AIR QUALITY IN LB BEXLEY: A GUIDE FOR PUBLIC HEALTH PROFESSIONALS

MAYOR OF LONDON

Greater London Authority
February 2022

Published by
Greater London Authority
City Hall
Kamal Chunchie Way
E16 1ZE
www.london.gov.uk
enquiries 020 7983 4000

PURPOSE OF THIS DOCUMENT

Public health professionals in local authorities have a critical role to play in driving systemic progress on air pollution. There is now an urgent need for ambitious local action to protect both human and planetary health. In the context of the pandemic and the escalating climate emergency, it is crucial that London's recovery is socially just and green. This will help to tackle these threats and prevent thousands of premature deaths caused by air pollution.

We published our last borough-specific guidance documents for local authority public health professionals in 2012. It is fair to say that a lot has changed since then.

Air pollution is a major cause of premature death and disease; and is the largest environmental risk to public health in the UK. The Greater London Authority (GLA) estimated that in 2019 there were between 3,600 and 4,100 premature deaths attributable to air pollution[1]. Both short and long-term exposure to air pollution can lead to a wide range of harmful effects which come about at every stage of life, from a foetus' first weeks in the womb all the way through to old age. The main pollutants of concern within London are nitrogen dioxide (NO_2) and particulate matter (PM). Currently, there is no clear evidence of a safe level of exposure below which there is no risk of adverse health effects. Therefore, reductions in concentrations of NO_2 and PM below air quality standards is likely to bring additional health benefits.

Air pollution affects everyone who lives and works in London. However, some – especially, children, the elderly, and people with pre-existing health conditions – are most vulnerable. People on low incomes or from ethnic minorities are also more affected by poor air quality, partly because they often live in the more polluted areas of London.

Children in London are almost four times more likely than children elsewhere in England to attend a school in a highly polluted area. In December 2020, a landmark ruling by a London Coroner concluded that Ella Adoo-Kissi-Debrah died, aged nine in 2013, from a combination of acute respiratory failure, severe asthma and air pollution exposure. It is the first time in the UK that air pollution has been listed as a medical cause on a death certificate. The Coroner's Prevention of Future Deaths report also highlighted a lack of public and professional awareness about the risks of air pollution.

Considering this it is more vital than ever for borough public health teams to work with other relevant local authority teams on air quality as air pollution does not respect borders. We recommend Joint Strategic Needs Assessments are regularly updated to include the latest information shown in this document. They should also take account of the recommendations set out in the Coroner's Prevention of Future Deaths report. Collaborative action is needed across sectors and systems to reduce air pollution, risks

[1] http://erg.ic.ac.uk/research/home/resources/ERG_ImperialCollegeLondon_HIA_AQ_LDN_11012021.pdf

and health inequalities; and to ensure air pollution is considered in every relevant policy at the local level. We must tackle different pollutants together and maximise societal gains. There are a wide range of co-benefits to improving air quality. This is not just in terms of improving health and reducing health inequalities; it will also help boost the economy, environment and climate change adaptation and mitigation.

In 2012, we provided local authorities with borough-specific guidance documents to support public health professionals who may not have previously worked in air quality. Our aim was to provide all the information needed to quickly get to grips with the issue of air quality. This updated document reflects the latest scientific evidence on both the impacts of, and solutions to, air pollution. This will enable effective local responses through setting out knowledge, recommendations, or approaches for action. It has been tailored to support and enhance collaboration and public health leadership to address air pollution. It presents the latest air quality and health data and analysis for London's 32 boroughs and the City of London in 33 bespoke reports.

We hope you will find this report useful for:

- assessing and framing air pollution risks in a health and environmental context and ensuring air pollution is prioritised appropriately
- extracting data and evidence that you can use in your Joint Strategic Needs Assessment on air quality, Health and Wellbeing Strategy and Air Quality Action Plan, including raising awareness of the health and economic costs of air pollution
- discussions with local authority colleagues around how to tackle the health impacts of air quality ensuring a joined-up approach at local and at system level, including in the context of action on climate change
- raising awareness of the contribution that action on air quality has to a range of public health outcome measures
- reaching out to colleagues in healthcare organisations, such as doctors, nurses and pharmacists around opportunities to strengthen their education, training and awareness in relation to air quality
- spreading best practice to GPs and sensitive receptors

Authors

This document was prepared by the Greater London Authority in partnership with the UK Health Security Agency (UKHSA). It includes input from the London Association of Directors of Public Health, London Councils, and public health specialists from the London boroughs of Croydon and Lewisham. It also includes input from environmental specialists in the London boroughs of Merton, Richmond upon Thames, Wandsworth, Kingston and Sutton.

To find out more, please contact: airquality@london.gov.uk

Contents

1 INTRODUCTION

1.1 Air pollution in London: Facts and figures

- In London alone, air pollution leads to thousands of premature deaths and costs the city's economy an estimated £3.7bn every year[2].
- NO_2 and $PM_{2.5}$, the two pollutants of greatest concern in London, are linked to a variety of adverse health impacts.
- Air pollution affects everyone who lives, works, or visits London but it disproportionally affects the poorest and most vulnerable communities, including children.
- In 2019, in areas where the least affluent Londoners live, the annual average concentration of NO_2 was 3.8 µg/m^3 more than the most affluent areas. That is 13 per cent higher. For $PM_{2.5}$, the most deprived areas had an annual average concentration 0.7 µg/m^3, six per cent higher than the least deprived areas.
- There is currently no safe level for $PM_{2.5}$ or NO_2. In recognition of this, the World Health Organisation (WHO) recently lowered its guideline limits for $PM_{2.5}$ to 5 µg/m^3 and NO_2 to 10 µg/m^3. The aim is to achieve the lowest concentrations possible[3].
- There have been improvements in air quality across London in recent years, especially for NO_2. In 2019, 84 per cent of major roads in London met the legal limit for NO_2[4], compared to 46 per cent in 2016 and just 37 per cent in 2013. Despite the dramatic progress to date, air pollution remains the biggest environmental risk to health.
- London has already taken bold action with the introduction of the central London Ultra Low Emission Zone (ULEZ) in 2018. This has reduced concentrations of NO_2 at roadside sites in the central zone by 44 per cent. The ULEZ was further expanded in 2021.
- Since 1 March 2021, most heavy vehicles have had to meet Euro VI emission standards of the Londonwide Low Emission Zone (LEZ). This includes lorries, buses, and coaches. These standards are the same as the ULEZ, so there is only one charge for heavy vehicles in London.
- The ULEZ expansion will reduce road transport emissions of nitrogen oxides (NO_x) by 30 per cent. This will mean an expected 92 per cent of roads in London would comply with legal limits for NO_2 by the end of 2021. Combined with other measures, this puts us on track for legal compliance by 2025 at the latest. Reducing NO_2 or PM concentrations below air quality standards is likely to bring additional health benefits
- More action is needed locally and nationally as most areas of London are exceeding WHO guideline limits for $PM_{2.5}$.

[2] https://www.london.gov.uk/sites/default/files/asthma_kings_report_april_2019_final.pdf
[3] https://www.who.int/publications/i/item/9789240034228
[4] https://data.london.gov.uk/dataset/london-atmospheric-emissions-inventory--laei--2019

1.2 The case for tackling London's air pollution crisis

There are a wide range of co-benefits to improving air quality. This is not just in terms of improving health and reducing health inequalities. It is also good for the economy, environment, and climate change adaptation and mitigation.

Air pollution affects everyone who lives and works in London; and London has some of the poorest air quality in England. The Mayor's vision is for London to have the best air quality of any major world city. His ambition is to go beyond the legal requirements to protect human health and minimise inequalities. The pandemic has highlighted stark health inequalities across the city. A report by Imperial College London offered a comprehensive overview of the most credible evidence for the links between air pollution and COVID-19. It found that there are a small number of studies supporting a relationship between long-term exposure to air pollution and higher risk of Covid-19 or its adverse consequences[5]. The report also highlighted air pollution's role in increasing vulnerability to, and severity of, a range of acute lower and upper respiratory infections.

1.3 Green Recovery from COVID-19

London is vulnerable to many of the impacts of the climate crisis, including worsening flooding and heatwaves. That is why the Mayor has been clear that London's recovery from the COVID-19 pandemic must be a green one.

The city's recovery is led by the London Recovery Board, chaired jointly by the Mayor and Chair of London Councils. It brings together leaders from across London's government, business and civil society, the health and education sectors, trade unions and the police. The aim is to oversee the long-term recovery effort. The board, which includes the NHS, has committed to taking a missions-based approach for both economic and social recovery.

One of the nine missions, the Green New Deal Mission, aims to tackle the climate and ecological emergencies and improve air quality. It will do this by doubling the size of London's green economy by 2030 to accelerate job creation for all. The Green New Deal Mission focuses on three key themes:

1) Decarbonising and transforming the built environment;
2) Greening London's transport and public realm; and
3) Mobilising new finance and support green jobs, skills and lifestyles.

Theme two has the potential to improve air quality. Project areas focus on supporting modal shift, electrifying London's vehicle fleet and infrastructure and developing zero emission zones. Prioritising sustainability, climate mitigation, and resilience is also a cross-cutting principle underpinning work across all the recovery missions.

[5] https://www.imperial.ac.uk/media/imperial-college/medicine/sph/environmental-research-group/ReportfinalAPCOVID19_v10.pdf

The first national lockdown in the pandemic (from March to June 2020) led to behavioural changes by Londoners which temporarily helped improve air quality. These included a reduction in personal vehicle use, road traffic, and an increase in active travel whilst socially distancing. Cleaner air and reduced traffic noise were widely noted and valued during this period. However, levels of road traffic and air pollution have been increasing since then. We now need coordinated action to ensure that these gains are not lost.

2 AIR POLLUTION AND ITS HEALTH IMPACTS

2.1 What is air pollution?

Air pollution is the largest environmental risk to public health in the UK[6]. Both indoor and outdoor air pollution can harm health. An air pollutant is anything in the air that could harm people's health, including small particles, liquid droplets and gases. Air pollutants are emitted from a range of man-made and natural sources; and can be classified as primary or secondary. Primary pollutants are emitted directly from a source whilst secondary pollutants form when other pollutants (primary pollutants) react in the atmosphere.

2.2 Main sources of air pollution in London

Most of the air pollution in London is produced by traffic, heating, and burning of solid fuels. Over 40% per cent of the NO_2 in London comes from road transport (LAEI, 2019). This is why the highest concentrations of NO_2 are recorded at busy roadside locations.

Around a third of the $PM_{2.5}$ emitted in London comes from road transport. A large proportion (40%) also comes from construction, wood burning, and commercial cooking (LAEI, 2019). Alongside emissions from local and regional sources, levels of PM are also influenced by emissions from mainland Europe and further afield. The sources of larger PM_{10} particles are broadly similar, and road transport accounts for around a quarter of PM_{10} in London. The 2019 London Atmospheric Emissions Inventory (LAEI) was published in December 2021 and provides an update to the previous LAEI2016 and a new baseline for 2019. Data from the LAEI is publicly available on the London Data Store and includes concentration maps, population exposure data and emissions by pollutant and source split by London Zone and by borough. Officers are encouraged to review the 2019 inventory and specific data sets for their boroughs.

2.3 Main pollutant types of concern in London

The UK Air Quality Standards Regulations (2010) sets standards for a variety of pollutants considered harmful to human health and the environment. These are detailed in Appendix 1. The pollutants of most concern in London are NO_2, $PM_{2.5}$ and ozone (O_3). NO_2 is a toxic gas produced during combustion processes, such as in the engine of a car. Some $PM_{2.5}$ occurs naturally, such as dust and sea salt, and some is man-made, such as particulates from vehicle exhausts and burning solid fuels. O_3 is a secondary man-made pollutant formed when air pollution from internal combustion engines (NOx) and power plants (Volatile Organic Compounds (VOCs)) combines chemically with oxygen. PM (see figure 1) and the gases NO_2 and O_3 are particularly damaging pollutants for human health.[7] $PM_{2.5}$ is the air pollutant thought to have the greatest impact on human health. There is no recognised safe level for health[2].

[6] https://www.gov.uk/government/publications/air-pollution-applying-all-our-health/air-pollution-applying-all-our-health

[7] https://www.blf.org.uk/support-for-you/air-pollution/what-is-it

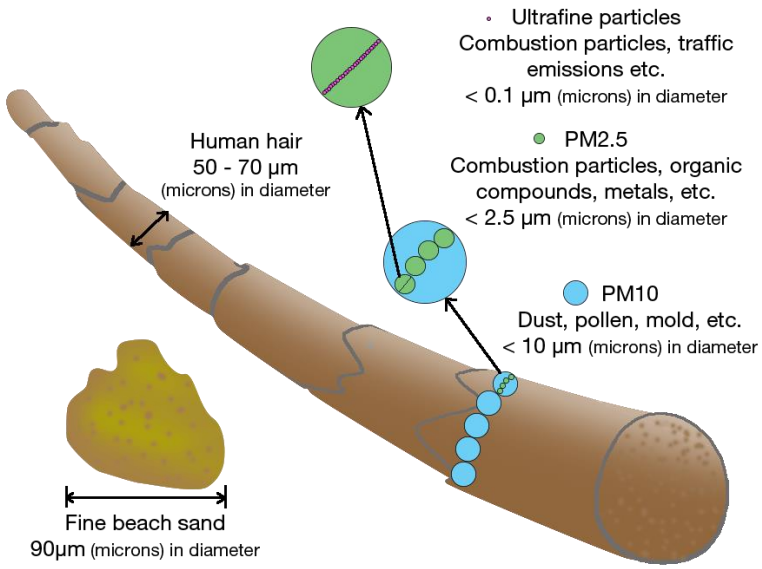

Figure 1 Types of particulate matter (UFP, $PM_{2.5}$, PM_{10}). Of these, UFP and $PM_{2.5}$ are the most harmful types for health. Image source VFA

2.4 Health effects of air pollution and associated health inequalities

The health effects of air pollution are complex, and range in severity. Air pollution can harm health at every stage of life from the first weeks in the womb all the way through to old age (figure 2).

