Bath's Clean Air Zone

Annual report 2021

Bath & North East Somerset Council

Improving People's Lives

Contents

Acronyms and Abbreviations

ANPR	Automatic Number Plate Recognition
AQMA	Air Quality Management Area
AQO	Air Quality Objective
ASR	Annual Status Report
ATC	Automatic Traffic Counter
AURN	Automatic Urban and Rural Network
BID	Business Improvement District
B&NES	Bath and North East Somerset Council
CAF	Clean Air Fund
CAP	Clean Air Plan
CAZ	Clean Air Zone
CSF	Critical Success Factor
CVRAS	Clean Vehicle Retrofit Accreditation Scheme
DEFRA	Department for the Environment, Food and Rural Affairs
DfT	Department for Transport
DVLA	Driver and Vehicle Licensing Authority
EU	European Union
FBC	Full Business Case
HGV	Heavy Goods Vehicle
JAQU	Joint Air Quality Unit
LAQM	Local Air Quality Management
LEP	Local Enterprise Partnership
LEV	Low Emissions Vehicle
LGV	Light Goods Vehicle
MTC	Manual Classified Counts
NO	Nitrogen Oxide
NO_2	Nitrogen Dioxide
NOx	Nitrogen Oxides
OS	Ordnance Survey
PCM	Pollution Climate Mapping
PCN	Penalty Charge Notice
PHGV	Private Heavy Goods Vehicle
PM	Particulate Matter
PM2.5	Particulate Matter with particles less than 2.5 micrometers diameter
PM10	Particulate Matter with particles less than 10 micrometers diameter
PRMS	Public Realm and Movement Strategy
TEA	Triethanolamine
TG	Technical Guidance
TMP	Traffic Management Plan
UK	United Kingdom
ULEV	Ultra-Low Emissions vehicle
UTC	Urban Traffic Control
UTMC	Urban Traffic Management and Control
VAT	Value Added Tax
WECA	West of England Combined Authority
WHO	World Health Organisation

Bath's Clean Air Zone 2021

↑ Before
↓ After

Where we were before launch

- **92%** of NOx caused by vehicle emissions
- **Hills & tall buildings** trap emissions
- **123** stations monitoring NO_2
- **11** sites exceed legal limits
- Government directs council to act in 'shortest possible time'

Health impacts

- Worsens heart and lung conditions
- **36,000** early deaths in the UK per year

What we did

- **8,000** responses to public consultation
- **Class C** Charging CAZ approved

Support for those affected

- **£9.4m** to upgrade vehicles
- **Exemption scheme** to support vulnerable groups
- **£1.7m** Bus retrofit scheme

Launch of the zone

- **15 March** 2021 Zone launched
- **128** New signs
- **68** ANPR cameras

£0 Cars and motorbikes

£9 Higher emission taxi, minibus, van

£100 Higher emission HGV, Coach, Bus

Cleaner air AHEAD

Week 1 of Bath's CAZ

- **40,000** unique vehicles Driving in the zone each day
- **71%** private no charge
- **6%** polluting charged

On the right path..

- **720+** Polluting vehicles Replaced with clean, compliant ones
- Chargeable vehicles in zone falls
- **85** Scheduled buses upgraded

Improvement in compliance

86% to 96%

73% to 99%

63% to 80%

67% to 94%

Cleaner air AHEAD

Air quality improvements

- **2021** post covid* Traffic returns to near normal levels
- **21%** Air quality improves (inside and outside zone) **
- **8** more sites now record NO_2 under legal limit
- **3** sites remain a concern but show improvements
- We continue to monitor air quality and traffic
- **£** surplus CAZ revenue will be invested in sustainable transport

Cleaner air AHEAD

Help us on our journey

- Most vehicles in Bath are cars
- **60%** of car trips start and end in Bath
- To help, please walk or wheel short trips
- **2+** Consider using car-share or electric vehicles
- Consolidate your deliveries

Bath & North East Somerset Council

Improving People's Lives

*Annual average compared with 2019 (pre-Covid)
** compared with baseline year, 2019

Executive summary

In 2017, the Government directed Bath & North East Somerset (B&NES) Council to reduce nitrogen dioxide (NO_2) pollution in Bath to within the annual average limit of 40 micrograms per cubic metre ($\mu g/m^3$) in the shortest possible time, and by the end of 2021 at the latest.

This type of pollution is chiefly caused by road traffic, and extensive technical work showed that a charging clean air zone would be the only way to achieve success in the time frame. Clean air zones work by deterring certain higher emission vehicles from entering areas of high pollution by levying a daily charge on the driver, encouraging a more rapid replacement of polluting vehicles for cleaner, compliant ones than would otherwise naturally occur.

On 15 March 2021, the Council introduced a charging Class C Clean Air Zone (CAZ) in Bath's city centre to drive down NO_2 pollution at several locations which regularly exceed these NO_2 limits, in particular risking children's health and the health of our most vulnerable residents. In a Class C CAZ, private cars and motorbikes are not charged, regardless of emissions.

In Bath, significant financial support has been made available to individuals and businesses to replace non-compliant, chargeable vehicles regularly driving in the zone, and around 700 polluting vehicles have already been replaced using government funds. More information on how the CAZ works can be found in 'How to use this report'.

Aims and limitations of this report

This report provides an update and indicative view of how the CAZ has performed during the first year of operation during 2021. It looks at impacts on air quality, traffic flow and vehicle compliance and multiple other measures.

Due to Covid-19 having an unprecedented impact on travel behaviour in 2020, baseline data from the last representative year (2017-2019) has been used to measure the impact and effectiveness of the zone.

You can find out more about how we measure and present the data in the section 'How to use this report'; and there is a more detailed explanation of how we monitor at the end of the report in the 'Monitoring explained' section.

Key findings

A Clean Air Zone (CAZ) is needed in Bath to reduce air pollution to improve the health of people in the city. Everyone is affected by poor air quality and some people with respiratory problems are at particular risk if air pollution increases.

The CAZ was implemented in March 2021 and higher-emission vehicles are now charged to enter the zone. A Financial Assistance Scheme (FAS) and bus retrofit scheme were set up to upgrade or retrofit higher-emission vehicles. The Council **supported hundreds of people, businesses, and bus operators by upgrading or retrofitting over 700 vehicles** by the end of 2021. There is also an ongoing behaviour change campaign aimed at helping people travel more actively and sustainably in Bath and the wider district.

The Covid pandemic has greatly affected working habits and travel patterns since the winter of 2019/2020. The effects of the pandemic are far-reaching and a major change to traffic composition has been an increase in delivery vehicles – mostly vans and heavy goods vehicles – as people limit their travel. This change in traffic composition has been impacting local neighbourhoods in Bath.

During much of 2021, the Cleveland Bridge was also closed to traffic as structural repairs were carried out. The bridge normally carries around 17,000 vehicles per day and so the diversion of lighter vehicles through the centre of Bath will have had a significant impact on local air quality during 2021.

Despite the impacts of Covid and Cleveland Bridge, nitrogen dioxide (NO_2) concentrations in the zone **reduced by 21%** compared with the baseline year, 2019. This is despite traffic flows in Bath largely returning to those seen pre-pandemic.

Three sites in Bath did not meet the annual limit value of 40 $\mu g/m^3$ but all recorded decreasing trends.

- Walcot Parade 2
- Wells Road and
- Dorchester Street.

We have been monitoring air quality and traffic flows outside of the CAZ to determine if the zone has simply displaced traffic and associated emissions, and findings show that NO_2 concentrations in urban area outside of the CAZ but within Bath, Bathampton and Batheaston **reduced by 22%** compared with 2019.

In general, traffic outside of the zone does not appear to have increased, however there are some locations where there may be more commercial traffic. We have ongoing surveys to understand whether the CAZ is the cause of any displacement, but we know that during 2021, the Cleveland Bridge closure diversions have significantly impacted traffic flows. Private cars are not charged in the CAZ and have no reason to avoid the zone.

We have focused our work on sites within the zone that still have higher concentrations of NO_2 and areas where traffic is found to have been displaced.

We thank the public for supporting the Council to implement the zone which is helping to improve air quality and the health of people in Bath.

Summary of annual air quality results from within the CAZ (CAZ_Only):

2019 is used as our baseline, comparative year because it is the most recent year with pre-CAZ data not impacted by the Covid pandemic.

- Average 2021 annual nitrogen dioxide (NO_2) concentrations within the CAZ are **21 per cent lower than in 2019**, representing a reduction of 7.0 µg/m^3. This is the average reading from a total of 65 monitoring sites that recorded data in both 2019 and 2021, with at least 25% data capture at all sites.
- **Three sites** recorded an annual average NO_2 concentration **greater than 40 µg/m³**. These sites were: Walcot Parade 2 (43.1 µg/m^3), Wells Road (42.6 µg/m^3), and Dorchester Street* (40.5 µg/m^3). **All these sites have an overall decreasing trend.***
- The number of sites exceeding 40 µg/m^3 decreased from 15% in 2019 to only 5% in 2021, **reducing by seven sites**.
- **None of the 65 sites** were found to have increased in NO_2 concentration since 2019.
- **Five sites** recorded annual average NO_2 concentrations **greater than 36 µg/m³ but at or below 40 µg/m³**. These sites were: Victoria Buildings* (40.0 µg/m^3), Anglo Terrace Façade (38.1 µg/m^3), Walcot Parade* (37.8 µg/m^3), Chapel Row 2* (36.2 µg/m^3), Gay Street 2* (36.1 µg/m^3). **All these sites have an overall decreasing trend**.

* Please see *Critical Success Factors* of the CAZ for information on how we consider the monitoring assessment criteria for each site and how these feed into the overall success of the scheme.

Summary of annual air quality results from within the wider Bath urban area (CAZ_Boundary):

- Average 2021 annual nitrogen dioxide (NO_2) concentrations within the wider Bath urban area (CAZ_Boundary) are **22 per cent lower than in 2019**, representing a reduction of 5.5 µg/m^3. This is the average reading from a total of 56 monitoring sites that recorded data in both 2019 and 2021, with at least 25% data capture at all sites. This demonstrates that air quality is consistently improving across the district.
- In 2021, **zero sites** within the wider Bath urban area (CAZ_Boundary) recorded **greater than 40 µg/m³**. This is a **reduction of one site** compared to 2019 and represents a decrease in the number of sites exceeding 40 µg/m^3 from 2% in 2019 to 0% in 2021.
- **None of the 56 sites** were found to have increased in NO_2 concentration compared with 2019.

Summary of annual air quality results from within the wider district (Wider_B&NES):

- Average 2021 annual nitrogen dioxide (NO_2) concentrations within the wider region of B&NES (Wider_B&NES) are **18 per cent lower than in 2019**, representing a reduction of 5.3 µg/m^3. This is the average reading from a total of 29 monitoring sites that recorded data in both 2019 and 2021, with at least 25% data capture at all sites. This demonstrates that air quality is consistently improving across the district.

Summary of annual traffic flow figures:

We used 2017 or 2018 as baseline comparative years for traffic flow because they are the most recent years with pre-CAZ data, not impacted by the Covid pandemic and with good-quality data.

- Nationally, average traffic volumes returned to around pre-pandemic levels and the numbers of **LGVs and HGVs now exceed pre-pandemic levels** (Department for Transport).
- Average 2021 **traffic flows in Bath were generally below pre-pandemic levels**.
- In January 2021, traffic flows across all site groupings within the CAZ, wider Bath urban area and wider district, were **more than 35% below the baseline**.
- By the end of the year in December 2021, traffic flows were closer to pre-pandemic levels between **2% and 9% below the baseline**.
- Despite general traffic flows returning to near pre-pandemic levels, air quality is improving.
- Aside from the ongoing changes to travel habits due to Covid, traffic flows within Bath and the CAZ **were not representative** during July-December 2021 due to the full or partial closure of Cleveland Bridge which diverted lighter traffic through the city centre and heavier traffic away from the city centre along the A4 or A36.
- At some sites, where we have traffic monitoring close to air quality monitors it is clear **increased traffic flows caused increased NO_2 concentrations**, for example at Chapel Row. Increased traffic flow at these sites during the second half of 2021 was due to traffic diverting to avoid Cleveland Bridge.
- We are gathering extensive evidence to assess any potential traffic displacement due to the CAZ. Private cars, which represent most vehicles driving in the zone, are not charged. Increases in commercial vehicles seen in local communities may be due to a higher demand in home deliveries.

Summary of annual vehicle compliance and financial assistance scheme (FAS) figures:

- The Council's financial assistance scheme (FAS) offered local businesses and individuals grants and interest-free loans to replace or upgrade non-compliant vehicles regularly driving in the zone.
- Compliance rates **across all vehicle groups improved** between March and December 2021.
- **40,000 unique vehicles**, on average, were recorded in the zone each day, between the launch and end of 2021.
- Most vehicles recorded in the CAZ are private cars, with an average of **28,500 unique cars** recorded in the zone each day during 2021. This equates to **71% of all vehicles**. Private cars are not charged.
- An average of 1,146 non-compliant vehicles were seen in the zone each day, during the first four weeks of operation in March/April 2021 compared to 550 during the last four weeks of 2021, **a decrease of 52%**.
- Owners of over 1,500 vehicles applied for financial support to upgrade or retrofit their vehicle.
- In total, the Council's FAS supported the **upgrade of 722 vehicles** from higher emission to **cleaner, compliant ones** in 2021.
- The percentage of chargeable non-compliant vehicles (as a percentage of all traffic) entering the zone each week **reduced from 6% in the launch week** to an average of **1% by the end of 2021**.
- Van/LGV compliance rose from 63% during the launch week to **80% by the end of 2021**. 3,143 individual vans/LGVs (compliant and non-compliant) were recorded in the CAZ each day (on average) during 2021.
- The Council's FAS supported the **replacement of 594 vans/LGVs** from higher emission to cleaner, compliant ones during 2021.
- Taxi/PHV compliance rose from 67% during the launch week to around **93% by the end of 2021**. An average of 385 individual taxis/PHVs were recorded in the CAZ each day during 2021.
- The Council's FAS supported the **replacement or upgrade of 91 taxis/PHVs** from higher emission to cleaner, compliant ones during 2021.
- Bus/coach compliance rose from 73% during the launch week to around **99% by the end of 2021**. An average of 109 individual buses/coaches were recorded in the CAZ each day during 2021. Bus/coach numbers may be lower than normal due to the ongoing effects of Covid and perceptions around the use of public transport.
- The Council's FAS supported the **upgrade of 22 non-scheduled buses/coaches** from higher emission vehicles to cleaner, compliant ones during 2021. Scheduled buses are also considered below.
- HGV compliance for vehicles weighing greater than 3.5T but less than 12T rose from 86% during the launch week to around **96% by the end of 2021**. An average of 119 vehicles were recorded in the CAZ each day during 2021.
- HGV compliance for vehicles weighing greater than 12T rose from 93% during the launch week to around **96% by the end of 2021**. An average of 288 vehicles were recorded in the CAZ each day during 2021.

- The Council's FAS supported the **upgrade of 14 HGVs** from higher emission to cleaner, compliant ones during 2021.
- Minibus compliance varied considerably due to the relatively low number of minibuses recorded in the CAZ each day during 2021. The daily average minibus compliance was around 73%.
- The Council's FAS supported the **upgrade of 2 minibuses** from higher emission to cleaner, compliant ones during 2021.
- Out of a total fleet of 226 scheduled buses, 88 were non-compliant when the bus retrofit programme started. By the end of December 2021, **85 had been successfully retrofitted to meet CAZ emission standards** with financial support from the government. Three vehicles are awaiting the development of a retrofit solution which is now being progressed.

*Covid-19 pandemic conditions continue to effect traffic flows and travel behaviours. Further analysis and time will be required to assess the longer-term impact of the pandemic on air quality.

How to use this report

This report provides information on the CAZ's performance during 2021. The main areas we discuss are:

- air quality data
- traffic flow data
- and fleet compliance data

We also discuss:

- retail/ business/office space vacancy figures
- retail footfall surveys
- Park and Ride passenger data
- walking and cycling counts
- bus usage data
- stakeholder Feedback from Council User Group Forums
- taxi fares and unmet demand surveys
- Early Measures Fund, zero emission parking permits
- bus retrofit uptake/ compliance
- financial support scheme uptake
- travel advisor session uptake
- anti-idling enforcement
- weight restriction enforcement
- e-cargo scheme

Timescales and baseline data

To determine the effectiveness of the CAZ, we compare data collected since the launch of the CAZ with baseline data from similar periods before its launch, so that we can consider seasonal effects on air quality and traffic flow. For quarterly data, we compare like-for-like data from previous years, breaking the year into the following quarters:

- Quarter 1 (Q1) – January, February, March
- Quarter 2 (Q2) – April, May, June
- Quarter 3 (Q3) – July, August, September
- Quarter 4 (Q4) – October, November, December

The primary focus of this report is the year 2021. Given the unprecedented conditions brought about by the Covid-19 pandemic in 2020 (including significant changes in transport and travel behaviour), we have discounted 2020 figures for comparative purposes, unless otherwise stated in the report.

When reading the report please note the following:

- Annual air quality data is bias-adjusted and annualised, where appropriate, unless otherwise stated. In some cases, a further adjustment is important where we distance-adjust the result to the façade. This may be used when we are considering the compliance of a diffusion tube site within Local Air Quality Management (LAQM) guidance.
- All quarterly air quality data is raw, meaning it is not adjusted in any way (bias or annualisation), unless otherwise stated.
- We use baseline data from 2019 to compare air quality monitoring results (because the Covid-19 pandemic affected 2020 data very heavily).
- Air pollution is affected by the seasons so quarterly data is compared to the same quarter from the baseline year.
- We use data from 2017/18 to compare traffic flows because the Council has insufficient data for some periods including 2019.
- Traffic flows also vary according to the seasons.
- We look at data from the entirety of 2021, despite the zone only launching on 15 March 2021.
- We also look at longer-term trends from 2017 to end of 2021.
- There are many graphs in this report, and each has its own scale.

Where we gather data from/what locations

We have identified three site groupings for comparison of data and to establish the impact of the zone on traffic flows and air quality both inside and outside of the CAZ:

- The clean air zone (sites within the CAZ boundary which we call 'CAZ_Only').
- The boundary area (sites outside the CAZ boundary but within the urban area of Bath including Batheaston and Bathampton, which we call 'CAZ_Boundary').
- The wider area (sites outside of the Bath, Batheaston and Bathampton urban areas, but within the rural areas and district-wide urban areas in Bath & North East Somerset, which we call 'Wider_B&NES').

Climate summary 2021

Air pollution is affected by meteorological conditions. This is a brief roundup of the monthly climate for the year, as described by the Met Office.

- Around the UK, 2021 had temperature and sunshine levels, with rainfall levels slightly below average.
- The mean UK temperature was 1.0°C above the 1961-1990 baseline.
- The first part of 2021 was generally colder and wetter than average, with the second half of the year warmer than average. April and June were drier than normal while September was particularly warm.

As most (approximately 80%) of NO_2 from vehicle emissions occurs as a result of chemical reactions after being emitted as nitric oxide (NO), meteorological conditions are a significant factor in the resulting measured concentrations. NO_2 is usually higher in winter due to the cooler temperatures of catalysts, significantly compromising the reduction of NOx from emissions. Heatwaves also increase levels of NO_2. Long periods of unusual weather can result in annual measured concentrations becoming an outlier in a long-term trend.

Air quality data in this report is provisional and has not been adjusted to take account of weather conditions – a process known as de-weathering. This process is used to remove the impact of weather variations from trends so that we can see the impact of other measures such as the implementation of the CAZ or a lockdown.

Find more climatic information at:
https://www.metoffice.gov.uk/research/climate/maps-and-data/summaries/index

Cleveland Bridge closure

Cleveland Bridge was closed to all traffic on 28 June 2021 for emergency repairs. The bridge usually carries around 17,000 vehicles per day, and so the closure affected traffic flows throughout Bath. The bridge remained closed to traffic until November, when it partially reopened with a restricted width and single-way, signal-control. Large vans, small lorries (under 7.5t) and coaches are continuing to use the diversions.

As a result of the closure, traffic flows in and around Bath were impacted during the second half of 2021. The resultant diversions lead to traffic displacement into areas surrounding the CAZ. We used Automatic Number Plate Recognition (ANPR) cameras to identify vehicle compliance in areas where we were unsure whether vehicles were trying to avoid the CAZ or the bridge. It was difficult to identify whether vehicles were displaced because of the bridge closure, CAZ, or both. We delayed some traffic displacement monitoring until after the partial reopening of the bridge in November 2021 to help us understand where traffic was flowing as a result of the CAZ.

Find more information about the bridge renovation at:
https://beta.bathnes.gov.uk/cleveland-bridge-renovation-project/scheme-overview

Covid-19 and air quality

- Multiple lockdowns in response to the Covid-19 pandemic had a significant effect on transport and travel behaviour, locally and nationally, which is why we've discounted 2020 data (unless otherwise stated).
- National traffic volumes returned to pre-pandemic levels by mid-2021 and in the case of LGVs and HGVs, levels exceed those seen pre-pandemic due to the increase in e-commerce and home deliveries.
- Covid is still influencing how people behave. There are lower rates of public transport use and higher rates of home-working and commuting by car.
- Online shopping and home-deliveries are increasing, which is leading to more commercial vehicles on the roads. For example, in mid-September 2021, light goods vehicles increased to 112% of their pre-pandemic levels whilst heavy goods vehicles increased to 110% and cars reduced to 97%, respectively (Department for Transport statistics)[1].

[1] Department of Transport statistics from the Office for National Statistics. Economic activity and social change in the UK, real-time indicators, 2021
https://www.ons.gov.uk/economy/economicoutputandproductivity/output/bulletins/economicactivityandsocialchangeintheukrealtimeindicators/23september2021

World Health Organisation air quality targets update

The targets set for air pollution limits are initially set by the World Health Organisation's (WHO) Air Quality Guidelines and then the UK government considers the potential for adopting these targets. These guidelines are intended to inform the setting of air quality standards but are not ready-made targets for adoption. The WHO itself does not expect any country to simply adopt its guidelines without first undertaking the steps we plan to take before setting targets, including a fully costed analysis and developing a pathway to achieving the targets.

It is vital that the targets set are stretching but achievable, as well as appropriate to our national circumstances. That is why the government is working with internationally recognised experts to deliver the evidence to inform target setting. On 15 July 2021 the government published the advice received to date from the Air Quality Expert Group and the Committee on the Medical Effects of Air Pollutants. You can find the advice here: https://uk-air.defra.gov.uk/library/air-quality-targets

The WHO air quality targets were updated in 2021 to reduce the limits for some measures, including NO_2 and $PM_{2.5}$. The government is running a public consultation on the proposed $PM_{2.5}$ targets in 2022.

Further information

- You'll find more information on how we've measured and compared data in each individual section.
- As part of our obligations under the Local Air Quality Management (LAQM) legislation (part IV of Environment Act 1995) we issue an Annual Status Report (ASR) in June of each year. This sets out and comments on air quality data from the previous 12 months across the wider area. These can be found at: https://www.bathnes.gov.uk/services/environment/pollution/air-quality/reports
- You can also view an interactive map of historical NO_2 data collected from monitoring locations around the area, here: https://www.bathnes.gov.uk/services/environment/pollution-noise-nuisance/air-quality/air-quality-data-long-term
- At the end of this report is a section called 'Monitoring Explained' which has been included to help you understand some of processes used to gather the data for this report.

1. Background information

This section provides information on why we need a CAZ in Bath, the type of air pollution that we're trying to tackle, and how we decided on a Class C charging CAZ. Further information can be found in the Full Business Case at: www.bathnes.gov.uk/BathCAZ.

1.1 Air pollution

Air pollution is the leading environmental health risk to the UK public, with an estimated 28,000 to 36,000 deaths annually attributed to it in the UK alone[2].

Long-term exposure to air pollution is linked to premature death associated with lung, heart and circulatory conditions, while short-term exposure exacerbates asthma and increases hospital admissions.

There is evidence to suggest that despite strengthening environmental policies, the poorest in our society are being unfairly exposed to worse air pollution without seeing improvements[3]. Clean air is important for everyone and will alleviate stress on our health system, improve people's lives and make our society more equitable.

