Air Quality in Marylebone

A summary report commissioned by the
Marylebone Forum

with support from Marylebone and Regent's Park ward budgets

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Contents

1 Introduction

This report was commissioned by the Marylebone Forum to summarise all the air quality ("AQ") data collected within Marylebone and its environs up to March 2023 as an evidence base to inform the aims and aspirations of its Neighbourhood Plan. The report focuses on two pollutants, Nitrogen Dioxide (NO_2) and Fine Particulate Matter (PM2.5). It assesses the impact of recent policies on pollution trends and the scope for further improvement. The report's first section explains the sources of these pollutants and why they matter.

The report is based on AQ data from reference monitors positioned near major/busy roads and in "background" locations, as well as from Breathe London 'Clarity' nodes (six of which were installed near schools, five in side streets) and NO_2 diffusion tubes. The next section explains the merits and limitations of these three pollution monitoring devices.

AQ datasets were analysed in different ways and are presented as charts with text to explain the main findings and remarks to provide further detail or context. The charts can be used as models by anyone who wishes to continue tracking AQ trends from the datasets being collated on the new Air Quality Data Platform of Westminster City Council ("WCC").

Air pollution is a top priority for residents and businesses in Marylebone as well as Westminster City Council. The Marylebone Forum therefore wishes to acknowledge the support of Councillors for Marylebone and Regent's Park wards who funded:

- installation of extra monitoring devices to measure pollution near schools in the Forum Area, and
- preparation of this comprehensive report to understand pollution patterns across the Forum Area and provide evidence for further action by the Forum and Council.

This report focusses on NO_2 and PM2.5. Section 4 outlines the main sources of these pollutants and the harms to health which they cause. Section 5 describes how they are measured and the merits and limitations of different monitoring devices.

The analyses of datasets for NO_2 and PM2.5 are presented separately in Section 6 and Section 7 respectively through charts and related remarks. In each of these sections, the most reliable data from reference monitors are presented first to show the context for the indicative data from Breathe London nodes. The latter's inherent lack of precision militates against deeper focus.

This assessment refers to outdoor air quality. Most people spend most of their time indoors.

For England, the objectives which the UK government has set for the annual average concentration of NO_2 is 40 µg/m³ (micrograms per cubic metre) - to be achieved by 31/12/2005. For PM2.5, it is 20 µg/m³ - to be achieved by 01/02/2020. The latter has recently been supplemented by a target of 10 µg/m³ for all relevant monitoring stations – to be achieved by 31/12/2040.[1] In September 2021, based on 15 years of research and evidence since its previous guidance, the World Health Organisation ("WHO") lowered its guideline for NO_2 from 40 to 10 µg/m³ and its guideline for PM2.5 from 10 to 5 µg/m³.[2]

[1] National Air Quality Objectives
[2] https://www.who.int/publications/i/item/9789240034228 and https://www.imperial.ac.uk/news/234354/who-quality-safety-targets-achievable-across/

NO_2, a gas, is of concern because exposure to high levels can inflame one's airways, cause problems with breathing and affect lung function. Children, the elderly and people with existing lung conditions like asthma and chronic obstructive pulmonary disease (COPD) are most at risk of harm. PM2.5, tiny particles of various shapes and chemical composition, are increasingly being identified as exacerbating or contributing to a wide range of health (notably cardiovascular) problems.[3]

2 Summary

This report documents marked improvements in Marylebone's AQ over the last eight years. Concentrations of NO_2 and PM2.5, the pollutants of greatest concern, declined considerably across central London between 2015 and 2023. The switch to cleaner buses and taxis, the creation and then extension of low emission zones for vehicles and the Covid lockdown all contributed to this.

Chart 1 gives an indication of how NO_2 concentrations vary across Marylebone depending on their location. Their precision depends on the measuring device used.

Chart 5 shows the declining trend in annual average concentrations of NO_2 up to March 2023 as measured by reference monitors – the most accurate and reliable sources of data. Roadside concentrations which were 90-120 µg/m³ (micrograms per cubic metre) in 2015 are now at or below 40 µg/m³, the current UK legal limit. Background concentrations have improved to being around 20 µg/m³ (double the WHO guideline).

NO_2 concentrations rise and fall during the day, with peaks coinciding with the morning and evening rush hours on working weekdays (see Charts 6 and 11). They also vary considerably between summer and winter months, especially away from heavily trafficked roads (most clearly seen in Chart 8). Concentrations decrease with distance away from "emission hotspots", rapidly at first, then more slowly towards the "background" concentration.

The most recent annual average PM2.5 concentrations in central London (Chart 10) and Marylebone (Chart 12) are about 10-12 µg/m³, similar to the new UK target but roughly double the WHO guideline. They show little diurnal, seasonal or geographic variation. These levels might seem low but current evidence suggests there is no safe level of PM2.5.

Ward councillors commissioned six Breathe London nodes near Marylebone schools for 12 months (April 2022 to March 2023) to monitor how air pollution might be affecting children and young people. The indicative concentrations recorded by these devices is reassuring – Chart 8 shows NO_2 followed a broadly similar pattern at five locations, with monthly averages around 20-30 µg/m³ most of the time only reaching 40 µg/m³ during three winter months. Chart 12 suggests that the indicative PM2.5 concentrations at all six locations stayed below 10 µg/m³ for nine of the 12 months. Practical experience with the nodes and technical conclusions drawn from this project are described in the Appendix.

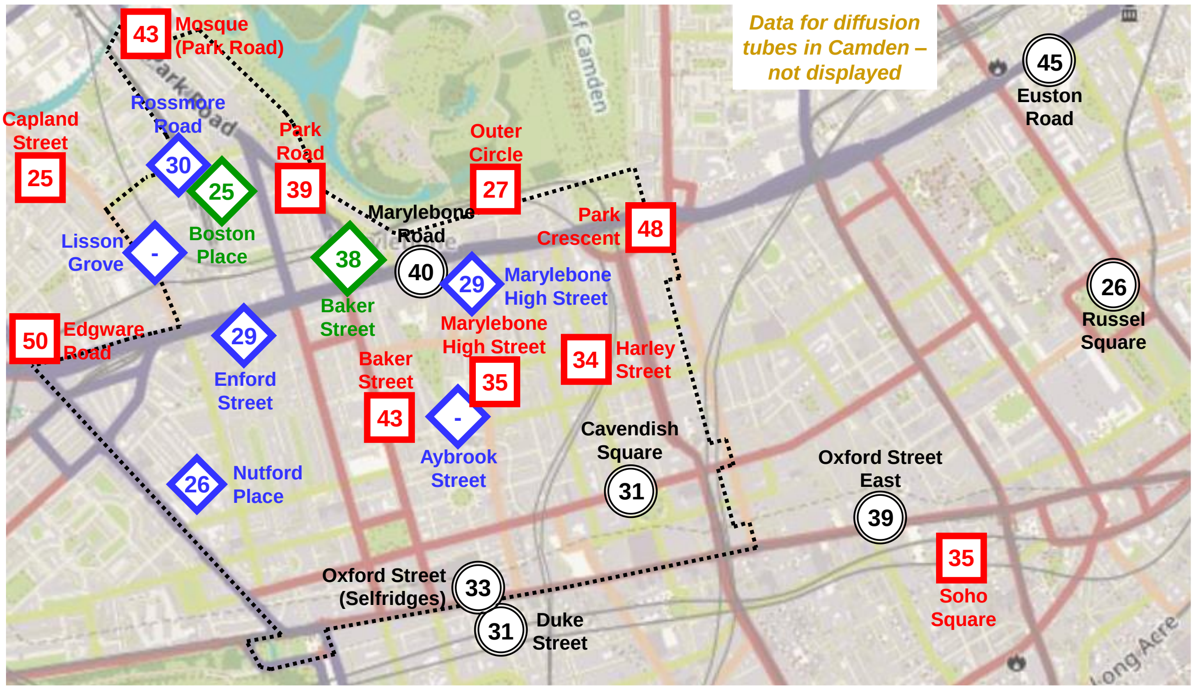
A specific analysis was done to examine the extent to which emissions from diesel trains at Marylebone station might be affecting neighbouring streets. Chart 13 shows NO_2

[3] https://www.gov.uk/government/publications/health-matters-air-pollution/health-matters-air-pollution also Impacts of air pollution across the life course – evidence highlight note G Fuller, S Friedman, I Mudway (04 2023)

concentrations mainly reflect traffic flows on those streets. The data suggest that Boston Place and Rossmore Road are not unduly affected by emissions from train operations.

In the absence of reference monitors or Breathe London nodes on the eastern side of the Forum Area, NO_2 diffusion tube data sourced from a "citizen science" project[4] are presented in Chart 14. Tube measurements on Harley Street (near Weymouth Street) and Marylebone High Street (near Waitrose) appear to track but slightly exceed the concentrations recorded by the reference monitor at Cavendish Square. In other words, they are comparable to levels on other "busy" roads in Marylebone.

Chart 1 – Map showing average concentration of NO_2 during the year to 31 March 2023 within and near the area covered by the Marylebone Forum[5]



The boundary of the Marylebone Neighbourhood Forum is shown as a line of black dots. The map shows NO_2 concentrations (in units of μg/m³) as measured using diffusion tubes (red squares, Breathe London nodes (diamonds – blue for the six installed for the schools project, otherwise green), and reference monitors (black rings). The Cavendish Square and Oxford Street East monitors have been closed since early June 2023.

NO_2 concentrations adjacent major, heavily trafficked roads in the Forum Area were 38-50 μg/m³ (*eg* Baker Street, Edgware Road, Marylebone Road, Park Road).

Adjacent busy roads, they were 30-35 μg/m³ (*eg* Marylebone High Street, Harley Street, Cavendish Square, Rossmore Road).

