'Invisible’ air pollution is the second biggest public health risk

Barbican Association
London: 26 April 2012

Simon Birkett, Founder and Director, Clean Air in London

www.twitter.com/CleanAirLondon
http://delicious.com/CleanAirLondon
www.cleanairinlondon.org
Record smog episode: looking to Parliament

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First sighting of Boris’ Pollution Suppressor

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Summary

- Great Smog of 1952
- Is air quality still a problem?
- Health impact in London and nationally
- Schools near our busiest roads
- Legal framework
- Sources of air pollution in London (and elsewhere)
- Key issues
- Manifestos for the Mayoral and London Assembly elections

*London and the UK should be leading the world in tackling air pollution as it did after the Great Smog of 1952*
As many early deaths now as we thought in 1952
Deaths in London attributable to short-term exposure to visible air pollution and long-term exposure to ‘invisible’ air pollution
Great Smog of 1952 – What happened?

- 5-8 December 1952: Great Smog. Estimated 4,075 premature deaths (and perhaps up to 12,000 in total)
- Until the 1960s London suffered from terrible coal smoke smogs
Great Smog of 1952 – What changed?

- The Government failed to act after the Great Smog
- Newspapers, such as The Times, pushed for cleaner air
- First Clean Air Act was a Private Members Bill which the Government later supported reluctantly
- Public and media pressure was instrumental in getting the Clean Air Act passed
- At this point London led the world in the effective control of air pollution
Is air quality still a problem?

• “The rate of decline in some air pollutants is now levelling off and improvements are increasingly costly to achieve. However, air pollution still reduces life expectancy by an **average of six months**, with social costs estimated at £8 to 17 billion per year.” Defra, July 2010. **CAL emphasis**

• “Air pollution in the UK has **declined significantly over recent decades** through measures to reduce pollution from transport, industrial and domestic sources. However, the rate of reduction is now levelling off for some key pollutants such as oxides of nitrogen.” Defra, December 2010

• **“Our air – air quality is good across 99% of the UK, but air pollution continues to harm human health particularly in some urban areas.”** Defra, July 2010

• “Air pollution shouldn’t harm you if you’re healthy.” Some health alerts
‘Epidemiology 101’ – Public health statistics

• Public health risks:
  – “There are between 15,000 and 22,000 alcohol-related deaths every year in England. Most of these deaths are premature: on average, every man in this group loses 20 and every woman 15 years of life compared with the average.” DoH, June 2008
  – “Obesity is responsible for 9,000 premature deaths each year in England, and reduces life expectancy by, on average, 9 years.” DoH, September 2007
  – “Smoking is responsible for 87,000 deaths in England each year.” DoH, December 2008. “Men who quit smoking by 30 added 10 years to their life.” NHS, July 2010

• 2,222 people killed in road accidents in GB in 2009. DfT, 2010

• Using the same ‘language’, there were 29,000 premature deaths in the UK in 2008 attributable to long-term exposure to anthropogenic (i.e. man-made) PM$_{2.5}$ at an average loss of life of 11.5 years
Health impact in London and nationally

Short-term exposure

**COMEAP 1998** (based on 1995/1996 pollution levels)
- **8,100** GB urban ‘deaths brought forward’ annually due to PM$_{10}$ (using +0.75% per 10 µg/m$^3$, 24 hour mean)
- **3,500** GB urban ‘deaths brought forward’ annually due to SO$_2$ (using +0.6% per 10 µg/m$^3$, 24 hour mean)
- **700 to 12,500** urban and rural GB ‘deaths brought forward’ during summer only due to O$_3$ (+3.0% per 50µg/m$^3$, 8 hour mean)

**Long-term exposure**

**COMEAP 2010**
- **29,000** premature deaths in the UK in 2008 attributable to long-term exposure to anthropogenic PM$_{2.5}$ (6% per 10 µg/m$^3$ increase in [annual mean] PM$_{2.5}$)
- 36.5 million life years over the next 100 years. Average across new births of six months
- Air pollution may have contributed to all 200,000 cardiovascular deaths at an average of two years

