Particulate Matter ($PM_{2.5}$) in Ambient Air in 2024

Let's clear the air

Hertfordshire

Document Information

Contributing Local Authorities (Hertfordshire):

North Hertfordshire District Council (NHDC)

Hertsmere Borough Council (HBC)

East Hertfordshire District Council (EHDC)

Watford Borough Council (WBC)

Stevenage Borough Council (SBC)

Welwyn and Hatfield District Council (WHDC)

Dacorum Borough Council (DBC)

Hertfordshire County Council – Public Health (HCC-PH)

Additional data obtained from

Central Bedfordshire Council

Luton Borough Council

London Luton Airport

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Document Status and Approval Schedule

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1.1	Draft	Draft for comment	Cerys Williams	11 Dec 2025	Matthew Clark	Dec 2025
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Executive Summary

Air quality monitoring across Hertfordshire and Bedfordshire in 2024 provides a clear picture of both progress and ongoing challenges in managing fine particulate matter ($PM_{2.5}$). The Hertfordshire and Bedfordshire Air Quality Monitoring Network (HBAQMN), supported by Defra's AURN site at Borehamwood, continues to deliver high-quality reference data essential for compliance assessment and long-term trend analysis. Complementing this, the deployment of low-cost multi-pollutant sensors has expanded spatial coverage and offered valuable insights into local variation, though their limitations in data capture and reliability reinforce the need for careful validation and reliance on reference-grade instruments for statutory reporting.

The evidence shows that annual mean $PM_{2.5}$ concentrations at all reference sites with sufficient data capture were well below the Annual Mean Concentration Target (AMCT) of 10 $\mu g/m^3$. This confirms strong regional performance against national objectives, with only isolated sites nationally — such as London Marylebone Road — failing to meet the threshold. Nationally, population exposure has already reduced by 25% compared to the 2018 baseline, surpassing the interim reduction target of 22% by 2028. These achievements demonstrate tangible progress towards the long-term legal requirement of compliance by 2040.

Long-term trends reinforce this positive trajectory. Between 2016 and 2024, annual average $PM_{2.5}$ concentrations declined steadily at both urban background and roadside sites, reaching their lowest levels to date. Episodes of moderate or higher pollution, classified under the Daily Air Quality Index (DAQI), have also decreased markedly, from seven days in earlier years to just one day in 2024. The absence of exceedances in 2020, likely linked to reduced activity during the pandemic, illustrates the direct influence of human behaviour on air quality. Nevertheless, episodic events in 2019 and 2022, driven by stagnant meteorological conditions and transboundary transport of secondary particulates from mainland Europe, highlight the persistence of external influences beyond local control.

Temporal analyses of pollutant behaviour further clarify the distinction between NO_2 and $PM_{2.5}$. NO_2 responds sharply to traffic volumes, with pronounced weekday and rush-hour peaks, making it well-suited to management under the Local Air Quality Management (LAQM) regime. $PM_{2.5}$, by contrast, reflects longer-lived influences such as domestic burning, seasonal meteorology, and regional transport. Its persistence underscores the need for coordinated long-term strategies that extend beyond local interventions.

The Public Health Outcomes Framework (PHOF) translates concentrations into measurable health impacts. In 2023, the fraction of mortality attributable to $PM_{2.5}$ ranged from 5.29% to 5.84% across Hertfordshire and Bedfordshire, consistently above the England average of 5.22%. There was sharp divergence observed in 2022, when Watford recorded 7.29%, illustrating how episodic pollution events can significantly affect health outcomes even when annual averages remain within compliance thresholds. This reinforces the importance of sustained monitoring and proactive local action to mitigate exposure.

Taken together, the findings demonstrate that Hertfordshire and Bedfordshire are benefiting from long-term reductions in $PM_{2.5}$, with fewer days of health-relevant pollution and concentrations well below statutory targets. Yet the persistence of seasonal peaks, episodic events, and measurable health burdens highlights that progress cannot be taken for granted. National government holds ultimate responsibility for meeting $PM_{2.5}$ targets, but local authorities remain critical partners in reducing emissions from sources within their control. The dual-network approach — reference monitors for compliance and trend analysis, supplemented by indicative sensors for spatial awareness — provides a robust framework for protecting public health, supporting statutory obligations, and guiding future air quality management.

In conclusion, Hertfordshire and Bedfordshire are well-placed to contribute to national compliance with the Environmental Targets (Fine Particulate Matter) Regulations 2023. Continued vigilance, investment in monitoring, and coordinated action at both local and national levels will be essential to sustain progress, reduce health inequalities, and ensure that the benefits of cleaner air are realised across all communities.

Contents

Table of Figures

Table of Tables

Chapter 1 - Introduction

Hertfordshire has an estimated 1,198,800 residents (Census 2021) and as well as large rural areas has over a dozen medium sized towns all close to London. It also has a heavy reliance on personal motor vehicles and at many locations across the County is faced with risk of road congestion.

The Public Health Outcomes Framework (PHOF), introduced in 2012, aims to improve health outcomes across the nation and reduce health inequalities. As part of this framework, $PM_{2.5}$ indicators were included to highlight the impact of air pollution—specifically fine particulate matter—on public health. These indicators enable Local Authorities to benchmark their performance, compare outcomes with other areas, and support data-driven decision-making across both tiers of local government.

Fine particulate matter ($PM_{2.5}$) poses a significant risk to public health due to its ability to penetrate deep into the lungs and enter the bloodstream. Exposure to $PM_{2.5}$ is linked to a range of serious health conditions, including heart disease, stroke, lung cancer, and respiratory illnesses. Emerging evidence also shows that these particles can reach nearly every organ in the body, contributing to systemic inflammation and chronic disease. Long-term exposure is associated with increased mortality, particularly among vulnerable populations such as children, older adults, and those with pre-existing conditions.

In 2014, Hertfordshire's Public Health conference highlighted the need for a county-wide $PM_{2.5}$ monitoring network, given strong evidence of the health risks posed by fine particles. At the time, there were only two reference-grade analysers, both located in Borehamwood, creating geographic bias, so councils were offered capital funding of £20,000 each to install additional equipment. The ongoing operational costs—including maintenance and data quality assurance—were expected to be covered by the councils themselves. While initial investment expanded coverage, ongoing costs led to fewer active sites over time. Initially the network consisted of x reference grade monitors and x indicative monitors. This has now reduced to x in 2024. The remaining network, now supplemented with Bedfordshire data, continues to provide vital evidence on $PM_{2.5}$ concentrations and trends, supporting statutory public health duties, Local Air Quality Management, and comparison against WHO guidelines. Further information on the formation of the network and how it has changed over the years can be seen in Appendix 1.

Chapter 2 - Current Monitoring Network

Hertfordshire and Bedfordshire Air Quality Monitoring Network

Currently 10 monitors that are equivalent to the reference method standard approved by Defra and the devolved administrations constitute the Hertfordshire and Bedfordshire Air Quality Monitoring Network (HBAQMN). Details on each individual monitor including where they are sited and the equipment used can be found in Appendix 1.

Borehamwood Meadow Park is also on Defra's Automatic Urban and Rural Network (AURN). The AURN is the main monitoring network in the UK and according to Defra "provides high resolution hourly information, which is communicated rapidly to the public, using a wide range of electronic, media and web platforms." Its main purpose is to monitor compliance with the Ambient Air Quality Directives and more recently used in the assessment of both the Annual Mean Concentration Target (AMCT) and Population Exposure Reduction Target (PERT) under the Environmental Target (Fine Particulate Matter)