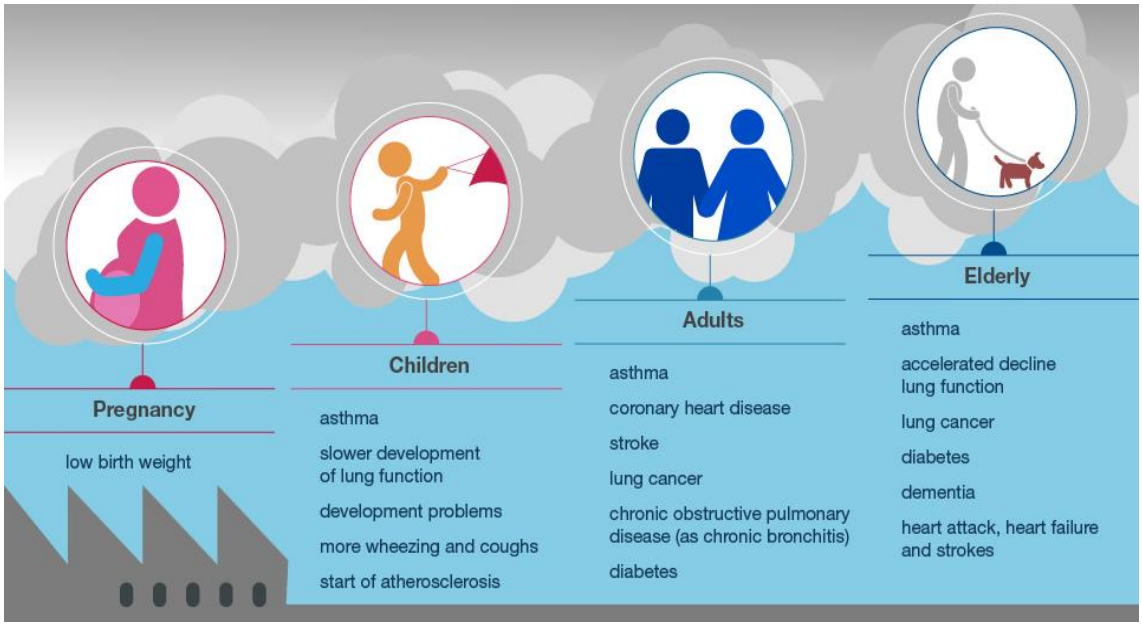

Figure 2 Impact of Air Pollution on Health throughout a lifetime. Taken from PHE Health Matters 2018

In some cases, the damage can be gradual and may not become apparent for many years. However, it can also have short-term impacts which may exacerbate symptoms, increase hospital

admissions and even death[8] (figure 3). Long-term exposure (over years or lifetime) reduces the number of years we spend in good health (healthy life expectancy). There is no level of exposure which doesn't impact on health. As such, reducing NO_2 or PM concentrations below air quality standards is likely to bring additional health benefits. This is reflected in the recently updated WHO air quality guidelines, which are significantly tighter than their previous guidelines[9].

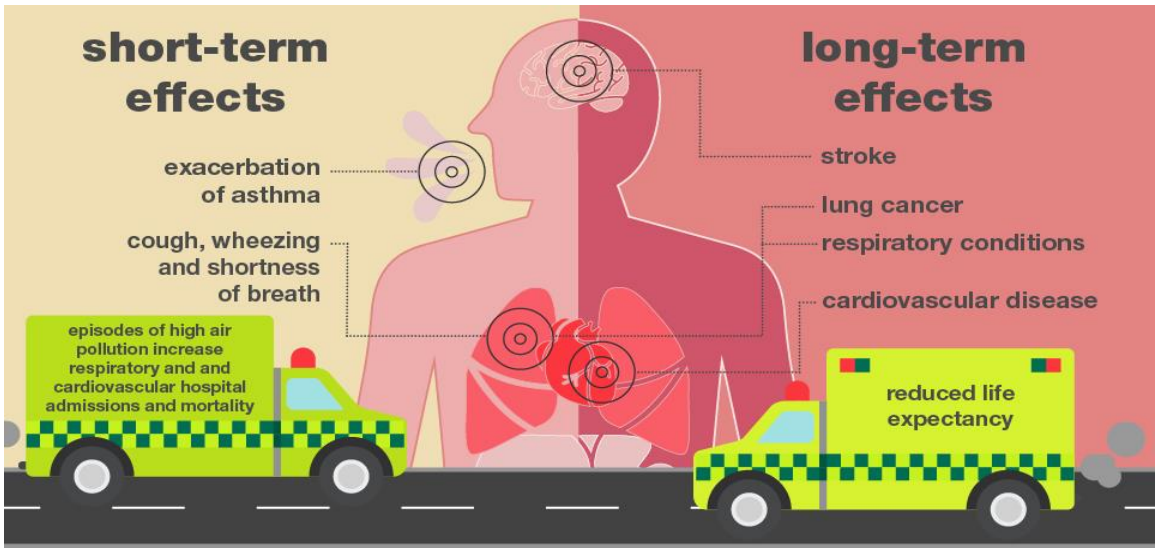

Figure 3 Health effects of air pollution, taken from PHE Health Matters, 2018.

Table 1 below summarises some of the main health impacts of NO_2, $PM_{2.5}$ and PM_{10}.

Table 1 Overview of health impacts for key pollutants of concern.

Pollutant	Key health impacts
NO_2	Effects on lung development (lung function growth), respiratory infections in early childhood and effects on lung function in adulthood.
$PM_{2.5}$[10]	Based on current evidence, $PM_{2.5}$ is thought to be the air pollutant which has the greatest impact on human health. Both short and long-term exposure to $PM_{2.5}$ increases mortality risk from lung and heart diseases and stroke as well as increasing hospital admissions.
PM_{10}[11]	Like $PM_{2.5}$ (which is a subcomponent of PM_{10}), PM_{10} harms the respiratory and cardiovascular systems, and increases the chance of premature death.

[8] Health matters: air pollution - GOV.UK (www.gov.uk)
[9] WHO Global Air Quality Guidelines (2021) https://www.who.int/news-room/q-a-detail/who-global-air-quality-guidelines
[10] A mixture of particles and/or liquid droplets in the air that have a diameter less than 2.5 micrometres across (one 400th of a millimetre).
[11] A mixture of particles and/or liquid droplets in the air that have a diameter less than 10 micrometres across.

When air pollutants enter the body, they can affect various organs and systems[12]. This includes:

- The eyes, nose and throat
- The lungs and respiratory system, including worsening asthma and chronic obstructive pulmonary disease and as a cause of lung cancer
- The heart – heart and blood vessel diseases, including strokes and hardening of the arteries (atherosclerosis), are some of the main health effects of air pollution.

There are several methods for measuring the impact of air pollution upon health. The Committee on the Medical Effects of Air Pollution (COMEAP) has released a comprehensive document[13] collating its recommendations for quantifying air pollutants' health impacts.

Long-term exposure to air pollution reduces life expectancy by increasing the incidence of lung, heart and circulatory conditions[14]. Long-term exposure to air pollution in early life can have a lasting effect on lung function, including suppressing children's lung function growth[15]. Maximising development of lung function in childhood is important as low lung function leads to less reserve if lung disease develops. This is associated with higher health risks if lung disease develops later in life.

Asthma, a long-term inflammatory condition of the conducting airways of the lungs, leads to coughing, wheezing, chest tightness and shortness of breath. Asthma symptoms in those who have the condition can be exacerbated by various stressors. These include respiratory viral infection, allergen exposure, and episodes of elevated air pollution[16].

There is increasing evidence of air pollution having a potential role in causing asthma, especially in people who live near busy roads[17]. In addition, short-term peaks in pollution levels are a trigger that can make asthma symptoms worse, increasing the risk of exacerbations[18]. This is also true for chronic obstructive pulmonary disease (COPD)[19]. Quality and Outcomes Framework data from GP

[12] https://www.gov.uk/government/publications/health-matters-air-pollution/health-matters-air-pollution

[13] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/927754/Summary_of_COMEAP_recommendations_for_quantification.pdf

[14] Jos Lelieveld, Andrea Pozzer, Ulrich Pöschl, Mohammed Fnais, Andy Haines, Thomas Münzel, Loss of life expectancy from air pollution compared to other risk factors: a worldwide perspective, *Cardiovascular Research*, Volume 116, Issue 11, 1 September 2020, Pages 1910–1917,

[15] Schultz ES, Litonjua AA, Melén E. Effects of long-term exposure to traffic-related air pollution on lung function in children. Current allergy and asthma reports. 2017 Jun;17(6):1-3.

[16] https://www.nhlbi.nih.gov/health-topics/asthma

[17] https://www.gov.uk/government/publications/health-matters-air-pollution/health-matters-air-pollution

[18] Orellano P, Quaranta N, Reynoso J, Balbi B, Vasquez J. Effect of outdoor air pollution on asthma exacerbations in children and adults: systematic review and multilevel meta-analysis. PloS one. 2017 Mar 20;12(3):e0174050.

[19] Song Q, Christiani DC, Ren J. The global contribution of outdoor air pollution to the incidence, prevalence, mortality and hospital admission for chronic obstructive pulmonary disease: a systematic review and meta-analysis. International journal of environmental research and public health. 2014 Nov;11(11):11822-32.

registers shows approximately 508,000 people with asthma and 117,000 people with COPD live in London (2019-20 data)[20].

Emerging evidence suggests air pollution may affect the brain and is possibly linked to dementia and cognitive decline[21] and mental health impacts[22]. There is also evidence associating air pollution with impacts in pregnancy and early childhood, such as low birth weight[23].

As shown in figure 4, some groups are particularly susceptible to the harms of air pollution. These include older people, children, pregnant women and those with existing cardiovascular or lung disease[24]. People who live / work in highly polluted areas, near busy roads, or who spend long periods in traffic, are also at increased risk. This is because congestion is strongly associated with air pollution, and car occupants are typically exposed to more air pollution than cyclists or pedestrians[25].

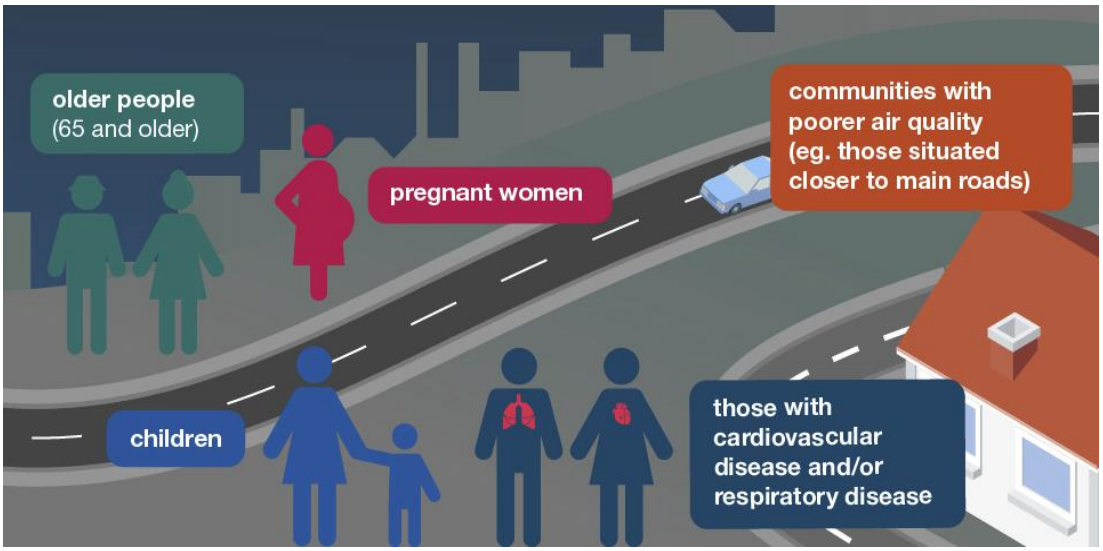

Figure 4 Air pollution affects everyone but there are inequalities in exposure and the greatest impact on the most vulnerable. Taken from PHE Health Matters 2018

20
https://app.powerbi.com/view?r=eyJrIjoiMDZiMmI2MzEtMWVjZC00YTVlLWI5NjEtMTNkODM3M2M0NDk3IiwidCI6IjUwZjYwNzFmLWJiZmUtNDAxYS04ODAzLTY3Mzc0OGU2MjllMiIsImMiOjh9

[21] Power MC, Adar SD, Yanosky JD, Weuve J. Exposure to air pollution as a potential contributor to cognitive function, cognitive decline, brain imaging, and dementia: a systematic review of epidemiologic research. Neurotoxicology. 2016 Sep 1;56:235-53.

[22] Braithwaite I, Zhang S, Kirkbride JB, Osborn DP, Hayes JF. Air pollution (particulate matter) exposure and associations with depression, anxiety, bipolar, psychosis and suicide risk: a systematic review and meta-analysis. Environmental health perspectives. 2019 Dec 18;127(12):126002.

[23] Stieb DM, Chen L, Eshoul M, Judek S. Ambient air pollution, birth weight and preterm birth: a systematic review and meta-analysis. Environmental research. 2012 Aug 1;117:100-11.

[24] https://www.gov.uk/government/publications/health-matters-air-pollution/health-matters-air-pollution

[25] http://content.tfl.gov.uk/technical-note-20-what-are-the-main-health-impacts.pdf

Ethnic minorities and deprived communities are hardest hit by air pollution in London[26]. In 2019, areas where the most deprived Londoners lived, had a higher annual average concentration of NO_2 by 3.8 µg/m^3 than the least deprived areas. For $PM_{2.5}$, areas where the most deprived Londoners live had an annual average concentration 0.7 µg/m^3 higher than the least deprived areas[27]. The Mayor is now taking measures to tackle London's air pollution. By 2030, these should reduce the gap in exposure to NO_2 between the least and most deprived by 70 per cent[28].

2.5 Indoor air pollution

Polluted air is a problem not only outside our homes and workplaces but inside them too. It is not the primary focus of this report. However, the WHO estimates that close to four million people worldwide die prematurely each year due to household (indoor) air pollution (2018 data[29]). This is a serious problem in countries where solid fuel is the main way to cook and heat homes, and where ventilation is poor.

In the UK, indoor air quality is affected by domestic gas combustion from cooking and heating. Other sources of indoor air pollution include wood-burning stoves and open fires, cleaning agents, VOCs, tobacco smoke, mould, condensation and asbestos. The National Institute for Health and Care Excellence (NICE) has recently provided guidance on improving indoor air quality[30].

In recent years, wood burner use has increased. This means its relative contribution to local $PM_{2.5}$ is increasing even more rapidly as contributions of other sources like traffic are gradually reduced. A European Environment Bureau report showed that even Euro-certified 'Eco-stoves' produce 750 times more $PM_{2.5}$ per gigajoule of energy than a modern HGV[31]. A recent study found that wood burning accounts for between 23 and 31 per cent of urban-derived $PM_{2.5}$ in London[32].

2.6 Public Health Outcomes Framework

The Public Health Outcomes Framework (PHOF) examines indicators that help to understand trends in public health. It also enables local authorities to benchmark and compare their own outcomes with other local authorities. For example, one indicator looks at the health impacts of air pollution: the fraction (%) of mortality attributable to long-term exposure to $PM_{2.5}$. This is calculated using modelled $PM_{2.5}$ levels. A graph showing breakdown by borough of the percentage of mortality attributable to long-term $PM_{2.5}$ exposure across London in 2019 is in chapter 5. The underlying data are in appendix 2 and the Public Health Outcomes framework in appendix 3.

[26] http://www.instituteofhealthequity.org/resources-reports/fair-society-healthy-lives-the-marmot-review
[27] https://www.london.gov.uk/sites/default/files/air_pollution_and_inequalities_in_london_2019_update_0.pdf
[28] https://www.london.gov.uk/sites/default/files/air_quality_in_london_2016-2020_october2020final.pdf
[29] https://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health
[30] https://www.nice.org.uk/guidance/ng149/resources/visual-summary-pdf-7022755693
[31] https://eeb.org/library/where-theres-fire-theres-smoke-emissions-from-domestic-heating-with-wood/
[32] https://uk-air.defra.gov.uk/assets/documents/reports/cat05/1801301017_KCL_WoodBurningReport_2017_FINAL.pdf

2.7 The Cost of Air Pollution

The 2019 Clean Air Strategy[33] estimated air pollution in England could cost £5.3bn a year in terms of health and social care by 2035. This is if no action is taken and includes both $PM_{2.5}$ and NO_2. This is a cumulative cost for health conditions strongly associated with air pollution: coronary heart disease; stroke; lung cancer; and childhood asthma. When health issues with weaker evidence of association are also added, the costs could reach £18.6bn by 2035. These include chronic obstructive pulmonary disease; diabetes; low birth weight; and dementia. Air pollution can impact people of working age, which can also have economic effects, for instance, if they must take days off work. The Confederation of British Industry (CBI) estimates that improving our air quality could benefit the UK's economy by £1.6bn each year. This would be by preventing premature deaths and providing three million additional working days. It also found that cleaner air in London would benefit the city's local economy by £500m, almost one third of the national yearly benefit[34].

