AIR QUALITY IN HELSBY

2024 Annual Report

Report for: Peel NRE Limited

Ricardo ref. ED12299

Issue: Issue 1

DATE: 14/07/2025

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Registered company no. 08229264 | VAT no. GB 212 8365 24

Customer:
Peel NRE Limited

Customer reference:
Helsby 2024 Annual Report

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Ricardo reference:
ED12299

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EXECUTIVE SUMMARY

This report provides details and results of the air quality monitoring programme which took place in Helsby, Cheshire from 1st January 2024 – 31st December 2024.

The work was carried out by Ricardo on behalf of Peel NRE Limited. The monitoring programme includes measurements of particulates (PM_{10} and $PM_{2.5}$), heavy metals, and Toxic Organic Micro Pollutants (dioxins, furans, dioxin like polychlorinated biphenyls, and polycyclic aromatic hydrocarbons), to assess their concentrations against the relevant air quality objectives.

Hourly PM_{10} and $PM_{2.5}$ monitoring was carried out using a Fine Dust Analysis System (FIDAS). The data capture rate for both PM_{10} and $PM_{2.5}$ in 2023 was 93%. The annual means measured for PM_{10} and $PM_{2.5}$ were 10.5 μgm^{-3} and 6.3 μgm^{-3}, respectively. The annual mean AQS objectives are >40 μgm^{-3} for PM_{10} and >20 μgm^{-3} for $PM_{2.5}$, therefore, the annual means are below the limit values. The 24-hour mean PM_{10} limit is 50 μgm^{-3} which may not be exceeded more than 35 times per year to meet the objective. There were no exceedances of this limit in 2024, therefore this objective was met.

Monthly collated filter samples of PM_{10} were analysed for a number of heavy metals. The 2024 annual mean concentrations were compared to the UK AQS Objective for lead and Ambient Air Directive target values or Environment Assessment Levels for other compounds where applicable. No metals exceeded their associated target values or levels.

Dioxins, furans, dioxin like polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) were extracted from samples collected and collated every three months from a High-Volume sampler. Benzo(a)pyrene (B[a]P) is used as a marker for PAHs in ambient air. The annual mean concentration of B[a]P in 2024 was 0.087 ngm^{-3}, which is well below the annual mean European target value of 1 ngm^{-3} and the UK objective of 0.25 ngm^{-3}.

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Appendices

1. INTRODUCTION

This report produced on behalf of Peel NRE Limited, relates to the period 1st January 2024 to 31st December 2024 during which time air quality monitoring of dioxins, furans, particulates, PAHs and heavy metals were undertaken in Helsby, Cheshire.

The monitoring, commissioned on behalf of Peel NRE, followed on from an original contract with the Bioenergy Infrastructure Group (B.I.G) acting on behalf of Ince Bio Power Ltd. The original contract, which was completed in July 2020, was to monitor pollutants prior to and post construction and commissioning of a new biomass renewable energy power plant in Cheshire (Plot 9, Ince Resource Recovery Park). Further information on the air quality monitoring which took place during this initial survey can be found in a report located on the Protos website[1].

Monitoring continued without a break following the initial survey and will be ongoing to provide members of the local and wider community with air quality data on an annual basis. It will also provide monitoring required by businesses operating at Protos to ensure compliance with planning conditions.

During the period 1st January 2024 to 31st December 2024, activity on site at Protos included:

1. Operational biomass energy plant on plot 9a.
2. Operational timber recycling facility on plot 3.
3. Construction of the Energy Recovery Facility (ERF) on plot 8.

For more information on any of these activities, please visit www.protos.co.uk/community or email community@protos.co.uk.

2. MONITORING SITE AND METHODS

2.1 MONITORING STATION

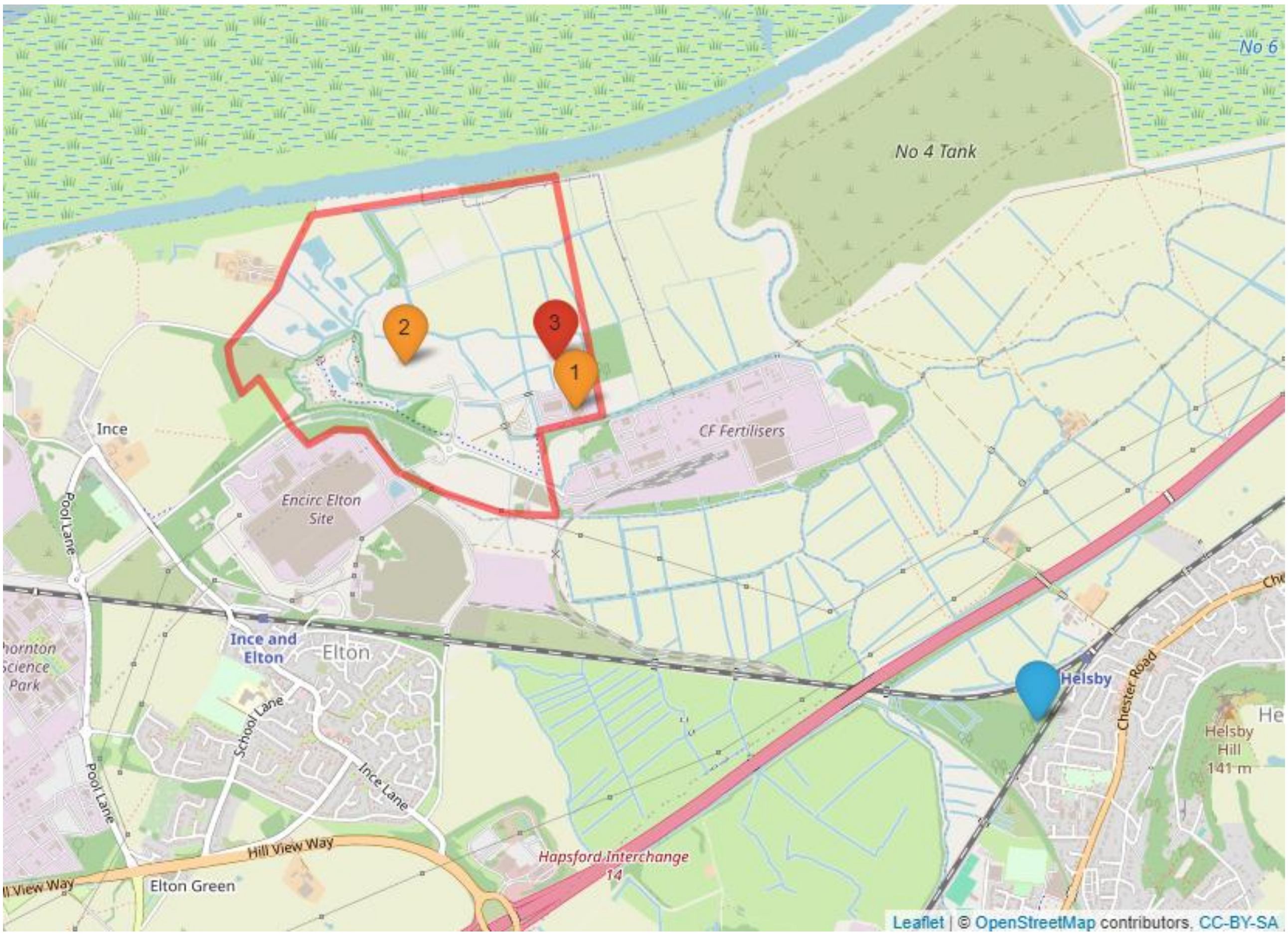
The monitoring station was set up in 2016 on land owned by Helsby Parish Council adjacent to an office building accessed from Mountain View, Helsby. The site was previously used by Ince Bio Power Ltd and will continue to be used for the purposes of ongoing monitoring for current and future facilities located at Protos.

Protos is an energy resource recovery park of 54ha, currently under development by Peel NRE. During 2024 three plots within Protos were occupied at the site, with one plot under construction. Figure 1 shows the location of the monitoring station (blue marker) with respect to the Protos development (as shown by the red line), the operational Ince Bio Power Plant and Ince Park Renewables Ltd (orange markers) and the site under construction (red marker).

This plan will be updated each year to show facilities at Protos which have been under construction, under commissioning, or operational during the reporting year.

[1] https://www.protos.co.uk/media-centre/community-downloads/#air-quality-documents.

Figure 1 Location of Helsby monitoring station (blue marker) and the Protos development. Operational facilities within the Protos development are shown as orange markers and facilities under construction are shown as red markers.



2.2 POLLUTANTS MONITORED

The monitoring station set up in Helsby is shown in Figure 2. The following sections provide an overview of the pollutants that Ricardo were contracted to measure at the site in Helsby, firstly by B.I.G. (now known as Evero), then since July 3rd 2020, by Peel NRE. In addition, hourly meteorological data from Liverpool John Lennon Airport (located 9 km NW of the monitoring station) were sourced from the NOAA Integrated Surface Database [1] and accessed using the worldmet R package [2].

Figure 2 Monitoring station located on land adjacent to RSK offices accessed from Mountain View in Helsby.

2.2.1 Particulate Matter

Airborne particulate matter varies widely in its physical and chemical composition, source and particle size. The terms PM_{10} and $PM_{2.5}$ are used to describe particles with an effective size with a median aerodynamic diameter of 10 and 2.5 µm respectively. These are of greatest concern with regard to human health, as they are small enough to penetrate deep into the lungs. They can cause inflammation and a worsening of the condition of people with heart and lung diseases. In addition, they may carry surface absorbed carcinogenic compounds into the lungs. Particles with a median aerodynamic diameter greater than 10 µm are less likely to travel as far into the respiratory system. These larger particles are also removed more readily from the air by sedimentation.

The main source of airborne particulate matter in the UK is combustion (industrial, commercial and residential fuel use). Other large sources include production processes, agriculture and road transport. PM and its precursors can also be transported long distances, and transboundary pollution from the continent can result in increased PM in the UK.

PM_{10} and $PM_{2.5}$ were measured using an MCERTS approved Fine Dust Analysis System (FIDAS). The FIDAS analyser utilises a light emitting diode (LED) to determine particle numbers and particle size distribution through light scattering of individual particles.

The output is recorded and stored every 10 seconds and averaged to 15 minute average values by an on-site data logger. This logger is connected to a modem to download the data to Ricardo. The data are then converted to concentration units and averaged to hourly mean concentrations. Data were processed according to the rigorous quality assurance and quality control procedures used by Ricardo, and ratified every six months, to produce the final dataset reported here.

2.2.2 Heavy Metals

Heavy metals are toxic metallic elements that can result in adverse health effects. Anthropogenic sources of heavy metals include emissions from industrial processes and fuel combustion.

A Partisol 2025 sampler was used to collect particulates in the PM_{10} fraction on a weekly schedule. The weekly filters were collated into monthly samples and sent to an analytical laboratory to be analysed for heavy metals including: Arsenic, Cadmium, Cobalt, Chromium, Mercury, Manganese, Nickel, Lead, Antimony, Thallium, Vanadium, Zinc, via UKAS accredited procedures, and Chromium VI (not accredited).

2.2.3 Toxic Organic Micro Pollutants (TOMPs)

Toxic Organic Micro Pollutants include a range of persistent organic pollutants (POPs), such as polychlorinated-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs). Exposure to POPs can have an adverse impact on human health and the environment. The main source of POPs in recent years in the UK are unintentional by-products from the incomplete combustion of fuels.

A High Volume sampler was used to collect samples for analysis of dioxins, furans, dioxin like PCBs and PAHs. Samples were collected every 2 weeks and collated into 3 monthly samples (Table 1). Sample blanks were also obtained and analysed and found to be within acceptable limits. The method used for the analytical measurement complies with US EPA 1613B for the PCBs, dioxins and furans, and EPA-TO-13A for PAHs.

Table 1 Start and end dates of 3-monthly periods for TOMPs sampling in 2024.

Period	Start Date	End Date
Period 1	27/12/2023	03/04/2024
Period 2	03/04/2024	11/07/2024
Period 3	11/07/2024	02/10/2024
Period 4	02/10/2024	24/12/2024

2.3 AIR QUALITY LIMIT VALUES

Table 2 shows the current UK objectives (included in the Air Quality Standards Regulations [3] and subsequent Amendments for the purpose of Local Air Quality Management), for the pollutants monitored at Helsby for this report. These regulations are based on those in the European Commission Directive on Ambient Air Quality and Cleaner Air for Europe [4], [5] (referred to as the Air Quality Directive) when the UK was a member of the European Union. Since Brexit, the UK is no longer tied to the EU limits, however, current objectives in the UK have been adopted from those stated in the Air Quality Directive, as shown in Table 2.

The current limit value for $PM_{2.5}$ is 20 μgm^{-3} as shown in Table 2. Under the Environment Act 2021, two new targets for $PM_{2.5}$ have been introduced into legislation for England, which are to be met by 2040 [6] [7]. These are:

- Annual mean concentration target for $PM_{2.5}$ of 10 μgm^{-3}, with an interim target of 12 μgm^{-3} to be met by the end of January 2028.
- Population exposure to $PM_{2.5}$ to be reduced by 35% compared to 2018 levels.

