatic, continuous NO_2 monitoring in tandem with passive diffusion tube monitoring. In response to a program of road changes aimed principally at facilitating bus & cycle travel and discouraging private transport within the city centre, diffusion tube locations were reviewed. Diffusion tube locations were also chosen in response to the submission of a planning application for a new district centre at Anglia Square where modelling had predicted NO_2 levels above the objective level. As a result, at the start of 2019:

- 2 NO_2 diffusion tube monitoring positions were removed as levels were well below the objective level
- 21 diffusion tubes locations were retained.
- 4 new diffusion tube locations were added.

The purpose of these changes was to site tubes to best assess any impact the road changes have had on NO_2 levels and to include locations which are taking higher traffic loading as a result of the road changes. It is therefore felt the data presented in this report provides a good indication of pollution levels at key locations. Re-assessment of the passive diffusion tube (DT) monitoring positions will continue as further road infrastructure changes are implemented.

A detailed assessment is not required for any pollutants and the council will progress to the next Annual Status Report (ASR) in 2021. This ASR includes key findings and conclusions determined from the review of the 2015 Action Plan but most importantly, refers to key measures proposed in the revised 2020 Action Plan. Although most of the major road changes will have been implemented, the benefits, in terms of improvements in air quality may not be realised for a further year or so.

These benefits may also be disguised by the road changes now 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, particularly those of Euro 6 specification, 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).

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 and older people, and those with heart and lung conditions. There is also often a strong correlation with equalities issues, because areas with poor air quality are also often the less affluent areas[1,2].

The annual health cost to society of the impacts of particulate matter alone in the UK is estimated to be around £16 billion[3].

Norwich City Council has monitored air pollution in the city since 1998. This report considers all new monitoring data acquired during 2019 and assesses the data against the Air Quality Strategy objectives. It also considers any changes that may have an impact on air quality.

The council have carried out all past rounds of review and assessment and in doing so have consolidated the previous four smaller AQMAs into a single central AQMA. The extent of the central AQMA is shown in Figure 2.1 and on the Defra website

https://uk-air.defra.gov.uk/aqma/details?aqma_id=951.

The AQMA was declared in 2012 for exceedances of the annual mean NO_2 objective. All other pollutants of concern have been screened out over time, though particulates are still measured at the 2 automatic analysers in Norwich. This is important, especially given the recent requirement for local authorities to work towards reducing emissions and/or concentrations of $PM_{2.5}$ (particulate matter with an aerodynamic diameter of 2.5µm or less).

A considerable amount of monitoring is carried out within the AQMA using passive diffusion tubes and the Council owned automatic analyser on Castle Meadow. The

[1] Environmental equity, air quality, socioeconomic status and respiratory health, 2010
[2] Air quality and social deprivation in the UK: an environmental inequalities analysis, 2006
[3] Defra. Abatement cost guidance for valuing changes in air quality, May 2013

city also benefits from having a Government-owned AURN urban background station, Norwich Lakenfields, in its area, located 120m outside the AQMA. Data from these stations are used within the report.

In 2009 Castle Meadow was given a classification of Low Emission Zone (LEZ) and was made a bus and taxi only street in an attempt to reduce traffic levels & congestion. Only vehicles with Euro 3 engine classification and above were allowed to use the LEZ. A Bus Charter was formulated and agreed with the bus operators as part of the introduction of a Voluntary Quality Partnership (VQP) between operators and local authorities to comply with this requirement. An updating of the Bus Charter is overdue and, working with County Council, it is intended to undertake this in 2021. Detail is presented in the 2020 Action Plan but essentially it will outline a timetable for making the LEZ Euro 6 and above. In addition, and again working with County Council, it is intended to extend the LEZ to incorporate additional bus and taxi only streets in the city centre. By virtue of this, engine switch off enforcement would likewise be extended to include these streets.

The automatic analyser in the Castle Meadow LEZ shows that, despite efforts to improve air quality, there are still challenges as annual mean NO_2 levels have fairly consistently exceeded the objective level. Historic data shows the exceedance to oscillate around 14µg/m^3 above the objective level. In 2018, the 1-hour mean was also exceeded, albeit only by 1 additional exceedance of the 200µg/m^3 allowance of 18 times/year. In 2019 however, NO_2 annual mean levels dropped to 41µg/m^3. Reasons for this are unclear as the County Council have confirmed there have been no significant changes in bus timetabling, the number of buses operating, changes in bus fleet or bus service allocations to bus stops. However, roadworks on Prince of Wales Road and Agricultural Plain meant that there was reduced levels of queueing of buses to exit Castle Meadow to the south. Now complete, changes to this junction includes the installation of modern, up-to-date traffic signalling on Agricultural Plain. This will hopefully contribute to a more sustained improvement in traffic flow, particularly related to bus movements through Castle Meadow. Engine switch-off enforcement commenced in August 2018 and hence the benefits associated with this may well also be contributing to the drop seen in the 2019 NO_2 levels.

Overall, NO_2 concentrations within the central AQMA are falling. In 2012, 10 of the diffusion tube monitoring locations exceeded the annual mean objective of 40µg/m^3.

This steadily reduced to 6 in 2015 despite an additional site being added in 2013 on Chapel Field North. In 2016 the number of locations exceeding the annual mean objective increased to 7 sites but 3 of these only by 1µg/m^3. In 2017 the number of sites dropped back down to 6. In 2018, levels fell again and quite significantly and, after DT locations having been rationalised and distance corrections applied, only 2 locations exceeded the objective level, only 1 of which representing relevant exposure - 52 St Augustine's Street. In 2019, the usual hot spots exceeded, Castle Meadow, Riverside Rd, St Augustine's Street, St Stephens Street and Chapel Field North. The highest exceedance was Castle Meadow Mid at 47µg/m^3. However once distance corrected and removing those not of relevant exposure, only 4 locations exceeded, 2 of which sitting at the objective level of 40µg/m^3. This shows levels continue to look promising and are on a downward trend despite relocating diffusion tubes to try and find hotspots.

There are not considered to be any new major sources of pollution. Although more locations exceeded the objective level this year compared to last, if the known problem areas are discounted, no new hotspots have been identified. This is reassuring. Unfortunately, the known hotspots occur principally on narrow medieval streets which form part of the major radial road network into and out of the city. These streets are also typically fronted by tall buildings, thus creating street canyons, or are constricted by waterways.

The last 5 years of monitoring therefore suggests the measures and policies implemented in the 2015 Action Plan are working and it will be exciting to see how the proposals in the new 2020 Action Plan translate into further improvements in air quality as this Action Plan builds significantly on the last one with definitive and quantifiable measures.

Measures to reduce NO_2 from road traffic will also, to some extent, have a positive benefit on reducing $PM_{2.5}$ levels - although $PM_{2.5}$ in Norwich is mostly a transboundary rather than city derived pollutant and hence is strongly affected by meteorology. Both Castle Meadow & Norwich Lakenfields automatic stations show that the annual mean objective level of 25µg/m^3 (not set in Regulations) was easily met again in 2019. Both stations also achieved the World Health Organisation recommended guideline level of 10µg/m^3 for the second year running.

Actions to Improve Air Quality

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 soon to be published 2020 Action Plan identifies the strengths of the previous action plans and the measures that are believed to have had the greatest impact on improving air quality and mostly builds on those particular strategies. As a result, the AQAP focuses principally on road infrastructure changes designed to further divert general traffic away from the congested city centre and reallocate 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 have now been implemented but the bus and taxi only roads remain some of the most polluted streets in Norwich and hence Norfolk County Council are also concentrating efforts to encourage bus companies to upgrade or replace their older more polluting vehicles. This strategy will be strengthened by the revision of the Bus Charter (Voluntary Quality Partnership) which will introduce a target date for Euro 6 and above compliance, initially within the Low Emission Zone. First Bus has committed, as part of the Transforming Cities Fund, to invest £15.8m in 55 new Euro 6 buses in Norwich, replacing current Euro 3, 4 and 5 vehicles. The ultimate aim however is to minimise emissions from traffic as much as possible and although an application by the 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.

An example of improvement in air quality resulting from road traffic alterations is the implementation of a new road layout and junction arrangements in the Chapel Field area of Norwich. This scheme complimented the restriction of private vehicle passage through the city centre and revised the traffic flow to prioritise bus access. Triplicate diffusion tube monitoring was carried out for a full year prior to the scheme commencing and has continued since. As a result of the changes, the annual mean NO_2 concentration has reduced from 61µg/m^3 in 2013 prior to the changes, to fairly consistently oscillate around 40µg/m^3 (when distance corrected) post road changes. This greatly improves air quality for residents fronting the road and those using the public gardens opposite. The traffic from Chapel Field North has now been fed onto Cleveland Road and Bethel Street where, in 2018, new diffusion tubes were installed. Even without distance correction, NO_2 levels consistently lay below the objective level and hence the DT on Bethel Street was removed leaving just the Cleveland Road tube.

Reassuringly other key radial streets which have been identified as likely to take a greater volume of traffic as a result of the road changes have all come in under the objective level, i.e. Hall Road, St Stephens Road, Heigham Street & Duke Street. Greater detail is presented in Section 3.2.1.

Another key action was the construction of the Norwich Northern Distributor Road (NDR) which was completed in April 2018 (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.

It is predicted that the Broadland Northway will:

- Reduce 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
- Reduce general traffic travelling through the city centre

- Significantly improve access for north Norwich and north & north east Norfolk, the wider road network and to Norwich International Airport
- Provide the transport infrastructure needed to allow planned and proposed growth
- Increase the opportunities for improving public transport and the provision for pedestrians and cyclists and hence promote these modes of travel.

It is not expected that the full benefits will be seen for another year or so, until the traffic has fully settled down, but traffic monitoring has been completed and is currently being analysed. 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

A key proposal in the AQAP is to work with local bus companies to encourage updating of bus fleets. The 2020 Action Plan is considerably bolder regarding this issue and reaffirms the commitment to agreeing with bus operators an agreed date for Euro 6 and ultimately zero emission compliance. It goes further still and proposes geographical extensions to the LEZ.

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 principle 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.

The Norwich Park & Ride contract is due for renewal in the next 18 months and this provides an opportunity for the 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.

County Council continues to work with the bus operators and applies for grants to help with the upgrade and replacement of older and more polluting buses.

The transport strategy for Norwich is currently being reviewed and will fully consider what interventions are needed to address issues of air quality and carbon emissions. Issues to be considered in this work could include restricting certain types of vehicles within specific areas of Greater Norwich, consideration of the number and pricing of city centre car parking spaces and a levy being raised based on parking provision. This review will also consider the impacts of a behaviour change strategy, integration of different transport modes and the adoption of a corridor-based approach with emphasis on different corridors being prioritised for different modes. It is hoped that a new transport strategy for Norwich can be adopted by Summer 2021.

A further approach adopted by Norwich City Council to improve air quality is engine switch off. In 2018, Norwich City Council applied to the Secretary of State for enforcement powers in order to enact the Road Traffic Regulations 2002 with the ultimate aim to issue Fixed Penalty Notices for engine switch off offences. These powers were acquired in early 2018 and enforcement commenced in the autumn 2018 on bus and taxi only roads i.e. Castle Meadow and St Stephens Street. The 2020 Action Plan recommends this policy be rolled out across the proposed extended LEZ and then throughout the AQMA. To date all drivers have been compliant and have switched their engines off when reminded. However, after 2 years it was expected drivers would have changed their behaviour such that there would be very few reminders required. This is mostly the case but not entirely and hence further work is still required in this area.

The Norwich Bus Charter is due a comprehensive review. The revised Charter will set target dates which reflect the progress in engine technology and current pollution issues and will initially concentrate on buses which transit through the Low Emission Zone. At a later date it is hoped that measures identified in the Charter will be rolled out across the whole city. The Norwich Bus Charter revision is also welcomed by Councils outside Norwich as buses that transit through Norwich also travel through the rural towns and villages.

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 now 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.

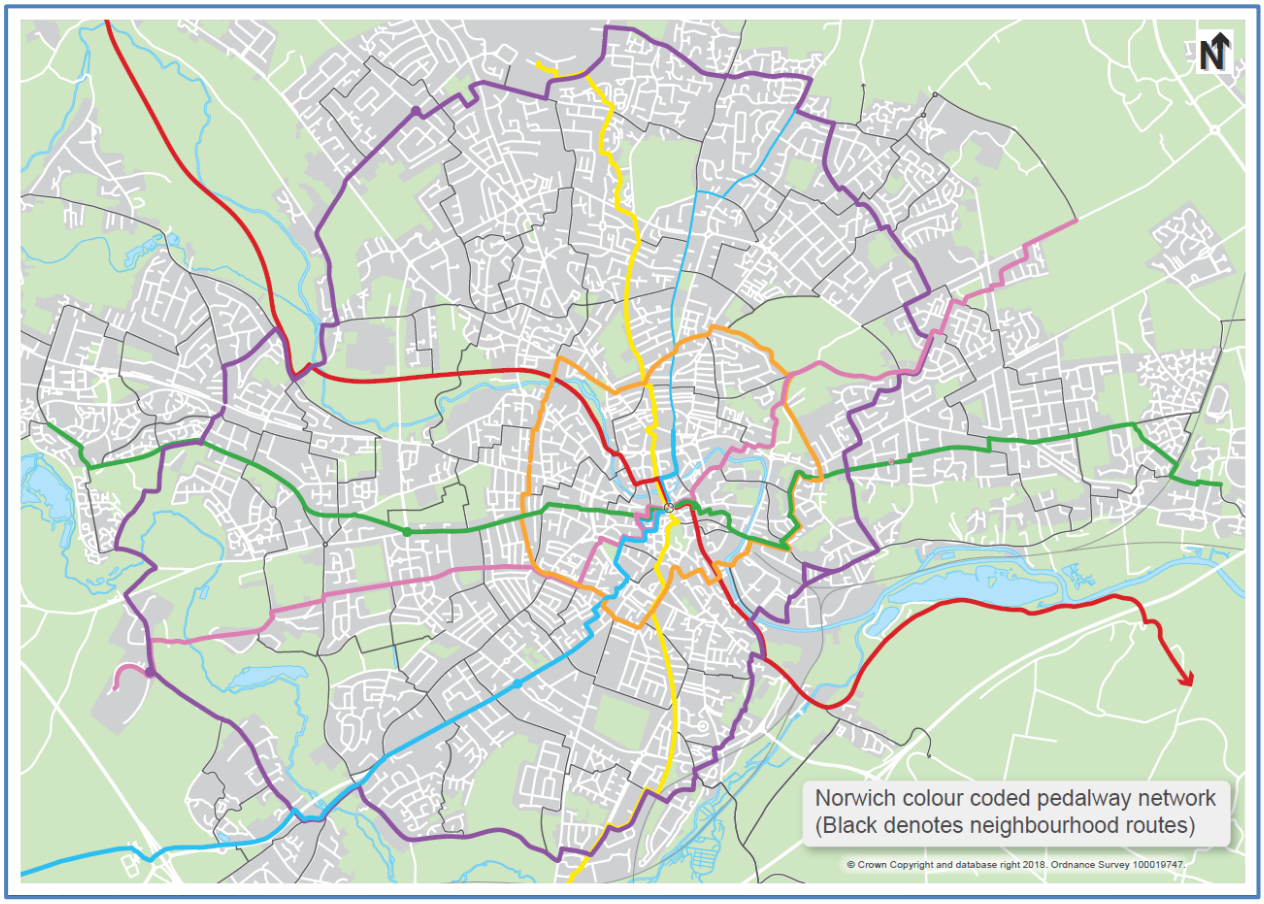
In addition, in early 2018, a working group of representatives from Norwich City Council, Broadland District Council, South Norfolk Council and Norfolk County Council (Highways) was set up specifically to develop a multi-authority approach to tackling poor air quality from transport within the Greater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

- To produce a positive change to air quality from transport.
- To develop better education of all road users to the effect of transport emissions on human health and the wider environment.
- 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 appropriate to be adopted elsewhere.
- Share findings of projects with interested third parties.

Clearly benefits aimed at improving air quality in adjoining district councils have a positive impact for the city, especially when it comes to improvements in bus fleets which serve not just Norwich but the communities beyond.

In support of this commitment, in 2012 a cycle network for the greater Norwich area was adopted which included 5 radial and 2 orbital pedalway routes and a number of neighbourhood cycle routes connecting those pedalway routes. Each of the 7 pedalways was colour coded.

City Schematic of Norwich Pedalways



Since being awarded Cycle City Ambition status in 2013, Norwich has seen a significant increase in cycling over at least 40%. In 2019 the western part of the Green pedalway was completed and in 2020 the eastern section.