Types and causes of air pollution

There are different causes and sources of air pollution. Historically, combustion of fossil fuels for energy, such as coal, produced smoke and sulphur dioxide (SO_2).

A major source of poor air quality in the UK contributing to nitrogen dioxide (NO_2) pollution and particulate matter (PM) pollution, is road traffic.

Particulate matter pollution, referred to as PM_{10} or $PM_{2.5}$, is made up of tiny bits of material from all sorts of places including smoke from fires, exhaust fumes, smoking or the dust from brake pads on vehicles. These particles are too small to see, and we can breathe them in without noticing.

Nitrogen dioxide (NO_2) comes from burning fuels or other materials, so levels are especially high around roads. But they are also produced from home gas boilers, bonfires, and other sources as well. You cannot see or smell nitrogen oxides, but they mix with the air we breathe and are absorbed into our bodies. Vehicle exhaust emissions contribute 35 per cent of all UK nitrogen oxide emissions (NOx) which is the single greatest source[4].

[2] Public Health England. Review of interventions to improve outdoor air quality and public health, 2019 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/938623/Review_of_interventions_to_improve_air_quality_March-2019-2018572.pdf

[3] Air Quality Management Resource Centre, UWE. Emissions vs exposure: Increasing injustice from road traffic-related air pollution in the United Kingdom, 2019
https://www.sciencedirect.com/science/article/pii/S1361920919300392

[4] DEFRA. Air quality: explaining air pollution – at a glance, 2019.
https://www.gov.uk/government/publications/air-quality-explaining-air-pollution/air-quality-explaining-air-pollution-at-a-glance

How does air pollution affect our health?

Air pollution particles and gases enter our bodies and can damage our cells in different ways. They usually get into our lungs first and can then move into our blood to reach organs such as our heart and brain.

Any amount of pollution can be damaging to our health, but the more that you are exposed to, the bigger the risk and the larger the effect on you and your family. Some people are more vulnerable to the impacts of air pollution than others. Those more at risk from air pollution include children, pregnant, older people, and those with lung and heart conditions (such as asthma, chronic obstructive pulmonary disease (COPD), lung cancer, coronary artery disease, heart failure and high blood pressure).

Air pollution in Bath

Historically, annual average nitrogen dioxide (NO_2) concentrations have regularly exceeded the legal limit of 40 $\mu g/m^3$ at several locations in Bath, and this is chiefly caused by vehicle emissions.

The problem is exacerbated by Bath's topography. The city sits in the bottom of a valley surrounded by hills, and its central roads are flanked by tall buildings. This means that in certain conditions vehicle emissions can get trapped in the atmosphere causing high levels of NO_2 in some locations.

Particulate matter in Bath was not found to exceed legal limits for either PM_{10} (particulate matter less than 10 micrometers in diameter) or $PM_{2.5}$ (particulate matter less than 2.5 micrometers in diameter), except at times when there were meteorological or other events that caused spikes in these pollutants, nationally. Bath is within the permitted number of PM2.5 24-hour exceedances in a year. There has been a downward trend in levels of PM in Bath since 2017.

Health impacts in Bath of NO_2 pollution

- NO_2 contributes to as many as 36,000 early deaths in the UK each year
- It irritates and inflames the lining of airways – which can worsen asthma and make breathing difficult among those with lung disease (such as bronchitis and emphysema). In Bath, around 12,000 people suffer from asthma
- Research shows that high levels of NO_2 can affect children's lung development and that children who grow up in highly polluted areas are more likely to develop asthma.

How we monitor air quality

B&NES has been monitoring air pollution for many years, reviewing the monitoring sites regularly, more recently to ensure coverage of key CAZ locations and potential diversion routes around the zone. Three pollutants are measured around the district: NO_2, PM_{10} and $PM_{2.5}$.

There are currently over 150 locations where NO_2 is measured, including 50 key sites with higher levels of pollution where three diffusion tubes are located at each location to improve data confidence.

To read more about how air quality is measured and analysed in relation to the effectiveness of Bath's CAZ, see the Impacts of the CAZ on Air Quality section.

To find out more information about air quality across B&NES go to:
https://www.bathnes.gov.uk/services/environment/pollution/air-quality

1.2 Why we need a charging CAZ

Following a successful ruling in 2017 by the Supreme Court, in a case brought against the government by Client Earth, the government directed Bath and North East Somerset (B&NES) Council to reduce the annual mean NO_2 concentration in Bath to within the legal limit value of 40 $\mu g/m^3$ in 'the shortest possible time' and 'by the end of 2021 at the latest'.

At the time of writing this report, the Joint Air Quality Unit (JAQU) is considering its formal assessment of whether the Council is on track to achieving success with the Ministerial Direction.

We immediately undertook significant technical work to understand what measures would be required to comply with air quality limits, establishing that a charging clean air zone would be the only measure capable of delivering the behaviour change necessary to improve air quality, to within legal limits, by the end of 2021.

A CAZ works by deterring higher emission vehicles from driving in the most polluted areas of the city by levying a charge, encouraging a more rapid replacement of polluting vehicles for cleaner, compliant ones than would otherwise occur.

Other cities around the UK have implemented CAZs including Birmingham (Class D) and Portsmouth (Class B). More cities are implementing CAZs, with some likely going live in 2022, including Bradford and Bristol. More cities will follow in the following years.

The government has provided all the funds required for us to prepare and implement the CAZ, work is overseen by the government's Joint Air Quality Unit (JAQU) and subject matter experts are also independently verifying the work being done.

The CAZ is one of many measures being introduced across the area to improve our health and the natural environment. In March 2019 the Council declared a Climate Emergency, resolving to provide the leadership to achieve carbon neutrality in Bath and North East Somerset by 2030[5]. In July 2020, the Council declared an Ecological Emergency, resolving to work with local and national partners to resist the destruction of natural habitats through planning policy and development management.

[5] Bath and North East Somerset Council. Climate Emergency, 2021
https://www.bathnes.gov.uk/climate-emergency

1.3 How we decided on a class C charging CAZ

The options for Bath to achieve success were a Class D charging clean air zone, charging all higher emission vehicles including cars and motorbikes or a Class C charging clean air zone, charging all higher emission vehicles except private cars and motorbikes but including additional traffic management.

We engaged extensively with the public throughout 2018/19 before reaching a decision on a Class C charging clean air zone. The overwhelming opinion was that while we needed to tackle pollution, a class C charging CAZ would strike a better balance by tackling pollution while also protecting central businesses and vulnerable residents that might be disproportionally affected by charging higher emission cars.

Technical modelling suggested that we could achieve success with a Class C CAZ provided we also introduced traffic measures at Queen Square to address a particular NO_2 hotspot on Gay Street.

In addition, it was agreed that significant financial support would be given to local individuals and businesses to help them replace polluting vehicles regularly entering the zone with cleaner, compliant ones. This mitigation would reduce the impact of charges on affected businesses, while further reducing emissions.

The full business case for the CAZ was approved by central government in January 2020 and can be read here:
https://beta.bathnes.gov.uk/policy-and-documents-library/baths-clean-air-zone

1.4 How Bath's CAZ works

Bath CAZ is a Class C charging clean air zone, which means that daily charges apply to the following higher emission vehicles driving in the zone that do not comply with Euro 6/VI (diesel), or Euro 4/IV (petrol) emissions standards:

- Taxis, private hire vehicles (PHVs), vans (including pick-ups and N1 campervans), minibuses, and light goods vehicles (LGVs) - £9 per day
- Buses, coaches, heavy goods vehicles (HGVs) and private heavy goods vehicles (PHGVs) - £100 per day
- A discounted charge of £9 per day is available for private (PHGVs), such as larger motorhomes and horse transporters, once registered with the Council.

Cars and motorbikes (except for taxis and PHVs) are not charged in a Class C CAZ, regardless of their emissions standard. This includes campervans classed as M1 on their V5C.

Importantly, the Council is not keen to penalise or make money from the zone. Its priority is to inform people about the charge, deter polluting vehicles from entering the zone, and encourage those with chargeable, non-compliant vehicles regularly entering the zone to upgrade their vehicles with financial support, if required.

Revenue from charges and fines is used to pay for the running of the scheme. Any money made over and above this must be reinvested in sustainable transport projects.

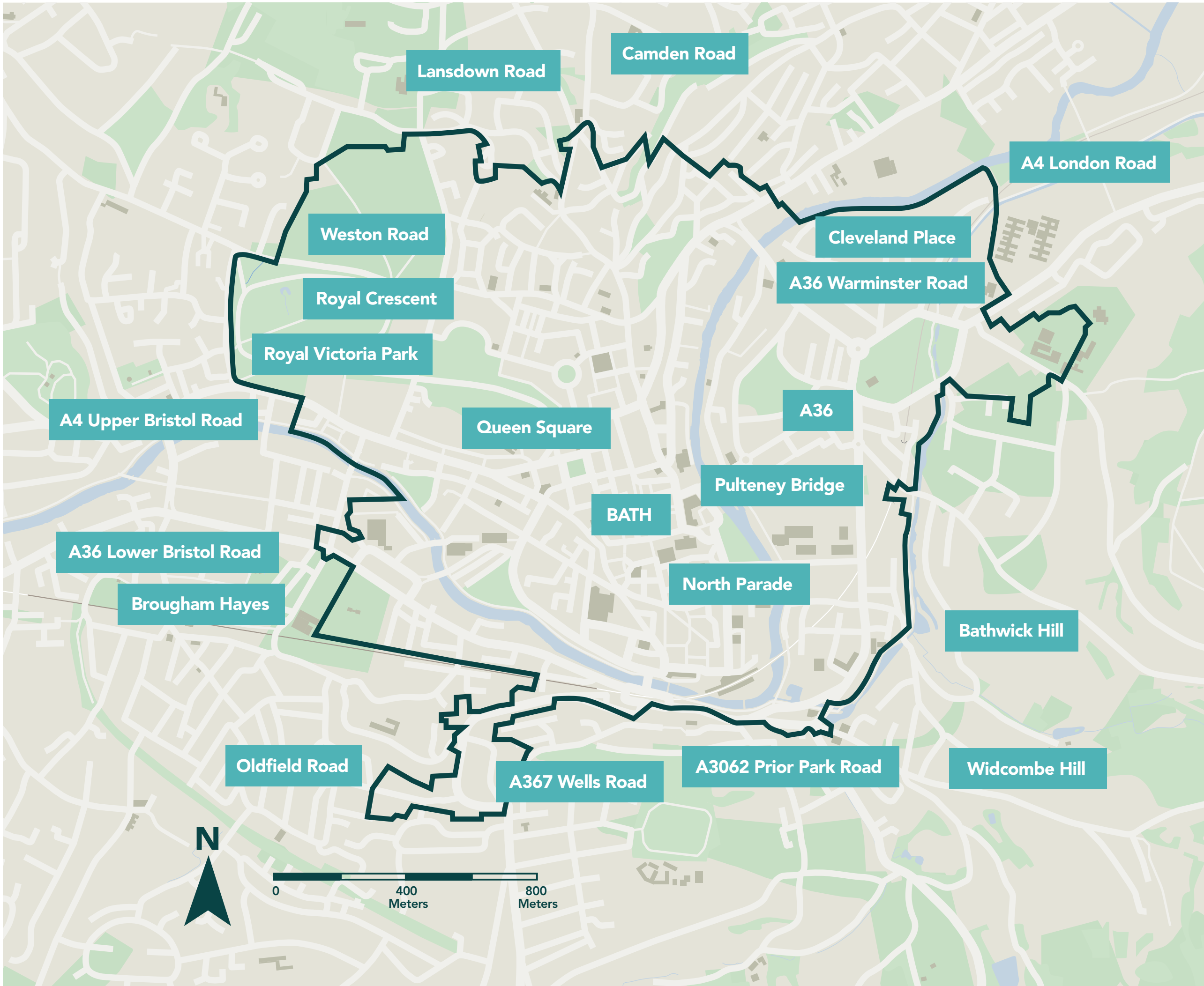
Zone boundary

The zone covers the very centre of the city (see Figure 1), but its boundary is designed to ensure that annual average NO_2 concentrations both inside and outside the zone are within the legal limit by the end of 2021, as per the government's directive.

The Clean Air Zone is as small as possible to minimise the social, economic and distributional impact of the scheme. However, it's also designed to capture as many non-compliant vehicle movements as possible across the city to ensure air quality improves both inside and outside the zone.

See the 'Impact of the CAZ on Air Quality' section for a map showing where NO_2 monitoring sites are currently located across the city.

Figure 1- A map of the CAZ boundary.



Exemptions

National exemptions apply permanently for ultra-low emission vehicles, hybrid and alternatively fuelled vehicles, disabled passenger tax class vehicles, disabled tax class vehicles, military vehicles, historic vehicles, and vehicles with retrofit technology accredited by the Clean Vehicle Retrofit Accreditation Scheme (CVRAS).

Local exemptions apply temporarily for two or four years (and for shorter periods) for certain vulnerable groups, hard-to-replace vehicles, and to encourage applications to the financial assistance scheme to upgrade or replace non-compliant vehicles. The range was developed in response to feedback from our public consultations and to mitigate the impact of charges on certain groups.

For more information on local exemptions see www.bathnes.gov.uk/CAZexemptions

Schemes to support and encourage vehicle compliance

Alongside zone charges that deter the use of non-compliant vehicles in the zone (and encourage owners to upgrade their vehicles), the Council introduced two government-funded schemes that help to mitigate the impact of charges on businesses/individuals regularly travelling in the zone while also contributing to air quality improvements:

- A financial assistance scheme for businesses and individuals regularly travelling in the zone to help replace or retrofit up to 1,500 polluting, chargeable vehicles with cleaner, compliant ones (via grants and or interest-free finance worth £9.4 million)
- A bus retrofit scheme to financially support local bus operators to retrofit the engines of all remaining non-compliant buses on scheduled routes in the city so that they meet the new emission standards i.e., are compliant with Euro VI diesel standards (worth £1.7 million)

The financial assistance scheme is currently closed to new applicants to ensure that there is enough funding for each application. The Bus retrofit scheme is largely complete, with three outstanding retrofits delayed while a specific retrofit solution is designed for the vehicles.

2. Assessing the impacts of Bath's CAZ

The purpose of the CAZ is to reduce nitrogen dioxide (NO_2) concentrations in Bath to within the annual average limit of 40 micrograms per cubic metre ($\mu g/m^3$) in the shortest possible time, and by the end of 2021 at the latest.

To show that we've met this requirement, we will need to evidence that the annual average concentrations of NO_2 recorded at every valid monitoring site (according to JAQU's criteria) in Bath (both inside and outside of the zone) do not exceed 40 $\mu g/m^3$.

However, in addition to air quality, the zone's introduction also impacts on traffic flow, vehicle compliance, business and personal travel behaviour, and the local economy.

Data is therefore continually collected on a range of measures so that we can assess the impact of the zone and identify any emerging trends in air quality and other criteria that may need corrective action. The Council is committed to monitoring and reporting on these measures at various intervals and the full list, including a reporting timeline is included in Table 1.

We have already introduced additional traffic and air quality monitoring in areas where the public has expressed concern about potential displacement effects. For more information see **Appendix 2: Investigating Traffic Displacement Concerns**.

The purpose of our quarterly reports is to provide an indicative view of the zone's performance, looking at three key measures: air quality data, traffic flow data and vehicle compliance data. These reports also include data on the financial assistance and bus retrofit schemes because of their influence on fleet compliance.

The purpose of our annual report is to provide a more in-depth view of the zone's performance with extra secondary measures considered. It also considers the success of individual sites with regards to the annual limit value. Where sites record NO_2 concentrations above or near the limit value, we focus in on how we can take corrective action to address this issue.

Our progress towards compliance (known as 'achieving success') is currently being reviewed by JAQU. However, we understand that the Council must initially demonstrate success at all valid monitoring sites and maintain this for a further two years at least. At this point, it is considered that the necessary behaviour change is embedded enough to ensure that, without the zone, average mean nitrogen dioxide concentrations would remain below the limit value.

Table 1- Data collection and collation for Bath CAZ annual reporting.

Measure	Data to be Used	Rationale for Inclusion	Data Collection Methods	Frequency of Data Output
M1: Air quality data	NO_2 concentrations data collected at existing monitoring locations in Bath and wider B&NES	To understand changes in air quality data, particularly NO_2 concentrations.	Diffusion tubes and real time monitoring	Quarterly and annually
M2: Traffic Flows	Traffic flows in and around the CAZ areas are collected to understand the changes in traffic flows as a result of the scheme.	To understand changes in traffic flows along key corridors and links on the highway network. This includes possible 'rat-run' routes flagged by residents during consultation.	ANPR cordon and ancillary Manual Classified Counts (MTC) or Automated Traffic Counts (ATC) on key roads or perceived 'rat-runs'	Quarterly and annually
M3: Vehicular fleet information	Number of compliant/ non-compliant vehicles travelling within Bath	To understand changes in the type of vehicles travelling in Bath.	ANPR cordon, cross-referencing with DVLA vehicle database	Quarterly and annually
M4: Retail/ business/office space vacancy figures	Vacancy statistics from internal council data (B&NES economy and growth team). Market data from property consultants. Purchasing Managers Index.	To assess economic impacts of the CAZ .	Internal data collection as part of ongoing process. Regular property market reports published by property consultants in the public domain could also be used.	Annually
M5: Retail footfall surveys	Footfall data from Bath Business Improvement District data and internal council data.	To understand changes to the number of people entering shops in Bath as well as the time they spend in each shop.	Bath BID and B&NES collect this data as part of ongoing processes.	Annually

M6: Park and Ride passengers data	Occupancy statistics (Cloud Amber) and bus ticket data (First). Monitor fleet mix	To understand changes in the number of people and the type of vehicle using the P&R into Bath.	Collected as part of ongoing monitoring activities by operators. ANPR at entrance to Park and Rides	Annually
M7: Walking and cycling counts	Pedestrian and cycle counts on key arterial routes	To understand changes in the number of people walking and cycling on key routes within Bath.	Commissioning of new surveys	Annually
M8: Bus usage and fare data	Occupancy statistics (Cloud Amber) and bus ticket data (First).	To understand changes in the number of people using the bus on each route into Bath.	Collected as part of ongoing monitoring activities by operators.	Annually
M9: Stakeholder Feedback from Council User Group Forums	Stakeholder Feedback covering relevant elected members, stakeholder groups, the LEP. Voice Box survey. Protected groups survey.	Understand the views of stakeholders to scheme delivery and impacts, and to understand some of the less quantified effects, including package effects.	Part of the on-going consultation process for transport strategies in the City.	Annually
M10: Taxi fares and unmet demand	Taxi fare data and unmet demand surveys	To understand changes to fares and demand on taxis to assess the economic impacts of the CAZ	Collected as part of ongoing monitoring activities by operators.	When unmet demand surveys are performed (every three years)
M11: Early Measures Fund – Zero-Emission Parking Permits	Statistics on zero-emission vehicle parking permits scheme uptake	To guage popularity	Collected as part of the parking permit scheme operation	Annually, and finally in 2022 when the scheme has ended

M12: Bus retrofit uptake/ compliance data	Statistics on bus retrofit scheme uptake and bus compliance	To understand changes to bus fleet operating in Bath.	Collected by ANPR cameras, as part of ongoing monitoring activities by operators and from the retrofit scheme	Quarterly and annually
M13: Financial support scheme uptake	Statistics on financial support scheme uptake	To understand the success and popularity of the financial support schemes in changing to compliant vehicles	Collected as part of the financial support scheme operation	Quarterly and annually and finally after the scheme has ended
M14: Travel advisor session uptake	Statistics on meetings with travel advisors	To understand the overall success of travel advisors and	Collected as part of the travel advisor scheme operation	Quarterly and annually
M15: Anti-idling enforcement	Data from enforcement action for anti-idling	To understand the success of the measure in reducing idling	Collected as part of the anti-idling enforcement scheme operation	Annually
M16: Weight restriction enforcement	Data from enforcement action for anti-idling	To understand the success of the measure in enforcing weight restrictions	Collected as part of the weight restriction enforcement scheme operation (from Trading Standards)	Annually
M17: Only-mile delivery uptake	Statistics on only-mile delivery uptake	To understand the success of the only-mile delivery measure with businesses	Collected as part of the delivery and servicing plans operation	Quarterly and annually

3. Impacts of the CAZ on air quality

The purpose of the CAZ is to reduce nitrogen dioxide (NO_2) concentrations in Bath to within the annual average limit of 40 micrograms per cubic metre (μg/m³) in the shortest possible time, and by the end of 2021 at the latest. 40 μg/m³ is the legal limit set for NO_2 in the Environment Act 1995 and the Bath and North East Somerset Council Air Quality Direction 2019[6].

To show that we've met this requirement, we will need to evidence that the annual average levels of NO_2 recorded at every valid monitoring site in Bath (both inside and outside of the zone) does not exceed 40 μg/m³. This is also in line with the Critical Success Factors (CSF) developed as part of the Full Business Case for the scheme.

3.1 Critical success factors of the CAZ

To successfully monitor and evaluate the performance of the CAZ, two critical success factors (CSF) were developed.

The primary CSF seeks to deliver compliance (in the shortest possible time) with the NO_2 concentration limit values outlined in the 2008 EU Air Quality Directive (AQD). This directive sets out sighting guidelines for monitoring locations. The Pollution Climate Mapping Model (PCM) used by JAQU in their assessment of our scheme, uses locations based on these requirements. To ensure that a receptor is compliant with AQD guidelines, it must be at least 25m away from a junction, 0.5m away from the nearest obstruction (including building façades), represent 100m stretch of road and be 1.5-4m high. An ideal location is 4m from the road and 2m high. Additionally, as the AQD looks at NO_2 concentrations at the point of monitoring, results are not adjusted to the façade, unlike the requirements on an Local Air Quality Monitoring (LAQM) site.

Currently not all 123 diffusion tube receptor sites in Bath comply with AQD guidelines because many have been in position for several years to comply with LAQM positioning (see below), enabling us to compare air quality with previous years.

The secondary CSF aims to deliver a scheme which leads to compliance with the Local Air Quality Management (LAQM) Air Quality Objectives for NO_2 concentrations. As LAQM focuses on NO_2 concentrations at the point of relevant public exposure (façades of schools, care homes, hospitals etc) NO_2 concentrations are adjusted to the nearest façade. Unlike the AQD requirements, sites can be placed on junctions and within 0.5m of a building façade, providing there is relevant public exposure.

[6] Environment Act 1995 Bath and North East Somerset Council Air Quality Direction, 2019
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/800802/air-quality-direction-bath-2019.pdf

Have we achieved success?

At the time of writing, JAQU is considering its formal assessment of the scheme after its first year of operation to identify whether we have met our legal obligation as outlined within the original Directive to reduce NO_2 concentrations in Bath.

In making this assessment they will consider each monitoring location against the criteria published in the Air Quality Standards Regulations 2010. Two diffusion tube monitoring sites, Walcot Parade 2 and Wells Road, remain in exceedance of legal limits. However, the position of the diffusion tubes which, by necessity, sit very close to a building facade, do not accord with the Air Quality Standards Regulations 2010 on which the directive was issued. They do, however, sit within the scope of the Local Air Quality Management Framework and therefore remain an ongoing concern.

We await the outcome of the formal assessment in due course.

3.2 How we collect and measure air quality data

We have measured air quality in Bath and North East Somerset since the mid-1990s. Currently we measure nitrogen dioxide (NO_2) and Particulate Matter ($PM_{2.5}$ and PM_{10}) concentrations, using multiple methods.

Automatic analysers measure NO_2 and PM in four permanent roadside locations in Bath. They take hourly readings of air pollution concentrations and provide more accurate readings than diffusion tubes. One of these monitoring stations is linked to the UK Automatic Urban and Rural Network (AURN) which provides national coverage of a range of pollutants.

