Imperial College London
Projects

Environmental Research Group

2nd (update) report relating to fires at Arnolds Field on Launders Lane in Rainham, Havering

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Contents

1 Introduction

The former gravel pit known as Arnolds Field is a located on Launders Lane in the vicinity of Rainham in the London Borough of Havering. The site was used as a regulated general landfill site for the period 1967 to 1971. In 2000 planning permission was granted to convert the site to community woodland however waste continued to be dumped at the site illegally. Uncontrolled dumping has led to a buildup up of material at the site with limited information on its composition. Waste has ignited on a number of occasions with a noted increase since 2018.These fires have led to complaints from local residents with continuing concern regarding potential health impacts of any exposure to this smoke. In early 2023 the London Borough of Havering (LBH) commissioned the Environmental Research Group- measurement team (ERG-M) at Imperial College London to measure and analyse ambient air pollution (using $PM_{2.5}$ and NO_2 as representative species) in the area around Arnolds Field. The overall aim being to generate, explore and interpret this data to identify any relationship between reported occurrence of fires at the Arnolds Field site and overall air quality in the local area.

This study uses a mix of existing measurement resources and additional monitoring sponsored by LBH and others. This additional monitoring was specifically located to augment existing capability and provide data in areas identified as likely to provide additional information on local conditions or where monitoring is required to gain a better understanding of the issue and any effects on ambient air quality. In parallel to this, the Transport Research Laboratory (TRL) were commissioned by LBH to undertake specific monitoring to identify any directly hazardous and toxic substances being emitted.

An initial report was produced in 2022 which was based on analysis of data from a local pre-existing reference grade monitoring site. This analysis demonstrated that intermittent fire events potentially had a detectable impact on particulate air pollution. This initial report also recommended the positioning of further monitoring infrastructure around Arnolds Field site to help better characterise local air quality. Additional Breathe London Communities sensor nodes were installed in 2022 and this second report seeks to quantify the potential impact of fires from October 2022 onwards based on data collected from these nodes.

2 Details and location of fires

2.1 Arnolds Field area fires

The study site is shown in figure 1 with the Arnolds Field site and approximate local residential areas potentially affected by fire emissions highlighted. Residential areas are mainly located to the north-west and west of Arnolds Field with the closest homes approximately 600m away from the former landfill site. An additional residential area was identified to the south-east but at a greater relative distance (approx. 2km) from where the fires are reported.

Figure 1: Map showing the Location of Arnolds Field fires and residential areas to the north-west, west and south-east.

The London Fire Brigade provided available records of callouts to incidents in the Arnolds Field area. Only a small number of events that may relate to the Arnolds Field site were recorded before 2018 so callouts to incidents has only been considered from 2019. The records received by ERG span the period 2019 - 2024. Fire records include the time of the call, the end time of Fire Brigade involvement, whether the fire is primary or secondary, the location and the type of land or property affected. For the purpose of this report, any fires described as affecting landfill site, wasteland, scrub land or heathland have been considered as possibly relating to the Arnolds Field waste site. The number of days each year affected by such events are shown in Table 1 (as reported in The London Borough of Havering Report “Possible Health Impact of Fires at Launders Lane: Time Series Analysis of Fires and Use of Health Care”).

Year	Total Number of days with fire
2018	1
2019	14
2020	17
2021	16
2022	36
2023	15
2024	18

Table 1: Number of days affected by fires that may relate to the Arnolds Field waste site in each year between 1st January 2018 and December 2024. This is limited for the post 2022 period as detailed reporting in the same detail and format was not available at the time of writing this report.

2.2 Fire reporting 2023 and 2024

Details of the fires recorded in the Arnolds Field area by London Fire Brigade in 2023 and 2024 are shown in Table 2. Over this 2 year period very few fires were documented on the London Fire Brigade incident website incidents reporting portal[i]. This repository reflects only significant or selected fires attended by the London Fire Brigade and is not a comprehensive log of all burning events at the Arnolds Field site i.e. this resource was used as a commentary on recorded burning events, not to count all burning events. Additional fire incidence data was provided for the period Jan 2023 to August 2024 and is presented in table 3. For 2023 details of the fires from this repository were related to Fire Service materiel in attendance rather than details of fire events themselves.

Date	Fire
19/07/2024 11:10 to 19/07/2024 16:34	Landfill site, Wasteland.
19/09/2024 13:33 to 11/08/2020 16:36	Landfill site, Wasteland.
20/09/2024 19:30 end unreported	Landfill site, Wasteland.

Table 2: Fires at Arnolds Field in 2023 and 2024 as reported by the London Fire Brigade incident website as of February 24th 2024.

Date	Fire
27/08/2024 ? to 27/08/2024 ?	?
17/08/2024 ? to 17/08/2024 ?	?
09/08/2024 ? to 09/08/2024 ?	?
07/08/2024 ? to 07/08/2024 ?	?
04 (or 05)/08/2024 ? to 04(05)/08/2024 ?	?
29/07/2024 21:21 to 29/07/2024 ?	?
26/07/2024 ? to ?	Grass fire

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19/07/2024 11:10 to ?	Grass fire
17/07/2024 10:13 to 17/07/2024 >19:47	?
11/2024 13:52 to 11/07/2024 17:22	Grass fire
05/2024 10:13 to 04/07/2024 11:06	?
04/07/2024 14:12 to 04/07/2024 15:48	?
10/05/2024 11:25 to 10/05/2024 12:46	?
30/08/2023 09:04 to 30/08/2023 14:09	Fire
29/08/2023 09:48 to 29/08/2023 18:08	Fire
28/08/2023 19:21 to 28/08/2023 21:27	Alarm caused
28/08/2023 17:24 to 28/08/2023 18:44	Fire
28/08/2023 08:39 to 28/08/2023 11:16	Fire
24/08/2023 10:55 to 24/08/2023 12:14	Secondary fire
25/08/2023 01:08 to 25/08/2023 01:57	Secondary fire
23/08/2023 09:01 to 23/08/2023 10:01	Secondary fire
23/08/2023 06:17 to 23/08/2023 08:27	Secondary fire
22/08/2023 16:39 to 22/08/2023 20:24	Fire
22/08/2023 07:11 to 22/08/2023 09:34	Fire
20/08/2023 06:32 to 20/08/2023 08:48	Fire
17/08/2023 20:21 to 17/08/2023 21:34	Fire
17/08/2023 06:05 to 17/08/2023 08:21	Secondary Fire
16/08/2023 04:07 to 16/08/2023 06:45	Alarm Caused-Secondary Fire
14/08/2023 19:52 to 14/08/2023 20:48	Secondary Fire
14/08/2023 06:43 to 14/08/2023 07:19	Secondary Fire
13/08/2023 12:53 to 13/08/2023 14:27	Secondary Fire
10/08/2023 20:22 to 10/08/2023 21:19	Secondary Fire
10/08/2023 07:10 to 10/08/2023 08:06	Secondary Fire
06/08/2023 20:19 to 06/08/2023 20:48	Secondary Fire
30/07/2023 11:33 to 30/07/2023 12:39	Secondary Fire
21/07/2023 15:36 to 21/07/2023 16:28	Secondary Fire
19/07/2023 15:51 to 19/07/2023 16:13	Secondary Fire

Table 3: Fires at Arnolds Field in 2023 and 2024, provided by the London Fire Brigade as part of the LBH fires study.

3 Meteorological data

3.1 London City Airport meteorological data

The closest reliable and publicly available meteorological data is available from the London City Airport meteorological station. Data from site was accessed via the National Oceanic and Atmospheric Administration (NOAA) Integrated Surface Database using the “worldmet” package in the R programming language. The relative locations of City Airport and Arnolds Field are shown in Figure 2. This data can be considered representative of overall conditions over a wide area but localised differences are expected, especially when wind speeds are lower or where conditions are more stable. Additional local meteorology is an important part of understanding local conditions and how these impact local emissions. To address this issue additional wind speed and wind direction instrumentation was installed at strategic locations alongside the additional monitoring sites at Spring Farm Park and Harris Academy Rainham.

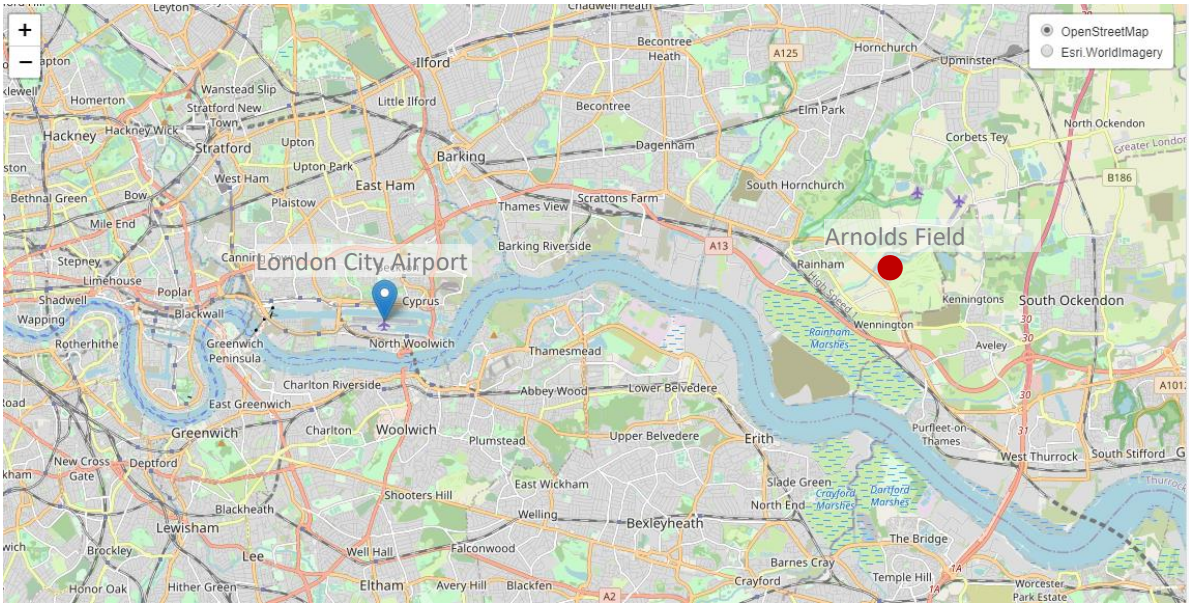

Figure 2: Location of City Airport relative to Arnolds Field

Meteorological data from London City Airport from 2018 to 2025 was examined. Wind speed and direction data shows that the most common wind direction is from the south-west. The highest wind speeds also occur from this direction. This is the case in all seasons, as shown in Figure . Winds from this direction would blow smoke from the fires in the direction of industrial areas, towards the quarry and aggregates works and not towards residential areas.

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Easterly and south-easterly winds would be most likely to bring smoke from the Launders Lane fires towards the main residential area to the north-west and west. This is not a common wind direction in any season but particularly in summer when the fires have been more common. Therefore, on most occasions, the wind is unlikely to blow smoke from the fires towards the main and closest residential areas. Easterly winds are more common than south-easterly and occur more in spring and summer. This could blow smoke towards the residential areas to the west. Figures 4 and 5 show that there was no significant variation in wind conditions between different years for the time period considered. Local variations in wind direction or low wind speeds also have the potential to transport smoke towards residential areas.

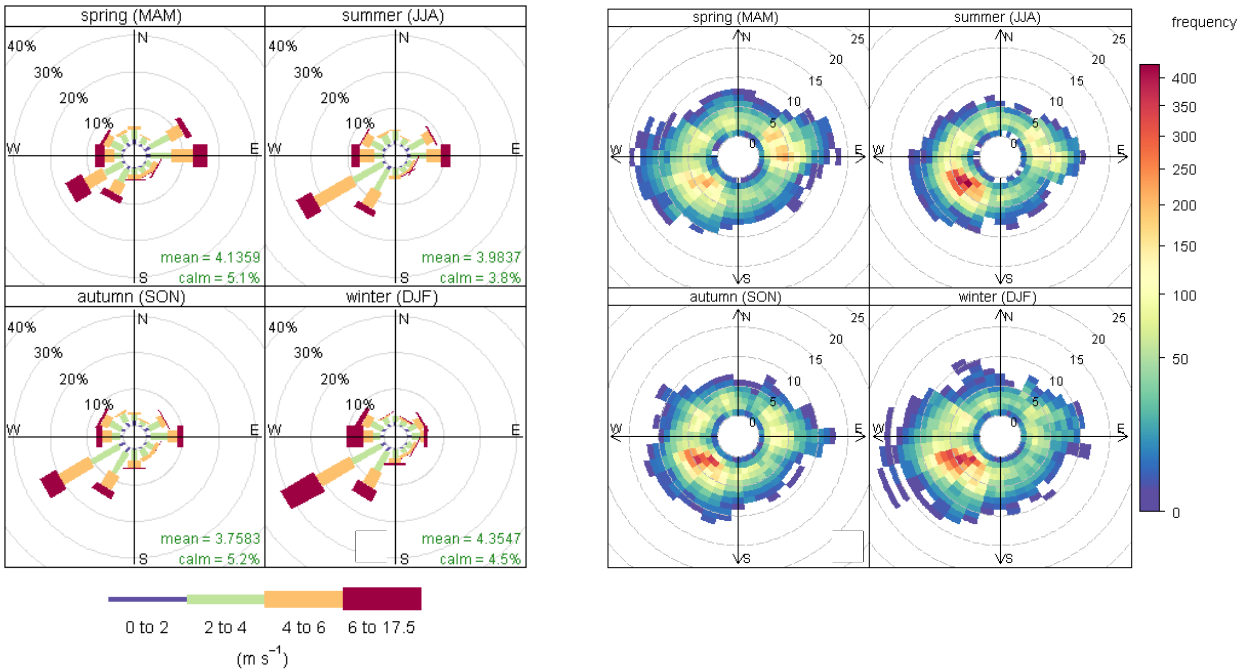

Figure 3: Wind speed and direction by season at London City Airport. Panel a shows wind roses (frequency of counts by wind direction (%)) and panel b shows more detailed wind speed and direction frequency plots.