With concerted efforts to increase cycle connectivity, improve cycle paths at major road junctions and bus & cycle priority lanes, cycling as a mode of transport has steadily increased. This 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 there will be up to 100 electric scooters.

Norwich City and County Councils are also looking into trialling the implementation of "School Streets"[4], 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. 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 51 x 7kW or above. Seven of these EV points are owned by the council and are located in the 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.

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 that is currently being investigated is the speciation of PM2.5, the study last having been undertaken in 2015. Collaborations with the UEA may also provide a more holistic approach to projects when applying for government funding.

Conclusions and Priorities

The council proposes to continue with automatic and passive NO_2 monitoring within the city area. As completion of road changes are implemented, the council will review the locations of passive monitoring positions so as to assess any resulting impacts from these changes. No excursions of the NO_2 objective were measured outside of the central AQMA. Monitoring shows the trend of declining pollution levels continues. 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

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

conflict of interests. This conflict will be a key consideration on all Planning Development schemes.

Whilst the automatic monitoring station owned and run by the council is still operational, it is an ageing unit. There will come a time in the not too distant future when it must be replaced, and this consideration needs to be factored into the council budget. This issue has been further highlighted now the TEOM particulate monitors, as of 2021, will no longer be approved as technologically adequate by Defra. In addition, its location is not one of relevant exposure (provided there is no exceedances of the 1 hour mean) and hence, as the council have now acquired over 10 years of data, the added benefit of monitoring at this location is limited.

With the introduction of engine switch off enforcement, the strive to replace ageing polluting buses and the updating of the Norwich Bus Charter, it is hoped improvements in air quality along Castle Meadow will naturally follow. Hence monitoring on Castle Meadow still has a useful purpose. With this in mind, the council continue to actively engage with suppliers of mobile monitoring units and co-location studies will continue to be undertaken with the station so as the accuracy and reliability of these units can be confidently assessed for future application.

The AQ Action Plan is due to be published in late 2020 and a comprehensive review of air quality, the problem areas and the additional measures that will be required to combat this has been carefully and boldly considered by both City & County Councils and all relevant partners.

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).

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.

For Clean Air Day the Norfolk Environmental Protection Group along with Public Health Norfolk and Highways have a united approach to 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 as a way 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 correct use of 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 perpetuated beyond the actual day itself.

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1 Local Air Quality Management

This report provides an overview of air quality in Norwich City Council during 2019. It fulfils the requirements of Local Air Quality Management (LAQM) as set out in Part IV of the Environment Act (1995) and the relevant Policy and Technical Guidance documents.

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

The statutory air quality objectives applicable to LAQM in England can be found in Table E.1 in Appendix E.

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 must prepare an Air Quality Action Plan (AQAP) within 12-18 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. Further information related to declared or revoked AQMAs, including maps of AQMA boundaries are available online at https://uk-air.defra.gov.uk/aqma/local-authorities?la_id=187

Alternatively, see Appendix D: Map of Monitoring Locations and AQMA, which provides plans of air quality monitoring locations in relation to the AQMA.

Figure 2. 1 Map of the Central Norwich AQMA

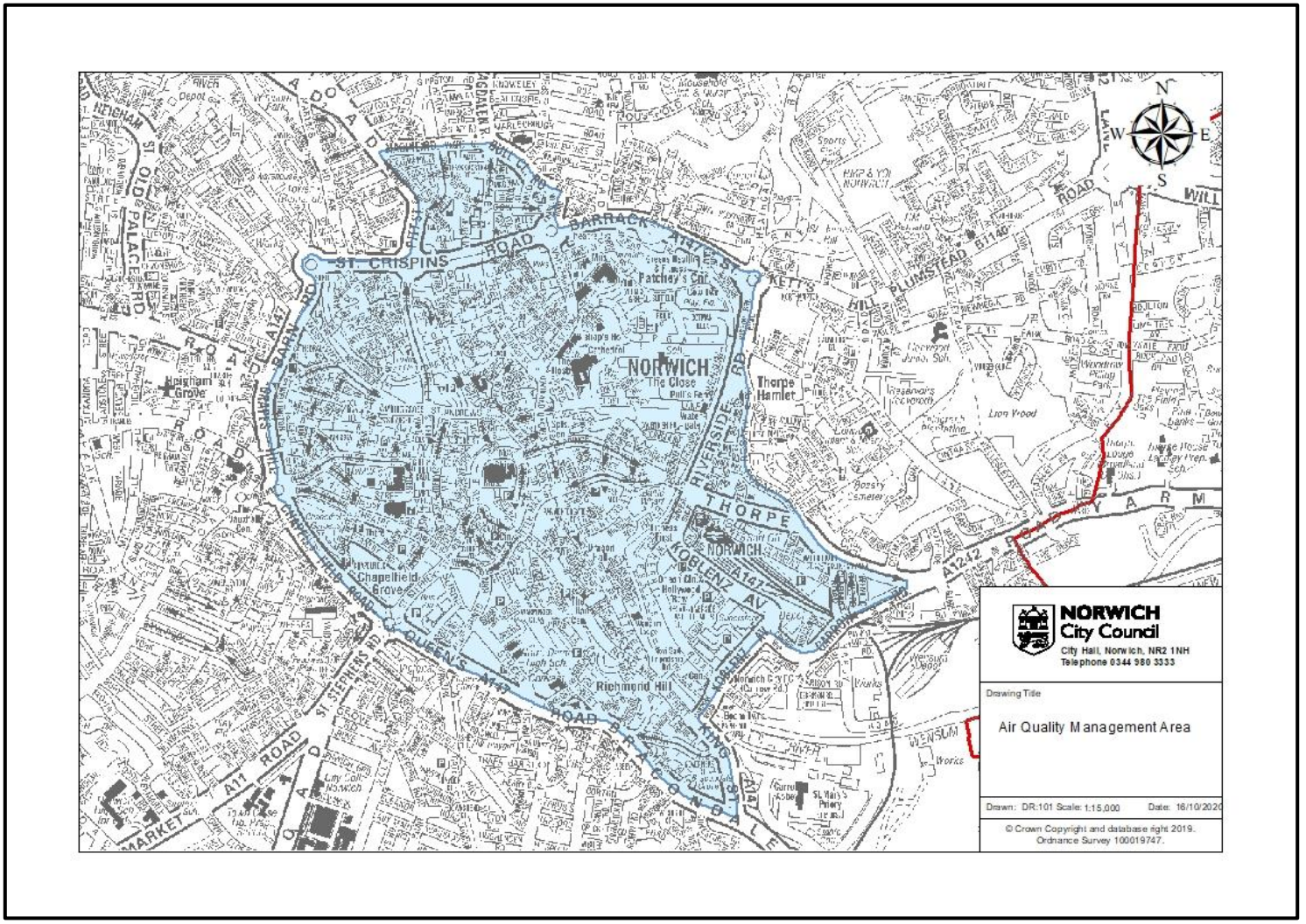


Table 2.1 – Declared Air Quality Management Areas

AQMA Name	Date of Declaration	Pollutants and Air Quality Objectives	City / Town	One Line Description	Is air quality in the AQMA influenced by roads controlled by Highways England?	Level of Exceedance (maximum monitored/modelled concentration at a location of relevant exposure)				Action Plan		
						At Declaration		Now		Name	Date of Publication	Link
Central AQMA	Nov -12	NO2 Annual Mean	Norwich	An area encompassing Norwich city centre, broadly following the inner link road	NO	52 (at 52 St Augustine's Street)	µg/m3	46	µg/m3	Action Plan for City of Norwich	2015	https://www.norwich.gov.uk/downloads/file/3020/2015_airquality_action_plan

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

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 sets out the Annual Status Report, which forms part of the Review & Assessment process required under the Environment Act 1995 and subsequent Regulations.

Norwich City Council have 1 declared Air Quality Management Area (AQMA).

Automatic monitoring was undertaken at 2 sites within the borough during 2018, Castle Meadow within the AQMA and the AURN urban background station Norwich Lakenfields. The annual mean NO_2 concentration at the Castle Meadow site was 54 µg/m^3 which exceeds the annual mean air quality objective (AQO). This has been consistent over the past 4 years showing that there are still challenges on this bus & taxi only street. The 1-hour mean at this site exceeded 200 µg/m^3 on 19 occasions throughout 2018, exceeding the 1-hour AQO. The Norwich Lakenfields site measured an annual mean concentration of 12 µg/m^3 and no exceedances of the 1-hour mean AQO.

The annual mean concentration of PM_{10} at the Castle Meadow automatic monitoring site was recorded as 27 µg/m^3 and there were 8 exceedances of the 24-hour mean of 50 µg/m^3, meeting both AQOs. For the Norwich Lakenfields site there was 1 exceedance of the 24-hour mean AQO and the annual mean concentration was 16 µg/m^3. The annual mean $PM_{2.5}$ concentration at both sites was 10 µg/m^3. Data capture was good at both sites.

Ozone monitoring is also carried out at the Norwich Lakenfields site. The annual mean concentration for 2018 was 48 µg/m^3 (99% data capture). The daily maximum 8-hour running mean exceeded 100 µg/m^3 on 12 occasions, more than the 10 allowed by the AQO.

Non-automatic (passive) monitoring of NO_2 was conducted at 23 sites during 2018. There were 4 diffusion tube sites that exceeded the NO_2 annual mean AQO, all located within the AQMA. These were DT11 (52 St Augustine's Street) - 44µg/m^3, DT13 (Castle Meadow) – 45µg/m^3 (not relevant exposure unless 1-hour mean exceeded), DT29 (4 Chapelfield North) – 41µg/m^3 (38µg/m^3 when distance corrected), DT34 (41 St Stephens Street) – 41µg/m^3 (31µg/m^3 when distance corrected). These results are a considerable improvement on previous years, especially as sites that have consistently exceeded, for example the triplicate tubes at 3 Riverside Road in 2018 fell below the objective level for the first time. This is a significant improvement compared to the 10 exceedances within the AQMA in 2012.

Changes to the monitoring strategy have been made in response to road changes, which have been aimed at restricting general traffic from travelling through the city centre. At the start of 2018, 13 NO_2 diffusion tube monitoring positions were removed that did not represent exposure, and/or where levels have consistently fallen below the AQO. In addition, 9 new positions were added at locations which are now taking higher loading of traffic as a result of the road changes.

The measures implemented to improve air quality have primarily been infrastructure changes designed to further pedestrianise and divert general traffic away from the congested city centre. Broadland Northway, Golden Ball Street and Farmers Avenue two-way traffic, Removal of general traffic except buses, taxis and bikes from Red Lion Street and full closure of Westlegate have all been completed. However, the bus and taxi only roads remain some of the most polluted streets in Norwich. Therefore, Norfolk County Council are also concentrating efforts to encourage bus companies to upgrade or replace the older more polluting vehicles. This strategy will be strengthened by the proposed revision of the Bus Charter (Voluntary Quality Partnership) to introduce target date for Euro 5 & 6 compliance initially within the Low Emission Zone.

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, the Pink pedalway now totalling 12.2 km & Blue & Yellow totalling 31 km. Engine switch off enforcement is now being undertaken on bus & taxi only roads. Failure to comply when asked to switch engine off when idling results in the issue of a Fixed Penalty Notice as an on the spot fine of £20. Expected to be extended to include other congested roads.

The report also discusses measures to reduce $PM_{2.5}$ emissions. This includes monitoring $PM_{2.5}$ at both automatic monitoring stations and working with partners within the Norfolk Environmental Protection Group's Air Quality sub-group to ensure regular two-way engagement with representatives of Public Health Norfolk. In addition, Norwich has 3 Smoke Free Zones although these have a historical origin rather than present day significance. The Council actively tries to educate owners and potential owners of wood burners and open fires as to the importance of burning material which does not produce smoke or fumes. This is primarily implemented through its website, planning applications and educational days such as Clean Air Day.

Measures expected to be implemented during the next reporting year are clearly outlined, as are the anticipated challenges and barriers. These proposed future actions are considered appropriate.

There is robust QA/QC of the monitoring data. The locally derived bias adjustment factor is used and no annualisation of monitoring data was conducted as data capture was good at all monitoring sites. The report provides a clear breakdown of historical data (and maps) of each monitoring site.

On the basis of the evidence provided by the local authority the conclusions reached are acceptable for all sources and pollutants. Following the completion of this report, Norwich City Council should submit an Annual Status Report in 2020.

In response to the comments made above, it is confirmed that both City and County Councils are committed to working towards reducing pollution levels within the AQMA and identifying any new pollution hotspots. The successful application for funding through the Transforming Cities Fund will go a long way to helping us achieve this commitment and especially as Norwich's main bus operator, First Bus, has promised to back this funding with its own commitment to upgrade all its fleet to Euro 5 & 6 buses.

Norwich City Council in combination with Norfolk County Council has taken forward a number of direct measures during the current reporting year of 2019 in pursuit of improving local air quality. Details of all measures completed, in progress or planned are set out in Table 2.2. The Table has been ordered in terms of perceived importance to reduce air pollution.

More detail on these measures can be found in the latest 2020 Action Plan to be submitted later this year. All Action Plans can be found by clicking on the following link: https://www.norwich.gov.uk/downloads/file/3020/2015_air_quailty_action_plan

Key completed measures implemented from the 2015 Action Plan are:

- Pedestrianising and road layout changes to key roads within the heart of the city centre (Westlegate, All Saints Green, Golden Ball St, Farmers Ave, Red Lion St).
- Implementation of engine switch off enforcement (on bus and taxi only roads)

- Completion of Northern Distributor Road (with the exception of last link to A47 over the River Wensum).
- More joined up and extended pedalways forming a comprehensive network throughout Norwich.
- Bus retrofitting to upgrade to Euro 6.
- Implementation of Taxi Policy to limit age of Hackney carriages to <15 years old.
- Change in Traffic Signal technology to ease traffic congestion and optimise traffic flow.

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 significant detrimental effect on the progress of these projects:

- Thorpe Road bus and cycle contraflow on a key radial route into the city centre – encouraging behavioural change to limit car use.
- 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).
- Completion of Tombland works to provide a high quality public space that is attractive to walk through and has improved links to cycle networks.
- Completion of works on King Street to improve the environment for walking and cycling.
- Implementation of traffic light technology that reduces journey times for buses and increases journey time reliability for public transport users.
- Green pedalway crossing from west to east through the city is now finalised, this will complete the 5 radial and 2 orbital pedalways.
- Continued roll-out and expansion of the bike and scooter hire scheme operated by Beryl.

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

- Encourage and install buses with cleaner technology removing more polluting buses from the City's streets.
- Encourage behavioural changes to a more sustainable mode 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 have been slower than desired.

Whilst the measures stated above and in Table 2.2 will significantly contribute towards compliance, Norwich City Council anticipates that further additional measures not yet prescribed will be required in subsequent years to achieve compliance and enable the revocation of the city centre AQMA.

More optimistically however, 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 eminently achievable. 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	EU Category	EU Classification	Date Measure Introduced	Organisations involved	Funding Source	Key Performance Indicator	Reduction in Pollutant / Emission from Measure	Progress to Date	Estimated / Actual Completion Date	Comments / Barriers to implementation
1	Castle Meadow Low Emission Zone	Promoting Low Emission Transport	Low Emission Zone (LEZ)	2006/09	Norwich City Council (NCC)	Norwich City Council (NCC)	Reduction in NO2 levels in Castle Meadow	Circa 10-15 µg/m3 NO2	Erratic decline in NO2 but probably would have been worse without LEZ.	Ongoing	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. (to be incorporated in revision of Bus Charter). 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 +	Norfolk County Council (NorCC)	Norfolk County Council (NorCC)	Reduced city centre congestion as well as wider network	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)	Ongoing	2021/22	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	NCC + (NorCC)	NCC + (NorCC)	Reduced city centre congestion as well as wider network / increased numbers of people walking and cycling	Specific value not known but will contribute to overall reduction in NO2 levels in city centre and surrounds	Designs well advanced for Grapes Hill roundabout. A new Dutch-style roundabout is being	2021/22	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.