Diffusion tubes are light, mobile and can be placed in many locations around the area, usually 1 to 15 metres from the road or at the kerbside (less than 1 metre from the road) and around 2-3 metres above ground level. The ambient air reacts with a chemical reagent in the tube so that NO_2 concentrations can be measured. The tubes are exposed to the air for one month before they are collected and sent to a laboratory for analysis. There are currently over 150 diffusion tube locations across Bath & North East Somerset.

In recent years, average annual levels of particulate matter pollution in Bath have not exceeded the legal limit of 40 $\mu g/m^3$ for PM_{10} and 25 $\mu g/m^3$ for $PM_{2.5}$. Occasional 24-hour exceedances occur but only at times when there were meteorological or other events that caused spikes in these pollutants, nationally. Whilst we continue to measure it, PM data will not form part of the quarterly or annual reports.

Comparing air quality data inside and outside of the zone

The Council has committed to assessing whether the introduction of the CAZ would lead to displacement impacts in areas outside of the zone's boundary.

To establish the impact of the zone on air quality in surrounding areas, and trends inside and outside of the zone, we present air quality data for the following areas:

- The clean air zone (sites within the CAZ boundary which we call 'CAZ_Only')
- The boundary area (sites outside the CAZ boundary but within the urban area of Bath including Batheaston and Bathampton, which we call 'CAZ_Boundary')
- The wider area (sites outside of the Bath, Batheaston and Bathampton urban areas, but within the rural areas and district-wide urban areas in Bath & North East Somerset, which we call 'Wider_B&NES')

A note on air quality monitoring locations

As of 2021 there are 163 diffusion tube monitoring sites across Bath and North East Somerset that contribute to the results in this report. There are a further four automatic analysers located within Bath.

66 sites are located in the clean air zone (Figure 2) and 57 in the city's urban area outside of the zone's boundary (Figure 3), with a further 40 in the wider district. We have reported on monitoring sites with long-term data or that will remain in place for a long time. There are more diffusion tube locations not included in this analysis because they are in place temporarily.

When analysing results, we have only considered like-for-like data in most cases, meaning if a diffusion tube site was not in place in a baseline year, we have not included it in the calculation. This is to ensure robust analysis.

Figure 2- A map showing the Clean Air Zone and the automatic analyser (squares) and diffusion tube (triangles) locations in Bath © Crown Copyright 2021. License number 100023334.

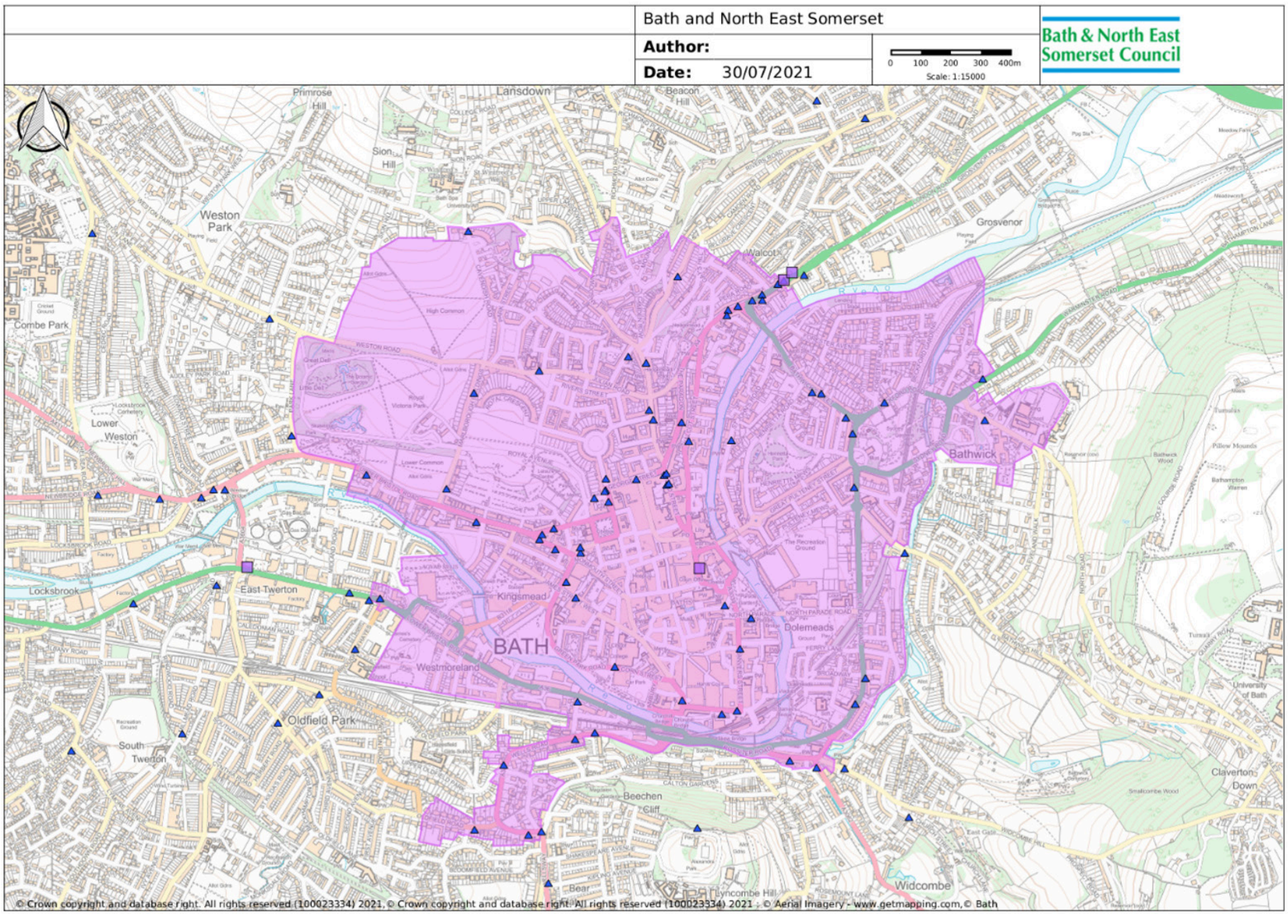
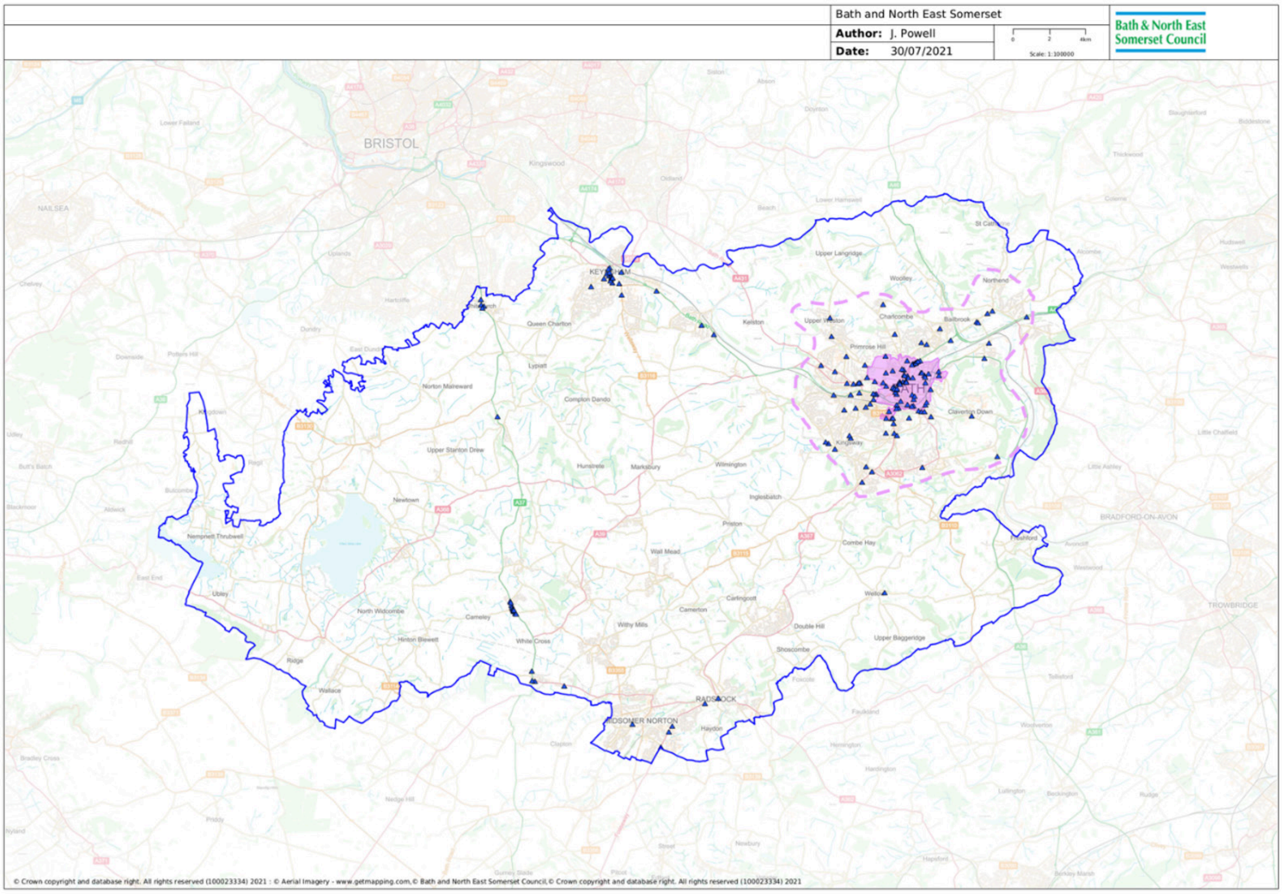


Figure 3 - A map showing diffusion tube locations in three site groupings: The wider district of Bath and North East Somerset (the blue line; Wider_B&NES), the wider Bath urban area outside of the CAZ (the dotted pink line; CAZ_Boundary) and the CAZ (the pink area; CAZ_Only). © Crown Copyright 2021. License number 100023334.



Numbers of diffusion tube sites in each location

Table 2 shows the growing number of diffusion tube air quality monitoring sites across B&NES. Additional sites were chosen based on the air pollution dispersion model developed for the CAZ Full Business Case, enabling us to check the impact of the CAZ against what was modelled.

Triplicate sites are where three diffusion tubes are co-located at one monitoring site to improve accuracy. These are located where annual NO_2 concentrations are predicted to be greater than 34 µg/m^3. The NO_2 concentration from each triplicate diffusion tube is averaged to produce one result for the site, so triplicate measurements are only counted once for analysis.

Table 2- Number of diffusion tube sites providing annualised data (triplicate sites are averaged, so only considered one location) from 2019 to the end of 2021, in the three site groupings.

Period	CAZ_Only	CAZ_Boundary	Wider_B&NES
2019	65	56	29
2020	65	56	34
2021	66	57	40

Most of the air quality data shown in this report comes from averaging monthly diffusion tube results. We also report data from four automatic analysers located in Bath.

Measuring air quality to take account of seasonal effects

Annual average concentrations are useful because they account for varying seasonal cycles of pollutants such as:

- Meteorological conditions, for example wind, precipitation, and temperature
- And to a lesser degree, human sources of air pollution, for example increased energy generation for heating in winter or increased agricultural activities in spring.

This is also why we compare air quality data against similar time periods, for example comparing data from 2021 Q4 to the baseline of 2019 Q4. Further information on monitoring can be found in the 'Monitoring Explained' section at the end of the report.

4. Annual air quality results, 2021

The following results reflect the annual mean from the entire year of 2021. The original launch date for the CAZ was November 2020, postponed to 15 March 2021 due to the Covid-19 pandemic. The CAZ was not active from 1 January 2021 until 15 March 2021 but businesses and individuals may have been taking steps to prepare for it i.e., replacing chargeable vehicles.

We analyse historical data to identify longer-term trends, as well as focussing closely on the sites which do not meet the 40 µg/m³ annual limit value. We compare 2021 data with baseline data from 2019. 2020 data has been discounted as a baseline because of Covid-19's unprecedented effect on traffic and travel behaviour.

The full monthly diffusion tube results can be found in the Air Quality Data appendix.

Focus sites

Here we look at the recent and longer-term data of sites within the CAZ (CAZ_Only) and wider Bath urban area (CAZ_Boundary) that recorded NO_2 concentrations during 2021 above 36 µg/m³. All other areas across the city have quarterly average levels below 36 µg/m³ (90% of the annual limit value) and are therefore excluded from the table.

Table and figures included in this section:

- Table 3: Sites within the CAZ and Bath's wider urban area that recorded an NO_2 concentration greater than 40 µg/m³ in 2021.
- Table 4: Sites within the CAZ and Bath's wider urban area that recorded an NO_2 concentration greater than 36 µg/m³ but less than 40 µg/m³ in 2021.
- Table 5: A breakdown of the overall number of sites recording above 36 µg/m³ and 40 µg/m³ in 2021.
- Table 6: Annual average NO_2 concentration in 2019 and 2021.
- Figure 4: A map of the CAZ with the three diffusion tube sites which recorded an annual average NO_2 concentration greater than 40 µg/m³ in 2021.
- Figure 5: Long term trend at sites recording greater than 40 µg/m³ in 2021.
- Figure 6: Long term trend at sites recording greater than 36 µg/m³ in 2021.

Table 3: NO_2 concentrations at locations where the annual average exceeded 40 µg/m³ in 2021, within the CAZ_Only and CAZ_Boundary site groupings. TA= triplicate average site.

Site ID	Site	Site Grouping	2019 Annual concentration (µg/m³)	2021 Annual concentration (µg/m³)	Change (µg/m³)
DT020 (TA)	Wells Road*	CAZ_Only	45.4	42.6	-2.8
DT042	Dorchester Street*	CAZ_Only	48.0	40.5	-7.5
DT224 (TA)	Walcot Parade 2*	CAZ_Only	55.2	43.1	-12.1

*Please note that whilst these sites record concentrations over 40 µg/m³ as an annual average, they site location is not compliant with the Air Quality Standards Regulations. See Critical Success Factors, page XX

Table 4: NO_2 concentrations at locations where the annual average concentration exceeded 36 µg/m³ but remained at or below 40 µg/m³, within the CAZ_Only and CAZ_ Boundary site groupings. TA= triplicate average site.

Site ID	Site	Site Grouping	2019 Annual concentration (µg/m³)	2021 Annual concentration (µg/m³)	Change (µg/m³)
DT060	Victoria Buildings	CAZ_Only	44.1	40.0	-4.1
DT198 (TA)	Walcot Parade	CAZ_Only	48.7	37.8	-10.9
DT222 (TA)	Anglo Terrace Façade	CAZ_Only	49.0	38.1	-10.9
DT248(TA)	Chapel Row 2	CAZ_Only	38.3	36.6	-1.7

Table 5: The total number of sites within the CAZ and wider Bath urban area, which recorded greater than 40 µg/m³ and 36 µg/m³ NO_2 concentrations during 2019 and 2021. The total number of sites reporting during each period is shown along with the proportion of sites recording greater than 40 µg/m³ and 36 µg/m³ because the total number of sites is variable. Note that sites which recorded above 40 µg/m³ will also have recorded above 36 µg/m³.

CAZ_Only and CAZ_ Boundary	Total no. sites reporting	No. sites >40 µg/m³ average	Proportion sites >40 µg/m³ (%)	No. sites >36 µg/m³	Proportion sites >36 µg/m³ (%)
2019	121	11	9	27	22
2021	123	3	2	7	6
Change	2	-8	-7	-20	-16

Comments and key findings:

- This data considers annual data from all sites within the CAZ and the surrounding urban area
- Three sites (Wells Road, Walcot Parade 2, Dorchester Street) record an annual mean concentration above 40 µg/m³. As stated, these sites are not compliant with the Air Quality Standards Regulations 2010 but are valid for monitoring under LAQM. When the results are façade adjusted under the LAQM framework, DT042 (Dorchester Street) recorded an annual mean of 34.6µg/m³, DT224 (Walcot Parade 2), 41.2µg/m³, and DT020 (Wells Road) remains at 42.6µg/m³ (as the tube is sighted close to the façade).
- Five sites (Victoria Buildings, Walcot Parade, Anglo Terrace Façade, Gay Street 2, Chapel Row 2) recorded an annual mean concentration above 36 µg/m³, but below 40 µg/m³.
- No sites recorded an increase in NO_2 concentration between the baseline year of 2019 and 2021.
- In Bath, 20 fewer sites recorded concentrations above 36 µg/m³ compared with 2019 and 8 fewer sites recorded concentrations over 40 µg/m³.
- In the wider Bath urban area in 2021, 2% of sites recorded greater than 40 µg/m³; 7% sites recorded greater than 36 µg/m³.

The three sites in the zone which recorded annual average NO_2 concentrations above 40 µg/m³, are being given extra consideration by the Council on ways to reduce air pollution. A map of the three sites which recorded above 40 µg/m³ at the monitor is provided in Figure 4.

The following investigates the longer-term history of air pollution at sites which recorded concentrations above 36 µg/m³ (within 10% of 40 µg/m³), with some useful background information.

Walcot Parade

A high volume of traffic passes the monitors. Traffic signals at the junction where the monitor is, means that traffic stopping and starting can increase emissions as vehicles pull away from a stop light. The catalytic converter in a vehicle cools down as it remains stationary, and this can cause higher NOx emissions when it pulls away. This effect can be worse for larger vehicles like buses.

Wells Road

This has high concentrations but with a downward trend. High concentrations are due to high traffic volumes. This could also be influenced by the catalytic converter of vehicles getting cold whilst coasting down a long hill. The monitor location is where the road flattens out and so vehicles are required to use their engine for the first time in a while.

Dorchester Street

At Dorchester Street, despite high concentrations, there is a long-term downward trend. High concentrations are due to high traffic volumes, particularly with high proportion of buses using the street. The monitor is also located by traffic lights so there is a lot of stop/start emissions (as explained above).

A note on distance adjusting:

Nitrogen dioxide concentrations reduce rapidly as you move away from the source (road). A LAQM receptor for nitrogen dioxide is a residential property, school, hospital etc. If a monitor is located at a roadside/kerbside location, then the concentrations are distance adjusted using a diffusion tube processing tool to calculate the concentration at the building façade. This is only carried out on concentrations which are above 36 μg/m^3 (within 10% of 40 μg/m^3) and we have not performed this calculation on any results in this report. It is an important for consideration when considering the success of the CAZ.

Figure 4: A map of the CAZ which highlights three sites (DT020- Wells Road; DT042-Dorchester Street; DT224- Walcot Parade 2) which recorded above 40 μg/m^3 at the monitor. © Crown Copyright 2022. License number 100023334.

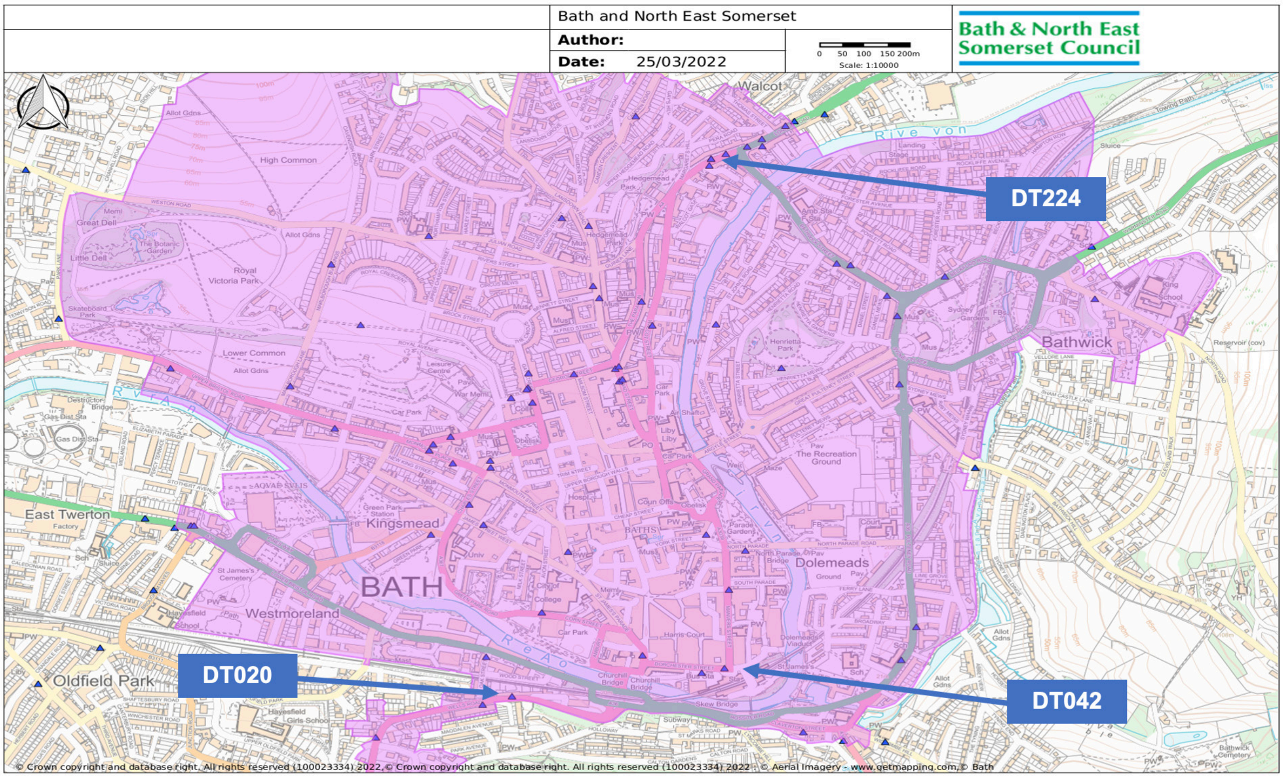
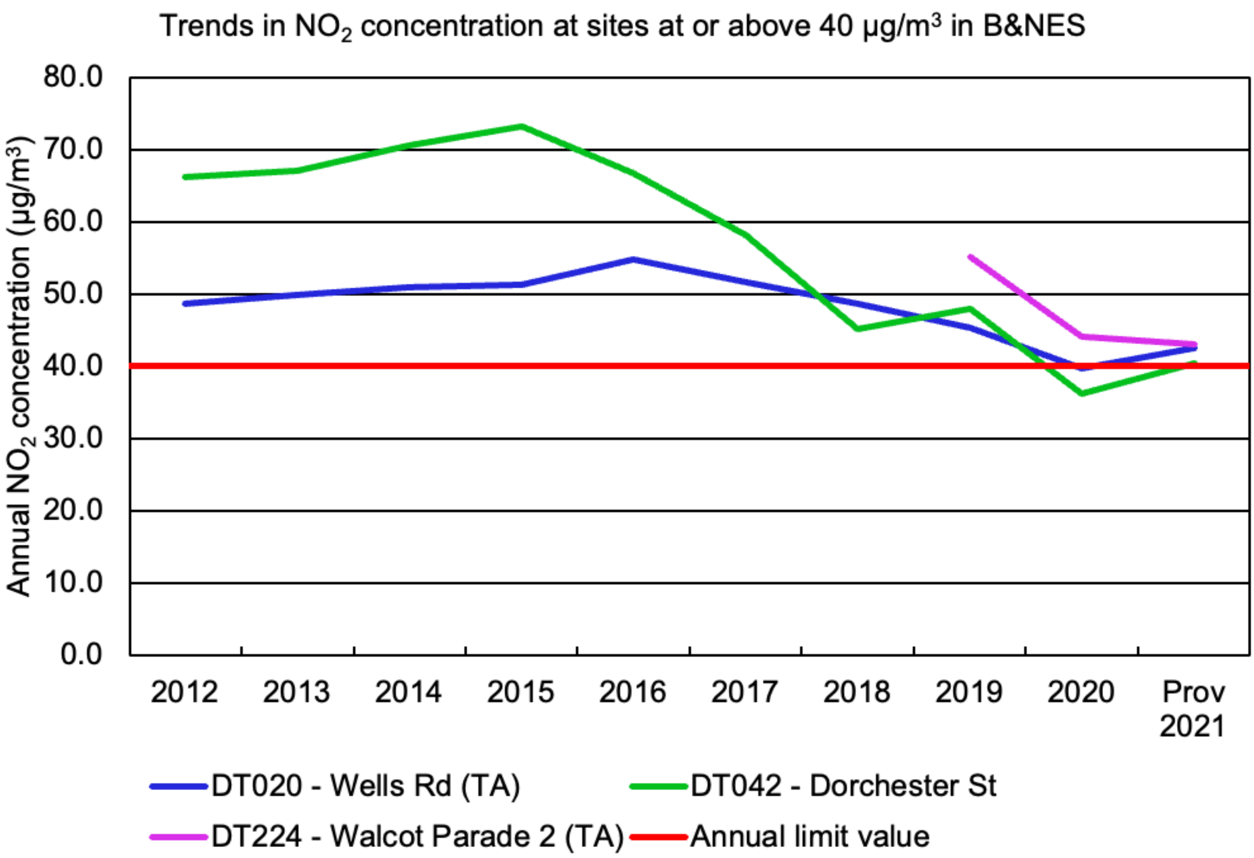


Figure 5, below, shows the NO_2 concentration over the last ten years at the sites which recorded the highest annual average concentrations in 2021. The trend is shown for as long as each site has been in place. Some sites have only monitored data in the last few years.