Along side streets they were 25-29 μg/m³ (*eg* Enford Street, Nutford Place, Boston Place), similar to concentrations at Capland Street (a background site, measured by diffusion tube) and Russell Square (a background site, measured by reference monitor).

[4] Established anticipating future use.
[5] Source: Air Quality England, London Air, Beathe London, Westminster City Council, HS2, and citizen science. (The locations should not be interpreted as precise.)
Note: The diffusion tube data has not been adjusted for bias (typically 5%-15%).

3 Conclusions

Marylebone's outdoor air quality is greatly improved. In general, concentrations now meet the UK objective for NO_2 and are either a little above or below the 2040 target for PM2.5. They still have some way to go before matching WHO guidelines and before visitors from rural areas perceive central London's air to be "clean".

Further improvements beyond the nadir achieved during Covid lockdown will involve difficult choices. That said, the rebound in NO_2 concentrations after the last Covid lockdown was modest, at least in part reflecting the cumulative impact of tightening the Low Emission Zone (for heavy vehicles) and expanding the ULEZ.

Actions taken to reduce carbon dioxide emissions as part of Marylebone Forum's priority on Sustainability are likely to help both reduce emissions of NO_2 and/or PM2.5 and accelerate progress towards Net Zero.[6]

Given the main sources of emissions, options which the Marylebone Forum might consider are:

Encourage businesses to switch away from gas and oil heating systems to cleaner alternatives and improve thermal/energy efficiency of buildings.

Encourage commercial kitchens to switch from using gas, wood or charcoal to electric appliances, and improve filtration systems in flues before venting to the atmosphere.

Discourage domestic wood-burning stoves and outdoor gas heaters, firepits, *chemineas*, BBQs.

Support the transition to (small) EVs while noting that the high costs and environmental impacts of existing battery technology mean that not all vehicles will be replaced.

Re-allocate road space freed up in selected side streets as people give up private cars for more greening/cycle storage/leisure.

Protect and enhance existing open spaces.

[6] "Setting Climate Commitments for Westminster" University of Manchester and Tyndall Centre Page 6 of the 2021-22 Progress Report on the Westminster Climate Emergency Action Plan indicates an intention to reduce emissions at a rate slower than needed to meet its 2040 Net Zero target (which contrasts with the 2030 Net Zero Target for London "London Net Zero 2030: An Updated Pathway" Mayor of London (01 2022)).

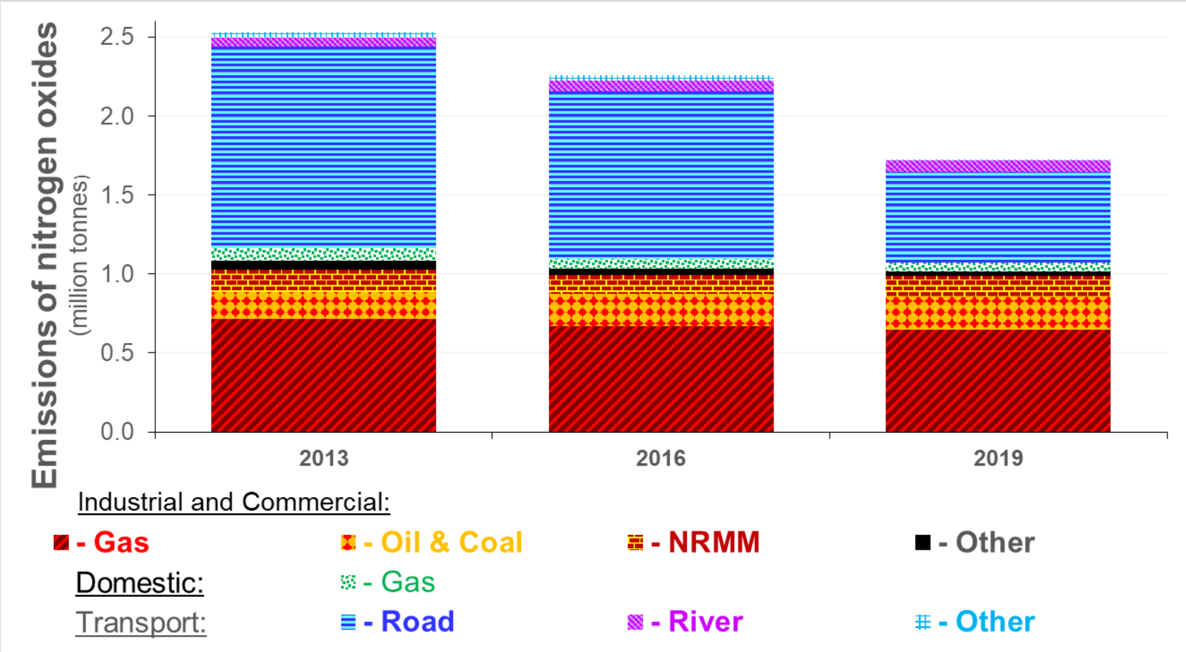
4 Air pollutants of concern and their sources

This report addresses two pollutants - Nitrogen Dioxide (NO_2), a gas, and Fine Particulate Matter (PM2.5) – for the simple reason that local emissions are directly harmful to human health within Marylebone.

Nitrogen Dioxide

Oxides of nitrogen (NOx) are formed when fuels like diesel, petrol, oil, gas are burned. NO_2 is a substantial component of the NOx totals shown in the chart.[7]

Chart 2 – Sources of Westminster's emissions of nitrogen oxides[8]



Main Finding:

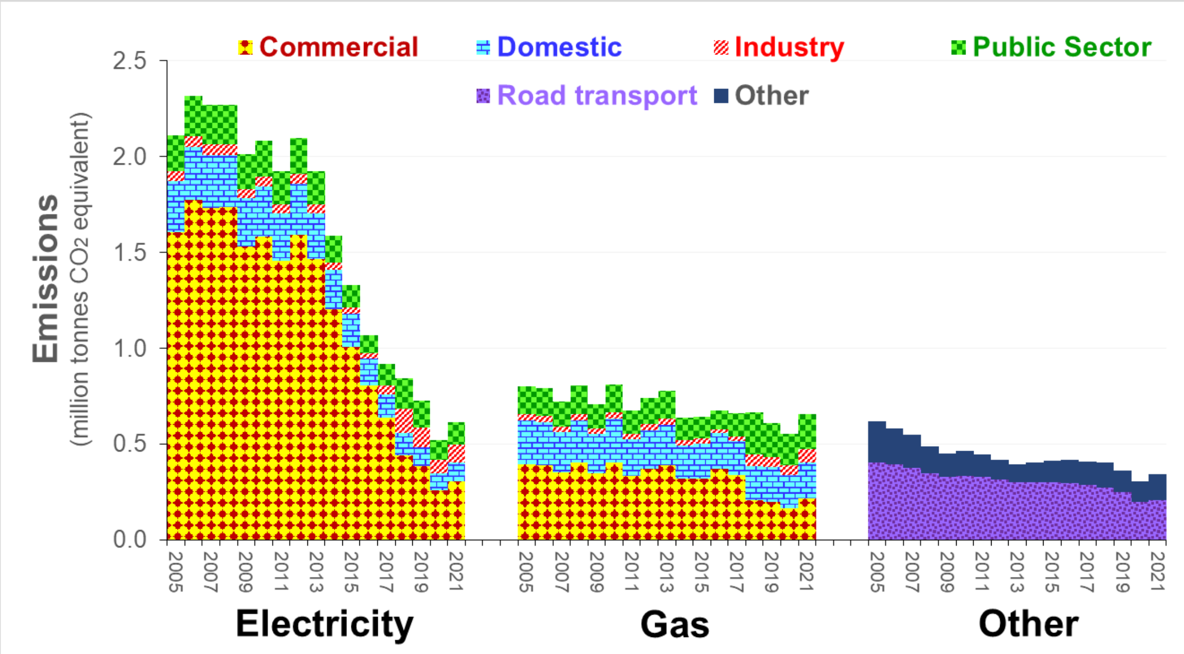
The LAEI 2019 showed that the category 'Industrial and Commercial - heat and power' accounted for more than half of total NO_2 emissions in Westminster.

Remarks: NO_2 used to derive primarily from fuel combustion in diesel engines but, by 2019, transport's contribution was down to 25%. Most of the improvement is due to improved vehicle engine technology coupled with progressive actions to reduce vehicle emissions in central London. Steps are also being taken to replace diesel-powered machinery (NRMM) on construction sites.

Post-covid, NO_2 emissions from buildings probably account for an even greater proportion. Gas (methane) was probably the leading contributor also in 2021 – as the following chart illustrates, carbon dioxide emissions from gas (primarily methane) across Westminster changed little between 2019 and 2021, despite the climate emergency.

[7] Nitrogen oxides "NOx" comprise nitric oxide "NO" and nitrogen dioxide "NO_2".
[8] Source: "London Atmospheric Emissions Inventory 2019".