Measure No.	Measure	EU Category	EU Classification	Date Measure Introduced	Organisations involved	Funding Source	Key Performance Indicator	Reduction in Pollutant / Emission from Measure	Progress to Date	Estimated / Actual Completion Date	Comments / Barriers to implementation
									designed for Heartseas e Fiveways junction		
4	Engine switch-off enforcement	Public Informati on	Other	2018	NCC	NCC	Reduction in NO2 levels in city centre and surrounds	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 on Castle Meadow close to CM1. To date this is considered to be one explanation)	Engine switch off enforceme nt in place with issue of Fixed penalty Notices for drivers who fail to comply when requested. To date no non-complianc e.	Comme nced August 2018	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 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 Informati on	Other	2017 – trial on Riversi de Rd	NCC + NorCC	NCC + NorCC	Reduction in NO2 levels in AQMA	Specific value not known but will contribute to overall reduction in NO2 levels in city centre and surrounds	Ongoing	Ongoing but October 2018 for switch off enforce ment on Castle Meadow	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	Promoti ng Low Emissio n Transpo rt	Public Vehicle Procurement - Prioritising uptake of low emission vehicles	N/A	NCC + NorCC	NCC + NorCC	Reduction in NO2 levels in city centre and surrounds	Specific value not known but will contribute to overall reduction in NO2 levels in city centre and surrounds	24 buses retrofitted by June 2018. First Bus has committed to £18m investment	Ongoing	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.

Measure No.	Measure	EU Category	EU Classification	Date Measure Introduced	Organisations involved	Funding Source	Key Performance Indicator	Reduction in Pollutant / Emission from Measure	Progress to Date	Estimated / Actual Completion Date	Comments / Barriers to implementation
									in new and refurbished vehicles to make their entire fleet Euro 5/6		
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		NorCC	NorCC	Reduction in NO2 levels in city centre and on busy feeder roads	Specific value not known but will contribute to overall reduction in NO2 levels in city centre and surrounds		2022/23	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	NorCC	NorCC	Reduction in NO2 levels in city centre and surrounds. Passive NO2 monitoring to be installed outside key schools.	Specific value not known but will contribute to overall reduction in NO2 levels in city centre and surrounds	Ongoing	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 Clean Air Day campaign – led by County & Public Health Norfolk.
9	CCAG programmes	Promoting Travel Alternatives	Promotion of cycling	2014-2019	NCC, NorCC	NCC, NorCC & DfT	Reduction in vehicle use in city centre. Increased no. people cycling	Specific value not known but will contribute to overall reduction in NO2 levels in city centre and surrounds	Complete	2019/20	Cycle routes have been extended and more joined up. All 2 orbital and 5 radial pedal ways now substantially complete.

Measure No.	Measure	EU Category	EU Classification	Date Measure Introduced	Organisations involved	Funding Source	Key Performance Indicator	Reduction in Pollutant / Emission from Measure	Progress to Date	Estimated / Actual Completion Date	Comments / Barriers to implementation
10	West to East traffic restriction in Norwich City Centre	Traffic Management	UTC, Congestion management, traffic reduction	2020/23	NorCC	NorCC (TCF funding)	Reduction in NO2 levels in city centre and surrounds	Specific value not known but will contribute to overall reduction in NO2 levels in city centre	Outline design underway	2022/23	Provides substantially improved conditions for pedestrians and reduces congestion with buses
11	Revised layout in St Stephens Street / Red Lion Street	Traffic Management	UTC, Congestion management, traffic reduction	2020/23	NorCC	NorCC (TCF funding)	Reduction in NO2 levels in city centre and surrounds	Specific value not known but will contribute to overall reduction in NO2 levels in city centre	Outline design underway	2022/23	Provides substantially improved conditions for pedestrians and reduces congestion with buses
12	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	NorCC	NorCC (TCF funding)	Reduction in NO2 levels in city centre and surrounds	Specific value not known but will contribute to overall reduction in NO2 levels in city centre	Outline design underway	2020/21	Provides a substantially improved and more direct route for buses and cyclists travelling into the city centre along a key radial route.
13	Mobility hubs at key transport interchanges	Transport Planning and Infrastructure	Public transport improvements-interchanges stations and services	2020/23	NorCC	NorCC (TCF funding)	Reduction in NO2 levels in city centre and surrounds	Specific value not known but will contribute to overall reduction in NO2 levels in city centre	Outline design underway	2022/23	Key hubs being developed are at Norwich Rail Station, Norwich Bus Station, Norfolk & Norwich University Hospital and Bowthorpe
14	Bus rapid transit	Transport Planning and Infrastructure	Bus route improvements	Ongoing	NCC + NorCC	NCC + NorCC	Reduced city centre congestion as well as wider network	Specific value not known but will contribute to overall reduction in NO2 levels in city centre and surrounds	Ongoing	Ongoing	Transforming Cities will see substantial provision of priority for buses along key transport corridors including Dereham Road, Wroxham Road and Cromer Road.

Measure No.	Measure	EU Category	EU Classification	Date Measure Introduced	Organisations involved	Funding Source	Key Performance Indicator	Reduction in Pollutant / Emission from Measure	Progress to Date	Estimated / Actual Completion Date	Comments / Barriers to implementation
15	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	NCC + NorCC	NCC + NorCC	Reduced city centre congestion	Specific value not known but will contribute to overall reduction in NO2 levels in city centre and surrounds	Approval to construct given at June 2018 Highways Committee	2019	Works underway to reduce congestion and encourage greater levels of sustainable modes on this important link between the rail station and city centre.
16	Extension to Thickthorn Park and Ride site	Promoting Travel Alternatives	Other	2020/23	NorCC	NorCC (TCF funding)	Reduced city centre congestion as well as wider network	Specific value not known but will contribute to overall reduction in NO2 levels in city centre	Outline design underway	2022/23	This will provide a sustainable travel option into the city centre as well as the University of East Anglia
17	Extension of Postwick Park and Ride site	Promoting Travel Alternatives	Other	TBC	NorCC	NorCC	Reduced city centre congestion as well as wider network	Specific value not known but will contribute to overall reduction in NO2 levels in city centre	Project suspended	TBC	While spare capacity remains at the existing site, expansion of the site will remain on hold.
18	Installation of Beryl Bikes, E-Bikes and E-scooters across the greater Norwich area	Promoting Travel Alternatives	Other	2020	NCC + NorCC	NCC + NorCC	As of October 2020, 51,200 journeys have been taken and 223,000km have been covered by users of the service.	Studies are showing that 15% of all journeys taken by bike or scooter would otherwise have been taken by car.	Public bike share launched in March with E-scooters added in September as part of DfT trials	Scheme largely installed by end of 2020. Contract with Beryl runs until 2025 with	Finding suitable space for bays to achieve optimal bay network density to drive up ridership.

Measure No.	Measure	EU Category	EU Classification	Date Measure Introduced	Organisations involved	Funding Source	Key Performance Indicator	Reduction in Pollutant / Emission from Measure	Progress to Date	Estimated / Actual Completion Date	Comments / Barriers to implementation
										option to extend.	
19	Introduction of School Streets	Transport Planning and Infrastructure	Congestion management, traffic reduction	2021/22	NCC / NorCC	NCC / NorCC	Reduction in traffic levels, improved air quality and greater numbers of pupils walking and cycling to school	Specific value not known but will encourage green corridors to be utilised by students/pupils	Introduction of School Streets	2021/22	The County Council will work with Sustrans and a wide range of stakeholders to implement.
20	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	NorCC)	NorCC (TCF funding)	Reduction in NO2 levels in city centre and surrounds	Specific value not known but will contribute to overall reduction in NO2 levels in city centre	Outline design underway	2022/23	Provides substantially improved conditions for pedestrians and cyclists
21	Construction of final link of Northern Distributor Road (NDR) over River Wensum joining up with A47 West	Transport Planning and Infrastructure	Other	2023-2025	NorCC	NorCC	Reduced city centre congestion as well as wider network	Specific value not known but will contribute to overall reduction in NO2 levels in city centre and surrounds	?	2025	Post construction monitoring will be undertaken.

Measure No.	Measure	EU Category	EU Classification	Date Measure Introduced	Organisations involved	Funding Source	Key Performance Indicator	Reduction in Pollutant / Emission from Measure	Progress to Date	Estimated / Actual Completion Date	Comments / Barriers to implementation
22	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	NCC + NorCC	NCC + NorCC	Reduced city centre congestion	Specific value not known but will contribute to overall reduction in NO2 levels in city centre and surrounds	Not started	TBC	Long term goal. Will be considered in light of emerging Transport for Norwich Strategy Review
23	Education & information campaigns to encourage more responsible driving and the use of alternative modes	Promoting Travel Alternatives	Other	Ongoing	NCC + NorCC	NCC + NorCC	Reduction in NO2 levels in city centre and surrounds	Specific value not known but will contribute to overall reduction in NO2 levels in city centre and surrounds	Ongoing	Ongoing	Continuation of work to promote Transport for Norwich objectives utilising funding from DfT through Access fund.
24	Construction of Northern Distributor Road (NDR)	Transport Planning and Infrastructure	Other	2015/18	NorCC	NorCC	Reduced city centre congestion as well as wider network	Specific value not known but will contribute to overall reduction in NO2 levels in city centre and surrounds	Completed	Completed 2018	Post construction monitoring will be undertaken. (Final link with A47 west still to be undertaken to complete the NDR).

Shading indicates measures completed in the last year.

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. Norwich City Council has also operated a $PM_{2.5}$ TEOM analyser at its automatic monitoring station for many years (currently roadside). We therefore hold 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. 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 who play an active role at the quarterly NEPG meetings. 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

3. The council has direct dialogue with officers of Norfolk County Council Highways Department, who also regularly attend the NEPG sub-group and hence feedback on any significant changes to road layout or traffic flow that may be proposed within the city. $PM_{2.5}$ exposure is considered alongside other pollutants as part of this dialogue.

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. It is however understood that, at least in Norwich, $PM_{2.5}$ is

primarily a transboundary pollutant. Figure A5 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.4 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 in addition to its proximity to the coast. A further PM2.5 source apportionment study is currently being discussed with research graduates at the UEA. It is expected 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.
7. Norwich has 4 Smoke Free Zones, although these have a historical origin rather than any real present day significance. The Council actively tries to educate owners, and potential owners, of woodburners and open fires as to the importance of burning material which does not produce smoke or fume. This is primarily implemented through planning applications, educational days such as Clean Air Day and the Norwich City Council website.

2.3.1 Open fires and wood burning stoves

The use of open fires and wood-burning stoves has risen in popularity over recent years. This means that we are seeing more smoke from chimneys which has a negative effect on air quality. This 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 with simple steps for those that use wood burning stoves or open fires to reduce environmental and health impacts.

Guide to open fires and wood burning stoves

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

3.1 Summary of Monitoring Undertaken

3.1.1 Automatic Monitoring Sites

This section sets out what monitoring has taken place and how it compares with objectives.

Norwich City Council undertook automatic (continuous) monitoring at one site, Castle Meadow, during 2019. 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 - Details of Automatic Monitoring Sites in Appendix A shows the details of the sites. National monitoring results are available at Defra's website: https://uk-air.defra.gov.uk/data/ .

A map showing the location of the monitoring sites is provided in Appendix D. Further details on how the monitors are calibrated and how the data has been adjusted are included in Appendix C.

3.1.2 Non-Automatic Monitoring Sites

Norwich City Council undertook non- automatic (passive) monitoring of NO_2 at 25 sites during 2019. Table A.2 in Appendix A shows the details of the 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[5], "annualisation" (where the data capture falls below 75%), and distance correction[6]. Further details on adjustments are provided in Appendix C.

[5] https://laqm.defra.gov.uk/bias-adjustment-factors/bias-adjustment.html
[6] Fall-off with distance correction criteria is provided in paragraph 7.77, LAQM.TG(16)

3.2.1 Nitrogen Dioxide (NO_2)

Table A.3 in Appendix A compares the ratified and adjusted monitored NO_2 annual mean concentrations for the past 5 years with the air quality objective of 40µg/m^3. Note that the concentration data presented in Table A.3 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 2019 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.

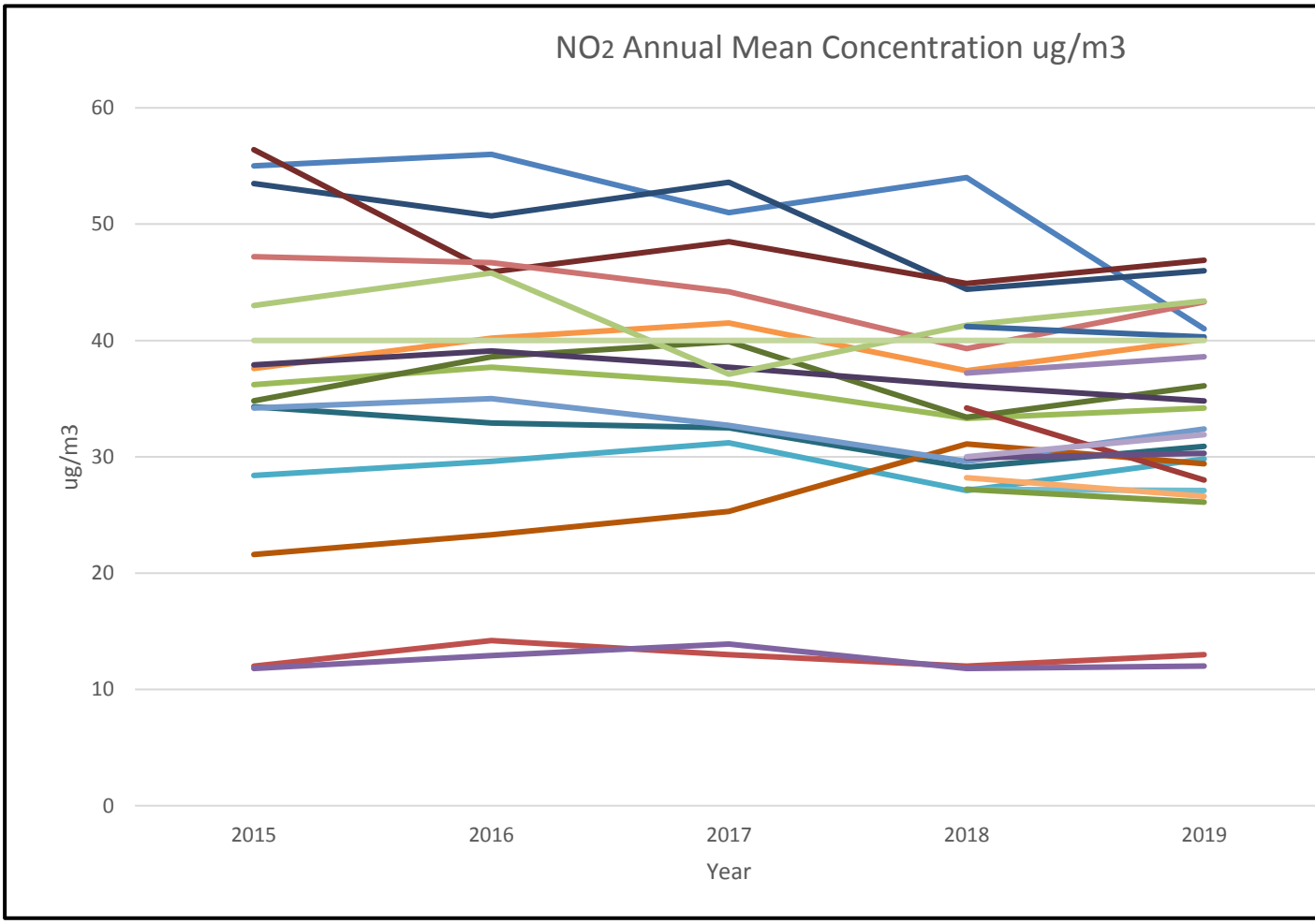


Table A.4 in Appendix A compares the ratified continuous monitored NO_2 hourly mean concentrations for the past 5 years with the air quality objective of 200µg/m^3, not to be exceeded more than 18 times per year.

The annual mean concentration at the Castle Meadow automatic monitoring site (CM1) was recorded as 41µg/m^3 for 2019 which only exceeds the annual mean objective by 1µg/m^3 (data capture was 96%). This is sigificantly lower than all 4 preceeding years which average 54µg/m^3. The exact reason behind this is unclear as County have confirmed there have been no significant changes to bus timetabling changes nor bus stop alterations. However, roadworks on Prince of Wales Road and Agricultural Plain meant that there was a reduction in queuing of buses to exit Castle Meadow to the south. Now complete, changes to this junction include the installation of up-to-date traffic signalling on Agricultural Plain. This will hopefully contribute to a more sustained improvement in traffic flow, particularly of buses along Castle Meadow. Engine switch-off enforcement commenced in August 2018 and hence it would be pleasing to believe the benefits associated with this may also be contributing to the drop seen in the 2019 NO_2 levels.

Historically the CM1 site, which lies at the heart of the AQMA has always had the highest levels of NO_2 but this year was exceeded by the diffusion tube locations on St Augustines St, Riverside Road, Chapel Field North and St Stephens Street. The diffusion tube on Castle Meadow followed the same pattern as previous years, this year having an annual mean of 47µg/m^3.