Where target analytes do not have a UK objective limit value, Ambient Air Directive (AAD) target values or Environmental Assessment Levels (EALS) used for Environmental Permit Risk assessments [8] were adopted for the purpose of this study, as shown in Table 3.

It should be noted that EALs for copper and mercury are no longer included in the analysis presented in this report. In 2023 the Environment Agency undertook a consultation to review and update the EALs for a number of pollutants. The long-term EALs for copper and mercury were changed from annual means to 24-hour means [9]. As the samples at Helsby are collated into 3 monthly measurements, 24-hour means cannot be calculated, therefore, it is not possible to compare to the new EALs for these two pollutants.

Table 2 UK and European air quality objectives for pollutants measured at Helsby.

Pollutant	UK Objective	European Objective	Measured as
PM_{10}	50 μgm^{-3} not to be exceeded more than 35 times a year	50 μgm^{-3} not to be exceeded more than 35 times a year	24 hour mean

Pollutant	**UK Objective**	**European Objective**	**Measured as**
PM_{10}	40 µgm^{-3}	40 µgm^{-3}	annual mean
$PM_{2.5}$	20 µgm^{-3}	20 µgm^{-3}	annual mean
Polycyclic Aromatic Hydrocarbons (PAH)	0.25 ngm^{-3} B[a]P	1 ngm^{-3} B[a]P	annual mean
Lead	0.25 µgm^{-3}	0.5 µgm^{-3}	annual mean

Table 3 Annual mean Ambient Air Directive (AAD) target values or Environmental Assessment Levels (EALS) for pollutants measured at Helsby.

Pollutant	Adopted limit (ngm^{-3})	Standard	Measured as
Arsenic (As)	6	AAD Target Value	annual mean
Cadmium (Cd)	5	AAD Target Value	annual mean
Manganese (Mn)	150	Environmental Assessment levels	annual mean
Nickel (Ni)	20	AAD Target Value	annual mean
Antimony (Sb)	5000	Environmental Assessment levels	annual mean

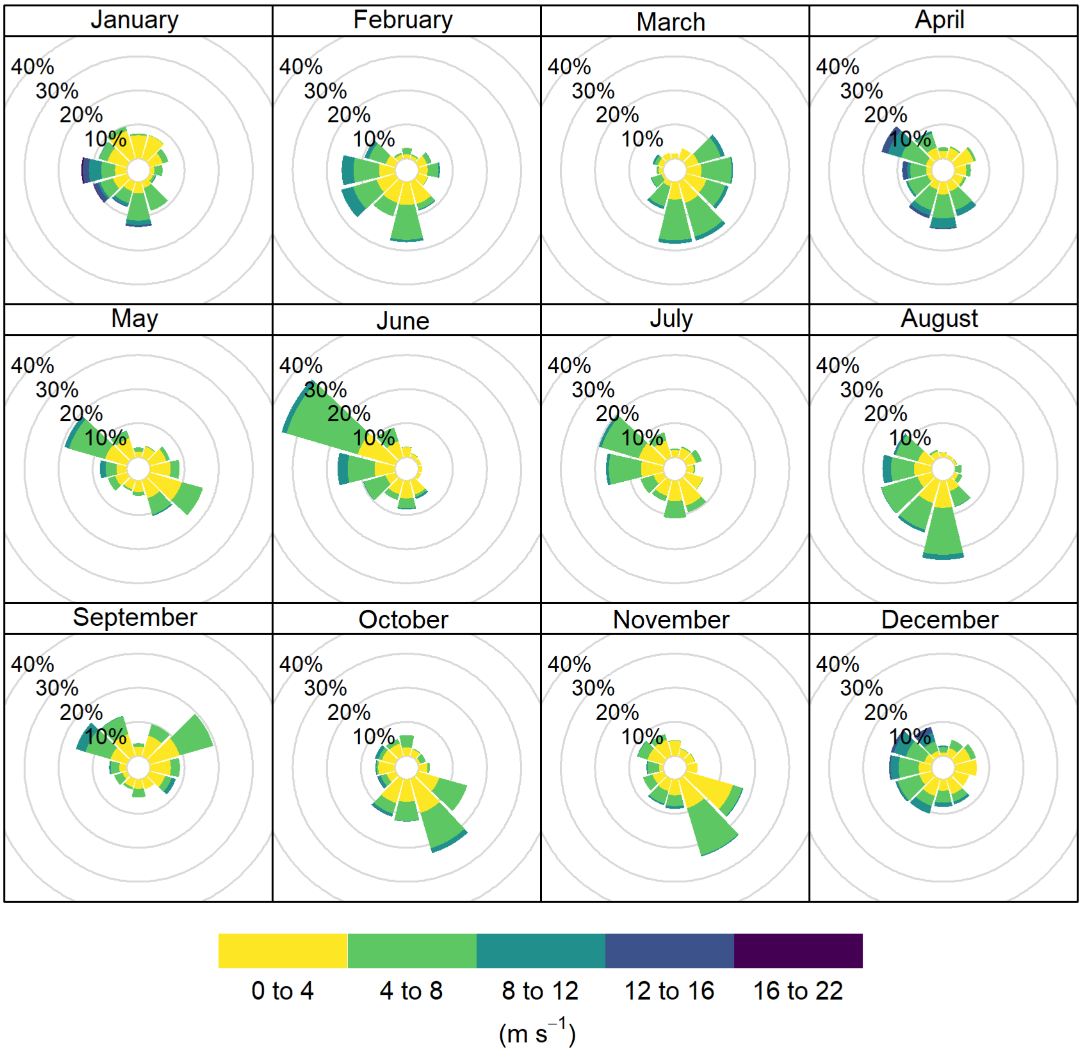
3. RESULTS AND DISCUSSION

The pollutant data measured at Helsby during 2024 have been analysed and where applicable measurements have also been assessed with respect to current Air Quality Objectives.

3.1 METEOROLOGICAL CONDITIONS

Figure 3 shows the distribution of wind speed and wind direction (wind rose) for each month at Liverpool John Lennon Airport. The “spokes” show the direction the wind is coming from, a longer spoke means a higher frequency of wind from that direction and the colours represent the wind speed (purple= high winds, yellow = calm winds). The highest winds were observed in January 2024, as a result of Storms Isha and Jocelyn between 21 and 24 January. Very high winds were also observed between 6 and 7 December 2024, due to Storm Darragh.

Figure 3 Monthly wind roses in 2024 for Liverpool John Lennon Airport. Data source: NOAA Integrated Surface Database (ISD) [1].



3.2 PM DATA ANALYSIS

3.2.1 Summary Statistics

Table 4 shows a summary of the PM data for 2024. The period mean concentrations are below the annual mean air quality objectives for PM_{10} and $PM_{2.5}$. There were no exceedances of the PM_{10} daily mean objective during 2024, therefore the objective was met. The data capture rates in 2024 for both PM fractions is 93%, which is above the data capture target of the Air Quality Standards Regulations of 90%.

Table 4 Summary statistics and exceedances for particulate matter measured at Helsby in 2024.

Statistic	PM_{10}	$PM_{2.5}$
Annual Mean (μgm^{-3})	10.5	6.3
Hourly Maximum (μgm^{-3})	56.9	46.7
Daily Maximum (μgm^{-3})	42.3	33.2
Data Capture rate (%)	93.0	93.0
Period mean > annual mean objective	No	No
Exceedances (daily mean > 50 μgm^{-3})	0	-

3.2.2 AQ Index Distribution

The plots below illustrate the distribution of AQ index values for Helsby for PM_{10} and $PM_{2.5}$. The AQIs are based on the daily mean for PM and each plot shows the number of days that concentrations measured are in each index. The index ranges from 1 to 10 and separated into four different bands: 1-3 = Low, 4-6 = Moderate, 7-9 = High, and 10 = Very High. Further information on the AQ Index is available in Table A1 in the appendix and from UK-Air [10]. During 2024, there were no days recorded when the PM_{10} or $PM_{2.5}$ AQI went above the “Low” banding (Index 1-3).

Figure 4 Distribution of AQI for PM_{10}.

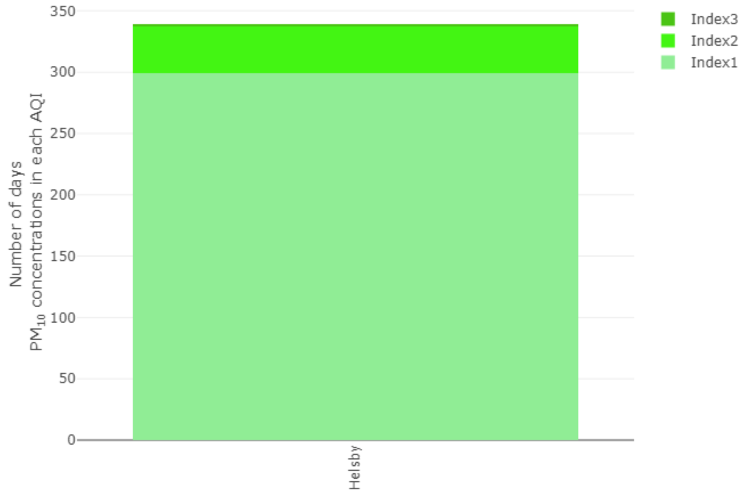
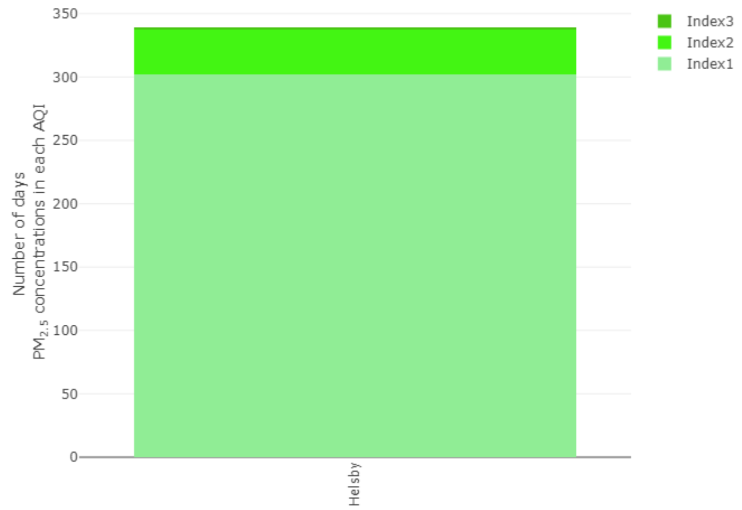


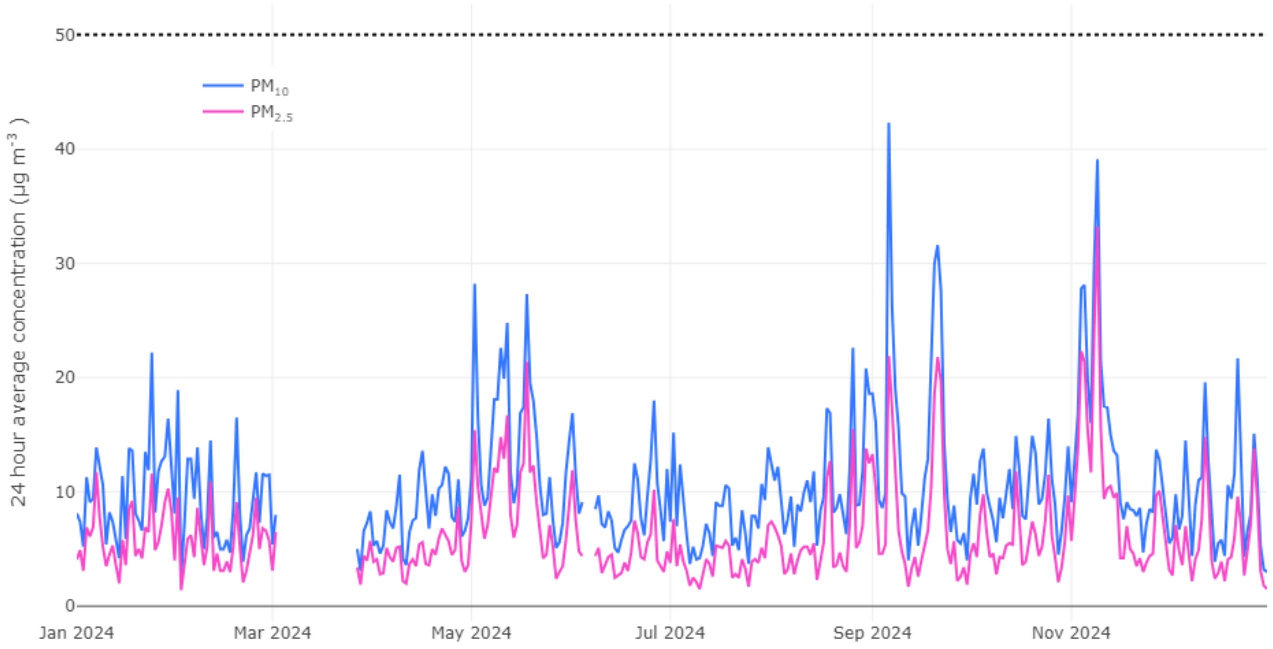
Figure 5 Distribution of AQI for $PM_{2.5}$.