Chart 3 – Trends in Westminster's Scope 1 and 2 carbon dioxide emissions[9]

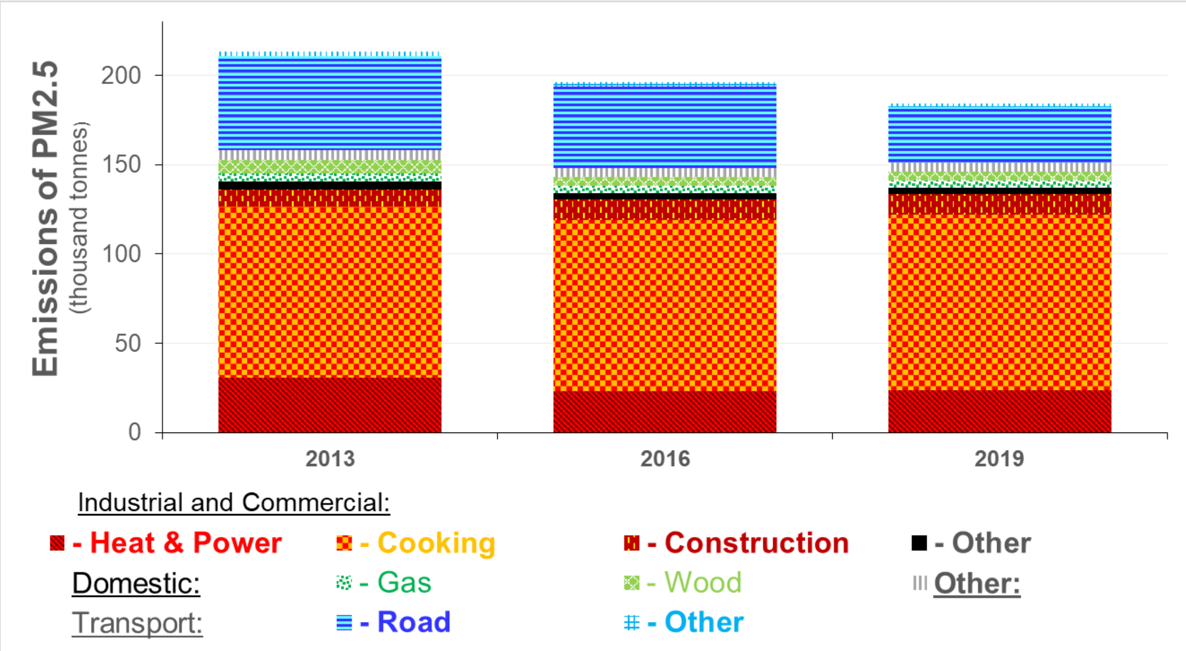


[9] Source: "[UK greenhouse gas emissions: local authority and regional]"
Note 1: For a given household or enterprise, Scope 1 refers to emissions directly from combustion for heat, cooking, driving, etc. Scope 2 refers to emissions from generating the electricity used. Scope 3 refers to emissions associated with the products and services one buys or sells.
Note 2: Annual updates are published with a time lag of roughly 18 months. A lag of at most one year would be more appropriate given the emergency, especially initially when most progress is needed.

Fine Particulate Matter

PM2.5 is the generic term for tiny air-borne particles which can be locally generated or come from outside London. They can be black carbon from diesel, greasy soot from cooking, wood ash, fine particles of sand, brakes, tyres, road surfaces, metal rails.

Chart 4 - *Sources of Westminster's emissions of PM2.5*[10]



Main Finding:

LAEI 2019 showed commercial cooking as by far the largest contributor of PM2.5 emissions in Westminster. The proportion from road transport had declined and is likely to be even lower now.

Remarks: The chart excludes quantities from outside Westminster. The percentage contribution of road transport is declining while that from the industrial and commercial sector - predominantly cooking – is rising. Under-performing air filtration and extraction systems in kitchens tend to increase expense and reduce staff performance. It is not possible to deduce the relative contribution of charcoal grills, wood burning ovens, stoves, and fire-pits.

Recent guidance from the Greater London Authority ("GLA") says that in 2019, 17 per cent of London's particulate matter pollution was from domestic wood burning.[11] Between 2010 and 2020, while diesel vehicle emissions decreased, PM2.5 from wood burning increased by 35 per cent. Replacement of petrol/diesel cars with heavier EVs (and SUVs) might also increase PM2.5 (and microplastics) from greater wear on tyres and road surfaces.

Since January 2022 all new wood burning stoves have to meet new environmental standards. However, Euro-certified 'Eco-stoves' produce 750 times more PM2.5 per unit of energy produced than a modern HGV. 'Ecodesign' wood burning stoves produce 450 times more toxic air pollution than gas central heating.

[10] Source: "London Atmospheric Emissions Inventory 2019".
[11] https://www.london.gov.uk/programmes-and-strategies/environment-and-climate-change/pollution-and-air-quality/guidance-wood-burning-london

PM2.5 is widely and increasingly recognised as an air pollutant especially harmful to human health. Both short and long-term exposure to PM2.5 increases hospital admissions and the risk of early deaths from respiratory and cardiovascular diseases. Children growing up exposed to PM2.5 are more likely to have reduced lung function and can develop asthma.

Besides NO_2 and PM2.5, combustion also releases carbon dioxide (CO_2), a gas that's implicated in global warming and climate change. Measures which reduce emissions of NO_2 and PM2.5 will also reduce CO_2 emissions and contribute to Net Zero Carbon targets.

5 Devices used to measure AQ - their merits and limitations

Concentrations of a number of air pollutants are measured at several sites across London, including in Westminster, by three main methods - sophisticated reference grade monitoring stations, low-cost nodes such as Breathe London's 'Clarity' node and EarthSense's 'Zephyr', and simple, inexpensive NO_2 diffusion tubes.

Reference monitors collect data on the concentrations of pollutants continuously. They are expensive scientific instruments and provide the most accurate and reliable AQ measurements. NO_2 is measured by all whereas only a few measure PM2.5. Local authorities, Business Improvement Districts ("BIDs") and landowners have installed a number of monitors near main roads in central London to track traffic-related emissions. Some reference monitors are deliberately placed away from busy roads to measure so-called "background" concentrations. Data from reference monitors are the core information on which the report's findings are anchored. Their data is provisional until ratified.[12]

'Clarity' nodes are low-cost AQ nodes which also measure pollutants continuously. Breathe London (managed by Imperial College) has deployed more than 400 of these across London. They are used primarily by community groups to better understand and engage with the issue of poor air quality. It costs over £2,000 to lease one for 12 months. These devices can only provide ***indicative*** measurements of NO_2 and PM2.5 concentrations but might be useful for measuring AQ at sites in between reference monitors. They perform reasonably well if their calibration and solar power supply remain stable. Chart A3 in the Appendix shows generally good consistency in the data recorded over two years at sites where a Breathe London node is co-located with a reference monitor, including on Marylebone Road.

Data from nine Breathe London nodes located in Marylebone were used in this report. Six were funded by Marylebone and Regent's Park ward councillors to measure air quality near five schools and a youth centre for 12-months up to the end of March 2023 (see Appendix). Three others were installed earlier (2021) in the Forum area - one co-located with the Marylebone Road reference monitor, a second at the Baker Street/Marylebone Road junction (by TfL) and the third, at the north end of Boston Place (by WCC).[13]

By default, Breathe London's 'Clarity' nodes rely on solar power to replenish their batteries and provide sufficient energy to function optimally. If shaded by tall buildings or mature trees, they might not have sufficient power to record measurements as frequently as they're designed to. Insufficient solar power compromised the performance of three nodes. When moved into stronger light they produced indicative data which was useful in the context of

[12] The time lag before ratification tends to be between three and fifteen months.
[13] Two Breathe London nodes co-located with the Marylebone Road reference monitor. Data from only one of these, powered by mains electricity, not solar panels, was used.

the numerous other data sources in the Forum Area. The node at Lisson Grove recorded spurious data between July 2022 and February 2023. It was replaced with another, newly calibrated node initially for three months (April-June 2023) to obtain a more reliable indicative measurement for that site. It was still operating at the time of writing.

NO_2 diffusion tubes are an inexpensive and well-established technology. Many local authorities and organisations follow DEFRA's standardised method to obtain monthly measurements of NO_2, using diffusion tubes, as part of their Air Quality Action Plans. Single tubes costing less than £10 per month are set up on site and exposed to the air continuously for a month before being capped and sent to a laboratory for chemical analysis. The lab result gives a single figure for how much NO_2 that tube had absorbed over the whole period of exposure.[14]

Diffusion tube data for this report were sourced from studies being done by WCC, the HS2 project team and a Citizen Science project. Previous NO_2 diffusion tube surveys have been done by the North Marylebone Traffic Group in relation to the Baker Street Two-Way and by WCC in relation to its proposals for Oxford Street District.[15]

WCC has recently launched an Air Quality Data Platform which makes AQ data freely available to the public with minimal delay, including as monthly averages, for all sites across Westminster at which measurements are made by reference monitors, low-cost nodes and NO_2 diffusion tubes. Some of that data is also reported in the Council's Air Quality Annual Status Reports.