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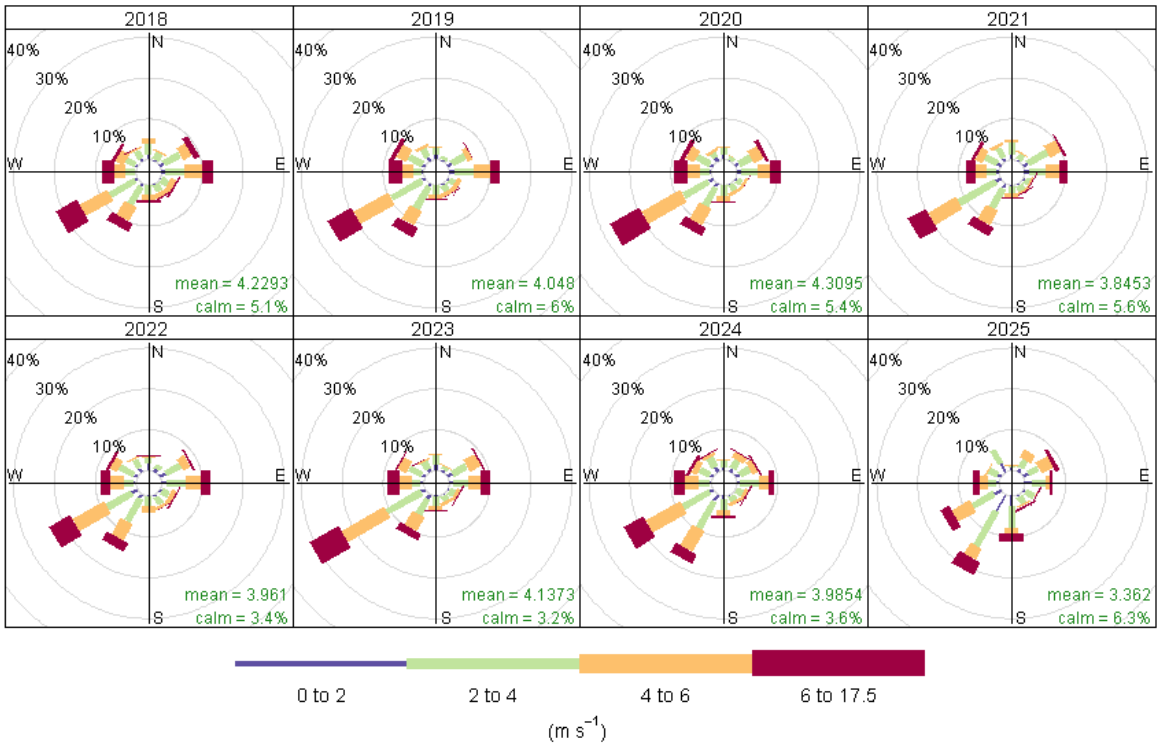

Figure 4: Wind speed and direction by year at London City Airport (frequency of counts by wind direction (%)).

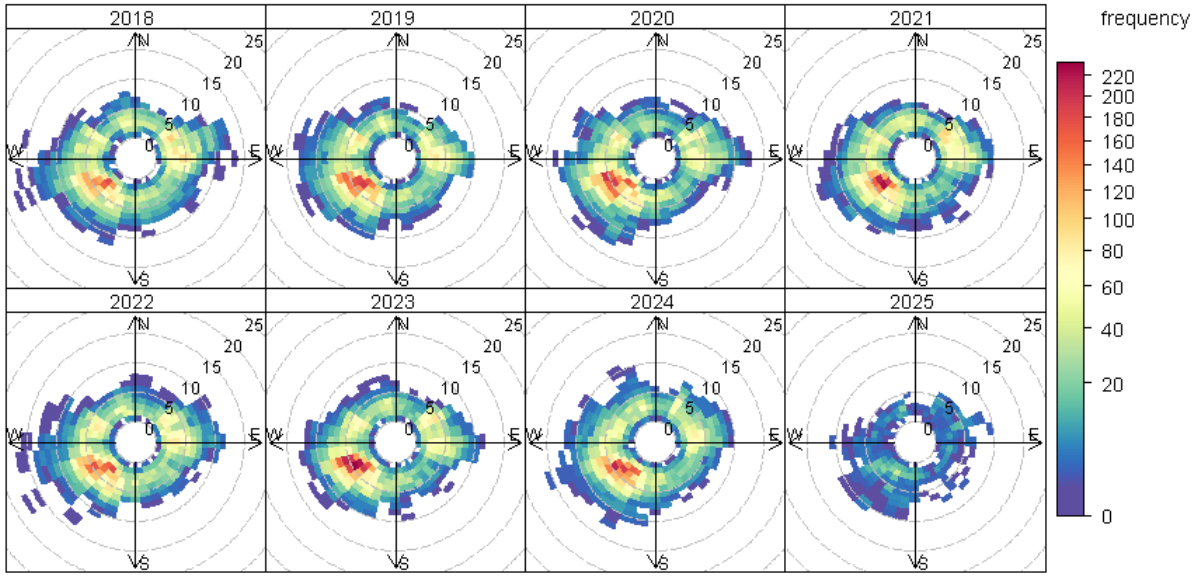

Figure 5: Frequency plots of wind speed and direction by year at London City Airport

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3.2 LBH Meteorological data

Representative wind speed and wind direction data is needed at a broadly matching scale relative to this increased air quality monitoring to better understand local emission, distribution and transport or air quality pollutants. To address this additional meteorological measurement equipment was installed at two locations in conjunction with the additional air quality monitors. These were at Spring Farm Park and Harris Academy Rainham, to provide a local perspective on wind conditions and when conditions likely to result in pollution from the fires potentially affecting residents. The measurement locations were chosen with the aim of being representative of the conditions in the Launders Lane and surrounding area. Data from the met site at Harris Academy is not currently available as a result of storm damage. The Harris Academy Rainham wind data was not available throughout the study since a storm caused a misalignment of the unit on 15th April 2024. Access issues have prevented realignment to date. Good correlation of the wind direction data was seen between Spring Farm Park and the Harris Academy Rainham (where data is available) and having the two sites with wind instrumentation was intended as redundancy for just such a situation.

Data from the Spring Farm Park was compared with data from the regionally representative London City airport meteorological station. Wind speeds at the Spring Farm Park farm were seen to be consistently lower than those reported at the London City Airport site though with a similar overall pattern (see figure 6). A scatter plot of wind speed at both sites is presented in figure 7 which further demonstrates this strong correspondence between overall pattern in terms of wind speeds. This is a notable difference as locally low winds and stagnant conditions have the potential for local emissions to build up and potentially impact local communities. Particularly during winter and overnight when atmospheric conditions can lead to a build-up of pollutants (associated with a lowering of the boundary layer height and temperature inversion layer height). Local wind direction as measured at the Spring Farm Park farm site is similar to that as measured at the London City Airport site (see figure 8).

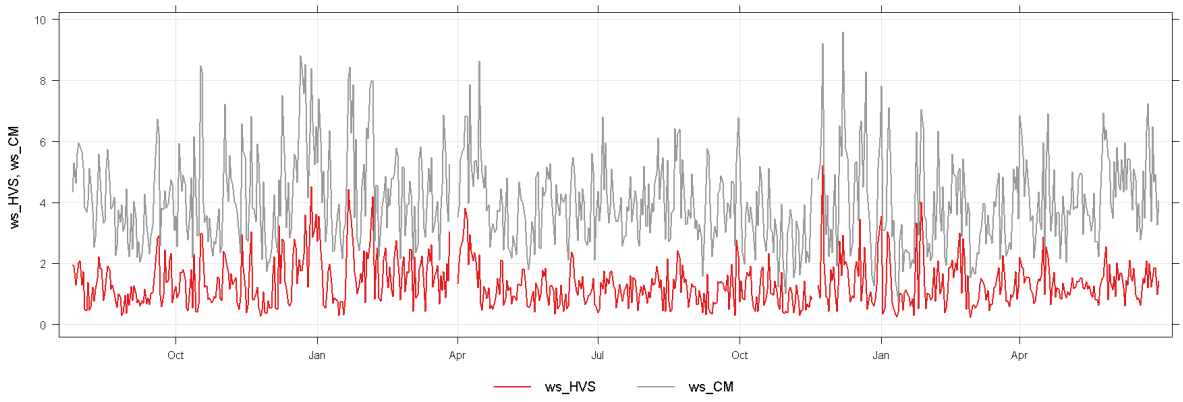

Figure 6: Wind speed data from the Spring Farm Park (ws_HVS in red) compared with data from the regionally representative London City airport meteorological station (ws_CM in grey).

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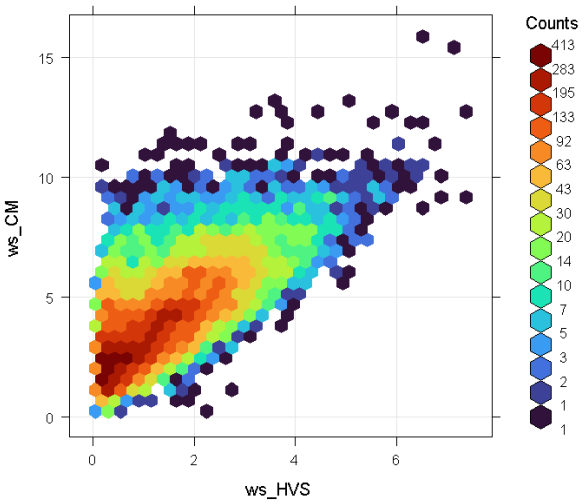

Figure 7: Scatter plot of wind speed at the Spring Farm Park (ws_HVS) compared with data from the regionally representative London City airport meteorological station (ws_CM).

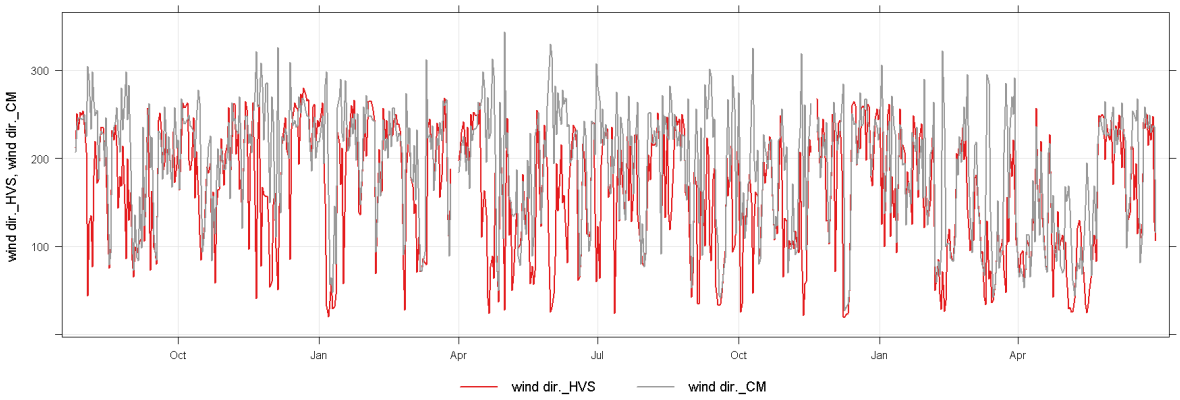

Figure 8: Wind direction data from the Spring Farm Park (wd_HVS in red) compared with data from the regionally representative London City airport meteorological station (wd_CM in grey).

These two meteorological data sets were compared to assess the scale of these measurable differences. Data from the Spring Farm Park site were subtracted from the London City airport data (both speed and direction) then plotted as a wind rose to identify differences (see figure 9). This shows that there is a difference in wind speed associated with north easterly winds.

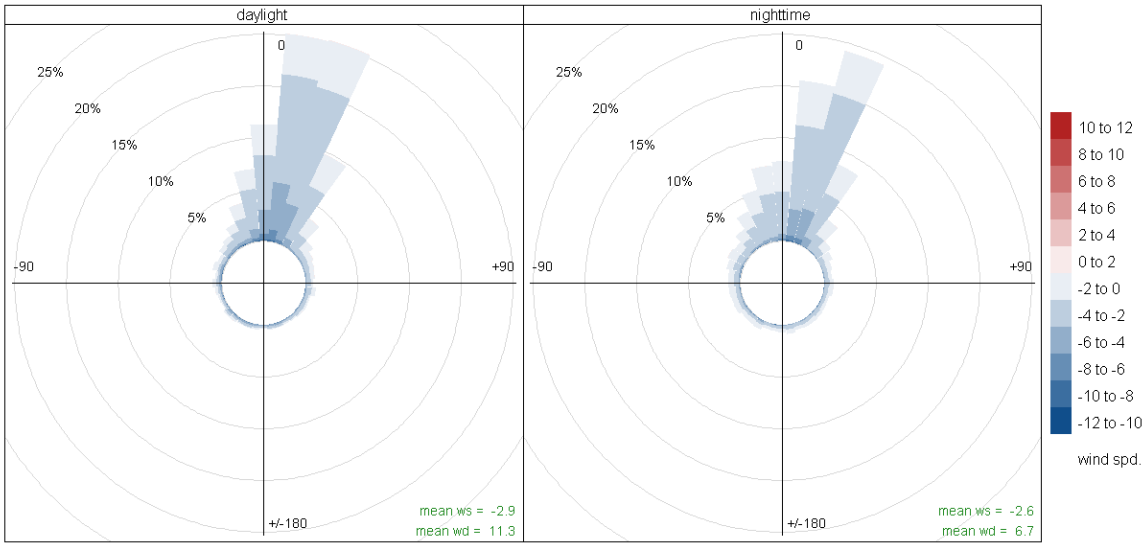

Figure 9: Wind rose (frequency by counts by wind direction)showing relative wind speed/wind direction difference split by daytime/nighttime.

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4 Air Quality data

4.1 Reference measurements

Havering Council has two long term reference standard air quality monitoring sites, one of which is located in Rainham, close to Arnolds Field and is most relevant to this analysis. It is located approximately 1.25 km to the north-west of the Arnolds Field site (see figure 10).