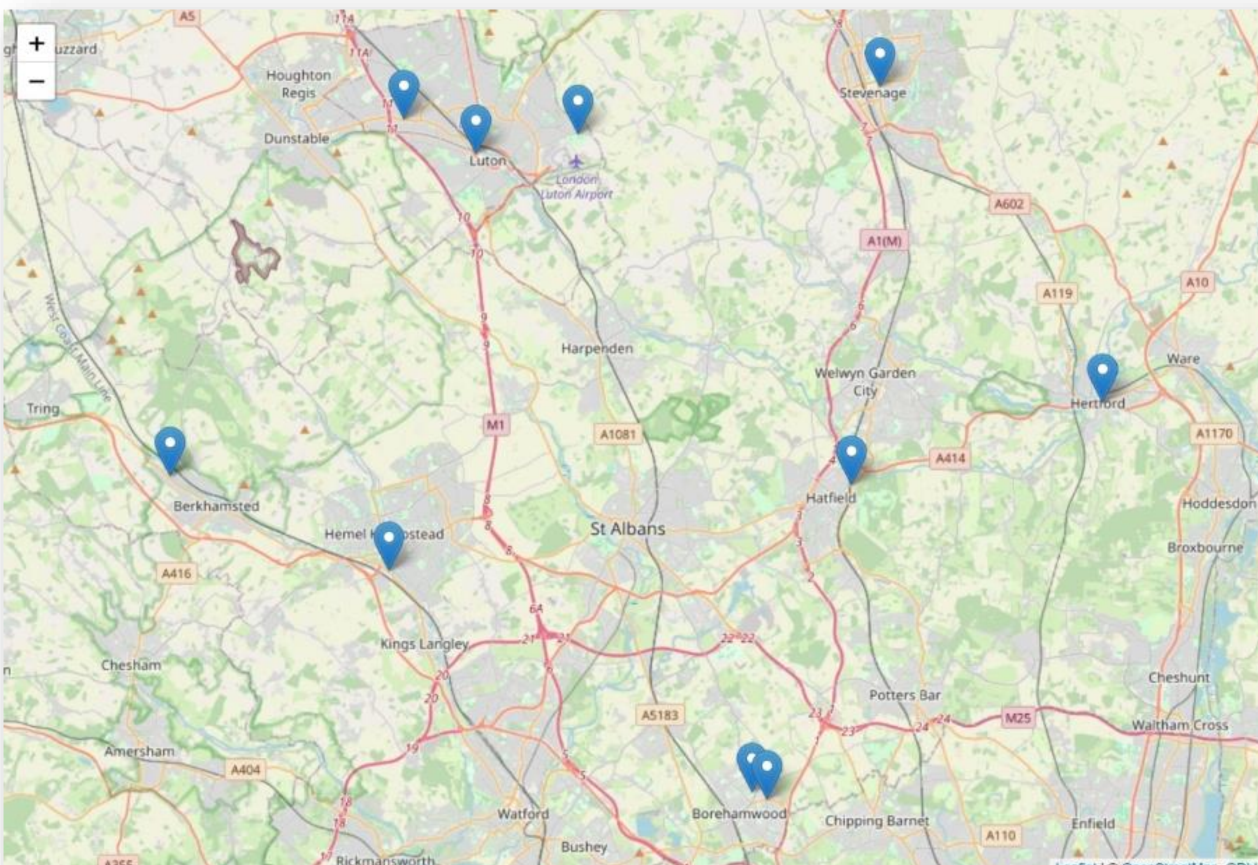

Figure 2.1 - Map showing locations of reference monitors in Herts and Beds

(England) Regulations 2023, subject to meeting the inclusion criteria on an annual basis (see chapter 5 on compliance for more information).

More information on undertaking PM monitoring and the list of approved technologies can be found in the Local Air Quality Management Technical Guidance (LAQM: TG) 22 (Defra, 2025). The data used in this report has been fully ratified in line with best practice and to meet Defra requirements. Data from the HBAQMN and the AURN analyser can be found on the Air Quality England website: Hertfordshire and Bedfordshire - Air Quality monitoring service. AURN can also be found at: Data Selector Tool - DEFRA UK Air - GOV.UK

Low-cost Multi-pollutant Sensor Network

In June 2024, Hertfordshire expanded its air quality surveillance by deploying a network of multi-pollutant sensors to improve understanding of fine particulate matter ($PM_{2.5}$) concentrations across the county. Unlike the Hertfordshire and Bedfordshire Air Quality Monitoring Network (HBAQMN), which focuses exclusively on outdoor (ambient) air, these new sensors can measure both ambient and indoor air pollution. As this report is concerned solely with ambient $PM_{2.5}$, only data from sensors installed outdoors is included.

The selected instruments, provided by AirScan, are described by the manufacturer as a “low-cost accurate system” designed to support high-density ambient air quality networks with real-time data capture. In addition to $PM_{2.5}$, the sensors monitor a suite of pollutants including Nitrogen Dioxide (NO_2), Ozone (O_3), Carbon Monoxide (CO), Sulphur Dioxide (SO_2), and PM10, as well as meteorological parameters such as temperature and humidity. To ensure data quality and comparability, all units were fully calibrated and baselined by AirScan against a nearby Defra reference monitoring station.

Data from these sensors are stored and managed by AirScan and made publicly available via the Hertfordshire County Council website. Sensor locations are listed in Appendix 2.

What’s the difference between reference and indicative monitors?

Reference monitors use high-precision instruments that meet strict regulatory standards. They provide highly accurate data and are typically used for compliance reporting and long-term trend analysis.

Indicative monitors, by contrast, are lower-cost sensors that offer useful insights into local air quality but may have greater uncertainty. They are often deployed to expand spatial coverage, raise public awareness, or support targeted interventions. While indicative data can reveal important patterns, it should be interpreted with caution and supplemented by reference-grade measurements where possible.

MCERTS Certification

MCERTS certification schemes are available for both types of monitors. To check which monitors or multi-pollutant sensors have been approved, please refer to the MCERTS Certified Products Database. Full certificate details for the monitors included in this report are provided in Appendix 2.

Chapter 3 - Monitoring Data for 2024

This report includes $PM_{2.5}$ data collected during 2024 from both reference monitors and multi-pollutant sensors across Hertfordshire and Bedfordshire. While every effort has been made to include all available data, several factors may affect completeness and interpretation:

- Data availability: Some monitors experienced temporary outages due to maintenance, calibration, or technical faults. Where possible, these gaps have been flagged and excluded from annual mean calculations.
- Sensor performance: Multi-pollutant sensors are included to provide broader spatial coverage, but their data may be subject to greater uncertainty compared to reference-grade monitors. These differences are considered when interpreting trends.
- Minimum data thresholds: To ensure reliability, annual averages are only reported for sites that met a minimum data capture threshold (typically 75% of the year). Sites falling below this threshold are noted in the figures and tables.
- Comparability across years: Year-to-year comparisons are based on consistent methods, but changes in network coverage or instrumentation may influence trends. These are highlighted where relevant.

All data processing was conducted using reproducible code in R, with transparent thresholds and quality checks applied consistently across sites. (Sources: Carslaw, 2012; Carslaw D.C., 2025)

Daily Mean 2024

Figures 3.1 and 3.2 display daily mean $PM_{2.5}$ concentrations recorded at monitoring sites across the region throughout 2024. Each panel corresponds to a distinct location. The red dashed line represents the World Health Organization's recommended daily limit of 15 $\mu g/m^3$, while the yellow lines indicate moderate pollution thresholds as defined by Defra's Daily Air Quality Index (DAQI). Exceedances of these lines may signal potential health risks, particularly for sensitive groups such as children, older adults, and individuals with respiratory conditions.

In Figure 3.1, which shows data from reference monitors, $PM_{2.5}$ concentrations remained consistently low across all sites. There was minimal variation over time, and only one day—during March 2024—saw concentrations rise from low to moderate levels. This brief exceedance occurred simultaneously at four locations, suggesting a short-lived regional pollution event.

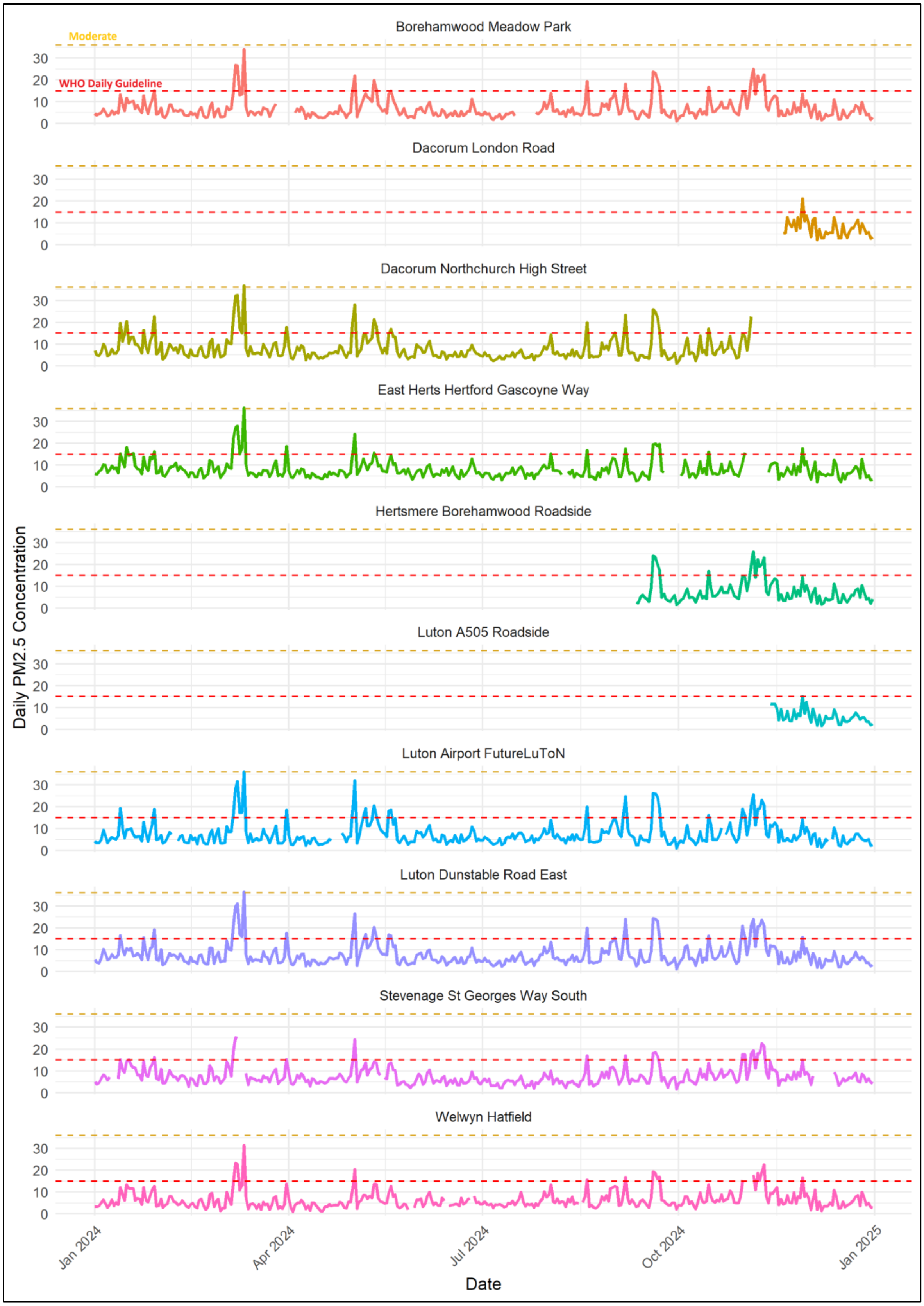

Figure 3.1 - Daily PM2.5 Concentrations Across Hertfordshire and Bedfordshire (2024)