3.2.3 Time Series

Figure 6 shows the 24 hour averaged time series of PM_{10} and $PM_{2.5}$ measured at Helsby during 2024. There was data gap from 2nd to 27th March 2024, which was the result of an issue with the FIDAS instrument. The instrument was removed from the site for testing in our laboratories and then sent back to the manufacturer to be fixed and serviced. A replacement FIDAS analyser, which was serviced and calibrated, was installed on 27th March to enable measurements to continue.

Figure 6 24 hour average PM_{10} and $PM_{2.5}$ concentrations measured at Helsby during 2024. The dashed line represents the PM_{10} 24 hour objective.



3.2.4 Time Variations

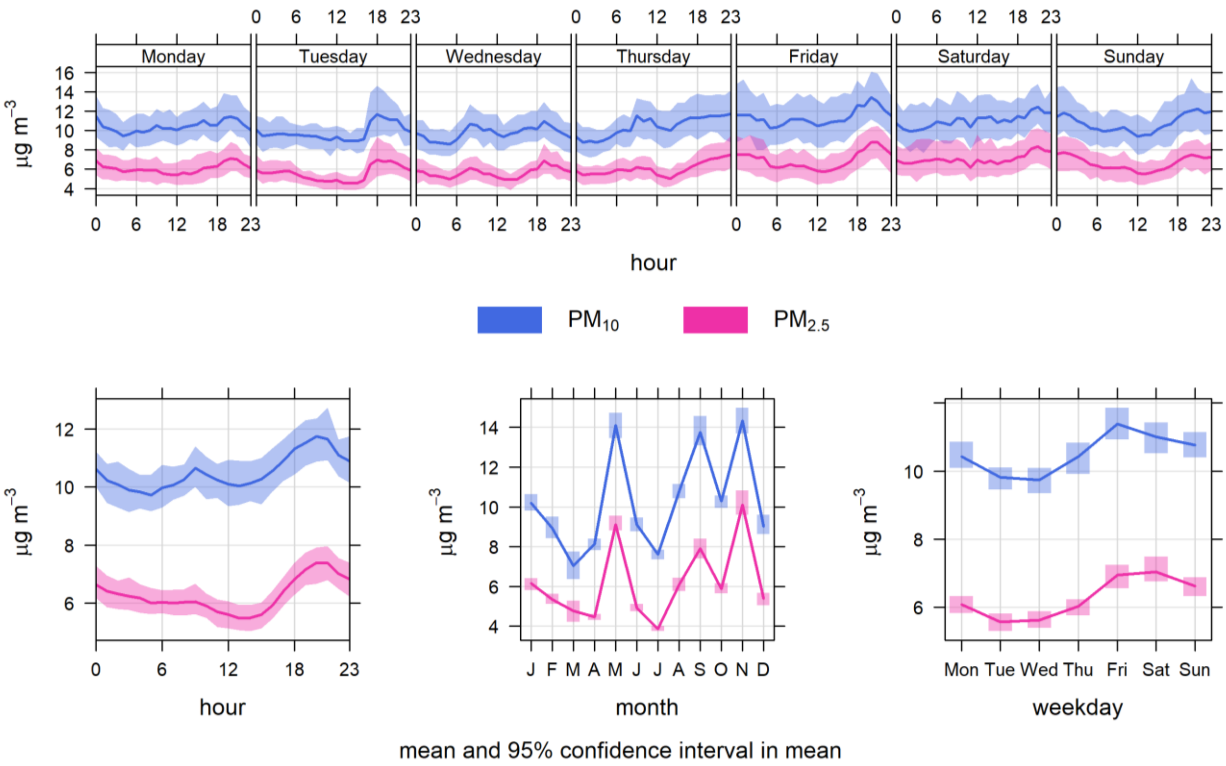
As PM_{10} and $PM_{2.5}$ are continuously measured on an hourly time period, the variability over short and long time periods can be assessed. Figure 7 shows the daily, weekly, and monthly variability in concentrations for 2024.

Seasonal: Variations in the PM concentrations across seasons can be seen in the “month” plot in Figure 7. PM concentrations were elevated during May, September, and November 2024. Elevated PM concentrations are common in the UK in spring, as secondary aerosols, formed from agricultural emissions, peak around this time of year. The increases in September and November are likely due to periods of high PM that were observed in many areas of the UK. Further details on these periods of elevated PM are provided in Section 3.2.5.

Weekly: The weekly cycles for PM_{10} and $PM_{2.5}$ are very similar with the lowest concentrations observed on Tuesday and Wednesday and highest on Friday and Saturday. The weekly cycle varies from year to year which may, in part, be related to changes in traffic patterns.

Diurnal: The diurnal cycle, as seen in the “hour” plot in Figure 7 shows a minimum in PM_{10} and $PM_{2.5}$ around noon to 1pm, with a small peak in the morning and a higher, broader peak in the evening. Concentrations remain high during the night-time, this might be due to a reduced surface boundary layer height during the night-time, rather than higher emissions of PM at night compared to midday. The surface boundary layer is the turbulent lower layer of the atmosphere that is influenced by the Earth’s surface, where vertical mixing of pollutants can occur. When the sun sets a lower stable nocturnal boundary layer forms which can trap pollutants near the ground, resulting in elevated concentrations compared to the daytime.

Figure 7 Temporal variations in PM_{10} and $PM_{2.5}$ concentrations measured at Helsby during 2024.



3.2.5 Calendar Plots

The plots in Figures 8 and 9 show daily variation in concentrations by pollutant for each month in 2024. The colours shown for each day relate to the concentration. The highest daily mean PM_{10} concentrations were observed on 6th September, with average daily concentrations of 42.3 µgm^{-3}. $PM_{2.5}$ concentrations were also elevated on this day (21.9 µgm^{-3}), however, the highest daily averaged $PM_{2.5}$ concentration observed in 2024 at the monitoring site was 33.2 µgm^{-3} on 9th November.

Elevated levels of PM observed in September (6-7th and 20-22nd) coincided with unseasonably warm weather in the UK. The Daily Air Quality Index (DAQI) on 6th September indicate “Moderate” levels of pollution were observed across many regions of England[2]. On 21st September, moderate pollution was observed across the Midlands. Therefore it is likely that widespread pollution contributed to the elevated PM levels observed in Helsby.

Elevated PM_{10} and $PM_{2.5}$ were also observed on 4-5th and 8-9th November. The cause of this is likely to be Bonfire Night celebrations. As Bonfire night fell on a Tuesday, celebrations are often also held at the weekend, which may explain the higher PM concentrations on 8-9th November.

[2] https://uk-air.defra.gov.uk/latest/measurement-summary-map

Figure 8 Calendar plot for PM_{10} measured at Helsby during 2024.

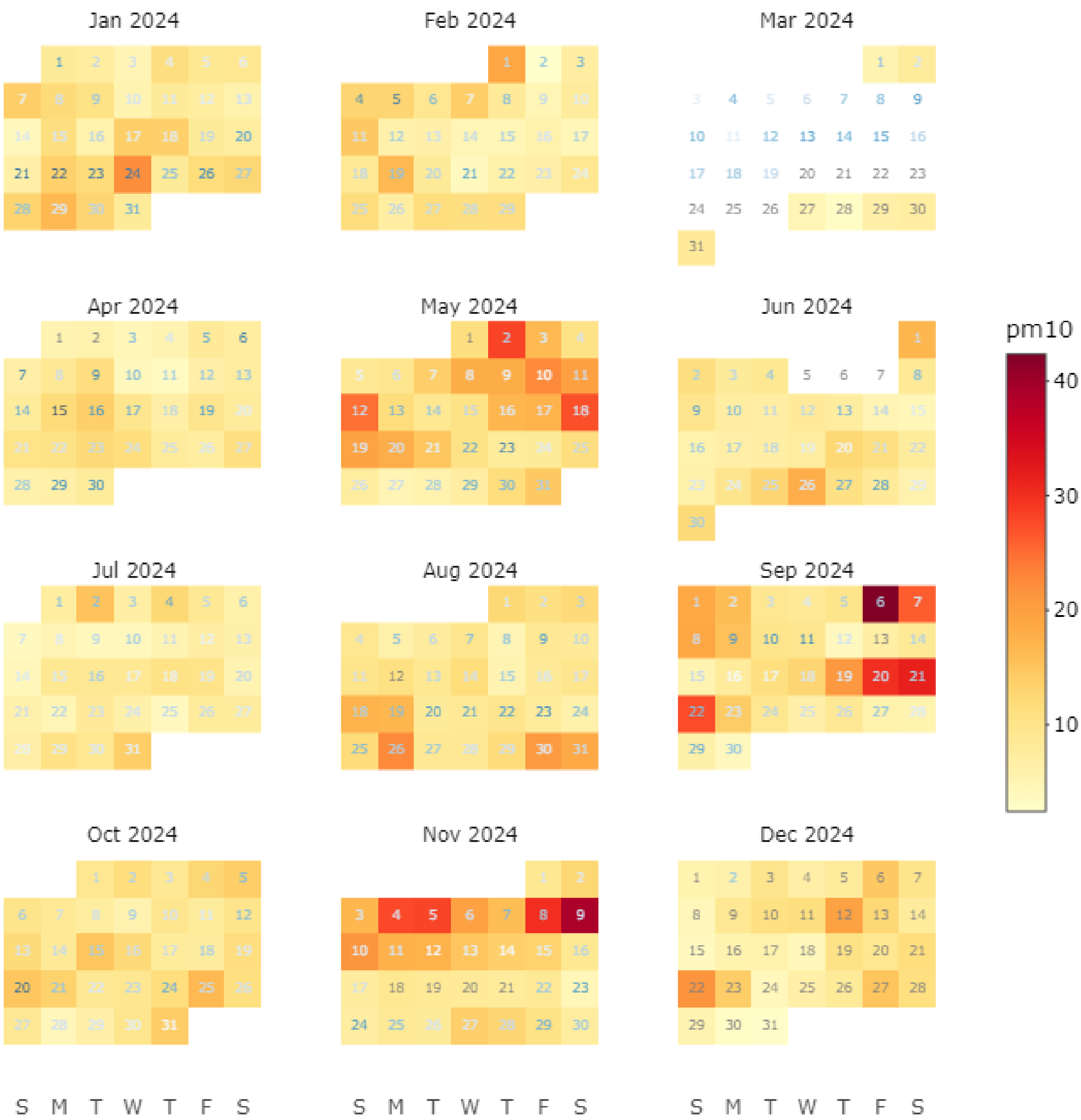
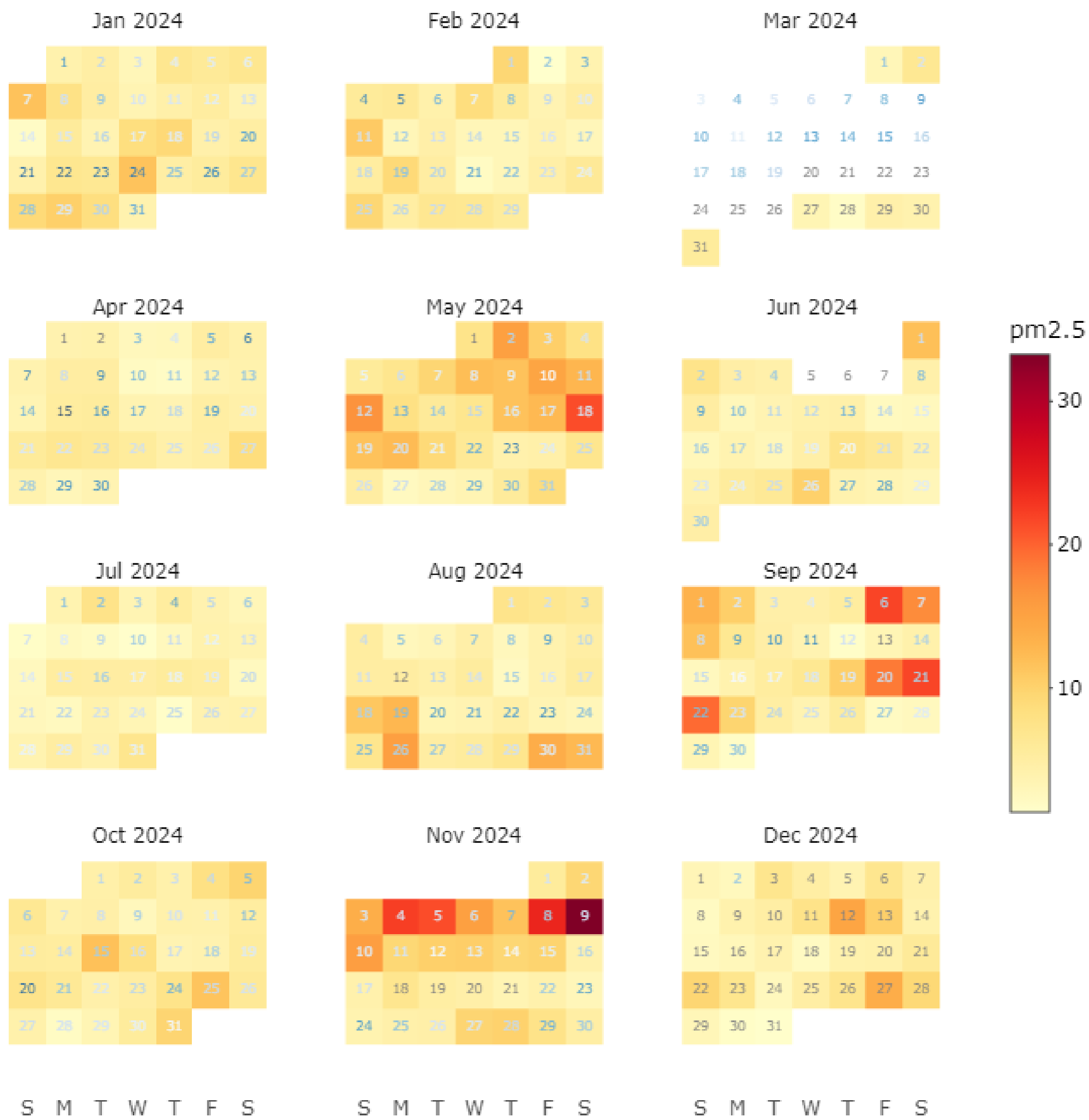