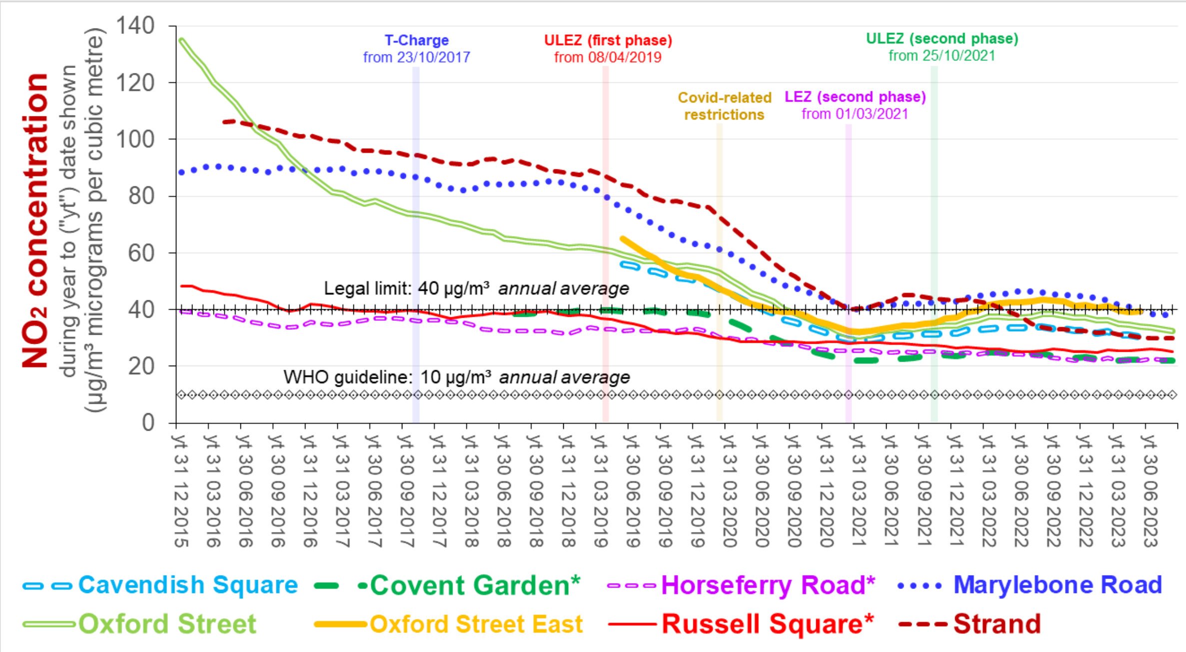
[14] In their annual reports on air quality, Local Authorities are required to adjust the measurements which the laboratory has determined. The "bias adjustment" (for the year as a whole) is a factor either dictated by the type of tube and its manufacturer / laboratory or which reflects the ratio between the annual average ratified for a reference monitor and the annual average for three tubes (from the same batch as are deployed by the Local Authority) co-located there.

[15] There is a lack of public information suggesting that measurements were made to document the impact on air quality of another project - the Marylebone Low Emission Neighbourhood and its construction.

6 Nitrogen dioxide, NO_2

6.1 The context, based on reference monitor data

Chart 5 – Trends in NO_2 concentrations since 2015 and contributory factors[16]



Main Finding:

Chart 1 shows that NO_2 concentrations have reduced markedly across central London since 2015, as a result of a series of measures implemented by the GLA. Roadside concentrations which were 90-120 µg/m³ (2-3 times higher than the current UK legal limit) in 2015 are now at or below 40 µg/m³. Background concentrations (asterisked sites) have improved to around half the UK legal limit (double the WHO guideline).

Remarks: Changes in the trendlines do not necessarily coincide with the date on which policy changes were introduced. Anticipating the changes, users of non-compliant vehicles might switch to alternative transport, amend their routes or vary when they travel.

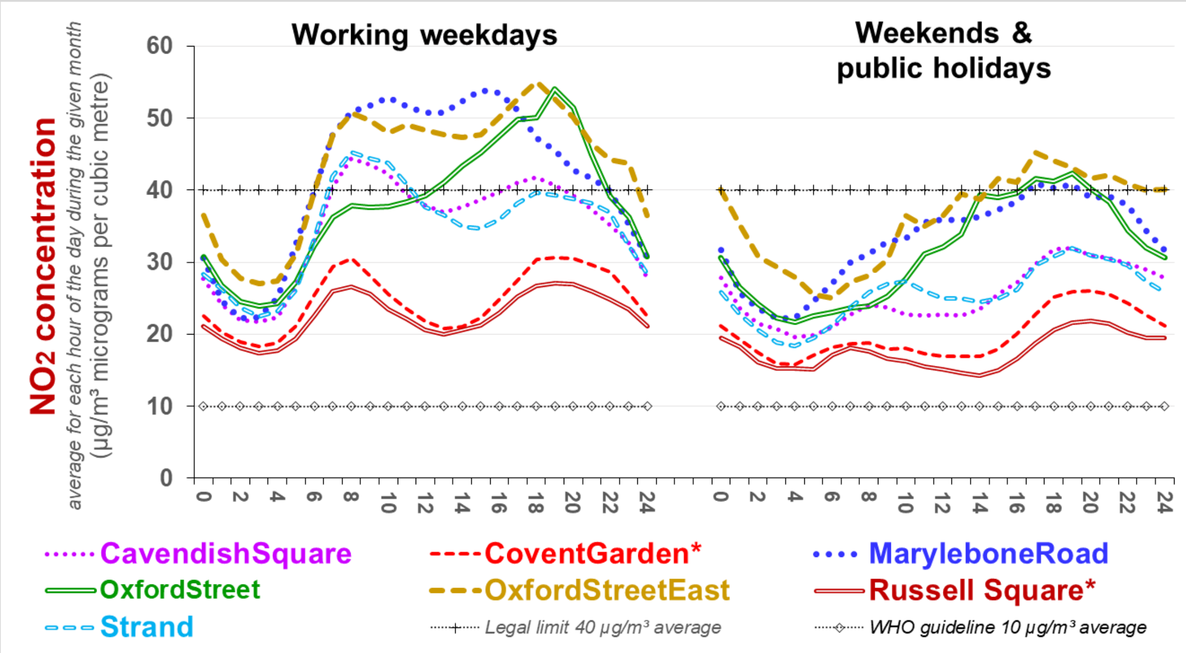
TfL's introduction of cleaner buses and overhaul of bus routes and frequencies along Oxford Street in 2016 had a big impact on pollution there. The introduction of the ULEZ in 2019 markedly reduced traffic pollution on Marylebone Road, its boundary.[17] The first Covid-related lockdown in early 2020 accelerated the decline in pollution levels at heavily trafficked locations to a nadir in winter 2020.

Concentrations on Oxford Street have shown the highest "rebound" since Covid restrictions ended. The further decline in concentrations at Strand during 2021/2022 were probably due to pedestrianisation of the formerly busy road.

The nadir, achieved when traffic and economic activity were severely restricted, suggests that radical measures or innovations may be necessary to improve Marylebone's AQ further.

[16] Source: Air Quality England and London Air.
Note 1: data prior to Q1 2023 has been ratified. Note 2: asterisks indicate background locations.
[17] Clean Air London has produced a briefing note detailing the evolution of the ULEZ.

Chart 6 – Average NO2 concentration at each hour of the day[18]



Main Finding:

NO_2 concentrations on working weekdays show peaks corresponding to peak traffic periods at both roadside and background monitors. Roadside concentrations, especially on Marylebone Road and Oxford Street, are much higher than in background localities.

Remarks: NO_2 concentrations remain low on heavily trafficked roads at weekends and public holidays - until the afternoon and evening.

The maps of Chart 7 (below) are presented together to enable direct comparison of the reduction in NO_2 pollution at each site between 2019 and 2023. The improvement at Strand, from 76 to 38 µg/m³, attributable to pedestrianisation, is particularly marked.

Main Finding:

In 2019, annual average concentrations of NO_2 were 63-76 µg/m³ on major roads, 50-55 µg/m³ on busy roads and 27-39 µg/m³ at background locations (asterisked). These concentrations considerably exceed those apparent for the most recent 12-month period – 40-44 µg/m³, 29-40 µg/m³ and 16-22 µg/m³ respectively.

Remarks: The colour coded LAEI map of NO_2 concentrations indicates the likely sources of air pollution. Concentrations are greatest along the most heavily trafficked roads (b,rown to red to orange) – typically through-routes, including prestigious Park Lane. Concentrations decrease steeply with distance from hotspots and, gradually, with distance away from central London (yellow to green to blue).

Transport for London is responsible for some of the most heavily trafficked (and polluted) roads in and around Marylebone. Other roads in Marylebone are within the remit of WCC.

LAEIs have hitherto been updated every three years. However, despite the hiatus initiated by covid and the great improvement shown on Chart 5, an LAEI for 2022 is not planned.

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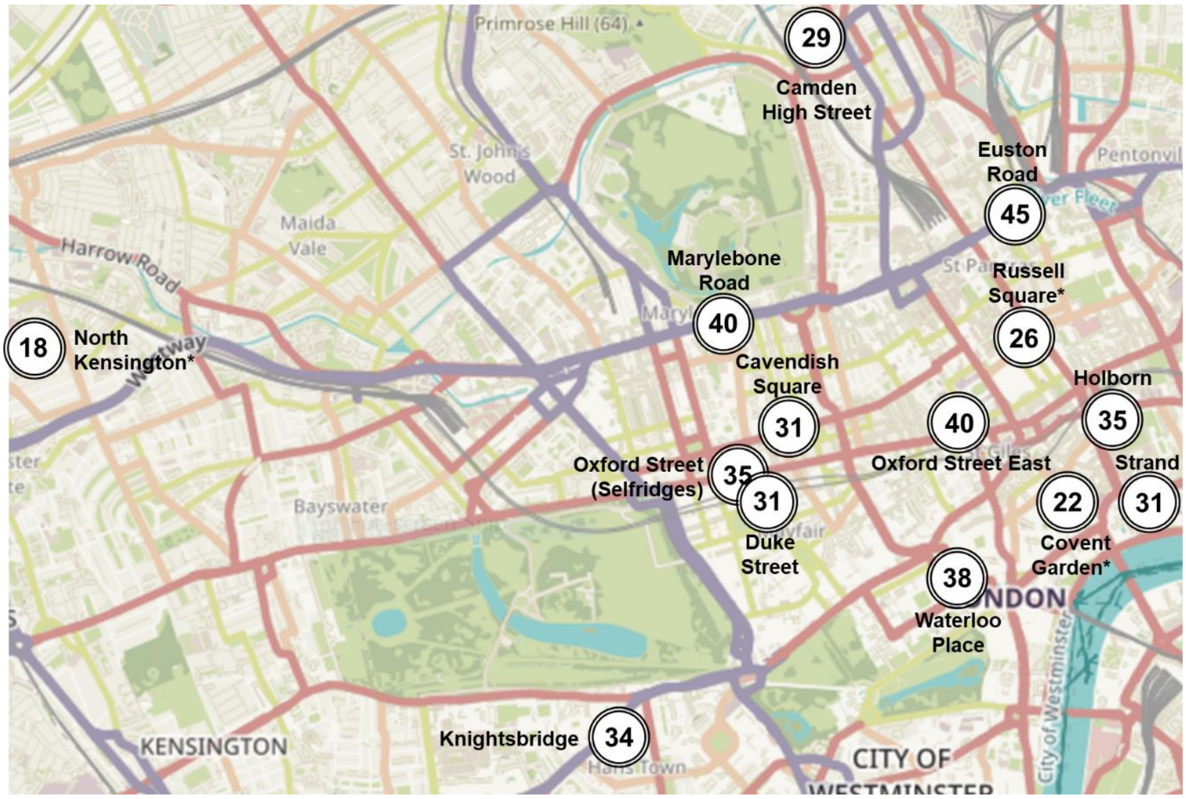
[18] Source: Air Quality England and London Air. Urban background sites are indicated by an asterisk. Note: the data refers to averages over 12 months ending on 31 March 2023.

