Report: 2022 Annual Regional Air Quality Monitoring Program Report

Overview: This annual report provides an overview of the 2022 ambient air monitoring results from monitors located in sensitive receptors in the Elk Valley. This report is required under EMA Air Permits 1807, 5352, 6249, 1501 and 4751.

The report was prepared for Teck (as the former operator of EVR) by RWDI.

For More Information:
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FINAL REPORT

TECK COAL LTD.
REGIONAL
AIR QUALITY MONITORING PROGRAM

SPARWOOD, BC

2022 ANNUAL REPORT

RWDI #2302721

March 29, 2023

SUBMITTED TO

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EXECUTIVE SUMMARY

Teck Coal Ltd. (Teck) operates four open pit coal mine operations: Elkview (EVO), Line Creek (LCO), Greenhills (GHO) and Fording River (FRO) and one open pit coal mine operation in care & maintenance in the Elk Valley: Coal Mountain (CM). Each mine is authorized by permits issued by the British Columbia Ministry of Environment & Climate Change Strategy (BC ENV) under the *Environmental Management Act* to discharge emissions to the air. These permits also require a Regional Air Quality Monitoring Program (RAQMP) that allows for an ongoing assessment of the efficacy of monitoring and to provide annual reporting summarizing the state of air quality and meteorology in the region.

This report covers results of monitoring in 2022 of the following parameters: particulate matter 10 micrometers in diameter and smaller (PM_{10}), particulate matter 2.5 micrometers in diameter and smaller ($PM_{2.5}$), nitrogen dioxide (NO_2) and ozone (O_3) at the five stations that are part of the RAQMP, namely, Hosmer, Sparwood Centennial Square (EV_SCS), Whispering Winds Trailer Park (EV_WWTP), Elkford Rocky Mountain Elementary School (GH_ERMES), and Line Creek (LC_02). Results of the monitoring were compared to British Columbia Ambient Air Quality Objectives (BC AAQO).

2022 data suggest that 24-hour PM_{10} and $PM_{2.5}$ exceedances or excursions were most frequent during the first two weeks in September. A Weight of Evidence (WOE) analysis, explained in Canadian Council of Ministers of the Environment Guidance Document on Achievement Determination Canadian Ambient Air Quality Standards for Fine Particulate Matter and Ozone (2012), was done to account for these exceedances and excursions using satellite images to indicate that smoke from wildfires was a major contributor to these events. Exceedances of these parameters outside this period were rare, except at LC_02 which is believed to be influenced by the LCO Coal Refuse Pile. The annual average BC AAQO for $PM_{2.5}$ was exceeded only at this station. No exceedances of the ambient objectives for NO_2 or O_3 were recorded.

Annual particulate concentrations at all stations decreased in 2022 except for PM_{10} at EV_SCS, which increased slightly. This decrease weakened the rising trend in GH_ERMES, which has the longest record. At LC_02, where concentrations have been steadily increasing since 2019, levels fell below the 2020 averages in 2022.

The completeness requirements of 75% for annual and 60% for quarterly data were met at EV_SCS, EV_WWTP, GH_ERMES and LC_02. stations. Hosmer is not required to meet these completeness objectives, as it is not part of any mine site permit. For reference, PM_{10} at Hosmer, did not meet 60% completeness for quarterly data and 75% for annual. The analyzer was removed for repairs in March, then suffered issues with overheating in June that were not fully resolved until October.

Meteorological monitoring at four sites shows winds to be influenced by the topography, which also generate upslope winds manifested as higher mean wind speeds in the afternoon. Precipitation totals are within one standard deviation of the 30-year mean except in April 2022 when rainfall was less than half the expected amount, and in August when more than twice the average was recorded at GH-ERMES. Negative temperature anomalies were observed from January to April, and again in November and December. July and August temperatures hovered above the mean.

Teck continued to receive and investigate feedback from the community. Most feedback received was related to dirty vehicles, general dust levels, or poor visibility in the Elk Valley area. Teck investigated each feedback submission and responded directly when possible.