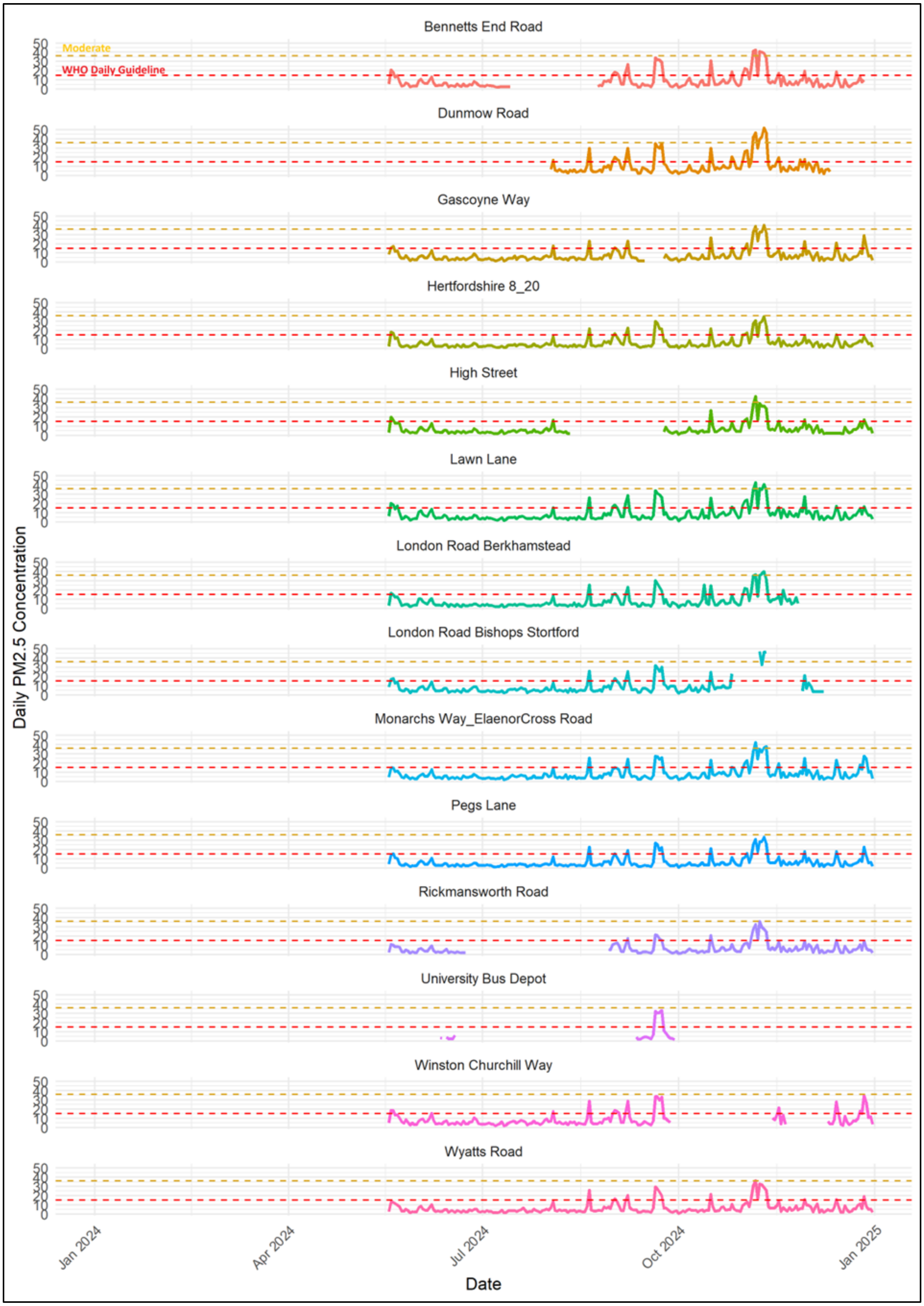

Figure 3.2 - Daily Mean AirScan Sensors 2024

Figure 3.2 shows daily $PM_{2.5}$ concentrations recorded by indicative monitors across the region during 2024. As these sensors were deployed in June 2024, the dataset does not cover the full calendar year. Additionally, there are some gaps in the data due to intermittent outages or quality control exclusions. Despite these limitations, the sites display broadly similar patterns, with elevated $PM_{2.5}$ concentrations observed during late autumn and winter. This seasonal trend is consistent with known influences such as colder temperatures, increased heating, and atmospheric conditions that can trap pollutants near the ground.

Hockerill Street AirScan Multi-pollutant Sensor

The Hockerill Street monitoring data has been excluded from the dataset due to evidence of sensor malfunction. This decision was based on a clear discrepancy between the results shown in Figure 3.2 and those in Figure 3.3, which indicate that the sensor was producing abnormally high readings. While the data is retained here for reference, it has not been used in the main analysis. On multiple occasions, the sensor reported daily average $PM_{2.5}$ concentrations exceeding 200 µg/m^3—more than eight times the WHO daily guideline of 15 µg/m^3 and far beyond the UK alert threshold of 36 µg/m^3. Whereas concentrations at all other sites presented in figures 3.1 and 3.2 rarely exceed the moderate threshold in 1 year. Pollutants with a long lifetime, such as $PM_{2.5}$, can remain in the atmosphere for days to weeks. This allows them to travel far from where they were created, affecting air quality and health across wide regions.

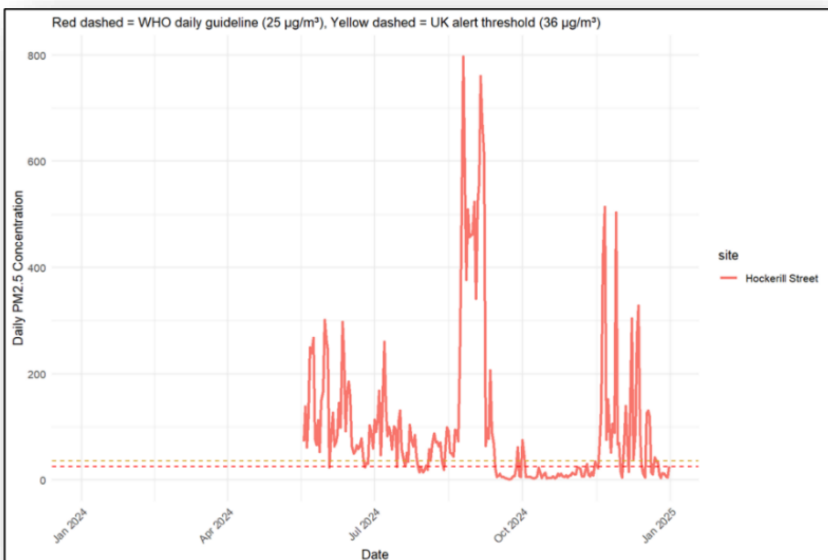

Figure 3.3 - Hockerill Street AirScan Sensor Daily Mean

Consequently, it would be expected to see corroborating evidence from nearby sites that supports these extreme values. As this was not the case, the data is overwhelmingly suggesting a sensor fault. This highlights the critical importance of validating air quality data. Erroneous readings, if left unchallenged, can undermine public trust and lead to misinformed decisions.

Annual Mean in 2024 and comparison with modelled Defra background maps.

In 2024, 7 out of 10 reference monitoring sites achieved a data capture rate of 75% or higher, meeting the threshold for reliable annual mean reporting.

- Hertsmere Borehamwood Roadside recorded a data capture rate between 25% and 75%. As recommended in Local Air Quality Management Technical Guidance (LAQM TG22), annualisation was applied to estimate the annual mean concentration (see appendix 3).
- Dacorum London Road and Luton A505 had data capture rates below 25%. In line with guidance, these sites were excluded from any analysis involving annual means due to insufficient data.
- All sites with sufficient data capture reported annual mean $PM_{2.5}$ concentrations below the UK Air Quality Objective of 10 µg/m^3 by 2040.

All multi-pollutant sensors achieved less than 75% data capture. As low-cost sensors are not currently considered suitable for compliance assessment or long-term trend analysis, subsequent findings are based exclusively on data from reference-grade monitors.