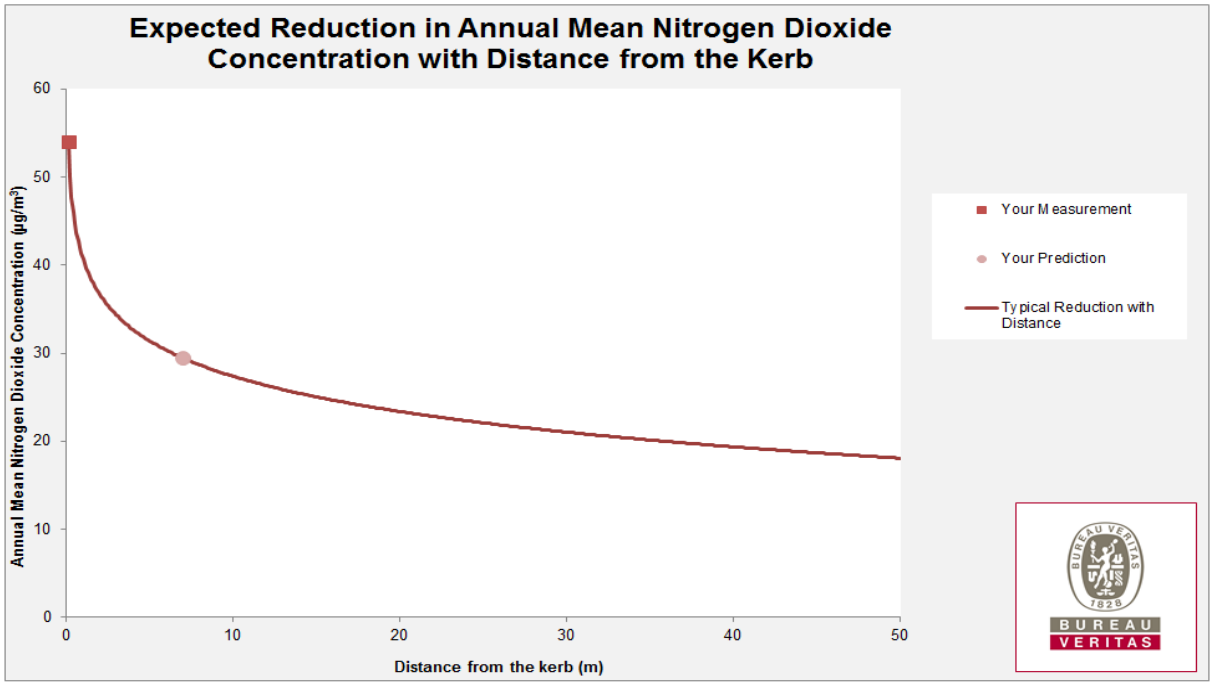
As always, it must be noted that the Castle Meadow automatic analyser site is not representative of relevent exposure for the annual mean for NO_2. The closest residence is sufficiently far enough away that the NO_2 levels would not only be well below the objective level but other factors would come 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 can however be considered relevant exposure for the 1 hour mean as pedestrians may be expected to spend one hour or more at this location. The NO_2 levels at the site of the Castle Meadow automatic analyser did breach this 1 hour objective but this year the measured levels exceeded

the 1 hour allowance of 200µg/m^3 on only 1 occasion throughout 2019, and only by 1µg/m^3, the objective allowing for 18 exceedences in the year.

It is anticipated that with the move towards cleaner buses and the continuing enforcement of engine switch off, Castle Meadow NO_2 levels are expected to decrease as it is felt that individual high polluting buses are significant contributors to this problem. The far reaching measures included in our 2020 Action Plan addresses these problems and sets a timetable for when access to the LEZ is limited to buses with Euro 6 engine classification and above. It is hoped these measures will reduce NO_2 levels to below the objective level.

Figure 3. 1 Example of NO_2 Fall Off With Distance



The Norwich Lakenfields urban background automatic monitoring site measured an annual mean concentration of 13 µg/m^3. Hence there is no exceedence of either the annual mean or the 1-hour mean. Figure A.2 shows that the NO_2 levels of the urban background site Norwich Lakenfields closely matches those of rural background sites such as Wicken Fen and St Osyth. In addition, the underlying background trend can still be seen in the Castle Meadow data.

Table A.3 in Appendix A shows the diffusion tube results for 2019, corrected for bias using a nationally derived bias adjustment factor of 0.89 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:

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

Using the national bias correction, a total of 6 diffusion tube sites exceeded the NO_2 annual mean objective of 40µg/m^3 for 2019. When distance corrected for relevant exposure 4 sites exceeded, although 2 of those sites sat at the objective level;

- DT11 (52 St Augustines Street) – 46µg/m^3

- DT9 (13 St Augustines Street) – 40µg/m^3
- DT29 (4 Chapelfield North) – 40µg/m^3
- DT26 (3 Riverside Road) – 43µg/m^3

The other sites, Castle Meadow Mid can not be classified as relevant exposure as the residential flats above the shops have non-opening windows and hence is only relevant for the 1 hour mean which was not breached (TG16 Feb 2018 7.31 states a breach of the 1 hour mean NO_2 level equates to an annual mean of 60µg/m^3). Whilst 41 St Stephens St, once distance corrected, sits well below the objective level.

- DT13 (Castle Meadow) – 47µg/m^3 (not relevant exposure unless 1 hour mean exceeded)
- DT34 (41 St Stephens Street) – 28µg/m^3 (distance corrected)

In 2019, 4 new DT locations were added whilst 2 were removed; the latter due to NO_2 levels being consistently below the objective level (DT 5 & DT38). These 2 locations were chosen so as to try and establish the lateral extent of pollution which proved to be insignificant. 1 new diffusion tube location was also added for this purpose (DT40). 3 of the new locations related to modelled high NO_2 levels having been predicted during the planning application process for a new district centre at Anglia Square to the north of the city centre (DT41, DT42, DT43). These high levels needed to be qualified.

Figure A.1 presents the results of the NO_2 (a) continuous and (b) continuous plus passive annual means from 2015 -2019. The trends on both graphs illustrate a slow but principally steady reduction in levels.

Riverside Road still shows a steady decline in NO_2 annual mean but with the exception of last year which was uncharacteristically low. It is still interesting to think the escalation in decline in 2018 was enhanced by the UEA engine switch off trial, perhaps reinforced by media coverage concerning engine switch off enforcement, which perhaps lost its impetus by 2019.

All of the diffusion tube sites which show an exceedence of the objective level remain within the existing Norwich Central AQMA despite 4 DT locations lying beyond the AQMA specifically for the purpose of identifying if the defined area is still appropriate. Reassuringly 52 St Augustines St is significantly lower than previous years (54µg/m^3

in 2017) but this decrease is difficult to explain as there have been no road changes in this area nor adjustments made to the traffic light timings. This diffusion tube location represents a worst case scenario being located on the building façade approximately 1m from the kerbside within a canyon street.

Castle Meadow Mid, as with the automatic monitoring station, is a bus & taxi only street and hence not unsurprisingly levels have fluctuated over the years but now seem to lie around the mid 40's μg/m^3 level. The whole of Castle Meadow is only relevant exposure for a 1 hour mean. This DT is located approximately 60m along the road from the NCC automatic analyser. This year there was 6μg/m^3 between the two which is quite reasonable give it is a busy urban street with bus stops at short intervals along it's entire length. The automatic analyser is sited immediately adjacent to a bus stop which itself is close to a set of traffic lights and hence queueing traffic is quite typical, especially at peak times. This scenario would support the view that particularly high levels of pollution can be very localised.

In September 2018, engine switch off enforcement was introduced on Castle Meadow. No Fixed Penalty Notices have been issued but enforcement officers do still need to ask drivers to comply. As a result it was realised that bus operators need further encouragement to ensure this message is being fully understood by their drivers. Norfolk County Council have announced that with the help of funding from the Transforming Cities Fund, First Bus will be upgrading their entire fleet of buses to meet Euro 5 & 6 classifications. Once fully implemented in 2023, it is expected the upgrade will translate directly into reductions in pollution levels as First Bus are the principle bus operator in Norwich operating 75% of all journeys. It is hoped this will encourage other operators to follow suit and, at minimum, remove older polluting buses from the Low Emission Zone.

The updated 2020 Action Plan refers to the current 2009 Bus Charter which will be updated as a matter of priority to bring in the target date for Euro 6 compliance, and expansion of the Low Emission Zone.

Chapel Field North levels continue to oscillate around the objective level. Pollution along this road is principally attributed to buses waiting at traffic lights to feed onto the busy Chapelfield roundabout. It is expected that buses with cleaner engines will decrease NO_2 levels to consistently below the objective level at this location.

St Stephens Street is a heavily congested bus and taxi only street. It is intended that the Transforming Cities Fund will allow changes to be made to alleviate this congestion by making it easier for buses to access and egress from bus stops. Student accommodation overlooks this street, which when distance corrected, falls well below the objective level and hence only a breach of the 1 hour mean would be applicable. Nevertheless reducing pollution levels along this busy shopping street is very welcome for cyclists and pedestrians alike.

Reassuringly both the junction at Finkelgate/Queens Road and the feeder road, Hall Road, remain below the objective levels again this year.

Heigham Street has frequent queueing traffic at traffic lights adjacent to a bridge over the River Wensum. Nevertheless the levels remain well below the objective level.

Duke Street suffers queueing traffic feeding onto the traffic light regulated St Crispins roundabout. Major new developments are proposed for this area which will see traffic from the adjacent St Marys Works development feeding directly onto Duke Street close to this junction. The purpose of this tube location was to assess NO_2 levels pre and post development. Present levels were found to be well below the objective level at 32µg/m^3.

Another new location last year was 24 St Stephens Road (DT35) and then in 2019, approximately 100m further down the road, Kingsley Rd (DT40) was added. Both lie close to the busy St Stephens roundabout. These tubes are located outside the AQMA in order to test if the AQMA boundary was still appropriate. St Stephens Rd takes a lot of general traffic but, more importantly, traffic from 2 main arterial routes, the A11 & A140, both feed directly into St Stephens Road. The annual mean at both DT sites fall comfortably within the objective level at 28µg/m^3 and 32µg/m^3 respectively. The above mentioned locations were all chosen because at peak times in particular the streets are heavily congested, principally by commuter traffic. Nevertheless the levels fall well below the objective level which all adds weight to the fact that the most significant pollution is attributable to queueing buses.

The remaining new locations on Magdalen Street (DT41 & DT42) and Edward Street (DT43) all indicate significant anomalies in the modelling of these streets for the Anglia Square project as all fall well below the objective level.

3.2.2 Particulate Matter (PM_{10})

Table A.5 in Appendix A compares the ratified and adjusted monitored PM_{10} annual mean concentrations for the past 5 years with the air quality objective of 40µg/m^3.Table A.6 in Appendix A compares the ratified continuous monitored PM_{10} daily mean concentrations for the past 5 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 which is below the annual mean objective of 40µg/m^3. There were 5 exceedances of the 24-hour mean of 50µg/m^3 (35 allowed), and the maximum daily mean recorded was 53µg/m^3 (95% data capture). 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, there were 4 exceedances of the 24-hour mean, the maximum being 124µg/m^3. The annual mean concentration was 14µg/m^3 (90% data capture) and hence again lies well below the annual mean objective of 40µg/m^3.

3.2.3 Particulate Matter ($PM_{2.5}$)

Table A.7 in Appendix A presents the ratified and adjusted monitored $PM_{2.5}$ annual mean concentrations for the past 5 years.

Additionally, data from the Castle Meadow site is shown for comparison. It should be noted however, 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.3 in Appendix A shows the annual mean concentrations at both sites and demonstrates that both Norwich sites already comfortably meet the annual average EU limit value of 25µg/m^3 which is to be met by 2020 and that levels for both sites are not dissimilar.

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

There has been an overall steady reduction in the annual average at Lakenfields since 2010, which is in line with the EU target value of 15% reduction at background urban locations between 2010 and 2020, also demonstrated by Figure A.3. In addition, in 2018 the World Health Organisation recommended guideline value of 10µg/m^3 has been met at both Lakenfields and Castle Meadow for the last 2 consecutive years.

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. Our historic monitoring data will be of considerable assistance in assessing such impacts. Although it must be noted that salt and residual particulates are the main source of $PM_{2.5}$ in Norwich - reference Figure A.4, neither originating from sources within 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 2019;

- Annual mean - 50µg/m^3 (99% data capture) (48 in 2018)
- Air Quality Strategy Objective for 2005 (O3) Daily maximum 8-hour running mean > 100 µgm-3 on more than 10 days – 17 exceedances (12 in 2018)
- EC Population Information Threshold (O3) 1-hour mean > 180 µgm-3 – 8 exceedances. (6 in 2018)
- EC Population Warning Value (O3) 1-hour mean > 240 µgm-3 – 0 exceedances. (0 in 2018)
- EC Health Protection Target Value (O3) daily maximum 8-hour running mean > 120 µgm-3 on more than 25 days – 0 exceedances (0 in 2018)
- Air Quality Standard (O3) 8-hour running mean > 100 µgm-3 – 113 exceedances (84 exceedances in 2018)
- Air Quality Strategy Standard for 2005 (O3) daily maximum 8-hour running mean > 100 µgm-3 – 17 exceedances (12 exceedances in 2018)
- EC Health Protection long-term objective (O3) daily maximum 8-hour running mean > 120 µgm-3 – 11 (5 exceedances in 2018).

There is only a small difference between the years 2019 & 2018 which could easily be explained by differences in weather systems between the 2 years but on the whole the levels are fairly consistent. It is anticipated that in future years climate change could lead to an elevation in ozone levels and hence monitoring of this pollutant at this stage is important.

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?	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, NO_2, PM2.5	Y	Chemiluminescent (Ambirak); TEOM	N/A	1	2.5
CM2	Lakenfields	Urban Background	623637	306940	O3, PM10, NOx, NO_2, 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

Site ID	Site Name	Site Type	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Pollutants Monitored	In AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube collocated with a Continuous Analyser?	Height (m)
DT1	256 King Street	Roadside	623863	307679	NO2	Y	0	3.5	N	1.5
DT4	Lakenfields	Urban Background	623681	307016	NO2	N	20	1.5	Y	2.5
DT6	130 Magdalen Street	Roadside	623161	309550	NO2	Y	0	4	N	2.5
DT9	13 St Augustine's St	Kerbside	622906	309496	NO2	Y	1	1.5	N	2.5
DT11	52 St Augustine's St	Kerbside	622826	309573	NO2	Y	0	1	N	2.5
DT13	Castle Meadow	Roadside	623141	308607	NO2	Y	N/A	2.5	N	2.5
DT16	Zipfel House	Roadside	623186	309650	NO2	Y	0	3	N	2.5
DT19	Cattlemarket Street	Roadside	623321	308431	NO2	Y	0	2	N	2.5
DT21	Rotary House	Roadside	623880	307659	NO2	Y	3	2	N	1.5
DT22	Carrow Bridge House	Roadside	623901	307710	NO2	Y	0	5	N	1.5
DT25	24 Bargate Court	Roadside	623422	309388	NO2	Y	0	4	N	2.5
DT26	3 Riverside Road	Roadside	623870	308516	NO2	Y	0	3	N	2.5
DT29	4 Chapelfield North	Kerbside	622532	308490	NO2	Y	1.5	1	N	2.5

Site ID	Site Name	Site Type	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Pollutants Monitored	In AQMA?	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube collocated with a Continuous Analyser?	Height (m)
DT31	Quantrell Hs, 199-203 Queens Rd	Kerbside	623380	307700	NO2	N	0	3	N	3
DT32	8 Hall Road	Kerbside	623399	307664	NO2	N	0	1	N	3
DT33	8 Winnalls Yd, Queens Rd	Kerbside	622986	307936	NO2	Y	0.5	4	N	3
DT34	41 St Stephens St	Kerbside	622898	308114	NO2	Y	6	0.5	N	3
DT35	24 St Stephens Rd	Kerbside	622755	307932	NO2	N	0	1	N	3
DT36	219 Heigham St	Kerbside	621910	309751	NO2	N	0	1	N	3
DT37	Adj. 7A Gunns Ct, Cleveland Rd	Kerbside	622492	308520	NO2	Y	3	2.5	N	3
DT39	49 Duke St	Kerbside	622884	309082	NO2	Y	0	1	N	3
DT40	St Stephens Rd (Kingsley Rd)	Roadside	622695	307855	NO2	N	1.5	2	N	2.5
DT41	Magdalen St (RSPCA)	Roadside	623148	309277	NO2	Y	1.5	3.5	N	2.5
DT42	Magdalen St (bus stop)	Roadside	623151	309326	NO2	Y	20	2.5	N	3
DT43	Edward St	Roadside	623037	309487	NO2	Y	2	1	N	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.3 – Annual Mean NO_2 Monitoring Results