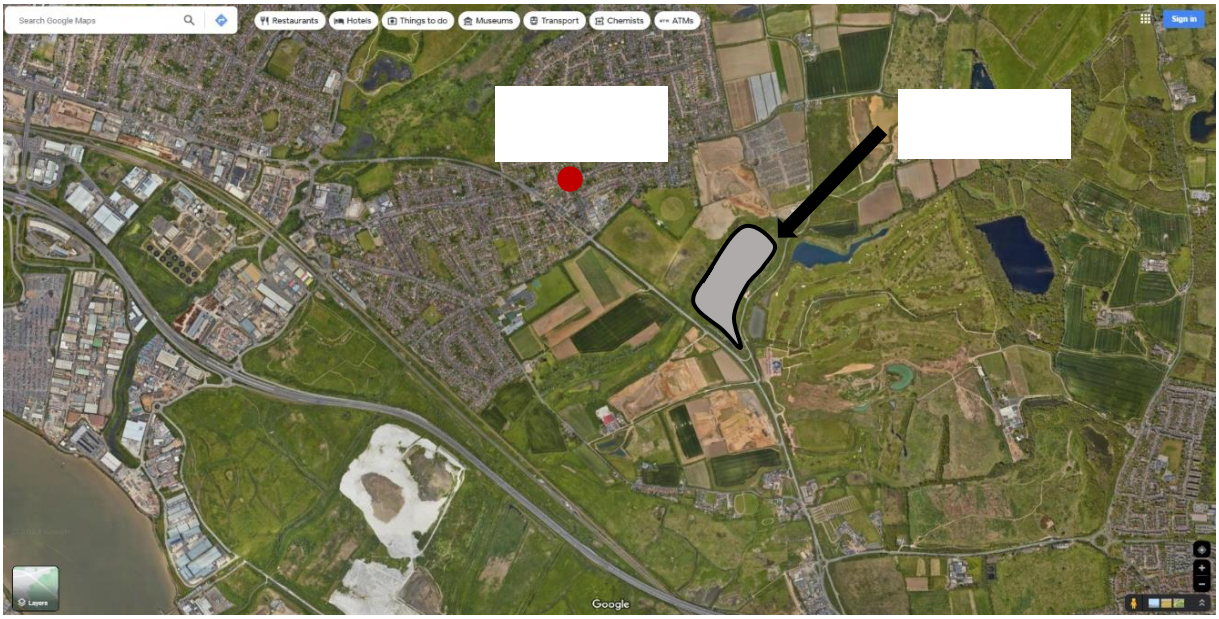

Figure 10: Location of Rainham reference site relative to the Arnolds Field fires

In the UK, outdoor air pollutants are regulated by the Air Quality Standards Regulations, 2010. These are based on the EU Air Quality Directive 2008/50/EC[ii] and the amending Directive (EU) 2015/1480 which were enshrined into UK law following the UK's departure from the EU in 2020. The Directive defines the measurement methods and includes guidance on appropriate siting. The Rainham site was installed in 1995. NOx is measured by chemiluminescence according to the requirements of the Directive. Particulate matter must be measured using methods that have demonstrated equivalence to the reference method. At Rainham PM_{10} and $PM_{2.5}$ are measured by TEOM 1405-DF FDMS which meets this requirement. Data management and ratification is carried out by Imperial ERG as part of the London Air Quality Network (LAQN)[iii]. The equipment is calibrated monthly and is operated and maintained in accordance with the requirements of Directive 2008/50/EC, including UKAS accredited audits by the National Physical Laboratory. These procedures meet the requirements of London Local Air Quality Management Technical Guidance (GLA, 2019) [iv]. During routine quality control checks undertaken as part of standard data reviewing in early 2025, concerns were identified with the reference instrument reporting $PM_{2.5}$ at the Rainham reference site. The identified issue has resulted in the backdated exclusion of data from Sept 2023 onwards as it has not been resolved. The feasibility of repair of this equipment is being currently investigated by LBH.

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Air quality measurements from the reference site in Rainham were examined for evidence of smoke from the Arnolds Field fires being detected at the measurement site. Smoke would be expected to cause increased concentrations of particulate matter, both PM_{10} and $PM_{2.5}$, with a high proportion of $PM_{2.5}$. $PM_{2.5}$ concentrations were examined in the first instance. Detailed analysis for 2018, 2019, 2020, 2021 and 2022 are presented in the preceding (1st) report on fires at Arnolds Field on Launders Lane in Rainham, Havering.

4.2 Breathe London Communities

The Breathe London sensor network began measuring NO_2 and $PM_{2.5}$ across London since 2021 with approximately 400 locations across London at the end of 2024 operated by Imperial ERG, in collaboration with the Greater London Authority (GLA). At the start of 2025 the Greater London Authority (GLA) funded element of the project (comprising 136 nodes) changed operator with the remaining sites (approximately 220 in May 2025) still under operation by Imperial ERG as the Breathe London Communities sensor network (BLC). The network provides measurements at local and hyperlocal scales using a unique network scaling approach based on the relationship between each BLC sensor node and reference site measurements, applied on a continuous basis. This provides an increased density of air quality measurements compared to the availability of reference measurements. Detailed information on the BLC network including technical details on the sensor nodes, how the network is operated and of the unique network scaling approach and its routine implementation can be found on the Breathe London Communities website[v]

The London Borough of Havering currently has six BLC nodes. One at the Rainham reference site, four paid for by LBH and one community sourced node (supported by Bloomberg philanthropies as part of BLC). Two other nodes were in place for 2 years before being decommissioned as they largely duplicated coverage at the Spring Farm Park location. The node co-located at the Rainham reference site was installed as a cross-check to ensure that increased pollution concentrations at the reference measurement site are also detected by the BLC node. The locations of Breathe London nodes in the borough in 2024 are shown in Figure 11.

The analysis in the preliminary report was used to inform potential additional locations where measurements may be needed to better characterise emissions associated with burning at the Launders Lane site. The majority of Breathe London nodes have been installed since the start of 2021, including the Rainham reference co-location node. The Acer Avenue and King Edwards Avenue sites were installed in October 2022, followed by the other additional Nodes in the area. In December 2024 the Node at Ingrebourne Links was relocated a short distance to just outside the boundary of their land. Therefore, data from these locations can only be used for analysis from this point and not for historical fire events prior to these dates, details of which have been provided up to October 2022.

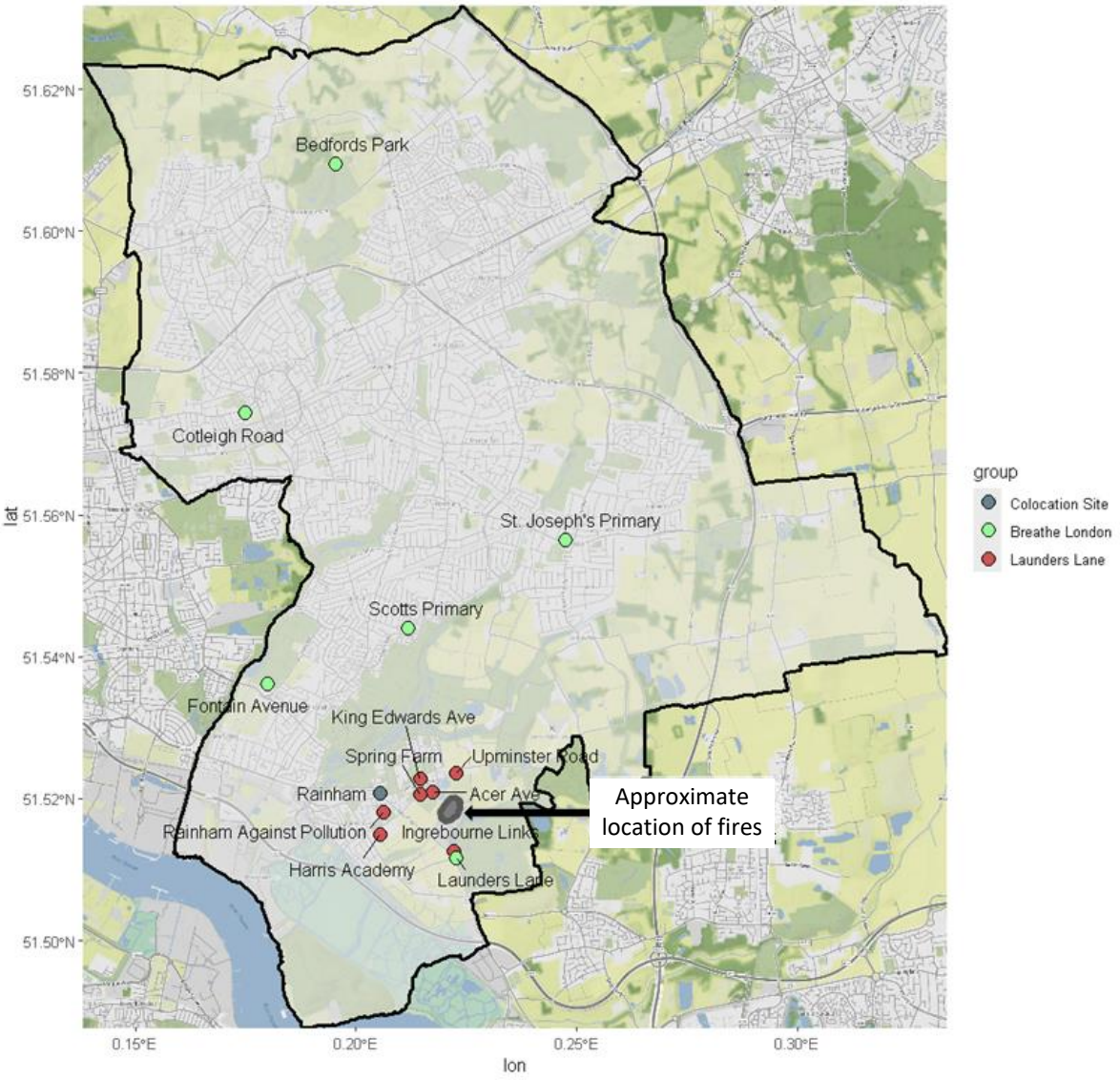

Figure 11: Locations of Breathe London nodes across the London Borough of Havering. The black outline shows the borough boundary. Including relocation and historic locations.

The Breathe London Communities (BLC) nodes were procured by the London Borough of Havering to augment the existing BLC nodes deployed across the wider borough as well as the reference site at Rainham. These additional nodes were distributed around the Arnolds Field site to help better constrain local environmental composition with a focus on the location of potential receptors as well as to provide information on pollutants at interstitial sites to fill observational gaps around the site. These additional locations based on the preliminary data analysis (see first report on fires at Arnolds Field produced for the London Borough of Havering and section 3.2.2). This increased density of air quality measurement sites at the local scale using the wider BLC network continuous scaling approach based on the relationship between the BLC network and regional reference site measurements.

4.3 Data comparison

The node co-located at the reference site at Rainham was installed in February 2021. These measurements were compared to the measurements from the reference $PM_{2.5}$ instrument for periods when a possible signal was detected from the fires. The main periods since February 2021 when smoke from the Launders Lane fires may have been detected occurred in June and July 2022 (see 1st Launders Lane report). Time series plots for these are shown in figures 12 **Error! Reference source not found.**and 13. These show that there is a good match between the reference and Breathe London measurements and as such Breathe London measurements are appropriate for analysis of the potential impact of the Launders Lane fires (see 1st Launders Lane report).

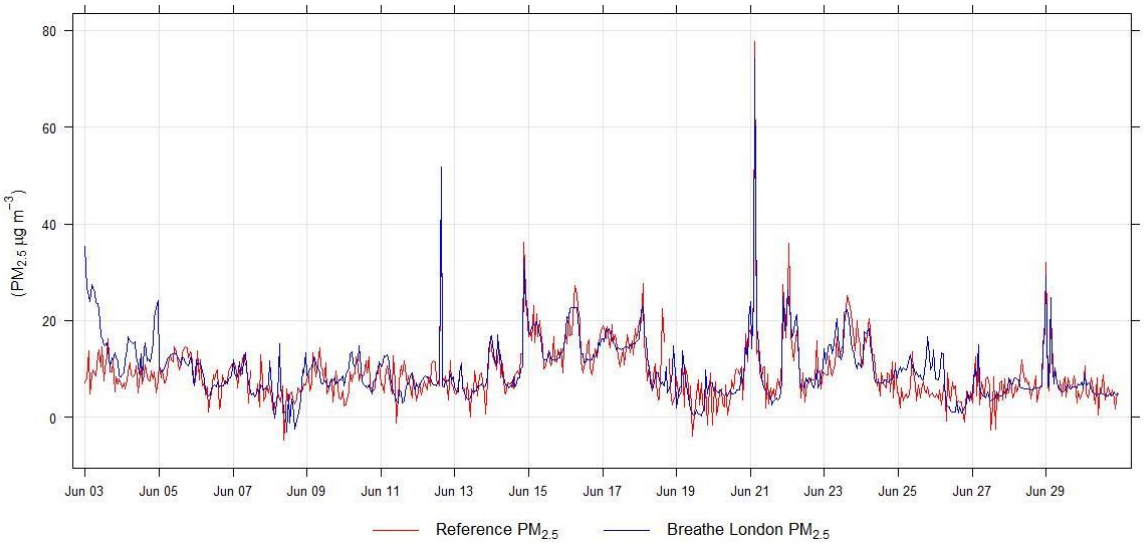

Figure 12: Time series plot of hourly mean $PM_{2.5}$ in June 2022. The red line shows measurements from the Rainham reference $PM_{2.5}$ monitor and the blue line shows $PM_{2.5}$ measurements from the Breathe London node.

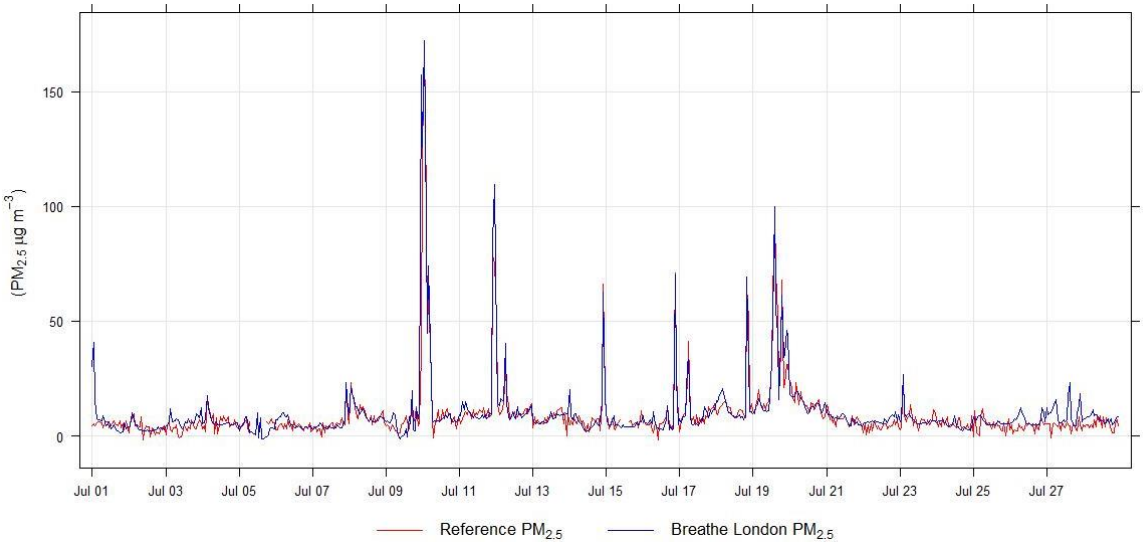

Figure 13: Time series plot of hourly mean $PM_{2.5}$ in July 2022. The red line shows measurements from the Rainham reference $PM_{2.5}$ monitor and the blue line shows $PM_{2.5}$ measurements from the Breathe London node.