Chart 7 – Upper map:[19] Annual averages for 2019 overlaid on the LAEI 2019 map. Lower map:[20] Averages for the year ending 31 March 2023

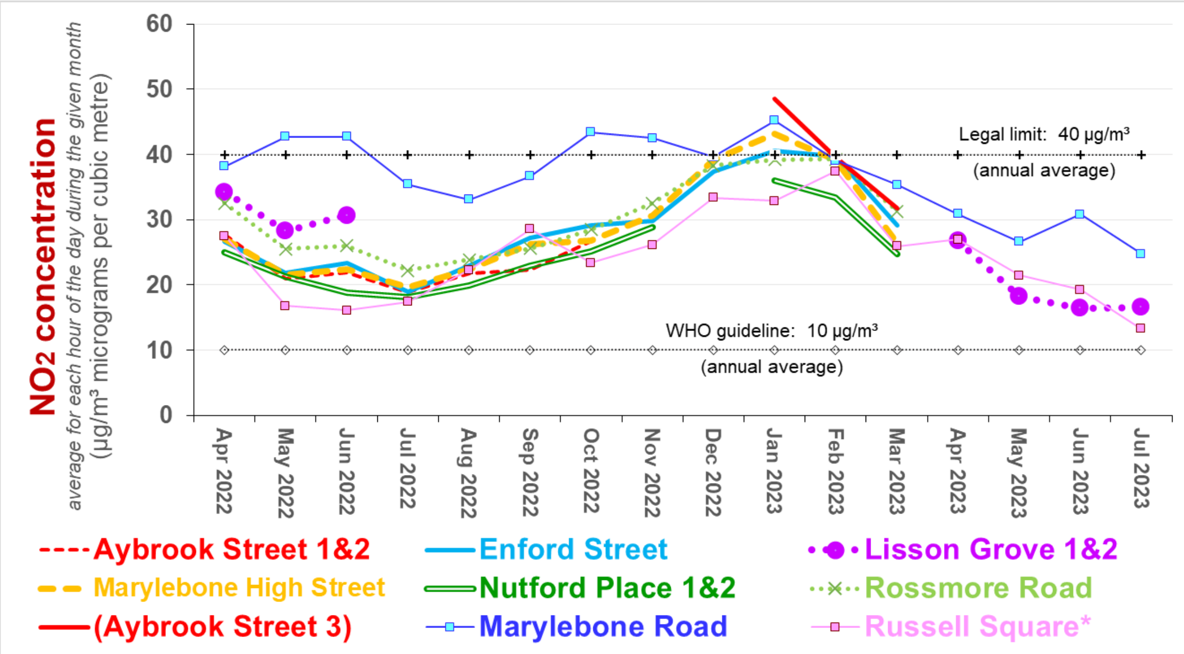


[19] Source: "London Atmospheric Emissions Inventory 2019 – Summary Note" (as seen 10 April 2023), London Air and Air Quality England (The locations should not be interpreted as precise.)

[20] Source: London Air and Air Quality England (The locations should not be interpreted as precise.)

6.2 Breathe London node data near schools

Chart 8 – Average monthly NO_2 concentrations at Breathe London nodes near schools[21]



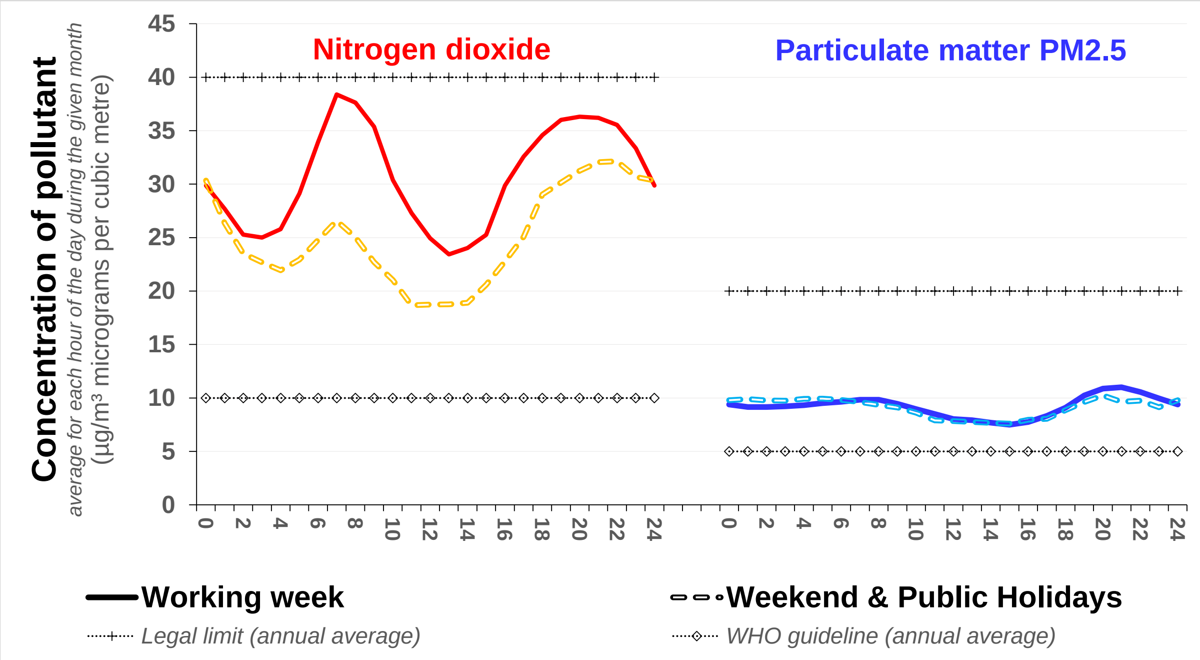
Main Finding:

Monthly average concentrations of NO_2 at each location largely followed the same pattern and show seasonal variation. They were closer to Russell Square's background concentrations in the summer and to Marylebone Road's roadside concentrations in the winter. NO_2 concentrations at functioning nodes were well below 40 µg/m³ for all but three winter months.

Remarks: The Lisson Grove node started to report spurious data early in July. It was replaced at the beginning of April 2023. The Nutford Place and Aybrook Street nodes were relocated during early January. The Aybrook Street node had been previously relocated. (see Appendix for a fuller discussion). NO_2 concentrations decrease as one moves from the kerb of a source of pollution towards a lightly trafficked, background location - rapidly while near the source, becoming progressively flatter with distance away from it. As such outdoor NO_2 concentrations at the schools may have been lower those indicated by the nodes (on road-side lamp posts) – if most of the NO_2 pollution derived from vehicles.

[21] Source: Breathe London and Air Quality England (for Russell Square - a reference monitor)

Chart 9 – Average NO_2 and PM2.5 concentrations at each hour of the day measured by a Breathe London node at a representative location[22]



Main Finding:

Indicative NO_2 concentrations at this representative Marylebone site on working weekdays peak at around 40 and 35 µg/m³ during the morning and evening rush hours respectively and are lowest between 11am and 3 pm. The best time for vigorous outdoor exercise is between noon and 2pm (except on hot, sunny days).

Remarks: NO_2 concentrations (at this location) were roughly 5 µg/m³ lower at weekends/holidays than during working weekdays.

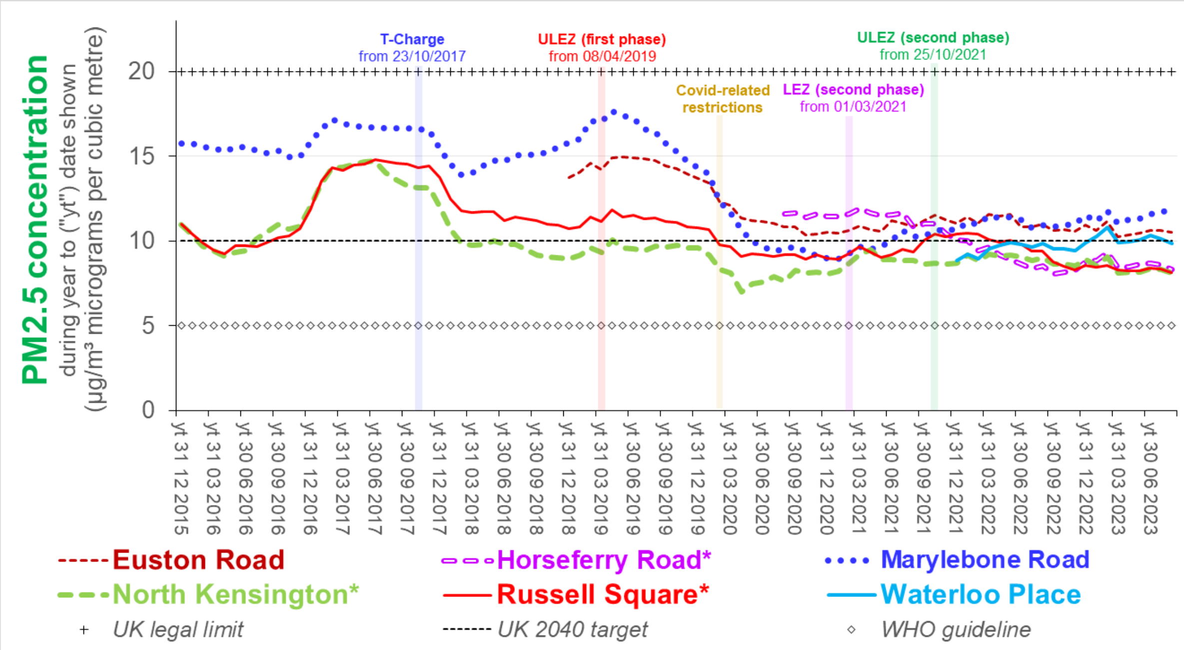
Indicative PM2.5 concentrations are in line with the new UK target limit of 10 µg/m³. (See also Section 7). They show very little hourly variation and stay much the same on working weekdays as on other days.