To contextualise the monitored $PM_{2.5}$ concentrations, background estimates were extracted from Defra's 1 km grid concentration maps for 2024. These maps provide modelled annual average pollutant levels across the UK and are designed to support local authorities in assessing air quality under the Environmental Act. (Defra, 2024) For each monitoring site, the background value was taken from the grid square in which the site is located. Comparing these estimates with measured concentrations helps identify the influence of local sources. In most cases, monitored values were slightly lower than the background, suggesting that regional or diffuse sources dominate. However, sites such as Dacorum Northchurch High Street, East Herts Hertford Gascoyne Way, Stevenage St George's Way South and Luton Airport FutureLuTon showed monitored levels close to or above background, indicating stronger local contributions.

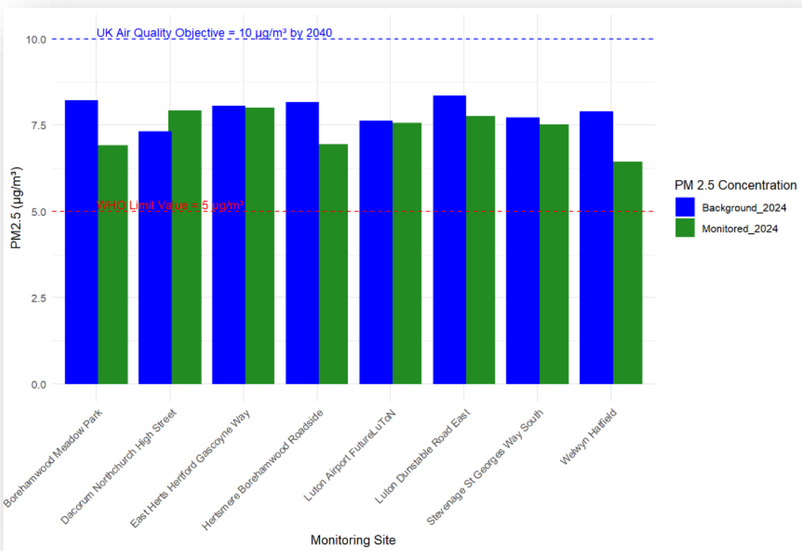

Figure 3.4 - Annual Mean 2023 compared with 1 km square Defra Background Map

Variation in $PM_{2.5}$ Concentrations

Figure 3.5 contains charts that show concentrations vary by day of the week, hour of the day, a combined hour–day plot, and monthly averages for the HBAQMN. Included for comparison is figure 3.6 which contains charts downloaded from Defra's [accredited official statistics for PM_{10}/$PM_{2.5}$ webpage](#) (Defra, 2025). Included in both sets of charts is 95% confidence intervals to illustrate uncertainty. Both sets of charts show data that has been averaged over all included sites. The interval for roadside sites in the Defra charts narrows over time because of an increase in the number of monitoring sites and a reduction in the variation between annual means for $PM_{2.5}$ measured at roadside sites.

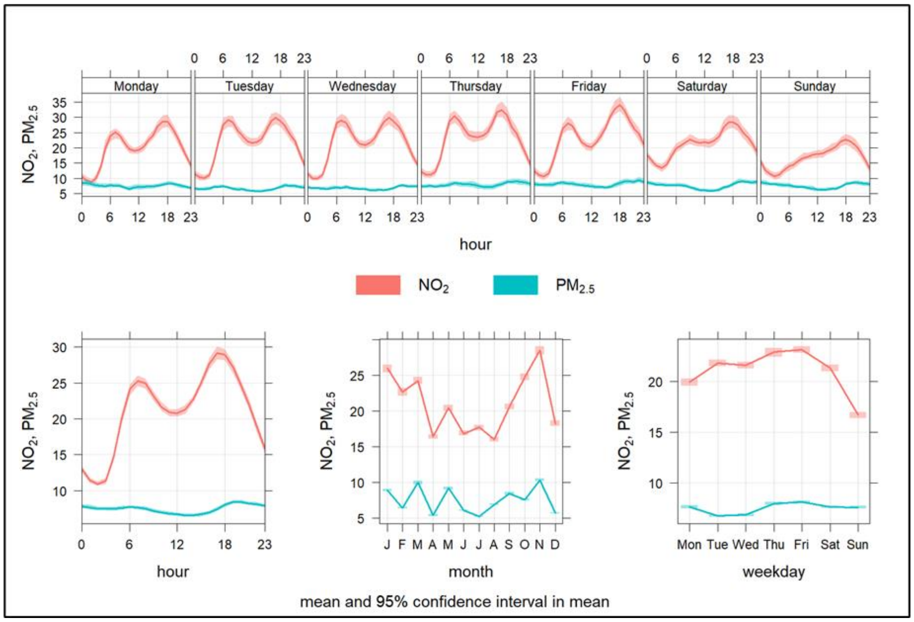

Figure 3.5 - HBAMN, temporal variation in pollutant concentration over 1 year in 2024

Monthly Variation in NO_2 and $PM_{2.5}$ Concentrations

Spring Peak: Both Hertfordshire & Bedfordshire monitors and AURN sites show a clear spring peak in March 2024, though it is stronger locally. According to the Air Quality Expert Group (AQEG), this seasonal rise is linked to nitrate particles transported from agricultural activity in continental Europe. The stronger peak in Hertfordshire and Bedfordshire likely reflects

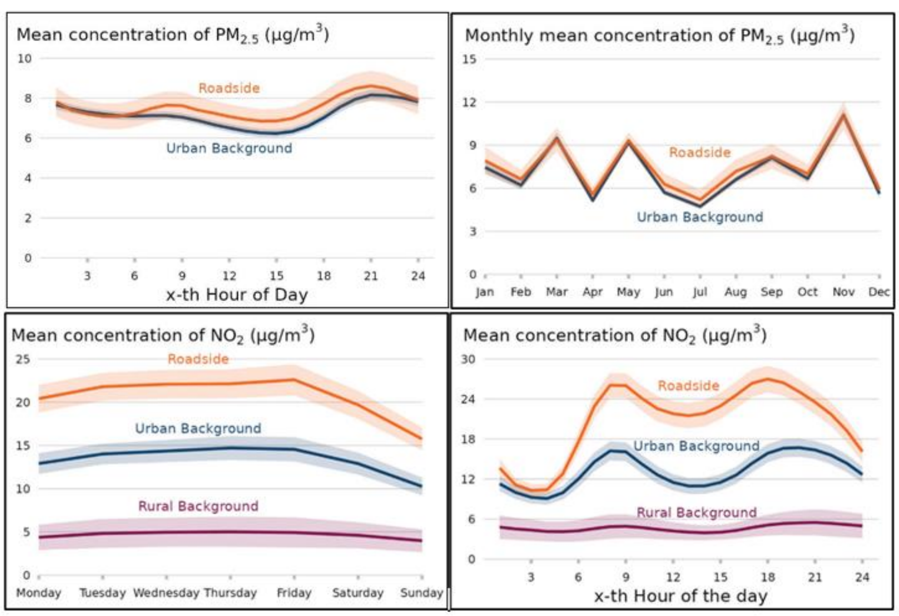

Figure 3.6 - AURN, temporal variation in pollutant concentrations over 1 year in 2024

their south-eastern location, which is more exposed to European inflows than western regions.

Winter peaks: Elevated concentrations in November and other winter months are evident in both datasets. These are attributed to domestic combustion of wood and coal in stoves and open fires, a major source of particulate matter across the UK and Europe.

Urban vs roadside sites: In Figure 3.7, concentrations at urban background and roadside sites converge slightly in winter, explained by Defra as evidence that domestic burning sources are often closer to background sites. It may also explain why concentrations fall in June and July. Concentrations of $PM_{2.5}$ are usually lowest in summer months, likely due in part to reduced pollution, such as less people burning fuels for heating and reduced traffic on the road.

Weather effects: The sharp drop in December 2024 reflects stormy conditions, where wind disperses pollutants and rainfall removes particles from the air.

Weekly Variation in NO_2 and $PM_{2.5}$ Concentrations

Although Defra did not produce a weekday variation chart for $PM_{2.5}$, Figure 3.6 highlights distinct differences between the two pollutants:

- NO_2 concentrations are lower on weekends, especially at roadside sites, reflecting reduced road traffic — the primary source of NO_2 emissions.
- $PM_{2.5}$ concentrations show less variation across the week, indicating stronger influence from non-traffic sources such as domestic burning and regional transport.

This contrast reflects their atmospheric behaviour: NO_2 is short-lived and responds quickly to local traffic changes, while $PM_{2.5}$ persists longer and reflects a broader mix of sources and transport patterns.

Hourly Variation in NO_2 and $PM_{2.5}$ and Concentrations

Monitoring data from the AURN and Hertfordshire & Bedfordshire networks show clear daily cycles:

$PM_{2.5}$ (Fine Particulate Matter)

- Evening peak (~9 pm): Highest concentrations at roadside and urban background sites, likely due to domestic burning.
- Midday dip: Background sites show a decline in mid-afternoon before evening levels rise again.
- Morning bump (~9 am): Smaller peak at roadside sites linked to rush hour traffic.
- Roadside vs background: Roadside sites consistently record slightly higher levels, reflecting additional vehicle emissions.