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4.4 BLC calendar analysis

Reviewing the data collected across the local BLC node network between October 2022 (when specific monitoring started to be installed) and October 2024 suggested a number of days where a visible local signal, possibly smoke, was recorded in the data on one or more of the nodes when comparing them with nodes outside the expected area of influence of any fire at the Arnolds Field site. These are presented in figure 14.

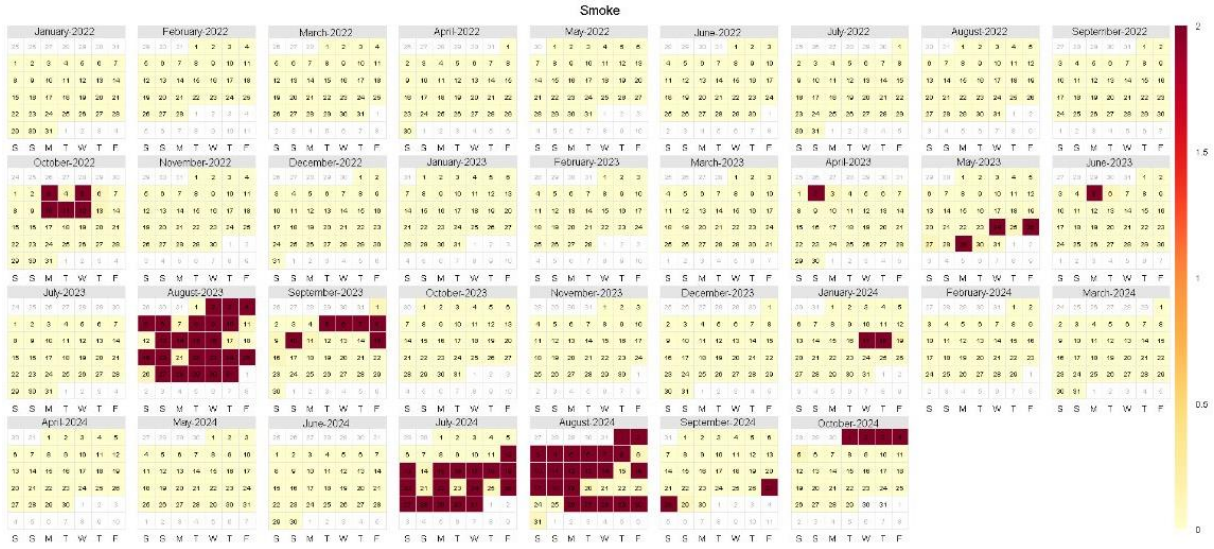

Figure 14: Calendar plot of identified smoke signal days node network between October 2022 (when specific monitoring started to be installed) and October 2024.

Based on this analysis, smoke signal days are defined here as where one or more BLC nodes recorded suddenly elevated pollution levels for any period of time during that day that did not align with anything similar recorded by reference monitoring outside the study area. These flagged days are more numerous than recorded fire brigade attendances suggesting that if burning at the Launders Lane site is responsible for these elevated events, that events for which the London Fire Brigade (LFB) were not in attendance or smouldering at the site before/ after LFB attendances were responsible. It should be noted that other local sources, not Arnolds Field, may also have been the cause of some of these signals.

Between December 2021 and October 2024 (1065 calendar days) 21 days were characterised as not being "low" for levels of $PM_{2.5}$ across Havering (i.e. above the 36 μgm^{-3} boundary between "low" and "moderate" bands as defined in the UK Daily Air Quality Index[vi]). For those days where levels of recorded $PM_{2.5}$ were above the UK DAQI "low" banding this was observed to be driven by regional background levels of $PM_{2.5}$. Table 4 lists these days for this period and also presents the value in μgm^{-3} for the regional background on $PM_{2.5}$. This background is the mean of reference station data across London. Where the day is highlighted in blue the regional background level is sufficient to elevate the day above "low" without the addition of local pollution. Where the day is highlighted in orange the regional background is responsible for 90% or above of the 36 μgm^{-3} $PM_{2.5}$ UK DAQI "low" threshold without the addition of local pollution.

Above Low Day	Regional background
22/12/2021	18
24/12/2021	9
14/01/2022	34
15/01/2022	27
18/01/2022	26
02/03/2022	21
03/03/2022	21
08/03/2022	26
21/03/2022	34
22/03/2022	35
23/03/2022	42
24/03/2022	44
25/03/2022	47
10/12/2022	22
11/12/2022	29
16/12/2022	33
14/02/2023	35
15/02/2023	29
30/08/2023	4
11/03/2024	34
22/09/2024	15

Table 4: Days where levels of $PM_{2.5}$ were above 36 μgm^{-3} for LBH Havering.

Official metrics for $PM_{2.5}$ such as those set out by UK, WHO and US regulatory bodies are calculated against annual or 24-hour average values. The use of a 24-hour window is partially an artefact of historical measurement and reporting limitations i.e. PM data was historically only available as daily averages and health reporting data tends to be recorded daily. The current UK – Daily Air Quality Index "Moderate" band is identified as being where the 24-hour period value exceeds 36 ugm^{-3}. Updated WHO guidelines were published in 2021 where daily $PM_{2.5}$ values are not to exceed 15 μgm^{-3} for more than 4 days over a given calendar year and the annual average should be not greater than 5 μgm^{-3}.

Between March 2022 and October 2024, 264 WHO daily exceedances (i.e. where daily average values >15 μgm^{-3}) were recorded for Havering. For 119 of those, background pollutant levels were enough to cause the exceedance. If the London background is subtracted from node measurements for the same period there were 4 days where local emissions were the primary cause of WHO exceedance. These days were the 28th, 29thand 30th of August 2023 and the 8th of September 2023.

The 30th August exceedance was "Very High" on the DAQI scale at one network site (Golf Club site). The whole of London routinely exceeds these updated WHO target values as do many rural areas of south east England. The WHO target values are aspirational and are aimed at providing a benchmark for future atmospheric conditions not as a currently achievable target. The UK Committee on the Medical Effects of Air Pollutants (COMEAP[vii]) states that "*The WHO Air Quality Guidelines are based on the evidence linking concentrations of pollutants in ambient air with adverse effects on health. They are set without reference to achievability*". These are related to the lowest level at which epidemiological studies to date have found an association between exposure to pollutants and adverse effects in the general population.

The Spring Farm Park site was selected for further analysis as it is geographically closest to residential areas and therefore considered representative of potential residential exposure. $PM_{2.5}$ data from the Spring Farm Park site for 2023 is presented in figure 15 showing periods where $PM_{2.5}$ is elevated. Corresponding $PM_{2.5}$ data from the Spring Farm Park site for 2024 is presented in figure 16.

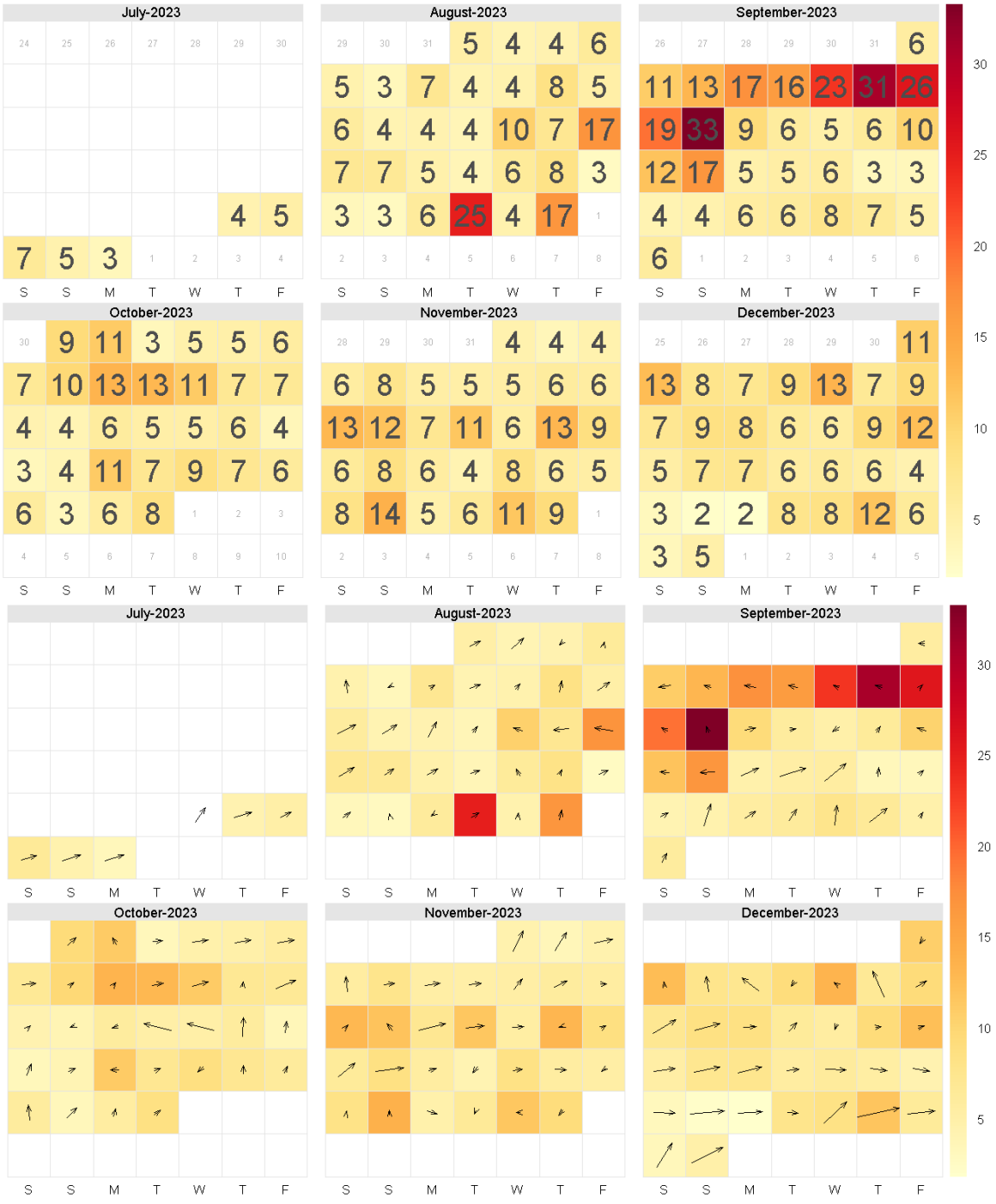

Figure 15: $PM_{2.5}$ daily mean concentrations at the Spring Farm Park site for 2023. The top panel shows dates annotated by average $PM_{2.5}$ values for that site. The bottom panel is annotated to show wind direction (orientation of arrow), with the length of the arrow scaled for wind speed.

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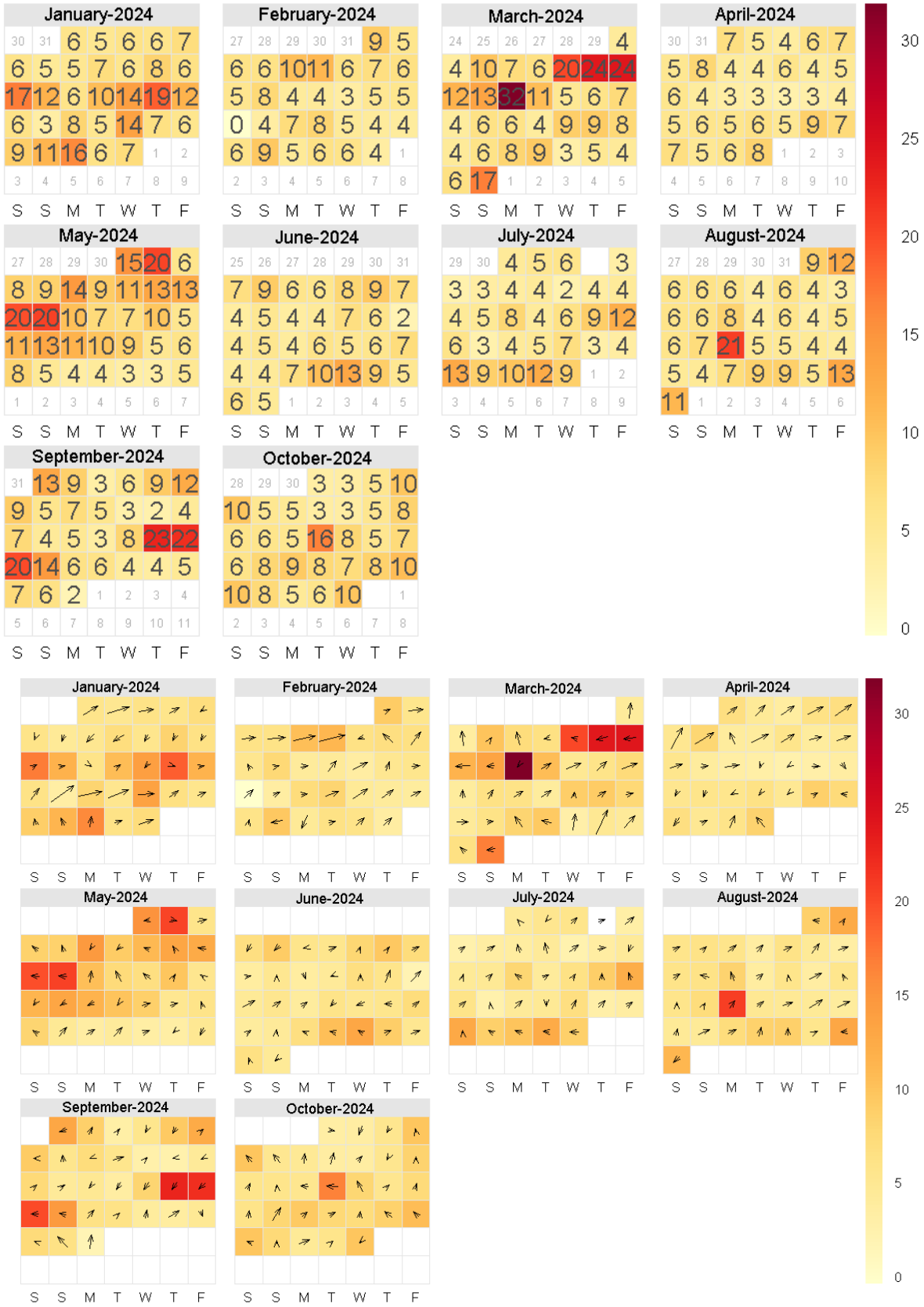

Figure 16: $PM_{2.5}$ daily mean concentrations at the Spring Farm Park site for 2023. The top panel shows dates annotated by average $PM_{2.5}$ values for that site. The bottom panel is annotated to show wind direction (orientation of arrow), with the length of the arrow scaled for wind speed.