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1 INTRODUCTION

Teck Coal Limited (Teck) operates four active open pit coal mines (the Sites) and one closed mine in care and maintenance in the Elk Valley (Figure 1). The Elk Valley is characterized by rugged terrain and localized mountain weather patterns, which define the dispersion of pollutants in the region. The communities of Elkford and Sparwood, both with populations of more than 2,500, are in the vicinity of the Sites.

Each mine is authorized by the following permits issued by the British Columbia Ministry of Environment & Climate Change Strategy (BC ENV) under the *Environmental Management Act* to discharge emissions to the air:

- Coal Mountain Operations (CMO) – PA-4751
- Elkview Operations (EVO) – PA-1807
- Fording River Operations (FRO) – PA-1501
- Greenhills Operations (GHO) – PA-6249
- Line Creek Operations (LCO) – PA-5352

Site permits contain a condition which states: *Regional Air Quality Monitoring Program:*

> *The Permittee must implement the most recent version of the approved Regional Air Quality Monitoring Program. This program must be implemented under the direction of a qualified professional.*
>
> *The permittee must cause a qualified professional to update the Regional Air Quality Monitoring Program at least every three years. The permittee must submit the updated Regional Air Quality Monitoring Program to the director for approval.*
>
> *An Annual Regional Air Quality Monitoring Program Report must be submitted to the director in accordance with the most recent approved version of the Regional Air Quality Monitoring Program.*

The Regional Air Quality Monitoring Program (RAQMP) aims to satisfy this condition. The monitoring program uses an Adaptive Management Framework to allow for continual assessment and adjustment of the program to ensure it continues to efficiently meet objectives over time.

This report satisfies the requirements of the RAQMP by presenting the results of air quality and meteorological monitoring conducted by Teck in the Elk Valley under the RAQMP. It integrates and supplements the reporting by each Site as required by their individual permits.

This report includes information on:

- results above provincial or federal ambient air quality objectives or guidelines and,
- temporal trends in ambient air quality concentrations.

As required to provide context for the ambient monitoring results, this report also includes:

- public input to visibility or nuisance dusting issues,
- changes in Teck mining operations that may impact air quality,
- changes in Teck's dust management plan, and
- changes in Teck's ambient monitoring program.

As part of the adaptive management framework, this annual report will also make recommendations to adjust the RAQMP where needed.

The criteria air contaminants (CACs) measured at these stations covered by the RAQMP include:

- Particulate matter smaller than 10 µm in diameter (PM_{10})
- Particulate matter smaller than 2.5 µm in diameter ($PM_{2.5}$)
- Nitrogen dioxide (NO_2)
- Ozone (O_3)

Monitoring results are compared to British Columbia Ambient Air Quality Objectives (BC AAQO) for each air contaminant in Table 1. With exceptions noted below, any value above the objectives for these contaminants is called an exceedance at a station. For $PM_{2.5}$, the BC AAQO is applied to the 98th percentile. The 1-hour NO_2 objective is based on the annual 98th percentile of the daily 1-hour maximum averaged over 3 consecutive years, while the 8-hour objective for O_3 is based on the annual 4th-highest daily 8-hour value averaged over 3 consecutive years. For these contaminants at these averaging periods, a value above the BC AAQO is referred to as an excursion, and an exceedance only occurs if these specific ranks or percentiles are above the BC AAQO.

Table 1: Applicable BC Ambient Air Quality Objectives

Contaminant	BC AAQO (µg/m³)			
	1-Hour	8-Hour	24-Hour	Annual
$PM_{2.5}$			25[1]	8
PM_{10}			50	
NO_2	113[2]			32
O_3	160	123[3]		

Notes:
[1] Applies to the 98th percentile
[2] Applies to the 98th percentile of daily 1-hour maximum over three years.
[3] Applies to 4th-highest daily 8-hour maximum averaged over three consecutive years
Blank cells mean there is no BC AAQO at that averaging period for that contaminant.