[22] Enford Street. Charts referring to other locations for which a full set of data was reported differ only slightly from the chart displayed here. Source: Breathe London.
Note: the data shown refer to averages over 12 months ending on 31 March 2023.

7 Fine Particulate Matter, PM2.5

7.1 The context, based on reference monitor data

Chart 10 – Trends in PM2.5 concentrations since 2015 and contributory factors[23]



Main Finding:

Since covid restrictions were removed, annual average concentrations of PM2.5 at three central London roadside monitors have been either similar to or marginally higher than the new UK target (double the WHO guideline) – with an unclear trend.

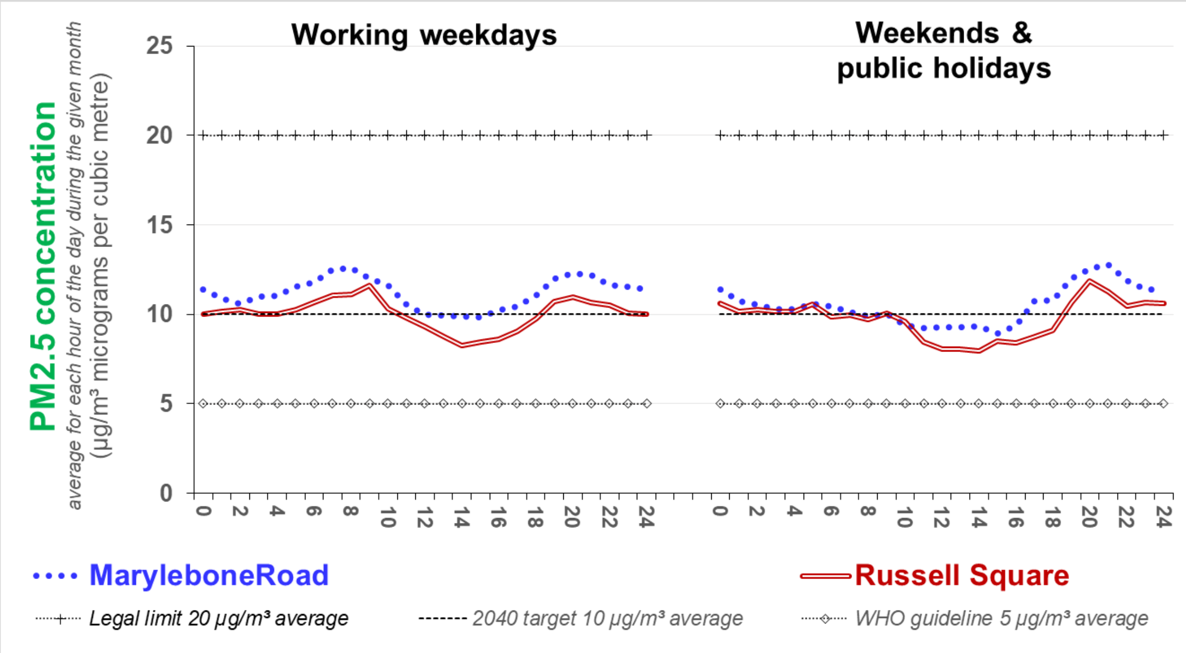
Annual average concentrations at three background sites (asterisked) were below the new UK target limit for the year ending 31 March 2023.

Remarks: Fewer reference monitors measure PM2.5 in central London than the number which measure NO_2 and some were only introduced in recent years.

PM2.5 concentrations on Marylebone Road started off about 50% higher than at the Russell Square background site in 2015. Average annual concentrations decreased steeply on Marylebone Road with the introduction of the ULEZ and continued during the covid-related lockdown before rebounding somewhat after restrictions were lifted. The current trend is slightly upwards.

[23] Source: Air Quality England and London Air.
Note 1: data prior to Q1 2023 has been ratified. Note 2: asterisks indicate background locations.

Chart 11 – Average PM2.5 concentrations at each hour of the day[24]



Main Finding:

PM2.5 concentrations on working weekdays are lowest during early afternoon, with peaks coinciding with the morning and mid-evening rush hours.

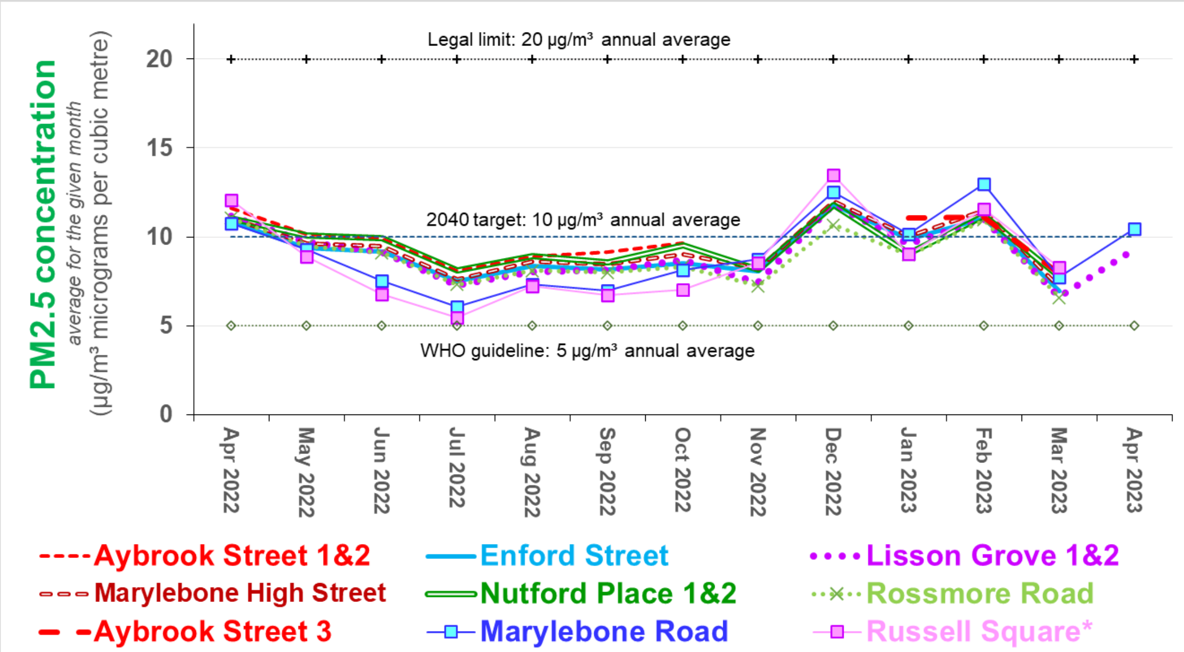
Remarks: Concentrations are slightly greater during working weekdays than on other days.

This, and the small difference between the heavily trafficked roadside site and the background location reflects not only the persistence and wide dispersal of PM2.5 under normal conditions, but also the contribution of PM2.5 from sources other than traffic.

[24] Source: Air Quality England.
Note: the data shown refer to averages over 12 months ending on 31 March 2023.

7.2 Breathe London node data near schools

Chart 12 - *Average monthly PM2.5 concentrations at Breathe London nodes near schools*[25]



Main Finding:

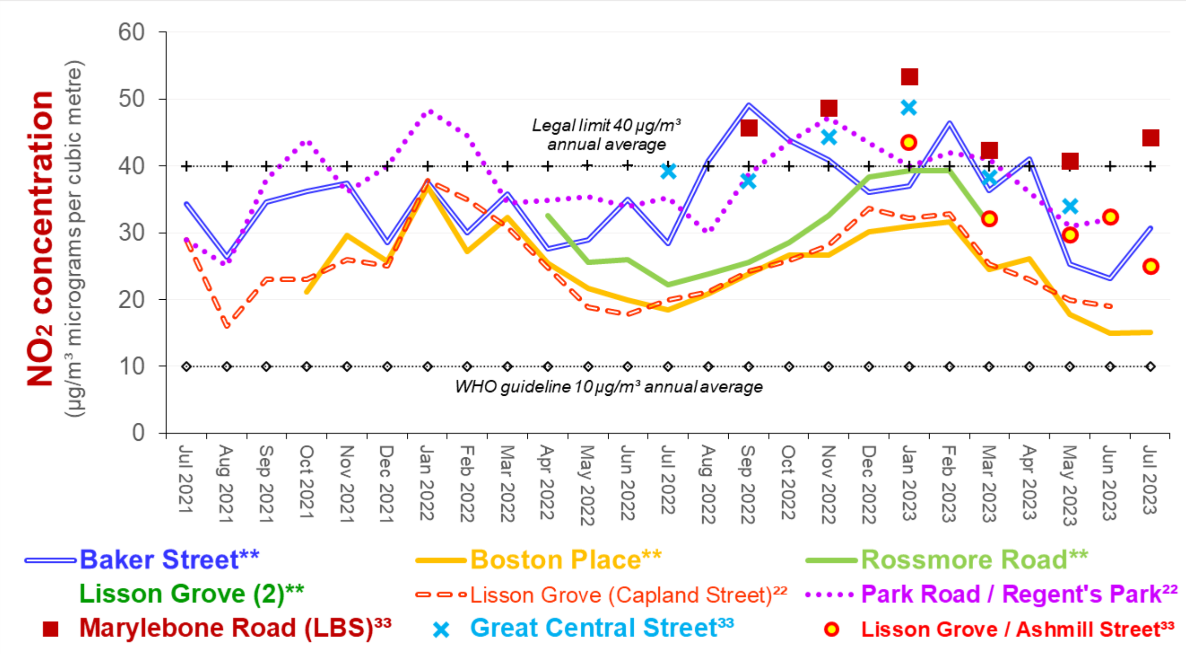
There was negligible difference in the indicative data reported for the six nodes. Monthly average PM2.5 concentrations were slightly below 10 µg/m³ during summer months and somewhat higher in winter.