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4.5 BLC timeseries analysis

Based on the identified smoke signal days node network between October 2022 (when specific monitoring started to be installed) and October 2024 (see figure 14), two possible windows where signals would be expected to be detected from the fires were identified. These are August 2023 and mid July to the end of August 2024. $PM_{2.5}$ network data for August 2023, July 2024 and August 2024 are presented in figures 17, 18 and 19 respectively. For clarity data are aggregated to 15 minute averages. The WHO 15 μgm^{-3} guideline value is highlighted in blue. Daytime and nighttime periods are highlighted (with grey representing nighttime 6pm-6am). From these figures it can be seen that, in line with earlier results (see figure 14), nighttime and early morning periods can contain peak pollutant events reflecting the expected impact of wind speeds regularly dropping overnight with local pollutants recirculation and build up (followed by dispersion associated with strengthening winds in the morning).

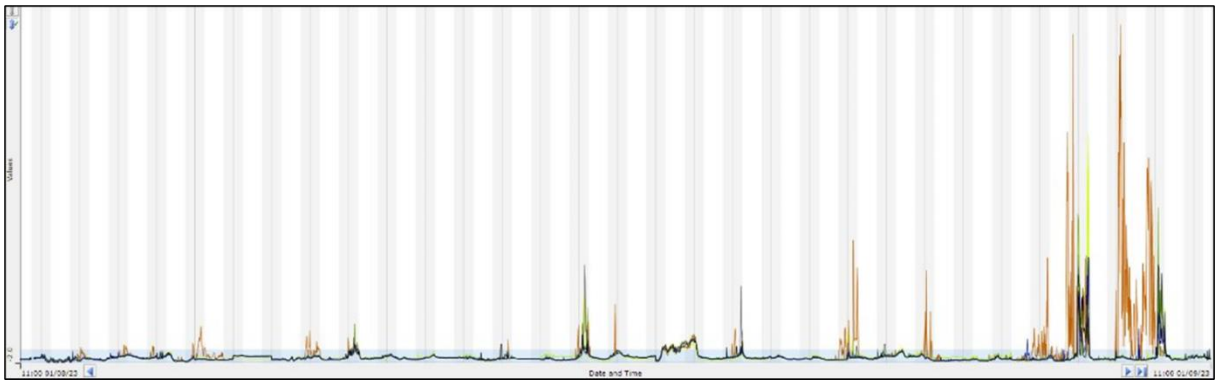

Figure 17: Timeseries of data from all nodes deployed around Arnolds Field for August 2023. The WHO 15 μgm^{-3} guideline value is highlighted in blue. Day/ night cycle is highlighted with grey representing nighttime.

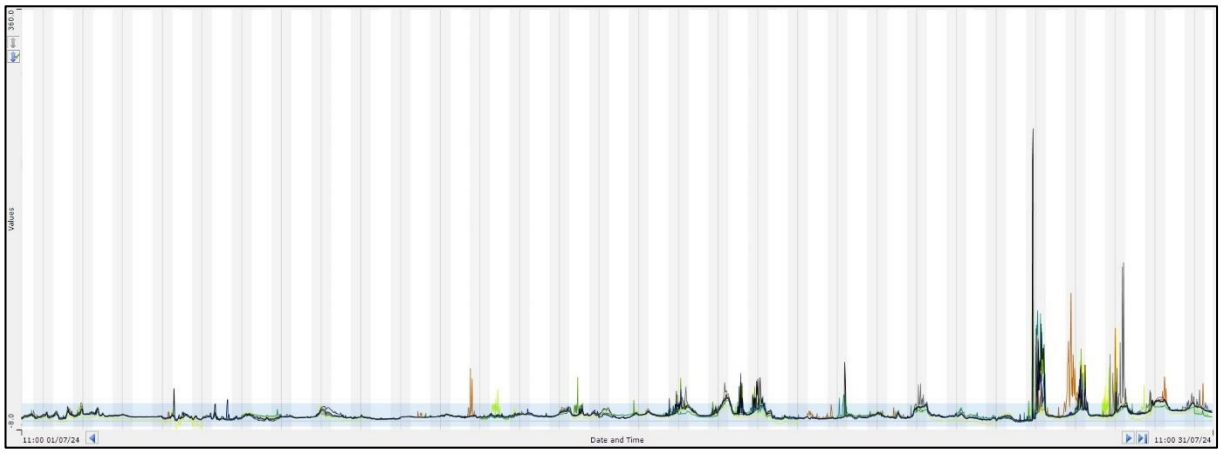

Figure 18: Timeseries of data from all nodes deployed around Arnolds Field for July 2024. The WHO 15 μgm^{-3} guideline value is highlighted in blue. Day/ night cycle is highlighted with grey representing nighttime.

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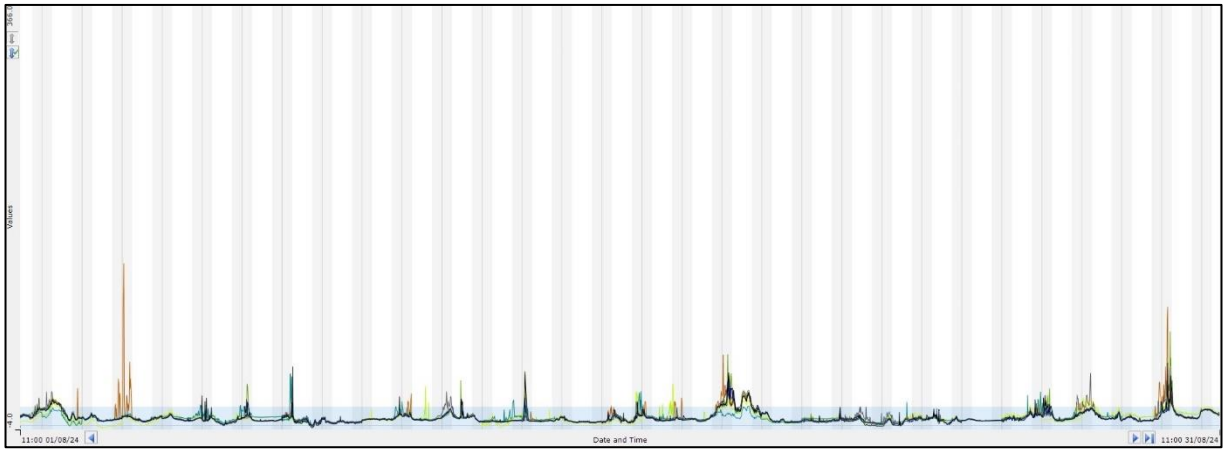

Figure 19: Timeseries of data from all nodes deployed around Arnolds Field for August 2024. The WHO 15 µgm^{-3} guideline value is highlighted in blue. Day/ night cycle is highlighted with grey representing nighttime.

The time series plot for September of 2024 is shown in figure 20. This period was selected as it highlights an elevated period around the 19th of September which is contemporaneous with the reported fires at Arnolds Field as well as an earlier less pronounced event on the 13th to 15th September. Figure 21 shows the daily averages for this same period to better compare with the calendar plot data presented figure 14.

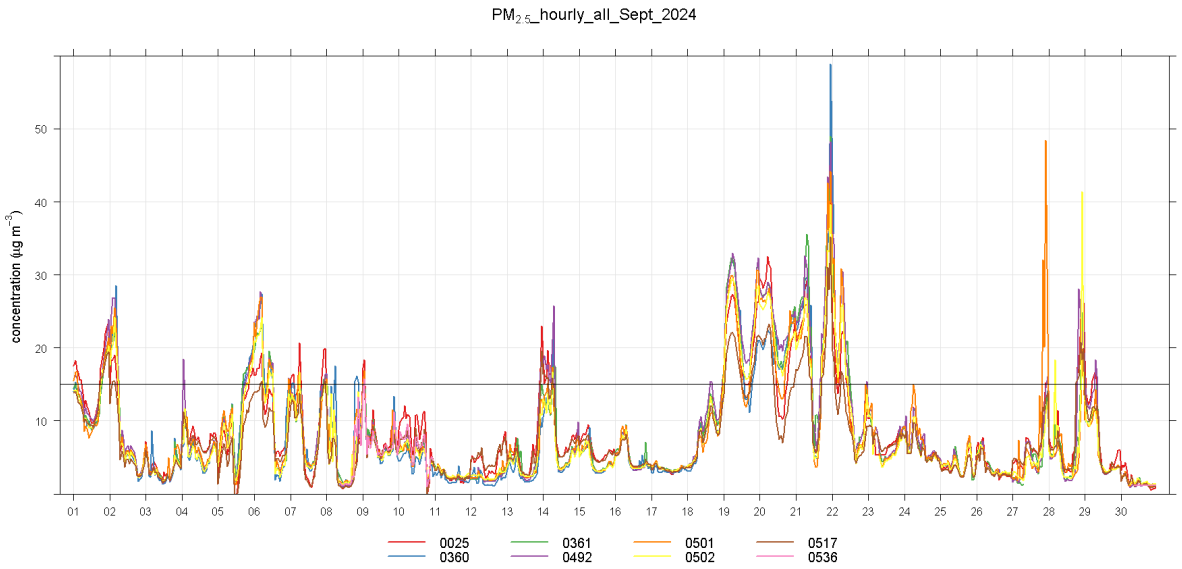

Figure 20: PM$_{2.5}$ hourly concentrations at BLC network sites for September 2024. The blue line highlights the WHO 15 µgm^{-3} guideline value. See appendix 3 for cross reference between site codes and site names

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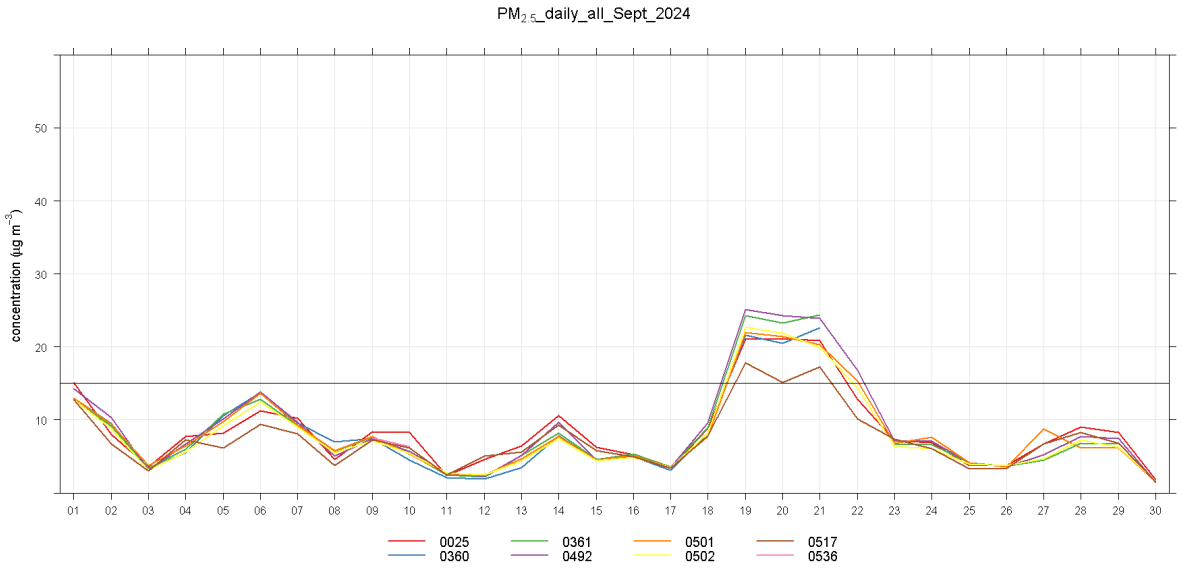

Figure 21: Time series plot of hourly mean $PM_{2.5}$ for September 2024. The blue line highlights the WHO 15 µgm^{-3} guideline value. See appendix 3 for cross reference between site codes and site names

The nodes deployed around the Arnolds Field site are not the most polluted when their annual average reported $PM_{2.5}$ values are compared with the other approximately 400 Breathe London nodes (as of the end of 2024). The annual average taken between October 2023 and October 2024 for these wider London nodes is approximately 5.3 - 9.3 µgm^{-3}, for the sites around Arnolds Field this range is approximately 5.7 - 8.3 µgm^{-3} and the nodes are scattered across the wider London node ranking.

In figure 17, 18 and 19, daytime and nighttime periods are highlighted with grey representing nighttime. From these figures it can be seen that nighttime and early morning periods can contain peak pollutant events. For the identified smoke days (as identified in figure 14) the average percentage increment (i.e. the node value minus the background value) plotted by hour of day shows a clear diurnal pattern (see figure 22). This reflects the expected impact of prevailing meteorological conditions where wind speeds regularly drop overnight allowing local pollutants to recirculate locally and build up. Stronger winds will then disperse this built-up pollution. It also matches anecdotal evidence provided by residents. For reference hourly site averages in µgm^{-3} for all sites across the study area for July and August 2024 are presented in figure 23.