**National range**
- **29,000 to 53,100** premature deaths attributable to air pollution

**London**
- **4,267** premature deaths in 2008 attributable to long-term exposure to PM$_{2.5}$. Ave 11.5 yrs
- Range 756 (1%) to 7,965 (12%). Assumes population weighted exposure of 15.34 µg/m$^3$
- Air pollution may have contributed to 15,800 cardiovascular deaths at ave three years
London schools within 150m and 400m of busy roads

*Roads carrying over 100,000 vehicles per day*
### EU legal standards compared to WHO guidelines

<table>
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<th>Pollutant</th>
<th>Legal standard</th>
<th>WHO guideline</th>
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</table>
| **Fine particulate matter (PM$_{2.5}$)** | 1. 25 µg/m$^3$ annual mean to become limit value in 2015  
2. 20 µg/m$^3$ exposure concentration obligation based on 3-year average  
3. Exposure reduction target in percentage by 2020 | 25 µg/m$^3$  
24-hour mean |
| **Particulate matter (PM$_{10}$)**  | 35 days over 50 µg/m$^3$ since 1 January 2005 (or 11 June 2011)  
40 µg/m$^3$ since 1 January 2005 (or 11 June 2011) | 50 µg/m$^3$  
24-hour mean  
20 µg/m$^3$ |
| **Nitrogen dioxide (NO$_2$)**       | 18 hours over 200 µg/m$^3$ since 1 January 2010  
40 µg/m$^3$ since 1 January 2010 | 200 µg/m$^3$  
40 µg/m$^3$ |
Concentration and trends – Mayor’s Air Quality Strategy
NO$_2$ annual mean concentrations for 2008
Concentrations of nitrogen dioxide (NO$_2$) in micrograms per cubic metre (µg/m$^3$)

- EU limit value for NO$_2$ from 1 January 2010
- Required NO$_2$ reduction
- EU limit value plus margin of tolerance for NO$_2$ from 1 January 2010
Sources of air pollution in London

*Mayor’s Air Quality Strategy 2010*

- Emissions (not concentrations). Based on 2008 estimates
- $\text{PM}_{10}$ (Central London)
  - Road transport 79%. Cars 23%; taxis 20%; LGVs 10%. Buses <10%
  - Tyre and brake wear 35%
- $\text{PM}_{2.5}$ (Greater London)
  - Road transport 80%; industrial and commercial gas combustion
  - LGV, cars and taxis 20% each. Buses 5%
  - Tyre and brake wear 25%
- Oxides of nitrogen
  - Road transport 46%; domestic gas 22%
  - Commercial gas, industry, airport and rail 7-8%
  - Cars 35%; HGVs 30%; buses 21%
- DfT 2009: Diesel versus petrol cars (g/mile): 21.7x $\text{PM}_{10}$; 2.1x NOx
Key issues

• Mayoral election
  – Pollution Suppressor
  – Smog alerts
  – Commitments. Boris’s backward steps and lack of promises

• Legal compliance with PM$_{10}$ and NO$_2$ legal standards

• Olympic and Paralympic Games
  – Olympic Route Network
  – Impact of smog episodes like 2003 or 2006

• Health and Wellbeing Boards

• Year of Air in 2013
Key issues: Smog episodes in 2012

Particle concentration distribution
Smog episodes in 2012 and cleanest air recorded: Particle number per cubic metre with diameter over 0.3 microns

Test time: 1 minute
Temperature: 9-10°C
Relative humidity: 24-31%
Particle concentration distribution

Barricade: Particle number per cubic metre with diameter over 0.3 microns

Test time: 1 minute
Temperature: 14-18°C
Relative humidity: 30-50%

- City of London School for Girls entrance_Total 325,748,408 particles/m³
- Barricade Underground exit_Total 376,735,335 particles/m³
- Beech Street_Westbound queue_Total 337,670,672 particles/m³
- Beech Street_Garchey Bay_Total 340,451,590 particles/m³
- Lauderdale_32_Lift lobby_Total 234,706,008 particles/m³
- Lauderdale_32_Sitting room_Total 278,117,315 particles/m³
- Lauderdale_32_Balcony south facing_Total 107,254,770 particles/m³