Figure 5: Up to ten-year trend in NO_2 concentration at sites recording annual mean concentrations of NO_2 above 40 µg/m³ in 2021.

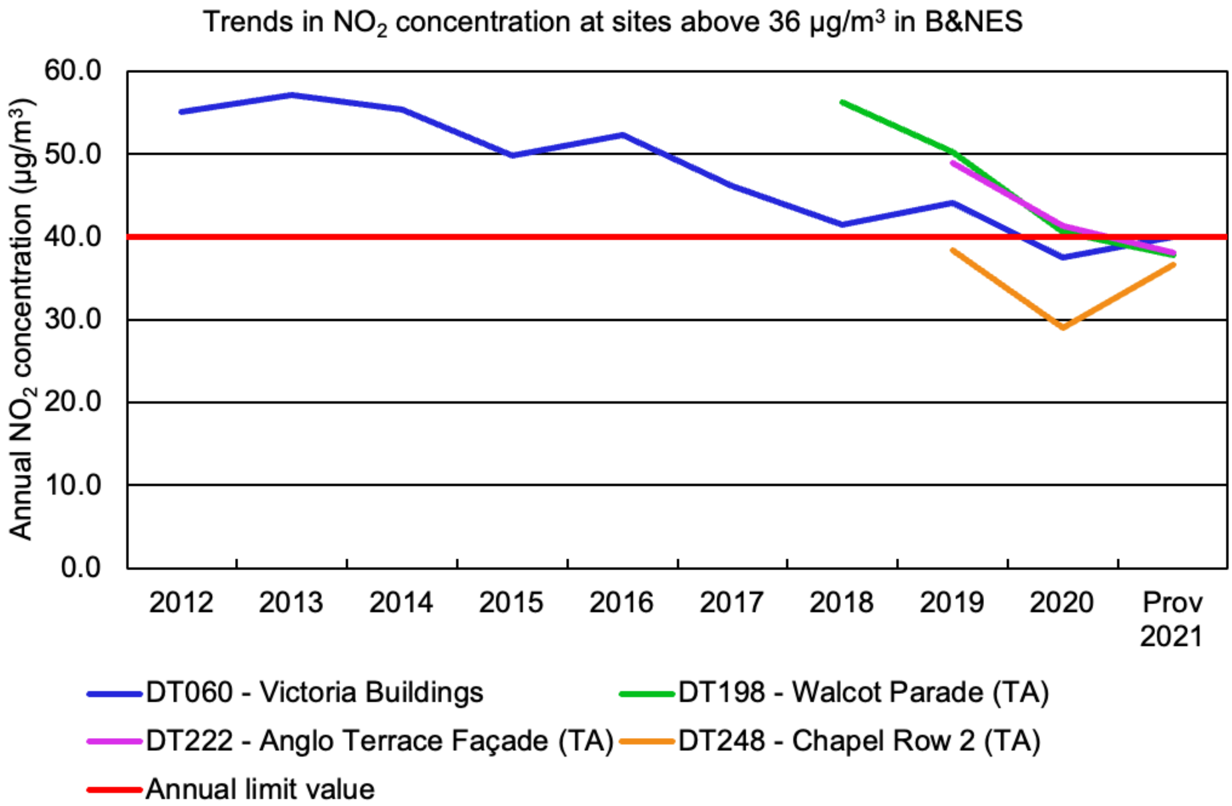


Comments and key findings:

- All sites have an overall decreasing trend
- The two sites which have been recording data for the longest period reached a peak in 2015/16 before reducing. A slight increase at DT020 and DT042 between 2020 and 2021 is almost certainly due to increasing traffic levels associated with the end of the pandemic and the Cleveland Bridge closure. Evidence of locally changing traffic flows affecting air quality is presented later in the report.
- Regarding the increase in NO_2 concentration at Wells Rd in 2015-2016, the diffusion tube was moved to its current location from slightly further up the hill, so it was closer to the residential properties (Figure 4).
- General fleet improvements may be a leading cause of decreasing NO_2 concentration after 2015 as the Euro 6/VI emission standard came into force.
- By the end of 2021, almost all scheduled buses in Bath have been upgraded or retrofitted to meet emissions standards, this will have contributed to the improvement in air quality at all sites in Bath.

Figure 6, below, shows the NO_2 concentration over the last ten years at the sites which recorded above 36 µg/m³ but at or below 40 µg/m³ annual measurement in 2021. The trend is shown for as long as each site has been in place. Some sites only began measuring data in the last few years.

Figure 6: Up to ten-year trend in NO_2 concentration at sites that recorded annual mean concentrations above 36 µg/m³ in 2021



Comments and key findings:

- All sites have an overall decreasing trend.
- Of the sites recording above 36 µg/m³ there has been an overall decrease, except at DT234 and DT248 which have not significantly changed since 2019.
- Traffic flows increased on Chapel Row during the second half of 2021 with the closure of Cleveland Bridge and there is further analysis identifying this link between increased traffic and higher NO_2 concentration, later in the report.
- The ongoing reducing trend in concentrations at Anglo Terrace Façade (DT222) in 2020 and 2021 may be associated with the Cleveland Bridge closure.
- General fleet improvements may be a leading cause of decreasing NO_2 concentration after 2015 as the Euro 6/VI emission standard came into force.

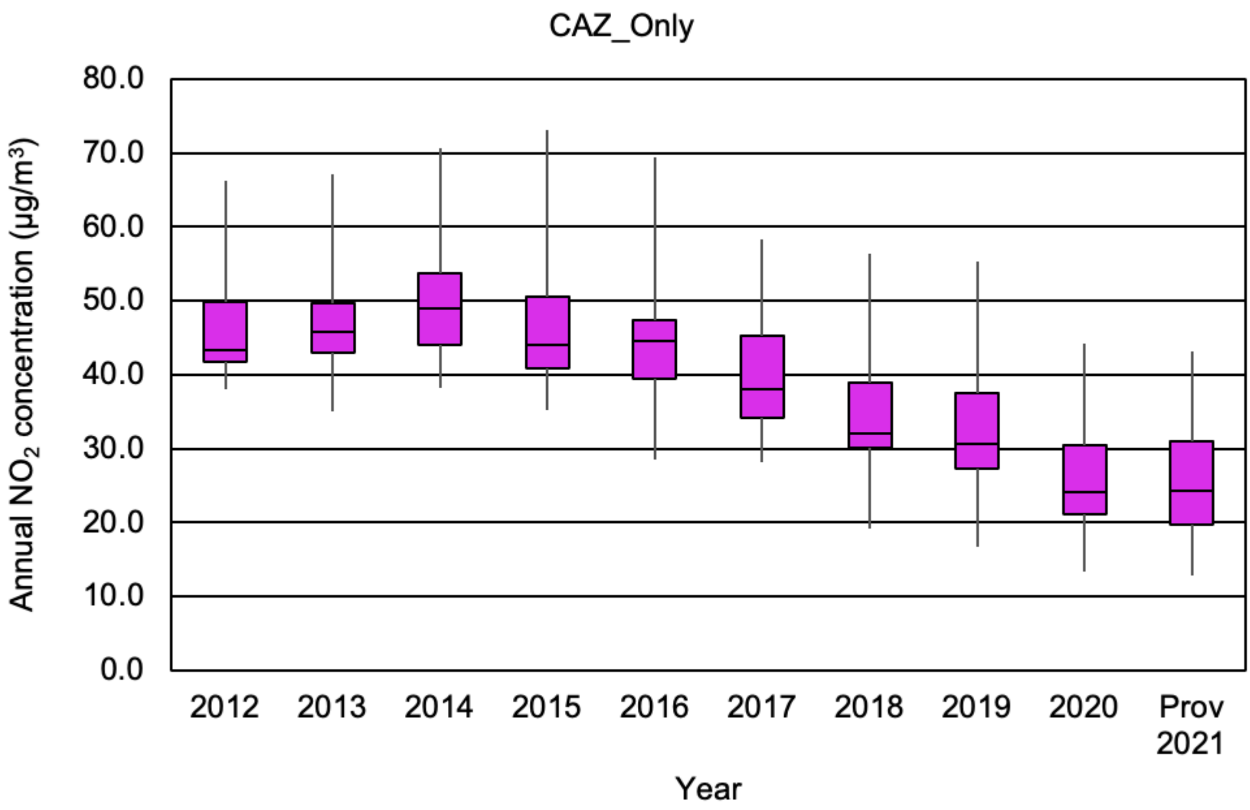
We are focussing on options for improving the air quality in locations where NO_2 concentrations are above 40 µg/m³ or 36 µg/m³ (within 10% of the annual limit value). The following section investigates long-term trends in NO_2 concentration across the CAZ and CAZ_Boundary as a whole.

Long-term trends

It is important to investigate individual sites where the NO_2 concentrations are high or increasing. It is also important to understand longer-term and more wide-ranging trends. Figure 7, below, shows boxplots of sites within the CAZ for the last 10 years.

Figure 7: Boxplots showing the range in NO_2 concentrations over the last 10 years in monitoring sites within the CAZ.

The whiskers show the minimum and maximum annual average NO_2 concentrations during that year. The bottom of the pink box shows the first quartile, the black line in the box is the median result and the top of the pink box is the third quartile. The box therefore represents the inter-quartile range, where 50% of the data is found.

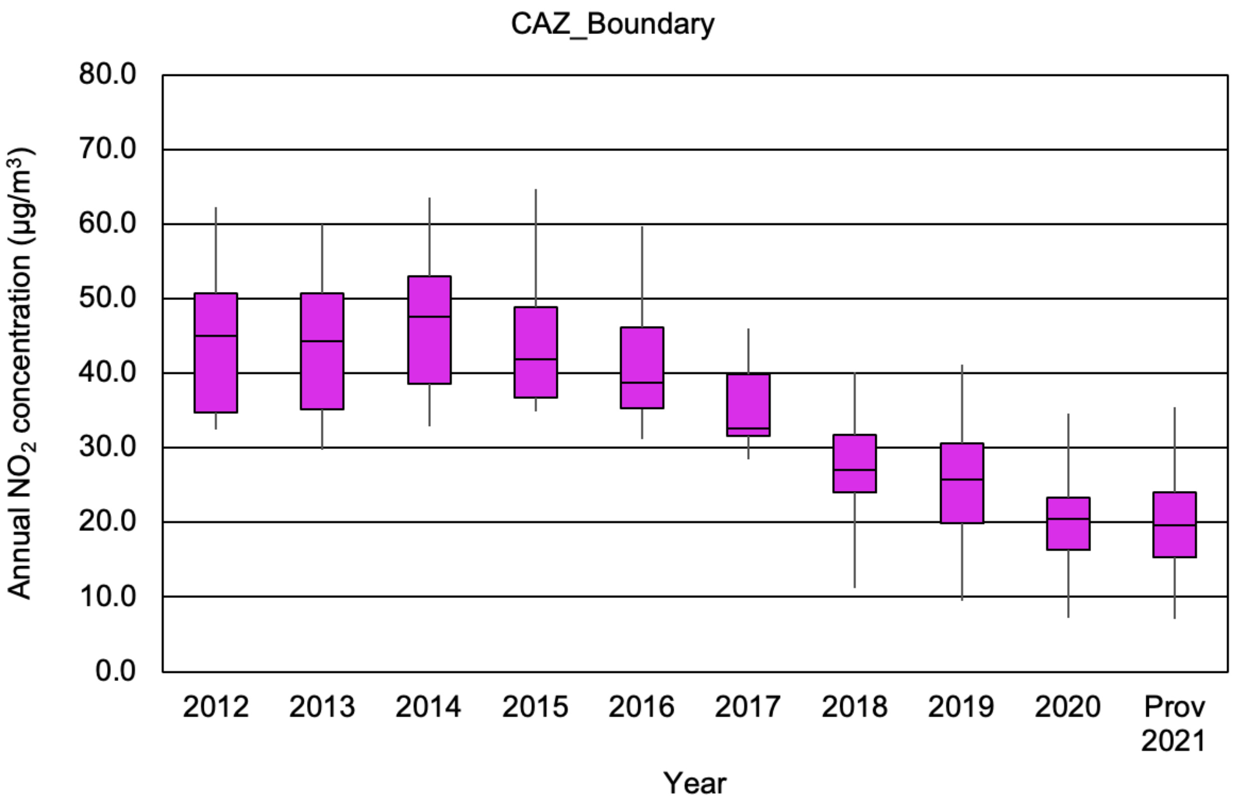


Comments and key findings:

- There is a clear decrease in the full range of data from 2014 onwards, that then stabilises between 2020 and 2021.
- Aside from the slight increase in median NO_2 during 2021 because of Covid and lower traffic in 2020, the last increase in median NO_2 was in 2016.
- The minimum and maximum data decreases so that the minimum 2012 datapoint is almost as low as the maximum 2021 datapoint.
- The provisional 2021 data shows that the interquartile range and median results remain relatively unchanged when compared to 2020.
- NO_2 concentrations in 2020 were lower than expected due to the Covid pandemic and lockdowns, so it is not unexpected that 2021 did not record lower concentrations than 2020.

Figure 8, below, shows boxplots of sites in the urban area outside of the CAZ for the last 10 years.

Figure 8: Boxplots showing the range in CAZ_Boundary NO_2 concentrations over the last 10 years. The whiskers show the minimum and maximum annual average NO_2 concentrations during that year. The bottom of the pink box shows the first quartile; the black line in the box is the median result; the top of the pink box is the third quartile. The box represents the inter-quartile range, where 50% of the data is found.



Comments and key findings:

- The CAZ_Boundary data shows a greater interquartile range in the earlier years than in the CAZ, which may represent the fact the wider urban area contains many monitoring sites located next to busy roads and those which are much less urban, thus resulting in a greater range of concentrations
- The interquartile range reduces in size through time. This is despite there being an increase in sites but may be because the reducing NO_2 concentration is approaching background levels towards 2021.
- Like the CAZ_Only grouping, the maximum 2021 data is almost at the same concentration as the minimum 2012-2016 data.
- The decrease in NO_2 is most pronounced between 2016-2020, but again the pandemic will have affected 2020.

An alternative way to consider the data is to plot in histograms. The blue columns in Figure 9 and 10 below relate to the data in 2019, while the green columns relate to 2021 data.

Figure 9: A histogram showing the number CAZ sites listed in 'bins' of annual NO_2 concentration in both 2019 and 2021.

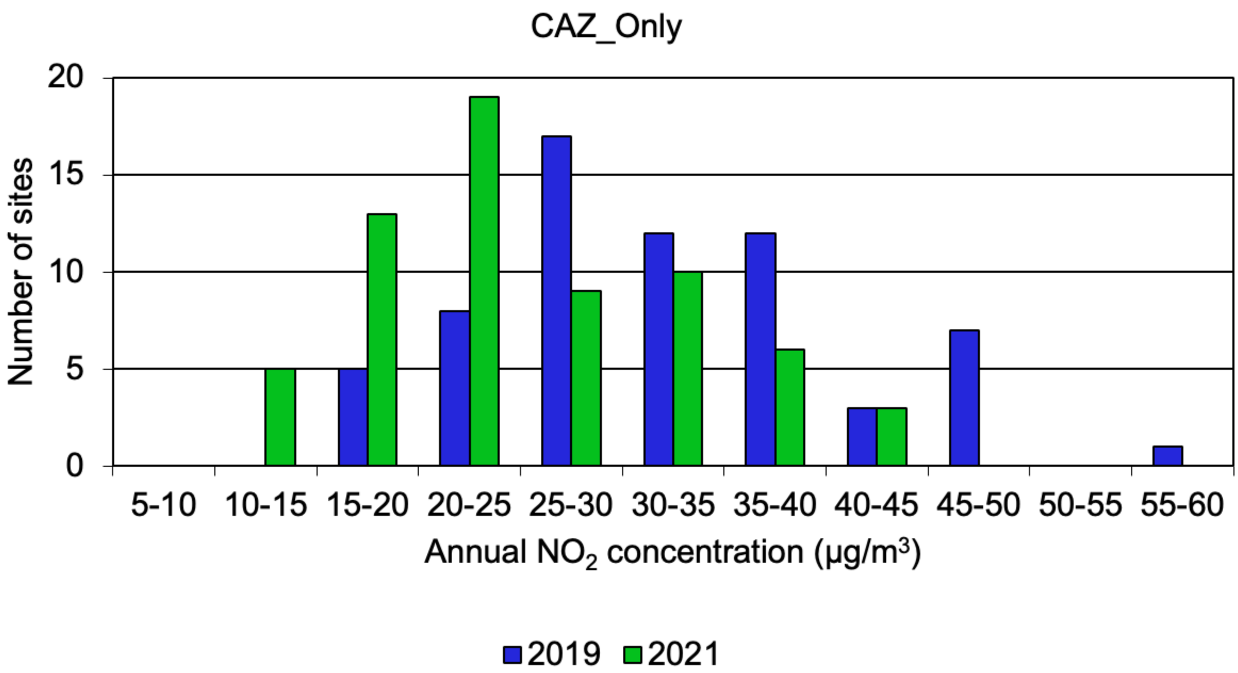
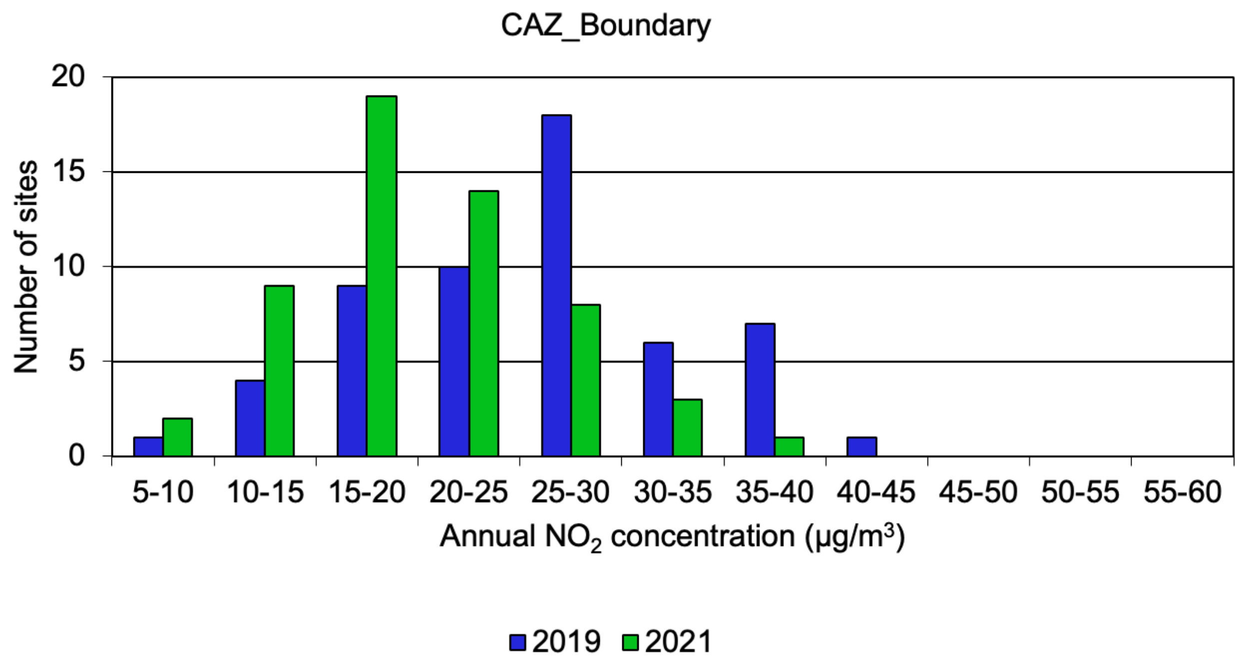


Figure 10: A histogram showing the number of CAZ sites listed in 'bins' of annual NO_2 concentration in both 2019 and 2021.



Comments and key findings:

- There is a clear shift as more 2021 sites are found in the lower bins than in 2019.
- Zero sites recorded above 45 µg/m³ during 2021 whilst many sites did so in 2019.

Table 6 provides the breakdown of the NO_2 concentrations across the three site groupings. The average annual NO_2 concentration across all three site groupings is shown dependent on how many sites were recording data during both 2019 and 2021.

Table 6: Provisional annual NO_2 concentrations across the three site groupings.

Period	CAZ_Only NO_2 (µg/m³)	CAZ_Boundary NO_2 (µg/m³)	Wider_B&NES NO_2 (µg/m³)
2019	32.4	25.4	29.1
2021	25.5	20.0	23.7
Change 2019 – 2021 (µg/m³)	-7.0	-5.5	-5.3
Change 2019 – 2021 (per cent)	-21.4%	-21.5%	-18.4%
Number of sites reporting results	65	56	29

Comments and key findings:

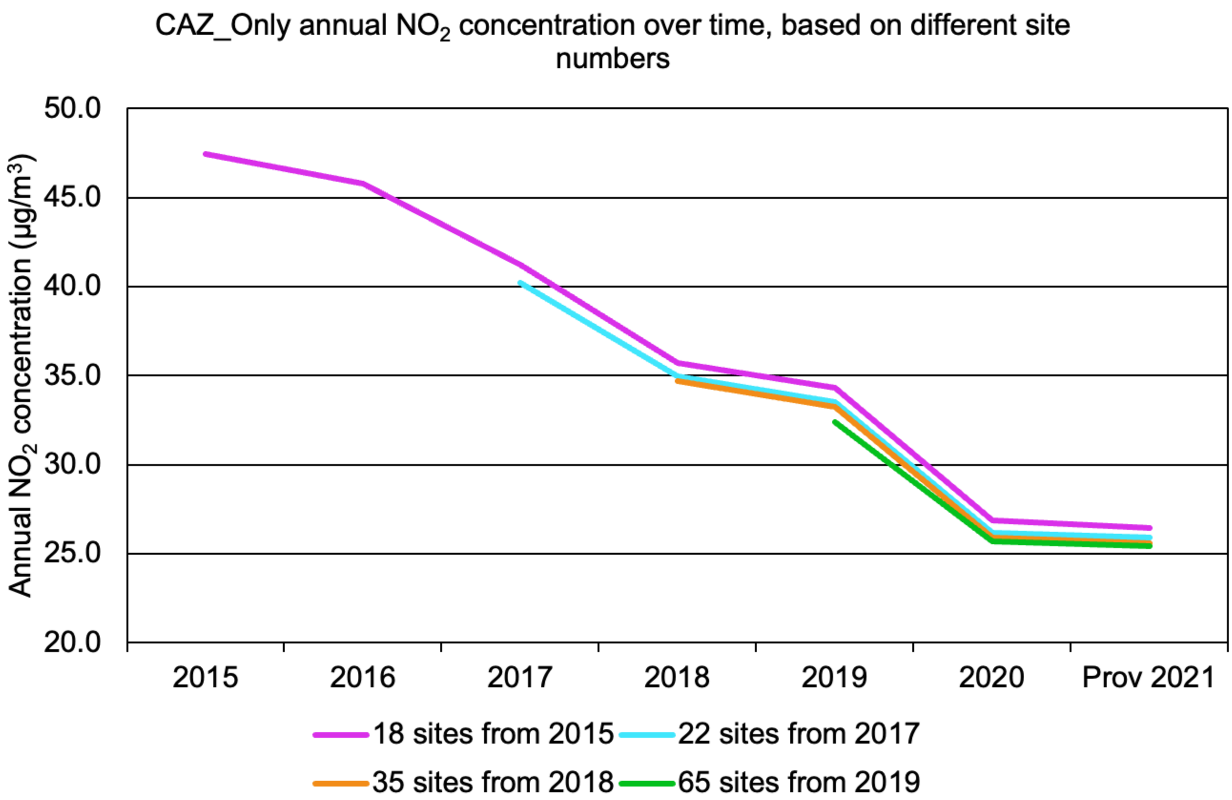
- NO_2 concentrations fell across all groupings. This is most pronounced in the CAZ_Only (-21%) and CAZ_Boundary groupings (-22%) and least pronounced in the Wider_B&NES grouping (-18%).
- Note that the baseline NO_2 concentration in 2019 is different across the three groupings. The CAZ_Only grouping has a greater actual NO_2 reduction when compared to the other groupings despite the percentage decrease being lower.
- Notably, NO_2 concentrations have decreased in the CAZ and its surrounding area, the CAZ_Boundary, by similar amounts suggesting that air quality improvements are not being limited to the CAZ.