[33] https://www.gov.uk/government/publications/clean-air-strategy-2019
[34] https://www.cbi.org.uk/media/5539/2020-09-cbi-economics-caf-report.pdf

3 POLICY AND LEGAL FRAMEWORKS FOR IMPROVING AIR QUALITY

3.1 World Health Organisation (WHO)

Most air quality legislation in Europe and the UK is derived from health-based evidence provided by the WHO. The WHO has published various guidelines for both global air quality and European air quality based on the latest worldwide research. In September 2021, the WHO announced changes to their guideline air quality limits (previously published in 2005). The annual $PM_{2.5}$ limit has reduced from 10 µg/m^3 to 5 µg/m^3 and annual NO_2 from 40 µg/m^3 to 10 µg/m^3.

The Mayor's current ambition is to meet the 10 µg/m^3 threshold for $PM_{2.5}$ by 2030. Many of the Mayor's strategies and policies (London Plan, LLAQM Guidance, London Environment Strategy) refer to the WHO limits. This will continue to mean the WHO limits at the time of writing, which was 10 µg/m^3. Meanwhile, the Mayor continues to work for a zero-pollution city. This includes efforts to achieve the health-based guidelines that WHO originally set for 2030 mindful of the impacts on Londoners. He will also continue to lobby for a 10 µg/m^3 threshold for $PM_{2.5}$ by 2030.

3.2 EU Directive

The European Union has issued an air quality Directive (2008/50/EC – the "Air Quality Directive").[35] The directive sets standards for a range of pollutants considered harmful to human health and the environment.

The UK is no longer a European Union member. However, the Air Quality Directive is now a part of UK domestic legislation through the Air Quality Standards Regulation[36].

The directive standards include limit values, which are legally binding and must not be exceeded. These limit values include a concentration value for the pollutant, an averaging period over which it is measured and when these should be achieved. In some case, it also includes an allowable number of exceedances of the value per year. The directive also includes target values, which are set out in the same manner as limit values. However, these should be reached where possible by taking cost-effective measures.

3.3 UK Air Quality Policy

The Air Quality Standards Regulations 2010

The Air Quality Standards Regulations 2010 include criteria for determining how to assess achievement of the limit values. This includes consideration of locations and length of exposure in relation to the averaging period of the limit values. In addition, the regulations state sampling points must be sited where the highest concentrations occur, and people exposed for longer

[35] http://ec.europa.eu/environment/air/quality/legislation/existing_leg.htm
[36] www.legislation.gov.uk/uksi/2010/1001/contents/made

periods of time. These should be significant in relation to the averaging period of any limit value (that is, 15 minutes, one hour, 24 hours etc).

The limit values for the UK Air Quality Standards and the updated WHO guideline limit values are shown below in table 2. The UK Air Quality Standards limit values for NO_2 were not met in parts of Greater London in 2019. However, the number of Londoners living in areas exceeding the UK Air Quality Standards for NO_2 fell from over 2 million in 2016 to 119,000 in 2019, a reduction of 94 per cent.

In 2016, the whole of London exceeded the previous WHO guideline limit for $PM_{2.5}$ of 10 µg/m^3. The latest data from LAEI2019 shows there are now almost 1.2 million Londoners living in areas below the 10 µg/m^3 limit and there has been a 19 per cent reduction in $PM_{2.5}$ across the whole of the city since 2016. However, with the WHO guideline limit for $PM_{2.5}$ reducing to 5 µg/m^3, there is still work to be done to ensure Londoners can breathe clean air.

Table 2 Air Quality Standards Regulations and updated WHO guideline values

Pollutant	UK Air Quality Standards (EU Limit Value)	WHO guideline value (2021 update)
NO_2	40 µg/m^3 annual mean 200 µg/m^3 1-hour mean	10 µg/m^3 annual mean 15 µg/m^3 1-hour mean[37]
$PM_{2.5}$[38]	25 µg/m^3 annual mean[39]	5 µg/m^3 annual mean 15 µg/m^3 24-hour mean
PM_{10}[40]	40 µg/m^3 annual mean 50 µg/m^3 24-hour mean	15 µg/m^3 annual mean 45 µg/m^3 24-hour mean

Clean Air Strategy, 2019

The Government's Clean Air Strategy[41] provides a policy framework for air quality management and assessment in the UK. It sets out these proposals in detail and indicates how devolved administrations intend to make their share of emissions reductions. It identifies air quality

[37] 200 µg/m^3 hourly average is not to be exceeded more than 18 times a year
[38] A mixture of particles and/or liquid droplets in the air that have a diameter less than 2.5 micrometres across (one 400th of a millimetre).
[39] In 2020, the annual mean limit value was reduced to 20 µg/m^3.
[40] A mixture of particles and/or liquid droplets in the air that have a diameter less than 10 micrometres across.
[41] https://www.gov.uk/government/publications/clean-air-strategy-2019

standards and objectives for key air pollutants which are designed to protect health and the environment. The Government has since brought forward plans to end the sale of new conventional petrol and diesel cars and vans to 2030[42]. This is ten years earlier than previously proposed.

Environment Act, 2021

The Act introduces a duty on the government to bring forward at least two air quality targets by October 2022 for consultation. This will be set in secondary legislation. The first will aim to reduce the annual average level of $PM_{2.5}$ in ambient air. The second will be a long-term target (set a minimum of 15 years in the future). The Environment Act did not include legally binding $PM_{2.5}$ targets or provide cities with the powers and funding needed to meet them.

3.4 Local authority responsibilities

Under the Environment Act 1995 [43] local authorities have a statutory responsibility in Local Air Quality Management (LAQM). This is to make sure that the national air quality objectives (appendix 1) will be achieved by the relevant deadlines. If a local authority finds any places where the objectives will not be achieved, it must declare an Air Quality Management Area (AQMA) there.

Much of London has been designated AQMAs. The DEFRA website has an interactive map of all AQMAs in the country. Local authorities which have wholly or partly designated their boroughs as AQMAs must under LAQM produce an Air Quality Action Plan (AQAP)[44]. AQAPs set out how local authorities, working with other agencies, will use their powers to meet the air quality objectives.

The Mayor's London Local Air Quality Management (LLAQM) framework[45] is the statutory process for London's local authorities to review and improve local air quality. In March 2019 boroughs were consulted on a range of updates and improvements to the LLAQM. After a successful consultation, the new LLAQM was published in October 2019. The updates were done to:

- ensure boroughs are taking ambitious action, which is properly coordinated at the regional level, and which supports Mayoral objectives. This includes those set out in the London Environment Strategy.

- ensure that London boroughs continue to work towards achievement of WHO guideline values for pollutants even when legal limits are met.

[42] https://www.gov.uk/government/news/government-takes-historic-step-towards-net-zero-with-end-of-sale-of-new-petrol-and-diesel-cars-by-2030

[43] www.environment-agency.gov.uk/netregs/legislation/.../107183.aspx

[44] http://uk-air.defra.gov.uk/reports/cat09/1107211126_Mapping_Action_Plan_Guidance_Final__Report_April_2011.pdf

[45] https://www.london.gov.uk/what-we-do/environment/pollution-and-air-quality/working-london-boroughs

- update information in the guidance documents to reflect new research, policies, and priorities.

There are 187 Air Quality Focus Areas in London. These are locations that not only exceed the national air quality objective for NO_2 but also have high levels of footfall. These areas were identified in the LAEI 2010 as requiring interventions to help reduce emissions and personal exposure. This is not an exhaustive list of London's hotspot locations. However, it is where the GLA believe the problem to be most acute. We have selected Air Quality Focus Areas based on the following factors:

- Baseline air quality for NO_2 and PM_{10} by 20m grid resolution
- Locations where air pollution limit values have been exceeded
- Level of human exposure
- Local geography and topography
- Local sources of air pollution
- Traffic patterns
- Future predicted air quality trend

4. AIR QUALITY MONITORING AND ASSESSMENT OF COMPLIANCE

There are several health and environmental strategies which are relevant to air quality. Details of these can be found in appendix 4.

4.1 Air Quality Monitoring in London

London's air quality is constantly monitored by high-accuracy Automatic Reference-Level monitors at over 100 different locations. Most of these are owned and paid for by London's boroughs. These sites are mainly managed through the London Air Quality Network (LAQN) delivered by the Measurement Team at Imperial College. Ricardo Energy and Environment also run several of these sites. More information on this network is available on the Air Quality England website.

There is minimal $PM_{2.5}$ monitoring within the London network. We encourage boroughs to consider increasing $PM_{2.5}$ monitoring capacity as this pollutant has the greatest impact on human health.

Analysers on Air Quality England and the LAQN are Defra-approved and calibrated and maintained in accordance with its technical guidance on air quality monitoring. You can read more here about Defra's approval method for gas analysers and particulate instruments.

The LAQN is supplemented by low cost Breathe London monitors and diffusion tubes. Breathe London's street-by-street sensor air quality monitoring system is being used to analyse harmful pollution in toxic hotspots across the city. These include near schools, hospitals, construction sites and busy roads. These data will support policymaking and help inform and engage local communities. However, it is not a replacement for the Reference-Level monitors which are vital for assessing trends and compliance with legal air quality limits. We recently launched two new ways for people, businesses and communities to join the Breathe London Network. The Breathe London Shop is intended for those who already have funding. There is also the Breathe London Community Programme through which communities can apply for 10 fully funded nodes in this round.

We are working towards consolidating these data, so they are freely available in one location on the Breathe London website.

4.2 Communicating levels of air pollution

The Daily Air Quality Index

The Daily Air Quality Index (DAQI) offers information on levels of air pollution and provides recommended actions and health advice. The index is numbered 1-10 and divided into four bands (low 1-2, moderate 4-6, high 7-8, very high 9-10). This provides detail about air pollution levels in a simple way, like the sun index or pollen index. The DAQI and its associated messaging are currently

being reviewed. This follows the Ella Adoo-Kissi-Debrah inquest and the need to include more specific messaging for different population groups[46].

Step 1: Determine whether you (or your children) are likely to be at-risk from air pollution. Adults and children with heart or lung problems are at greater risk of symptoms. Older people are more likely to suffer from heart and lung conditions than young people. It therefore makes good sense for them to be aware of current air pollution conditions. Children with asthma may notice they need to use their reliever medication more on days when air pollution levels are higher than average.

Step 2: If you may be at-risk, and are planning strenuous activity outdoors, check the air pollution forecast.

Step 3: Use the health messages corresponding to the highest forecast level of pollution as a guide.

Mayor's air quality alerts system

The Mayor's air quality alerts system communicates to Londoners on days where air pollution is elevated. It uses stakeholder organisations' networks and messages displayed in public locations (including bus countdown signs). It issues alert communications in several formats to reach as many Londoners as possible. The system uses the same criteria as the DAQI.

During periods of moderate, high and very high air pollution the Mayor's Air Quality Alert system sends warning emails to signed-up stakeholders. This includes over 3,300 school contacts. Alerts and guidance are also available via social media and the London.gov website.

When a high and very high air pollution day is forecast, air quality alerts are displayed at many public locations across London. This includes all bus stop Countdown signs, the road network and on the London Underground. These are combined forecasts - meaning they are based on a number of public forecasts: airText, Defra (Met Office) and Imperial. Furthermore, for high and very high air pollution episodes we also alert the London Resilience Forum (which includes the NHS and UK HSA). This action enables more Londoners to be reached via their networks.

Work is underway to improve the reach of the alerts especially for vulnerable groups, including understanding how alerts can work within health care settings. Local authorities can play a key role in making this happen through their local health, education and social care networks and involvement in integrated care systems. To find out more and for support on working with local NHS networks, please email airquality@london.gov.uk.

AirTEXT

airTEXT provides information on the level of pollution in an area using 'low', 'moderate' and 'high' bandings. Whenever moderate or high levels of pollution are expected, subscribers to the airTEXT

[46] Government responds to Coroner after Ella Adoo-Kissi-Debrah inquest - GOV.UK (www.gov.uk)

service receive a text message, call or voicemail. This enables the recipient to determine what steps they should take to prepare themselves for the expected level of pollution. For example, taking a different route/mode of transport to work, keeping their medication with them or not exercising outside on certain days. Currently around 10,000 people use the airTEXT service through text, Twitter or the website.

4.3 Actions already taken to clean up London's air

The Mayor is committed to cleaning up London's air and is delivering an ambitious action plan to tackle this problem. He has introduced a range of hard-hitting measures to reduce air pollution and protect public health. These include:

Incentivising the use of cleaner vehicles. Much of the improvements in air quality seen in London since 2016 can be attributed to the Central London ULEZ (figure 5). The ULEZ operates 24/7 daily, within the same area of central London as the congestion charge. In October 2021, the ULEZ expanded up to but not including, the North and South Circular Roads. Most vehicles, including cars and vans, need to meet the ULEZ emission standards, or pay a daily charge to drive in the zone.