Figure 9 Calendar plot for $PM_{2.5}$ measured at Helsby during 2024.



3.2.6 Polar Plots

To investigate possible sources of PM in 2024, meteorological data measured at Liverpool John Lennon Airport was used to assess the hourly mean PM_{10} and $PM_{2.5}$ concentrations with wind speed and wind direction.

Figure 10 and Figure 11 show bivariate polar plots or "pollution roses" of PM_{10} and $PM_{2.5}$, respectively. The plots indicate how the PM concentration varies with wind direction and wind speed, with blue colours representing lower PM levels, and red colours higher PM levels.

PM_{10}: In 2024, the highest concentrations of PM_{10} were observed when the wind was from the west under high (>10 ms^{-1}) wind speeds and when the wind was from the east under calmer wind speeds (< 5 ms^{-1}).

$PM_{2.5}$: $PM_{2.5}$ shows a similar pattern with wind direction to PM_{10}.

Higher PM_{10} and $PM_{2.5}$ at low wind speeds is typically associated with local sources. Polar plots for 2020 through to 2024 (Figure 12), show that the elevated PM at low wind speeds to the east is observed across all years. The higher PM at high wind speeds is typically from the northwest which may be related to sources from the M56 and potentially the Protos site. Elevated PM at moderate-high wind speeds is also observed from the southwest in some years which could be due to pollution events bringing elevated PM from further afield.

Figure 10 Bivariate polar map of PM_{10} for 2024.

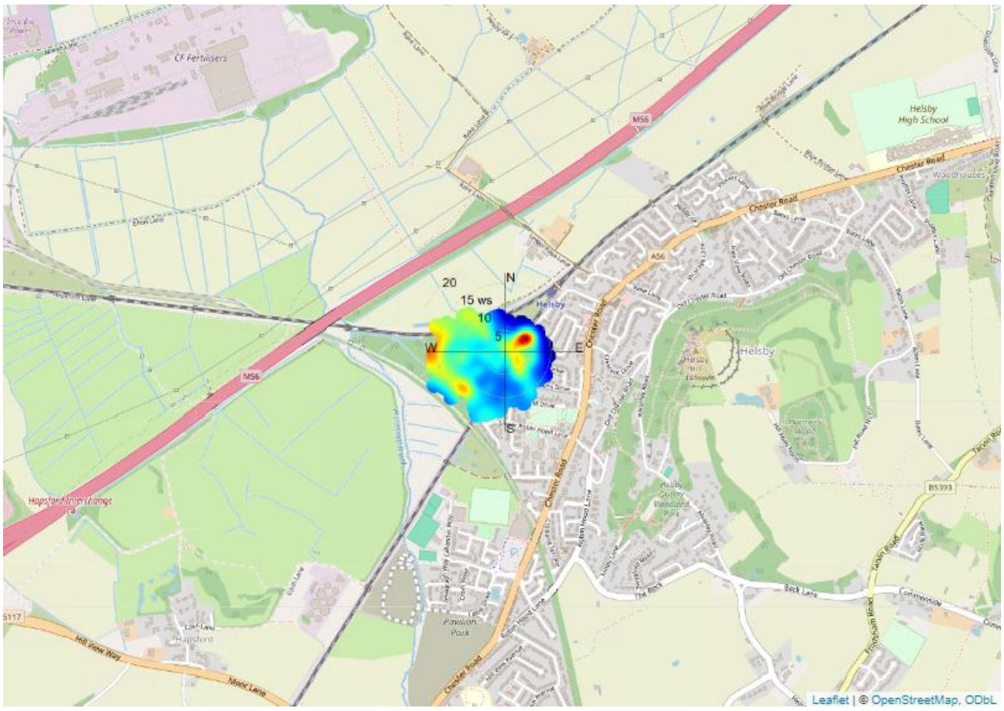


Figure 11 Bivariate polar map of $PM_{2.5}$ for 2024.

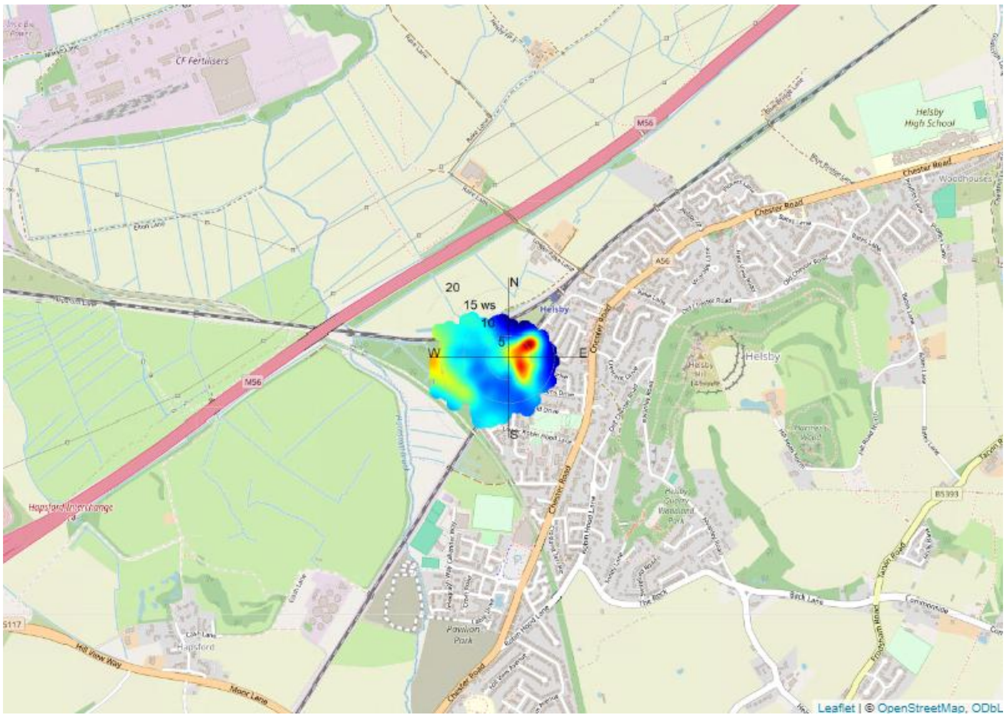
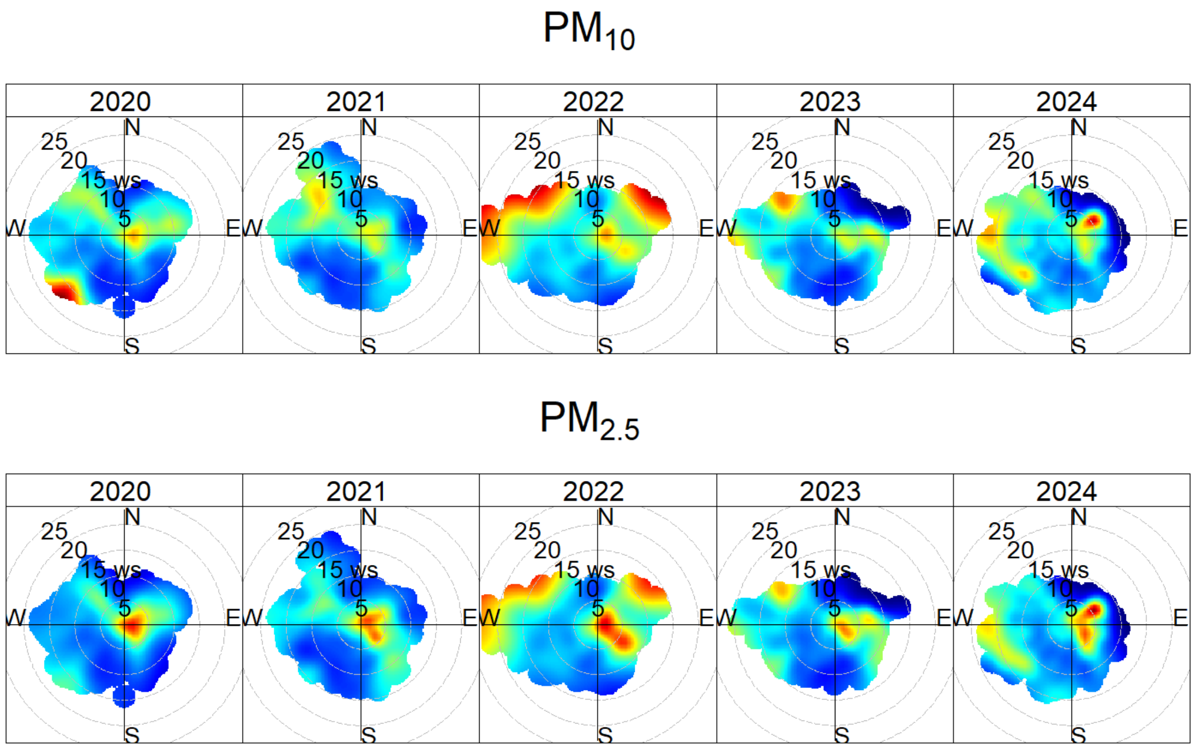


Figure 12: PM_{10} and $PM_{2.5}$ bivariate polar plots for 2020 to 2024.

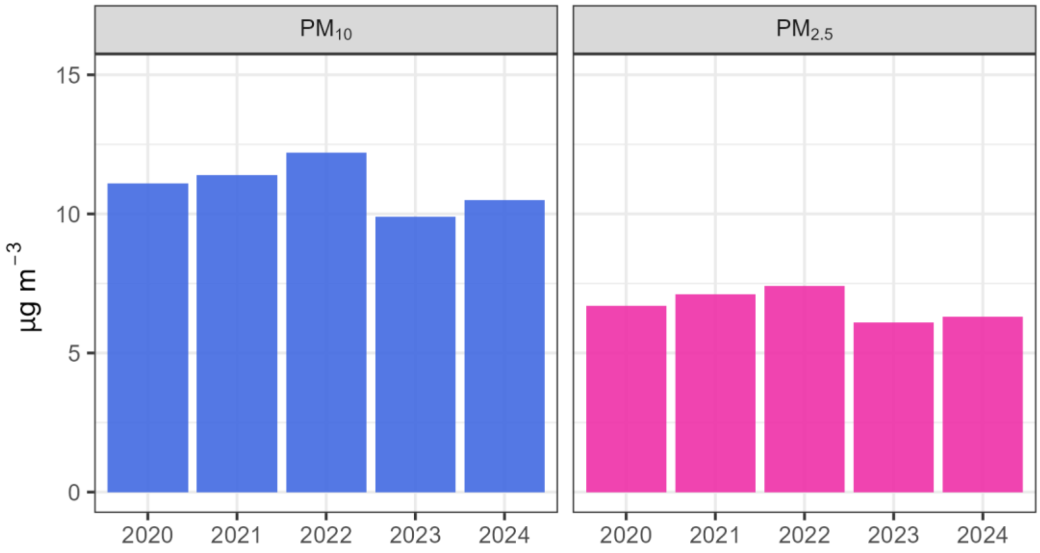


3.2.7 Annual Variation

Figure 13 shows the annual mean PM_{10} and $PM_{2.5}$ concentrations measured at Helsby from 2020 to 2024. The measured concentrations in all years are well below the annual mean air quality objectives for PM_{10} and $PM_{2.5}$.