The trends in all three site groupings are promising. The difference in site numbers in each grouping will most likely not affect the overall results by a significant amount, and this is explained further in the following section.

Evaluating diffusion tube annual monitoring

It's useful to look at what average annual NO_2 concentrations would be in different years, depending on how many sites we had in operation. We would expect that the annual average for a site grouping with a lower number of sites in operation would be less accurate. However, our analysis indicates that this is not the case as shown in Figure 11 below.

Figure 11: A graph showing the average annual NO_2 concentration over time from sites based in the CAZ, based on different site numbers.



As more monitoring sites are added each year, the data is enriched and the overall annual NO_2 concentration for that area becomes more accurate.

Looking into longer-term trends, Figure 11 shows the annual NO_2 concentration between 2015 and 2021. Each line represents the average annual NO_2 concentration according to the number of sites monitored. The pink line represents 18 sites that have been recording since 2015. Over time, monitoring sites were added to increase our understanding of the NO_2 concentration in certain areas, as well as improving data overall. Sites are often chosen in areas where high pollution is believed to exist.

Comments and key findings:

- All the data lines follow the same overall trend suggesting if you have a reasonable number of sites located within the CAZ, the results and their trend, are similar.
- Overall, more monitoring sites reduce the average NO_2 concentration slightly with the largest difference seen between the lowest number of sites (18) and the highest (66).
- In 2021, all four years produce annual average results within 1 µg/m^3 of each other, despite there being a difference of up to 47 sites
- This suggests that within the CAZ, at least, we can expect there to be little difference to overall average trends if more sites are monitored. Of course, it is still important to locate new sites to understand localised pollution.
- When analysing annual average trends, it is most accurate to use the greatest amount of available data possible, so we focus on the 65 sites in place in 2019 and 2021.

All the data analysed and discussed to this point has been diffusion tube data. Diffusion tubes are small, cost-effective, and easy to site near sources of emissions like roadsides. They are passive monitors which are sent to a laboratory monthly for analysis to produce a monthly NO_2 concentration and used to determine an annual average.

Automatic analysers are more accurate but costly and larger. These machines detect the NO_2 concentration every hour but cannot be sited easily around a district. In Bath, there are four automatic analysers (Figure 2). Their readings are used to calculate a local bias which corrects the diffusion tube data. A national bias is calculated using nationwide diffusion tubes and automatic analysers, and we compare our local bias to this national average to understand differences.

Further information on all the types of monitoring discussed in this report, can be found in the 'Monitoring Explained' section at the end.

Automatic analyser trends

The previous results discuss the results of our diffusion tube monitoring. With hundreds of diffusion tubes sited around the CAZ and wider B&NES district, they are useful for understanding trends in air quality across the district and localised air pollution, but they are not as accurate as automatic analysers.

The locations of our four automatic analysers can be found in Figure 2, earlier in this report. These machines are bulky and cannot be moved so while they are more accurate than diffusion tubes, they are less useful for localised air pollution or wider geographical trends.

Table 7: Shows data from the four automatic analysers in Bath.

Year	NO_2 concentration (µg/m³)			
	A4 London Road	Chelsea House	Guildhall	Windsor Bridge
2016	-	29	34	33
2017	-	29	30	33
2018	-	26	29	30
2019	29	22	27	29
2020	28	20	19	23
2021	27	18	20	23

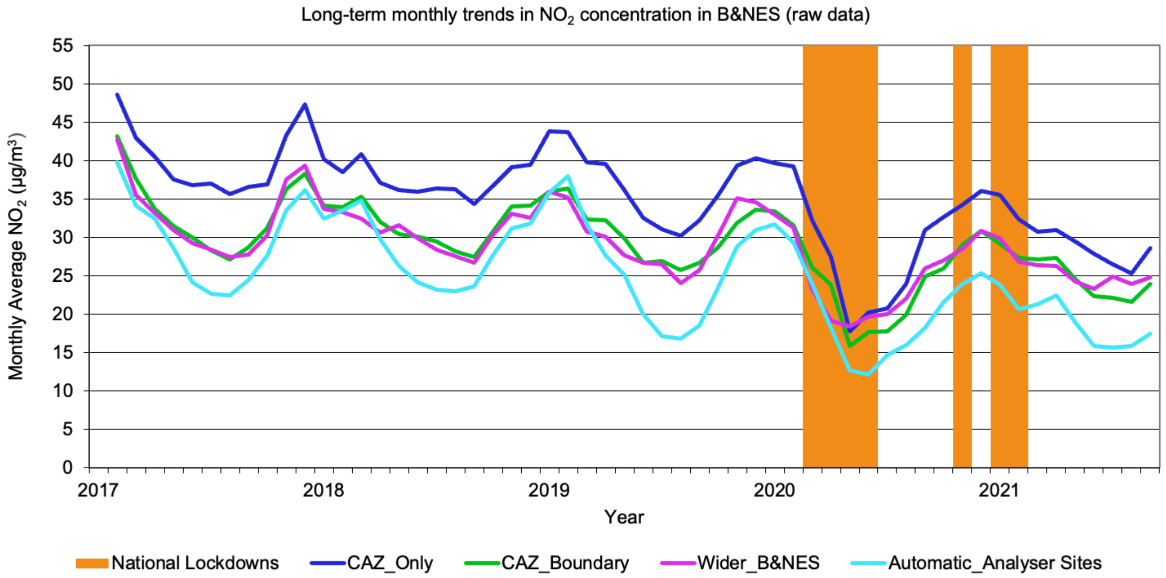
Comments and key findings:

- All four automatic analysers recorded annual average NO_2 concentrations below the 40 µg/m³ annual limit value.
- The largest decrease since 2016 was found at the Guildhall with a 14 µg/m³ decrease over 5 years.
- The A4 London Road site recorded the highest NO_2 concentration in 2021 but at 27 µg/m³ this is still well below the limit value.

Monthly long-term data

Figure 12: Monthly average diffusion tube NO_2 concentrations in B&NES from 2017 to 2022, separated into the three site groupings (raw, unadjusted data) alongside the average of three automatic analyser sites in Bath (Chelsea House, Guildhall, Windsor Bridge). A fourth automatic analyser site on the A4 has limited NO_2 data so was omitted.

Figure 12, above, shows the monthly average readings that were taken from 54 long-term monitoring diffusion tube sites (18 within the CAZ, 12 in the urban area outside of the CAZ, and 24 in the wider area outside of Bath) and three automatic analysers at Chelsea House, the Guildhall and Windsor Bridge in Bath.



Comments and key findings:

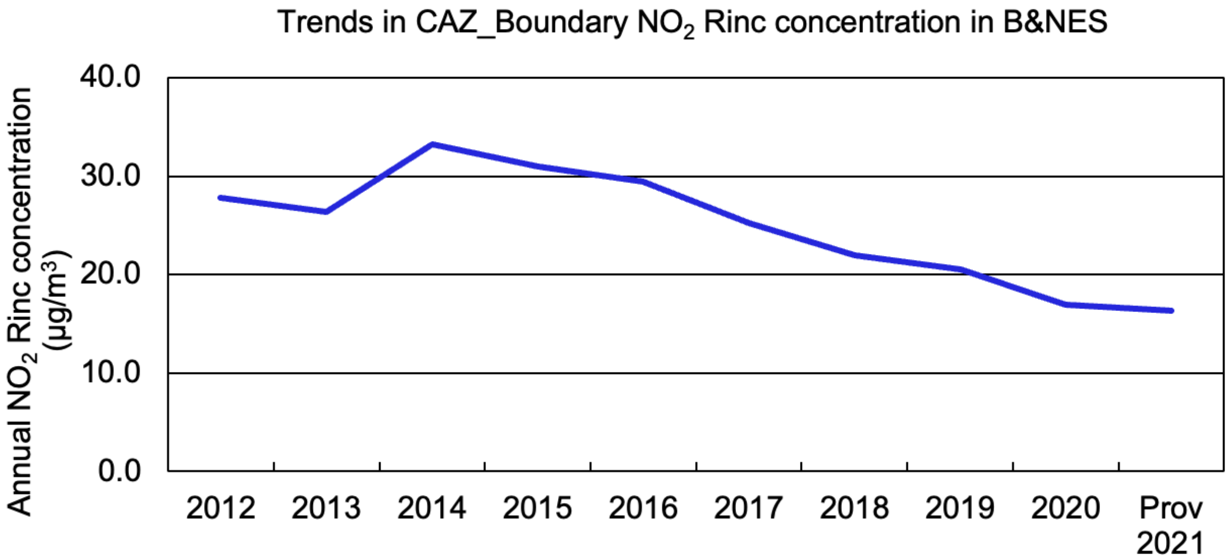
- The data used in this analysis is raw monthly data and is unadjusted
- For comparison purposes, we have only included and compared sites that have been in place since 2017 (dozens of additional monitoring sites have been added since 2017 which are not included).
- The automatic analyser data is lower than that of the diffusion tubes for multiple reasons. One reason is that data is more accurate than diffusion tubes which need to be adjusted with a bias using data from the automatic analyser. Also, there are only three data sources for the automatic analysers.
- There is a general downward trend with average monthly NO_2 concentrations falling since 2017. This is likely due to the natural replacement of older, more polluting vehicles with cleaner, compliant ones.
- Clean Air Zones seek to accelerate natural replacement rates to rapidly improve fleet compliance. Due to Covid-19, the natural replacement rate has stalled as new vehicle registrations declined during the pandemic. The CAZ has helped to maintain some this replacement rate, rather than increase it[7].
- There is a clear seasonal trend in the data, with increased NO_2 concentrations in the winter. This is part of the reason why there is an upturn in the trend at the end of 2021, despite improvements, as well as traffic returning to pre-pandemic levels.
- Increased winter NO_2 concentrations are primarily due to:
  - lower vehicle catalyst temperatures meaning exhaust emissions abatement technology is less effective.
  - increased emissions from domestic sources, such as gas flues.
  - the fact that NO_2 is retained in colder air for longer than warmer air.
- A marked decrease in mid-2020 is due to significantly less traffic on the roads because of Covid-19 restrictions.

[7] Department for Transport, 2021 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1021032/vehicle-licensing-statistics-april-to-june-2021.pdf

Roadside increment

The roadside increment (Rinc) of NO_2 concentration shows the changes in traffic related NO_2 concentration derived by subtracting the background NO_2 concentration from the average NO_2 concentration. The graph below (Figure 13) shows a deeper understanding of the contribution of traffic to the NO_2 concentration near the CAZ.

Figure 13: Trends in Rinc in the CAZ_Boundary area since 2012.



Comments and key findings:

- In this analysis, the Rinc of the annual average of NO_2 concentration from seven sites (which have data since 2012) within the CAZ_Boundary area, minus the annual Alexandra Park NO_2 concentration average.
- The Rinc is useful as it demonstrates the proportion of NO_2 pollution from road traffic sources, as opposed to other sources e.g., gas boilers.
- Background sites are positioned away from roads to avoid localised pollution from road traffic. In Bath, the urban background location is at Alexandra Park, which is in the urban area outside of the CAZ.
- We have sited new background locations around B&NES in all three site groupings to improve data collection
- Rinc enables you to calculate what proportion of NO_2 pollution comes from vehicles on local roads, with a more representative measurement of background air pollution over several square kilometres.
- There is a clear decreasing trend in the Rinc since 2014 due to natural fleet upgrades and the introduction of Euro 6 in 2015.
- The Rinc in 2020 was likely lower than it would have been due to Covid lockdowns. In 2021, traffic returned to pre-pandemic levels, but the Rinc still decreased.

5. Impacts of the CAZ on traffic flow

A clean air zone is primarily designed to improve the compliance of vehicles driving in polluted areas rather than reducing traffic volumes i.e., it is aimed at reducing pollution, not congestion.

However, road traffic is the most significant cause of NO_2 pollution in Bath, so we monitor any changes in traffic flow in and around the zone and on the highway network around the city. This data helps us understand whether the zone is negatively impacting air quality and/or road safety on other roads.

5.1 How we measure changes in traffic flow

We monitor the direction and volume of traffic on specific routes using manual classified counts (MTC), automated traffic counts (ATC) and automatic number plate recognition (ANPR) cameras.

Our report focuses on key roads inside and outside the clean air zone and on connecting highways. Traffic flows are continually monitored at various locations across the city and, for the purpose of monitoring the impact of the CAZ, are reported quarterly and annually.

To understand the impact of the zone we compare data from a similar time frame in 2017 or 2018. We have discounted data from 2020 due to the unprecedented impact on traffic and travel caused by the Covid-19 restrictions. In addition, the Council has insufficient data for the year 2019. Sometimes there is no baseline data to draw on if the monitoring location is new or temporary.

It is important to remember that not all vehicles are chargeable, and most vehicles have no need to avoid the zone or seek alternative routes. Our traffic counts record any traffic movement, regardless of the vehicle type or compliance status.

Online shopping and home-deliveries are increasing, which is leading to more commercial vehicles on the roads. In mid-September 2021, light goods vehicles increased to 112% of their pre-pandemic levels while heavy goods vehicles increased to 110%. Cars reduced to 97% of their pre-pandemic level. (Department for Transport statistics).

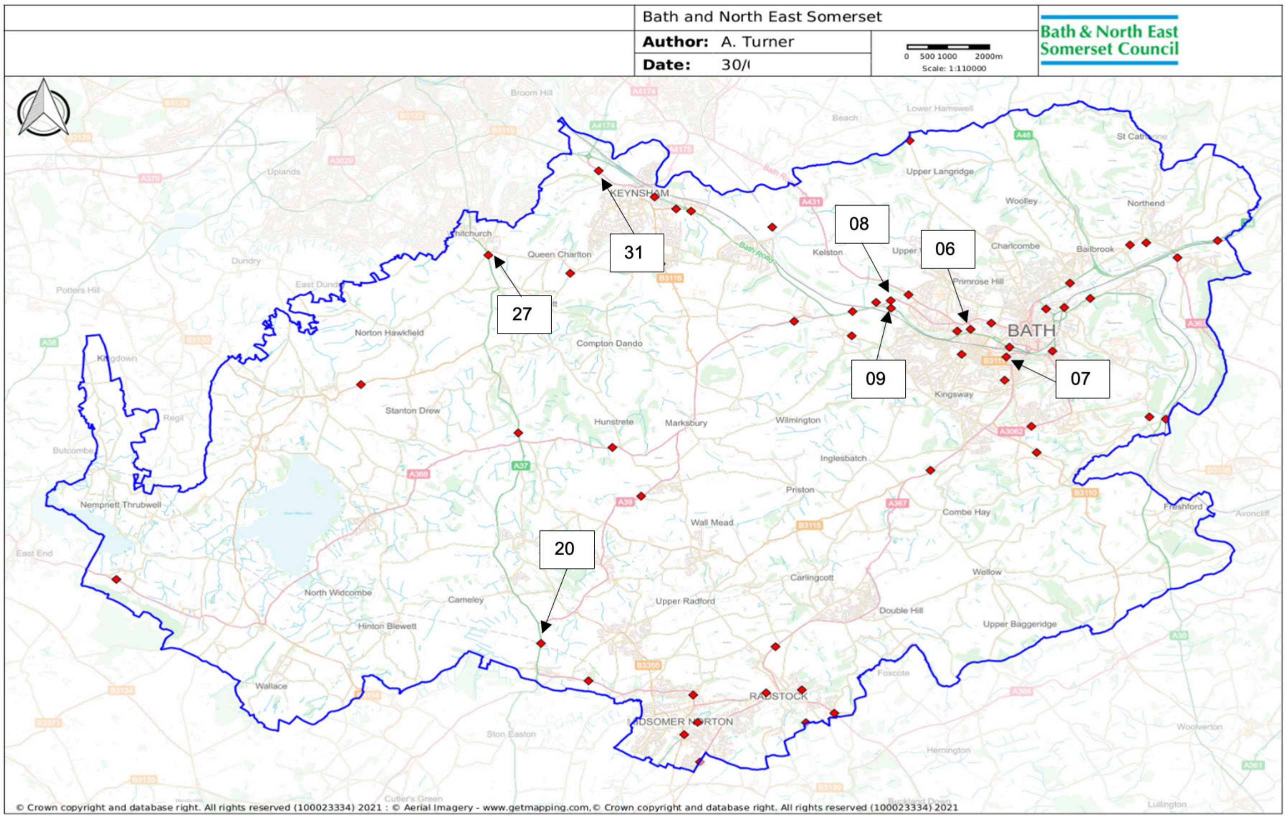
Figure 14 shows a map of the wider area, including the city of Bath, where automatic traffic counts (ATCs) are in place to analyse traffic flow. A list of the locations used in the analysis can be found in Table 8. These permanent ATCs were selected as they were in use prior to the introduction of the CAZ and can therefore be used for comparison purposes.

Where possible we have used three sites from each site grouping to draw conclusions. In the case of the CAZ, only one site had consistent data. Other monitoring methods such as temporary ANPR cameras will be used to monitor areas of perceived concern. For more information see **Appendix 2: Investigating traffic displacement concerns**.

Table 8: ATC locations from Figure 14 in their site grouping.

Site ID	Location	Site Category
06	A3064 Windsor Bridge, North of Stable Yard	CAZ_Boundary
07	A367 Wells Road- North of Hayesfield Park	CAZ_Only
08	A4 Newbridge Road, East of A36 Lower Bristol Road	CAZ_Boundary
09	A36 Lower Bristol Road, East of Newbridge	CAZ_Boundary
20	A37 Farrington Gurney, South of A39	Wider_B&NES
27	A37 Bristol Road Whitchurch, South of Norton Lane	Wider_B&NES
31	A4175 Durley Hill, West of Durley Hill	Wider_B&NES

Figure 14: ATC locations (red diamonds) used for traffic flow analysis. The number refers to the site ID which can be found in Table 8. © Crown Copyright 2021. License number 100023334.



5.2 Traffic flow data results

Annual and quarterly traffic flow data is analysed here to identify short and long-term trends. This section outlines data from the selected ATCs and is used to identify trends in and around the CAZ. Later in the report, and primarily in Appendix 2, we discuss areas of potential CAZ traffic displacement, how we investigate these and what measures we are putting in place to avoid displacing traffic.

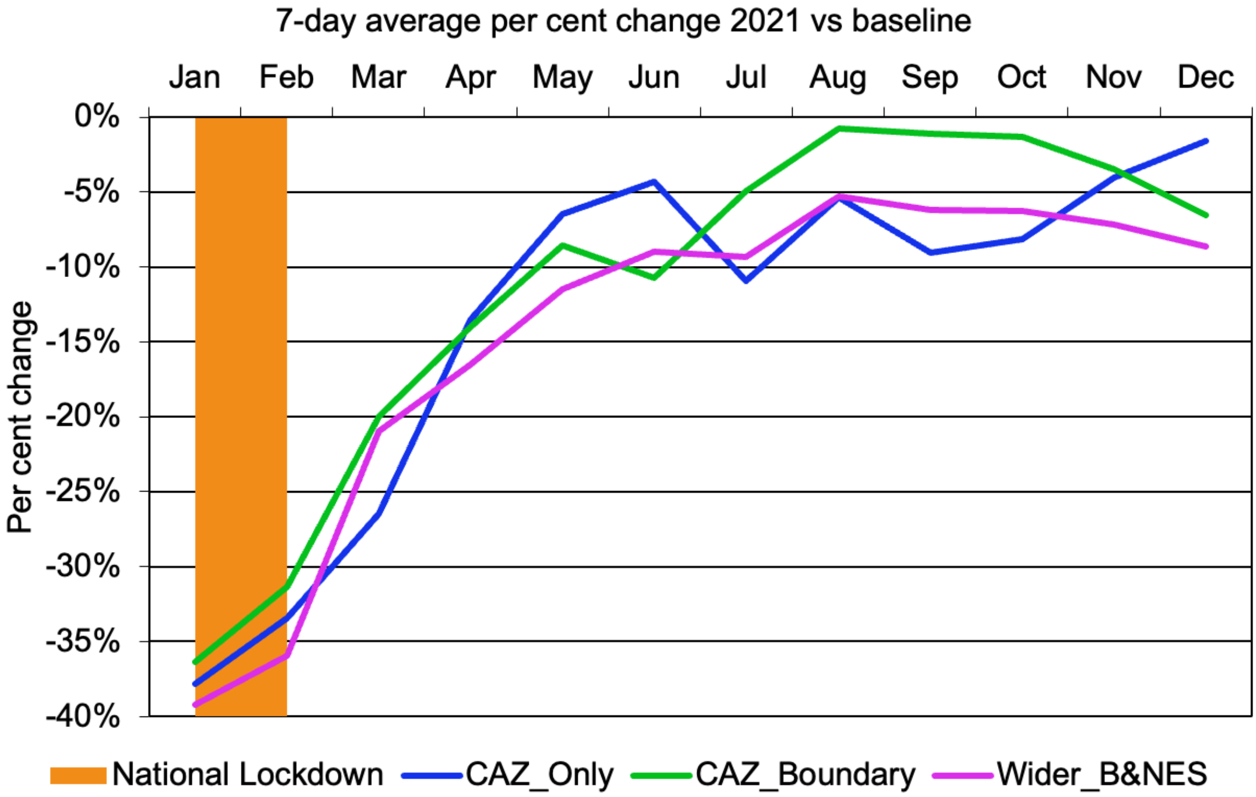
Table 9: Two-way traffic flow data for ATCs by site grouping from the last year with representative data (2017 or 2018) and 2021. The highlighted orange quarter was when a national lockdown was in place, restricting movements.

Year	Quarter	7-day average		
		CAZ_Only	CAZ_Boundary	Wider_B&NES
2017/ 2018	1	16574	14426	15779
	2	16930	15168	17002
	3	17021	14799	16815
	4	17146	14653	16207
2021	1	10718	10210	10699
	2	14670	13486	14906
	3	14482	14464	15645
	4	14908	14110	15020

Table 10: Percentage change in average monthly traffic flows from 2017/18 to 2021. The bottom row shows the average change between the years.

Month	7-day average		
	CAZ_Only	CAZ_Boundary	Wider_B&NES
January	-38%	-36%	-39%
February	-33%	-31%	-36%
March	-26%	-20%	-21%
April	-14%	-14%	-17%
May	-6%	-9%	-11%
June	-4%	-11%	-9%
July	-11%	-5%	-9%
August	-5%	-1%	-5%
September	-9%	-1%	-6%
October	-8%	-1%	-6%
November	-4%	-3%	-7%
December	-2%	-7%	-9%
Average change 2017/2018 to 2021	-13%	-12%	-15%

Figure 15: 2021 traffic levels compared to the baseline year across all site groupings



Comments and key findings:

- At the beginning of 2021, during the Covid pandemic lockdown in January/ February, traffic in all areas was 35% below pre-pandemic levels.
- At the end of the final lockdown in Spring 2021, traffic levels increased to between 5% and 15% below normal pre-pandemic levels.
- Traffic volume returned to within 10% of pre-pandemic levels in all areas by August 2021.
- Traffic flows in the zone returned to pre-pandemic levels by December 2021, while those in the urban area outside the CAZ returned to pre-pandemic levels by August 2021 (before decreasing again towards the end of the year).
- Only one site was used to analyse the area within the CAZ so some caution must be used when drawing conclusions.
- In addition, the closure of Cleveland Bridge is known to be significantly affecting the levels and directions of traffic flow throughout the entire second half of 2021 (28 June 2021- November 2021: full closure; November 2021 onwards: partial closure).
- Nationally, traffic levels have generally returned to pre-pandemic levels (Department for Transport)[8].