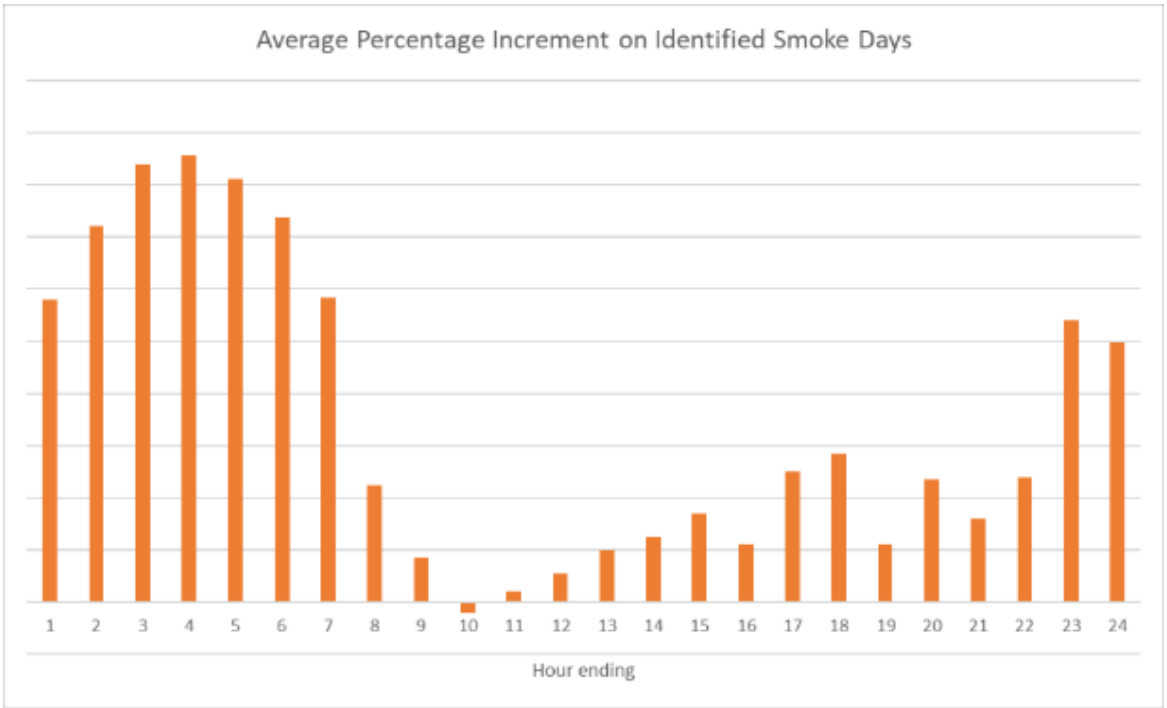

Figure 22: Average percentage increment (i.e. the node value minus the background value) plotted by hour of day for identified smoke days (as identified in figure 11).

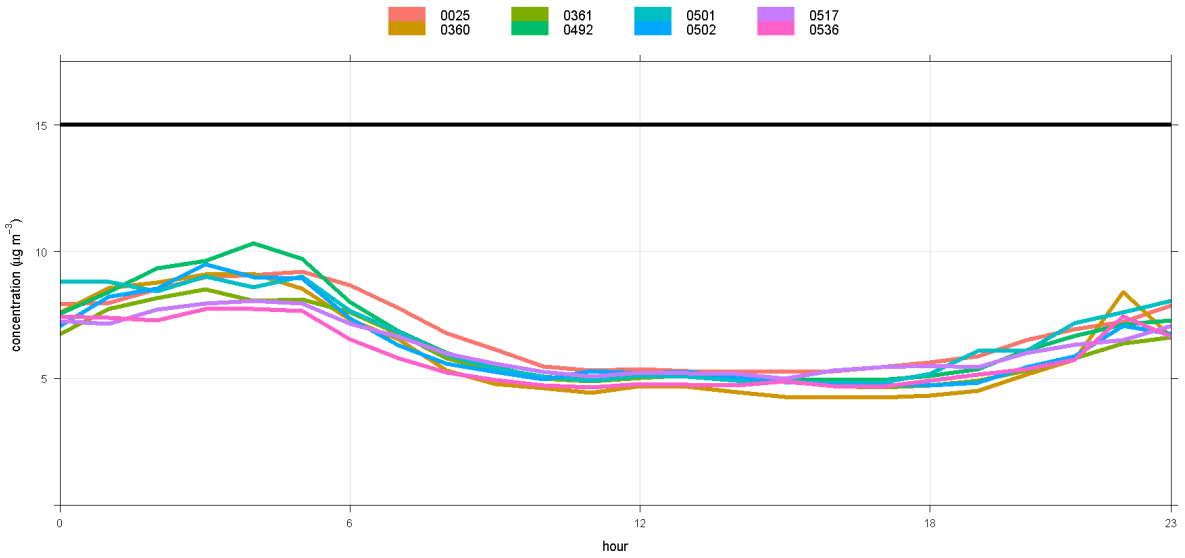

Figure 23: Hourly site averages in µgm^{-3} for all sites across the study area for July and August 2024 with the WHO 15 µgm^{-3} guideline value highlighted in black. See appendix 3 for cross reference between site codes and site names

$PM_{2.5}$ network data was further analysed for the last week of July and first week of August 2024 as potential smoke events were both reported and potentially identified in the data for this period. Figures 24 and 25 show all the node data (aggregated as three hourly averages for clarity of presentation) for these periods overlaid with wind direction and wind speed (where wind speed is denoted by the length of the pink arrows and direction shown by their orientation). For the July window three distinct elevated periods are seen with peaks seen at different BLC nodes at different times, mostly when conditions are stagnant. Where the wind speeds are more elevated levels are lower. For the August window one distinct event is reported at the Golf and Country Club site when conditions are stagnant. Wind speeds are higher on either side of this period the concentrations are lower and more similar at all BLC sites. The Ingrebourne Links Golf and Country Club site is located to the South in close vicinity to the Arnolds Field site. The easterly winds either side of this period would be expected to disperse any local pollutants away from the installed sites and associated locations of local receptors. Further, more detailed analysis would potentially provide further insight into these patterns of behaviour (depending on the number of events which occur).

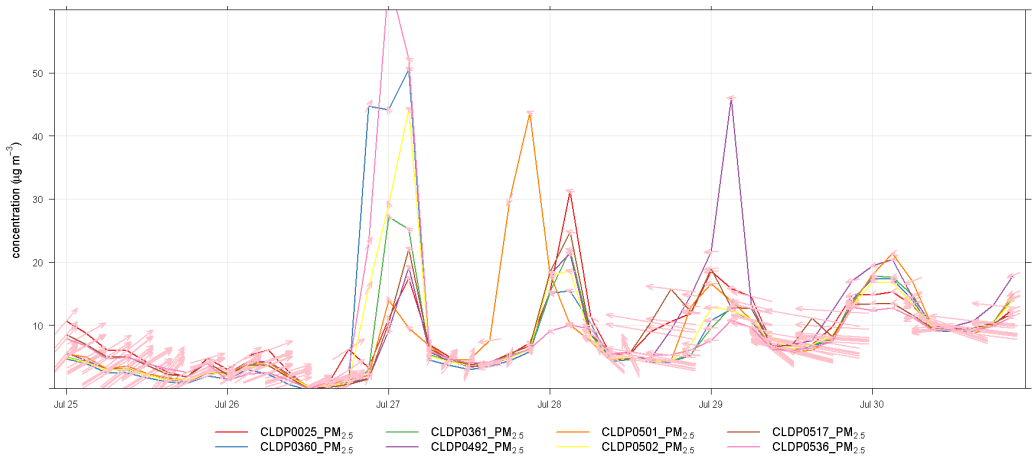

Figure 24: Timeseries of aggregated data from all nodes deployed around Arnolds Field for the last week of July 2024 with wind direction and wind speed overlaid. See appendix 3 for cross reference between site codes and site names.

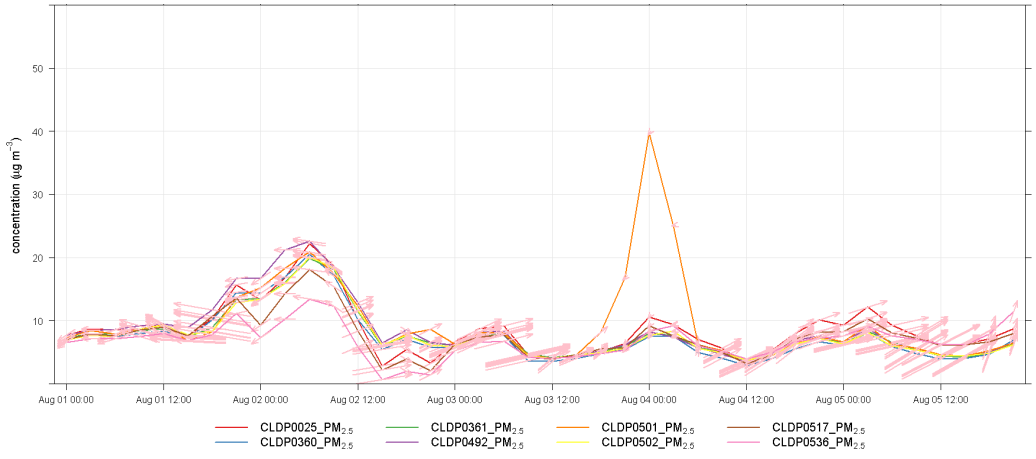

Figure 25: Timeseries of aggregated data from all nodes deployed around Arnolds Field for the first week of August 2024 with wind direction and wind speed overlaid. See appendix 3 for cross reference between site codes and site names.

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4.6 Sectoral investigation

In complex environments such as that found in Urban areas in general and LBH in particular source analysis using bivariate polar plotting can help disaggregate source characteristics. Polar bivariate plots show measured concentrations as polar coordinates by wind speed and direction. Analysis of concentration by wind speed provides information on the direction of primary sources, the addition of wind speed enables a deeper analysis of local sources. These plots help identify potential areas of elevated concentrations for wind speed direction ranges. The utility of these plots is based on the meteorological data being representative for all sites and that sufficient data has been collected to be statistically valid.

Bivariate polar plots of the BLC local network data is presented here (figure 26) for the period where local meteorological data is available. The top plot (labelled A) shows all data between January 2022 and October 2024. The middle plot (labelled B) shows data from only designated smoke days for this period. The bottom plot (labelled C) shows data from only designated non smoke days for this period. All plots are presented on the same scale for comparison. These plots suggest a source to the east at low to higher wind speeds, with smaller sources to the west at relatively higher winds speeds. Overall the sources seem to be widely distributed at all nodes for this whole period (top panel A). When filtering for identified smoke days only (middle panel B) suggests relatively elevated source/sources at low wind speeds at all nodes. This is more pronounced at very low winds at the Ingrebourne Links Golf and Country Club site (node 501) which is located to the south of the Arnolds Field site but in very close proximity to its border. Suggesting that a very local source is most significant for these selected days. For the other nodes there is some suggestion for smoke days only that there is a local source to the south and south east i.e. in the general direction of the Arnolds Field site by node. When filtering to remove identified smoke days (bottom panel C), the plots are more in line with those produced for the whole measurement period.

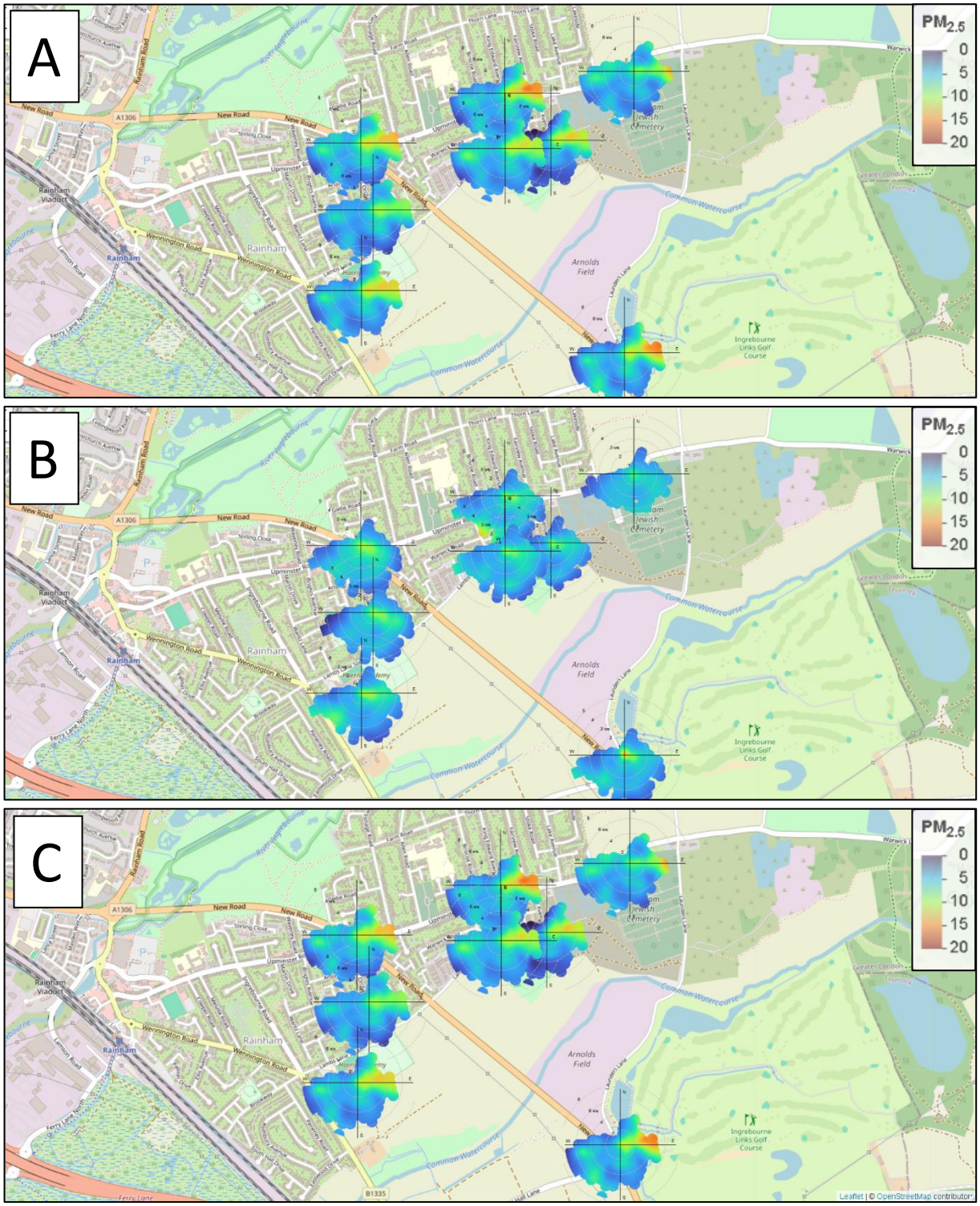

Figure 26: Polar bivariate plots for the Arnolds Field area showing data from local BLC nodes and using data from the Spring Farm Park facility. The top plot (labelled A) shows all data between January 2022 and October 2024. The middle plot (labelled B) shows data from only designated smoke days for this period. The bottom plot (labelled C) shows data from only designated non smoke days for this period.