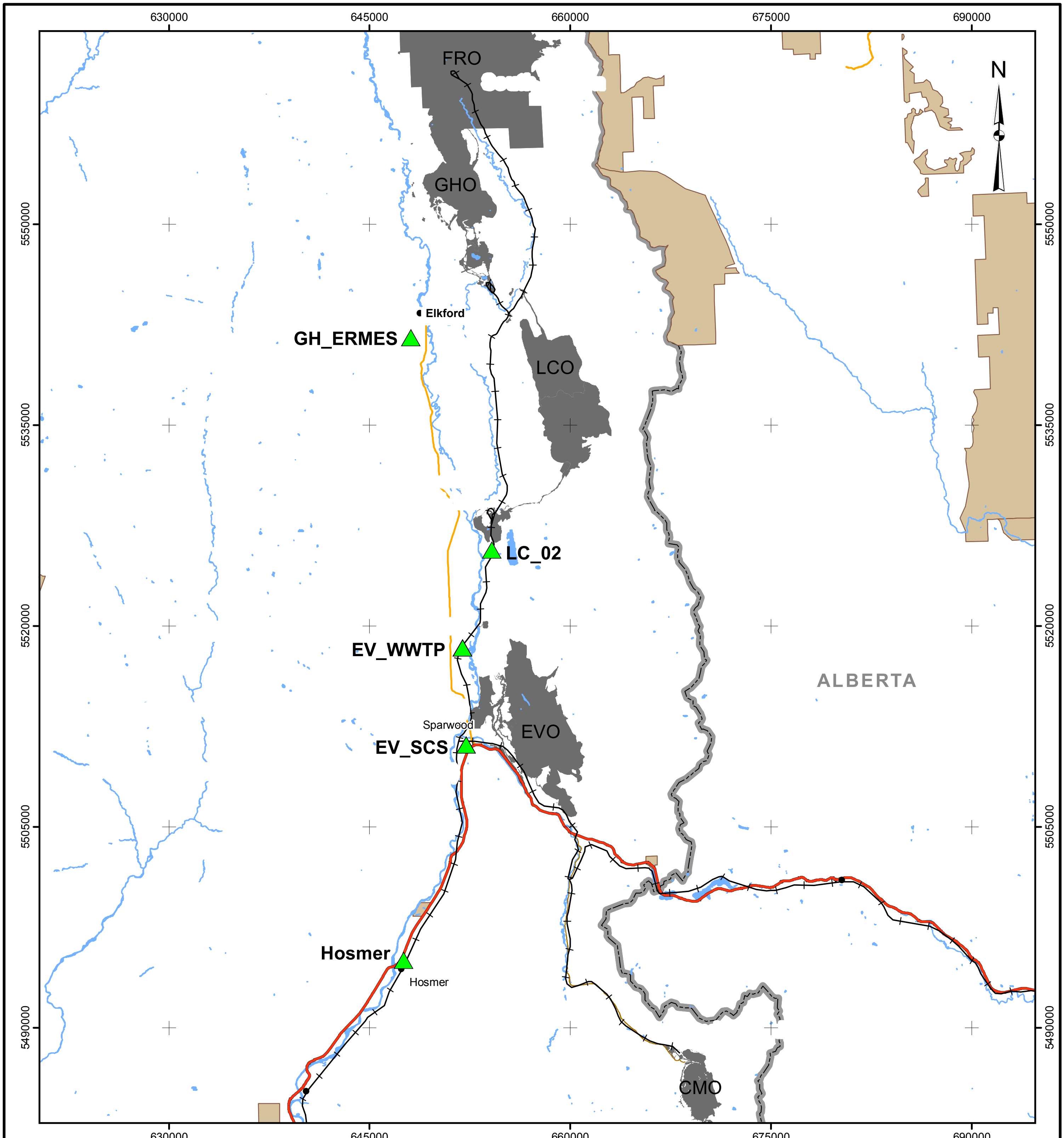
2 MONITORING LOCATIONS

Air quality and meteorological monitoring is conducted at the Sites and in three communities in the Elk Valley. Tech operates several continuous air monitoring stations, whose results are used for research and guiding fugitive dust management plans.