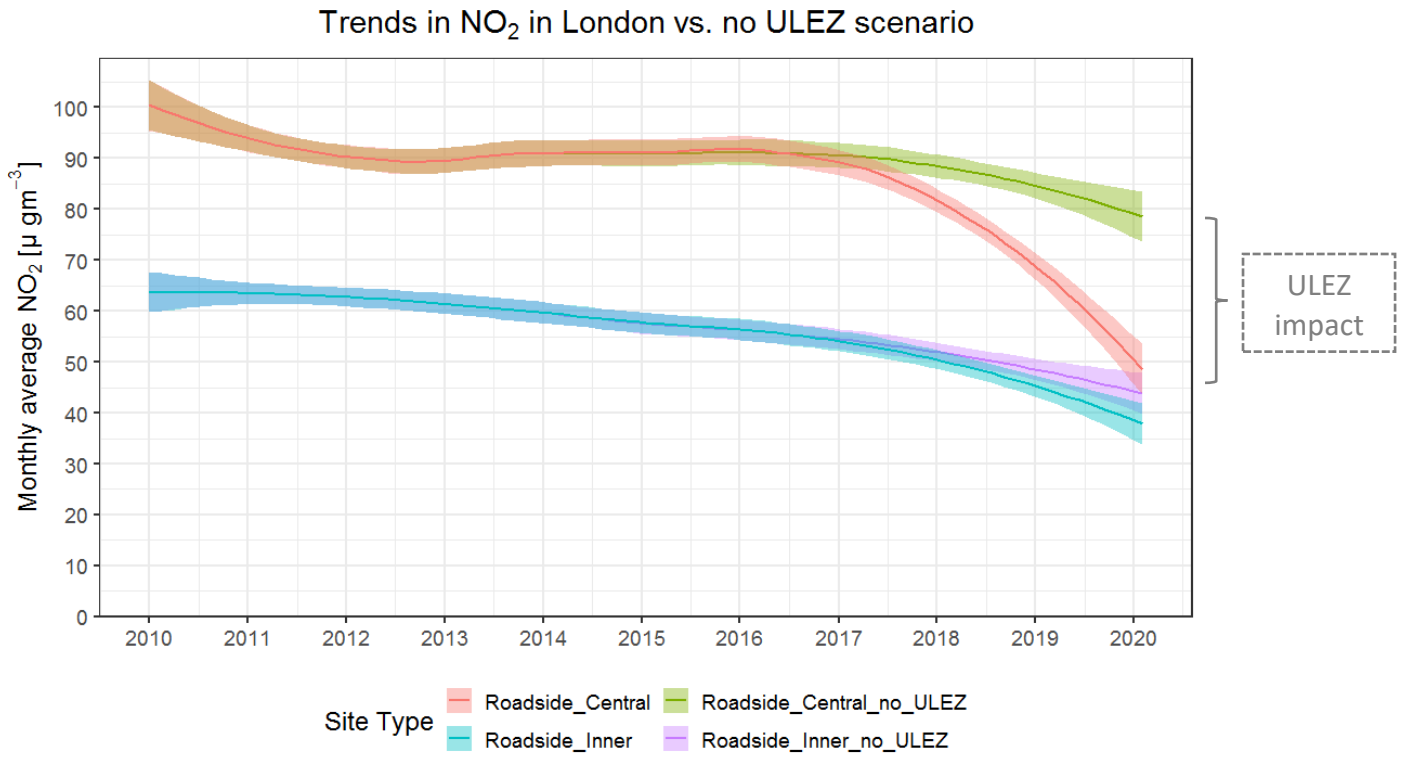

Figure 5 Trend in NO_2 in London vs no ULEZ scenario

In the first 10 months of the central London scheme (before the pandemic), the ULEZ had already delivered a range of benefits:

- Trend analysis shows in February 2020 concentrations of NO_2 at roadside sites in the central zone were 39 µg/m^3 less than in February 2017[47]. This is a fall of 44 per cent. After the first ten months of operation average compliance with ULEZ standards were 79 per cent in a 24-hour period. This was 77 per cent in congestion charging hours. This is far higher than 39 per cent in February 2017 and 61 per cent in March 2019, the month before the ULEZ was introduced.
- Analysis was carried out to determine the directly attributable impact of the ULEZ. In the first two months of 2020. NO_2 concentrations in central London were on average 29 µg/m^3 lower than they would have been otherwise. This equates to a reduction of 37 per cent.
- Preliminary estimates indicate that by the end of 2019, the ULEZ had reduced NO_x emissions from road transport in the central zone by 230 tonnes. This is a reduction of 35 per cent.
- The ULEZ is also helping to tackle the climate emergency. Preliminary estimates indicate that by the end of 2109, the ULEZ had reduced carbon dioxide (CO_2) emissions from road transport in the central zone by 12,300 tonnes. This is a reduction of six per cent.
- It's too early to measure most long-term health benefits. However, we have commissioned Imperial College London to measure changes in asthma exacerbations and hospital admissions[48].
- Compliance has steadily increased since its introduction. In May 2021, some 87 per cent of vehicles seen in the central zone on an average day met the strict ULEZ emissions standards.

The expanded ULEZ was launched on 25 October 2021. It operates up to, but not including, the North Circular Road and South Circular Road to create a single, larger zone. Nearly four million people live within the expanded ULEZ zone. Here six in ten households do not own a car yet suffer poor air quality in part caused by polluting vehicles. The compliance rate (percentage of vehicles detected in the zone that meet the strict emissions standards) during the first month was 92 per cent[49]. This is a 53 per cent increase on the 2017 compliance levels of 39 per cent. On an average weekday, there were 47,000 fewer non-compliant vehicles in the expanded zone than the two weeks before the scheme was introduced. This is a 37 per cent reduction in non-compliant vehicles. There were also 11,000 fewer vehicles driving at all.

The ULEZ expansion will result in a 30 per cent reduction of road transport emissions of NO_x. This means that 92 per cent of roads in London were expected to comply with legal limits for NO_2 by the end of 2021. Combined with other measures, this puts us on track for legal compliance by 2025 at the latest.

Since 1 March 2021 most heavy vehicles, including lorries buses and coaches, have had to meet the Euro VI emission standards of the London-wide Low Emission Zone (LEZ). These standards are the same as the ULEZ meaning there is only one charge for heavy vehicles operating in London.

[47] In February 2017 the Mayor confirmed the introduction of the T-charge as a stepping-stone for the ULEZ and this can be seen as the start of the accelerated change in the vehicle fleet as Londoners and businesses prepared for the new schemes and buses on routes in central London began to be upgraded to become ULEZ compliant

[48] Health Impact Assessment of Air Pollution on Asthma in London | London City Hall

[49] https://www.london.gov.uk/WHAT-WE-DO/environment/environment-publications/expanded-ultra-low-emission-zone-first-month-report

Six months on from their introduction, these changes are already delivering results[50]. Ninety-five per cent of large and heavy vehicles operating in London met the standards in August 2021. This is up from 48 per cent in February 2017 when the scheme was announced.

The LEZ also has significant benefits outside of London. Independent analysis shows that vehicles passing through London's Low Emission Zone went through 95 per cent of towns and cities in England and Wales. This has brought cleaner air to a combined population of 18 million people.

The Mayor has invested over £61m in funding for scrappage schemes that helped small businesses, charities operating minibuses and low-income and disabled Londoners. These schemes have helped replace nearly 15,000 older, more polluting vehicles. Over the past two and a half years the Mayor's scrappage schemes have proved very popular. Combined, they have helped thousands of Londoners and small businesses prepare for the ULEZ and its expansion. Demand for the schemes has been consistently high throughout that time. It shows how ordinary Londoners are taking the steps they need to clean up London's filthy air well in advance. The Mayor continues to make the case to Government to fund a targeted national scrappage scheme.

Cleaning up London's bus fleet. The Mayor continued transforming London's bus fleet by phasing out pure diesel buses and committing to buy only hybrid or zero-emission double decker buses from 2018. As of 1 January 2021, all buses in Transport for London's (TfL's) 9,000-strong core bus fleet meet or exceed the cleanest Euro VI emission standards. This effectively makes the whole city a Low Emission Bus Zone and reduces bus-related NOx emissions by 90 per cent. There are currently over 600 zero emission buses in the fleet. London now has the largest zero emission bus fleet in Western Europe.

Cleaning up the taxi fleet. The Mayor is phasing out diesel taxis to help make London's taxi fleet the greenest in the world. Since January 2018, TfL policy has been for all newly registered taxis to be Zero Emission Capable (ZEC). To support this, in 2017 the Mayor provided funding for taxi delicensing, to help get rid of the oldest, most polluting diesel black cabs from London's fleet. There are currently well over 5,000 ZEC, including more than 100 fully electric, taxis in operation in London. This is from a baseline of zero in 2017.

Cleaning up private hire (minicabs). Private hire vehicles are also subject to strict emission standards. As of 1 January 2020, private hire vehicles under 18 months must be ZEC when licensed for the first time. From 1 January 2023, this will apply to all private hire vehicles licensed for the first time. With their 10-year age limit, this will help London's private hire fleet be zero emission capable by 2033 at the latest. There are now over 14,000 Zero Emission Capable private hire vehicles.

Reducing air pollution from other, non-road sources. The Mayor is also acting on non-road sources of air pollution, including construction. This includes the unique Non-Road Mobile Machinery Low Emission Zone (NRMM LEZ). This has eliminated over 16.5 tonnes of PM and 297 tonnes of NOx emissions from construction between 2016 and 2019. The project has since been

[50] https://www.london.gov.uk/sites/default/files/lez_six_month_on_report-final.pdf

expanded from the initial 13 boroughs and now covers the whole of London. It is managed by Merton.

Cleaning up the air around schools. Since 2018 the Mayor has spent more than £1m on air quality action at schools and nurseries. This includes auditing the air quality at 50 primary schools and 20 nurseries in the city's most polluted areas. It also includes funding measures to help schools and nurseries reduce local pollution. Based on the positive results of these pilot programmes this approach is now being replicated by several London boroughs.

In February 2021 the Mayor launched the London Schools Pollution Helpdesk. This aims to support schools across the city to carry out air quality audits and implement recommendations. Progress in this area is particularly urgent for schools in Air Quality Management Areas. Public health departments should be aware of the school audit programme. All schools, particularly those near main roads, should perform air quality audits.

Cleaning up air pollution hotspots in London boroughs. The Mayor's Air Quality Fund of £22m has supported a variety of local and pan-London projects to improve air quality. For example, the Hackney Low Emission Neighbourhood contributed to an estimated 16 per cent reduction in local NOx emission. Find out more about Low Emission Neighbourhoods here.

Expanding London's electric vehicle charging infrastructure. The Mayor has supported delivery of over 300 rapid charge points – from zero in 2016 – and over 3,000 standard charge points. This includes London's first rapid charging hub at Stratford International. Two further hubs are planned at Baynard House, City of London and Glass Yard, Greenwich. London now has over 600 rapid charge points and over 8,000 residential charge points, a third of the UK's total. These have been delivered thanks to leadership and effective collaboration between the public and private sectors.

Empowering Londoners to take action to reduce their exposure to pollution. Alongside a comprehensive air quality monitoring network, the Mayor operates a system of alerts on the days with the worst air pollution. This includes providing information on more than 2,500 countdown signs at bus stops. See section 4.2 for more on communicating levels of air pollution.

As well as the GLA funded Breathe London network, Sutton, Kingston, Merton and Richmond upon Thames are using the network to install their own monitors. They are installing an additional 131 air quality sensors as part of the South London Partnership's InnOvaTe Project. By the end of 2022, the network will have over 300 sensors[51].

Case study: School Streets
Between April 2020 and March 2021, over 300 School Streets have been delivered across London with funding from TfL and the boroughs. The aim is to tackle children's exposure to air pollution and improve their health.

[51] https://www.breathelondon.org/

School Streets are initiatives where roads surrounding schools are closed to motor traffic at drop-off and pick-up times. This enables children to walk or cycle to school, reducing car trips and improve air quality. School Streets also provide space for social distancing and help to reduce road danger around schools, making journeys safer and easier.

To measure their air quality benefits, 30 sensors from the Breathe London network were installed at 18 primary schools across Brent, Enfield and Lambeth. These record NO_2 levels on School Streets. It found that stopping traffic at pick-up and drop-off times reduced NO_2 levels by up to 23 per cent at these schools. On average, 81 per cent of parents and carers supported the measures at their children's school.

Case Study: Idling Action

Vehicle Idling Action is a London-wide behaviour change campaign. It is funded by the Mayor's Air Quality Fund and led by the City of London and London Borough of Camden. The campaign is helping to reduce localised air pollution caused by motorists leaving their engines running when parked. The project team works directly with 31 local authorities. It runs school workshops, engages businesses to use greener vehicles and cargo bikes, offers vehicle fleet training, and ensures idling regulations are enforced across London.

Since 2016, over 1,500 idling action events have taken place, teaching 3,860 students about air pollution and health. Their schools have also been supported to act on engine idling by delivering 77 air quality and anti-idling workshops across 31 boroughs. In addition, the project has delivered Idling Action events at 35 schools and idling hotspots to engage idling drivers. Idlers were asked to switch off their engines and informed about the impact idling has on air quality and health. In 2021, the project created a four-week billboard, radio and digital advertising campaign – Engine Off Every Stop (EOES). It ran across London to raise awareness of engine idling and its health impacts and reached an estimated nine million plus people.

Case study: StreetSpace for London

The emerging recovery from the spring 2020 COVID-19 lockdown presented a challenge for TfL. This is because public transport was required to run at much lower levels of passenger capacity to provide space for social distancing. There were concerns that car travel may be more attractive than before the pandemic. This was due to temporarily lower congestion levels and public perceptions about the risk of exposure to coronavirus on public transport. However, a potential car-based recovery was recognised to have major risks to safety, public health, economic recovery and the environment. In addition, it was contradictory to the aims of the Mayor's Transport Strategy.

In response, TfL developed the StreetSpace for London programme, in line with national government guidance to urgently reconsider how street space is used. The aim was to provide safe and appealing spaces to walk and cycle as an alternative to car use. Interventions included temporary cycle routes to extend the strategic cycle network and footway widening to make more space for people walking. This was applied in town centres and at transport hubs.

StreetSpace for London focused on rapidly rolling out cycling infrastructure, bus priority, neighbourhood improvements and lower speeds, using temporary materials and an accelerated approach. By March 2021, almost 100km of new or upgraded cycle routes were built, and 86km of bus lanes were upgraded to 24/7. In addition, 2,259 signal timing changes were made to prioritise people walking, and 88 Low Traffic Neighbourhoods were delivered.

4.4 Impact of COVID-19 on air quality in London

In March 2020 strict measures were introduced to tackle the COVID-19 pandemic in London. This had a significant impact on NO_2 levels, mainly due to less motor traffic. Once weather effects were accounted for, reductions were, in general, greater at roadside sites than urban background sites. The change in NO_2 concentrations from COVID-19 restrictions must be seen within the wider context of improvements in London's air quality in recent years. This is due to initiatives such as the ULEZ. Additionally, during lockdown O_3 and PM concentrations increased highlighting the importance of non-transport emission sources and the need for action on these also.

In 2020, hourly average NO_2 at all central London sites had already reduced by 35 per cent compared to the same period in 2017. This was before measures to address the COVID-19 outbreak were introduced. During the first lockdown there was an additional reduction of 26 per cent. This reduction was even higher at roadside sites (figure 6). NO_2 levels at monitoring sites in central London remained low in 2021 despite increases in traffic following the end of lockdowns. Just a 2.7 per cent increase was seen when comparing the first lockdown in 2020 to the same period in 2021.

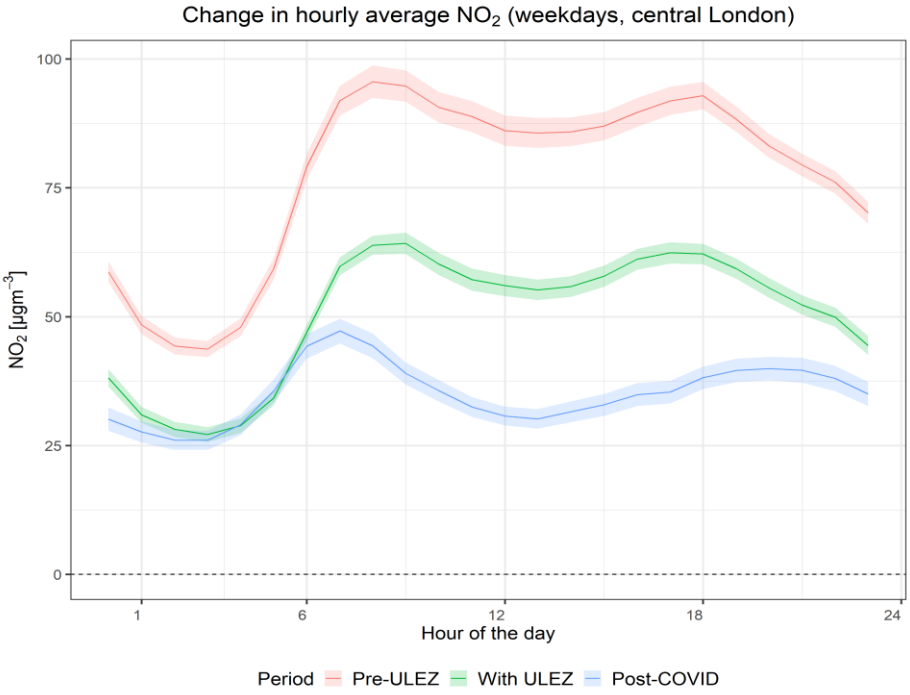

Figure 6 Changes in hourly average NO_2 (weekdays, central London)

5 AIR QUALITY AND ITS HEALTH IMPACTS IN LB BEXLEY

5.1 Location and monitoring

The London Borough (LB) of Bexley is situated in South East London. It is made up of 17 wards and has a population of 247,258[52].