NO_2 (Nitrogen Dioxide)

- Strong morning and evening peaks at both roadside and background sites, closely following commuter traffic volumes (Defra's Road Traffic Estimates, 2024).
- Road traffic exerts a more immediate and dominant influence on NO_2 than on $PM_{2.5}$, whose peaks are less pronounced.

Why This Matters

- NO_2 behaves like match smoke — dispersing quickly and responding to local traffic changes.
- $PM_{2.5}$ lingers like dust in a room — requiring regional and long-term strategies to manage.

Policy Implications

- NO_2: Well-suited to management under the Local Air Quality Management (LAQM) regime, including Air Quality Management Areas (AQMAs) where targeted interventions can reduce roadside concentrations.
- $PM_{2.5}$: Requires regional coordination and long-term strategies, addressing both local sources (e.g., domestic burning, local traffic) and transboundary pollution transported from other areas in the UK and continental Europe.

The principle of "Think Global, Act Local" has long guided environmental policy, emphasising that local actions contribute to global outcomes such as climate change mitigation. In contrast, Local Air Quality Management (LAQM) has traditionally operated on a "Think Local, Act Local" basis, since pollutants like nitrogen dioxide (NO_2) have short atmospheric lifetimes and their impacts are highly localised.

Fine particulate matter has a longer atmospheric lifetime and can be transported across regions and national boundaries. Local measures — such as reducing traffic emissions, discouraging domestic wood burning, and promoting sustainable transport — remain essential, but they are not sufficient on their own.

For $PM_{2.5}$, a more appropriate framing could be: "Think Regional, Act Local."

This principle recognises that local authorities must act to reduce emissions from sources within their control. However, regional and national collaboration is vital, since transported pollution contributes significantly to local concentrations. Policies should therefore combine local interventions with regional coordination, ensuring that efforts are aligned across boundaries and supported by national frameworks.

Chapter 4 - Trends in $PM_{2.5}$ Concentrations (2016 – 2024)

Over the past nine years, evident in figure 4.1 below, concentrations of fine particulate matter ($PM_{2.5}$) have shown a general downward trend across Hertfordshire and Bedfordshire. This mirrors the national picture shown in figure 4.3, where:

- At urban background sites, annual average $PM_{2.5}$ concentrations fell from 12.4 µg/m^3 in 2009 to 7.2 µg/m^3 in 2024 — the lowest level recorded to date.
- At roadside sites, annual mean concentrations declined from 12.8 µg/m^3 in 2009 to 7.5 µg/m^3 in 2024 — the lowest level recorded to date.

Overall, the decline in PM2.5 concentrations at both AURN urban and roadside sites closely follow the downward trend observed for PM10 (of which PM2.5 is a subset

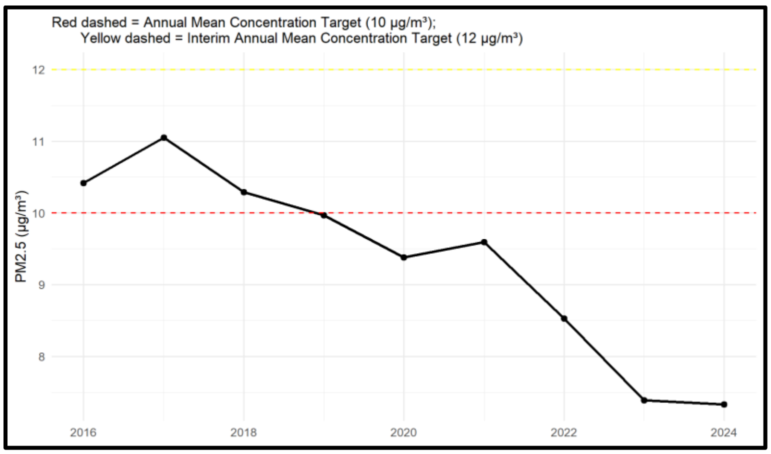

Figure 4.1 - Annual Mean PM2.5 Across All Sites

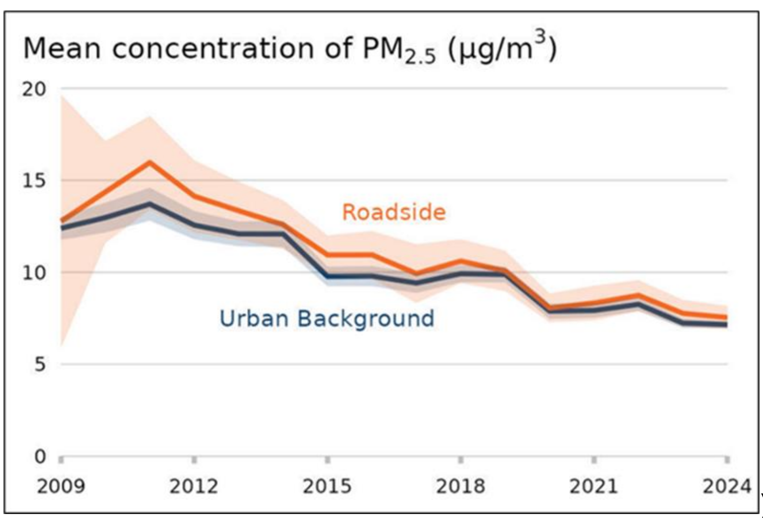

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Figure 4.2 - AURN Annual Means

Figure 4.3 shows how each site's annual $PM_{2.5}$ concentration compared with the regional mean. Although the sites do not follow a uniform trajectory, the spread of deviations narrows noticeably in 2024. This indicates that site-level concentrations became more similar to one another, with fewer locations standing out as unusually high or low. In other words, 2024 was the year with the least divergence from the overall trend, suggesting a more consistent air quality picture across the area.

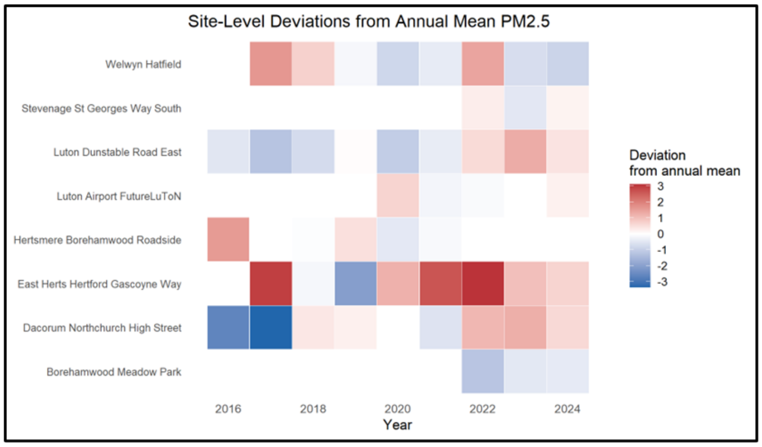

Figure 4.3 - Site Level Deviations from Herts and Beds Annual Mean

Days where concentrations are moderate or above.

The charts highlight occasions when air pollutant concentrations reach levels that may affect human health. Categories from the Daily Air Quality Index (DAQI) are used to classify these episodes, making it easier to understand potential impacts. Each DAQI category is paired with health advice that recommends actions to reduce risk. Figure 4.3 presents calendar plots showing the daily mean by DAQI category in a familiar, easy-to-read format. For $PM_{2.5}$, "Moderate" air pollution (shown in yellow and orange on the chart) is triggered when the latest 24-hour running mean concentration exceeds 35 µg/m^3.

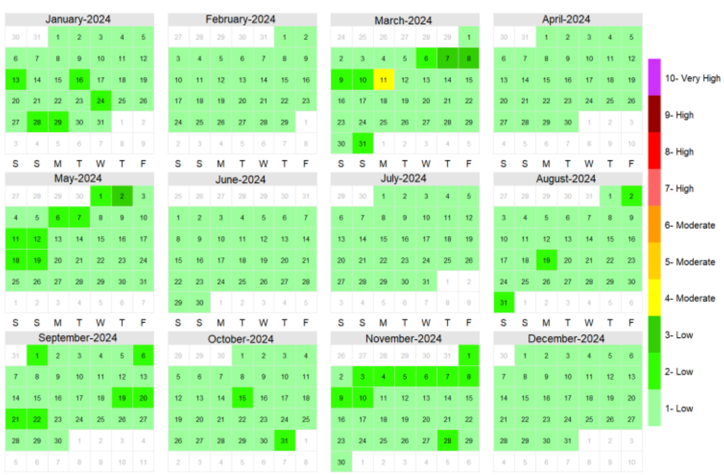

Figure 4.6 - DAQI calendar plot HBAQMN 2024

Figure 4.7 - Calendar Plot showing DAQI categories over the previous 8 years

Figure 4.4 demonstrates that the number of days exceeding the moderate threshold has generally decreased over the past nine years. A notable dip occurred in 2020, when—likely because of reduced activity during the pandemic—there were no days above the threshold. Otherwise, the trend shows a steady decline from seven days to just one day.