This section describes the five stations and parameters that are included in the RAQMP. Figure 1 presents the locations of the monitoring stations, whose coordinates are listed in Table 2. Table 3 lists the parameters measured at each of the monitoring stations.

Table 2: Locations of stations in the Regional Air Monitoring Program.

Station ID and Name		Latitude (°N)	Longitude (°W)	Elevation (m)
Hosmer	Hosmer	49.590260	114.959234	1057
EV_SCS	Sparwood Centennial Square	49.732786	114.88766	1138
EV_WWTP	Whispering Winds Trailer Park	49.798506	114.888639	1160
LC_02	Line Creek Continuous (Near Grave Lake)	49.873617	114.842284	1301
GH_ERMES	Elkford Rocky Mountain Elementary School	50.007794	114.933420	1333



LEGEND

- AIR MONITORING STATION
- CITY / TOWN / COMMUNITY
- CANADIAN PACIFIC RAILWAY
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- ROAD
- BRITISH COLUMBIA / ALBERTA PROVINCIAL BOUNDARY
- MINE OPERATIONS
- PROVINCIAL PARK
- WATERBODY

10 0 10

SCALE 1:400,000 KILOMETRES

Figure Modified by RWDI

REFERENCE

Provincial Boundary and communities obtained from The Atlas of Canada, Natural Resources Canada. Alberta Hydrography obtained from CanVec, Government of Canada, Natural Resources Canada. BC Hydrography, Dominion Coal Blocks and project data obtained from Teck Coal Limited. Roads obtained from Geobase. Provincial parks and Railroad data obtained from Geogratis. Projection: UTM Zone 11 Datum: NAD 83

PROJECT

TECK COAL REGIONAL
AIR MONITORING PROGRAM

TITLE

AIR MONITORING STATIONS

PROJECT No. 12-1349-0003			SCALE AS SHOWN	REV. 0
DESIGN	DR	03 Jan. 2014	**FIGURE 1**	
GIS	DJH	16 Mar. 2017		
CHECK	ABS	16 Mar. 2017		
REVIEW	TAD	16 Mar. 2017		

1500459_Teck_Monitoring_Figure 1_Monitoring Stations.mxd

Table 3: Parameters measured at each station in the Regional Air Monitoring Program.

Station ID and Name		Air Quality				Meteorology				
		PM_{10}	$PM_{2.5}$	NO_2	O_3	Wind Speed and Direction	Temperature	Relative Humidity	Barometric Pressure	Precipitation
Hosmer	Hosmer	✓	✓			✓	✓	✓	✓	
EV_SCS	Sparwood Centennial Square	✓	✓	✓	✓	✓	✓	✓		
EV_WWTP	Whispering Winds Trailer Park	✓	✓			✓	✓	✓		
LC_02[1, 2]	Line Creek Continuous (Near Grave Lake)	✓[1]	✓[1]			✓	✓	✓		
GH_ERMES	Elkford Rocky Mountain Elementary School	✓	✓			✓	✓			✓

Notes:

[1] PM_{10} and $PM_{2.5}$ are measured at LC_02 using a DustTrak. Other stations use Thermo 5030i SHARP units.

[2] LC_02 started monitoring wind speed, temperature and relative humidity from July 2022.

A comprehensive list of all of the monitoring stations operated by Teck Coal Limited in the Elk Valley, including the parameters measured at each station, is provided in Attachment 1. The list includes the monitoring objectives at each station, and whether the monitoring is a requirement of the RAQMP, a permit condition, or if it is being done independently by Teck Coal.