In 2007 LB Bexley designated the whole of the borough as an AQMA due to exceedances in NO_2 and PM_{10}. Air quality is monitored at four automatic monitoring sites in the borough.

The annual mean limit value for NO_2 and for PM_{10} is 40 μg/m^3. Concentrations within the limit value are highlighted in green, exceedances of the limit value are highlighted in yellow, with exceedances greater than 50% of the limit value indicated in red.

More information about air pollution limit values is included in appendix 1.

5.2 Annual mean concentrations

Annual mean NO_2 concentrations measured at all automatic monitoring stations have constantly decreased over the 7-year period (2014-2020) for which data have been reported (see table 3, below).

The automatic monitoring station A2 at Falconwood has previously breached the annual mean objective of 40 μg/m^3 (table 3). Whilst all sites have remained below the objective in recent years, they all remain above the WHO guideline limit (10 μg/m^3). Note, the monitoring sites are described as either background, kerbside, roadside or industrial background. A2 at Falconwood is a kerbside site whilst Slade Green, Belvedere Primary School, and Bexley Business Academy are background sites. Specific details of each site can be found in the LB Bexley annual status reports.

Table 3 Annual Mean NO_2 Concentration monitoring results (μg m^{-3})

Site	2014	2015	2016	2017	2018	2019	2020
Slade Green (Background)	27	26	25	25	23	22	18
Belvedere Primary School (Background)	27	24	28	28	28	28	18
Bexley Business Academy (Background)	23	22	24	21	21	21	16
A2 at Falconwood (Kerbside)	47	41	41	40	39	36	28

[52] https://www.bexley.gov.uk/discover-bexley/bexley-facts-and-figures/bexleys-population

The national air quality objective for PM_{10} is 40 µg/m^3 and for $PM_{2.5}$ is 25 µg/m^3. As mentioned previously, the WHO has recently updated its Air Quality guidelines following an assessment of the health effects of air pollution and thresholds for health-harmful pollution levels. The new WHO guideline value for PM_{10} is 15 µg/m^3 and 5 µg/m^3 for $PM_{2.5}$. In LB Bexley, PM_{10} levels are below the national air quality objective. However, concentrations at some monitoring sites in the borough (Bexley Business Academy and A2 at Falconwood) remain higher than the updated WHO standard (15 µg/m^3) highlighting the need for more action on reducing PM emissions in London. Currently there two $PM_{2.5}$ monitoring stations in LB Bexley (Slade Green and A2 at Falconwood), one of which exceeds the WHO guideline value.

There is no safe level of exposure which doesn't impact on health. Therefore, further reduction of NO_2 or PM concentrations below air quality standards is likely to bring additional health benefits.

5.3 Air quality focus areas

In 2016 the GLA identified two Air Quality Focus Areas within LB Bexley, these are outlined in figure 7 below. Population exposure at schools, nurseries, care homes and hospitals can be seen in appendix 6.

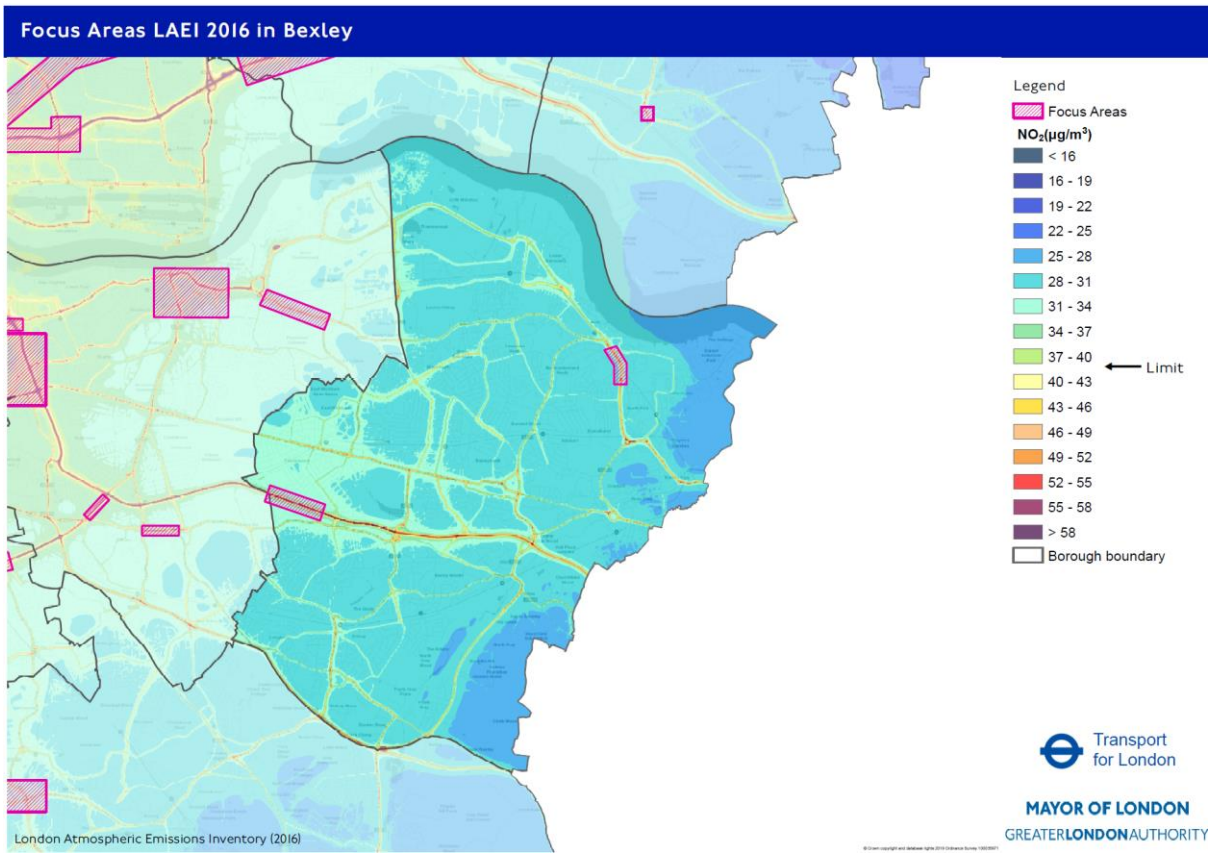

Figure 7 LB Bexley Focus Areas, London Atmospheric Emissions Inventory (LAEI 2016)

5.4 Health Impacts in LB Bexley

The Public Health Outcomes Framework, mentioned in Chapter 2, includes a benchmark tool which enables the comparison of the fraction (%) of mortality attributable to long term exposure to $PM_{2.5}$ in each local authority in the UK. Statistics for each of the London boroughs are included in Appendix 2.

Imperial College London have recently carried out research looking at the health burden of current air pollution and estimates of the mortality impacts of $PM_{2.5}$ and NO_2 in London[53]. See appendix 7 for data sources and calculations. The overall findings from this research are that in 2019 in Greater London, the equivalent of between 3,600 and 4,100 deaths (61,800 to 70,200 life years lost) were estimated to be attributable to human-made $PM_{2.5}$ and NO_2, considering that health effects exist even at very low levels of air pollution. This calculation includes deaths from all causes including respiratory, lung cancer and cardiovascular disease. Local Authority population, total deaths from all causes, range of mortality burden (deaths) for $PM_{2.5}$ and NO_2 and mean fraction of mortality attributable to $PM_{2.5}$ and NO_2 in 2019 can be found in appendix 8.

Figure 8 below presents the mean fraction of mortality attributable to $PM_{2.5}$ and NO_2 in each London borough compared to the London average. The boroughs with the lowest fraction of mortality attributable to $PM_{2.5}$ and NO_2 are outer London boroughs and the boroughs with the highest fraction of mortality attributable to $PM_{2.5}$ and NO_2 are inner London boroughs.

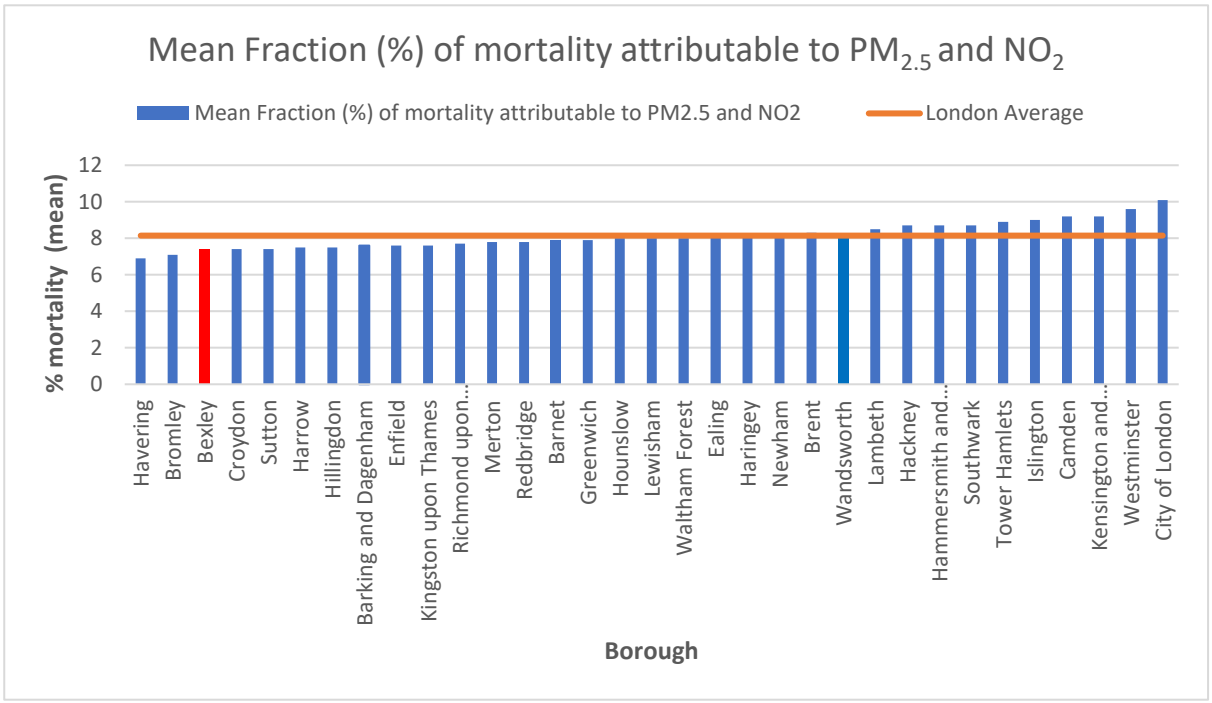

Figure 8 Mean fraction of mortality attributable to $PM_{2.5}$ and NO_2 in each London borough

53 https://www.london.gov.uk/sites/default/files/london_health_burden_of_current_air_pollution_and_future_health_benefits_of_mayoral_air_quality_policies_january2020.pdf

The Imperial College research also looked at a breakdown of mortality burden and life years lost at a ward level across London (table 4). Results are presented as an upper and lower range of life years lost based on the multi pollutant exploratory method (including life years lost as a result of $PM_{2.5}$ and NO_2).

Table 4 Mortality burden and life years lost attributed to exposure to $PM_{2.5}$ and NO_2 pollution in 2019 in wards in the London Borough of Bexley.

Ward	Population	Deaths (all causes)	Mortality burden (min)	Mortality burden (max)	Life years lost (min)	Life years lost (max)
Barnehurst	15336	189	12.45	14.71	211.91	250.53
Belvedere	20629	204	13.98	16.33	214.31	250.39
Bexleyheath	20236	341	23.47	27.28	278.31	323.56
Blackfen & Lamorbey	21135	283	19.59	22.80	360.27	419.45
Blendon & Penhill	20439	258	17.95	20.82	245.64	285.36
Crayford	20029	261	17.24	20.25	260.88	306.70
Crook Log	20595	306	21.39	24.83	233.17	270.89
East Wickham	20220	272	19.01	22.16	278.12	324.44
Erith	12576	155	10.38	12.17	155.31	182.18
Falconwood & Welling	20712	232	16.61	19.21	236.53	273.43
Longlands	13318	253	17.15	20.03	219.39	255.48
Northumberland Heath	13297	143	9.46	11.14	148.75	175.12
St Mary's & St James	13915	190	12.50	14.68	154.47	181.33
Sidcup	19185	413	28.08	32.70	438.20	510.06
Slade Green & Northend	13605	166	10.94	12.91	185.60	219.05
Thamesmead East	18730	176	11.84	13.76	202.75	235.61
West Heath	20758	217	14.95	17.44	205.86	240.13

6 WHY FURTHER ACTION IS NEEDED

Some of the actions already being taken across London to improve air quality are presented in section 4.3 above. However, there is much to do with most of London exceeding the interim WHO guideline limit for $PM_{2.5}$. In addition, areas of the capital still exceed NO_2 WHO guideline values. Currently there is no clear evidence of a safe level of exposure below which there is no risk of adverse health effects; therefore, further reductions in concentrations of PM and NO_2 likely to bring additional health benefits. Coordinated action and collaboration is needed to reduce air pollution, improve health and to reduce health inequalities.

6.1 Maximising the health benefits from improving air quality

Certain measures to improve air quality have significant co-benefits for health and reducing health inequalities if appropriately targeted. PHE's (now UK HSA) 2019 evidence review[54] looked at how to reduce the harm to health from outdoor air pollution. It found that there is some strong evidence that interventions in each of the five areas reviewed can reduce harmful emissions. This includes vehicles and fuels, spatial planning, industry, agriculture, and people's behaviour. They recommend adopting an intervention hierarchy approach. That means taking measures to prevent or reduce pollution rather than mitigation after it occurs or relying on reducing exposure. It also recommends adopting a 'net health gain' principle so that any new development or proposed changes should deliver an overall benefit to public health. Evaluation should be embedded in the design and costing of all interventions to gather evidence to inform best practice in the future.

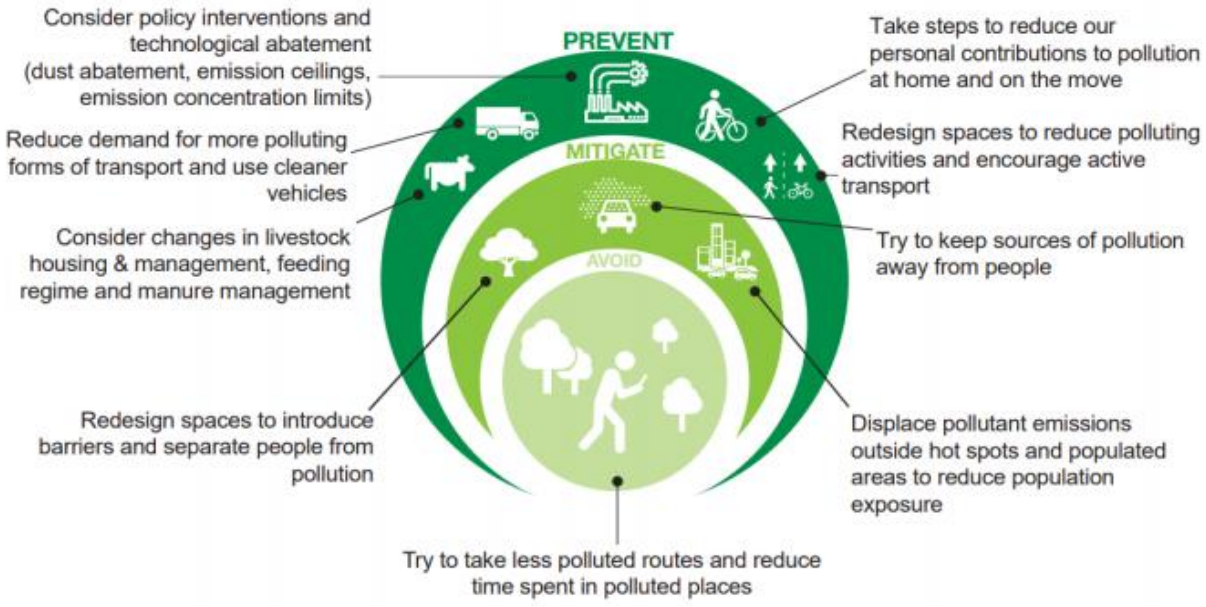

Figure 9 Illustrated Air Pollution Hierarchy, taken from PHE's 2019 evidence review.