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Monitoring Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2019 (%) (2)	NO_2 Annual Mean Concentration (µg/m^3) (3) (4)				
							2015	2016	2017	2018	2019
CM1	623202	308615	Kerbside	Automatic	96	96	**55**	**56**	**51**	**54**	**41**
CM2	623637	306940	Urban Background	Automatic	99	99	12	14.2	13	12.00	13
DT1	623863	307679	Roadside	Diffusion Tube	100	100	36.2	37.7	36.3	33.3	34.2
DT4	623681	307016	Urban Background	Diffusion Tube	100	100	11.8	12.9	13.9	11.8	12.0
DT6	623161	309550	Roadside	Diffusion Tube	100	100	28.4	29.6	31.2	27.1	29.8
DT9	622906	309496	Kerbside	Diffusion Tube	100	100	37.6	**40.2**	**41.5**	37.4	**40.1**
DT11	622826	309573	Kerbside	Diffusion Tube	100	100	**53.5**	**50.7**	**53.6**	**44.4**	**46.0**
DT13	623141	308607	Roadside	Diffusion Tube	100	100	**56.4**	**45.9**	**48.5**	**44.9**	**46.9**
DT16	623186	309650	Roadside	Diffusion Tube	100	100	34.8	38.6	39.9	33.4	36.1
DT19	623321	308431	Roadside	Diffusion Tube	100	100	37.9	39.1	37.7	36.1	34.8
DT21	623880	307659	Roadside	Diffusion Tube	100	100	34.3	32.9	32.5	29.1	30.9
DT22	623901	307710	Roadside	Diffusion Tube	100	100	21.6	23.3	25.3	31.1	29.4
DT25	623422	309388	Roadside	Diffusion Tube	100	100	34.2	35	32.7	29.6	32.4
DT26	623870	308516	Roadside	Diffusion Tube	92	92	**47.2**	**46.7**	**44.2**	39.3	**43.3**

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Monitoring Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2019 (%) (2)	NO_2 Annual Mean Concentration ($\mu g/m^3$) (3) (4)				
							2015	2016	2017	2018	2019
DT29	622532	308490	Kerbside	Diffusion Tube	100	100	**43**	**45.8**	37.1	**41.3**	**43.4**
DT31	623380	307700	Kerbside	Diffusion Tube	100	100				37.2	38.6
DT32	623399	307664	Kerbside	Diffusion Tube	100	100				27.2	27.1
DT33	622986	307936	Kerbside	Diffusion Tube	83	83				28.2	26.6
DT34	622898	308114	Kerbside	Diffusion Tube	100	100				**41.2**	**40.3**
DT35	622755	307932	Kerbside	Diffusion Tube	92	92				34.2	28.0
DT36	621910	309751	Kerbside	Diffusion Tube	100	100				27.2	26.1
DT37	622492	308520	Kerbside	Diffusion Tube	100	100				29.9	30.3
DT39	622884	309082	Kerbside	Diffusion Tube	100	100				30	31.9
DT40	622695	307855	Roadside	Diffusion Tube	100	100					32.6
DT41	623148	309277	Roadside	Diffusion Tube	100	100					34.2
DT42	623151	309326	Roadside	Diffusion Tube	83	83					33.0
DT43	623037	309487	Roadside	Diffusion Tube	100	100					22.5

☒ **Diffusion tube data has been bias corrected**

☒ **Annualisation has been conducted where data capture is <75%**

☒ **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 adjustment**

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.**

(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%).

(3) Means for diffusion tubes have been corrected for bias. All means have been "annualised" as per Boxes 7.9 and 7.10 in LAQM.TG16 if valid data capture for the full calendar year is less than 75%. See Appendix C for details.

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

Figure A.1 – Trends in Annual Mean NO_2 Concentrations - Automatic Monitoring Stations

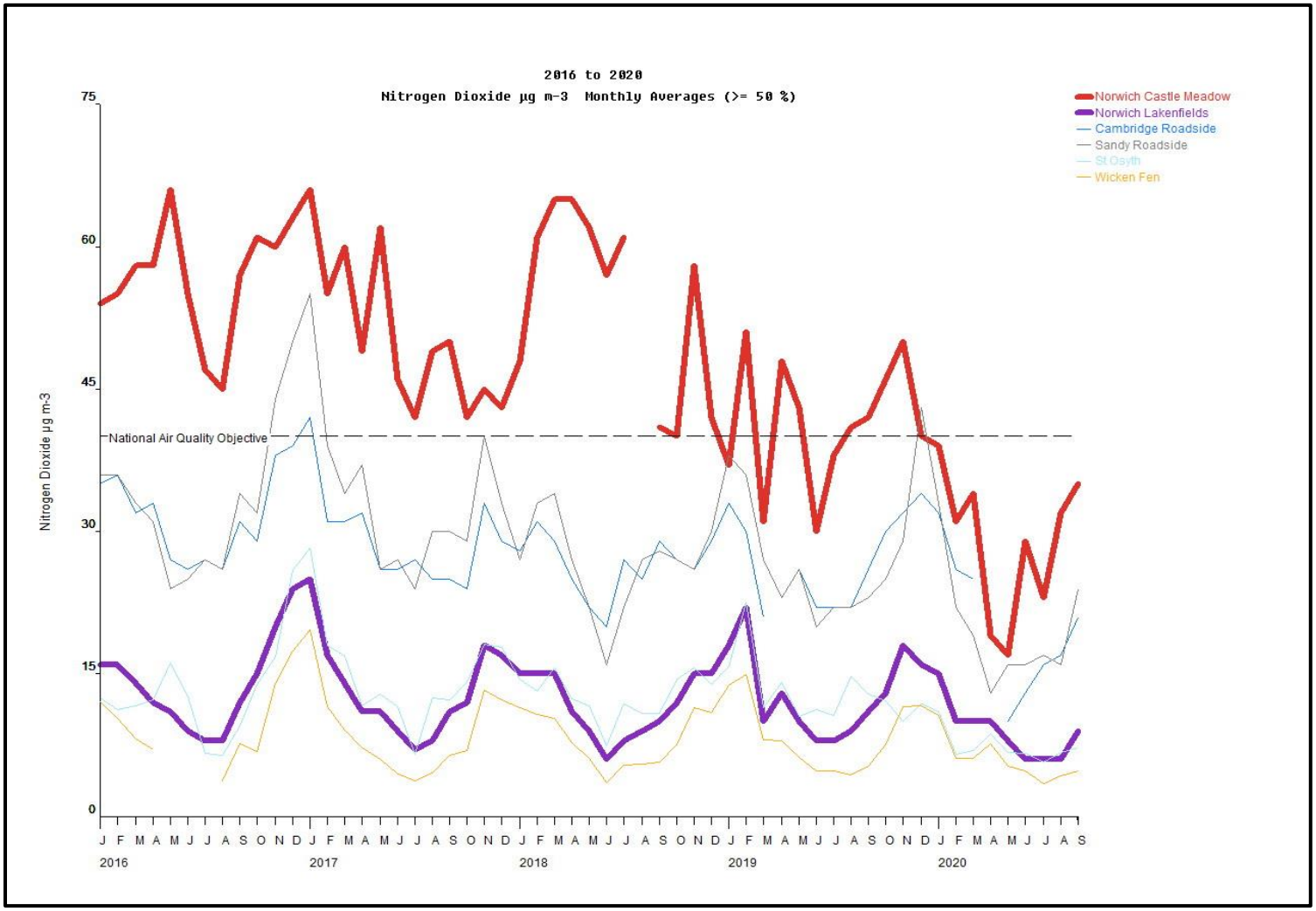


Figure A.2 – Trends in Annual Mean NO_2 Concentrations - Continuous & Passive Monitoring

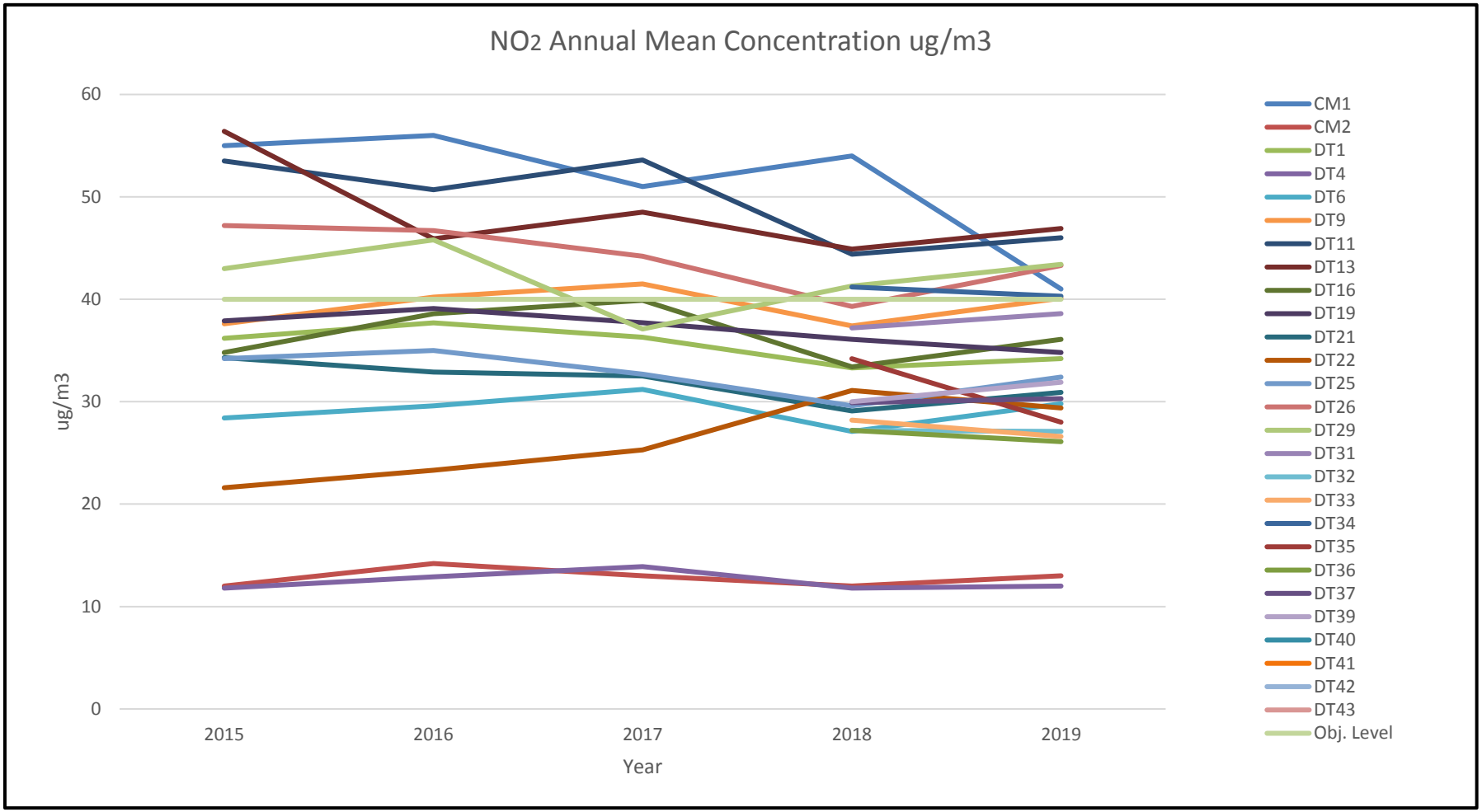


Table A.4 – 1-Hour Mean NO_2 Monitoring Results

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Monitoring Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2019 (%) (2)	NO_2 1-Hour Means > 200µg/m^3 (3)				
							2015	2016	2017	2018	2019
CM1	623202	308615	Kerbside	Automatic	96	96	6	4	1	19	1
CM2	623637	306940	Urban Background	Automatic	99	99	0 (55)	0	0	0	0

Notes:

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.**

(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%).

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

Figure A.3 – Trends in Number of NO_2 1-Hour Means > 200µg/m^3

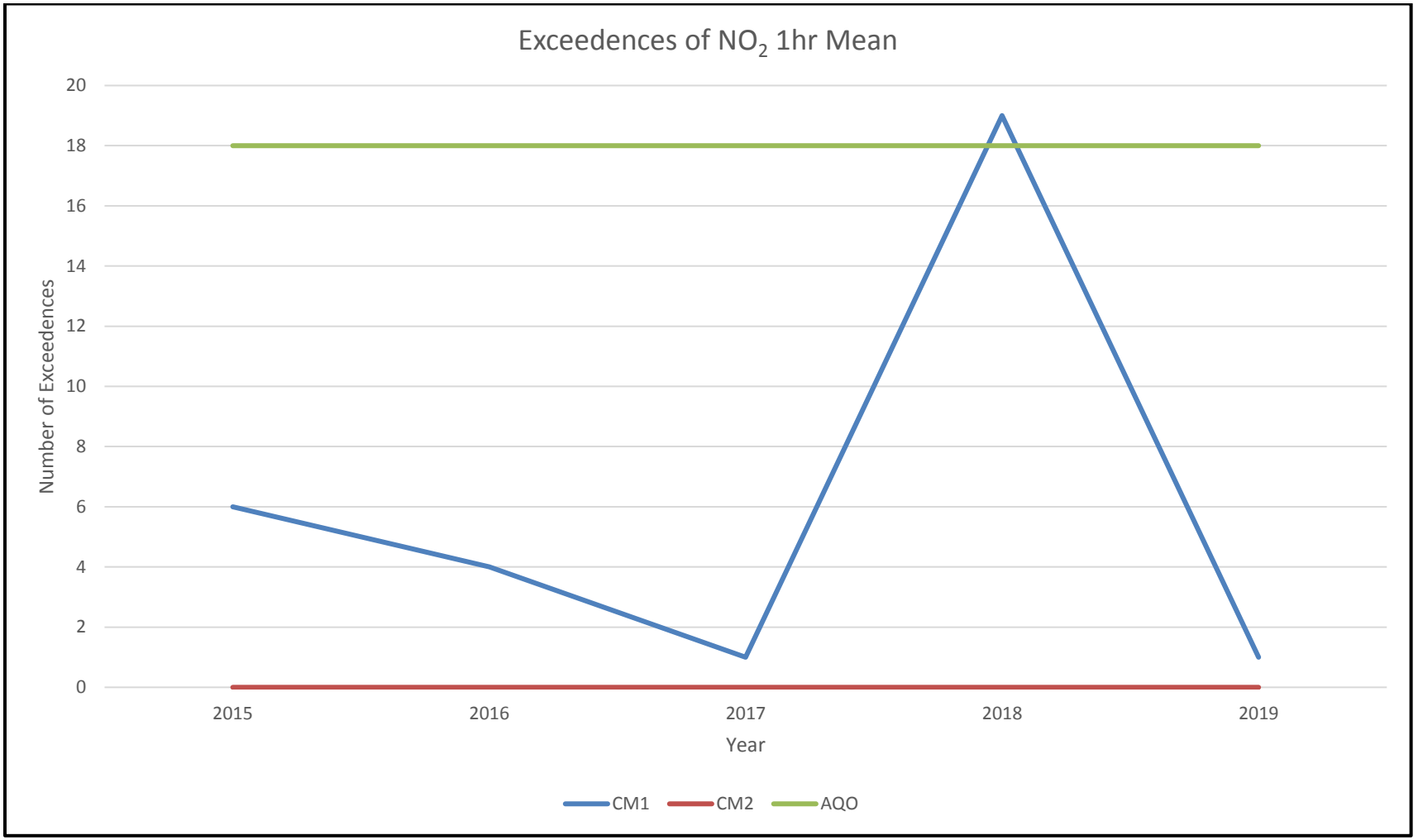


Table A.5 – Annual Mean PM_{10} Monitoring Results

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2019 (%) (2)	PM_{10} Annual Mean Concentration (µg/m³) (3)				
						2015	2016	2017	2018	2019
CM1	623202	308615	Roadside	95	95	21	20	23	27	19
CM2	623637	306940	Urban Background	90	90	15	16	16	16	14

☒ **Annualisation has been conducted where data capture is <75%**

Notes:

Exceedances of the PM_{10} annual mean objective of 40µg/m³ are shown in **bold.**

(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%).

