

Imperial College
London
Projects

Environmental
Research Group

Breathe London network report April – June 2021

Gary Fuller, Timothy Baker, Robert Hepburn, David Green,
Andrew Grieve, Ben Barratt.

Environmental Research Group, Imperial College London

The Environmental Research Group

Founded in the early 1990s, the Environmental Research Group (ERG) is internationally renowned for its work on air quality. The ERG's approach to tackling air pollution is extensive, covering air quality measurement and modelling, testing and deploying portable sensors and policy development. The ERG established and continues to operate the London Air Quality Network, Europe's most advanced air quality monitoring network, with over 100 stations providing a comprehensive picture of air pollution across London. The ERG works closely with government at all levels to shape policy around air pollution. Over the last 15 years all major air pollution strategies in London, including the congestion charging scheme, have been devised and tested using emissions and air pollution models developed by ERG. It was the first UK organisation to make air quality information publicly available online, leading the way for the development of air quality apps used by thousands every day. The Environmental Research Group is led by Professor Frank Kelly, Humphrey Battcock Chair of Environment and Health. It is part of the School of Public Health at Imperial College London.

Contents

Summary of key performance indicators	4
1. Introduction	5
2. Deployment of nodes	5
KPI: Install, maintain and insure air quality sensors at 100+ sites	5
3. Quality assurance and quality control.....	6
KPI: Demonstrate sensors continue to meet the uncertainty requirements of the EU Air Quality Directive for indicative (Class 1) methods for particulate matter (PM _{2.5}) and nitrogen dioxide (NO ₂)	6
4. Data capture	7
KPI: Ensure a minimum 90% of sensors are in operation at any given time.....	7
5. Network expansion.....	8
KPI: Increase the number of sensors in the network by an additional 5% per year by allowing the website to integrate data from sensors owned by Londoners, businesses and organisations	8
6. Website development.....	8
KPI: Website must be live continuously and display data in real time from the sensors	8
7. Application Programming Interface.....	8
KPI: Data must also be available via an Application Programming Interface (API).....	8

Summary of key performance indicators

This is the second quarterly report detailing work undertaken by the Environmental Research Group to deliver the Breathe London network contract awarded by the GLA in December 2020.

Work is described in relation to seven key performance indicators (KPIs), as specified in the contract and summarised in Table 1. The report is not intended to be an exhaustive description of the network and its outputs, which will be captured on the network website (www.breathelondon.org) and in associated reports.

This report delivers the seventh KPI: “Network evaluation report to be produced every 3 months including performance of sensors (e.g., number online, number of QA/QC issues) and number of visits to the website”

Table 1: Summary of key performance indicators.

KPI	Target	Status
Install, maintain and insure air quality sensors at 100+ sites	100+	71
Demonstrate sensors continue to meet the uncertainty requirements of the EU Air Quality Directive for indicative (Class 1) methods for particulate matter (PM _{2.5}) and nitrogen dioxide (NO ₂)	NO ₂ : 25% uncertainty PM _{2.5} : 50% uncertainty	NO ₂ : 25% uncertainty PM _{2.5} : 29% uncertainty (network means)
Ensure a minimum 90% of sensors are in operation at any given time	100% of hours	99.2% of hours
Increase the number of sensors in the network by an additional 5% per year by allowing the website to integrate data from sensors owned by Londoners, businesses and organisations	5% expansion by January 2022	n.a.
Website must be live continuously and display data in real time from the sensors	End of March 2021	Launched 15 th March 2021
Data must also be available via an Application Programming Interface (API)	Not specified	API complete. Launching end 2021

1. Introduction

Breathe London is a new partnership between the Mayor of London, Imperial College London (facilitated via Imperial Projects) and Bloomberg Philanthropies. The Mayor is providing funding for 130 air quality sensor nodes to be installed at hospitals, schools and other priority locations which will be displayed on the new website – www.breathelondon.org.

Community groups, charities, businesses, individuals, academics, and boroughs will also be able to “buy in” to the Breathe London network to source air pollution data for local projects or schemes.

This report summarises progress on building the network during April to June 2021.

2. Deployment of nodes

KPI: Install, maintain and insure air quality sensors at 100+ sites

71 GLA sponsored nodes were deployed by the end of June 2021, as shown in Table 2. These nodes comprise of a mix of locations, including schools, hospitals, reference site co-locations, London Borough community placements and other areas of interest.