This pattern is consistent with national monitoring data from the AURN, where Defra reports a decreasing trend in hours of 'Moderate' or higher $PM_{2.5}$ air pollution since 2011.

The accredited official statistics for $PM_{2.5}$ (Defra, 2025) provide further context for the higher pollution episodes observed in earlier years of the chart.

In 2019, particulate pollution was particularly high in February and April. This was attributed to a combination of secondary pollution formed over mainland Europe and wind conditions that carried this pollution to the UK. A subsequent period of low wind conditions allowed emissions from UK sources to accumulate in the atmosphere, leading to unusually high concentrations of particulate matter.

In 2022, one significant widespread particulate pollution episode was recorded. This occurred in spring and coincided with low wind speeds and the transport of air masses over Europe, again contributing to elevated $PM_{2.5}$ concentrations.

Chapter 5 - Compliance

It is recognised that National Government holds responsibility for meeting the $PM_{2.5}$ targets outlined below. However, this does not absolve local government of liability. The Air Quality Strategy: Framework for Local Authority Delivery (Defra, 2023) reinforces that Local authorities contribute to meeting national targets as well as local objectives and while $PM_{2.5}$ is not formally part of the Local Air Quality Management framework, authorities are still expected to use their powers to reduce emissions from sources within their control.

All monitors on the Herts and Beds Network recorded annual means significantly below the Annual Mean Concentration Target (AMCT) of 10 $\mu g/m^3$. The AMCT will only be legally met when, after 2024, all AURN sites record an annual average below this threshold.

In the 2024 compliance assessment summary (Defra, 2025), Defra reported that all AURN sites met the interim target of 12 $\mu g/m^3$ by 2028, with only one site failing to meet the AMCT: London Marylebone Road, a roadside site in central London. Compliance with the long-term targets becomes a legal requirement from 2040 onwards. In the meantime, the interim targets including the new target of 10 $\mu g/m^3$ by 2030 published on 1st December 2025 will be applied as a guide to compliance.

The Population Exposure Reduction Target (PERT) for $PM_{2.5}$ is a minimum of 35% reduction compared to 2018 by 31 December 2040. Again, there are interim targets of

- a population exposure reduction target of 22% compared to 2018 to be achieved by December 2028
- a population exposure reduction target of 30% compared to 2018 to be achieved by December 2030

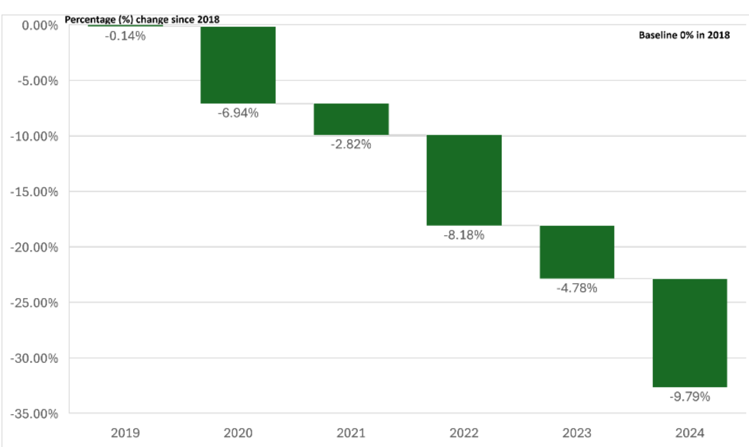

Figure 5.1- Percentage reduction in PM2.5 concentrations in Hertfordshire

Information on progress towards meeting the $PM_{2.5}$ targets, including details of how they are calculated, can be found on the UK-Air website (Defra, 2023). As of 2024, the national population exposure calculated using the relevant AURN data has reduced by 25% compared to the baseline year of 2018. Exceeding the interim target of 22% reduction by 2028. It does not yet meet the new interim target of 30% reduction compared to 2018 to be achieved by December 2030. For guidance only, the

PERT for Hertfordshire was calculated using the methodology outlined on the UK-Air website. This information should be considered with caution as the number of sites included in the calculation is far fewer than on the AURN. In 2024, there has been a 28.81% reduction in $PM_{2.5}$ concentrations since the base year of 2018.

Chapter 6 - Public Health Outcome Framework

The Public Health Outcomes Framework (PHOF), launched in 2012 by the Department of Health in England, was designed to improve population health and wellbeing while reducing inequalities. One of its indicators measures the mortality burden associated with long-term exposure to particulate air pollution ($PM_{2.5}$), expressed as the percentage of annual deaths from all causes in those aged 30 and older.

Using the updated method, the indicator is derived from population-weighted annual average $PM_{2.5}$ concentrations (provided by Ricardo E&E) and mortality data from the Office for National Statistics (ONS), applying a relative risk model. These averages are suitable for estimating the mortality burden from long-term exposure to anthropogenic $PM_{2.5}$. They differ from Local Authority-specific maps, which use the same model outputs but provide source-sector splits and projections to support Local Air Quality Management (see Chapter 3).

The indicator is reported at local authority level, enabling regional comparisons and highlighting areas with higher pollution burdens.

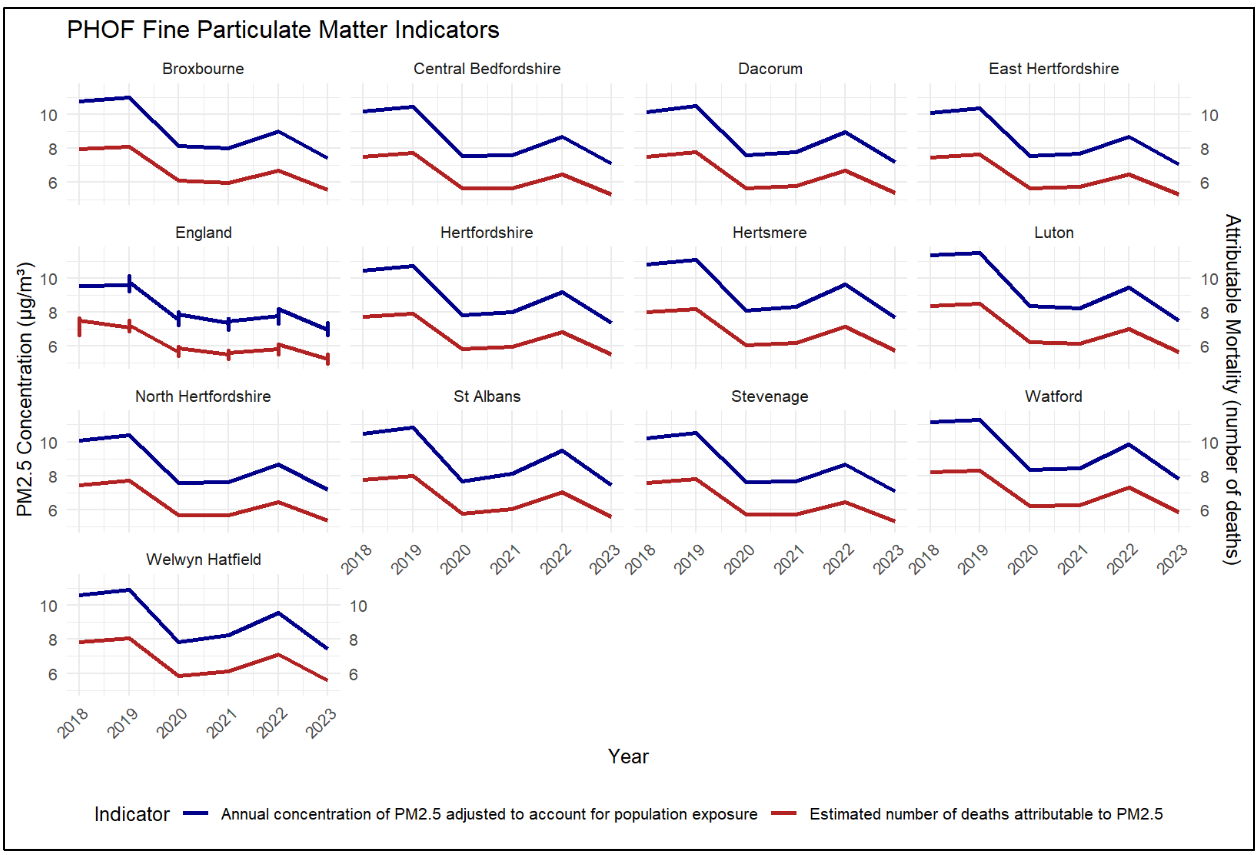

Figure 6.1 - PHOF Indicators

Findings for Hertfordshire and Bedfordshire

Charts illustrate annual modelled estimates of population-weighted average background $PM_{2.5}$ concentrations alongside indicator D.01 – Air pollution: estimated fraction of mortality attributable to $PM_{2.5}$. The relationship is clear: higher background concentrations correspond to a greater estimated mortality burden.