[8] Department of Transport statistics from the Office for National Statistics. Economic activity and social change in the UK, real-time indicators, 2021 https://www.ons.gov.uk/economy/economicoutputandproductivity/output/bulletins/economicactivityandsocialchangeintheukrealtimeindicators/23september2021

Diurnal traffic flow trends

An ‘inner-cordon’ traffic survey has been carried out in Bath using data from eleven ATCs (Figure 16), that are roughly around the zone’s boundary. The survey has not been consistent and there is missing data, but it can offer insights into the diurnal trends in traffic flow in the city centre to help us understand changing travel behaviours.

Figure 16: Map of inner-cordon ATC sites for hourly traffic flow analysis.

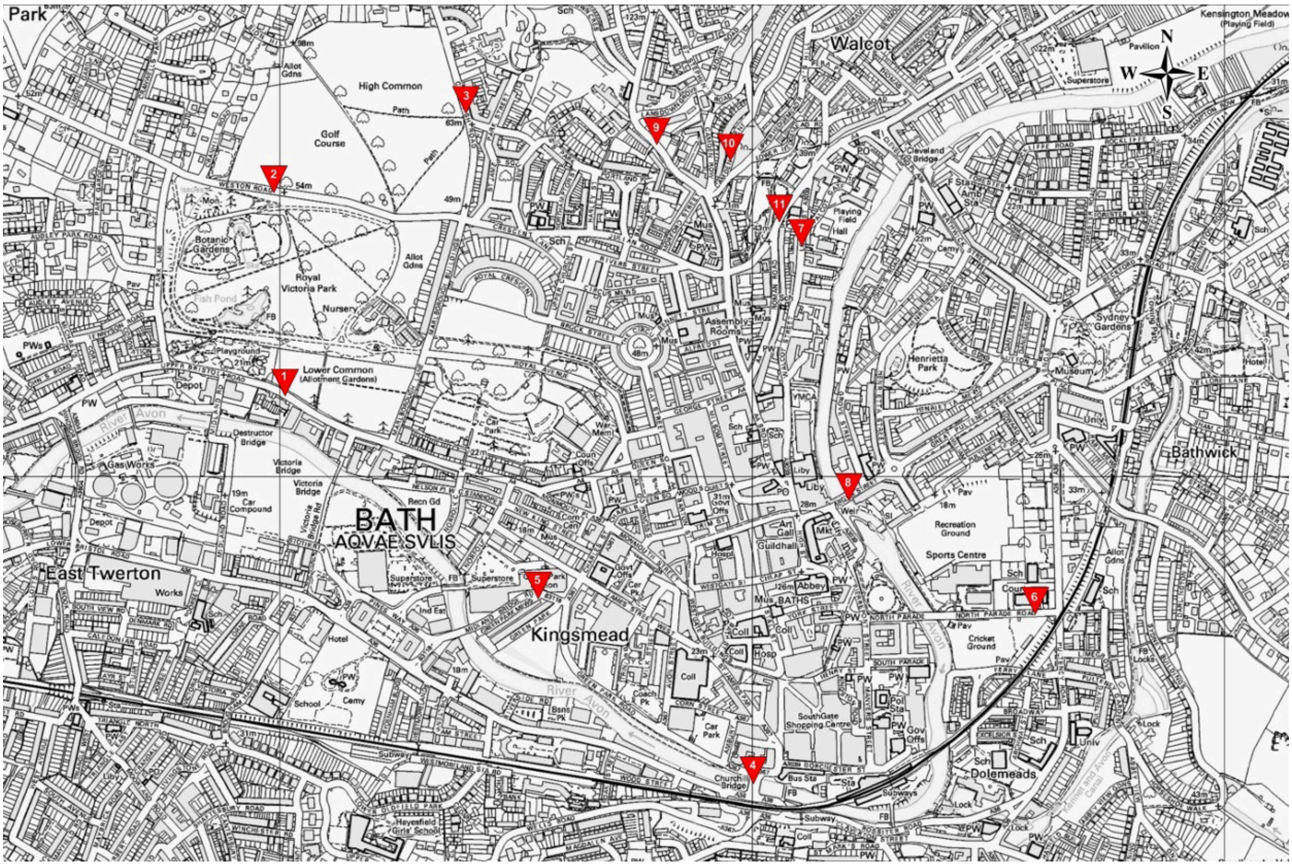
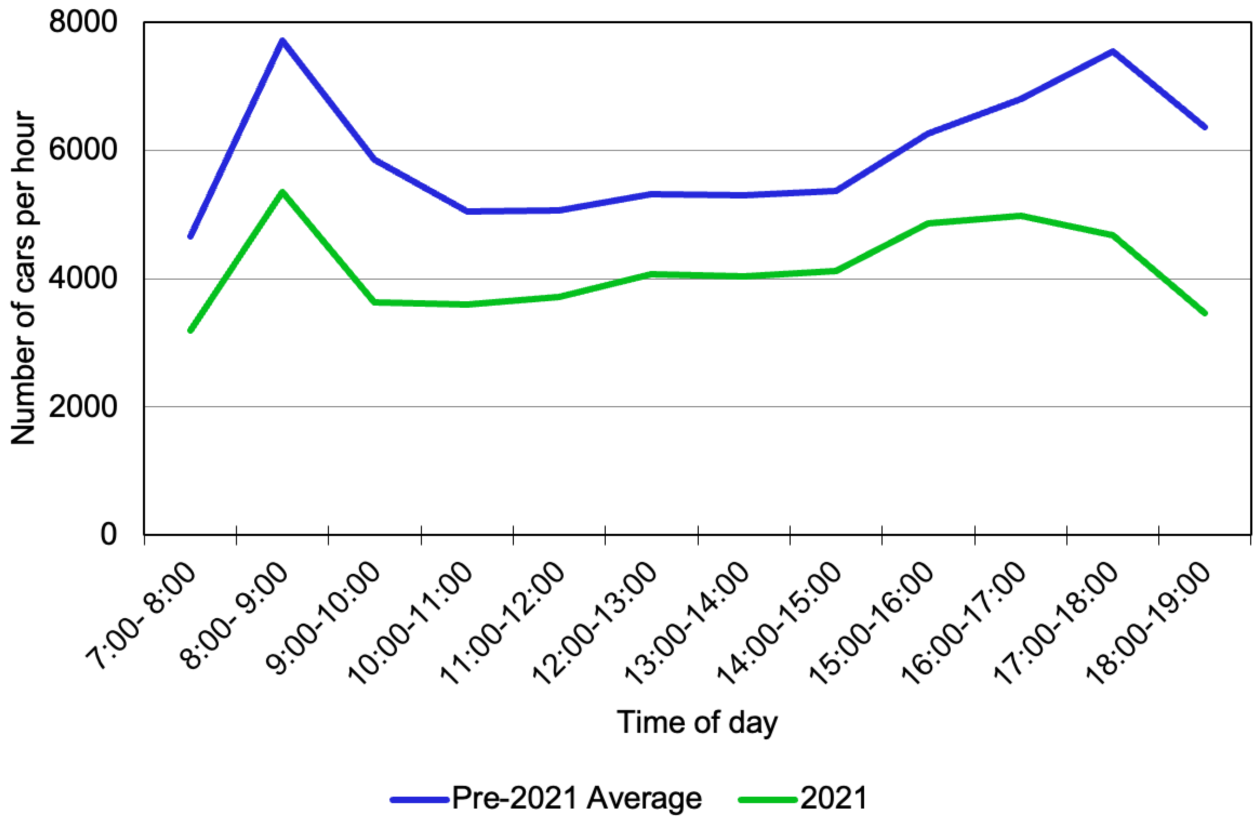


Figure 17, below, shows the number of cars passing eleven ATCs within Bath city centre (split over a day) to illustrate changes that occurred in 2021. The pre-2021 average is from 2000-2020 without 2014 and 2019 which equates to an 18-year average.

Figure 17: Bath inner cordon car count over the time of day. The pre-2021 average draws on data from 2000-2020.



Comments and key findings:

- Fewer cars travelled through the inner cordon in 2021 compared to the pre-2021 average. The morning peak (8-9am) saw almost 8,000 cars on average (pre-2021) but in 2021, we recorded around 5,000 cars on average.
- Throughout the day in 2021, 2,000 fewer cars were recorded per hour than the pre-2021 average (and up to 3,000 fewer were recorded in the evening).
- The Covid pandemic has contributed to the changes, with a lockdown in early 2021, increased working from home and online shopping.
- In 2021, the morning peak remains between 8-9am while the evening peak is reduced. Pre-2021 shows a peak between 5-6pm whereas there is a more extended and less pronounced peak in 2021 between 3-6pm.

Background on traffic flows in 2021

Travel patterns have changed significantly in the last few years due to the pandemic.

While pre-pandemic statistics show that rural areas traditionally had higher rates of home working (at around 32% compared with urban areas at around 13%[9]), this has risen to 36% post-pandemic (according to a snapshot of the proportion of people home-working in the UK in January 2022).

With less people going to work at all times of day, and a noticeably diminished evening peak hour (Figure 17), traffic movements are spread across the day, potentially reducing the impact of highly concentrated air pollution due to less congestion. In addition, more people may be leaving their homes at different times of the day for shopping or leisure, taking the pressure of roads at peak times.

Home deliveries and e-commerce have also increased, reaching a record 35% of all retail spend[10]. This may account for greater numbers of vans and HGVs on local roads.

The overall picture by the end of 2021 shows traffic generally returning to just below pre-pandemic levels but with different patterns due to a shift in work and travel behaviours.

5.3 Local links between traffic levels and air quality

We are carefully monitoring traffic in locations where annual or quarterly average NO_2 concentrations remain above 40 μg/m^3 or have an increased quarterly average concentration.

In some locations we have traffic flow data collected from either ATCs or the zone's ANPR cameras, which are located very close to diffusion tube sites. These sites can be used to assess the relationship between traffic flows and NO_2 concentrations in a specific location. However, it's important to note that vehicle emissions are not the only source of NO_2, so traffic volume and composition are not the only determining factors of total concentrations.

In the fourth quarter of 2021 (Oct to Dec), four sites recorded an average NO_2 concentration above 40 μg/m^3 as well as an increased concentration, when compared to the fourth quarter in 2019 (Dorchester Street, St James Parade, Wells Road 4 and Chapel Row 2). Two of these sites (Chapel Row and Wells Road) have diffusion tube data and traffic flow data located within 20 metres of each other.

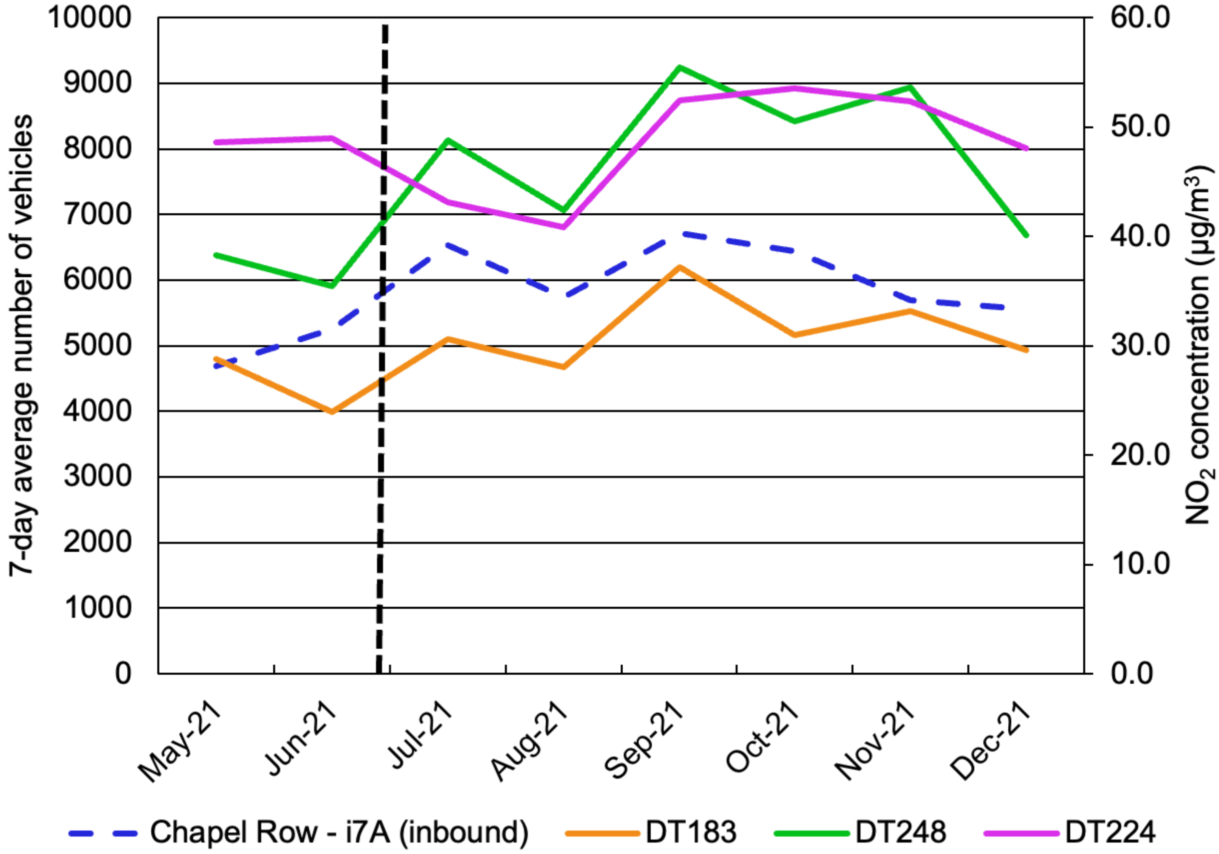
[9] DEFRA. Statistical Digest of Rural England, 2020. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/984921/Home_Working_Dec_2020_final_with_cover_page.pdf

[10] ONS. Retail sales, Great Britain, January 2021. https://www.ons.gov.uk/businessindustryandtrade/retailindustry/bulletins/retailsales/january2021

Chapel Row

At Chapel Row, NO_2 concentrations increased in the summer months. The likely cause is an increase in traffic volumes through this area, as NO_2 concentrations track the changes in traffic flow (Figure 18)

Figure 18: One-way eastbound traffic flow on Chapel Row (left y-axis) plotted with NO_2 concentrations of diffusion tubes (DT183, DT248, DT224; right y-axis). The closure of Cleveland Bridge is shown by the dotted black line, traffic flow is represented by the blue dotted line (Chapel Row – i7A (inbound).



During the summer of 2021 the daily number of vehicles travelling through Chapel Row inbound towards Queen Square rose from 4,500 in May 2021 to nearly 6,500 during the summer months (Figure 18). The increase in traffic was mainly due to a diversion in place due to the closure of Cleveland Bridge for essential repairs.

The bridge fully closed to traffic on 28 June 2021. The official diversion directed vehicles over Windsor Bridge, with expected increases in traffic on the A4 and A36. Vehicles below 7.5T were able to use central routes through the city centre. Traffic flows during the second half of 2021 were affected by the closure, with drivers finding alternative routes through Bath. As of November 2021, the bridge had reopened to light traffic in a two-way shuttle mode.

The NO_2 concentrations at both diffusion tubes located on Chapel Row mirror the traffic flow trend into Queen Square. DT248 is located on the north side of the road (the side the traffic flow data comes from) while DT183 is located on the south side of the road.

In addition to these observations, our highways team noted an increase in peak outbound/ eastward flows at the Walcot Parade junction during the Cleveland Bridge closure. This increase in the outbound number of vehicles during the peak hour was from around 500 vehicles per hour pre-bridge closure, to around 650 vehicles per peak hour after the bridge closure. Traffic that would have previously arrived at the junction from Cleveland Bridge, instead approached via Walcot Parade (during the closure and continued partial closure).

The width restriction on the bridge and shorter green time for traffic approaching the bridge, resulted in less demand on the Walcot Parade junction. Walcot Parade eastbound traffic was, as a result, given more green time, therefore allowing a better flow of traffic eastwards on the London Road. The consistent flow contrasts to the normal flow which is stopped by traffic signals allowing vehicles to move onto and off the bridge.

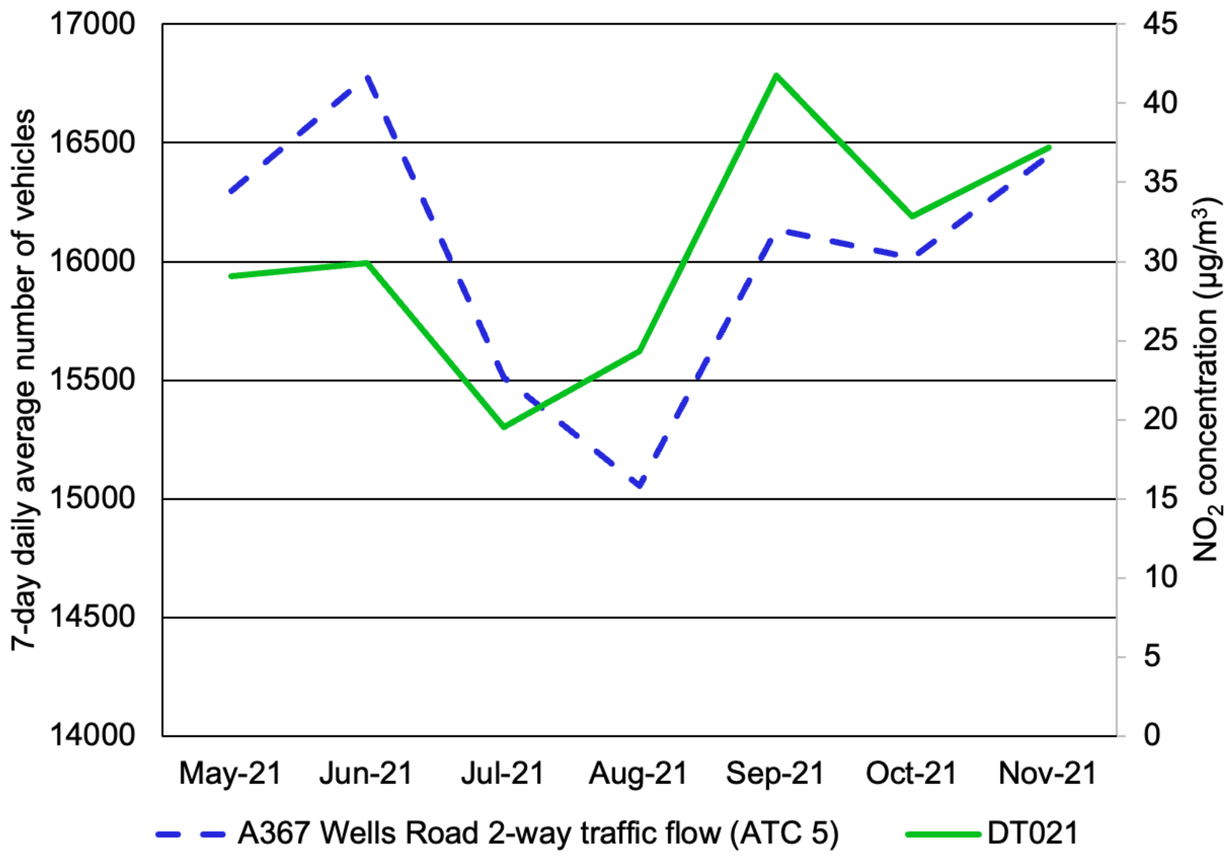
This may be why NO_2 concentrations at the worst-performing diffusion tube, Walcot Parade 2 (DT224), reduced by 22%, from 55.2 μg/m^3 in 2019, to 43.1 μg/m^3 in 2021. This contrasts to the NO_2 concentration at Chapel Row (DT248) where NO_2 concentrations decreased by only 4% from 38.3 μg/m^3 in 2019 to 36.6 μg/m^3 in 2021. This much smaller reduction in NO_2 could be due to the increased traffic on Chapel Row.

The bridge closure allows more capacity on London Road and Walcot Parade but with less stop starting. The reduction in stop-starting reduces the amount of acceleration events and cooling of catalysts, resulting in lower emissions of NOx.

Wells Road

The other site which has both ATC and diffusion tube locations within a short distance of each other, is Wells Road. The two-way traffic flow and closest diffusion tube are shown in Figure 19. Again, the trend for NO_2 concentrations, closely follows the trend for traffic volumes. These results demonstrate how fluctuating traffic flows can directly affect local air quality.

Figure 19: Two-way traffic flow on A367 Wells Road (north of Hayesfield Park; left y-axis) plotted alongside the NO_2 concentration of diffusion tube site Wells Road/ Upper Oldfield Park (DT021; right y-axis).



The Council monitoring these locations, including real-time monitoring, to understand which vehicles are producing the most significant emissions and why.

The following section describes our commitment to monitor areas of potential traffic displacement due to the CAZ. A CAZ will always cause some level of displacement, but air quality has improved in the boundary area outside of the zone, more so than within the zone itself.

6. Areas of potential traffic displacement

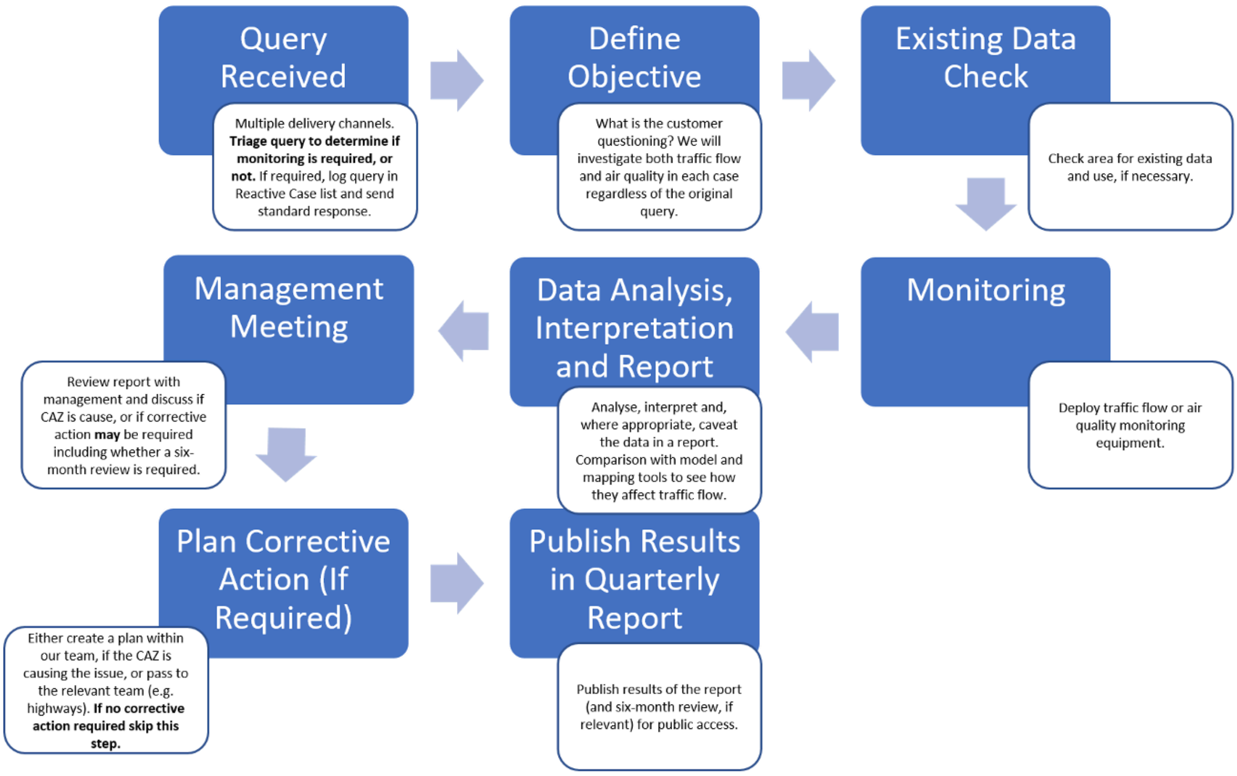
A key commitment of the Council was to monitor any concerns arising from the introduction of the CAZ. The purpose is to improve vehicle compliance rates while minimising the impact on normal traffic flows. Nationally, average traffic volumes have returned to pre-pandemic levels and the numbers of LGVs and HGVs on the network are now exceeding pre-pandemic levels (Department for Transport).