Remarks: However, during summer 2022, data from all the nodes exceeded the concentrations measured by reference monitors at Marylebone Road and Russell Square, begging questions about calibration. The nodes were installed on road-side lamp posts close to the main entrance of each school. Outdoor PM2.5 concentrations around the school would have been similar to those indicated by the monitors.

[25] The Nutford Place and Aybrook Street nodes were relocated during early January. The Aybrook Street node had been previously relocated. The Lisson Grove node started to report spurious data during July. It was replaced at the beginning of April 2023.
Source: Breathe London and, for Russell Square (a reference monitor), Air Quality England.

8 Impact of NO_2 emissions from Marylebone station

Chart 13 – NO_2 concentrations in northern Marylebone, around the railway station[26]



Main Finding:

NO_2 concentrations on Boston Place (Breathe London node) closely track those recorded at a WCC background monitoring site on Capland Street (NO_2 diffusion tube) over 18 months. The data suggest that Boston Place and Rossmore Road, beside and above the railway tracks of Marylebone Station, are not unduly affected by emissions from train operations.

Remarks: NO_2 concentrations in the area mainly reflect road traffic. They are highest on or near the busiest roads - Marylebone Road, Park Road, Baker Street and Great Central Street - and lowest where traffic is lightest - Boston Place and Capland Street. Data for the replacement Breathe London node is not presented on the chart - it is similar to that for Boston Place, which is improbable given the different environs.

The Rail Safety and Standards Board has conducted a survey which measured NO_2 at seven locations in and around Marylebone station over 12 months. Data requested from Chiltern Railways for inclusion in this report had not been received at the time of writing.

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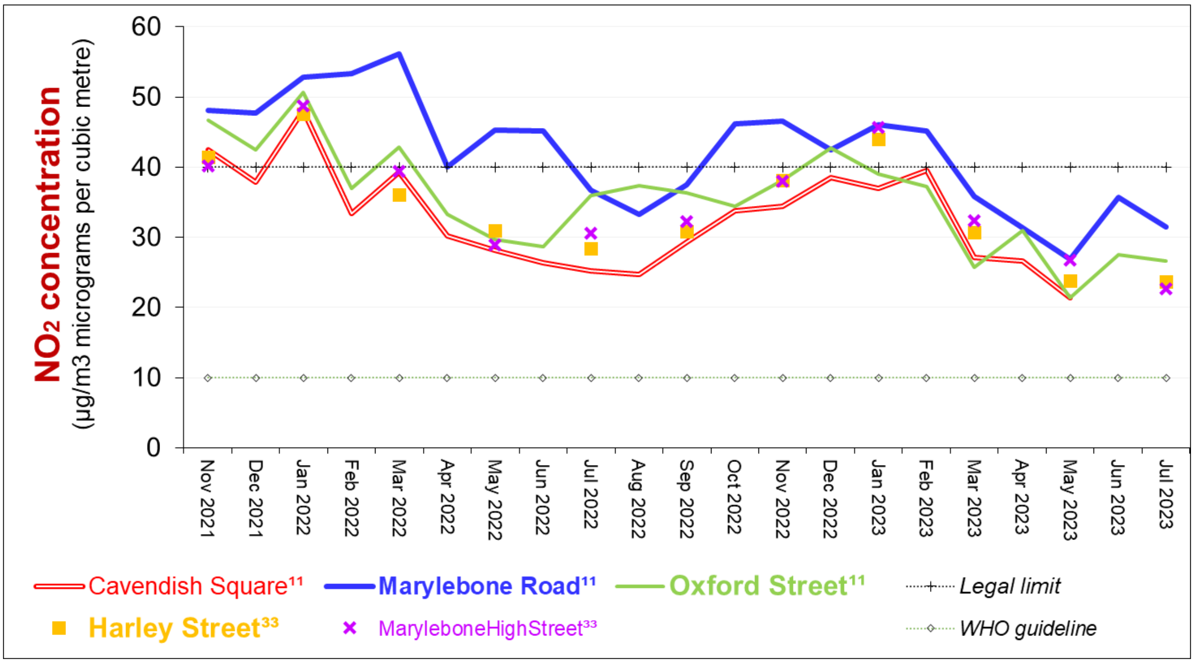
[26] Source: ** Breathe London; [22] Westminster City Council and [33] citizen science.
Note: The diffusion tube data has not been adjusted for bias.

9 NO_2 concentrations in eastern Marylebone

Chart 14 – NO_2 concentrations in eastern Marylebone[27]



Main Finding:

NO_2 concentrations measured by diffusion tubes on Harley Street (just south of Weymouth Street) and towards the south end of Marylebone High Street are similar, and slightly higher than those recorded by the roadside reference monitor on Cavendish Square.

Remarks: The data for Harley Street and Marylebone High Street were sourced from a "citizen science" project with NO_2 diffusion tubes in the absence of formal monitoring sites on the eastern side of the Forum Area. The Cavendish Square monitor has been closed since early June 2023, as has that at Oxford Street East.

The concentrations and seasonal variation found on Harley Street and Marylebone High Street are consistent with those on other "busy" roads in the area. The slightly lower concentrations on Cavendish Square may be because that site is less confined by buildings.

[27] Source: ([11] reference monitors) London Air; ([33] diffusion tubes, not adjusted for bias) citizen science. Note: the diffusion tube data has not been adjusted for bias.

APPENDIX

A1 Experience with Breathe London ‘Clarity’ nodes in the Schools Project

The six Breathe London nodes funded by Marylebone and Regent’s Park ward councillors were deployed near the following schools and youth centre:

1) St Vincent’s Catholic Primary School - first on Aybrook Street, then half-way along St Vincent Street and finally, for contrast, at the junction of Marylebone High Street and Blandford Street;

2) St Mary’s Bryanston Square Primary School, on Enford Street;

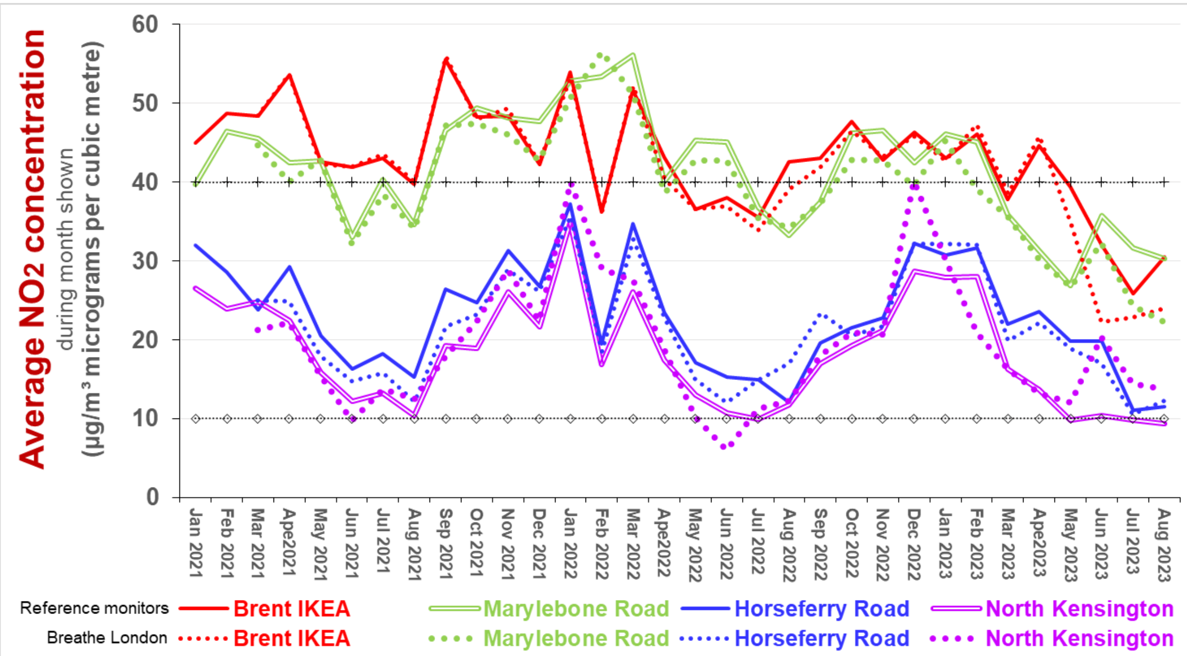
3) St Edward’s Catholic Primary School, on Lisson Grove;

4) St Marylebone School, on Marylebone High Street;

5) Hampden Gurney C of E Primary School – first on Nutford Place, then at the junction between Forset Street and George Street;

6) Fourth Feathers Youth Club, on Rossmore Road.