- 2023: Mortality attributable to $PM_{2.5}$ ranged from 5.84% in Watford to 5.29% in East Hertfordshire and Central Bedfordshire, all above the England average of 5.22%.
- 2022 divergence: Local authorities had previously tracked closely with the England trend. In 2022, however, England recorded 5.82%, while Watford rose sharply to 7.29% and East Hertfordshire to 5.46%. Aside from the widespread springtime particulate pollution episode noted in Chapter 4, no clear explanation has been identified for this divergence

Chapter 7 - Conclusion and Recommendations

Conclusion

The 2024 compliance assessment confirms that Hertfordshire and Bedfordshire are performing strongly against national $PM_{2.5}$ targets. All monitors in the regional network reported annual means well below the Annual Mean Concentration Target (AMCT) of 10 µg/m^3, reinforcing the area's generally favourable air quality profile. While the AMCT will only be legally binding once all AURN sites consistently record values below this threshold, interim compliance has already been achieved, and in 2024 only London Marylebone Road exceeded the actual limit of 10 µg/m^3. Nationally, population exposure has fallen by 25% since 2018, surpassing the interim reduction target of 22% by 2028 and demonstrating tangible progress towards the long-term 2040 goal.

For Hertfordshire and Bedfordshire, the Public Health Outcomes Framework (PHOF) provides a complementary lens, translating pollutant concentrations into measurable health impacts. In 2023, the fraction of mortality attributable to $PM_{2.5}$ ranged from 5.29% to 5.84% across local authorities, consistently above the England average of 5.22%. This highlights that, despite compliance with concentration targets, the health burden remains significant. The sharp divergence observed in 2022, when Watford recorded 7.29% compared to England's 5.82%, underscores the sensitivity of health outcomes to episodic pollution events and regional inflows, as noted in Chapter 4.

Taken together, these findings emphasise that national progress on $PM_{2.5}$ reduction does not absolve local authorities of responsibility. While compliance targets are set at national level, the Air Quality Strategy (Defra, 2023) makes clear that local powers must be used to tackle emissions from domestic burning, transport, and other controllable sources. Sustained reductions in both concentrations and health burden will depend on this dual approach: national frameworks to drive long-term compliance, and local interventions to address the everyday realities of exposure.

What Next?

Current Policies.

Hertfordshire County Council has made cleaner air a central priority, recognising that "poor air quality is everybody's business" (Hertfordshire County Council, 2019) and that behaviour change is essential to reducing exposure (Hertfordshire County Council, 2023). Through the Sustainable Hertfordshire Strategy, with its ambition of "Cleaner air for all by 2030," the Council aims to lead in measuring and reducing pollutants while promoting cleaner modes of transport. Achieving this requires strong stakeholder engagement and collaborative action to raise awareness, build support, and inspire changes in everyday behaviour (Hertfordshire County Council, 2023). The new corporate plan reinforces this commitment by pledging to grow a more sustainable Hertfordshire through community outreach, involving residents in decision-making, and celebrating the contributions of individuals and organisations to environmental sustainability (Hertfordshire County Council, 2025).

Emerging evidence.

In the last 5 years across multiple authoritative reports listed below, there is a clear consensus that air pollution remains the UK's most significant environmental risk to public health, despite long-term improvements in air quality.

- Prevention of Future Deaths Report from the Inquest of Ella Kissi-Debrah (Barlow, 2021)
- Chief Medical Officer's Annual Report 2022: air pollution (Whitty, 2022)
- Healthy Air Coalition, Making Britain's air cleaner, healthier and better to breathe: A blueprint for government action (Healthy Air Coallition, 2025)
- A breath of fresh air: responding to the health challenges of modern air pollution (Royal College of Physicians, 2025)
- Environment Agency Chief Regulator's report 2024-25: supporting evidence (Environment Agency, 2025)

The Healthy Air Coalition highlights air pollution as a "public health emergency" requiring urgent, coordinated action across all levels of government, with disproportionate impacts on children, people with chronic disease, and deprived communities ((Healthy Air Coallition, 2025). The Chief Medical Officer's Annual Report 2022 reinforces this by documenting growing evidence of links between air pollution and a wider range of health outcomes, from adverse birth impacts to dementia, while also emphasising inequalities in exposure and the need for better data on personal and indoor exposures (Whitty, 2022). The Prevention of Future Deaths report from the inquest of Ella Adoo Kissi Deborah underscores the human cost of delayed action and poor communication, noting that thousands of premature deaths each year are avoidable and that public awareness of pollution risks remains low (Barlow, 2021). Similarly, the Environment Agency Chief Regulator's Report 2024–25 stresses that air pollution continues to damage quality of life, with an estimated 30,000 deaths annually and economic costs of £27–50 billion, disproportionately affecting vulnerable and low-income groups (Environment Agency, 2025). Finally, the Royal College of Physicians' report A Breath of Fresh Air calls air pollution a preventable public health crisis, emphasising that "there is no safe level" and urging more ambitious action, including recognition of indoor air pollution and the need for a UK-wide public health campaign (Royal College of Physicians, 2025). Taken together, these reports converge on common themes: air pollution is a serious and preventable public health crisis; its impacts are broader and more severe than previously understood; inequalities in exposure and health burden must be addressed; and urgent, coordinated action is required at both national and local levels to protect health and reduce avoidable deaths.

Citizen science strengthens air quality decision-making by expanding monitoring coverage, revealing hidden vulnerabilities, and giving communities a voice in shaping fairer policies. However, challenges remain around data quality, integration into formal frameworks, and ensuring inclusive participation without stigmatizing or excluding vulnerable groups.

Shifting perspectives: from clean air to healthy air

A recent Blog published by the Environment Agency in their "Creating a better place" series Dr Pippa Douglas (Environment Agency), Dr Emma Marczylo (UK Health Security Agency) and Prof. Sean Tyrrel (Cranfield University) (Environement Agency, 2024) proposes that we move away from the concept of "clean" air and think of the goal is to have "healthy" air. We need to recognise that "healthy" air is not just the absence of pollutants but also the presence of beneficial biological components. More information on this project can be found on the BioAirNet website BioAirNet – BioAirNet.

Does the Monitoring Network Need to Expand?

Expanding an air quality monitoring network should be driven by clear objectives rather than by technology availability alone. Before investing in new equipment, authorities should ask:

What do we want to learn from the data?
For example, is the goal to track compliance with statutory targets, to understand local exposure hotspots, or to evaluate the impact of interventions?

Do we need new equipment to answer this question?
In some cases, existing reference monitors, supplemented by modelled background maps or short-term studies, may already provide sufficient evidence.

Are there better options available?
Low-cost sensors can expand spatial coverage and raise public awareness, but they carry greater uncertainty. Reference-grade monitors remain essential for compliance and long-term trend analysis. In some cases, targeted short-term deployments, mobile monitoring, or improved modelling may achieve the same goal more efficiently.

Ultimately, expansion should be considered where there are clear gaps in spatial coverage, where local sources are suspected to contribute disproportionately to exposure, or where communities would benefit from more granular information. Otherwise, strengthening data quality, validation, and integration with health outcomes may deliver greater value than simply adding more monitors. A potential consideration would be to involve the public in monitoring in the form of a citizen or people science project. It has been reported that citizen science can strengthen air quality decision-making by expanding monitoring coverage, revealing hidden vulnerabilities, and giving communities a voice in shaping fairer policies. However, challenges remain around data quality, integration into formal frameworks, and ensuring inclusive participation without stigmatizing or excluding vulnerable groups.

Chapter 8 References

Barlow, P. (2021, April 21). *Ella Kissi Debrah.* Retrieved from Courts and Tribunals Judiciary: https://www.judiciary.uk/prevention-of-future-death-reports/ella-kissi-debrah/

Carslaw D.C., D. J. (2025, 09 08). *The openair book - A Guide to the Analysis of Air Pollution Data*. Retrieved 11 05, 2025, from openair-project: https://openair-project.github.io/book/

Carslaw, D. a. (2012). openair --- an R package for air quality data analysis. *Environmental Modelling & Software, 27-28*, 52-61.

Defra. (2023, August 25). *The air quality strategy for England.* Retrieved from GOv.UK: https://assets.publishing.service.gov.uk/media/64e8963d635870000d1dbf9d/Air_Quality_Strategy_Web.pdf

Defra. (2024, 11 13). *Background Mapping data for local authorities*. Retrieved from UK-Air: https://uk-air.defra.gov.uk/data/laqm-background-home

Defra. (2025, 05). *UK Regions (exc. London) Technical Guidance.* Retrieved from Defra: https://laqm.defra.gov.uk/air-quality/featured/uk-regions-exc-london-technical-guidance/

Environement Agency. (2024, 09 26). *Shifting perspectives: from clean air to healthy air*. Retrieved from gov.uk: https://environmentagency.blog.gov.uk/2024/09/26/shifting-perspectives-from-clean-air-to-healthy-air/

Environment Agency. (2025, November 21). *Environment Agency Chief Regulator's report 2024-25: supporting evidence.* Retrieved from gov.uk: https://www.gov.uk/government/publications/environment-agency-chief-regulators-report-2024-25/environment-agency-chief-regulators-report-2024-25-supporting-evidence

Healthy Air Coallition. (2025, June 30). *Making Britain's air cleaner, healthier and better to breathe: A blueprint for goernment action on clean air.* Retrieved from Healthy Air Coalition: https://drive.google.com/file/d/1TCjZO2cWvFlZpi5Y56P4n5rzYD6aDGQp/view

Hertfordshire County Council. (2019). *Air Quality Strategy 2019.* Retrieved from Hertyfordshire County Council: https://www.hertfordshire.gov.uk/media-library/documents/about-the-council/data-and-information/public-health/air-quality-strategy.pdf

Hertfordshire County Council. (2023, March). *Sustainable Hertfordshire Strategy 2022 (Revised March 2023).* Retrieved from Hertfordshire County Council: https://www.hertfordshire.gov.uk/microsites/sustainable-hertfordshire/media/sustainable-hertfordshire-strategy-revised-march-2023.pdf

Hertfordshire County Council. (2025). *On your side, Hertfordshire County Council 2025 - 28*. Retrieved 11 20, 2025, from Hertfordshire County Council.