AirTEXT
http://www.airtext.info/
Defra
London Air Quality Network
London Air Quality Network episodes
http://www.londonair.org.uk/LondonAir/asp/publicepisodes.asp?region=0
BBC 5 day forecast
http://www.bbc.co.uk/weather/26137441
Met Office surface pressure forecast
http://www.metoffice.gov.uk/weather/uk/surface_pressure.html
Two week weather forecast
http://www.timeanddate.com/weather/uk/london/est
Particle concentration distribution
Home office on 7 March 2012

- Blue line: Home office - Before filtration
- Red line: Home office - After filtration (one hour)
Key issues: Year of Air in 2013
UK has highest % age of zones exceeding LV+MOT

Nitrogen dioxide 2009
Annual limit value for the protection of human health
- limit value
- Limit value - margin of tolerance
- > margin of tolerance
- Zone designated, data missing
- Area not designated
- Geospatial information missing
- Outside data coverage

London: 26 April 2012
Clean Air in London
Key issues: Manifesto for ‘clean air in London’

Mayoral candidates must promise to:

• Lead the fight to improve London’s air
• Clean up London’s transport
• Build a low emission city
• Protect the most vulnerable
• Ensure a legacy from the Olympic Games

*Clean Air in London intends to rank the candidates before the Mayoral election*
The vision: Clean air urgently and sustainably in all large cities

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Summary

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‘Epidemiology 101’ – Protecting public health

• “Since 1900, the average lifespan of persons in the United States has lengthened by over 30 years; 25 years of this gain are attributable to advances in public health”, Journal of the American Medical Association, 1999

• “Public health experts agree that environmental risks constitute 25% of the burden of disease”. WHO, 2011
Is air quality still a problem? Yes!

- Great Smog: 4,075 early deaths attributable to short-term exposure to ‘visible’ air pollution. No understanding of health impacts of long-term exposure to air pollution until mid-1990s and later. Only smoking causes more early deaths.

- March 2010: Mayor Johnson estimates 4,267 premature deaths in London in 2008 attributable to long-term exposure to ‘invisible’ PM$_{2.5}$.

- Traffic related air pollution may be responsible for 15-30% of all new cases of asthma in children. Note: the most vulnerable may be exposed to up to 50% more air pollution than the least vulnerable.

- Air pollution concentrations have been broadly unchanged since the late 1990s. Using the same language used for alcoholism, obesity and smoking, the average loss of life is 11.5 years. We live in the ‘1%’.

- “We now need Mayor Johnson and the Government to play their part in tackling an invisible public health crisis with as many early deaths attributable to air pollution in London in 2008 as we thought occurred during the Great Smog of 1952.” Simon Birkett, TIME.com, April 2011.
‘Epidemiology 101’ – An introduction to ‘air quality’

• Several ambient air pollutants
  – Nitrogen dioxide (NO₂)
  – Tropospheric ozone (O₃)
  – Particulate matter: ultrafine (PM₀.₁); fine (PM₂.₅); coarse (PM₂.₅-10) and PM₁₀
  – Sulphur dioxide (SO₂)
  – Others e.g. benzene

• Mortality (death) and morbidity (sickness). Acute (short time) and chronic (long time)
• Size matters. Smaller particles penetrate deeper into lungs and bloodstream
• Toxicity matters. So don’t just worry about PM₂.₅
• Time scale matters. ‘Time series’ studies to assess short-term. ‘Cohort’ for long-term
• Unknown degree of overlap between pollutants and time scales
• Anthropogenic (man-made) vs non-anthropogenic air pollution
• Population weighted exposures have been based on residency not personal exposure
• Concentration response function is not linear. Impact on those aged 30+. Children
• Relative risk (hazards rates); year (of life) lost; average years lost per victim; and average nationally
Key messages