In 2024, annual mean PM_{10} and $PM_{2.5}$ concentrations increased very slightly from 2023 but are still below the concentrations observed across 2020 to 2022. PM can be transported long distances in the atmosphere, therefore, variations in concentrations year-on-year can be caused by changes in meteorological conditions, in addition to variations in local emissions.

Figure 13 PM_{10} and $PM_{2.5}$ annual mean concentrations from 2020 to 2024.

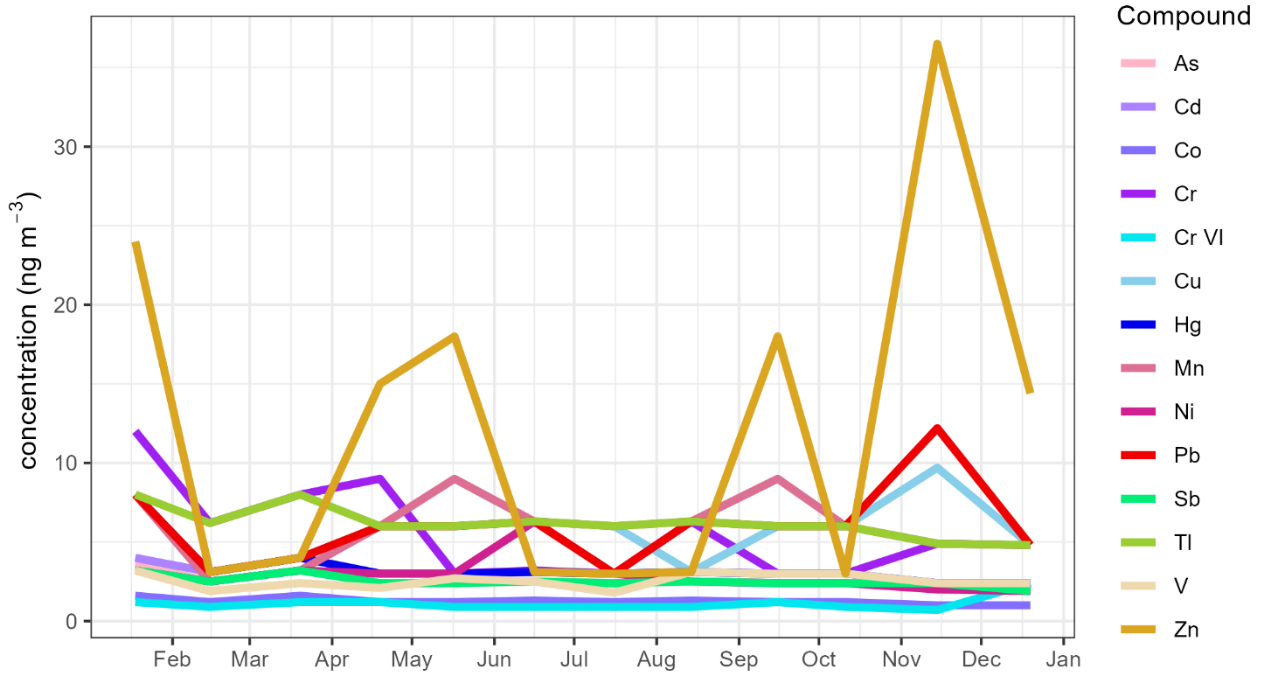


3.3 HEAVY METALS ANALYSIS

Figure 14 shows a time series of the metal concentrations for each month, during 2024. Data from the analysis of the monthly samples are provided in Table C1 in Appendix 3.

As highlighted in previous years, zinc concentrations are highly variable throughout the year. In 2024 concentrations dropped below the limit of detection in March and April, and again from June to August and in October.

Figure 14 Heavy metal concentrations measured at Helsby during 2024. Points shown at mid-point of 4-week period.



To assess the concentrations of heavy metals measured in Helsby, a comparison of annual means against UK AQS Objective, Ambient Air Directive target values or Environment Assessment Levels (outlined in Table 3) has been performed.

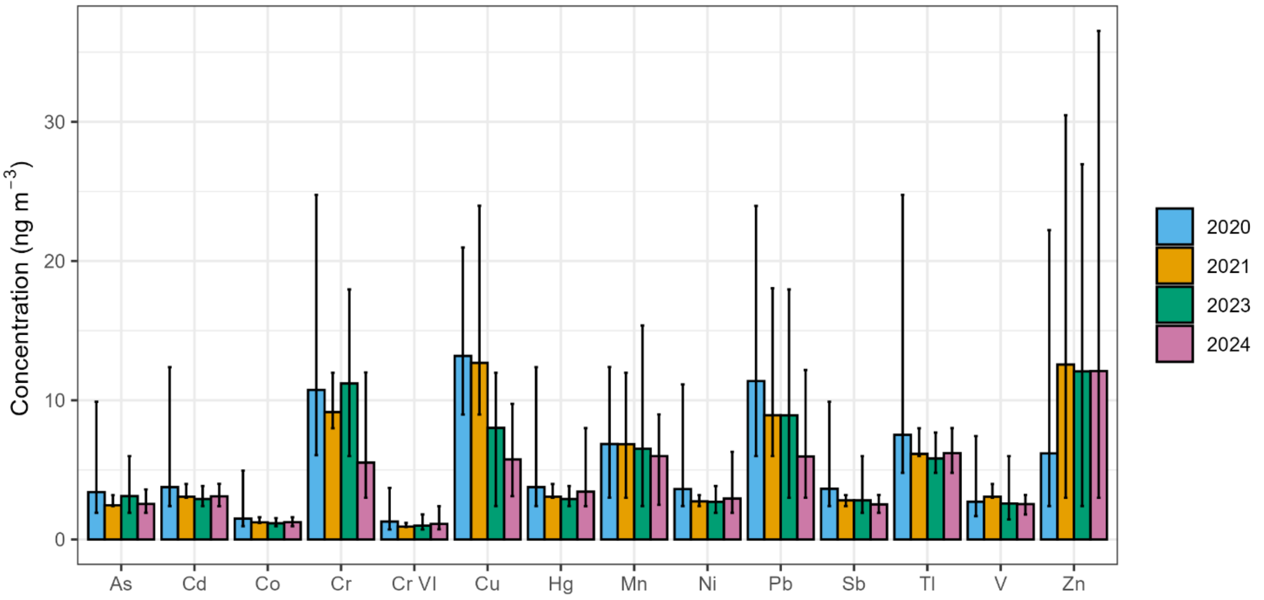
Annual averages for heavy metal concentrations measured during 2024 are shown in Table 5. The annual averages with and without measurements below detectable limits are provided. For some heavy metals concentrations were below the LOD for each sampling period during the year. In these cases period averages calculated without measurements below detectable limits are blank.

Table 5 Summary statistics for heavy metals during 2024.

Adopted limits (ng.m^{-3})	As 6	Cd 5	Co -	Cr -	Cu -	Hg -	Mn 150	Ni 20	Pb 250	Sb 5000	Tl -	V -	Zn -	Cr VI -
Annual Average	2.6	3.2	1.3	5.6	6	3.5	6.1	3.0	6.1	2.6	6.3	2.6	12	1.0
% of limit	44%	63%					4.1%	15%	2.4%	0.052%				
Annual Average (without < LOD)	2.9	-	-	5.6	6.2	-	6.1	3.7	6.2	2.4	-	2.7	21	-
% of limit (without < LOD)	48%						4.1%	18%	2.5%	0.049%				

To assess how concentrations of heavy metals have varied over time, annual mean concentrations for each heavy metal species for 2020, 2021, 2023 and 2024 were calculated (see Figure 15). Annual means could not be calculated for 2022, as data is only available for the final five months of 2022 (further information is provided in the 2022 annual report). The results show that concentrations have decreased overall for chromium (Cr), copper (Cu) and lead (Pb) from 2020 to 2024. Other species (e.g. As, Cd, Co, Hg, Tl, Cr VI, Mn, Ni, Sb) have remained at similar levels over the years. It should be noted that many of these species are at or below the limit of detection. Zinc (Zn) increased from 2020 to 2021 but has remained at a similar level since then. Data over a longer time period (10 years typically) is required to provide robust information on whether there is an ongoing long-term trend in these species.

Figure 15 Annual average of heavy metal concentrations measured at Helsby from 2020 to 2024. Error bars represent the maximum and minimum values recorded. Note that annual means were not available for 2022.



3.4 PAH ANALYSIS

Table 6 shows the period mean of the measured PAHs in PM_{10} calculated from the 3-monthly samples in 2024. All compounds sampled were above the LOD. Benzo(a)pyrene (B[a]P) is used as a marker for assessment of PAHs against UK and European objectives. The annual mean concentration of B[a]P in 2024 was 0.087 ngm^{-3}, which is well below the European target value of 1 ngm^{-3} and below the stricter UK objective of 0.25 ngm^{-3}. To assess the use of B[a]P as a marker for PAHs, additional PAHs are required to be measured as per the Fourth Daughter Directive (DD4). These additional compounds should include at a minimum: benz[a]anthracene, benzo[b]fluoranthene, benzo[j]fluoranthene, benzo[k]fluoranthene, indeno[1,2,3-cd]pyrene and dibenz[a,h]anthracene. All these compounds were measured at Helsby, along with other PAHs. Please note, however, as for previous years, the naphthalene concentrations reported are highly uncertain due to potential breakthrough on the sampling media at the flow rates used.

Table 6: Summary statistics for PAHs during 2024. Benzo(a)pyrene is used for assessment of PAHs against air quality objectives.

Compound	Annual Mean (ngm^{-3})	Compound	Annual Mean (ngm^{-3})
Naphthalene	0.048	Chrysene	0.157
Acenaphthylene	0.011	Benzo(b)fluoranthene	0.178
Acenaphthene	0.082	Benzo(k)fluoranthene	0.064
Fluorene	0.436	Benzo(a)pyrene	0.087
Phenanthrene	4.878	Indeno(1,2,3-cd)pyrene	0.107
Anthracene	0.176	Dibenzo(ah)anthracene	0.015

Compound	Annual Mean (ngm^{-3})	Compound	Annual Mean (ngm^{-3})
Fluoranthene	1.208	Benzo(ghi)perylene	0.090
Pyrene	0.838	Benzo(j)fluoranthene	0.062
Benzo(a)anthracene	0.094	Dibenzo(ac)anthracene	0.017

Concentrations of PAHs for each of the four periods in 2024 are shown in Figure 16. The data for each period are provided in Table C2 in Appendix A3.

Figure 16: PAH concentrations measured at Helsby during 2024.