3 AIR QUALITY MONITORING RESULTS

This section discusses results of air quality monitoring at the five stations in 2022 for comparison with applicable BC AAQO. Additional statistics on concentrations and data completeness are provided in Appendix A.

3.1 Annual Averages

Annual hourly average concentrations are presented in Table 4. Only LC_02 was found to exceed the annual objective for $PM_{2.5}$. The annual hourly average NO_2 concentration was 35% of the objective.

Table 4: Annual hourly average concentrations in 2022.

Station ID	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	NO_2 (µg/m³)
	-	BC AAQO = 8 µg/m³	BC AAQO = 32 µg/m³
Hosmer	7.9	6.1	-
EV_SCS	17.4	6.9	11.3
EV_WWTP	9.2	6.2	-
GH_ERMES	9.6	5.6	-
LC_02	11.7	**10.6**	-

Notes: Values in boldface are above applicable objective. NO_2 is monitored only at EV_SCS.

3.2 Exceedances and Excursions

Concentrations that are above a BC AAQO are either exceedances or excursions. If the BC AAQO is defined as the maximum, any value above it is an exceedance. This applies to 24-hour PM_{10} concentrations, and to annual averages. If the BC AAQO of a pollutant is defined as a percentile averaged typically over three years, any value above the BC AAQO is referred to as an excursion. This applies to daily average $PM_{2.5}$ and to 1-hour NO_2 concentrations.

A summary of exceedances and excursions is found in Table 5. Exceedances and excursions are most frequent at LC_02, which is closest to LCO's Coal Refuse Pile. This station also uses a non-reference instrument.

Among the other stations EV_SCS and GH_ERMES register the most exceedances and excursions, which will be discussed further.

Table 5: Excursions and exceedances in 2022.

Station Name	Contaminant	Averaging period	Applicable BC AAQO	Excursions or exceedances[4]	
				Number	Percentage of days[3]
Hosmer	PM_{10}	24 hours	50 μg/m^3	0	0.0%
	$PM_{2.5}$	24 hours	25 μg/m^3[1]	9	2.6%
EV_SCS	PM_{10}	24 hours	50 μg/m^3	6	1.7%
	$PM_{2.5}$	24 hours	25 μg/m^3	10	2.9%
	NO_2	1 hour	113 μg/m^3[2]	0	0.0%
	O_3	8 hours	123 μg/m^3	0	0.0%
EV_WWTP	PM_{10}	24 hours	50 μg/m^3	2	0.6%
	$PM_{2.5}$	24 hours	25 μg/m^3	8	2.2%
GH_ERMES	PM_{10}	24 hours	50 μg/m^3	2	0.6%
	$PM_{2.5}$	24 hours	25 μg/m^3	8	2.2%
LC_02	PM_{10}	24 hours	50 μg/m^3	11	3.5%
	$PM_{2.5}$	24 hours	25 μg/m^3	24	7.6%

Notes:

[1] The 24-hour $PM_{2.5}$ BC AAQO is based on 98th percentile of daily values.

[2] The 24-hour NO_2 BC AAQO is based on the Canadian Ambient Air Quality Standard (CAAQS) of 113 μg/m^3 applied to the 98th percentile of daily 1-hour maxima averaged over 3 years.

[3] Percentage based on number of valid readings.

[4] Exceedances are concentrations that are greater than the BC AAQO in cases where the BC AAQO is based on the maximum value. Excursions are values that are above the BC AAQO in cases where the BC AAQO is based on a percentile.

3.3 PM_{10}

Figure 2 shows the time series of the 24-hour average PM_{10} concentrations at the five stations. As noted earlier, exceedances are most frequent at LC_02 owing mainly to its proximity to LCO's Coarse Coal Refuse Pile. The highest values occurred in early September, which coincided with exceedances at other stations in the RAQMP network.

Polar concentration plots depicting hourly concentrations averaged by wind speed and direction at each station are provided in Figure 3. The distance from the center of each coloured bar forming each wedge indicates the wind speed.