Royal College of Physicians. (2025, 06 25). *A breath of fresh air: responding to the health challenges of modern air pollution.* Retrieved from Royal College of Physicians: https://www.rcp.ac.uk/policy-and-campaigns/policy-documents/a-breath-of-fresh-air-responding-to-the-health-challenges-of-modern-air-pollution/

Whitty, C. (2022, 12 08). *Chief Medical Officer's annual report 2022: air pollution.* Retrieved from gov.uk: https://www.gov.uk/government/publications/chief-medical-officers-annual-report-2022-air-pollution

Appendix 1

Operational Sites - Hertfordshire

AQE Code	Site	Site Type[1]	Grid Reference	Equipment	Start Date
BDMP[3]	Borehamwood Meadow Park	Urban Background	519759, 197107	FIDAS[2]	1 Oct 2017
HB018	Dacorum London Road[9]	Urban Traffic	505709 , 205477	FIDAS[2]	18 Nov 2024
HB013	Dacorum Northchurch High Street[9]	Urban Traffic	497295, 208901	FIDAS[2]	12 Aug 2015
HB012	East Herts Hertford Gascoyne Way[9]	Urban Traffic	532764, 212519	BAM[2]	28 Aug 2016
HB009	Hertsmere Borehamwood Roadside	Urban Traffic	532764, 212519	FIDAS[2,4]	10 Sept 2024
HB017	Stevenage St Georges Way South[9]	Urban Traffic	523589, 223965	BAM[2]	1 Nov 2021
HB001	Welwyn Hatfield[9]	Urban Traffic	523283, 209161	BAM[2]	28 Apr 2016

Table 1 - Operational Sites Hertfordshire

Operational Sites – Bedfordshire

AQE Code	Site	Site Type[1]	Grid Reference	Equipment	Start Date
LUTR[3]	Luton A505 Roadside	Urban Traffic	505927, 222644	FIDAS[2]	12 Nov 2024
LA001	Luton Airport FutureLuToN	Urban Industrial	512578, 222204	GRIMM[5]	19 Jun 2019
HB007	Luton Dunstable Road East	Urban Traffic	508706, 221353	FIDAS[2]	27 Oct 2017

Table 2 - Operational Sites Bedfordshire

Closed Sites – Hertfordshire

AQE Code	Site	Site Type[1]	Grid Reference	Equipment	Closing Date
HB008	Hertsmere Borehamwood Background	Urban Background	520290, 197087	FIDAS[2]	23 May 2017
HB009	Hertsmere Borehamwood Roadside	Urban Traffic	532764, 212519	TEOM - FDMS[2]	31 Dec 2023
HB003	Hitchin Stevenage Road Particulates[9]	Urban Traffic	518713 , 228349	BAM[2]	31 Dec 2023
HB015	Stevenage St Georges Way[9]	Urban Traffic	523589, 223965	BAM[2]	1 Nov 2021
HB004	Watford Town Hall[9]	Urban Traffic	510572, 196809	FIDAS[2]	27 Nov 2023

Table 3 - Closed Sites Hertfordshire

Operational Multi-Pollutant Sensors

Reference Code	Site	Site Type	Equipment	Grid Reference	Start Date
E45F01F74020	Bennetts End Road, Hemel Hempstead	Urban Traffic	Airscan AQM[6]		18 May 2024
E45F01E3DACF	Dunmow Road, Bishop's Stortford	Urban Traffic	Airscan AQM[6]		2 Aug 2024
E45F01E3DAA8	Gascoyne Way, Hertford	Urban Traffic	Airscan AQM[6]		18 May 2024
E45F01F74044	Hertfordshire 8/20	Urban Traffic	Airscan AQM[6]		18 May 2024
E45F01F74023	High Street, Elstree	Urban Traffic	Airscan AQM[6]		18 May 2024
E45F01E3DA5A	Hockerill Street, Bishop's Stortford	Urban Traffic	Airscan AQM[6]		18 May 2024
E45F01F73FF0	Lawn Lane, Hemel Hempstead	Urban Traffic	Airscan AQM[6]		18 May 2024
E45F01F74047	London Road, Berkhamsted	Urban Traffic	Airscan AQM[6]		18 May 2024
E45F01F73F99	London Road, Bishop's Stortford	Urban Traffic	Airscan AQM[6]		18 May 2024
E45F01F73FDE	Monarchs Way/Eleanor Cross Road, Waltham Cross	Urban Traffic	Airscan AQM[6]		18 May 2024
E45F01E3DB9A	Pegs Lane, Hertford	Urban Traffic	Airscan AQM[6]		18 May 2024
E45F01F74011	Rickmansworth Road, Chorleywood	Urban Traffic	Airscan AQM[6]		18 May 2024
B827EB774B12	University Bus Depot, Gypsy Moth Avenue	Urban Traffic	Airscan AQM[6]		18 May 2024
E45F01F74026	Winston Churchill Way, Waltham Cross	Urban Traffic	Airscan AQM[6]		18 May 2024
E45F01F74029	Wyatts Road, Chorleywood	Urban Traffic	Airscan AQM[6]		18 May 2024

Table 4 - AirScan Multi-Pollutant Sensors

Withdrawn Multi-Pollutants Sensors

Site	Site Type	Grid Reference	Equipment	Start Date	Closing Date
College Road, Cheshunt[8,9]	Roadside	535314, 202244	AQ Mesh[7]	2 Sept 2015***	July 2017
Eleanor Cross Rd Waltham Cross[8,9]	Roadside	536266, 200376	AQ Mesh[7]		July 2017
Rickmansworth Rd, Chorleywood[8,9]	Roadside	504162, 196286	AQ Mesh[7]	Mar 2016***	Mar 2017*
Uxbridge Road, Rickmansworth[8,9]	Kerbside	505263, 194250	AQ Mesh[7]		Mar 2017

Table 5 - Withdrawn AQ-Mesh Sensors

1. The site classifications used for the AURN are those defined in the Air Quality Standards Regulations 2010 and differ from the site classifications used for Local Air Quality Management. These Air Quality Standards Regulations 2010 site classifications are summarised in Table 7-8 on page 120 of the LAQM technical guidance (Defra, 2025)
2. Reference equivalent Defra approved monitor
3. AURN Site (Defra owned and managed site, not funded by Hertfordshire Public Health)
4. Equipment upgraded to FIDAS in 2024
5. Demonstrated reference equivalence in other European countries, Defra approved in October 2025.
6. Currently uncertified Multi-Pollutant Sensors
7. Certified complaint with performance standard for indicative ambient particulate monitors(IAPM)
8. Air Quality Data collected by AQDM and Envitech Europe (see website Air Quality in the United Kingdom).
9. Initial capital funding provided by Hertfordshire Public Health

Appendix 2

Performance standard for continuous ambient air quality monitoring systems(CAMS, Defra Approval)

Certificate Holder	Product(Model)	Certificate No.	Date of issue	Certified Parameter(s)
GRIMM Aerosol Technik GmbH	EDM280	**CSA MC 250461 00**	31/10/2025	$PM_{2.5}$
				PM_{10}
PALAS GmbH	Fidas 200 Method 11 Fidas 200 S Method 11 Fidas 200 E Method 11	**CSA MC 160290 04**	25/07/2024	PM_{10}
				$PM_{2.5}$
Thermo Fisher Scientific	TEOM 1405-F $PM_{2.5}$ FDMS	**Sira MC 130209 03**	05/06/2023	$PM_{2.5}$
Thermo Fisher Scientific	TEOM 1405-F PM_{10} FDMS	**Sira MC 130210 03**	05/06/2023	PM_{10}
Thermo Fisher Scientific	TEOM 1405-DF FDMS Dichotomous monitor for $PM_{2.5}$ & PM_{10}	**Sira MC 130211 03**	05/06/2023	$PM_{2.5}$
				PM_{10}

Table 6 - MCERTS certificates CAMS and Defra approved

Performance standard for indicative ambient particulate monitors

Certificate Holder	Product(Model)	Certificate No.	Date of issue	Certified Parameter(s)
Environmental	AQMesh (heated inlet)	CSA MC 240422 01	29/07/2025	$PM_{2.5}$
				PM_{10}
Environmental	AQMesh (unheated inlet)	CSA MC 240423 01	29/07/2025	$PM_{2.5}$
				PM_{10}
				PM_{10}
				$PM_{2.5}$

Table 7 - MCERTS certificate IAPM monitors, not approved by Defra for LAQM