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Daily $PM_{2.5}$ averages the data can be conditioned by local wind direction and plotted as stacked bar charts. Each daily bar (in this case) represents the total value of $PM_{2.5}$ for that day. And each category in these daily bar chart represents the proportion of this total amount associated with a particular wind direction. Data for the Ingrebourne Links Golf and Country Club site (node 501, south of Launders Lane site) for July and August 2024 is shown in figure 27. Overall data is shown in blue and data from the broad wind sector (wind direction in degrees) associated with potential direct transport from Launders Lane highlighted in yellow (north for 501). These plots show limited potential direct transport of air masses to these sites from the Launders Lane area over this period relative to the overall pollutant levels reported. This does not take into account stagnant conditions which would more likely affect the closely situated the Ingrebourne Links Golf and Country Club site.

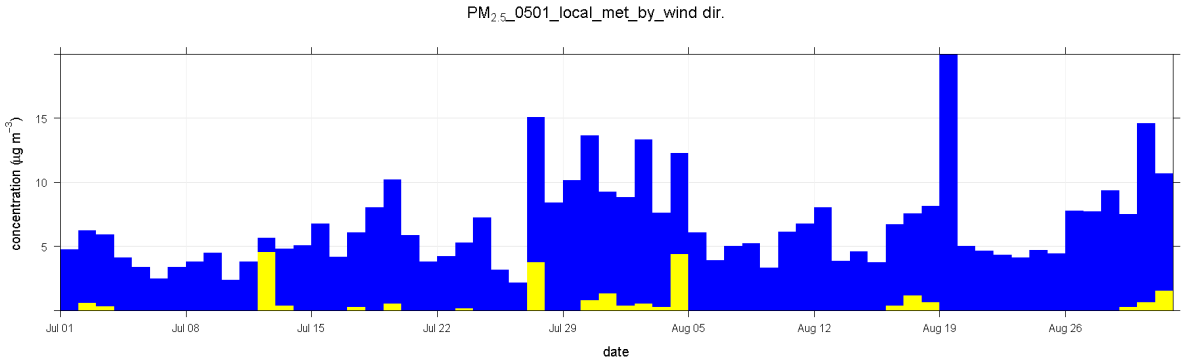

Figure 27: Stacked bar chart of 24 hour averaged $PM_{2.5}$ data at the Ingrebourne Links Golf and Country Club site (site 501) for July and August 2024 conditioned by wind direction. Overall data in blue with the wind sector associated with potential direct transport from Launders Lane at this site highlighted in yellow (north).

4.7 Local increment

Using the data from Rainham and the nodes installed around the Launders Lane site compared with data from the Slade Green site and the average calculated from background reference sites on the London Air Quality network (inner London and outer London) it is possible to calculate an expected increment associated with fires at the Arnolds Field site but only if more comprehensive fire incidence data is available for the study period.

Fig28. 2024

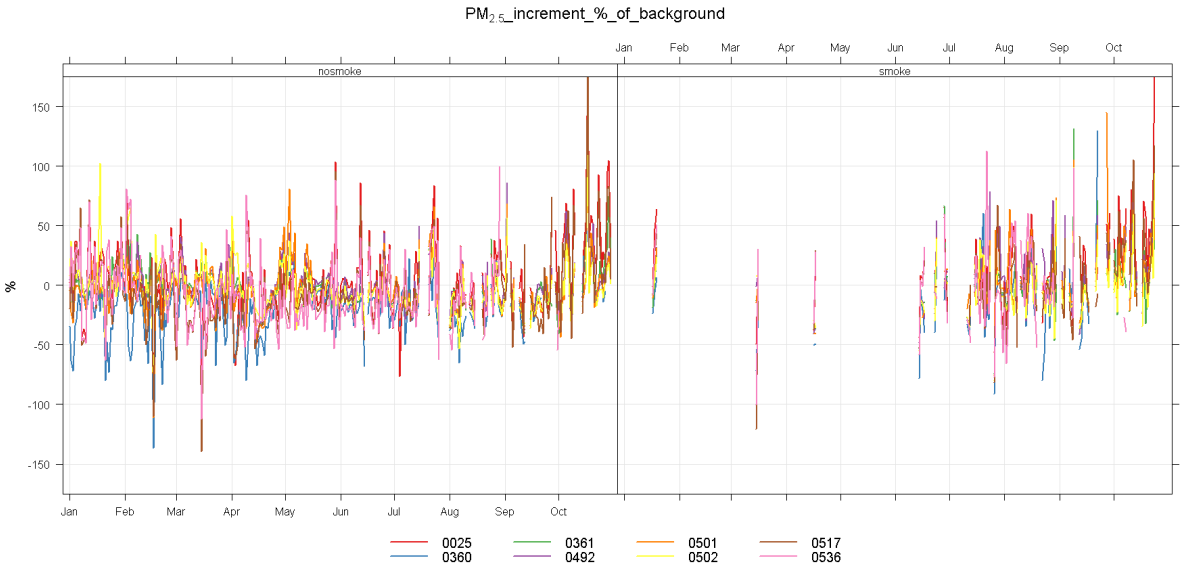

Fig 29

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See Appendix 3 for table of annual local increments per Node per year and cross reference between site codes and site names.

5 Discussion and Recommendations

- The Breathe London Communities web site displays Daily Air Quality Index levels for $PM_{2.5}$ using the predictive trigger system which is part of the DAQI. Triggers were designed to be responsive to large area changes in $PM_{2.5}$ pollution and therefore short-lived elevated spikes typically seen as a result of fires can produce false triggers to higher levels. Once triggered, in line with defined DAQI behaviour, they stay active for the rest of the day so may persist after smoke has cleared. As a result whilst on the day an elevated level may be indicated as a result of a trigger, the retrospective calculation of the daily level based on the whole days data may be lower. This is then reported on the web site.

- Due to the wide dispersal of smoke associated with meteorological conditions, a broad range of Lower Layer Super Output Areas (LSOAs) need to be included in any study. The preliminary Launders Lane report detected a signal at the Rainham reference site, approximately 1.25km from Arnolds field site, and in subsequent fires a $PM_{2.5}$ signal also has been detected at more widely spaced monitoring points than those just put in place specifically for Arnolds Field. As a result analysis of health impacts should include a wider area than that immediately surrounding Arnolds Field and should cover all 14 Lower Layer Super Output Areas (LSOAs) in Havering. Areas of neighbouring Thurrock may also be affected.

- Additional Breathe London nodes were installed as part of this study to increase coverage of ambient air quality measurements to help improve understanding of the impact of the fires at Arnolds Field. Two additional nodes were recommended as a result of the initial 2022 analysis.
  - A node was installed on Upminster Road north to the north-east of the Arnolds Field site to improve evidence of potential effects in the area most likely to be impacted by smoke, according to the most common wind direction.
  - A node , with additional Wind Speed and Direction measurement, was installed at Spring Park Farm to the west of the Arnolds Field site representing the large residential area with potentially exposure to smoke from the fires. Easterly winds are more common than south-easterly winds which would bring smoke towards the original air quality measurement locations, Acer Avenue and King Edward Avenue, particularly in spring and summer when more fires tend to occur.

- Additional PM_{10} monitoring is still not recommended on the basis of the 2022 analysis report. Similar increases in PM_{10} and $PM_{2.5}$ were measured from 2018 to 2022 and a large proportion of this PM was noted to be in the $PM_{2.5}$ size fraction. PM_{10}:$PM_{2.5}$ ratios did not improve the evidence for detection of smoke from Arnolds Field fires. $PM_{2.5}$ is of greater concern for its effects on health than PM_{10} as is it more likely to penetrate deep into the lungs if respired.

- Based on the long-term monitoring network deployment analysis it is recommended that the nodes installed at Ingrebourne Links Golf and Country Club (small relocation to Launders Lane in Dec 2024), Harris Academy Rainham, Spring Farm Park and Upminster north should be retained

beyond their current expiration date. The Nodes at Acer Avenue and King Edwards Avenue could be decommissioned as they do not materially add to the overall data provision for understanding emissions from Launders Lane. This plan does not require any nodes to be moved or relocated as a result of the relative decommissioning dates (see appendix 2).

6 Conclusions

- London Fire Brigade records show that 1 to 36 days per year were affected by fires at the Arnolds Field former landfill site on Arnolds Field during the years 2018 to 2024, with the largest number (36) in 2022. This level of detailed data from the LFB was not available beyond 2022.

- Analysis of wind speed and direction data from London City Airport shows that the most common wind direction at this location was from the south-west. Additional meteorological equipment was installed in the study area in order to provide local meteorological measurements.

- South-westerly winds would transport smoke from fires at Arnolds Field towards the north-east. This area has limited residential housing but does have industrial areas and a cemetery where people could be exposed to smoke.

- The main residential areas close to the Arnolds Field site are to the west and north-west, meaning winds from the east and south-east would be most likely to blow smoke from fires towards these areas. South-easterly winds were not frequent, particularly during the summer. Easterly winds occurred more frequently, particularly during spring and summer when fires were also more frequently recorded. Such conditions could expose residents west of Arnolds Field to smoke.

- Longer periods of increased $PM_{2.5}$ concentrations at Rainham were associated with widespread pollution events during the analysis period so the Launders Lane fires are not the main source of exposure to particulate pollution for residents in this area. However, the detection of smoke at the measurement site which is likely to affect the wider area is a concern due to unknown and potentially toxic components (see TRL compositional analysis).

- Although numerous fires were potentially detected by monitoring, the variability of emissions in terms of sustained magnitude and area of impact meant that levels at single locations, averaged over the day as is required for both UK and WHO metrics, was only impacted significantly enough to drive banding above DAQI “low” on very few occasions and these were primarily driven by regional conditions. Rainham air quality is similar to elsewhere in London (on average).

- Looking at annual average $PM_{2.5}$ there is no observable difference between the levels detected at monitoring around Arnolds Field and the immediate wider area, or across London. This is because the number of fire days is small compared to non- fire days. Whilst the levels at local monitoring locations breach the WHO guideline of remaining below 15μgm^{-3}, all of London breaches this, and much of the south east of England even in rural areas. This guideline is an aspirational target. There is no evidence that any UK limits are being broken currently.

- Smoke signals are likely observed on a significant number of days annually (greater than number of LFB call out days). It is likely that fires at the Arnolds Field site increase particulate air pollution ($PM_{2.5}$) at monitoring sites in the area with impacts detectable at least 1 km away. This influence is greatest when winds are very low or conditions are stagnant. This increase has a limited contribution to daily average levels and very limited contribution to annual average concentrations.

7 References and endnotes

Carslaw, D. C. and K. Ropkins, (2012). openair—an R package for air quality data analysis. Environmental Modelling & Software. Volume27-28,pp. 52–61.

Carslaw, D. C. (2019). The openair manual — open-source tools for analysing air pollution data. Manual for version 2.6-6, University of York.

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[i] https://www.london-fire.gov.uk/incidents/

[ii] European Commission (EC) 2008. Directive 2008/50/EC of the European Parliament and of the Council on ambient air quality and cleaner air for Europe. Commission of the European Community, Brussels.

[iii] www.londonair.org.uk

[iv] https://www.london.gov.uk/sites/default/files/llaqm_technical_guidance_2019.pdf

[v] About — Breathe London Communities

[vi] What is the Daily Air Quality Index? - DEFRA UK Air - GOV.UK

[vii] Committee on the Medical Effects of Air Pollutants - GOV.UK

8 Appendix 1: Network health

With any monitoring network there will be failures of the equipment in the field over time. With the small sensors rather than a field repair , as is carried out with the reference equipment at Rainham, the unit is simply swapped out for a new one. Whilst most of the sensors ran without need for replacement the location at Upminster Road North seemed especially problematic requiring several swaps (see table 6). The less urban location of this site may have resulted in a higher impact from insects residing inside the sample inlet.

Site Name	Replacement Installed
Rainham (reference co-location)	01/08/2023
Ingrebourne Links Golf and Country Club	14/06/2024
Upminster Road North	10/10/2023
Upminster Road North	24/11/2023
Upminster Road North	02/09/2024
Upminster Road North	12/11/2024

Table 6: Sensor replacement incidences.

On some occasions the unit recovered itself, e.g. a blockage cleared, or the fault was intermittent meaning that only some data needed to be excluded in a period. Data for these periods was excluded from the data set. The data indicating a fault in need of replacement was also excluded. The excluded data from $PM_{2.5}$ is shown in table 7.

Site	Start of fault	End of Fault	Readings Excluded
Acer Avenue, Rainham	22-Sep-24	11-Oct-24	3207
King Edward Ave	08-Sep-24	19-Oct-24	564
Harris Academy Rainham	27-Nov-24	11-Dec-24	55
Upminster Road North	12-Oct-23	26-Nov-23	8320
Upminster Road North	10-Sep-24	30-Sep-24	3610

Table 6: Dates for excluded $PM_{2.5}$ data. Note that standard sampling is at 7 minute intervals

9 Appendix 2: Monitoring Update Discussion

As London Borough of Havering commissioned nodes approached their expiration dates, LBH needed to determine which nodes are suitable for long-term monitoring, with approval from the Launders Lane Technical Group. It was recommended that the termination of two Havering-commissioned nodes post-summer 2024, retaining four nodes under LBH commission would be an appropriate plan. It is important to note that the flexibility afforded by the mobility of monitoring kits enables us to decommission nodes in any order. For example, if it was decided to terminate Node A while Node B expires earlier, we can relocate Node A's kit to Node B's location.

Meteorology needs to be considered in this discussion process. The King Edwards and Acer Avenue nodes give the least distinct information since the wind direction is largely covered by the Spring Farm Park node. However, removing any other Nodes would compromise detection in a wind sector, as the others cover N (Upminster Road), W (Harris Academy), NW (Spring Farm) and SE (Ingrebourne Links Golf and Country Club). As for NE, Upminster Road is the only location that which has the potential to provide representative data covering SW prevailing winds.