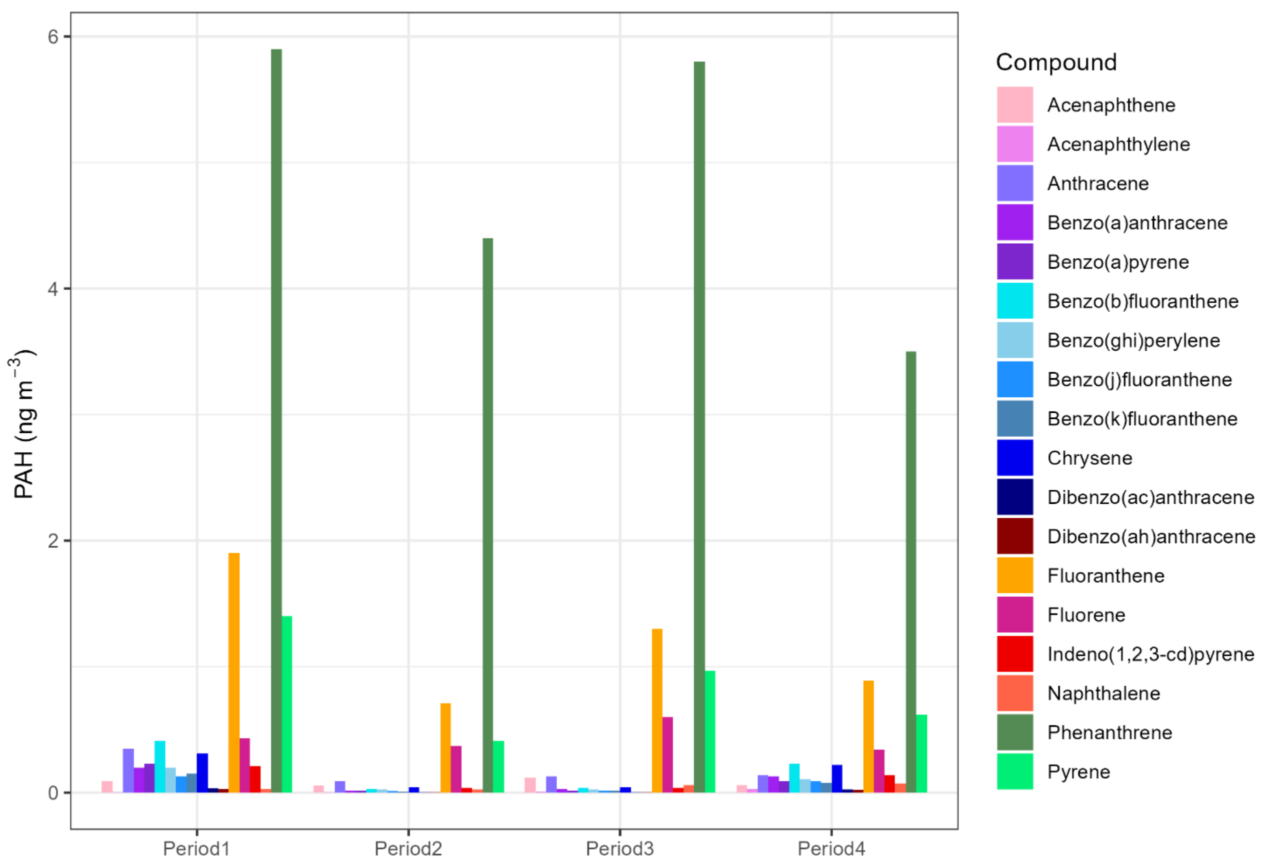
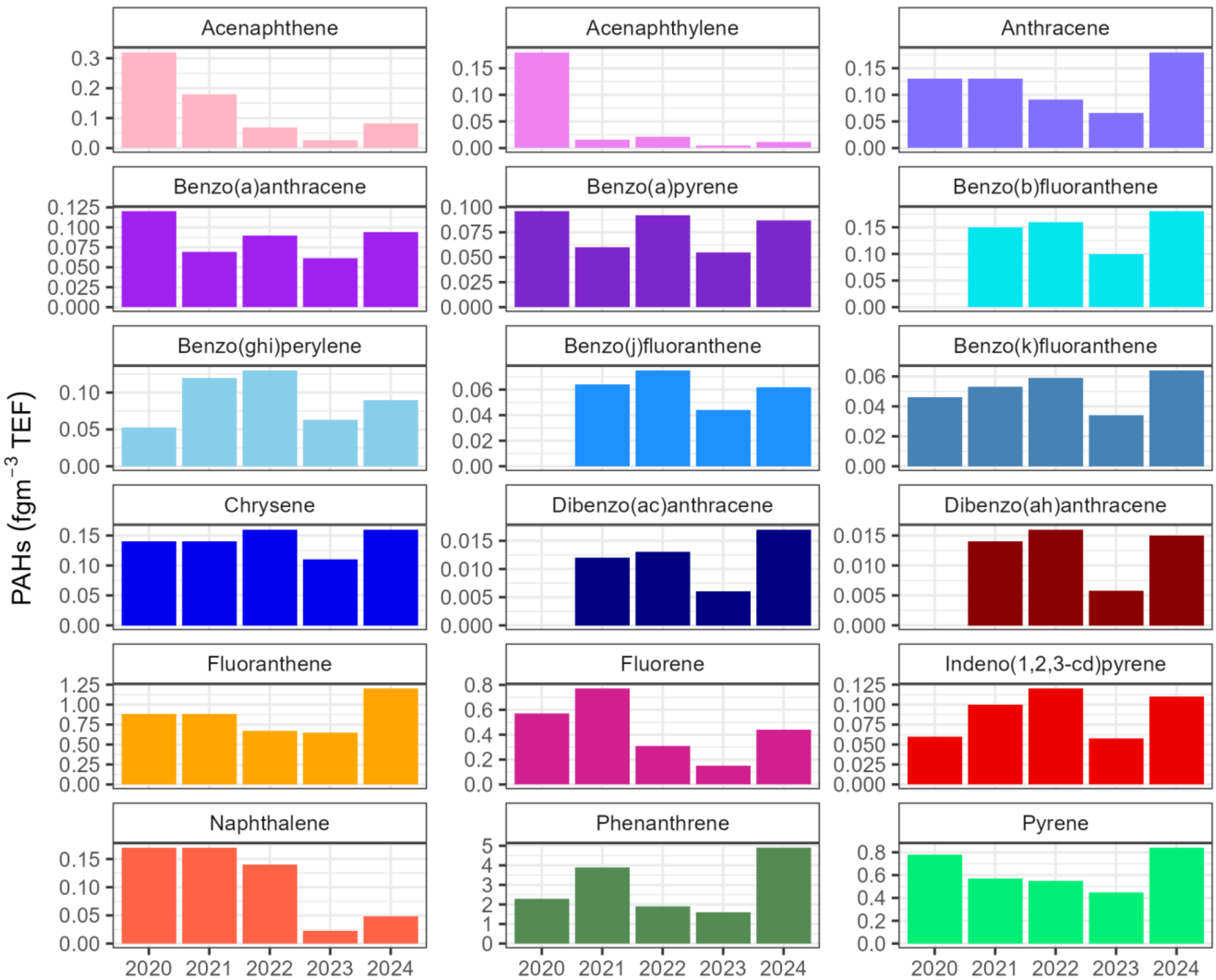


Figure 17 shows a comparison of annual mean PAH concentrations from 2020 to 2024. The analysis shows that the concentrations increased from 2023 to 2024, for all compounds. For some of the compounds, the concentrations measured in 2024 were higher than those of all previous years when measurements were taken. For B[a]P the measured concentrations have remained well below the UK objective of 0.25 ngm^{-3} for all years. Concentrations of the compound can vary year by year and measurements over future years will need to be undertaken to determine whether the increase observed in 2024 will continue.

Figure 17: Annual mean concentrations of PAHs from 2020 to 2024



3.5 DIOXINS, FURANS AND PCB ANALYSIS

The TOMPs data (Dioxins, Furans and PCBs) for Helsby have been converted to Toxic Equivalency using the World Health Organization Toxic Equivalency Factors (see Appendix A2). The annual mean concentrations for each set of compounds measured at Helsby in 2024 are provided in the tables below.

For 2378 Tetra CDD, 2378 Tetra CDF, and PCB-189, the concentrations during at least one of the periods, were below the detection limit of the instrument for analysis. The annual means without the data below the limit of detection are also provided in the table for these compounds.

Table 7: Summary statistics for Dioxins at Helsby during 2024. Numbers in parenthesis show the annual means calculated without the data below the limit of detection.

Compound	Annual Mean (fgm^{-3} TEF)
2378 Tetra CDD	0.545 (0.440)
12378 Penta CDD	1.615
123478 Hexa CDD	0.137
123678 Hexa CDD	0.335

Compound	Annual Mean (fgm^{-3} TEF)
123789 Hexa CDD	0.235
1234678 Hepta CDD	0.259
OCDD Octa CDD	0.005

Table 8: Summary statistics for Furans at Helsby during 2024.

Compound	Annual Mean (fgm^{-3} TEF)
2378 Tetra CDF	0.423 (0.313)
12378 Penta CDF	0.243
23478 Penta CDF	3.400
123478 Hexa CDF	0.478
123678 Hexa CDF	0.478
234678 Hexa CDF	0.703
123789 Hexa CDF	0.169
1234678 Hepta CDF	0.169
1234789 Hepta CDF	0.021
OCDF Octa CDF	0.001

Table 9: Summary statistics for PCBs at Helsby during 2024.

Compound	Annual Mean (fgm^{-3} TEF)
PCB-81	0.0016
PCB-77	0.0040
PCB-123	0.0005
PCB-118	0.0150
PCB-114	0.0004
PCB-105	0.0039
PCB-126	0.48
PCB-167	0.0003
PCB-156	0.0006
PCB-157	0.0002
PCB-169	0.0035
PCB-189	0.0001 (0.00005)

Bar plots showing the concentrations of Dioxins, Furans and PCBs measured at Helsby for each of the four periods in 2024 are shown in Figure 18 to Figure 20, below. The data for each period and compound are provided in Table C3 in Appendix A3.

Figure 18: Dioxin concentrations measured at Helsby during 2024.

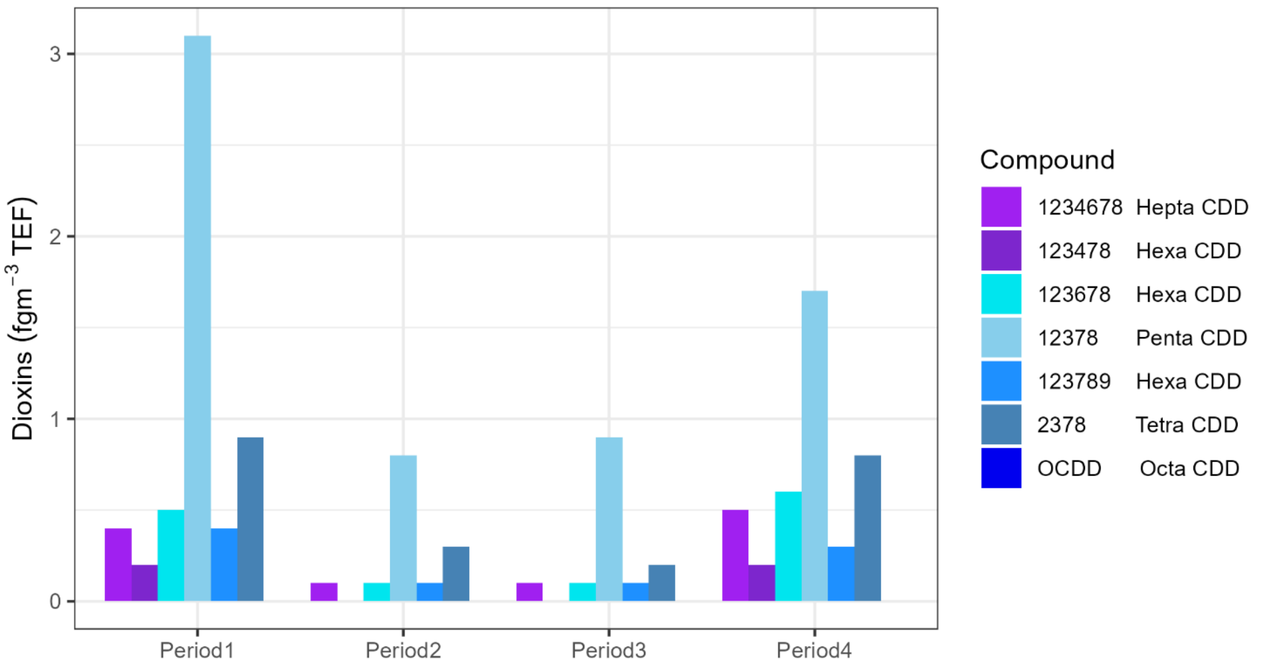


Figure 19: Furan concentrations measured at Helsby during 2024.

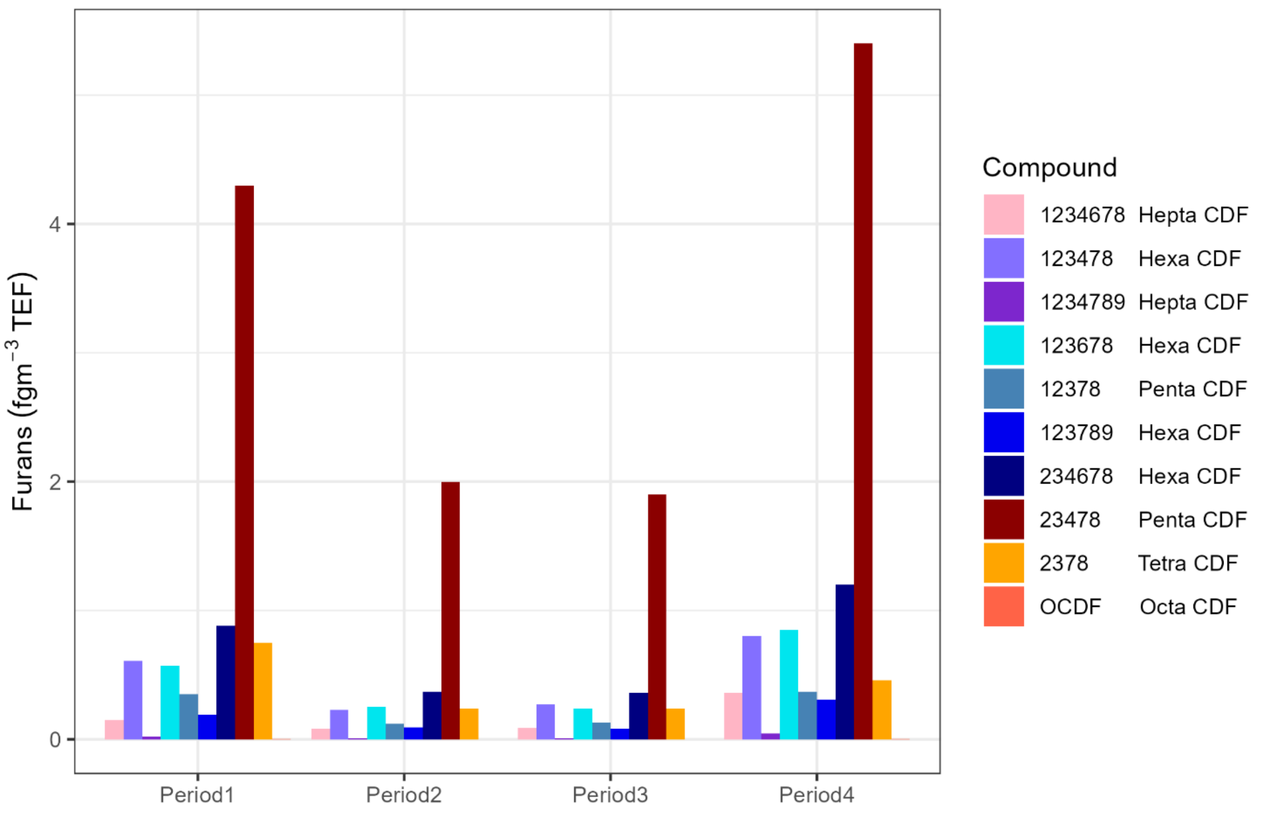


Figure 20: PCB concentrations measured at Helsby during 2024. Note, for PCB-126 actual concentrations are x10.