Chart A1 – The performance of Breathe London nodes co-located with reference monitors[28]



Main Finding:

In general, there is little difference in the NO_2 concentrations reported by Breathe London nodes (dotted lines) co-located with reference monitors (dashed or solid lines) over a 2-year period. The nodes therefore seem to offer a practical, low-cost way for communities to assess air quality.[29]

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[28] Source: Air Quality England and Breathe London.

[29] Provided of course that the data generated by the nodes is actively monitored and carefully interpreted, including with comparison to data reported for monitoring devices elsewhere.

Remarks: The calibration of the nodes might require adjustments when provisional concentrations reported by reference monitors are ratified – if the ratified amounts differ sufficiently from the provisional data.

However, in densely built Marylebone, the nodes' solar panels did not generate sufficient charge during the winter months at three of the six school locations. One continued to record data albeit at longer intervals, but two ceased recording and had to be re-charged and re-located to better lit positions.

Chart A2 – Average concentrations for the school project's six nodes at each hour of the day[30]

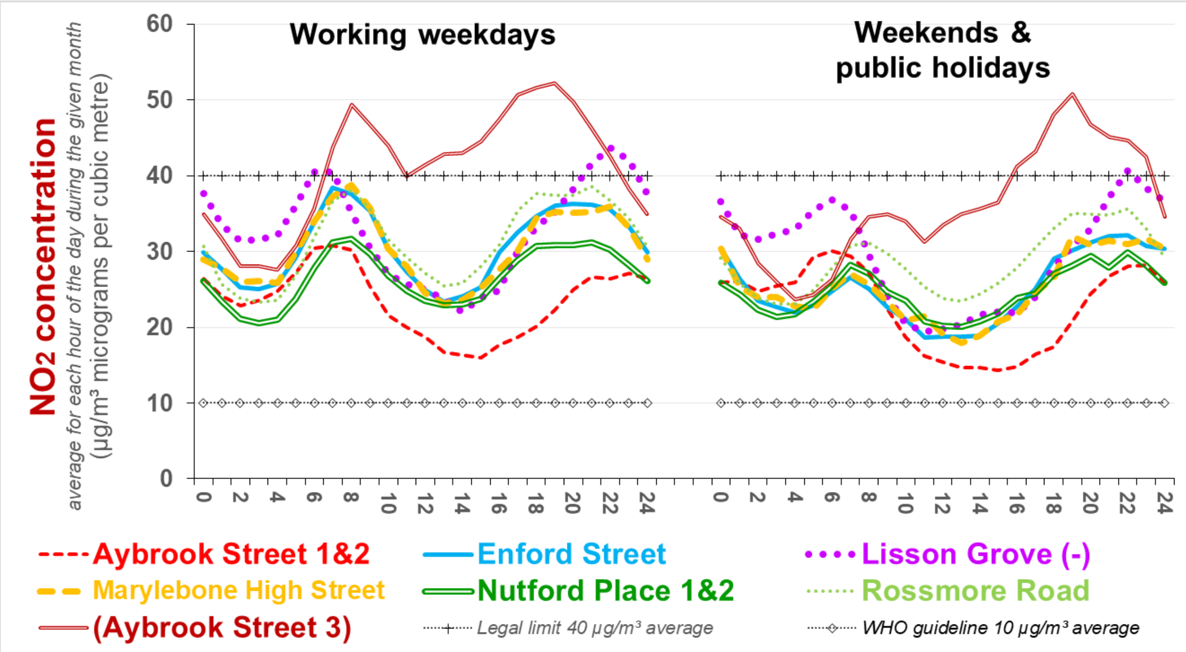

Chart A2 indicates that NO_2 concentrations (during winter) at the third (more heavily trafficked) site of the "Aybrook Street" node differed markedly from those (in summer) at its lightly trafficked first and second locations. To some extent. seasonal variation explains not only that difference, but also why those concentrations are respectively greater and less than reported for the other five nodes.

The indicative data for NO_2 reported by the Lisson Grove node started to become spuriously high in June / July 2022. Imperial College's normal quality-checking routines did not pick this up and the node continued to record unusable data until the end of the project period. It was replaced with a newly calibrated node at the beginning of April 2023 to obtain three months of validation data for reassurance that concentrations at that site are as one might expect relative to measurements of NO_2 concentrations at other sites nearby.

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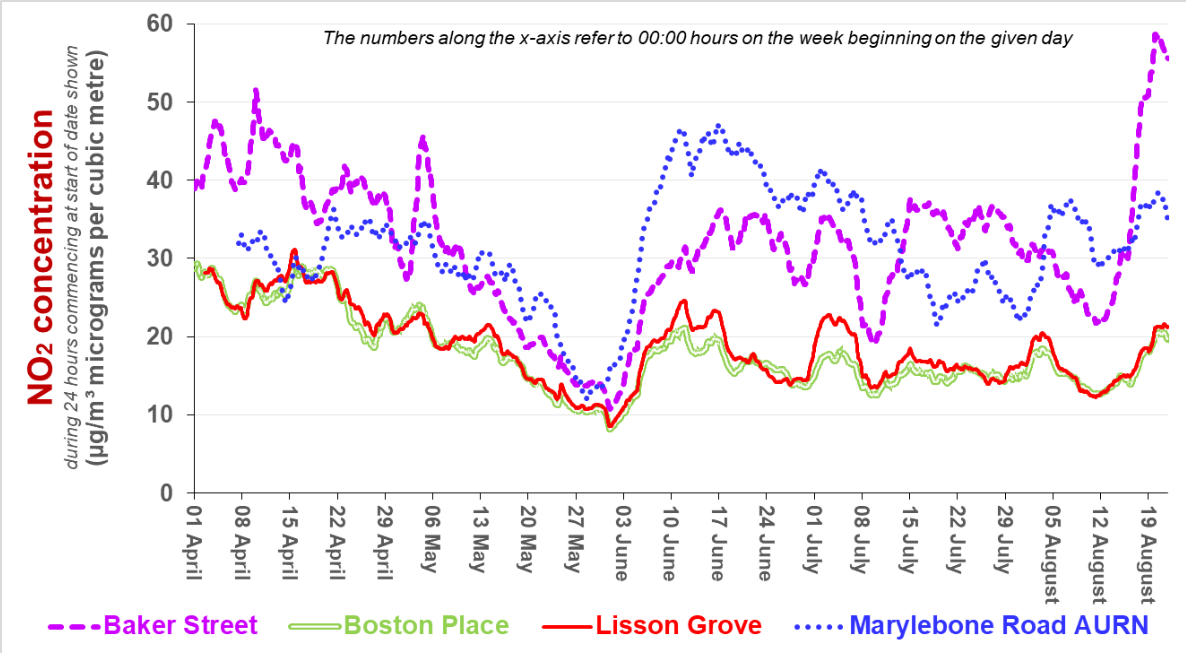
[30] Source: Breathe London.
Note: the data refer to averages over the period the nodes were deployed (or, for Lisson Grove, the first three months of deployment).

Chart A3 – Assessment of the performance of the replacement Breathe London node at Lisson Grove[31]



As a further cross-check, during 2023, NO_2 concentrations were measured using diffusion tubes installed at a similar height as the initial node and on the same lamp post. The monthly concentrations reported (in µg/m³), without adjustment for bias, were 43, 32, 30, 32 and 25 in January, March, May, June and July respectively (see Chart 13) – somewhat greater than suggested by the indicative weekly concentrations reported by the replacement node. Taking seasonal variation into account, concentrations reported by both methods tend to confirm that there is nothing untoward in terms of AQ on Lisson Grove.

The geographic characteristics of the Lisson Grove and Boston Place sites differ more than the close correlation of the data reported for those nodes might suggest.

Concentrations recorded at the node on the Baker Street/Marylebone Road junction diverge more than one might expect from those at Marylebone Road (and have done so from time to time since mid-2022). The Baker Street node is installed at a lower height above the road surface than the norm. The fluctuations and divergence seem to warrant recalibration and/or replacement of that node. Breathe London has been made aware of this and may consider a remedy with the node's sponsor – TfL.

A2 Concluding technical remarks

This project has shown that prior knowledge of the local area – of traffic volumes, potential sources of emissions and the prevailing AQ – is important before starting to measure pollutants. LAEI maps are a useful starting point to find out what the local pollutant patterns look like, and both Air Quality England and London Air provides relevant information, including an authoritative map of current air quality.

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[31] Source: Air Quality England (Marylebone Road AURN) and Breathe London.
Note: the replacement node was installed at the beginning of April 2023.
Date on which data downloaded: 31/08/2023

It is also valuable to set up a network of monitoring devices, with at least one roadside and a background reference monitor in the vicinity, to benchmark the network's concentrations against. Otherwise, it's difficult to assess whether the data being reported by any node is reasonably indicative or potentially erroneous. The devices in the network should be installed at a height from the ground where they are likely to be tamper-proof. Ideally, all should be at the same height. Regular evaluation of the consistency of data across several devices (not only in the network) can help to identify if their calibration remains stable. Our experience showed that Breathe London's assurance protocols are not failsafe.

If using solar-powered devices like 'Clarity' nodes, the solar panel must receive enough direct sunlight even in the winter. Project personnel need to keep an eye on whether they are re-charging sufficiently. WCC's Schools AQ Monitoring Project uses EarthSense 'Zephyr' nodes connected to an electricity supply, either from the lamp posts they are mounted on or from the school.