• As many early deaths in London in 2008 attributable to long-term exposure to ‘invisible’ air pollution as we thought occurred in the Great Smog of 1952 due to short-term ‘visible’ air pollution
• Scientists didn’t know about long-term impacts until mid-1990s and later
• Health impacts: cardiovascular, respiratory, cancer and asthma
• Only smoking causes more early deaths than air pollution
• Traffic related air pollution may be responsible for 15-30% of all new cases of asthma in children
• We are in a communications ‘battle’ with those seeking delay (including some in Government)
  – “We agree with your objective but not with the timescale to get there”
• We must use metrics that relate to those well established for alcoholism, obesity and smoking etc. We must speak the same ‘language’
• People want and deserve to understand the risks they face. Children and the elderly are particularly vulnerable. Inequalities are a particular concern
• There is a tremendous opportunity for London to lead the world again
Links between urban ambient particulate matter and health – time series analysis of particle metrics

R Atkinson¹, Ross Anderson¹, Gary Fuller², Ben Armstrong³, Roy Harrison⁴
¹ St George’s University of London, ² King’s College London, ³ London School of Hygiene & Tropical Medicine, ⁴ University of Birmingham

Introduction

- Many epidemiological studies have reported associations between outdoor particulate matter and adverse health effects.
- Particulate matter is a mixture of particles of varying size, number and composition and the nature of this mixture varies according to emission sources, secondary chemical reactions in the atmosphere, weather conditions and other factors.
- For the protection of public health it would be desirable to know which component of the particulate mixture to target with regulation.
- The purpose of this study was to analyse, using time series methods, the health effects of various particle metrics within London and to identify which of the particle metrics are most important for health impact considerations.

Method

- Daily measurements for carbon, nitrate, sulphate, chloride and particle number concentrations made at North Kensington (NK) were obtained for the period 1st January 2000 to 31st December 2005. Mass measurements of PM₁₀ (particles with a median diameter of 10 microns or less) and PM₂.₅ made using different measurement technologies were also obtained.
- Daily counts of deaths and emergency hospital admissions for respiratory and cardiovascular disease were also compiled.
- Time series regression methods accounting for seasonal patterns in deaths/admissions, temperature, and other potential confounders were used to evaluate the associations between each particle metric and the health endpoints.
- The analysis focused on days when data were available for all pollutants (695 days).
- Results are presented as percentage increase in the average number of daily deaths per interquartile range increase in particle metric.

Results

- Results for deaths due to cardiovascular and respiratory mortality are shown in Figures 1 and 2.
- A specific association between particle number concentrations and deaths due to cardiovascular disease was observed. This association was independent of other metrics and was also observed for admissions for cardiovascular diseases (not shown).
- Respiratory mortality was associated with a range of metrics most notably the mass based measurements (PM₁₀ and PM₂.₅). A similar pattern of associations for respiratory admissions was also observed.

Conclusions

- Preliminary conclusions from these analyses suggest that particle numbers (predominantly very fine particles) are the most relevant particle metrics in terms of cardiovascular disease.
- Deaths and admissions from respiratory disease were associated with a range of particle metrics and is less clear which metrics are the most relevant. Further work is underway to investigate this issue.

Acknowledgements

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University of Birmingham

Appendix

Relationship between central site measurements and personal exposure

- A further component of this study was to examine the relationship between central site measurements and personal exposure to various PM metrics using published work and results from the KUHIOH study.
- This analysis helps inform the evidence from ecological time series studies based upon pollution data collected at a single location within a city.
- The key finding relevant to this ecological time series study was that there were substantial longitudinal correlations between outdoor measurements (central or home) and personal exposure (PM₁₀ & PM₂.₅).
Don’t forget indoor air quality:
We can protect ourselves from up to 90% of air pollutants

If your hospital or workplace has a mechanical ventilation system or air conditioning (i.e. it is likely to contain the necessary ducting) please ask:

“Does our ventilation system include regularly maintained air filters that comply with European standard EN 13779 and, if not, why not?”