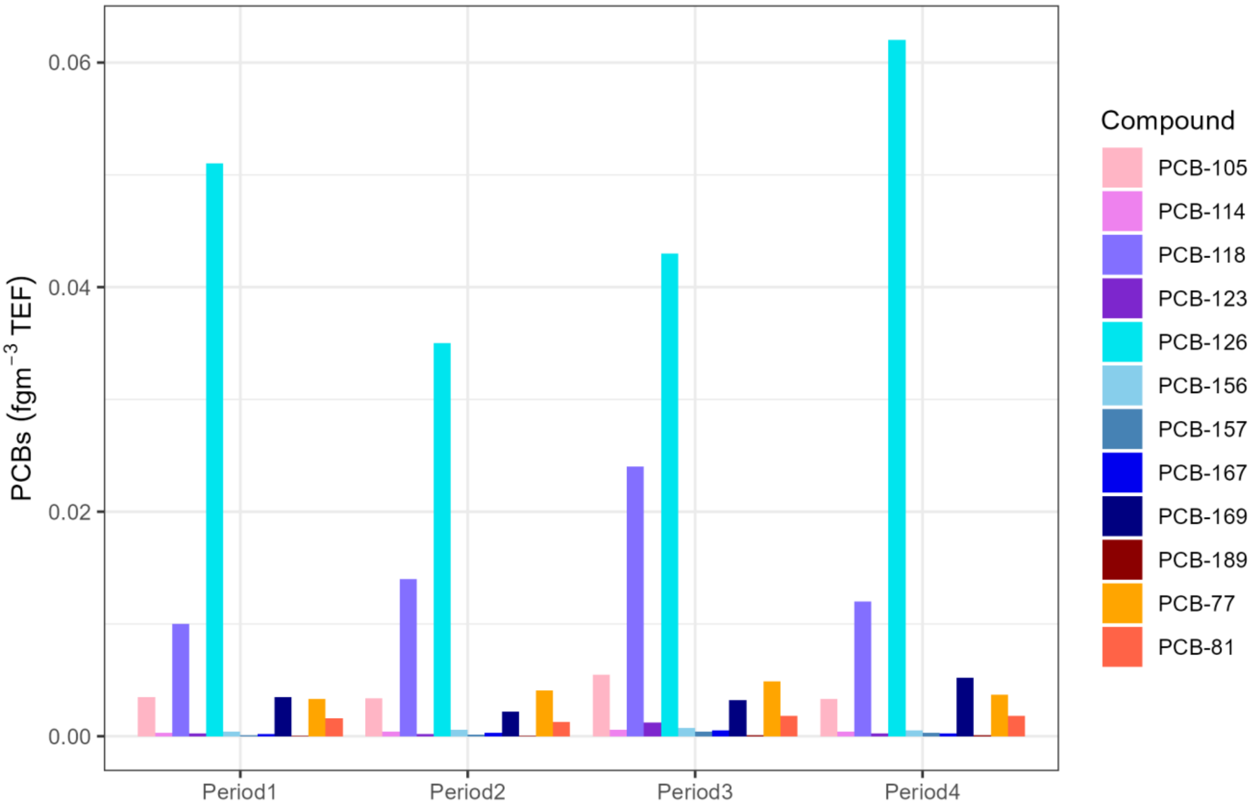


Figure 21 to Figure 23 below show the annual mean concentrations of dioxins, furans and PCBs measured at Helsby from 2020 to 2024. For the dioxins (Figure 21), there is an increase in concentrations in 2024 when compared to 2023 for 123478 Hexa CDD and 1234678 Hepta CDD. All other dioxins were lower in 2024.

All furans measured (Figure 22) show a decrease in 2024 compared to 2023, with the exception of Octa CDF which saw a very small increase (~6%). The change in PCB concentrations between 2023 and 2024 (Figure 23) varied, with increased observed for some compounds and decreases for others.

For all the compounds measured here data from future monitoring will help determine whether there are ongoing trends or if the changes are just natural variability in the concentrations.

Figure 21: Annual mean concentrations of Dioxins from 2020 to 2024

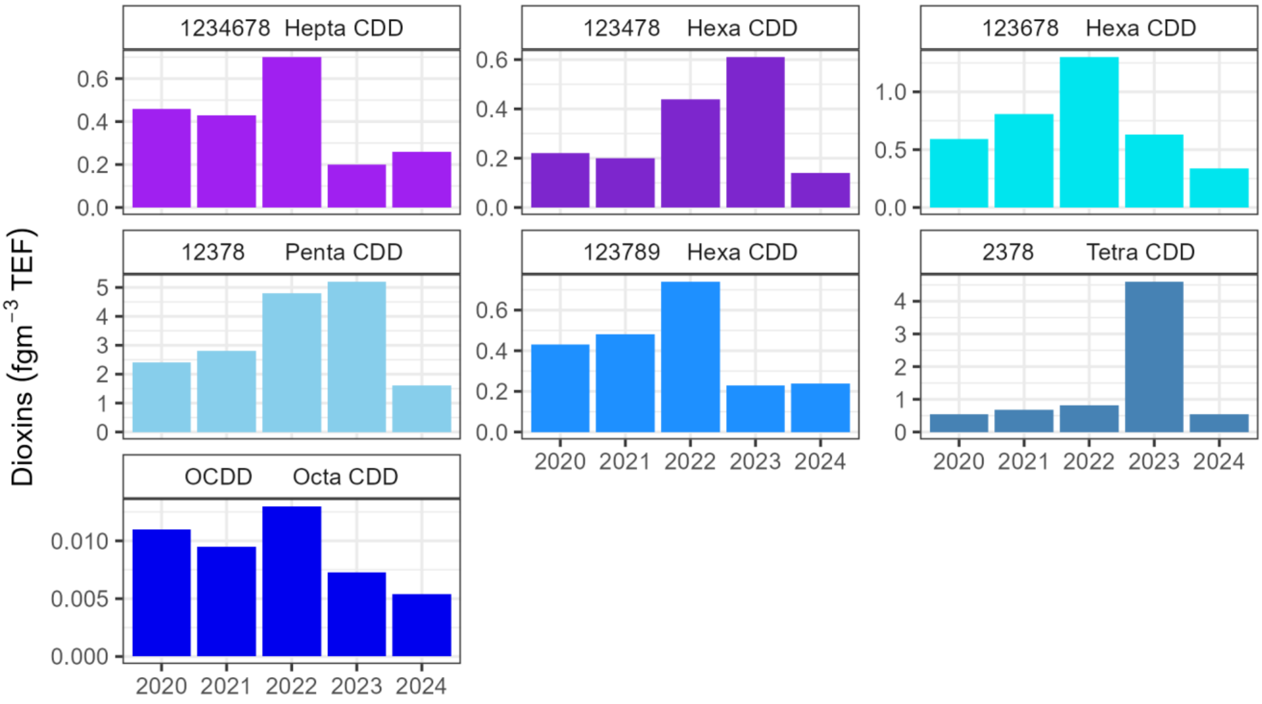


Figure 22: Annual mean concentrations of Furans from 2020 to 2024

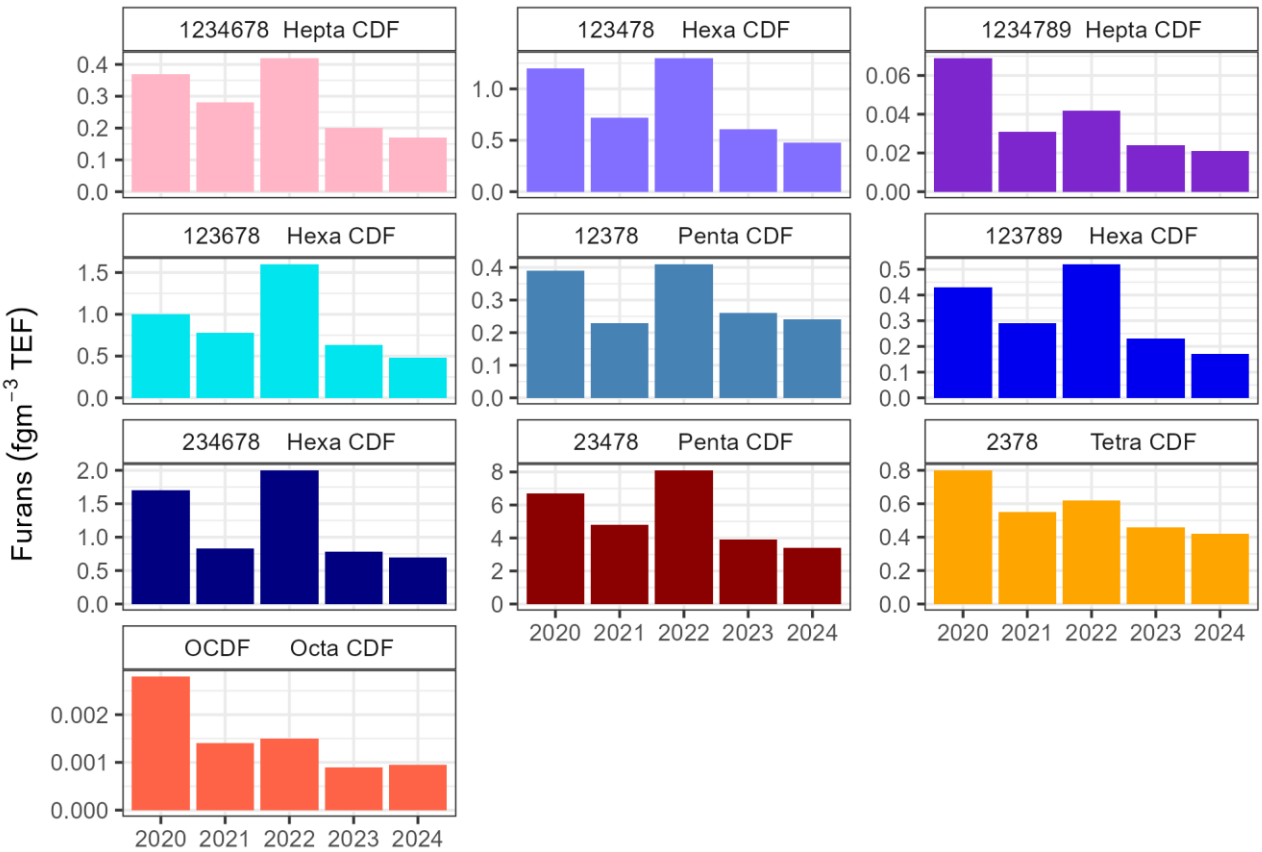
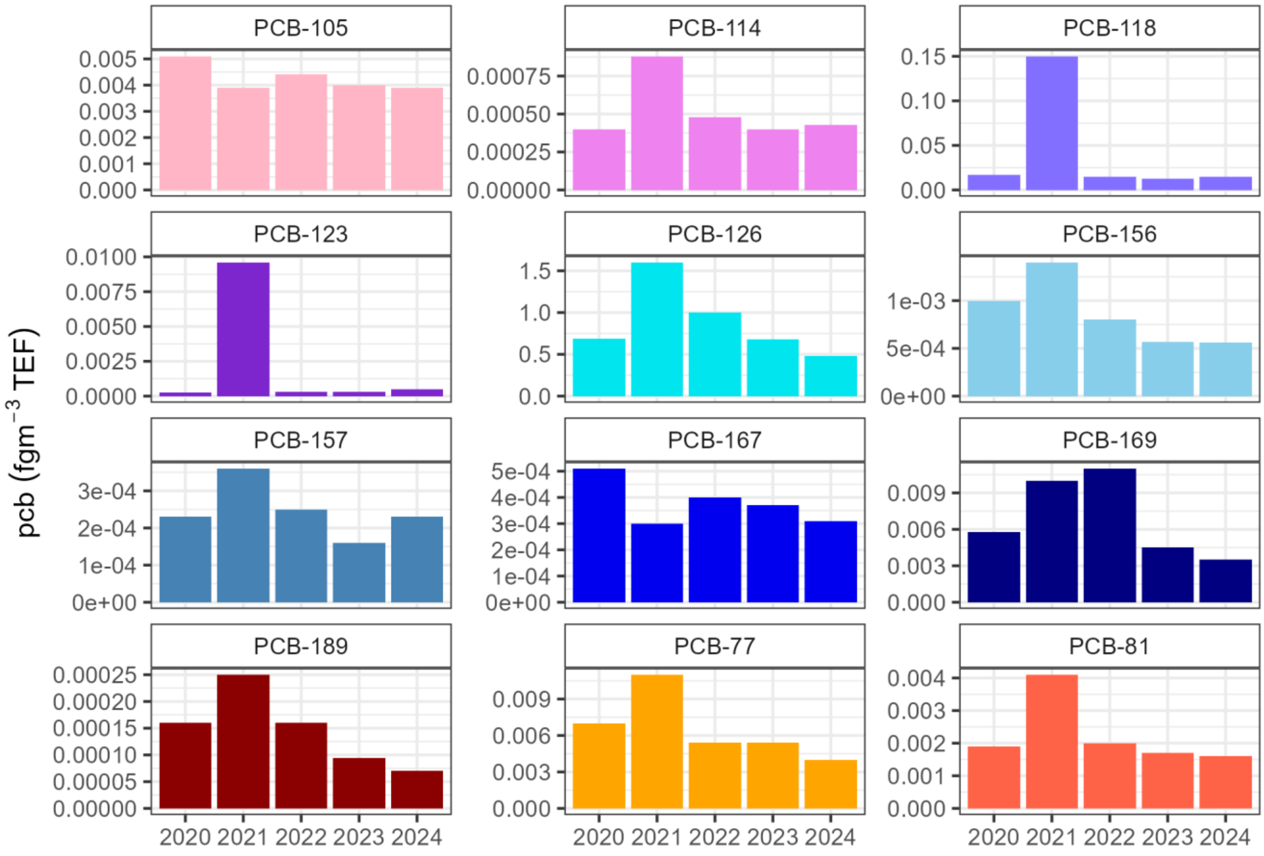