[54] UKHSA (2019) Review of interventions to improve outdoor air quality and public health: Principal interventions for local authorities
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/937341/Principal_interventions_for_local_authorities-air_quality_public_health.pdf

6.2 Communicating with patients and the public

The Prevention of Future Deaths report after the Ella Adoo-Kissi-Debrah inquest highlighted the public's low awareness of the health impacts of air pollution. It made the case for better communication of these risks and what people can do about them. Both local authorities and medical and nursing professionals should provide this information, for example by signposting to Defra's pollution forecast and various online resources[55, 56]. This is needed both during air pollution episodes and more generally regarding the long-term benefits to health of improving air quality. It is an important area with opportunities for stronger local authority - NHS collaboration at local and integrated care system (ICS) level.

One of the many actions people can take, to reduce their exposure and their contribution to air pollution, is to consider how they travel. Reducing unnecessary car trips can make a big difference. It is important that health professionals and local government help communicate options to the public to help them make the healthiest choices. Appendix 9 has a list of actions Londoners can take to mitigate against air pollution. Local authorities also play an important role in enabling this by investing in infrastructure, public transport and designing healthy environments.

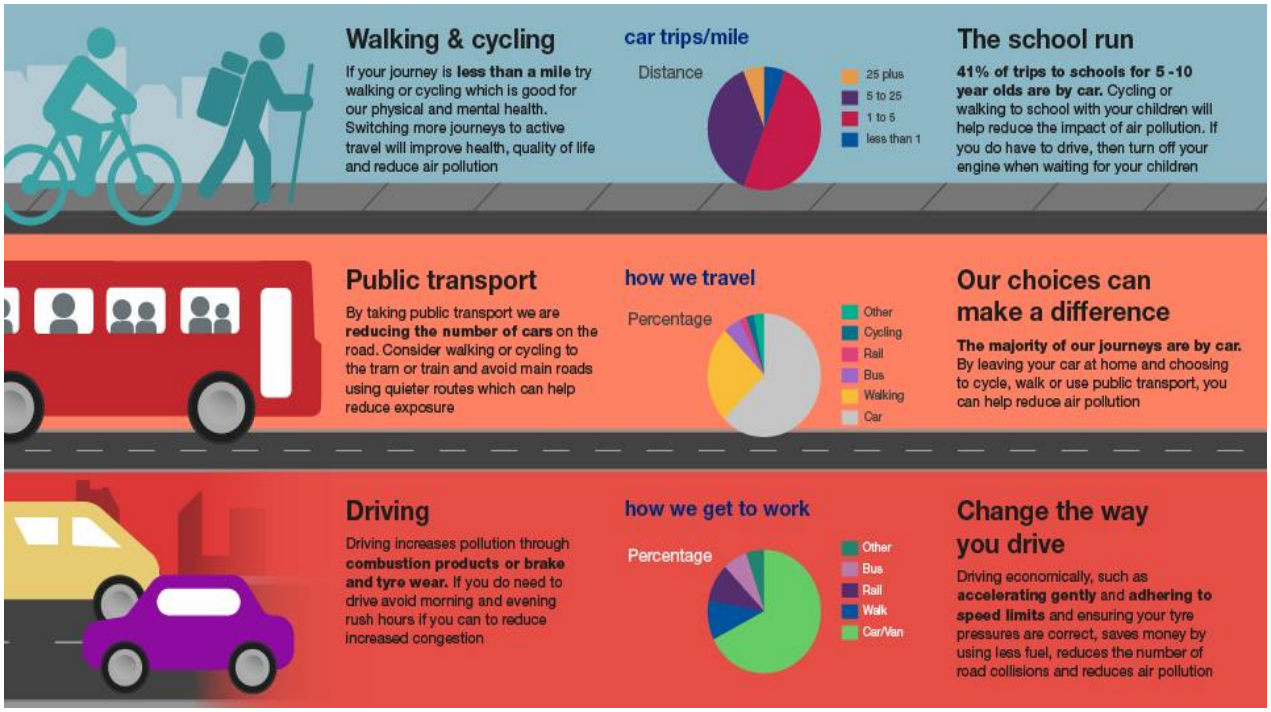

Figure 10 Why travel makes a difference. Taken from PHE Health Matters 2018

[55] https://www.gov.uk/government/publications/health-matters-air-pollution/health-matters-air-pollution
[56] https://www.cleanairhub.org.uk/

Case study: Mobilising GPs on air pollution

A recruitment campaign has been launched to engage 40 GPs from across England. The aim is to explore the vital role they can play in protecting patients against air pollution. Learning from the six-month pilot project will help shape a national model for GP action on air pollution. The 40 health professionals will become Clean Air Champions. Through the project they'll discover how best to engage patients on air pollution health risks, and what patients can do to reduce their exposure.

Air pollution is well recognised as a critical public health issue. Evidence shows increases in the daily number of GP respiratory consultations and inhaler prescriptions following short-term increases in exposure to air pollution[57]. The project is supported by Defra and rolled out by Global Action Plan and UK Health Alliance on Climate Change, with Imperial College London. GP Clean Air Champions will be offered an air pollution training session and receive communications material on air pollution to share with patients. Training materials for health professionals and patient focused resources can also be found on the action for cleaner air website. For more information contact cleanerair@globalactionplan.org.uk or visit the Clean Air Hub.

6.3 Actions boroughs can take to improve air quality

Boroughs have a statutory responsibility to deliver actions locally, and to detail these in up-to-date Air Quality Action Plans. Boroughs should already use the LLAQM Borough Air Quality Action Matrix as part of their London Local Air Quality Management action planning obligations. The list of actions in the matrix use levers that are under borough control to help improve air quality. This is not an exhaustive list, however. Boroughs should continue to explore new ways to improve local air quality and build upon the suggested actions.

The Coroner for Inner South London, in his report following the inquest into Ella Adoo-Kissi-Debrah's death, noted there was low public awareness of pollution. It called for action to be taken to improve public awareness about air pollution and its sources and impacts upon health. This would help individuals reduce their personal exposure to air pollution. Central Government, the Mayor of London, London Borough of Lewisham and medical professional organisations were identified as the parties needing to take such action. However, the report is clearly also relevant to all local authorities and other organisations responsible for protecting public health or improving air quality.

Borough officers and public health professionals can play an important role in promoting and empowering behaviour change for stakeholders and the general public to:

- reduce the sources of, and people's exposure to, air pollution across the borough and beyond

[57] https://ehjournal.biomedcentral.com/articles/10.1186/s12940-021-00730-1#citeas

- achieve better health outcomes for all, particularly for vulnerable groups most impacted by air pollution

Local Environment and Air Quality Strategies should be mindful of all forms of pollution. Risk should be considered at both consistent low-level exposure and intermittent high-level exposure.

Borough officers and public health professionals should promote a step change in local transport systems to prioritise air quality and public health. Investment in walking and cycling infrastructure to enable active travel should be prioritised, alongside a rapid shift towards zero emission vehicles.

Boroughs and their local partner organisations have a key role to play in engaging with and raising awareness among their residents. This includes informing them of London-wide measures and the many initiatives in place to help reduce exposure to air pollution. For example, the new London Schools Pollution Helpdesk, the Mayor's pollution alerts and airTEXT alert service (see section 4.2).

Borough officers and public health professionals can also incorporate and promote adherence to recently published NICE guidance on outdoor air quality and health[58]. This has guidance based on four quality statements, spanning local authorities, public sector organisations and healthcare providers, based on the most recent evidence.

Borough public health teams should work closely with air quality and environment colleagues and prioritise communicating health messages to the public. This includes both during air pollution episodes and more generally about the long-term health benefits of cleaner air.

In March 2021, Association of Directors of Public Health (ADPH) London and London Environment Directors' Network revised their joint position statement on air quality[59]. You can view their recommendations for action to clean up London's air in appendix 10. This includes the need for London boroughs to support a shared narrative and campaign on air quality and public health impacts across London. This will help change the public's perception around their own contribution to cleaner air.

Air pollution does not respect boundaries. Of course, localised emissions from transport, heating and industry all contribute to London's air pollution. However, it also receives a large amount of transboundary pollution from outside the city. This is primarily true of PM, but to a far lesser extent for gaseous pollutants like NO_2. In fact, over half the city's concentrations of $PM_{2.5}$ come from regional and often transboundary sources outside of London[60]. Therefore, alongside local action and collaboration with neighbouring boroughs, London needs national, European and international action to meet the previous WHO guideline value of by 2030.

[58] https://www.nice.org.uk/guidance/qs181
[59] https://adph.org.uk/networks/london/wp-content/uploads/2021/03/ADPH-London-LEDNet-Air-Quality-Joint-Position-full.pdf
[60] https://www.london.gov.uk/sites/default/files/air_quality_in_london_2016-2020_october2020final.pdf

7 NEXT STEPS

We hope the updated air quality data and health information in this report will be of use when developing local initiatives.

Under the Environment Act 1995[61] local authorities have a statutory responsibility to participate in Local Air Quality Management. Actions must be delivered locally, and Air Quality Action plans kept up to date and developed with public health involvement and expertise.

Boroughs are encouraged to continue the ambitious action for cleaner air and improved public awareness many already lead the way on. This work needs to be well coordinated across London, particularly through work with neighbouring boroughs. Boroughs are also asked to support Mayoral objectives around air quality including those within the London Environment Strategy. This is part of the work towards achievement of the previous WHO target for pollutants even when legal limits are met. Find out more and view resources about borough obligations under the London Local Air Quality Management framework here.

Public Health officers are asked to:

- work closely with relevant colleagues across air quality, transport, planning and housing teams as well as wider stakeholders, as appropriate. This is in order to drive forward action on the priorities and measures outlined in section 6.3
- include updated borough-specific data and updated epidemiological and health economic evidence from this report in your Joint Strategic Needs Assessment (JSNA). This will help ensure air quality is integrated into strategic decision making and relevant council plans and strategies. The recent LAEI 2019 publication has useful data to include in JSNAs[62]
- act in line with the concerns raised in the Prevent Future Deaths report for Ella Adoo-Kissi-Debrah[63]. Residents, especially those most vulnerable, must be informed about both the impacts and sources of information about air pollution. It includes being alerted to periods of higher pollution as well what steps they can take to reduce their day-to-day exposure. This should be both through the local authority's own public communications and through partnership work with clinical and social care colleagues.
- ensure regular contact with your borough Air Quality Officer. Discuss what is being done locally to tackle air quality and how to bring public health evidence and approaches to bear in this work. Activities should include:
    - Air Quality and Health agenda alignment
    - Joint working on priority projects and input into key local strategies and the local plan

[61] www.environment-agency.gov.uk/netregs/legislation/.../107183.aspx
[62] https://data.london.gov.uk/dataset/london-atmospheric-emissions-inventory--laei--2019
[63] https://www.judiciary.uk/wp-content/uploads/2021/04/Ella-Kissi-Debrah-2021-0113-1.pdf

    - Communications and messaging around air quality and health
    - Reaching out to colleagues in healthcare organisations, such as doctors, nurses and pharmacists around opportunities to strengthen their education, training and awareness in relation to air quality.
    - Funding for initiatives
    - Sharing best practice to GPs and sensitive receptors
- ensure that you are consulted early on any planned Air Quality Action Plan updates and identify opportunities for maximising the health benefits. Make relevant connections with your Health and Wellbeing Strategy. For example, by promoting physical activity through increasing walking and cycling or ensuring improvements to housing stock tackle fuel poverty and improve ventilation.

Please share your thoughts on this report and what information would be useful to you. Let us know about any innovative work on air quality and health you are doing in your borough.

Find out more at http://www.london.gov.uk/airquality
For any comments or questions please email airquality@london.gov.uk

8 APPENDICES

Appendix 1 National Air Quality objectives and European Directive limit and target values[64]

National air quality objectives and European Directive limit and target values for the protection of human health						
Pollutant	**Applies**	**Objective**	**Concentration measured as [10]**	**Date to be achieved by (and maintained thereafter)**	**European Obligations**	**Date to be achieved (by and maintained thereafter)**
Particles (PM_{10})	UK	50 µg/m^3 not to be exceeded more than 35 times a year	24 hour mean	31 December 2004	50 µg/m^3 not to be exceeded more than 35 times a year	1 January 2005
	UK	40 µg/m^3	annual mean	31 December 2004	40 µg/m^3	1 January 2005
	Indicative 2010 objectives for PM_{10} (from the 2000 strategy and Addendum) have been replaced by an exposure reduction approach for $PM_{2.5}$ (except in Scotland – see below)					
	Scotland	50 µg/m^3 not to be exceeded more than 7 times a year	24 hour mean	31 December 2010	50 µg/m^3 not to be exceeded more than 35 times a year	1 January 2005
	Scotland	18 µg/m^3	annual mean	31 December 2010	40 µg/m^3	1 January 2005
Particles ($PM_{2.5}$) Exposure Reduction	UK (except Scotland)	25 µg/m^3	annual mean	2020	Target value - 25 µg/m^3	2010
	Scotland	10 µg/m^3		31 December 2020	Limit value - 25 µg/m^3	1 January 2015
	UK urban areas	Target of 15% reduction in concentrations at urban background		Between 2010 and 2020	Target of 20% reduction in concentrations at urban background.	Between 2010 and 2020

National air quality objectives and European Directive limit and target values for the protection of human health						
Pollutant	**Applies**	**Objective**	**Concentration measured as[1]**	**Date to be achieved by (and maintained thereafter)**	**European Obligations**	**Date to be achieved by (and maintained thereafter)**
Nitrogen dioxide	UK	200 µg/m^3 not to be exceeded more than 18 times a year	1 hour mean	31 December 2005	200 µg/m^3 not to be exceeded more than 18 times a year	1 January 2010
	UK	40 µg/m^3	annual mean	31 December 2005	40 µg/m^3	1 January 2010
Ozone	UK	100 µg/m^3 not to be exceeded more than 10 times a year	8 hour mean	31 December 2005	Target of 120 µg/m^3 not to be exceeded by more than 25 times a year averaged over 3 years	31 December 2010
Sulphur dioxide	UK	266 µg/m^3 not to be exceeded more than 35 times a year	15 minute mean	31 December 2005	-	-
	UK	350 µg/m^3 not to be exceeded more than 24 times a year	1 hour mean	31 December 2004	350 µg/m^3 not to be exceeded more than 24 times a year	1 January 2005
	UK	125 µg/m^3 not to be exceeded more than 3 times a year	24 hour mean	31 December 2004	125 µg/m^3 not to be exceeded more than 3 times a year	1 January 2005
Polycyclic Aromatic Hydrocarbons	UK	0.25 ng/m^3 B[a]P	as annual average	31 December 2012	1.0 ng/m^3	31 December 2012

[64] This does not include the 2020 amendments to $PM_{2.5}$ limit values.