Any questions: visit www.camfilfarr.co.uk a sponsor of Clean Air in London or call 01706 238 000

Note: a building may have air conditioning but not ventilation or air filters (and/or vice versa)
Air pollution – How bad is it?
London Air Quality Network: Neasden Lane

[Image of a webpage from the London Air Quality Network showing monitoring statistics and maps.]

London: 26 April 2012
Clean Air in London
Air pollution – How bad is it?
London Air Quality Network: Marylebone Road

London: 26 April 2012
Clean Air in London
Air pollution – How bad is it?
London Air Quality Network: Marylebone Road

London: 26 April 2012
Clean Air in London
Air pollution – How bad is it?
London Air Quality Network: Euston Road

London: Euston Road
London: April 26, 2012
Clean Air in London 34
Air pollution – How bad is it?
London Air Quality Network: Euston Road

London: 26 April 2012
Clean Air in London
Table 1: Summary of exceedance of NO$_2$ limit values and date of expected compliance by zone.

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<th>Zone/Agglomeration</th>
<th>2008 baseline</th>
<th>Km of road exceeding annual limit value</th>
<th>Projected Km of road exceeding annual limit value in 2010</th>
<th>2008 baseline</th>
<th>Postponement of the compliance date required? (Yes/No)</th>
<th>Compliance with NO$_2$ limits projected by</th>
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## UK Plans and Programmes for NO$_2$: page 2

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<td>2015</td>
<td>✓</td>
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<td>2020</td>
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## UK Plans and Programmes for NO$_2$: page 3

<table>
<thead>
<tr>
<th>Region</th>
<th>LEZ Status</th>
<th>In-City Zone</th>
<th>Roadside Zone</th>
<th>LEZ Status in 2020</th>
<th>Early Indication</th>
<th>Note</th>
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<td>North West &amp; Mersyside</td>
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<td>210</td>
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<td>✓</td>
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<td>7</td>
<td>Yes</td>
<td>&lt;2015</td>
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<td>Highland</td>
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<td>19</td>
<td>No</td>
<td>2020</td>
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<td>Northern Ireland</td>
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<td>27</td>
<td>3</td>
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<td>≤2015</td>
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<td></td>
<td>40</td>
<td>40</td>
<td>2303</td>
<td>3</td>
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</table>

n/a refers to the fact that the LEZ scenario has not been applied in the zone.

*Projections show a chance of compliance by 2010 but projection uncertainties mean the confidence is low. Early indication from the 2010 assessment of air quality for the UK supports this judgement for all these zones.

≤2015 means by 2015 or possibly before
Record smog episode: looking to Canary Wharf

© 2012 Simon Birkett and Clean Air in Cities Limited
Record smog episode: looking to City Hall

© 2012 Simon Birkett and Clean Air in Cities Limited
Key issues: The Pollution Suppressor

http://youtu.be/WUkvGkD0yYA
Key issues: The Pollution Suppressor
“Each year, as the weather gets warmer, there is a possibility of some air pollutants reaching higher levels for short periods of time, especially if there is still, sunny weather. Whilst most people will not be affected by short term peaks in air pollution, some people, particularly vulnerable groups such as those with existing heart or lung conditions, may experience increased symptoms.

“Defra encourages people to take sensible precautions based on the levels of air pollution in their region and their health, such as reducing or avoiding strenuous activity and ensuring they have access to their usual medication, such as asthma inhalers.