Figure 30 shows the locations of the nodes funded by Havering Council as of Oct 2024. The yellow dots on the map show the LB Havering commissioned nodes that are up for consideration to terminate following the summer of 2024 (numbered for reference not preference). These nodes are:

1. Ingrebourne Links Golf and Country Club
2. Harris Academy Rainham
3. Spring Farm Park
4. Acer Avenue, Rainham
5. King Edwards Ave, Rainham
6. Upminster Road North

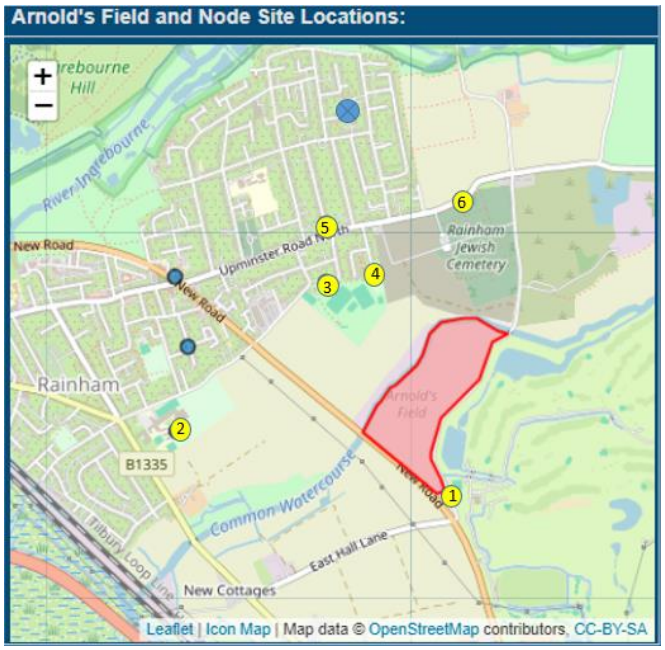

Figure 30: Locations of Breathe London Community nodes (yellow dots) currently funded by LBH. Nodes identified as potentially being suitable for decommissioning are numbered from 1-6.

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For reference the blue dots on the map show the nodes deployed in the study domain but are not commissioned by London Borough of Havering. These are the Rainham reference colocation node and the Rainham Against Pollution node (Orchard Ave). Both are positioned to the north west of the Arnolds Field site with the prevailing wind being from the Launders Lane site. Neither have an elevated baseline for $PM_{2.5}$. The Rainham reference site node was deployed in February of 2021 and the Rainham Against Pollution node was installed in August of 2023. Table 5 provides details of the nodes and outlines the rationale for either retaining or decommissioning these nodes.

Node	Position / Prevailing Wind Direction	Other Monitors at site?	>low PM 2.5	Max PM 2.5	>low NO2	"High" TRL Data	Date Installed	Subscription End Date	Rationale and Potential Risks
Ingrebourne Links Golf and Country Club (1 on map)	S / Away	TRL monitors	Yes	10	No	N/A	25 July 2023	23 May 2024 Agreement to host node: 21 January 2025	**Rationale for retaining Ingrebourne Links Golf and Country Club:** i. The Golf Course node is in a sensitive location; it has picked up a score of 10 on DAQI during fire season. ii. According to the TRL report, prevailing winds originate from the south/southwest direction. Given the southern positioning of this node, retention facilitates valuable comparison with other nodes. iii. The Golf Course node was located in the close to the TRL monitors. The TRL installation was at the lake the node at the car park. This has been moved to just outside the grounds to Launders Lane/New Road (due to hosting costs at previous location) iv. This node is physically closest in distance to the primary location of the L:aunders Lane site fires.
Harris Academy Rainham (2 on map)	W / Away	TRL Monitors and Met Units	No	3	No	N/A	19 July 2023	23 May 2024	**Rationale for retaining Harris Academy:** i. This is a sensitive receptor, as children and young people are vulnerable to the health impacts of air pollution. Because this node is located on a school, terminating this node would raise concerns among residents.
Spring Farm Park (3 on map)	NW / Towards	TRL Monitors and Met Units	No	3	No	Ethylbenzene, Xylene	26 July 2023	23 May 2024	**Rationale for retaining Spring Farm and terminating Acer Avenue and King Edwards.** i. The Spring Farm node is located in the exact location as TRL monitors and associated met units. ii. The Power BI Dashboard indicates minimal variations in patterns among the three nodes. iii. In terms of wind, Spring Farm node's coverage adequately addresses prevailing wind directions, so King Edwards and Acer Avenue do not give distinct information. **Potential Risks:** i. While Spring Farm node is located on council property. King Edwards Ave and Acer Ave nodes are on residential property. Removal of these nodes may rise concerns among residents, especially as residents volunteered to host them. ii. Long-term results need to be maintained.
Acer Avenue, Rainham (4 on map)	NNW / Towards	No	No	3	No	Toluene	21 October 2022	20 October 2024	
King Edwards Ave, Rainham (5 on map)	NNW / Towards	No	Yes	4	No	N/A	21 October 2022	20 October 2024	
Upminster Road North (6 on map)	N / Towards	No	No	2	No	N/A	3 October 2023	14 July 2024	**Rationale for keeping Upminster Road North:** Given the wind direction which comes from the south/southwest predominately, retaining this node is advisable as it is positioned north of Arnolds Field.

Table 5: Details of the nodes that were considered for decommissioning with details of each and considered rationale for either retaining or decommissioning each at the time of decommissioning

10 Appendix 3: Annual Local Increments

SiteName	SiteCode	Year	First Reading	Last Reading	Node Annual Average (ug/m3)	Annual Background (ug/m3)	Local Increment (ug/m3)	Percentage of Background	Percentage of Node Annual Average
Rainham (reference co-location)	CLDP0025	2021	23/02/2021	31/12/2021	11.11	8.36	2.75	32.84	24.72
Scotts Primary School	CLDP0062	2021	22/06/2021	31/12/2021	9.84	7.73	2.1	27.2	21.38
Bedfords Park Walled Garden	CLDP0160	2021	29/09/2021	31/12/2021	8.01	7.47	0.54	7.16	6.68
Cotleigh Road - Havering	CLDP0162	2021	10/10/2021	31/12/2021	13.78	7.6	6.17	81.2	44.81
Fontain Avenue -Havering	CLDP0163	2021	10/10/2021	31/12/2021	10.61	7.62	2.99	39.26	28.19
Rainham (reference co-location)	CLDP0025	2022	01/01/2022	31/12/2022	10.8	9.12	1.68	18.37	15.52
Scotts Primary School	CLDP0062	2022	01/01/2022	31/12/2022	10.91	9.13	1.78	19.47	16.3
Bedfords Park Walled Garden	CLDP0160	2022	01/01/2022	31/12/2022	10.29	9.34	0.95	10.16	9.22
Cotleigh Road - Havering	CLDP0162	2022	01/01/2022	31/12/2022	12.12	9.12	3	32.86	24.73
Fontain Avenue -Havering	CLDP0163	2022	01/01/2022	31/12/2022	9.76	9.12	0.64	7.02	6.56
Acer Avenue, Rainham	CLDP0360	2022	21/10/2022	31/12/2022	8.12	9.69	-1.57	-16.19	-19.32
King Edwards Ave, Rainham	CLDP0361	2022	23/10/2022	31/12/2022	10.04	9.76	0.28	2.9	2.82
Rainham (reference co-location)	CLDP0025	2023	01/01/2023	31/12/2023	8.49	8.05	0.45	5.54	5.25
Scotts Primary School	CLDP0062	2023	01/01/2023	31/12/2023	9.1	8.02	1.08	13.48	11.88
Bedfords Park Walled Garden	CLDP0160	2023	01/01/2023	31/12/2023	8.52	8.02	0.5	6.22	5.86
Cotleigh Road - Havering	CLDP0162	2023	01/01/2023	31/12/2023	9.35	8.02	1.33	16.57	14.22
Fontain Avenue -Havering	CLDP0163	2023	01/01/2023	31/12/2023	7.55	8.02	-0.47	-5.81	-6.17
Acer Avenue, Rainham	CLDP0360	2023	01/01/2023	31/12/2023	7.04	8	-0.97	-12.07	-13.72
King Edwards Ave, Rainham	CLDP0361	2023	01/01/2023	31/12/2023	8.39	8.09	0.3	3.66	3.53
Harris Academy Rainham	CLDP0492	2023	21/07/2023	31/12/2023	7.51	6.91	0.6	8.64	7.96
Ingrebourne Links Golf and Country Club	CLDP0501	2023	27/07/2023	31/12/2023	8.11	7.04	1.07	15.21	13.2

Spring Farm Park	CLDP0502	2023	27/07/2023	31/12/2023	7.7	7.04	0.66	9.44	8.63
Rainham Against Pollution (Orchard Ave)	CLDP0517	2023	08/08/2023	31/12/2023	7.7	7.35	0.35	4.76	4.55
Upminster Road North	CLDP0536	2023	26/11/2023	31/12/2023	7.26	7.04	0.22	3.07	2.98
St. Joseph's Catholic Primary	CLDP0556	2023	01/12/2023	31/12/2023	5.1	5.73	-0.64	-11.11	-12.5
Rainham (reference co-location)	CLDP0025	2024	01/01/2024	31/12/2024	8.51	8.01	0.5	6.2	5.84
Scotts Primary School	CLDP0062	2024	01/01/2024	13/12/2024	9.15	8.08	1.07	13.24	11.69
Bedfords Park Walled Garden	CLDP0160	2024	01/01/2024	13/12/2024	8.47	8.1	0.37	4.57	4.37
Cotleigh Road - Havering	CLDP0162	2024	01/01/2024	13/12/2024	8.73	8.08	0.65	8.03	7.43
Fontain Avenue -Havering	CLDP0163	2024	01/01/2024	13/12/2024	7.26	8.08	-0.82	-10.18	-11.33
Acer Avenue, Rainham	CLDP0360	2024	01/01/2024	29/10/2024	6.67	7.73	-1.07	-13.8	-16
King Edwards Ave, Rainham	CLDP0361	2024	01/01/2024	30/10/2024	7.4	7.64	-0.25	-3.22	-3.33
Harris Academy Rainham	CLDP0492	2024	01/01/2024	31/12/2024	8.24	8.02	0.22	2.74	2.66
Ingrebourne Links Golf and Country Club	CLDP0501	2024	01/01/2024	17/12/2024	7.93	8.11	-0.18	-2.23	-2.28
Spring Farm Park	CLDP0502	2024	01/01/2024	31/12/2024	7.66	8	-0.34	-4.24	-4.43
Rainham Against Pollution (Orchard Ave)	CLDP0517	2024	01/01/2024	31/12/2024	7.33	8.01	-0.69	-8.56	-9.37
Upminster Road North	CLDP0536	2024	01/01/2024	31/12/2024	6.69	7.53	-0.84	-11.14	-12.54
St. Joseph's Catholic Primary	CLDP0556	2024	01/01/2024	31/12/2024	7.78	7.98	-0.2	-2.51	-2.58
Launders Lane/New Road	CLDP0622	2024	17/12/2024	31/12/2024	7.06	6.92	0.14	1.99	1.96

Table 6: Annual Local Increment of PM2.5 compared to Annual Average and regional background

SiteName	SiteCode	Year	First Reading	Last Reading	Node Average (ug/m3)	Background Average (ug/m3)	Local Increment (ug/m3)	Percentage of Background	Percentage of Node Average
Rainham (reference co-location)	CLDP0025	2023	2023-03-25	2023-11-10	8.33	6.86	1.46	21.3	17.56
Scotts Primary School	CLDP0062	2023	2023-03-25	2023-11-10	7.43	6.72	0.71	10.55	9.54
Bedfords Park Walled Garden	CLDP0160	2023	2023-03-25	2023-11-10	7.16	6.72	0.44	6.6	6.19
Cotleigh Road - Havering	CLDP0162	2023	2023-03-25	2023-11-10	8.6	6.72	1.88	28.01	21.88
Fontain Avenue -Havering	CLDP0163	2023	2023-03-25	2023-11-10	7.26	6.72	0.54	8.1	7.49
Acer Avenue, Rainham	CLDP0360	2023	2023-03-25	2023-11-10	6.55	6.72	-0.17	-2.46	-2.52
King Edwards Ave, Rainham	CLDP0361	2023	2023-03-25	2023-11-10	7.97	6.72	1.25	18.56	15.65
Harris Academy Rainham	CLDP0492	2023	2023-08-02	2023-11-10	8.23	6.73	1.5	22.36	18.27
Ingrebourne Links Golf and Country Club	CLDP0501	2023	2023-08-02	2023-11-10	13.82	6.73	7.09	105.44	51.32
Spring Farm Park	CLDP0502	2023	2023-08-02	2023-11-10	8.87	6.72	2.15	31.91	24.19
Rainham Against Pollution (Orchard Ave)	CLDP0517	2023	2023-08-08	2023-11-10	9.64	7.49	2.16	28.79	22.35
Rainham (reference co-location)	CLDP0025	2024	2024-01-17	2024-12-31	9.56	8.21	1.35	16.44	14.12
Scotts Primary School	CLDP0062	2024	2024-01-17	2024-12-06	9.15	8.21	0.93	11.36	10.2
Bedfords Park Walled Garden	CLDP0160	2024	2024-01-17	2024-12-06	8.22	8.21	0.01	0.1	0.1
Cotleigh Road - Havering	CLDP0162	2024	2024-01-17	2024-12-06	9.67	8.21	1.46	17.74	15.07
Fontain Avenue -Havering	CLDP0163	2024	2024-01-17	2024-12-06	8.04	8.21	-0.18	-2.14	-2.19
Acer Avenue, Rainham	CLDP0360	2024	2024-01-17	2024-10-17	6.96	7.37	-0.41	-5.55	-5.88
King Edwards Ave, Rainham	CLDP0361	2024	2024-01-17	2024-10-24	7.05	7.3	-0.25	-3.36	-3.48
Harris Academy Rainham	CLDP0492	2024	2024-01-17	2024-12-31	8.88	8.18	0.71	8.68	7.98
Ingrebourne Links Golf and Country Club	CLDP0501	2024	2024-01-17	2024-12-06	8.68	8.28	0.4	4.79	4.57
Spring Farm Park	CLDP0502	2024	2024-01-17	2024-12-31	8.09	8.2	-0.11	-1.34	-1.36

Rainham Against Pollution (Orchard Ave)	CLDP0517	2024	2024-01-17	2024-12-31	8.38	8.21	0.17	2.01	1.97
Upminster Road North	CLDP0536	2024	2024-01-17	2024-12-31	7.4	7.78	-0.39	-4.97	-5.23
St. Joseph's Catholic Primary	CLDP0556	2024	2024-01-17	2024-12-31	7.53	8.09	-0.56	-6.87	-7.38
Launders Lane/New Road	CLDP0622	2024	2024-12-31	2024-12-31	9.52	7.8	1.71	21.95	18

Table 7: Average Local Increment of PM2.5 compared to Node average and regional background on days identified as "smoke days"

The local increment is calculated by calculating the mean from reference PM2.5 instruments at background locations across the London Air Quality Monitoring Network and then subtracting this from the Node measurements. There is some variation in the annual background for each Node since the background readings are only included where there is a valid Node reading for the same hour. Where there is a negative number then this means that the Annual average from the Node is lower than the region background.

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