(3) All means have been "annualised" as per Boxes 7.9 and 7.10 in LAQM.TG16, valid data capture for the full calendar year is less than 75%. See Appendix C for details.

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

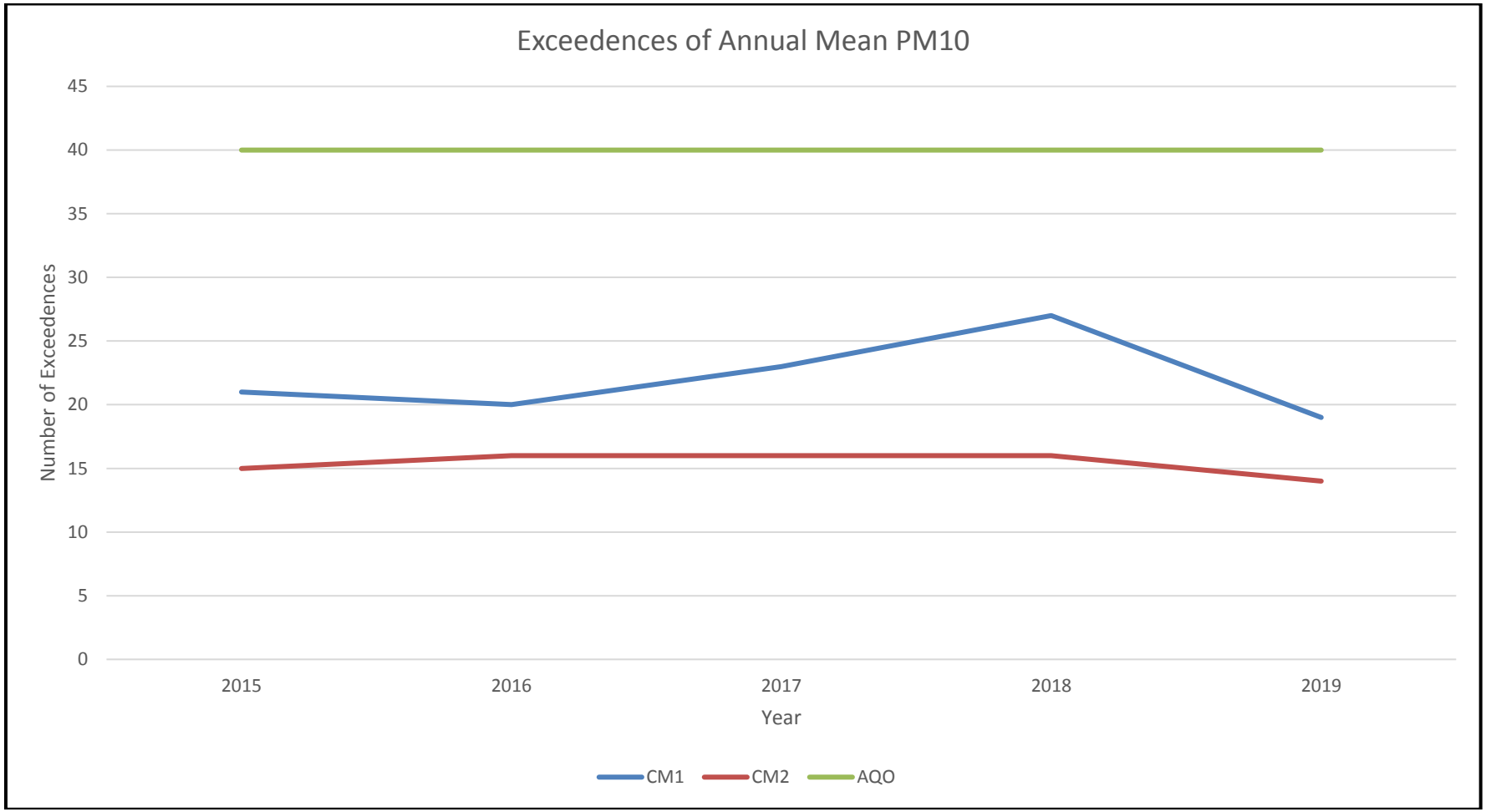


Table A.6 – 24-Hour Mean PM_{10} Monitoring Results

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2019 (%) (2)	PM_{10} 24-Hour Means > 50µg/m³ (3)				
						2015	2016	2017	2018	2019
CM1	623202	308615	Kerbside	95	95	6	4	4	8	5
CM2	623637	306940	Urban Background	90	90	5	1 (27)	5	1	4

Notes:

Exceedances of the PM_{10} 24-hour mean objective (50µg/m³ not to be exceeded more than 35 times/year) are shown in **bold.**

(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%).

(3) If the period of valid data is less than 85%, the 90.4th percentile of 24-hour means is provided in brackets.

Figure A.5 – Trends in Number of 24-Hour Mean PM_{10} Results >50µg/m^3

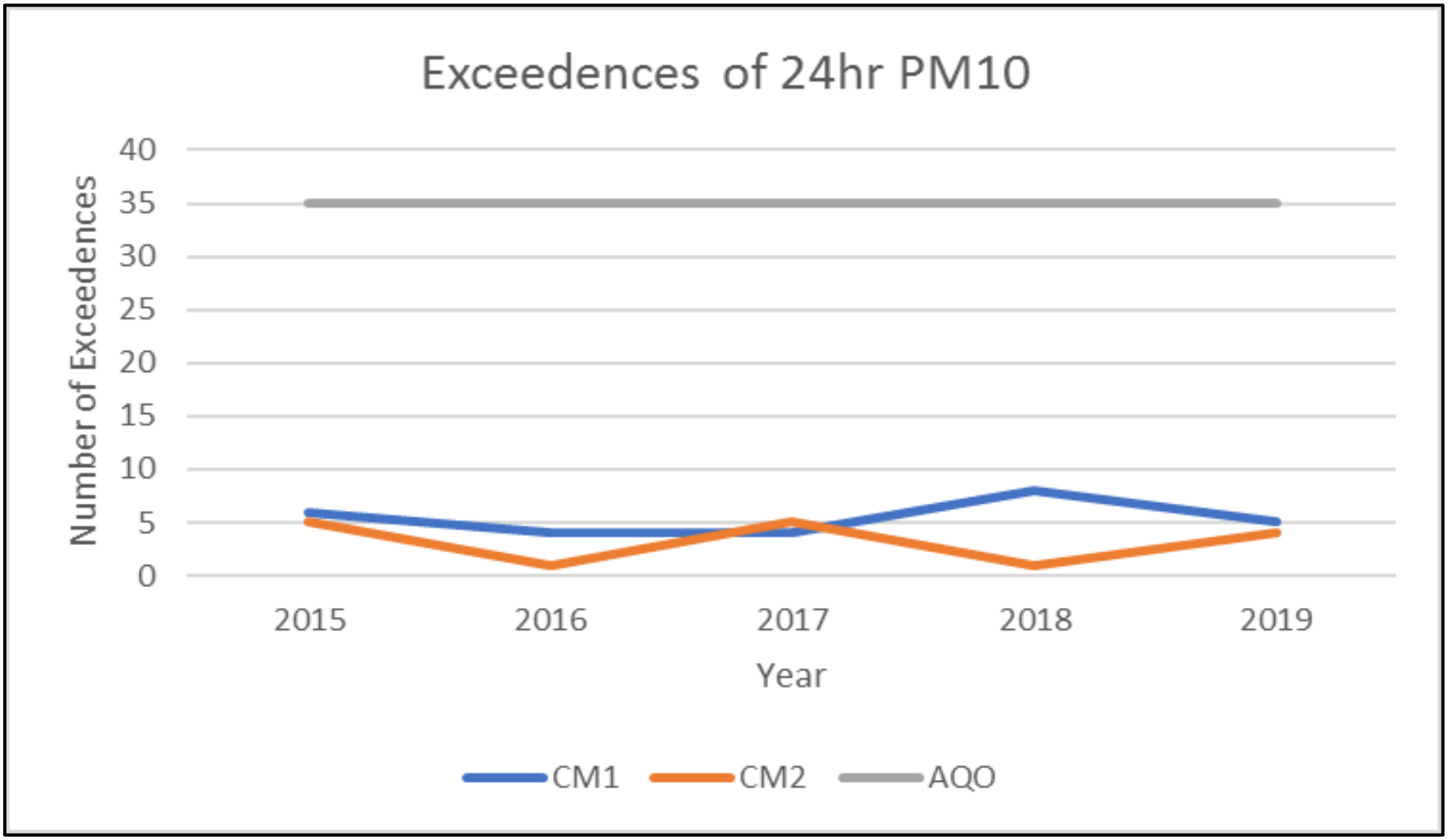


Table A.7 – $PM_{2.5}$ Monitoring Results

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2019 (%) (2)	$PM_{2.5}$ Annual Mean Concentration ($\mu g/m^3$) (3)				
						2015	2016	2017	2018	2019
CM1	623202	308615	Kerbside	91	91	9	11	15	10	10
CM2	623637	306940	Urban Background	97	97	12	11	12	10	10

☒ **Annualisation has been conducted where data capture is <75%**

Notes:

(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%).

(3) All means have been "annualised" as per Boxes 7.9 and 7.10 in LAQM.TG16, valid data capture for the full calendar year is less than 75%. See Appendix C for details.

Figure A.6 – Trends in Annual Mean PM2.5 Concentrations

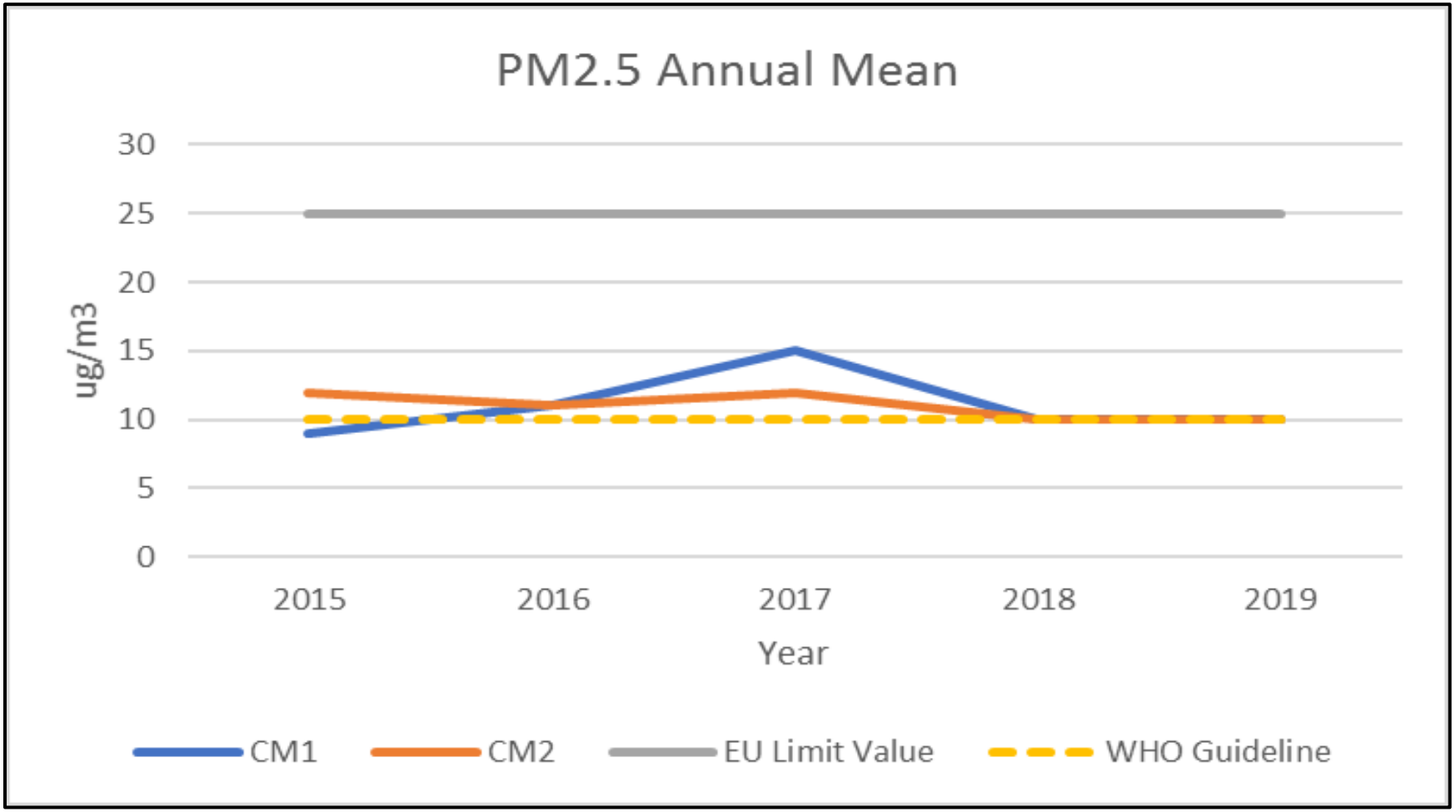
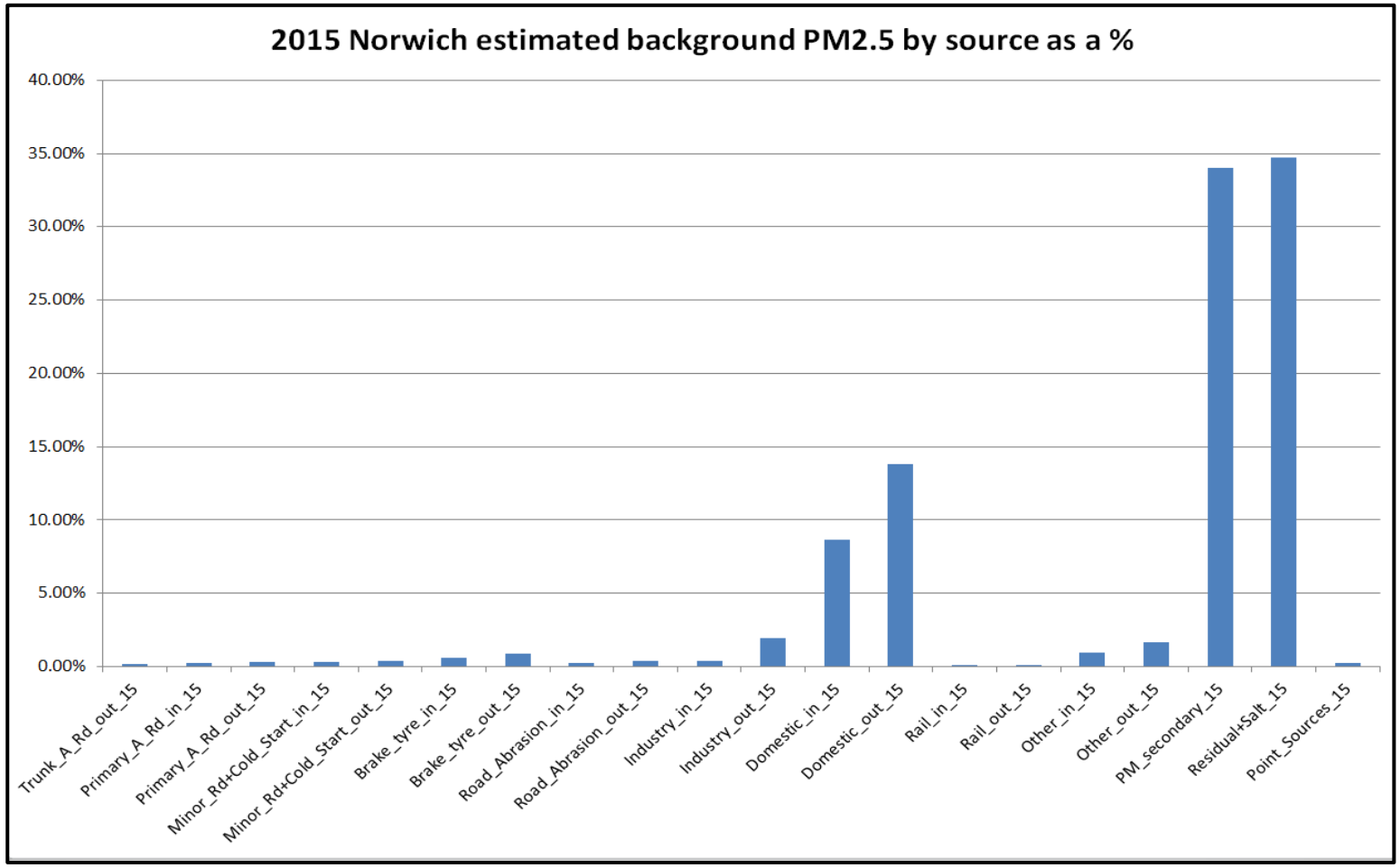