The COVID-19 pandemic and associated lock downs continued to have significant impact on the selection of node locations and subsequent deployments. ERG staff were limited to remote working and access to facilities was severely restricted. Many of those assigned nodes in local authorities and other organisations were working remote to their offices with limited access to the relevant neighbourhoods. Furthermore, wider pandemic-related responsibilities diverted borough officers away from node deployment to more critical roles. Despite this, 71 nodes were checked, calibrated and deployed during the first six months of the contract.

Further delays were caused by restricted access to installation locations at school sites carried over from the Breathe London pilot network.

Table 2: Number of GLA sponsored nodes deployed and in operation in each London Borough as of June 2021

London Borough	Number of nodes
Barking and Dagenham	0
Barnet	2
Bexley	2
Brent	1
Bromley	0
Camden	2
City of London	2
Croydon	2
Ealing	1
Enfield	0

Greenwich	8
Hackney	1
Hammersmith and Fulham	1
Haringey	3
Harrow	0
Havering	2
Hillingdon	1
Hounslow	1
Islington	2
Kensington and Chelsea	6
Kingston	1
Lambeth	2
Lewisham	6
Merton	0
Newham	1
Redbridge	3
Richmond	1
Southwark	4
Sutton	2
Tower Hamlets	6
Waltham Forest	1
Wandsworth	3
City of Westminster	4
Total	71

3. Quality assurance and quality control

KPI: Demonstrate sensors continue to meet the uncertainty requirements of the EU Air Quality Directive for indicative (Class 1) methods for particulate matter (PM_{2.5}) and nitrogen dioxide (NO₂)

The calibration and scaling process applied to Breathe London nodes is described in the first quarterly report (available at <https://www.breathelondon.org/network-reports>). These methods continue to be improved and developed and will be published in a peer reviewed scientific journal in due course.

The impact of the corrections applied to the nodes will be assessed using the methodology recommended in EU guidance. The uncertainty is calculated at the hourly limit value (200 µg m⁻³) for NO₂ and the indicative threshold is 25%, the uncertainty for PM_{2.5} is calculated at the suggested daily limit value of 35 µg m⁻³ and the indicative threshold is 50%.

Prior to deployment each node is co-located at the Honor Oak Park London Supersite for 10-14 days. Following a two day stabilisation period, these data are used to calculate a linear

This report is the independent expert opinion of the author(s).

correction algorithm generated from the node and the reference instrument, which is applied to all subsequent data at the node's destination location. Uncertainty is calculated by comparing calibrated node performance against the reference instrument.

Network mean uncertainty at the EU Limit Value across the quarter is shown in Table 3. These percentages are based on all nodes passing through the co-location calibration process up to the end of June 2021.

While the network mean for both species fell within the uncertainty targets, a small proportion of individual nodes did not meet the targets. These individual nodes will be further investigated and replacement and/or additional calibrations carried out where necessary. These results highlight the need for correction methods beyond standard linear correction for small sensors, particularly NO₂. To address this, we are currently developing a second stage correction algorithm to account for uncertainties arising from variable environmental conditions after deployment. This dynamic algorithm utilised data from 18 nodes permanently co-located with a range of LAQN reference sites. The impact of applying this dynamic correction method on uncertainty will be presented in future reports.

Table 3: Uncertainty targets for indicative methods and corresponding uncertainties at the EU Limit Values¹

Pollutant	Target uncertainty (%)	Mean measured uncertainty (%)	Proportion of nodes not achieving target (%)
NO ₂	25	25	20
PM _{2.5}	50	29	2

4. Data capture

KPI: Ensure a minimum 90% of sensors are in operation at any given time

The data collection system created to interface between the nodes and Breathe London website is described in the first quarterly report (available at <https://www.breathelondon.org/network-reports>).

Data capture across the quarter is shown in Table 4. These percentages are based on a count of all valid hourly mean concentrations recorded by nodes deployed at permanent sites (i.e., not undergoing calibration at reference sites) throughout the period April to June 2021. All data from all deployed nodes pass through a series of automated quality checks, confirmed by regular manual check by Imperial analysts. Invalid data are excluded prior to calculation of data capture rates.