National air quality objectives and European Directive limit and target values for the protection of human health						
Pollutant	**Applies**	**Objective**	**Concentration measured as[1]**	**Date to be achieved by (and maintained thereafter)**	**European Obligations**	**Date to be achieved by (and maintained thereafter)**
Benzene	UK	16.25 µg/m^3	running annual mean	31 December 2003	-	-
	England and Wales	5 µg/m^3	annual average	31 December 2010	5 µg/m^3	1 January 2010
	Scotland, Northern Ireland	3.25 µg/m^3	running annual mean	31 December 2010	-	-
1,3-butadiene	UK	2.25 µg/m^3	running annual mean	31 December 2003	-	-
Carbon monoxide	UK	10 mg/m^3	maximum daily running 8 hour mean/in Scotland as running 8 hour mean	31 December 2003	10 mg/m^3	1 January 2005
Lead	UK	0.5 µg/m^3	annual mean	31 December 2004	0.5 µg/m^3	1 January 2005
		0.25 µg/m^3	annual mean	31 December 2008	-	-

National air quality objectives and European Directive limit and target values for the protection of vegetation and ecosystems						
Pollutant	**Applies**	**Objective**	**Concentration measured as[1]**	**Date to be achieved by (and maintained thereafter)**	**European Obligations**	**Date to be achieved by (and maintained thereafter)**
Nitrogen oxides	UK	30 µg/m^3	annual mean	31 December 2000	30 µg/m^3	19 July 2001
Sulphur dioxide	UK	20 µg/m^3	annual mean	31 December 2000	20 µg/m^3	19 July 2001
	UK	20 µg/m^3	winter average	31 December 2000	20 µg/m^3	19 July 2001
Ozone: protection of vegetation and ecosystems	UK	Target value of 18,000 µg/m^3 based on AOT40 to be calculated from 1 hour values from May to July, and to be achieved, so far as possible, by 2010	Average over 5 years	1 January 2010	Target value of 18,000 µg/m^3 based on AOT40 to be calculated from 1 hour values from May to July, and to be achieved, so far as possible, by 2010	1 January 2010

https://uk-air.defra.gov.uk/assets/documents/Air_Quality_Objectives_Update.pdf

Appendix 2 Fraction (%) of mortality attributable to long term exposure to $PM_{2.5}$ (2019)

Local Authority	Fraction (%) of mortality attributable to long-term exposure to $PM_{2.5}$
Barking and Dagenham	6.8
Barnet	6.3
Bexley	6.1
Brent	6.4
Bromley	5.7
Camden	6.6
City of London	6.9
Croydon	6.0
Ealing	6.4
Enfield	6.5
Greenwich	6.4
Hackney	6.8
Hammersmith and Fulham	6.6
Haringey	6.6
Harrow	6.0
Havering	6.0
Hillingdon	6.0
Hounslow	6.2
Islington	6.8
Kensington and Chelsea	6.8
Kingston upon Thames	5.9
Lambeth	6.6
Lewisham	6.4
Merton	6.3
Newham	7.0
Redbridge	6.7
Richmond upon Thames	6.0
Southwark	6.6
Sutton	5.8
Tower Hamlets	6.7
Waltham Forest	6.9
Wandsworth	6.4
Westminster	6.8
London Region	6.4
England	5.1

Appendix 3 Public Health Outcomes Framework indicators that could be influenced by policies to improve air quality

Theme	Public Health Outcomes Framework Indicator
Air pollution	Fraction of mortality attributable to particulate air pollution
Noise pollution	The percentage of the population exposed to road, rail and air transport noise of 65dB(A) or more, during the daytime
	The percentage of the population exposed to road, rail and air transport noise of 55 dB(A) or more during the night-time
Fuel poverty	Fuel poverty
Sustainability plans	NHS organisations with a board approved sustainable development management plan
Life expectancy	Healthy life expectancy at birth and aged 65 (males & females)
	Life expectancy at birth and aged 65 (males & females)
	Disability-free life expectancy at birth and aged 65 (males & females)
	Inequality in life expectancy at birth and aged 65 (males & females)
Premature mortality	Mortality rate from causes considered preventable
	Under 75 mortality rate from cardiovascular diseases considered preventable
	Under 75 mortality rate from cancer considered preventable
	Under 75 mortality rate from respiratory disease considered preventable
Musculoskeletal problem	Percentage reporting a long term musculoskeletal (MSK) problem
Excess winter deaths	Excess winter deaths index and in those aged 85+
Low birth weight babies	Low birth weight of term babies
Use of outdoor space	Utilisation of outdoor space for exercise/health reasons
Physical activity	Percentage of physically active children and young people
	Percentage of physically active adults and percentage of physically inactive adults
Overweight and obesity	Obesity in early pregnancy
	Reception: Prevalence of overweight (including obesity)
	Year 6: Prevalence of overweight (including obesity)
	Percentage of adults (aged 18+) classified as overweight or obese

Theme	Public Health Outcomes Framework Indicator
Road traffic accidents	Killed and seriously injured (KSI) casualties on England's roads
Injuries	Hospital admissions caused by unintentional and deliberate injuries in children (aged 0-14 years; 0-4 years and 15-24 years)
Falls and hip fractures	Emergency hospital admissions due to falls in people aged 65 and over; aged 65-79 and 80+
	Hip fractures in people aged 65 and over; aged 65-79 and 80+
Social interaction	Social Isolation: percentage of adult social care users and adult carers who have as much social contact as they would like
Self-reported wellbeing	Self-reported wellbeing - people with a low satisfaction score
	Self-reported wellbeing - people with a low worthwhile score
	Self-reported wellbeing - people with a low happiness score
	Self-reported wellbeing - people with a high anxiety score
Sickness absence	Percentage of employees who had at least one day off in the previous week and percentage of working days lost due to sickness absence in previous week

There are other public health indicators which are included in other public health profiles rather than the PHOF itself which could be influenced by policies to improve air quality. These include but are not limited to the following:

Prevalence of and mortality from asthma and COPD and hospital admissions for asthma, COPD and other respiratory diseases, which are found here: Inhale - INteractive Health Atlas of Lung conditions in England - PHE

Prevalence of diabetes, coronary heart disease and stroke, which are found here: Cardiovascular Disease - PHE

Additional indicators related to active travel and physical activity can be found here - https://fingertips.phe.org.uk/profile/physical-activity

Appendix 4 Relevant London Strategies

London Health inequalities strategy, 2018[65]

The London Health Inequalities Strategy sets out the Mayor's aims and objectives for addressing health inequalities in London. It provides a vision for the health of Londoners and sets a direction of travel for collaborative working over the next ten years, with partners, agencies and communities. The strategy is supported by a 'health in all policies' approach. This means that many of the actions that the Mayor will take which will have an impact upon health inequalities, originate in other Mayoral strategies. The Mayor's key ambition under the strategy's 'Healthy Places aim is 'for London to have the best air quality of any global city, with progress fastest in the most polluted areas, benefitting people most vulnerable to the effects of air pollution'.

The Health and Care Vision for London, 2019[66]

The London Vision partnership is made up of the Greater London Authority, UKHSA, London Councils and the National Health Service (NHS) in London. It exists to provide coordinated leadership and a shared ambition to make our London the healthiest global city and the best global city in which to receive health and care services. It reflects the Mayor's Health Inequalities Strategy, London Councils' Pledges to Londoners, the Prevention Green Paper and the NHS Long Term Plan. Air quality has been prioritised one of the ten key areas of focus where partnership action is needed at a pan-London level, with the ambition that every Londoner breathes safe air, and a commitment by the Mayor, NHS England, London Councils and UKHSA to work together to reach legal NO_2 concentration limits and to work towards WHO $PM_{2.5}$ limits by 2030.

London Plan[67]

The new London Plan (2021) introduces significant new protections for local and regional air quality, including in relation to the most damaging $PM_{2.5}$ particulates. For the first time, the largest developments will be required to take an Air Quality Positive approach, meaning that they will have to consider in depth how they will contribute to improving local and regional air quality through intelligent approaches to design, the urban realm and heating and transport infrastructure.

More broadly the new London Plan requires all new developments to take into account local air quality to ensure that they are suitable for their use and location, that they are Air Quality Neutral, that they do not have unacceptable impacts during construction and that they take particular care to protect the most vulnerable and most disadvantaged members of society.

[65] https://www.london.gov.uk/sites/default/files/health_strategy_2018_low_res_fa1.pdf
[66] 11448_hlp_london_vision_-_annual_report_2019_full_version.pdf
[67] https://www.london.gov.uk/sites/default/files/the_london_plan_2021.pdf

Mayor's London Environment Strategy (LES)[68]

The Mayor's London Environment Strategy (LES) was published in May 2018. The LES sets out how London will have the cleanest air of any major world city, meeting legal requirements and the previous WHO health-based guidelines. The LES has multiple environmental objectives: improving air quality to protect public health, creating new green spaces and improving biodiversity, reducing greenhouse gas emissions and increasing efficiency of energy, waste and water, and helping London to prevent and adapt against climate change. The three air quality objectives under which all other polices and proposals are structured are:

Objective 4.1 Support and empower London and its communities, particularly the most disadvantaged and those in priority locations, to reduce their exposure to poor air quality

Objective 4.2 Achieve legal compliance with UK and EU limits as soon as possible, including by mobilising action from London Boroughs, Government and other partners

Objective 4.3 Establish and achieve new, tighter air quality targets for a cleaner London by transitioning to a zero emission London by 2030, meeting WHO Health based guidelines for air quality

The Mayor's Transport Strategy [69]

The Mayor's Transport Strategy (MTS) sets out the Mayor's policies and proposals to reshape transport in London over the next two decades with the ambition that 80% of trips are made by active or sustainable modes (walking, cycling and public transport) with all Londoners achieving the 20 minutes of active travel each day that they need to stay healthy by 2041.

Transport has the potential to shape London, from the streets where Londoners live, work and spend time, to the Tube, rail and bus services they use every day. By using the Healthy Streets Approach to prioritise human health and experience in planning the city, the Mayor wants to change London's transport mix so the city works better for everyone

[68] https://www.london.gov.uk/what-we-do/environment/london-environment-strategy
[69] https://www.london.gov.uk/what-we-do/transport/our-vision-transport/mayors-transport-strategy-2018

Appendix 5 PM monitoring in LB Bexley

Annual Mean PM_{10} Concentration monitoring results ($\mu g\ m^{-3}$)

Site	2014	2015	2016	2017	2018	2019	2020
Slade Green	15	14	18	17	18	17	13
Belvedere Primary School	17	14	14	17	19	19	15
Bexley Business Academy	19	18	15	15	15	14	17
A2 at Falconwood	26	22	22	19	21	19	20

Annual Mean $PM_{2.5}$ Concentration monitoring results ($\mu g\ m^{-3}$)

Site	2014	2015	2016	2017	2018	2019	2020
Slade Green	16	15	11	11	12	12	9
A2 at Falconwood	14	14	15	13	13	12	13

Appendix 6 Population exposure

The table below summarises the number of care homes, hospitals and medical centres and schools in Bexley and shows the number of each exceeding the $PM_{2.5}$ legal limit (25µg/m^3), interim WHO guideline (10µg/m^3) and final WHO guideline limit (5µg/m^3). Full datasets can be found in the LAEI2019.

Number of care homes	Number exceeding $PM_{2.5}$ legal (25µg/m^3)	Number exceeding $PM_{2.5}$ WHO interim (10µg/m^3)	Number exceeding $PM_{2.5}$ WHO final (5µg/m^3)
12	0	11	12
Number of Hospitals and medical centres	Number exceeding $PM_{2.5}$ legal (25µg/m^3)	Number exceeding $PM_{2.5}$ WHO interim (10µg/m^3)	Number exceeding $PM_{2.5}$ WHO final (5µg/m^3)
1	0	0	1
Number of Schools	Number exceeding $PM_{2.5}$ legal (25µg/m^3)	Number exceeding $PM_{2.5}$ WHO interim (10µg/m^3)	Number exceeding $PM_{2.5}$ WHO final (5µg/m^3)
89	0	76	89

The table below summarises the number of care homes, hospitals/ medical centres and schools in Bexley and shows the number of each exceeding the NO_2 legal limit (40µg/m^3), interim WHO guideline (30µg/m^3) and final WHO guideline limit (10µg/m^3). Full datasets can be found in the LAEI2019.

Number of care homes	Number exceeding $NO_{2.}$ legal (40µg/m^3)	Number exceeding NO_2 WHO interim (30µg/m^3)	Number exceeding NO_2 WHO final (10µg/m^3)
12	0	0	12
Number of Hospitals and medical centres	Number exceeding $NO_{2.}$ legal (40µg/m^3)	Number exceeding NO_2 WHO interim (30µg/m^3)	Number exceeding NO_2 WHO final (10µg/m^3)
1	0	0	1
Number of Schools	Number exceeding $NO_{2.}$ legal (40µg/m^3)	Number exceeding NO_2 WHO interim (30µg/m^3)	Number exceeding NO_2 WHO final (10µg/m^3)
89	0	0	89

Care homes

London context

Of an estimated 322 care homes, none are in locations where the average NO_2 concentration was above the legal limit in 2019. 281 (87%) of these facilities are in areas exceeding the WHO interim $PM_{2.5}$ guideline of 10µg/m^3 and all are in areas exceeding the WHO $PM_{2.5}$ guideline of 5µg/m^3.

Bexley

All care homes in Bexley, except Baugh House, exceed the interim WHO guideline of 10µg/m^3 for $PM_{2.5}$ (highlighted orange below right). All care homes in Bexley exceed the WHO guideline of 10µg/m^3 for NO_2 (highlighted yellow below left). Data are presented in alphabetical order.

Care homes in Bexley	LAEI 2019 Average NO_2 (ug/m3)	LAEI 2019 Average $PM_{2.5}$ (ug/m3)
Abbotsleigh Mews	24.7	10.2
Adelheide Care Home	25.4	10.5
Baugh House	22.9	9.9
Court Lodge	24.7	10.4
Finch Court	23.2	10
Heron Crescent Sheltered Scheme	26	10.3
Heron House	23.3	10
Howard Gable House	23.1	10
Kings House Chrysalis Care Independent Fostering Agency	26.2	10.6
Maples Care Home	25.9	10.5
Meadows Court	23.7	10
Wolsey House	25.8	10.3

Hospitals and medical centres

London Context

Of an estimated 291 hospitals it is estimated that 26 (9%) of these are in locations where the average NO_2 concentration was above the legal limit for NO_2 in 2019. 295 (91%) of these facilities were in areas exceeding the WHO interim $PM_{2.5}$ guideline of 10µg/m^3 and all were in areas exceeding the WHO $PM_{2.5}$ guideline of 5µg/m^3.

Bexley

There is one hospital in Bexley which is within the interim WHO guideline of 10µg/m^3 for $PM_{2.5}$ (highlighted yellow below right) and exceeds the WHO guideline of 10µg/m^3 for NO_2 (highlighted yellow below left).