Highest values (around 90 µg/m³, indicated as orange to red) were at EV_SCS during moderate winds from the southeast and north, suggesting the impact from Teck EVO mine. Average concentrations at the other stations were lower, with no single direction registering the highest concentrations.

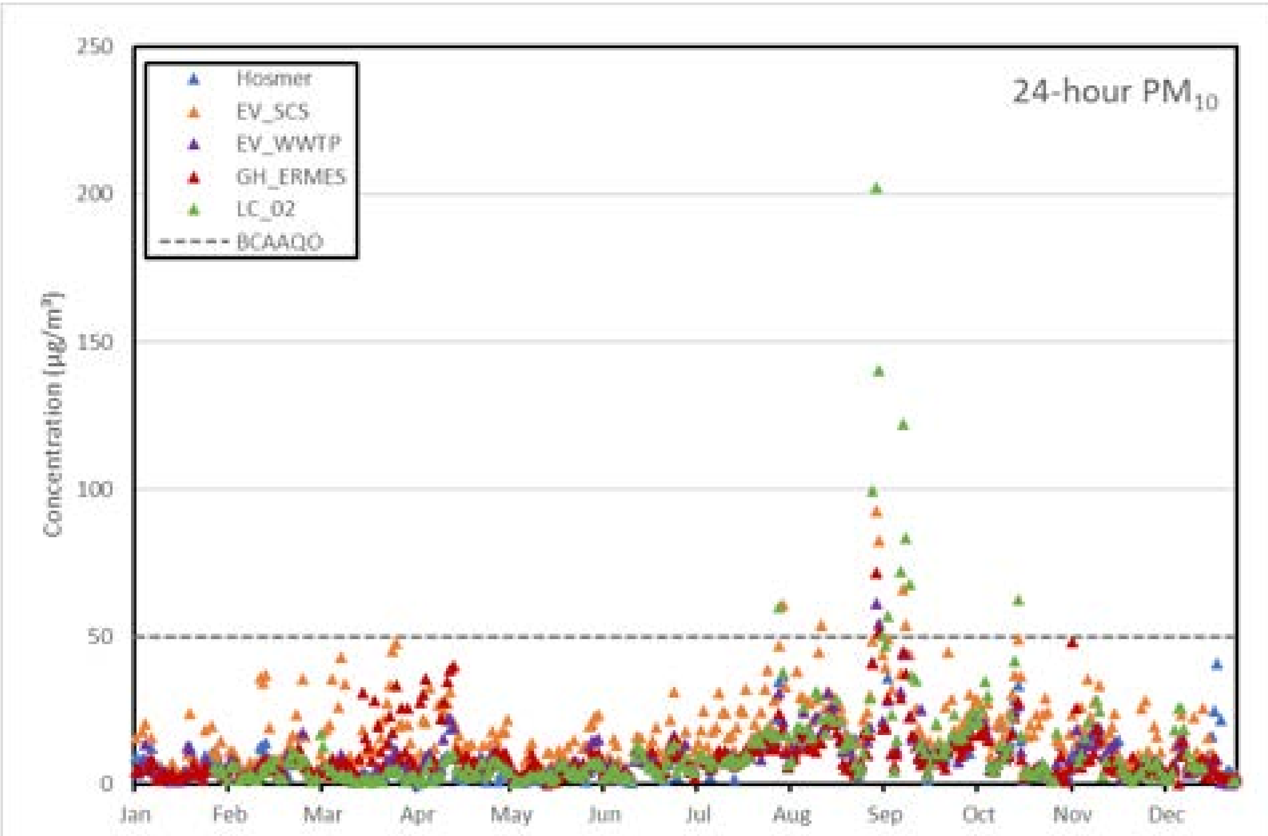


Figure 2: Daily averaged PM_{10} concentrations.

Note: Dashed line indicates BC AAQO of 50 µg/m³.