Figure A.7 – PM2.5 Source Apportionment



Appendix B: Full Monthly Diffusion Tube Results for 2019

Table B.1 - NO_2 Monthly Diffusion Tube Results - 2019

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	NO_2 Mean Concentrations ($\mu g/m^3$)														
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean		
															Raw Data	Bias Adjusted (0.89) and Annualised (1)	Distance Corrected to Nearest Exposure (2)
DT1	623863	307679	36.5	43.2	32.9	35.7	36.2	33.3	33.2	36.5	37.3	41.1	46.0	41.7	38.5	34.2	
DT4	623681	307016	21.4	21.5	13.2	11.9	10.2	9.5	8.4	9.5	12.2	13.9	19.6	17.8	13.5	12.0	
DT6	623161	309550	40.2	37.4	31.4	27.1	50.8	25.5	25.3	29.0	30.8	31.9	38.6	33.9	33.5	29.8	
DT9	622906	309496	49.5	44.5	41.3	49.3	48.7	40.6	40.1	39.0	46.4	48.3	55.5	37.8	45.1	**40.1**	**40.1**
DT11	622826	309573	66.3	32.1	58.6	45.2	26.5	50.9	55.7	57.7	57.7	56.6	57.5	54.8	51.6	**46.0**	**46**
DT13	623141	308607	49.8	56.5	52.3	53.6	59.0	47.0	47.8	51.7	54.2	50.6	63.3	47.1	52.7	**46.9**	n/a (3)
DT16	623186	309650	50.3	51.0	39.7	28.4	34.1	31.5	34.6	42.5	38.5	41.8	46.6	48.5	40.6	36.1	
DT19	623321	308431	42.3	43.7	32.1	44.1	37.9	28.3	32.9	33.3	34.8	53.3	48.8	38.1	39.1	34.8	
DT21	623880	307659	31.8	40.5	35.1	36.0	34.1	26.8	28.3	38.4	33.0	38.6	37.6	36.2	34.7	30.9	
DT22	623901	307710	44.5	42.9	36.2	30.8	31.3	27.1	29.3	27.9	28.4	32.8	34.4	30.7	33.0	29.4	
DT25	623422	309388	44.4	39.8	37.7	25.7	34.4	30.6	33.7	35.5	38.9	39.6	42.0	35.0	36.4	32.4	
DT26	623870	308516	47.6		48.5	49.0	47.0	45.0	44.9	50.8	49.4	51.9	52.0	48.6	48.7	**43.3**	**43**
DT29	622532	308490	55.2	49.2	46.8	46.9	48.4	41.5	43.8	45.2	53.2	51.6	60.0	45.4	48.8	**43.4**	**40**
DT31	623380	307700	60.2	53.3	40.9	36.2	35.6	36.4	35.8	42.5	40.7	44.4	46.8	47.7	43.4	38.6	
DT32	623399	307664	37.4	38.2	29.8	33.4	29.9	24.3	26.3	24.5	32.6	13.9	42.2	32.6	30.4	27.1	
DT33	622986	307936	40.3	32.2	30.2			26.9	26.3	19.7	28.6	29.7	41.4	23.9	29.9	26.6	

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	NO_2 Mean Concentrations ($\mu g/m^3$)														
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean		
															Raw Data	Bias Adjusted (0.89) and Annualised (1)	Distance Corrected to Nearest Exposure (2)
DT34	622898	308114	46.1	53.4	46.0	49.0	46.8	43.0	36.3	43.7	42.3	47.5	48.8	40.9	45.3	**40.3**	28
DT35	622755	307932	35.4	41.2	29.7	31.0	29.4	26.6	23.3	25.1	28.9		40.5	34.7	31.4	28.0	
DT36	621910	309751	36.9	29.3	29.7	25.2	28.0	16.9	27.0	25.3	30.4	34.9	36.2	32.5	29.4	26.1	
DT37	622492	308520	37.9	37.1	31.8	30.6	29.4	30.7	29.0	29.8	34.1	37.7	45.8	34.9	34.1	30.3	
DT39	622884	309082	38.5	37.7	35.6	43.4	38.3	33.4	30.8	32.6	35.6	34.9	39.9	29.1	35.8	31.9	
DT40	622695	307855	40.9	35.8	36.3	38.9	37.8	34.8	32.3	32.1	37.1	36.5	46.5	30.7	36.6	32.6	
DT41	623148	309277	43.1	44.1	34.7	37.4	39.7	36.0	32.7	30.5	39.6	37.5	49.0	37.0	38.4	34.2	
DT42	623151	309326	46.3	39.3	36.8	42.1	35.6		31.9		37.9	37.2	47.1	35.0	37.1	33.0	
DT43	623037	309487	32.0	38.9	22.9	21.1	19.4	18.9	17.7	20.5	23.9	28.3	33.1	26.2	25.2	22.5	

☐ **Local bias adjustment factor used**

☒ **National bias adjustment factor used**

☒ **Annualisation has been conducted where data capture is <75%**

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

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.**

(1) See Appendix C for details on bias adjustment and annualisation.

(2) Distance corrected to nearest relevant public exposure.

(3) n/a refers to distance correction being not applicable because nearest relevant receptor is at such a distance that any correction would be meaningless as other factors would come into play.

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

National Diffusion Tube Bias Adjustment Factors

Supplier/ Analyst: Gradko
Preparation Method: 50% TEA in Acetone
National Bias Adjustment Factor (from spreadsheet v09/20): **0.89** (29 studies)

National Diffusion Tube Bias Adjustment Factor Spreadsheet — Spreadsheet Version Number: 09/20

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 2021
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:	Step 2:	Step 3:	Step 4:
Select the Laboratory that Analyses Your Tubes from the Drop-Down List	Select a Preparation Method from the Drop-Down List	Select a Year from the Drop-Down List	Where there is only one study for a chosen combination, you should use the adjustment factor shown with caution. Where there is more than one study, use the overall factor[3] shown in blue at the foot of the final column.
If a laboratory is not shown, we have no data for this laboratory.	If a preparation method is not shown, we have no data for this method at this laboratory.	If a year is not shown, we have no data[2]	If you have your own co-location study then see footnote[4]. If uncertain what to do then contact the Local Air Quality Management Helpdesk at LAQMHelpdesk@bureauveritas.com or 0800 0327953

Analysed By[1]	Method (To undo your selection, choose (All) from the pop-up list)	Year[2] (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[5]	Bias Adjustment Factor (A) (Cm/Dm)
Gradko	50% TEA in acetone	2019	R	RBWM	12	38	35	6.6%	G	**0.94**
Gradko	50% TEA in acetone	2019	UB	Bureau Veritas	11	38	32	21.6%	G	**0.82**
Gradko	50% TEA in acetone	2019	KS	Croydon	11	50	43	16.2%	G	**0.86**
Gradko	50% TEA in acetone	2019	R	Croydon	11	53	44	20.5%	G	**0.83**
Gradko	50% TEA in acetone	2019	SU	Greenwich	12	20	17	17.0%	G	**0.85**
Gradko	50% TEA in acetone	2019	R	Greenwich	12	60	53	14.3%	G	**0.87**
Gradko	50% TEA in acetone	2019	R	Greenwich	12	44	36	24.6%	G	**0.80**
Gradko	50% TEA in acetone	2019	R	Greenwich	12	41	39	5.8%	G	**0.95**
Gradko	50% TEA in acetone	2019	R	Greenwich	12	37	34	10.8%	G	**0.90**
Gradko	50% TEA in acetone	2019	R	Greenwich	12	33	33	0.1%	G	**1.00**
Gradko	50% TEA in acetone	2019	R	Greenwich	12	36	33	9.8%	G	**0.91**
Gradko	50% TEA in acetone	2019	R	Hammersmith and Fulham	11	57	58	-2.3%	G	**1.02**
Gradko	50% TEA in acetone	2019	R	Newham	12	35	30	16.3%	G	**0.86**
Gradko	50% TEA in acetone	2019	UB	Royal Borough of Kensington and Chelsea	12	27	27	-2.2%	G	**1.02**
Gradko	50% TEA in acetone	2019	R	Sandwell MBC	10	40	33	20.9%	G	**0.83**
Gradko	50% TEA in acetone	2019	UB	Sandwell MBC	11	17	15	10.5%	S	**0.91**
Gradko	50% TEA in acetone	2019	UB	Sandwell MBC	12	25	22	18.2%	G	**0.85**
Gradko	50% TEA in acetone	2019	R	Sandwell MBC	12	30	30	0.5%	S	**1.00**
Gradko	50% TEA in acetone	2019		Overall Factor[3] (29 studies)				Use		0.89

Factor from Local Co-location Studies (Local Bias Adjustment Factor)

Norwich Lakenfields urban background AURN site **(based on 12 periods of data)**
Bias Factor A**: 0.93** (0.89 - 0.97)
Bias B: 8% (3% - 12%)
Diffusion Tubes Mean: 14µg/m³
Automatic Mean: 13µg/m³
Data Capture for periods used: 99%
Adjusted Tubes Mean: 13 (13-14) µg/m³

A copy of the precision and accuracy spreadsheet used to calculate the local bias correction is shown below:

Checking Precision and Accuracy of Triplicate Tubes

AEA Energy & Environment
From the AEA group

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	Automatic Method: Period Mean	Automatic Method: Data Capture (% DC)	Data Quality Check: Tubes Precision Check	Data Quality Check: Automatic Monitor Data
1	08/01/2019	05/02/2019	22.8	20.1		21	1.9	9	17.2	19.3	99.7	Good	Good
2	05/02/2019	05/03/2019	18.9	23.3	22.3	21	2.3	11	5.8	20.1	99.3	Good	Good
3	05/03/2019	09/04/2019	13.3	13.7	12.7	13	0.5	4	1.2	11	97	Good	Good
4	09/04/2019	08/05/2019	11.2	12.1	12.5	12	0.7	6	1.7	12.2	99.6	Good	Good
5	08/05/2019	05/06/2019	9.6	10.7	10.2	10	0.5	5	1.4	10	99.9	Good	Good
6	05/06/2019	02/07/2019	9.6	9.4	9.6	10	0.1	1	0.3	8	99.7	Good	Good
7	02/07/2019	08/08/2019	8.6	8.4	8.3	8	0.1	2	0.4	8	99.7	Good	Good
8	08/08/2019	05/09/2019	9.5	9.0	10.1	10	0.5	6	1.3	9	99.4	Good	Good
9	05/09/2019	02/10/2019	12.4	12.0	12.1	12	0.2	2	0.5	11	96.8	Good	Good
10	02/10/2019	05/11/2019		14.4	13.3	14	0.8	6	7.1	14	99.8	Good	Good
11	05/11/2019	03/12/2019	18.3	20.8	19.6	20	1.3	6	3.1	19.9	99.4	Good	Good
12	03/12/2019	08/01/2020	17.9	18.2	17.4	18	0.4	2	1.0	15.2	99.8	Good	Good
13													
											Overall survey -->	Good precision	Good Overall

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

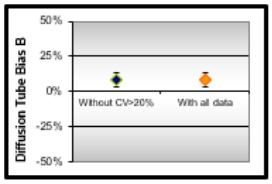
(Check average CV & DC from Accuracy calculations)

Site Name/ ID:	Norwich Lakenfields

Precision: 12 out of 12 periods have a CV smaller than 20%

Accuracy (with 95% confidence interval) without periods with CV larger than 20%	
Bias calculated using 12 periods of data	
Bias factor A	0.93 (0.89 - 0.97)
Bias B	8% (3% - 12%)
Diffusion Tubes Mean:	14 µgm^{-3}
Mean CV (Precision):	5
Automatic Mean:	13 µgm^{-3}
Data Capture for periods used:	99%
Adjusted Tubes Mean:	13 (13 - 14) µgm^{-3}

Accuracy (with 95% confidence interval) WITH ALL DATA	
Bias calculated using 12 periods of data	
Bias factor A	0.93 (0.89 - 0.97)
Bias B	8% (3% - 12%)
Diffusion Tubes Mean:	14 µgm^{-3}
Mean CV (Precision):	5
Automatic Mean:	13 µgm^{-3}
Data Capture for periods used:	99%
Adjusted Tubes Mean:	13 (13 - 14) µgm^{-3}



Jaume Targa, for AEA
Version 04 - February 2011

If you have any enquiries about this spreadsheet please contact the LAQM Helpdesk at: LAQMHelpdesk@uk.bureauveritas.com

Discussion of Choice of Factor to Use

In previous years the national bias adjustment factor has been applied - with the exception of 2019. At the time of writing the 2019 ASR, only 8 studies had been submitted to the national spreadsheet and some of these submissions showed a significant variation in bias. On account of the lack of sufficient number of studies to dilute the poorer data submissions, the March national spreadsheet was considered to be less reliable than the local one which had shown good data precision.

This year the report writing 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, however, 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 will always defer to the national database in preference to the locally derived one unless there is good reason to choose otherwise, as in 2019.

The nationally derived bias adjustment factor of 0.89 has therefore been applied.

Distance Correction

Table A2 lists diffusion tube locations and distance to relevant exposure. Where a "0" has been entered in the table, the tube/s is located on the façade of a building of relevant exposure.

Table B1 presents the annual mean NO_2 level at each DT location and the 5 locations which require a distance correction to be applied.

Distance correction has been calculated where NO_2 levels are over 40 µg/m³ or within 10% of it.

Whether distance correction is appropriate or not has been determined in accordance with Paragraphs 7.77-7.79 of LAQM.TG16.

Where DT NO_2 annual mean levels are over 40 µg/m³ or within 10% but are located on the façade of buildings of relevant exposure, the bias corrected annual mean has just been repeated in the distance correction column i.e. a distance correction of zero applied.

Distance correction has been calculated using the "NO_2 fall off with distance calculator" available on the LAQM website and found at;

https://laqm.defra.gov.uk/tools-monitoring-data/no2-falloff.html

Where appropriate either the single or multiple tube calculator has been used.

Annualisation

As all data, continuous and passive, met the 75% or over data capture, there has been no requirement to apply an annualisation factor as described in Boxes 7.9 and 7.10 of LAQM.TG16.

PM 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 $PM_{2.5}$.

QA/QC of Automatic Monitoring

In order to satisfy the requirements outlined in LAQM (TG16), the following QA/QC procedures were implemented:

- 2-weekly calibrations of the analysers at Castle Meadow roadside station and 4-weekly calibrations at Lakenfields urban background station;
- Annual audits;
- 6-monthly servicing of the monitoring sites; and
- 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 and consisted of a number of performance checks to identify any faults with the equipment. The calibration cylinders were also checked against another gas standard in order 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 was to ratify the data. 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) and Lakenfields by Bureau Veritas.