Figure 23: Annual mean concentrations of PCBs from 2020 to 2024



4. CONCLUSIONS

This report provides the results from the analysis of the pollutant data measured at the site in Helsby in 2024.

The results show that annual mean concentrations of PM_{10} and $PM_{2.5}$ in 2024 were 10.5 μmg^{-3} and 6.3 μmg^{-3} respectively. These are well below the annual mean AQS objective of 40 μgm^{-3} for PM_{10} and 20 μgm^{-3} for $PM_{2.5}$. There were also no exceedances of the 24-hour PM_{10} limit of 50 μgm^{-3}.

Variations in hourly PM_{10} and $PM_{2.5}$ concentrations with wind speed and direction were assessed to investigate sources of particulates. Higher concentrations of PM_{10} and $PM_{2.5}$ were associated higher wind speeds from the west and calmer wind from the east.

Some periods of elevated PM were observed in September which were likely due to widespread pollution events that were observed in other regions across England. Increases in November were also observed, which may be related to Bonfire Night celebrations.

Filter samples of PM_{10} were collected every month and heavy metal concentrations extracted. The annual mean concentrations for all metals with assessment levels were below the associated target values. Many of the metals analysed were also below the limit of detection.

Samples were collected and collated every 3 months for analysis of dioxins, furans, PCBs, and PAHs. The annual mean concentration of Benzo(a)pyrene (B[a]P), which is used as a marker compound for PAHs, was 0.087 ngm^{-3} in 2024, which is below the European (1 ngm^{-3}) and UK (0.25 ngm^{-3}) objectives.

The measured concentrations for all PAH compounds where higher in 2024 when compared to 2023. The concentrations of all except one of the furans measured decreased in 2024, when compared to 2023. For dioxins and PCBs, the change between 2023 and 2024 was variable, with some compounds showing an increase and others a decrease. Variations in concentrations, both positive and negative, can occur year-to-year. Long-term data is required to make any robust conclusions of any increasing or decreasing trends.

5. REFERENCES

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APPENDICES

Appendix 1 Air Pollution Bandings

Table A1 *Description of air pollution bandings*

Banding	Index	Accompanying health messages for at-risk individuals
Low	1,2,3	Enjoy your usual outdoor activities.
Moderate	4,5,6	Adults and children with lung problems, and adults with heart problems, who experience symptoms, should consider reducing strenuous physical activity, particularly outdoors.
High	7,8,9	Adults and children with lung problems, and adults with heart problems, should reduce strenuous physical exertion, particularly outdoors, and particularly if they experience symptoms. People with asthma may find they need to use their reliever inhaler more often. Older people should also reduce physical exertion.
Very High	10	Adults and children with lung problems, adults with heart problems, and older people, should avoid strenuous physical activity. People with asthma may find they need to use their reliever inhaler more often.

Appendix 2 Toxic Equivalency Factors

The International Toxic Equivalent (ITEQ) values for individual congeners are calculated for each sample using the WHO schemes. The factors are provided in Table B2. Where an isomer has a result less than the LOD a value equivalent to the LOD is used to determine the ITEQ. Therefore, these values represent a worst case assessment. Additional total ITEQ values are also calculated, assuming that where a result is less than the limit of detection then the ITEQ contribution is zero.

Table A2 Toxic equivalency factors for TOMPs

Compound	WHO TEF	Compound	WHO TEF
DIOXINS		**PCBs**	
2378 Tetra CDD	1	PCB-81	0.0003
12378 Penta CDD	1	PCB-77	0.0001
123478 Hexa CDD	0.1	PCB-123	0.00003
123678 Hexa CDD	0.1	PCB-118	0.00003
123789 Hexa CDD	0.1	PCB-114	0.00003
1234678 Hepta CDD	0.01	PCB-105	0.00003
OCDD Octa CDD	0.0001	PCB-126	0.1
FURANS		PCB-167	0.00003
2378 Tetra CDF	0.1	PCB-156	0.00003
12378 Penta CDF	0.05	PCB-157	0.00003
23478 Penta CDF	0.5	PCB-169	0.003
123478 Hexa CDF	0.1	PCB-189	0.00003
123678 Hexa CDF	0.1		
234678 Hexa CDF	0.1		
123789 Hexa CDF	0.1		
1234678 Hepta CDF	0.01		
1234789 Hepta CDF	0.01		
OCDF Octa CDF	0.0001		

Appendix 3 Datasets

The following tables provide the analysis of heavy metals, PAHs, Dioxins, Furans and PCBs, for each period during 2024.

Table C1 Analysis of heavy metals for each period. Values with the prefix “<” denote data where the values were below the limit of detection.

start	end	Report ID	As	Cd	Co	Cr	Cu	Hg	Mn	Ni	Pb	Sb	Tl	V	Zn	Cr VI
04/01/2024	01/02/2024	ASC/63060.001	3.60	<4.00	<1.60	12.00	8.00	8.00	8.00	3.20	8.00	<3.20	<8.00	3.20	24.00	<1.20
01/02/2024	29/02/2024	ASC/63501.001	<2.49	<3.11	<1.24	6.22	<3.11	<3.11	2.49	<2.49	<3.11	<2.49	<6.22	<1.87	<3.11	<0.93
04/03/2024	05/04/2024	ASC/64430.001	<3.19	<3.99	<1.60	7.99	<3.99	<3.99	3.19	<3.19	3.99	<3.19	<7.99	<2.40	<3.99	<1.20
05/04/2024	03/05/2024	ASC/64573.001	<2.40	<3.00	<1.20	8.99	5.99	<3.00	5.99	3.00	5.99	<2.40	<5.99	2.10	14.98	<1.20
03/05/2024	31/05/2024	ASC/64690.001	<2.40	<3.00	<1.20	3.00	5.99	<3.00	8.99	3.00	5.99	<2.40	<5.99	2.70	17.97	<0.90
31/05/2024	02/07/2024	ASC/64847.001	2.52	<3.15	<1.26	3.15	6.30	<3.15	6.30	6.30	6.30	<2.52	<6.30	2.52	<3.15	<0.95
02/07/2024	30/07/2024	ASC/64848.001	<2.40	<3.00	<1.20	3.00	5.99	<3.00	5.99	3.00	3.00	<2.40	<5.99	<1.80	<3.00	<0.90
30/07/2024	29/08/2024	ASC/65044.001	<2.52	<3.15	<1.26	6.30	3.15	<3.15	6.30	<2.52	6.30	<2.52	<6.30	3.15	<3.15	<0.94
29/08/2024	03/10/2024	ASC/65304.001	<2.40	<3.00	<1.20	3.00	5.99	<3.00	8.99	<2.40	5.99	<2.40	<5.99	3.00	17.97	<1.20
26/09/2024	26/10/2024	ASC/65726.001	<2.40	<2.99	<1.20	2.99	5.99	<2.99	5.99	<2.40	5.99	<2.40	<5.99	2.99	<2.99	<0.90
28/10/2024	02/12/2024	ASC/65829.001	2.44	<2.44	<0.97	4.87	9.74	<2.44	4.87	<1.95	12.18	2.44	<4.87	2.44	36.53	<0.73

Table C2 Analysis of PAHs for each period.

Compound	Period 1	Period 2	Period 3	Period 4
Naphthalene	0.030	0.026	0.062	0.072
Acenaphthylene	0.005	0.003	0.007	0.028
Acenaphthene	0.092	0.057	0.118	0.062
Fluorene	0.432	0.375	0.598	0.338
Phenanthrene	5.850	4.385	5.767	3.511
Anthracene	0.347	0.091	0.127	0.137
Fluoranthene	1.924	0.714	1.306	0.890
Pyrene	1.361	0.406	0.970	0.616
Benzo(a)anthracene	0.204	0.015	0.028	0.128
Chrysene	0.315	0.044	0.044	0.223
Benzo(b)fluoranthene	0.406	0.032	0.039	0.234
Benzo(k)fluoranthene	0.154	0.010	0.015	0.078
Benzo(a)pyrene	0.227	0.015	0.016	0.089
Indeno(1,2,3-cd)pyrene	0.213	0.037	0.037	0.141
Dibenzo(ah)anthracene	0.029	0.003	0.003	0.023
Benzo(ghi)perylene	0.202	0.027	0.024	0.106
Benzo(j)fluoranthene	0.125	0.012	0.016	0.092
Dibenzo(ac)anthracene	0.034	0.004	0.004	0.026

Table C3 Analysis of Dioxins, Furans and PCBs, for each period.

Compound	Period 1	Period 2	Period 3	Period 4
DIOXINS				
2378 Tetra CDD	<0.86	0.27	0.21	0.84
12378 Penta CDD	3.1	0.75	0.91	1.7
123478 Hexa CDD	0.21	0.049	0.048	0.24
123678 Hexa CDD	0.5	0.13	0.13	0.58
123789 Hexa CDD	0.43	0.08	0.08	0.35
1234678 Hepta CDD	0.36	0.095	0.082	0.5
OCDD Octa CDD	0.0082	0.0023	0.002	0.0092
2378 Tetra CDF	<0.75	0.24	0.24	0.46
12378 Penta CDF	0.35	0.12	0.13	0.37
23478 Penta CDF	4.3	2	1.9	5.4
123478 Hexa CDF	0.61	0.23	0.27	0.8
123678 Hexa CDF	0.57	0.25	0.24	0.85

Compound	Period 1	Period 2	Period 3	Period 4
234678 Hexa CDF	0.88	0.37	0.36	1.2
123789 Hexa CDF	0.19	0.09	0.08	0.31
1234678 Hepta CDF	0.15	0.08	0.09	0.36
1234789 Hepta CDF	0.02	0.0096	0.0095	0.045
OCDF Octa CDF	0.00092	0.00036	0.00042	0.0021
PCBs				
PCB-81	0.0016	0.0013	0.0018	0.0018
PCB-77	0.0033	0.0041	0.0049	0.0037
PCB-123	0.00025	0.0002	0.0012	0.00027
PCB-118	0.01	0.014	0.024	0.012
PCB-114	0.00031	0.00042	0.00056	0.00043
PCB-105	0.0035	0.0034	0.0055	0.0033
PCB-126	0.51	0.35	0.43	0.62
PCB-167	0.0002	0.0003	0.00051	0.00023
PCB-156	0.00044	0.00056	0.00073	0.00053
PCB-157	0.00011	0.00013	0.00039	0.0003
PCB-169	0.0035	0.0022	0.0032	0.0052
PCB-189	0.000044	0.000052	<0.000092	<0.00009

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