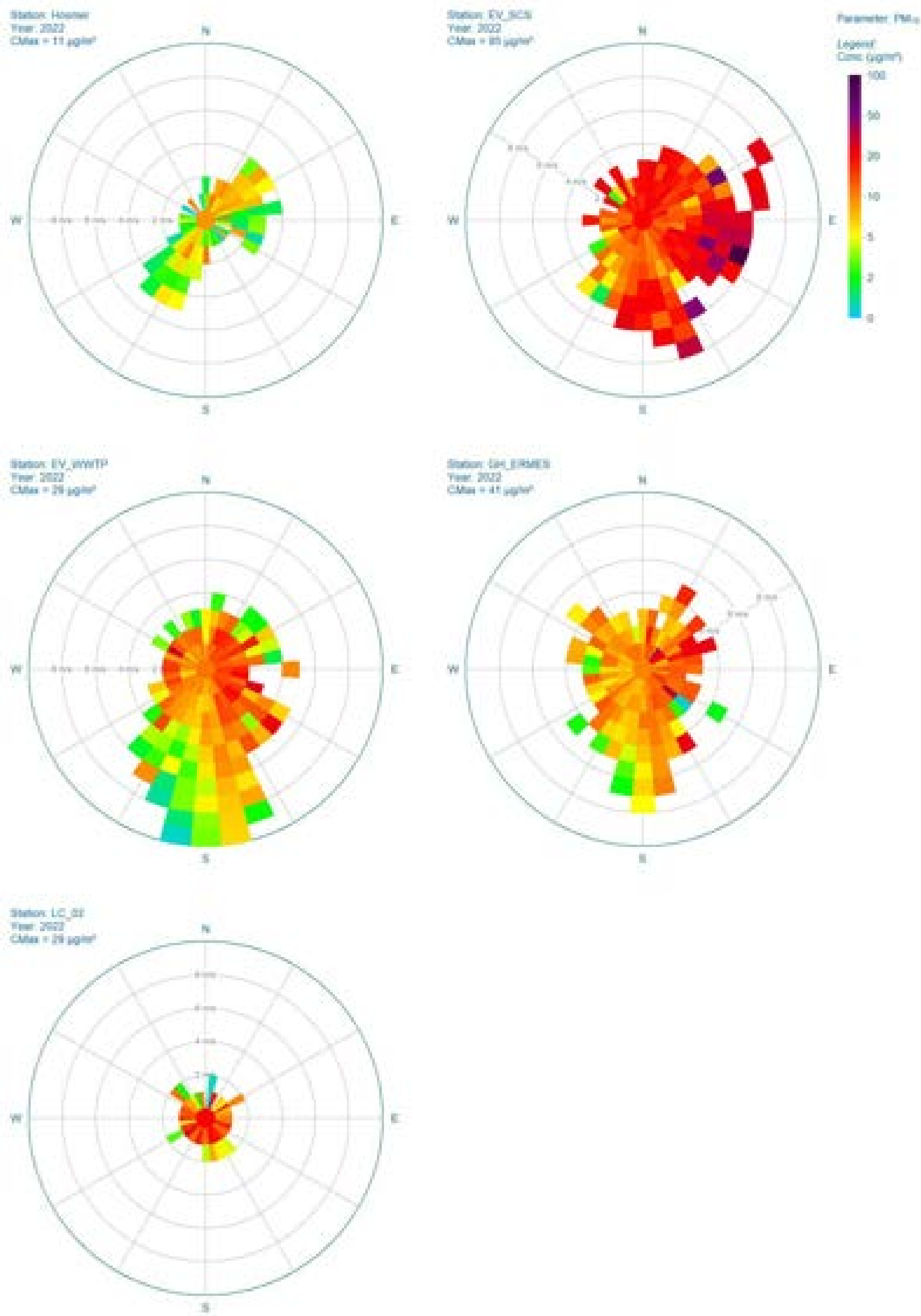


Figure 3: Polar concentration plots of PM_{10} concentrations (µg/m³) in 2022.