“Find out what the air quality is like in your region via the following link: http://uk-air.defra.gov.uk or by calling Defra’s freephone helpline on 0800 556677. These sources also offer health advice based on current air pollution levels to the general public and those who may be particularly sensitive to air pollution. You can subscribe through the website to email bulletins for pollution forecasts and latest pollution information.”
Key issues: Legal compliance for $PM_{10}$ and $NO_2$

- Clean Air in London’s complaint to European Commission
  - $PM_{10}$ time extension until 2011 was unlawful
  - Even if sustained, it was breached in Neasden Lane in 2011
  - $NO_2$ limit values breached in 40 of 43 UK zones in 2010
  - No time extension sought for 17 zones. London by 2025!
- Clean Air in London’s Environmental Information case
- Infraction action in five stages
  - First and second written warning. CJEU. Second written warning. Unlimited lump sum and daily CJEU fines
  - Infraction against UK for $PM_{10}$ is currently frozen between stages 2 and 3. Note: Localism Act allows transfer of fines
- ClientEarth legal case against Defra
Key issues: Olympics and Paralympic Games

• Olympic Route Network
  – Admit it will cause local, temporary and unmitigated breaches of NO$_2$ air quality laws (and PM$_{10}$?)
  – Marylebone Road on 25/35 Bad Air Days
  – Marylebone Road FDMS station on 17/35 Bad Air Days
  – Upper Thames Street on 29/35 Bad Air Days. Loss of power
  – Plan to use Pollution Suppressor to mitigate PM$_{10}$
• Possible impact a smog episode like 2003 or 2006
Key issues: Health and Wellbeing Boards

Public health outcomes framework 2013-2016

• Metrics for Health and Wellbeing Boards from 2013 include Domain 3: Health protection; 3.1 Air pollution:

“The mortality effect of anthropogenic particulate air pollution (measured as fine particulate matter, PM$_{2.5}$) per 100,000 population”

• Mortality Burden: To be expressed as attributable deaths and associated years of life lost
Attributable deaths by London borough in 2008

Inner London has highest pollution. Outer London shows more early deaths as borough size is bigger (incl. non-anthropogenic)

<table>
<thead>
<tr>
<th>Boroughs ranked by average concentration of PM2.5</th>
<th>Boroughs ranked by total estimated premature deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tot pop</td>
<td>PM2.5</td>
</tr>
<tr>
<td>City of London</td>
<td>0.155</td>
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<tr>
<td>Westminster</td>
<td>214.750</td>
</tr>
<tr>
<td>Camden</td>
<td>207.166</td>
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<tr>
<td>Kensington and Chelsea</td>
<td>169.015</td>
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<tr>
<td>Tower Hamlets</td>
<td>231.664</td>
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<tr>
<td>Islington</td>
<td>195.114</td>
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<tr>
<td>Waltham Forest</td>
<td>226.706</td>
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<tr>
<td>Southwark</td>
<td>276.836</td>
</tr>
<tr>
<td>Hammersmith and Fulham</td>
<td>178.856</td>
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<tr>
<td>Hackney</td>
<td>223.357</td>
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<tr>
<td>Lambeth</td>
<td>201.783</td>
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<td>Wandsworth</td>
<td>200.051</td>
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<td>201.651</td>
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<tr>
<td>Enfield</td>
<td>251.256</td>
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<tr>
<td>Barking</td>
<td>317.721</td>
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<td>Ealing</td>
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<tr>
<td>Lewisham</td>
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<td>Hounslow</td>
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<td>Barnet</td>
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<td>Beckenham and Dagenham</td>
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<td>Havering</td>
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</tbody>
</table>

Greater London (per CCAL) 7,073,219 4,271

Greater London (per Mayor) 7,073,217 4,267

Note: Provisional calculations prepared by Campaign for Clean Air in London (30 June 2010 as at 12 noon)
Key issues: Year of Air in 2013
We need continuity and the tightening of health and legal protections

Working in partnership with other Member States, we will also use the European Commission review of air quality legislation, expected in 2013, to seek:

• Amendments to the Air Quality Directive which reduce the infraction risk faced by most Member States, especially in relation to nitrogen dioxide provisions.
• Simplifications to the legal framework (e.g. through reducing requirements for Member States) to reduce costs and administrative burdens to local authorities and businesses whilst maintaining or improving health and ecosystem protection.
• Requirements that are strictly proportional to evidence on costs and benefits.

*Defra, Red Tape Challenge, Environment Theme proposals (19 March 2012)*