We are actively investigating over a dozen discrete locations where the public have expressed concern about a perceived increase in traffic in their communities since the launch of the CAZ. All locations logged and active are set out in **Appendix 2**.

How we're investigating possible traffic displacement

From the launch of the CAZ in March 2021, comments from residents about potential CAZ-related impacts have been logged and investigated. Figure 20 shows the process we have put into place when following up these queries.

Figure 20: A process map showing the details of the traffic displacement process followed when a query is received.



Comments about traffic displacement:

- The pandemic was an unforeseen event that was not predicted and inevitably, traffic flows have been impacted in a way outside of any modelling done for the Full Business Case.
- In early 2021, there were lower levels of traffic, particularly cars, although the increase of home deliveries has increased to a record 35% of all retail spend[11], which accounts for a proportion of the greater numbers of LGVs and HGVs in local communities. As lockdown restrictions have lifted the numbers of commercial vehicles have increased beyond pre-pandemic levels.
- In June 2021, Cleveland Bridge closed to traffic for urgent repairs to the structure of the bridge. Despite partially reopening in November 2021, the impact of the closure of the bridge displaced traffic throughout the second half of 2021.

Overview of cases:

Please see Appendix 2 for more detailed traffic displacement monitoring information.

- Some locations were due to be monitored again after the full reopening of Cleveland Bridge, however, unexpected structural repairs to the bridge meant this was delayed. Therefore, given the partial bridge closure these surveys were arranged at a time where the disruption to traffic would be minimal.
- ANPR surveys were repeated at Lyndhurst Road (Oldfield Park), Whiteway Road and Lansdown Lane to understand the traffic composition.
- We are aware that the monitoring survey at Charlcombe Lane in October 2021 may have been affected by a partial road closure within the area. This survey was therefore repeated in June using three temporary automatic traffic counters.
- We are continuing to monitor NO_2 concentrations at Twerton High Street to understand the trends in results.
- Upon reviewing Old Newbridge Hill there have been no further concerns regarding traffic displacing as result of the CAZ. However, the Traffic Regulation Order surrounding a new weight restriction is still being developed with highways.
- We reviewed and undertook further monitoring in the following areas of investigation: Upper Camden Place, Southdown Road, Shophouse Road, Penn Hill Road, Englishcombe Lane and Cavendish Road.
- We reviewed the following areas of investigation where no discernible increase or concerning traffic issues were found: Rosemount Lane, Sham Castle Lane, Prior Park Road and Norton St Philip. These cases will be removed from the appendix in the following report.

[11] ONS. Retail sales, Great Britain: January 2021.
https://www.ons.gov.uk/businessindustryandtrade/retailindustry/bulletins/retailsales/january2021

7. The impact of the CAZ on fleet compliance

Transport is widely acknowledged as a key driver of air quality issues. It is estimated that around 92% of all Nitrogen Oxide (NO_x) emissions in the wider area are attributable to road traffic. Older vehicles generally emit more NO_x as recent technological advances in selective catalytic reduction has led to a lowering of NO_x emissions from vehicles, particularly those with a Euro 6 standard.

The purpose of the CAZ is to speed up the natural replacement of older, more polluting vehicles with cleaner, compliant ones that meet the city's minimum emission standards. It does this by levying charges on owners of non-compliant vehicles that don't meet emission standards (i.e., pre-euro 6 diesel and pre-euro 4 petrol vehicles), so that they are incentivised to upgrade or replace their vehicle sooner than they might otherwise do (to avoid paying a daily charge). In Bath, financial assistance is available to help support businesses and individuals that need help to do this, mitigating the impact of charges.

Improvements in Bath's fleet are brought about in the following ways:

- Naturally as part of regular fleet upgrade programmes and because of pressure on manufacturers from government, environmental organisations and the public to improve vehicle emissions.
- More recently and locally, as a specific reaction to the introduction to Bath's CAZ and other zones around the country e.g., drivers bringing forward plans to upgrade or replace older vehicles to avoid charges.
- And in response to direct Council and government-funded interventions to encourage upgrades, including a bus retrofit scheme and the financial assistance scheme which offers grants and or interest-free finance to those regularly driving in the zone to replace non-compliant vehicles.

To understand whether the CAZ is working to reduce emissions and air quality, we are monitoring rates of vehicle compliance in the zone.

7.1 How we measure fleet compliance in Bath

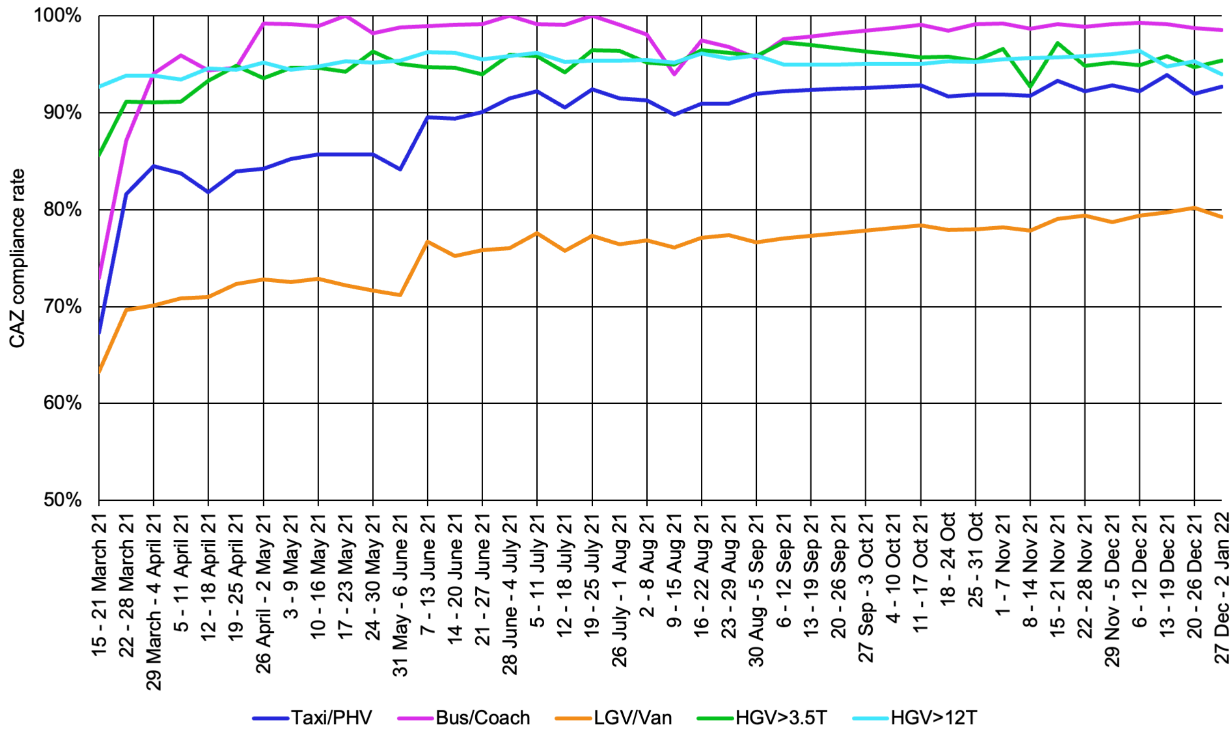
We measure changes in fleet composition using data gathered from 68 automatic number plate recognition (ANPR) cameras positioned around the perimeter of Bath's CAZ, and within the zone itself. Where traffic displacement concerns have been raised outside of the zone, and we have determined that there is an increase in traffic flow, additional compliance monitoring is being undertaken using temporary ANPR cameras. See: Appendix 2.

The camera captures individual number plates which are then cross referenced with a DVLA vehicle database to establish the number of vehicles in the zone on any given day, the type of vehicle captured in the zone e.g. bus, HGV, van etc., its age, and the euro standard of the vehicle (if available). This enables us to understand the number of compliant vehicles driving in the zone and in areas of potential traffic displacement. This is presented as a percentage of total vehicles driving in these areas each week.

To understand how fleet compliance in the zone has changed following the introduction of the CAZ, we are looking at weekly data from the cameras. We include data from our additional temporary monitors in the traffic displacement section of the report.

7.2 Vehicle compliance data for Bath CAZ

Figure 21: Vehicle compliance rates within the CAZ as a 7-day average. Please note the y-axis compliance rate starts at 50%.



Comments and key findings:

- 40,000 unique vehicles drive in the zone each day, on average (compliant, non-compliant, chargeable and non-chargeable vehicles)
- A vehicle is compliant when it meets the minimum emission standards for Bath's CAZ i.e., it's either euro 6 diesel, euro 4 plus petrol, hybrid, alternatively fuelled vehicles or an electric vehicle.
- Most vehicles in the zone are private cars, with 28,500 unique private cars seen in the zone each day during 2021. This equates to 71% of all vehicles.
- Private cars and motorbikes are not charged
- The percentage of chargeable non-compliant vehicles (as a percentage of all traffic) entering the zone each week fell from 6% in the launch week to 1% by the end of 2021.
- 1,146 non-compliant vehicles were seen in the zone, on average, each day, during March/April compared to 550 each day, on average, during December 2021, a decrease of 52%.
- Bus/coach compliance rose from 73% during the launch week to around 99% by the end of 2021. 109 individual buses/coaches were recorded, on average, in the CAZ each day during 2021.
- HGV compliance for vehicles weighing greater than 12T rose from 93% during the launch week to around 96% by the end of 2021. An average of 288 vehicles were recorded in the CAZ each day during 2021.
- HGV compliance for vehicles weighing greater than 3.5T but less than 12T rose from 86% during the launch week to around 96% by the end of 2021. An average of 119 vehicles were recorded in the CAZ each day during 2021.

- Taxi/PHV compliance rose from 67% during the launch week to around 93% by the end of 2021. An average of 385 individual taxis/PHVs were recorded in the CAZ each day during 2021.
- Van/LGV compliance rose from 63% during the launch week to 80% by the end of 2021. 3,143 individual vans/LGVs (compliant and non-compliant) were recorded in the CAZ each day (on average) during 2021.
- Rates of compliance are anticipated to continue to improve in the next year, particularly with respect to the supply of compliant LGVs which have been impacted most significantly by the pandemic.
- Compliance was supported through the government-funded financial assistance scheme and bus retrofit schemes, in addition to drivers upgrading outside of the schemes.

8. The impact of the CAZ on other measures

We committed to measuring the impact of the zone on the city of Bath, in terms of footfall, business, retail, public transport etc to understand any adverse or positive effects. The plan was published prior to the Covid pandemic and during the public consultations when we were potentially proposing a class C charging CAZ that would also charge private cars.

After significant consultation, a charging zone C (not charging private cars) was approved and the CAZ was launched five months later than planned in March 2021, more than a year into the Covid pandemic.

Please note: The following measures may well have been disproportionately affected by Covid-19 and many of our partners, providing data, have concluded that the effect of Covid is far greater than that of the CAZ. Nonetheless, we have considered each measure to assess the effect of the zone.

8.1 Retail, business, and office space vacancy rate

Vacancy figures for buildings within Bath are considered to assess whether the CAZ has had an impact on the number of businesses operating in Bath, with a view to ensure the economic impacts of the CAZ are not negative.

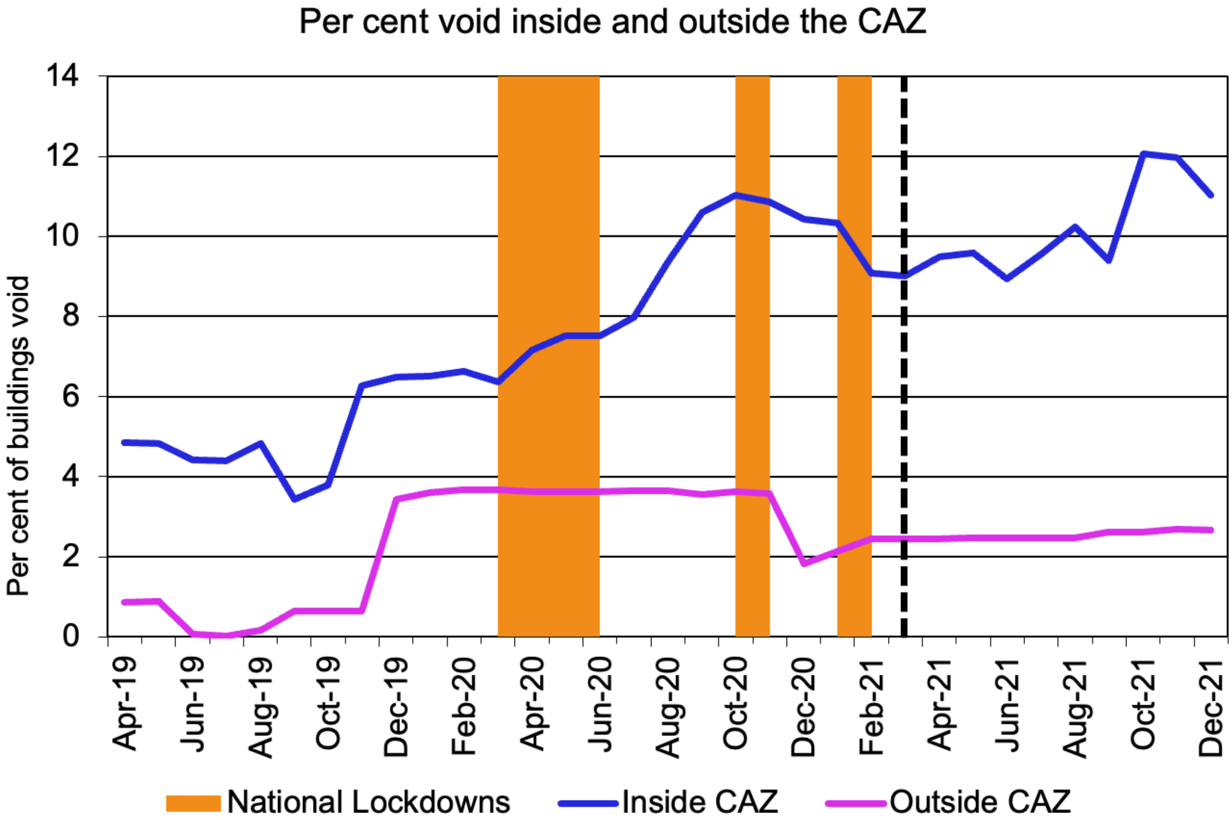
This data is continually collected by the Council's Property Services team, in relation to its own assets. Most of the Council-owned properties are within the CAZ.

The theoretical rent is the full amount the Council could collect if all the Council-owned properties were filled. In mid-2019 (pre-pandemic) the Council had a total theoretical rent of approximately £16,500,000 inside the CAZ and approximately £510,000 outside the CAZ. By mid-2021 these values had fallen to approximately £14,500,000 inside the CAZ and risen to approximately £540,000 outside the CAZ.

To add context to the general picture, rental values in the centre of Bath have dropped dramatically in the last few years, with rents now approximately 30-40% below what they were 5 years ago. The reason the theoretical rent has dropped is largely due to the impact of Covid, together with the move of some retailers to online retailing, reducing demand for business space in the centre of cities.

Figure 22 below shows the percentage of the Council-owned buildings which are vacant at a given time.

Figure 22: The percentage of Council-owned buildings vacant. The CAZ launch is shown by the dotted black line.



Comments and key findings:

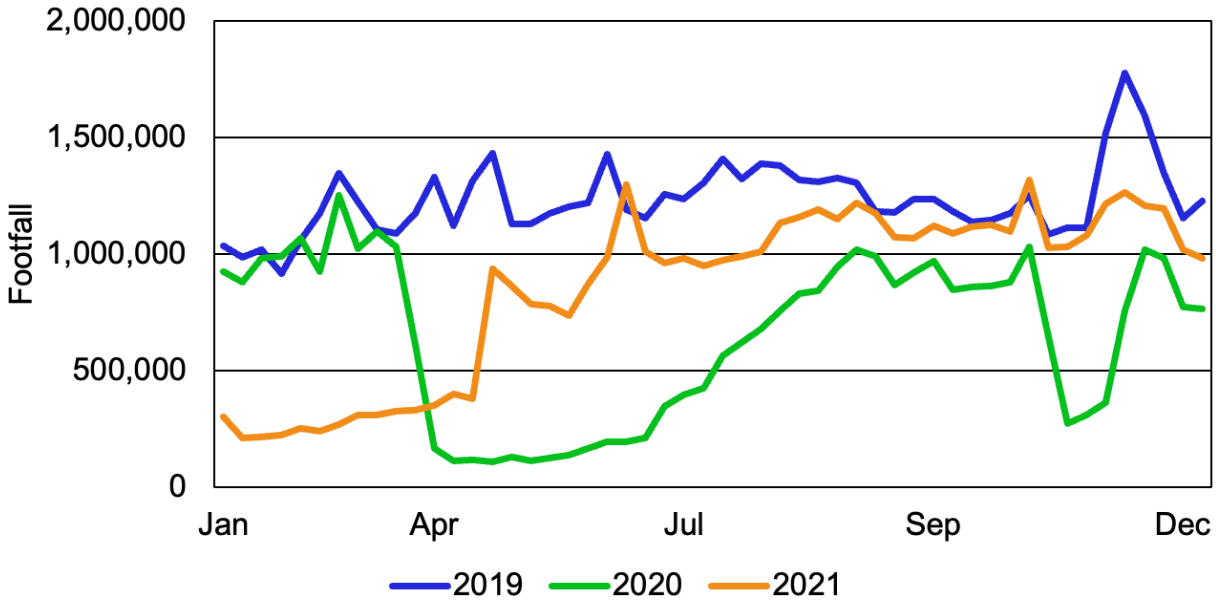
- The percentage of Council-owned buildings which are vacant within the CAZ has risen from 5% in mid-2019 to 11% by the end of 2021.
- The percentage of Council-owned buildings which are vacant outside of the CAZ has risen from around 1% in mid-2019 to 3% by the end of 2021, however there are fewer Council-owned properties outside of the CAZ.
- The recent increase in the vacancy rate can be attributed to Covid with a clear increase in the CAZ vacancy rate after the first lockdown.
- There was very little change in the vacancy rate inside or outside the CAZ within the first six months of the CAZ.

8.2 Retail footfall rates

Footfall data from Bath Business Improvement District (BID) has been analysed to understand the number of people in Bath. The data is collected by Bath BID and is not the Council's own data.

Figure 23 shows the total footfall in Bath from 2019 until 2022, from the following locations: Burton Street, House of Fraser (Milsom Street), Milsom Street, Northgate Street, Sawclose, Southgate Street. The three national lockdowns are highlighted on the graph.

Figure 23: Footfall data in Bath city centre from the Bath BID. Data is collected from the following locations: Burton Street, House of Fraser (Milsom Street), Milsom Street, Northgate Street, Sawclose, Southgate Street.



Comments and key findings:

- Prior to the pandemic in 2019, footfall figures remain relatively stable, with peaks associated with some holidays such as Easter and a more defined peak at Christmas.
- In 2020, there are three sudden drops in footfall, firstly a sudden and extended drop in April 2020 during the first lockdown; later in 2020, there is another drop around the Autumn lockdown; and finally, the last lockdown can be seen in early 2021.
- There are clear returns to higher footfall after each lockdown and by mid-2021, footfall had almost returned to pre-pandemic levels.
- It appears that people are keen to return to Bath City Centre and its businesses when restrictions are not in place.
- The Christmas boom in shopping seen in 2019, cannot be seen in 2020 and 2021. This may be related to Covid levels and restrictions being implemented around these times. Plus, there was no Christmas market with its significant marketing budget to promote the city.

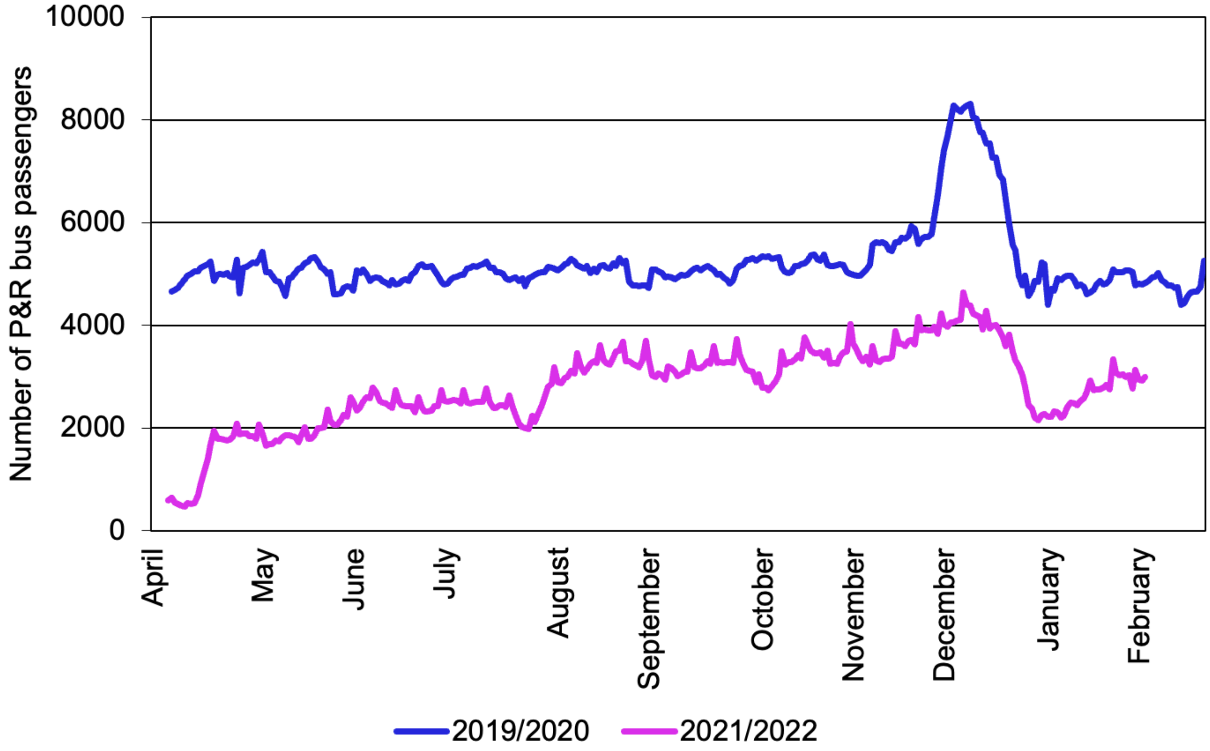
Bath BID VISA data shows that Bath has had a good post-pandemic recovery, and that the city is keeping pace, particularly around the food and drink sectors. Key factors could be Bath's outdoor appeal and the growth of outdoor eating spaces. There have been multiple campaigns aimed at highlighting Bath to UK visitors during the pandemic, for example, Rediscover Bath run by Bath BID in collaboration with Visit West, Visit Bath and Visit England.

As footfall figures remain high at the end of 2021, it is important to understand how people are travelling into the city and whether they are changing their habits as the pandemic is beginning to end.