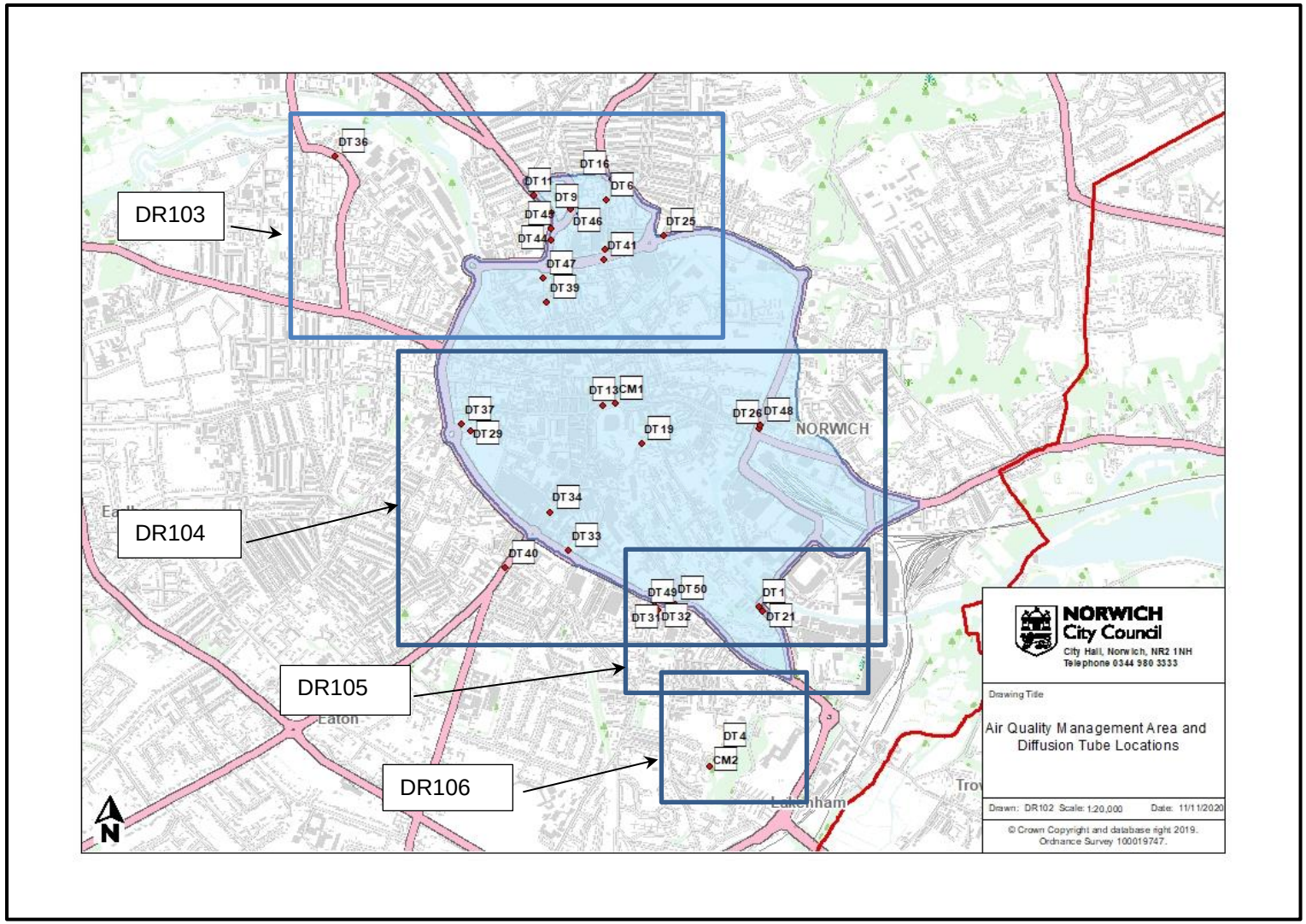
QA/QC of Diffusion Tube Monitoring

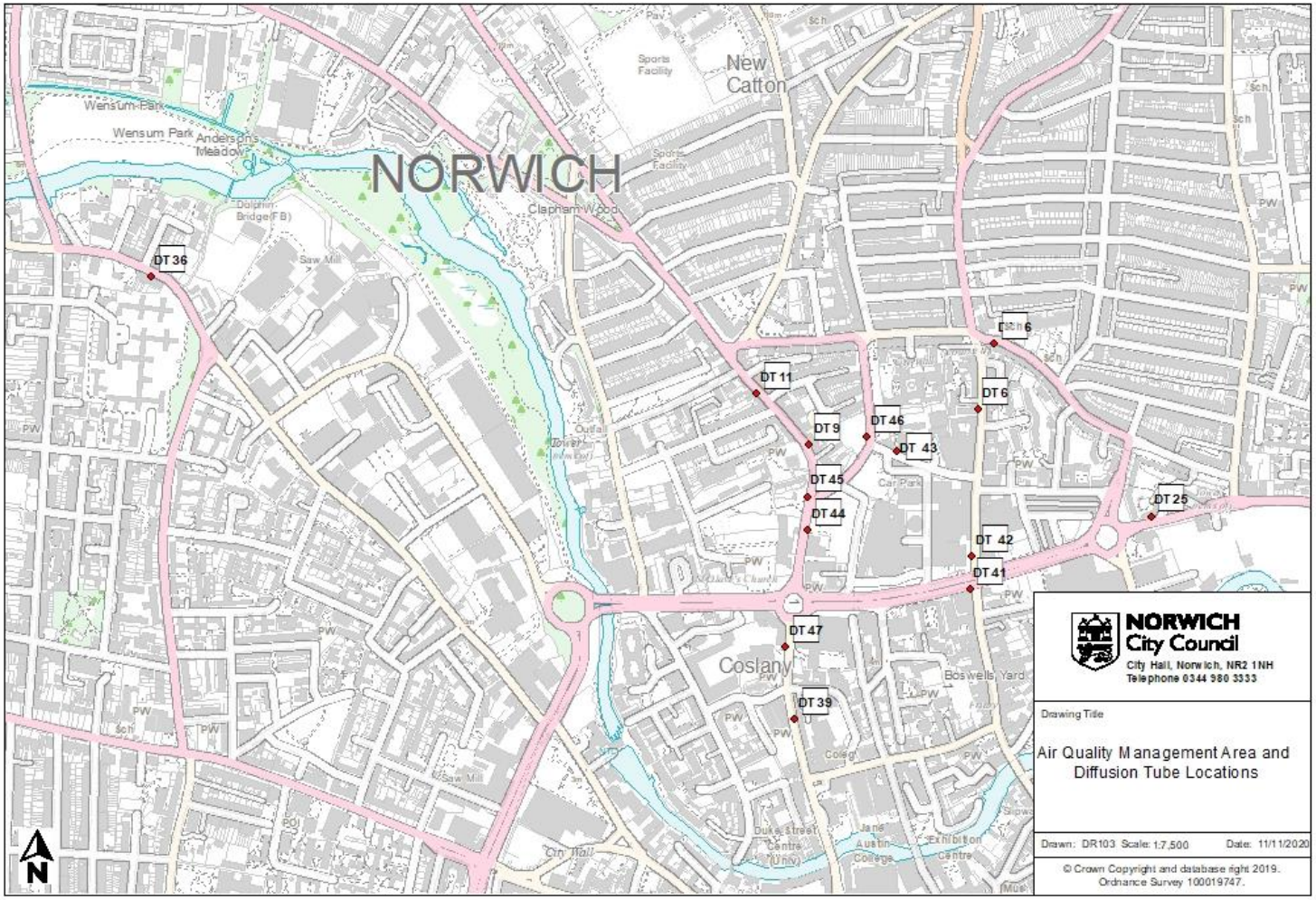
The diffusion tubes are supplied and analysed by Gradko International utilising a 50% Triethanolamine (TEA) in Acetone preparation method. Gradko participate in the AIR PT scheme for NO_2 diffusion tube analysis and also the Annual Field Inter-Comparison Exercise. The lab follows the procedures set out by the Defra Harmonisation Practical Guidance.

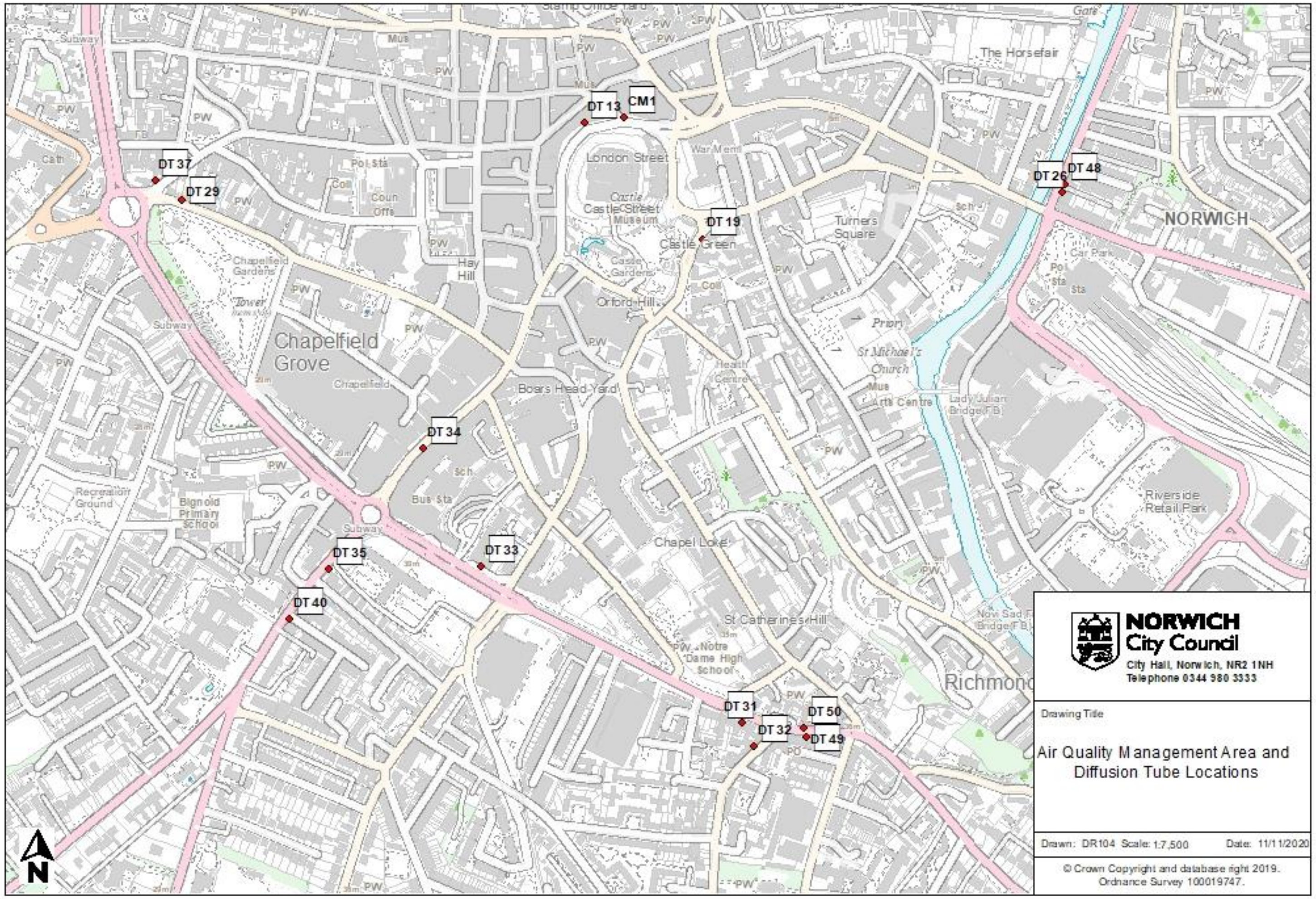
More information and results of the AIR PT testing is available on the following link:

http://laqm.defra.gov.uk/diffusion-tubes/qa-qc-framework.html

Appendix D: Map of Monitoring Locations and AQMA




NORWICH
New Catton
Wensum Park
Anderson's Meadow
Dolphin Bridge (FB)
Clapham Wood
Coslany
Sports Facility
Car Park
Boswells Yard
City Hall
Duke Street Centre (Univ)
Jane Austin College
Exhibition Centre
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
N
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 33
DT 35
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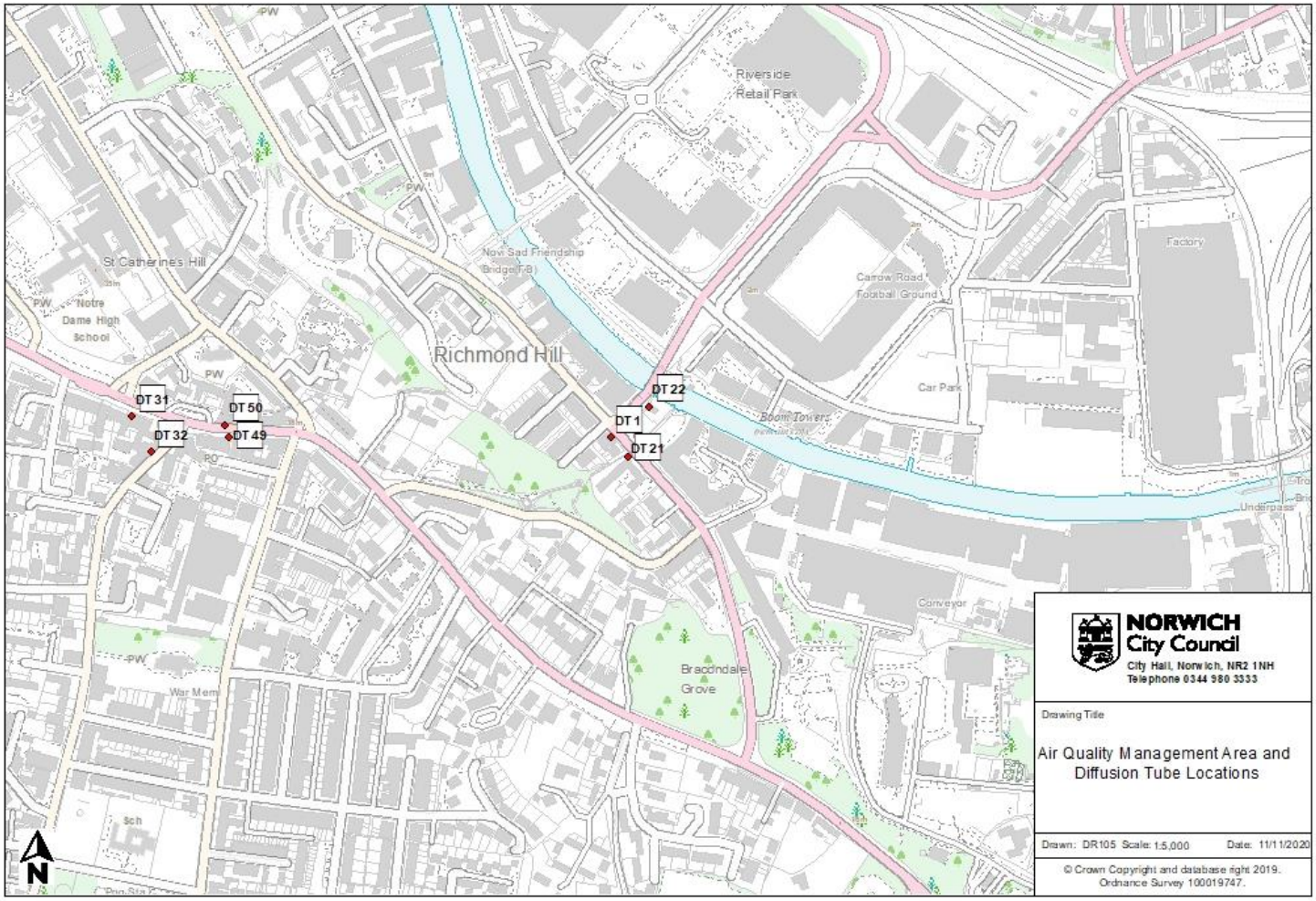
DT 31
DT 32
DT 50
DT 49
NORWICH City Council
City Hall, Norwich, NR2 1NH
Telephone 0344 980 3333
Drawing Title
Air Quality Management Area and Diffusion Tube Locations
Drawn: DR104 Scale: 1:7,500 Date: 11/11/2020
© Crown Copyright and database right 2019. Ordnance Survey 100019747.


Riverside Retail Park
St Catherines Hill
Notre Dame High School
Novi Sad Friendship Bridge (T-B)
Carrow Road Football Ground
Factory
Richmond Hill
Car Park
Boom Towers
Underpass
Conveyor
Bracondale Grove
War Mem
Sch
DT 31
DT 50
DT 32
DT 49
DT 22
DT 1
DT 21
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
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Please Note: Diffusion Tube Locations DT44-48 are not relevant to this report as they relate to 2020 DT locations.

Appendix E: Summary of Air Quality Objectives in England

Table E.1 – Air Quality Objectives in England

Pollutant	Air Quality Objective[7]	
	Concentration	Measured as
Nitrogen Dioxide (NO_2)	200 µg/m^3 not to be exceeded more than 18 times a year	1-hour mean
	40 µg/m^3	Annual mean
Particulate Matter (PM_{10})	50 µg/m^3, not to be exceeded more than 35 times a year	24-hour mean
	40 µg/m^3	Annual mean
Sulphur Dioxide (SO_2)	350 µg/m^3, not to be exceeded more than 24 times a year	1-hour mean
	125 µg/m^3, not to be exceeded more than 3 times a year	24-hour mean
	266 µg/m^3, not to be exceeded more than 35 times a year	15-minute mean

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

Glossary of Terms

Abbreviation	Description
AQAP	Air Quality Action Plan - A detailed description of measures, outcomes, achievement dates and implementation methods, showing how the local authority intends to achieve air quality limit values'
AQMA	Air Quality Management Area – An area where air pollutant concentrations exceed / are likely to exceed the relevant air quality objectives. AQMAs are declared for specific pollutants and objectives
ASR	Air quality 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
LAQM	Local Air Quality Management
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
PM_{10}	Airborne particulate matter with an aerodynamic diameter of 10µm (micrometres or microns) 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

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

DETR (2000) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, Department of the Environment, Transport and the Regions, Cm 4548, SE 2000/3, NIA 7

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