Table 4: Data capture over the reporting period for deployed nodes

Pollutant	Network mean data capture (%)	Hours with 90% of nodes in operation (%)
NO ₂	99.8	99.2
PM _{2.5}	99.8	99.2

¹ Unlike reference instruments, sensor uncertainty can change retrospectively with the application of new correction algorithms and rescaling of historical data.

This report is the independent expert opinion of the author(s).

5. Network expansion

KPI: Increase the number of sensors in the network by an additional 5% per year by allowing the website to integrate data from sensors owned by Londoners, businesses and organisations

Expansion of the network was restricted while the first 130 GLA sponsored nodes were deployed. However, the GLA agreed to an exceptional expansion of nodes funded by the South London Partnership – a sub-regional collaboration of five London boroughs: Croydon, Kingston upon Thames, Merton, Richmond upon Thames and Sutton – to deliver the InnovaTe Project, which will link co-located air quality and traffic count data gathered outside of schools. The first 13 SLP nodes were installed during this reporting period, representing a network expansion of 10%.

Additional funding provided by Bloomberg Philanthropies to provide free nodes to disadvantaged communities was described in the first quarterly report (available at <https://www.breathelondon.org/network-reports>). The Breathe London Community Programme is due to launch in October 2021.

6. Website development

KPI: Website must be live continuously and display data in real time from the sensors

The website launched on 15th March with a live map showing the location and current daily air quality index of each deployed node alongside a selectable layer of LondonAir reference sites. Further details were provided in the first quarterly report. There were no further developments to the website during this reporting period.

There was a total of 5,200 visits to the breathelondon.org website between April and June 2021, peaking at 600 weekly visits (Figure 1).

7. Application Programming Interface

KPI: Data must also be available via an Application Programming Interface (API)

An Application Programming Interface (API) for Breathe London data has been developed, but its launch was put on hold until the second stage correction algorithm described in Section 3.

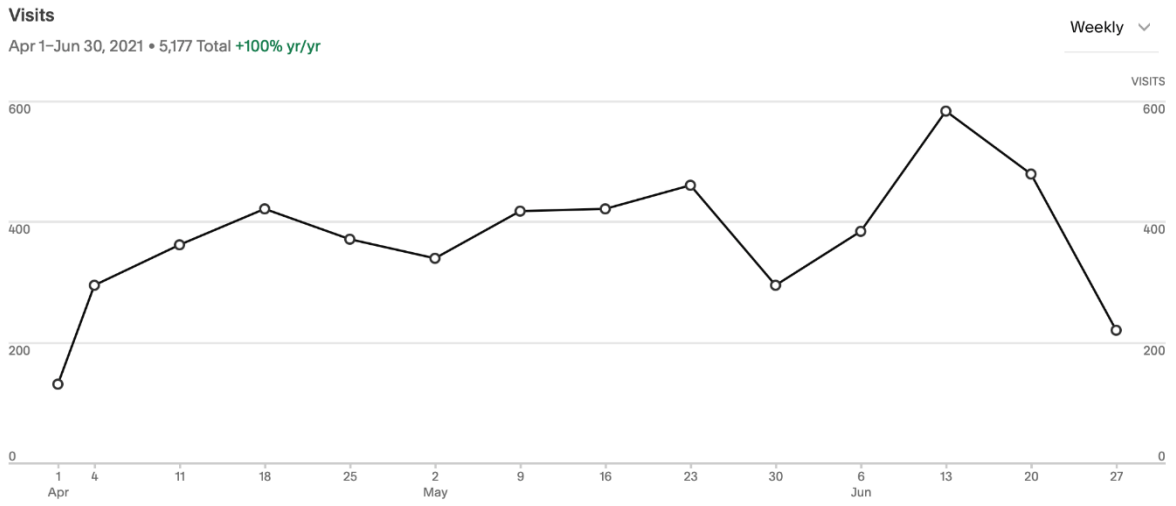


Figure 1: Weekly timeseries of visits to the breathelondon.org website

**Imperial College
London**
Projects

**Environmental
Research Group**

Contact us:

Natasha Ahuja, Project Manager.
Email: n.ahuja@imperial.ac.uk

Imperial Projects is a wholly owned company of Imperial College London