Hospitals and medical centres	LAEI 2019 Average NO_2 (ug/m3)	LAEI 2019 Average $PM_{2.5}$ (ug/m3)
Queen Mary's Hospital	23.4	9.9

Schools

London Context

Analysis on NO_2 concentration data shows that the following number of each type of educational facilities are in areas of NO_2 exceedance of the legal limit in 2019. Analysis shows that of 3,262 education establishments assessed, 52 (1.6%) are in areas exceeding legal limits for NO_2. Analysis shows that of 2,258 state primary and secondary schools, 20 (0.9%) are in areas exceeding legal limits for NO_2. No schools in Bexley exceed the legal limit for NO_2. The analysis of $PM_{2.5}$ concentrations (based on 150m buffer) indicates that 88% of schools (2,883 establishments) are in areas exceeding the WHO interim guideline of 10µg/m^3 with all exceeding the WHO guideline of 5µg/m^3.

Bexley

76 schools in Bexley exceed the interim WHO guideline of 10µg/m^3 for $PM_{2.5}$ (highlighted orange below right). All schools exceed the WHO guideline of 10µg/m^3 for NO_2 (highlighted yellow below left). Data are presented in alphabetical order.

Schools	LAEI 2019 Average NO_2 (ug/m^3)	LAEI 2019 Average $PM_{2.5}$ (ug/m^3)
Aspire Academy Bexley	24.1	10.2
Barnehurst Infant School	23.2	10.1
Barnehurst Junior School	23.8	10.2
Barrington Primary School	23.7	10.2
Bedonwell Infant and Nursery School	23.3	10.1
Bedonwell Junior School	23.3	10.1
Belmont Academy	23.4	10.1
Belvedere Infant School	23.9	10.2
Belvedere Junior School	24.5	10.3
Benedict House Preparatory School	24.1	10.2
Beths Grammar School	24.7	10.2
Bexley Grammar School	23.8	10.2
Bexleyheath Academy	25.9	10.4
Birkbeck Primary School	24	10.1
Bishop Ridley Church of England VA Primary School	25.2	10.4
Blackfen School for Girls	25.7	10.4
Brampton Primary Academy	24.7	10.3

Schools	LAEI 2019 Average NO_2 (ug/m^3)	LAEI 2019 Average $PM_{2.5}$ (ug/m^3)
Break Through	24.2	10.2
Burnt Oak Junior School	25.1	10.3
Bursted Wood Primary School	22.9	10
Castilion Primary School	24	10
Chatsworth Infant School	23.2	10
Chislehurst and Sidcup Grammar School	24.2	10.2
Christ Church (Erith) CofE Primary School	22.5	9.9
Cleeve Meadow School	22.9	10
Cleeve Park School	22.9	10
Cornerstone School	24.5	10.3
Crook Log Primary School	25.1	10.3
Danson Primary School	23.8	10.2
Days Lane Primary School	23.4	10.1
Dulverton Primary School	23.4	10.1
East Wickham Primary Academy	25	10.4
Eastcote Primary Academy	24.5	10.2
Endeavour Academy Bexley	22.7	9.9
Foster's Primary School	23.8	10.2
Gravel Hill Primary School	28.5	10.6
Haberdashers' Aske's Crayford Academy	22.1	9.8
Haberdashers' Aske's Crayford Temple Grove	22	9.8
Haberdashers' Aske's Slade Green Temple Grove	21.5	9.8
Harris Academy Falconwood	26	10.5
Harris Garrard Academy	23.7	10
Hillsgrove Primary School	23.7	10.2
Holy Trinity Lamorbey Church of England School	24.4	10.2
Hook Lane Primary School	24.7	10.3
Hope Community School	23.2	10
Horizons Academy Bexley	24.5	10.2
Hurst Primary School	23.4	10.1
Hurstmere School	23.8	10.1
Jubilee Primary School	24.3	10.1
King Henry School	22.7	10
Lessness Heath Primary School	24.4	10.3
Longlands Primary School	23.3	10.1
Marlborough School	24	10.1
Mayplace Primary School	22.4	9.8
Merton Court School	23.3	10
Normandy Primary School	22	9.9

Schools	LAEI 2019 Average NO_2 (ug/m^3)	LAEI 2019 Average $PM_{2.5}$ (ug/m^3)
Northumberland Heath Primary School	23.2	10.1
Northwood Primary School	23.3	10
Old Bexley Church of England School	23.2	10
Orchard Primary School	23.5	10.1
Our Lady of the Rosary Catholic Primary School	23.5	10.1
Park View Academy	26.5	10.6
Parkway Primary School	23.4	10
Peareswood Primary School	26	10.6
Pelham Primary School	24.1	10.2
Rose Bruford College	22.8	10
Royal Park Primary Academy	21.8	9.8
Shenstone School	22.9	9.9
Sherwood Park Primary School	24.6	10.2
St Augustine of Canterbury CofE Primary School	23.5	10.1
St Catherine's Catholic School	24.5	10.1
St Columba's Catholic Boys' School	24.7	10.2
St Fidelis Catholic Primary School	24.2	10.2
St John Fisher Catholic Primary School	23.8	10.1
St Joseph's Catholic Primary School	23.1	9.9
St Michael's East Wickham Church of England Primary School	23.4	10.2
St Paulinus Church of England Primary School	25.2	10.2
St Peter Chanel Catholic Primary School	23	9.9
St Stephen's Catholic Primary School	25	10.4
St Thomas More Catholic Primary School	23.5	10.2
St. Paul's (Slade Green) Church of England Primary School	22.1	9.8
Townley Grammar School	26.8	10.5
Trinity Church of England School, Belvedere	23.3	10.1
Upland Primary School	23.6	10.2
Upton Primary School	29.4	11
Welling School	23.8	10.2
West Lodge School	26.3	10.5
Willow Bank Primary School	24.7	10.2
Woodside Academy	22.4	9.9

Appendix 7 Imperial College London study data sources and methodology

Air Quality data was taken from 20m grid data to OA concentration. Particulate matter with diameter <2.5 um ($PM_{2.5}$) and nitrogen dioxide (NO2) annual mean concentrations across Greater London were predicted for a range of years between 2013 and 2050 using the London Air Quality Toolkit (LAQT) model as part of previous studies commissioned and undertaken in partnership with TfL and GLA. These included the "LAEI 2013"[70] , "LAEI 2016"[71] , "2019 snapshot (Dajnak et al., 2020b)", "Low Emission Zone (LEZ) Scenarios", "Ultra Low Emission Zone (ULEZ)"[72], "London Environment Strategy (LES)"[73] and "$PM_{2.5}$ in London: Roadmap to meeting WHO (2005) guidelines by 2030"[74]. $PM_{2.5}$ and NO_2 annual mean concentrations air pollution data were extracted at 20m grid resolution and intersected with the latest Output Area (OA) layer from the Office of National Statistics (ONS)[75] for the Greater London area (a total of 25,053 OAs). Each concentration grid point within each OA was further averaged at OA level.

Population-weighted average concentration (PWAC): Population-weighting was done at LSOA (Lower Super Output Area) and Ward level in the case of the mortality burden and impact calculations, respectively. The OA averaged concentrations were multiplied by the population aged 30 plus for each gender and the resulting population-concentration product summed across all OAs in each LSOA and Ward and then divided by the LSOA and Ward population, respectively. The LSOA and Ward population-weighted means were then used directly in the health impact calculations across all LSOA and Wards in London (This process allows one health calculation per LSOA or Ward rather than calculations in each separate OA).

Previously, burden calculations were based only on concentrations of $PM_{2.5}$ (COMEAP, 2010). The new COMEAP report considers whether there is an additional burden or impact from nitrogen dioxide or other pollutants with which it is closely correlated. The method considers both pollutants together, as correlations between the pollutants mean that health studies in the population for either pollutant alone, actually overlaps with the effects of the other pollutant.

Burden calculations are a snapshot of the burden in one specific year, assuming that concentrations had been the same for many years beforehand. They are not suitable for calculation in several successive years as they do not have a mechanism for allowing the number of deaths the year before to influence the age and population size the following year as the lifetables used in impact calculations do. The current (2019) burden and mortality impacts calculations update the 2010 calculations in Walton et al (2015) with both the new methodology in COMEAP (2018a) and new input data for 2019.

[70] https://data.london.gov.uk/dataset/london-atmospheric-emissions-inventory-2013
[71] London Atmospheric Emissions (LAEI) 2016 - London Datastore
[72] https://consultations.tfl.gov.uk/environment/air-quality-consultation-phase-3b/user_uploads/supporting-information-document-updated-12.12.17.pdf
[73] https://www.london.gov.uk/sites/default/files/london_environment_strategy-_draft_for_public_consultation.pdf
[74] PM2.5 in London: Roadmap to meeting WHO guidelines by 2030 | London City Hall
[75] Statistical GIS Boundary Files for London - London Datastore

Appendix 8 Local Authority population, total deaths from all causes, range of mortality burden (deaths) for $PM_{2.5}$ and NO_2 and mean fraction of mortality attributable to $PM_{2.5}$ and NO_2 in 2019.

Results are presented as an upper and lower range based on the multi pollutant exploratory method.

Local Authority	Population	Total deaths (all causes)	Min Mortality Burden ($PM_{2.5}$ and NO_2)	Max Mortality Burden ($PM_{2.5}$ and NO_2)	Mean Fraction (%) of mortality attributable to $PM_{2.5}$ and NO_2
Barking and Dagenham	112817	1196	84	97	7.6
Barnet	237392	2377	177	201	7.9
Bexley	152358	2030	139	162	7.4
Brent	194987	1695	133	149	8.3
Bromley	214539	2633	172	204	7.1
Camden	148202	1121	99	109	9.2
City of London	5336	39	4	4	10.1
Croydon	234684	2460	168	196	7.4
Ealing	208672	1926	147	165	8.1
Enfield	196590	1999	142	164	7.6
Greenwich	165076	1538	113	129	7.9
Hackney	159657	1051	86	96	8.7
Hammersmith and Fulham	110435	904	74	83	8.7
Haringey	163007	1158	90	101	8.2
Harrow	154615	1459	102	118	7.5
Havering	161093	2372	149	178	6.9
Hillingdon	178404	1941	135	155	7.5
Hounslow	162861	1510	114	128	8.0
Islington	130719	1058	90	100	9.0
Kensington and Chelsea	103440	801	70	77	9.2
Kingston upon Thames	106433	1070	76	87	7.6
Lambeth	188880	1399	112	126	8.5
Lewisham	179928	1491	111	127	8.0
Merton	129272	1204	87	100	7.8
Newham	187014	1271	98	111	8.2
Redbridge	177858	1699	124	142	7.8
Richmond upon Thames	129096	1190	86	98	7.7

Local Authority	Population	Total deaths (all causes)	Min Mortality Burden ($PM_{2.5}$ and NO_2)	Max Mortality Burden ($PM_{2.5}$ and NO_2)	Mean Fraction (%) of mortality attributable to $PM_{2.5}$ and NO_2
Southwark	181281	1327	109	121	8.7
Sutton	129996	1481	101	118	7.4
Tower Hamlets	163630	1039	88	97	8.9
Waltham Forest	163151	1371	102	116	8.0
Wandsworth	194946	1475	115	129	8.3
Westminster	156281	1091	100	110	9.6

Appendix 9 Actions for Londoners to mitigate against air pollution

Travel

- If possible walk, cycle or take public transport rather than travelling by car, and choose less polluted routes, for example by using the GLA's Clean Air Route Finder.
- If you need to drive:
  - ensure that your car is not wasting fuel by regularly checking oil levels and tyres are not flat
  - use eco driving techniques as advised by the Energy Saving Trust [76]
  - avoid idling your engine when stationary
  - consider joining a car club
- If you are buying a car:
  - avoid older diesel cars, as they tend to be more polluting than petrol models
  - buy the most efficient and cleanest vehicle that you can. Look for the car's Euro standard – this is the air pollution standard that the vehicle was constructed to meet, ranging from Euro 1 (worst) to Euro 6 (best). Note, following the ULEZ expansion, diesel cars must be Euro 6 or will be subject to ULEZ daily charge if in the expanded zone.
  - consider purchasing an electric car and benefit from road tax and congestion charge exemption, cheaper fuel costs and government subsidies. From 2030 it will no longer be possible to buy a new conventional internal combustion engine car.
  - Consider if you really need to own a car and if it would be more economical to join a car club

At work

- Develop travel plans to encourage and support employees to use public transport, walk or cycle
- Consider changes to reimbursement arranges that incentivise uptake of more active modes of travel.
- If employees must drive as part of their jobs, organise eco-driving training for them
- Install workplace energy efficiency measures, including replacing old boilers[77]
- Freight operators are encouraged to sign up to TfL's Freight Operator Recognition Scheme which encourages safe and sustainable driving and maintenance practices
- Buy, or hire, the cleanest vehicles available [78]

[76] http://www.energysavingtrust.org.uk/Transport/Consumer/Fuel-efficient-driving
[77] www.green500.co.uk
[78] www.travelfootprint.org

At home

- Turn down the central heating when possible
- Install home energy efficiency measures
- Avoid installing polluting wood-burning stoves (and only use the cleanest approved fuels) and avoid burning garden or domestic waste
- reduce use of household sprays, air fresheners and other aerosols, and always follow product instructions
- if possible, avoid or reduce activities that produce particulate matter such as using open solid-fuel fires or candles and always keep the room well ventilated during these activities
- reduce damp and condensation and prevent mould by:
    - using background ventilation (such as trickle vents, or whole-house mechanical ventilation systems)
    - using mechanical ventilation (such as extractor fans), and opening windows where possible and safe to provide temporary increased ventilation
    - avoiding moisture-producing activities (such as air-drying clothes) indoors if possible, or improving ventilation if these cannot be avoided
    - repairing sources of water damage and ensuring that residual moisture is removed

More advice for improving indoor air quality at home can be found in the NICE guidance.

Appendix 10 LEDNET/ ADPH Recommendations for action to clean up London's air

In light of the COVID-19 pandemic, the Association of Directors of Public Health (ADPH) London and London Environment Directors' Network (LEDNET) have revised their joint position on air quality.[79] They provided the following recommendations for action by a wide range of actors and decision-makers, at national and local levels, to clean up London's air:

- To advocate for at least 2.5% of UK annual GDP to be spent on tackling air quality and climate change in the UK.
- Capitalise on behavioural changes on active travel during COVID-19 pandemic, protect Londoners, particularly children and young people from exposure to poor air quality, and promote further inclusive active travel.
- Support a London-wide shared narrative and campaign on air quality and public health impacts to change perception on how they contribute to air pollution.
- Restrict driving fuelled by petrol or diesel and support cleaner alternatives by supporting schemes such as the ULEZ and scrappage schemes. In addition, support local schemes such as restricted and emissions-based parking, low emissions zones, school streets and Low emission neighbourhoods. Finally, build better walking and cycling infrastructure.
- Support retrofitting schemes of London's residential properties to reduce fuel poverty, address health issues caused by inefficient housing and green the economic recovery from the COVID-19 pandemic.
- Use public sector procurement and social value action to reduce our own contribution to air pollution, particularly by moving faster towards ultra-low and zero emissions vehicle fleets.
- Speak with one voice as boroughs to secure the resources and powers needed to reduce air pollution and protect the health of our residents

[79] https://adph.org.uk/networks/london/wp-content/uploads/2021/03/ADPH-London-LEDNet-Air-Quality-Joint-Position-full.pdf