8.3 Park and ride passenger rates

Park and Ride (P&R) data is collected by bus operators and contributed by WECA and shown graphically for 2019-2022 in Figure 24. The data is used to understand people's travel habits into the city of Bath. The P&R sites are located at Lansdown to the north of Bath (878 spaces), Newbridge to the west (698 spaces) and Odd Down to the south (1230 spaces). P&R can be an attractive method of travelling into Bath because of the price of parking being more expensive in the city centre than the P&R and because congestion can be an issue in the city centre.

Figure 24: Total daily Park & Ride bus passenger numbers for the three P&R sites in Bath: Lansdown, Newbridge and Odd Down. Note the figures are collected based on a financial year. The number of daily passengers has been smoothed in the figure to reduce the effect of weekday and weekend variation.



Comments and key findings:

- The average P&R bus ridership was stable throughout most of the year at around 5,000 daily passengers throughout most of 2019 prior to the pandemic, with an increase in people using the services around Christmas.
- The Covid pandemic clearly reduced passenger numbers with less than 1,000 riders per day after the third and final lockdown in Spring 2021.
- Ridership increased in 2021 but never returned to pre-pandemic levels, probably as people were still worried about Covid and more people were working from home.
- People taking the P&R in Winter 2021/2022 peaked at around 4,000 which is half that see in 2019/2020.
- In the Autumn and Winter of 2021/2022 people taking the park and ride averaged around 3,000 people daily.

While footfall data (Figure 23) has shown that Bath city centre has recovered from Covid, in terms of shoppers entering the city, the Park and Ride passenger numbers remain below what would be expected. This implies that people are not using the P&R as much as before and therefore travelling into the city via other means.

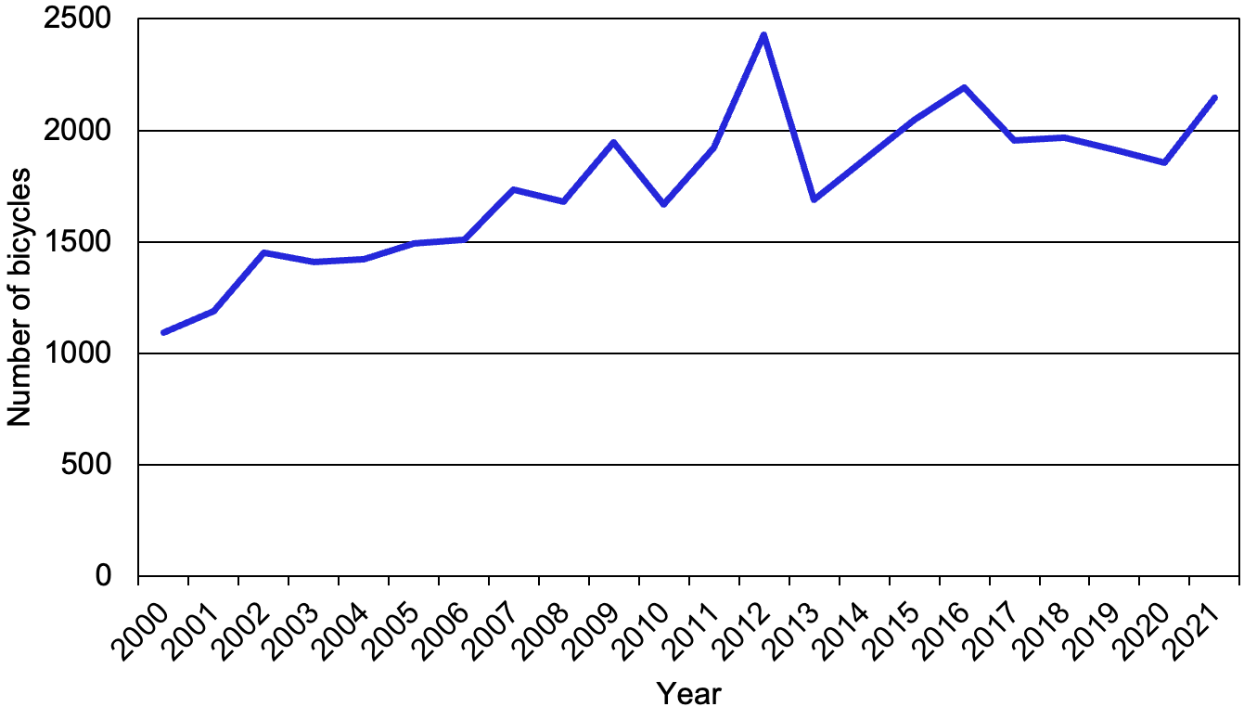
The Council aims to make Bath more attractive to people walking, cycling and using public transport. Alongside the CAZ, the Liveable Neighbourhoods scheme is working to reduce the dominance of cars on our roads and make our streets safer for walkers and cyclists.

8.4 Cycling counts

Cycling counts are collected by the Council to understand how people are travelling in Bath. Increasing active and sustainable transport is part of the wider Council strategy due to the associated health benefits of walking and cycling. The Council measures cycle numbers using a network of automatic traffic counters (ATCs) that can detect bicycles passing over them. Figure 25, below, shows the overall number of bicycles detected passing over eleven inner-Bath ATC sites.

Note: The data is from one day per year so can be significantly affected by bad weather.

Figure 25: Bath inner cordon bicycle count trend over the last 21 years.

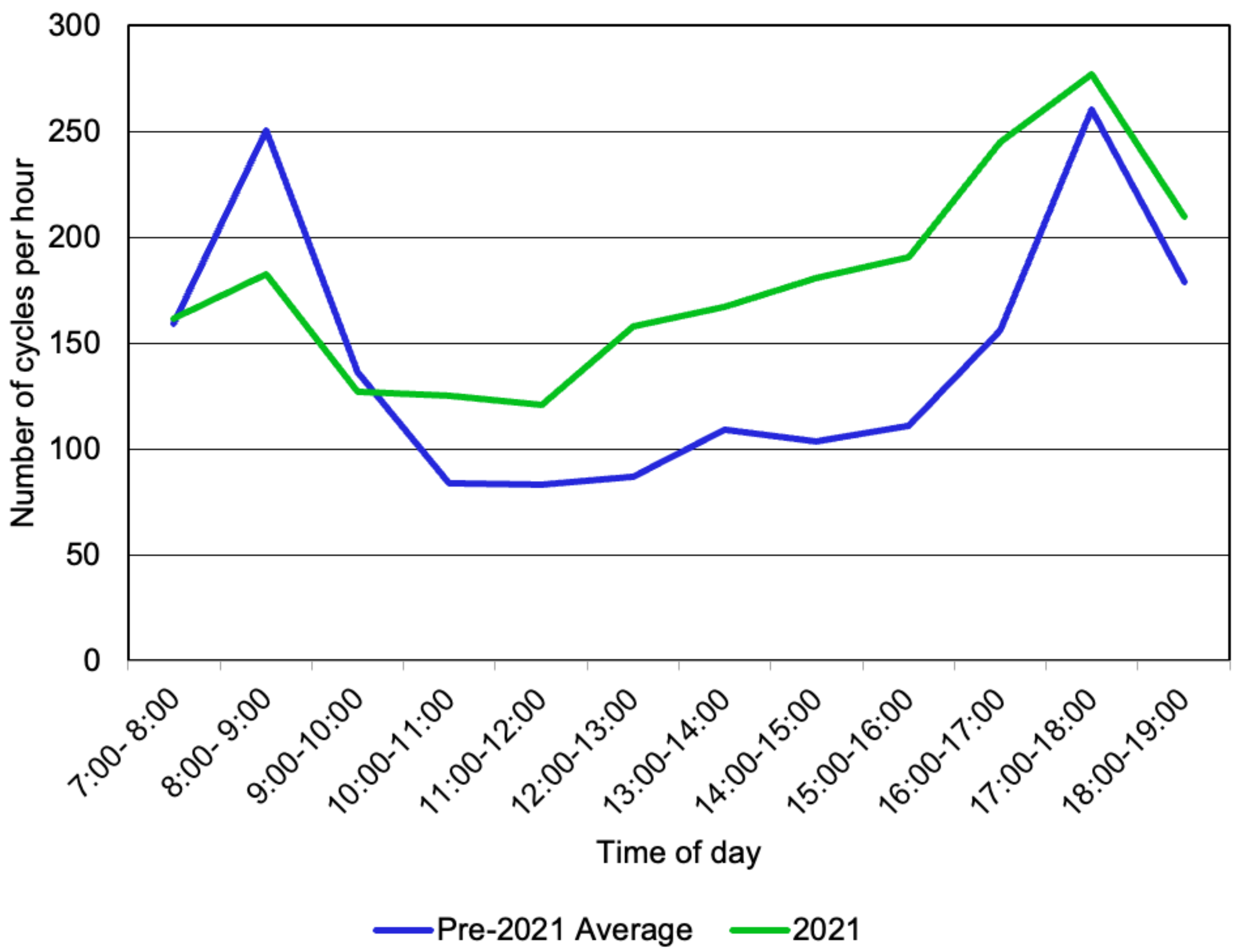


Comments and key findings:

- This survey is carried out on one day during the year so the weather can significantly change the number of people cycling that day.
- People choosing to travel by bicycle has increased in Bath since 2000.
- In 2021, more than double the number of bicycles were recorded compared to 20 years earlier.
- A peak in 2012 could be related to the London 2012 Olympics, which spurred interest in cycling around the UK.
- The Covid pandemic has boosted cycling with more people avoiding public transport modes.
- Schemes promoting active and sustainable travel are gaining traction across the country and in Bath, with Liveable Neighbourhoods as well as the CAZ promoting behaviour change.

Figure 26, below, shows the number of bicycles passing the same eleven ATCs but split over a day, to illustrate changes that occurred in 2021. The pre-2021 average is from 2000-2020 without 2014 and 2019 equating to an 18-year average.

Figure 26: Bath inner cordon bicycle count over the time of day. The pre-2021 average uses data from 2000-2020.



Comments and key findings:

- The pre-2021 daily spread of bicycles clearly shows a morning (8-9am) and evening (5-6pm) peak where rush hour existed.
- The hourly number of cycles in 2021 exceeds that of the pre-2021 average, except before mid-morning.
- The 2021 daily spread of bicycles retains both a morning and evening peak within the same time periods but both peaks are less pronounced, particularly the morning one.
- The lower 2021 morning peak would be consistent with more flexible working due to the Covid pandemic.
- Peak hours still exist in 2021 however the morning peak is diminished, potentially due to more people working from home.
- The evening peak in 2021 is less pronounced but there is a gentle increase in the number of bicycles from around midday implying that the commuting time has become more fluid, or people are travelling for different reasons such as shopping during the afternoon.

8.5 Bus usage rates

Now the scheme is operational, we have reviewed the available bus usage statistics and are unable to draw any meaningful conclusions. This is due to the absence of a pre-pandemic (2019) baseline and fluctuating numbers of operators. Additionally, this data includes journey data for trips across the whole of B&NES and not just into Bath.

8.6 Stakeholder feedback from council user groups

Ipsos Mori have produced an in-depth report investigating how the CAZ has affected people in deep-dive case studies.

8.7 Taxi fares and unmet demand rates

The taxi survey performed by the Council is only an indication of customer demand on Hackney Carriages and not the wider taxi trade. The last survey was carried out before the CAZ was introduced and the next survey is scheduled for 2023. No change in the number of Hackney Carriage licenses has been issued since 2015 and there will be no more changes until 2023 at the earliest. There has been no decrease in the number of licenses issued since 2015 and the cap is set at 125. The Hackney Carriage fares are reviewed annually and are determined by indices set from the Office for National Statistics. Our licensing team have suggested that the introduction of the CAZ has had no impact on the Council Hackney Carriage license numbers or fares.

8.8 Early measures fund – zero-emission vehicles parking permits

On 1 April 2019 we introduced a scheme to reduce the cost of parking permits for zero-emission vehicles. Discounts on the standard permit prices were available across a range of parking permit types. There was a total of 170 reduced price permits available each year for three years from April 2019. The number of zero-emission vehicle parking permits issued is outlined in Table 11, below.

Table 11: Number of zero-emission parking permits issued per financial year.

Year	Number ULEV permits issued
2019-2020	18
2020-2021	30
2021-2022	43

The number of permits issued grew each year, although never reached the total number of permits available. We expect growth in the local zero-emission market to continue and this will be beneficial for air quality.

Ultra-Low Emission Vehicles (ULEVs), which include hybrids, made up 5% of all private cars seen in the CAZ at around 1,500 per day of a total approximate 30,000 private cars. This number is growing.

8.9 Bus retrofit uptake and compliance rates

Traffic and air quality modelling prepared for the CAZ Final Business Case included the assumption that all scheduled public bus services would be compliant (euro VI) standard by its launch. At the time, 88 out of a fleet of 226 scheduled buses operating in Bath were non-compliant.

To prepare for launch, the Council secured government funds to support bus operators to upgrade the remaining 88 buses with engine emissions abatement technology as certified by the Clean Vehicle Retrofit Accreditation Scheme (CVRAS).

In autumn 2020, agreements were finalised with six bus operators to commence installation of the retrofit technology as soon as possible. In addition, two buses not operating as a public-registered bus service (Wessex Water) were upgraded (replaced with new Euro 6 buses). Some coaches were retrofitted through the Council 's financial assistance scheme.

Approximately £1.7 million was awarded towards grants to operators to retrofit buses operating on public registered bus services.

Comments and key findings:

- By the end of September 2021 (six months after the launch of the zone), 85 out 88 non-compliant buses operating as public buses in central Bath were successfully retrofitted with emission abatement technology.
- Preliminary reporting suggests that on average the NOx reduction for retrofitted vehicles exceeds the 80% target set as part of CVRAS and therefore the vehicles are operating in line with compliant/Euro VI standards.
- Overall, compliance for buses is close to 100% and the final three retrofits are scheduled for completion in spring 2022.

8.10 Financial support scheme uptake rates

To mitigate the impact of charges and further support air quality improvements, the Council has invested £9.4 million of government funds in a financial assistance scheme that offers grants and interest-free loans to businesses and individuals wishing to replace non-compliant, chargeable vehicles with cleaner, compliant ones.

Businesses and individuals could apply for funding to upgrade or retrofit the vehicle if they passed a basic eligibility test, proving that they travel at least two days per week on average in the zone over a 60-day period. Those passing the test could then apply for grants and/or interest loans via the Council's approved vehicle asset finance providers.

Table 12 below shows the number of vehicles that, by the end of December, were eligible to be replaced and the number of vehicles replaced.

Table 12: Vehicles eligible for the financial assistance scheme and the number of vehicles already replaced up to the end of December 2021.

Vehicle category	Number of vehicles eligible for FAS funding to upgrade/ retrofit	Number of vehicles upgraded by businesses using FAS funding at end of Dec 21
M1 (taxis or private hire vehicles as private cars are compliant)	150	91
M2 (minibuses)	4	2
M3 (buses and coaches)	21	21
N1 (light goods vehicles i.e., vans)	1346	594
N2; N3 (heavy goods vehicles <12T; HGVs >12T)	38	14
Total	1559	722

*The two minibuses upgraded were LGVs and so included in those figures, below.

Comments and key findings:

- By the end of 2021, 1,559 vehicles had passed basic eligibility tests, and 722 vehicles have already been replaced.
- 596 non-compliant LGVs (including 2 minibuses) regularly travelling in the zone and 91 taxis/PHVs have already been replaced through the scheme
- HGVs already have a higher compliance rate across the UK and in Bath and were therefore not a priority for the financial assistance scheme. However, 38 HGVs regularly travelling into Bath have been approved for finance and 14 have been replaced.
- Around 650 individuals and businesses have been supported through the scheme.
- At the end of December 2021, there were 119 active exemptions for vulnerable businesses that were eligible for finance but failed credit checks
- At the end of December 2021, approx. £4.8 million had been spent upgrading and retrofitting vehicles via the financial assistance scheme.

8.11 Travel advisor session uptake rates

The Council's team of Travel Advisors has been the main point of contact for people applying to the Financial Assistance Scheme (FAS). They work to provide information to people and support them through the FAS process.

During 2021, Travel Advisors contacted a total of 1,716 people, informing and guiding people through the CAZ Financial Assistance Scheme. They subsequently helped to fit 1,768 vehicles with telematic devices to establish eligibility for funding. A further 40-50 people submitted their own telematics data to the Council for analysis.

A total of 1,559 vehicles were deemed eligible for funding to upgrade or retrofit the vehicle, and at the end of 2021, a total of 722 vehicles had been successfully upgraded or retrofit through the FAS.

8.12 Anti-idling enforcement

Since the scheme was launched, the Council has been keen to maintain awareness around driver behaviour including the request not to idle engines, especially in locations where vulnerable people could be subjected to pollution, e.g., schools.

Bespoke signage has been developed and erected in locations of concern following engagement with local communities. After a review, the Council is adopting an educational, proactive approach and developing an online toolkit to enable material to be downloaded and used by residents and community groups.

8.13 Weight restriction enforcement

A webform for members of the public to report allegations of breaches of weight restrictions has been developed and officers within public protection are responding to complaints and carrying out proactive monitoring of roads carrying out weight restriction limits.

8.14 E-cargo scheme

The council hopes to encourage more sustainable delivery practices within the city to further support air quality improvements, tackle congestion, and help reach carbon neutral targets by 2030.

In 2021, the council secured £500,000 from the government to support the use of e-cargo bike deliveries within Bath. E-cargo bike couriers offer fast, zero-carbon deliveries for businesses who need to transport small-medium sized packages over a short distance. This delivery method offers businesses an affordable, eco-friendly alternative to fossil-fuelled deliveries made by vans.

The E-Cargo Bath scheme encourages businesses in Bath to trial deliveries with e-cargo bike couriers to reduce the number of vehicles on our roads.

The scheme hopes to inspire businesses to adopt e-cargo bike deliveries in the longer term and prove that sustainable delivery practices are cost efficient in comparison to traditional delivery methods.

Businesses in Bath can register their interest in the scheme online and are contacted if eligible. Travel advisors work closely with e-cargo bike operators and businesses to arrange a trial with an e-cargo bike courier. If the two-week trial is successful, there is opportunity to discuss longer subsidised trials to help businesses achieve a sustainable transition to e-cargo bike deliveries.

9. Conclusions

The high levels of NO_2 concentrations recorded in Bath present a public health risk that's not acceptable to the Council, or to central government. Any amount of pollution can be damaging to our health, but the more pollution you are exposed to, the greater the risk and larger the effect. Some people are more vulnerable to the impacts of air pollution than others. Those more at risk from air pollution include children, pregnant and older people; people with lung conditions such as asthma, chronic obstructive pulmonary disease (COPD) and lung cancer; and people with heart conditions such as coronary artery disease, heart failure and high blood pressure.

The Council is committed to reporting on the impact of the CAZ on air quality, traffic flow and vehicle compliance on an annual and quarterly basis so that we can monitor progress towards our target. This target is to reduce NO_2 concentrations to below the annual limit value of 40 µg/m³ at all individual monitoring locations in Bath.

This report has set out related data and key findings from 2021, and, as highlighted in our summary, the trends are encouraging. Air quality is improving across the entire district, despite traffic returning to near pre-pandemic levels.

Post-Covid, Bath experienced the best economic recovery of any UK city, and this boost has been seen in footfall figures remaining high for the city centre. Despite this, bus usage figures have remained lower than those seen pre-pandemic meaning it is likely people are travelling into Bath by car. Changing behaviours and travel patterns associated with Covid-19 continue to affect people.

Air quality conclusions

Average nitrogen dioxide (NO_2) concentrations within the CAZ in 2021 are 21% lower than in 2019, representing a reduction of 7 µg/m³. A reduction of 22% or 5 µg/m³ was also recorded in the urban area outside of the zone.

Despite this improvement, annual average concentrations of NO_2 at three sites still exceed 40 µg/m³. We will continue to monitor these sites closely. In 2019, 11 sites in Bath exceeded the limit value.

The fact that air quality is improving outside the CAZ shows that it is not negatively impacting other areas.

Every diffusion tube site within the CAZ recorded lower NO_2 concentrations compared to 2019. These results show good progress towards all sites soon meeting the annual limit value.

Traffic flow conclusions

Nationally, traffic flows have returned to pre-pandemic levels. Average traffic flows in Bath were 35% below pre-pandemic levels in January, but by the end of 2021 were 2-9% below pre-pandemic levels. Traffic outside of the zone's boundary did not increase compared to baseline figures.

A key commitment of the Council is to monitor any concerns arising from the introduction of the CAZ. In 2021, traffic flows were substantially impacted by the Covid-19 restrictions during the first half of the year, and the closure of Cleveland Bridge during the second half of the year. We are investigating several locations where the public has expressed concerns over a perceived increase in traffic in their communities since the zone's launch. These locations are outlined in Appendix 2.

Vehicle compliance conclusions

The CAZ is encouraging the purchase of new or second hand compliant, lower emission vehicles and discouraging motorists with polluting vehicles, with the desired effect of improving local air quality.

40,000 unique vehicles a day enter the zone, however 71% of these are private cars which are not charged. By the end of 2021, 550 non-compliant, chargeable vehicles were seen in the zone each day, compared to 1,142 per day during the first week of launch in March. This is despite the overall number of vehicles travelling in the zone increasing each week (from around an average of 32,500 per day in March to 43,000 in December 2021) as lockdown eased.

By the end of 2021 more than 720 of Bath's most polluting vehicles had been replaced or upgraded via the council's financial assistance scheme and more vehicles are being replaced by the scheme, and independently, each day.

Next steps

The significant reductions in NO_2 concentrations across the area are heartening but with three locations still exceeding the limit value, there is still work to do. We will be focusing our efforts on these areas in the coming months.

We would like to thank the public for their support and continue to urge all residents to do their bit by walking, cycling, or taking public transport whenever they can.

10. Monitoring Explained

10.1 Air Quality Monitoring Techniques

There are multiple methods whereby data on air quality is obtained.

Automatic Analyser

High-resolution measurements can be taken by automatic analysers that draw in ambient air. There are four of these instruments located within B&NES that are constantly monitoring air quality. The locations of the automatic analysers can be seen in Figure 2. One of the automatic analysers makes up part of the Automatic Urban and Rural Network (AURN) which feeds back to a national monitoring network. The data produced by these machines is compared with that of diffusion tubes to ensure accurate results.

Diffusion Tubes

Less expensive than automatic analysers, diffusion tubes can be located on existing street furniture. Due to the ease of deployment, hundreds of diffusion tubes can be located within a district building a picture of air pollution over a large area. Current locations of diffusion tubes can be seen in Figures 2 and 3. The tubes are exposed to ambient air for one month, before being sent to a laboratory for analysis. Data is then adjusted to consider laboratory or other inaccuracies before an annual mean is derived. Diffusion tubes are passive samplers and consist of a small plastic tube containing a chemical reagent called triethanolamine (TEA), in the case of NO_2 monitoring.

10.2 Traffic Monitoring Techniques

There are multiple methods whereby data on traffic flow and composition is obtained.

Automatic Number Plate Recognition (ANPR)

As part of the CAZ project, ANPR cameras were installed within and at entry/exit points to the zone, forming a cordon. The cameras focus on the numberplates of vehicles and then the vehicle information can be drawn from the DVLA database. Further useful data can be generated from matching entries into the system. For example, journey times through the CAZ.

Automatic Traffic Count (ATC)

Permanent Automatic Traffic Counters

As part of ongoing traffic monitoring, that was in place pre-CAZ, there are permanent ATCs at multiple locations in the district. Current locations of ATCs can be seen in Figure 8. These counters are built into the road and continuously monitor data on vehicle volume, speed and classification.

Temporary Radar Automatic Traffic Counters

To quickly respond to potential traffic displacement issues, it is important to have monitoring equipment that is ready to deploy at short notice. Temporary radar ATCs can be fastened to existing street furniture and monitor vehicle volume and speed.

Video Survey Equipment

Much like Temporary radar ATCs, video survey cameras are easy to install on existing street furniture, at short notice. These cameras do no record vehicle speed but do record vehicle volume and classification, which can be useful in cases where it is important to know the type of vehicles using a route. These cameras can be used to assess how many vehicles enter/ exit junctions, which can be important.

Manual Traffic Counts

At times, manual traffic counts are superior to automatic equipment. Enumerators can be employed to manually count vehicles passing a specific point.