3.4 $PM_{2.5}$

Figure 4 shows the time series of the 24-hour average $PM_{2.5}$ concentrations at the five stations. Most excursions in all stations took place in the same period in early September.

From the polar concentration plots in Figure 5 the highest average concentrations occurred at LC_02, where winds speeds are typically low, with no specific wind direction causing the maximum.

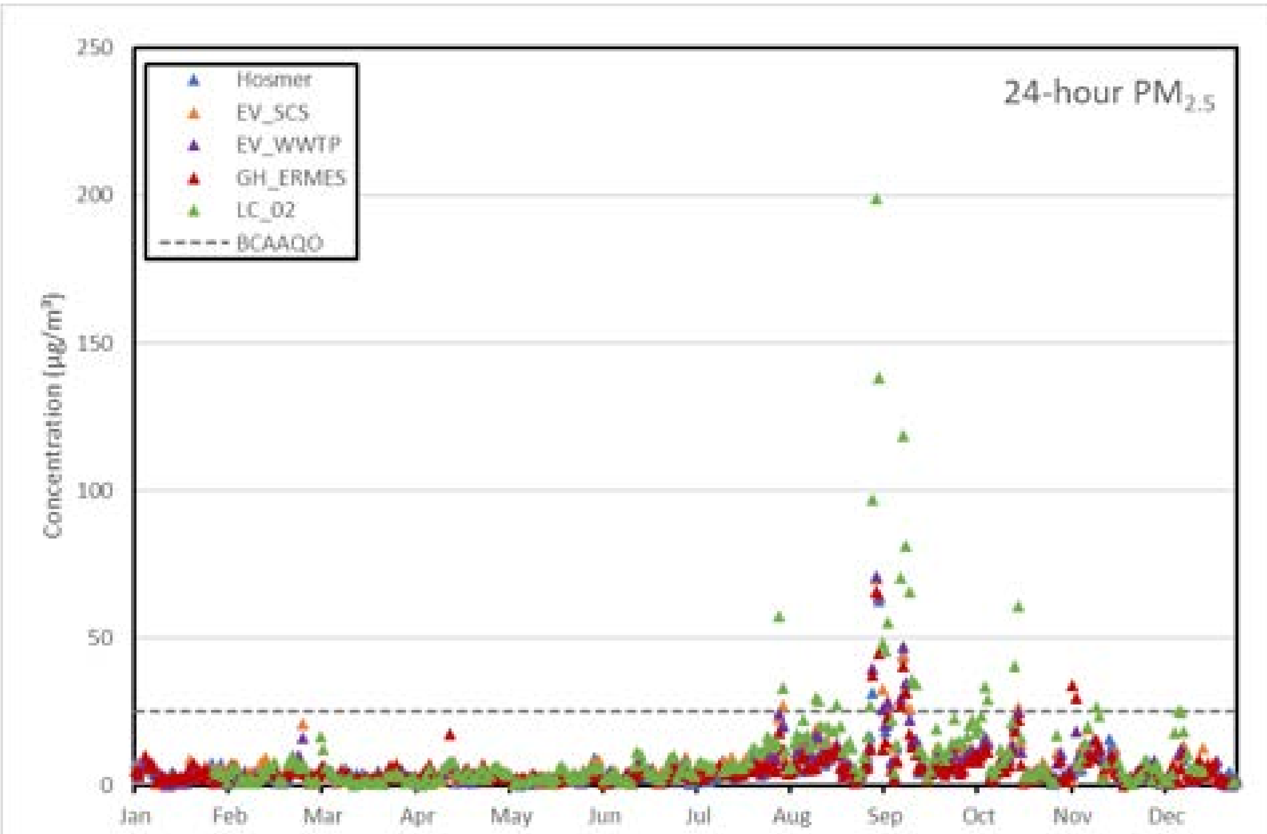


Figure 4: Daily averaged $PM_{2.5}$ concentrations in 2022.

Note: Dashed line indicates BC AAQO of 25 μg/m³.

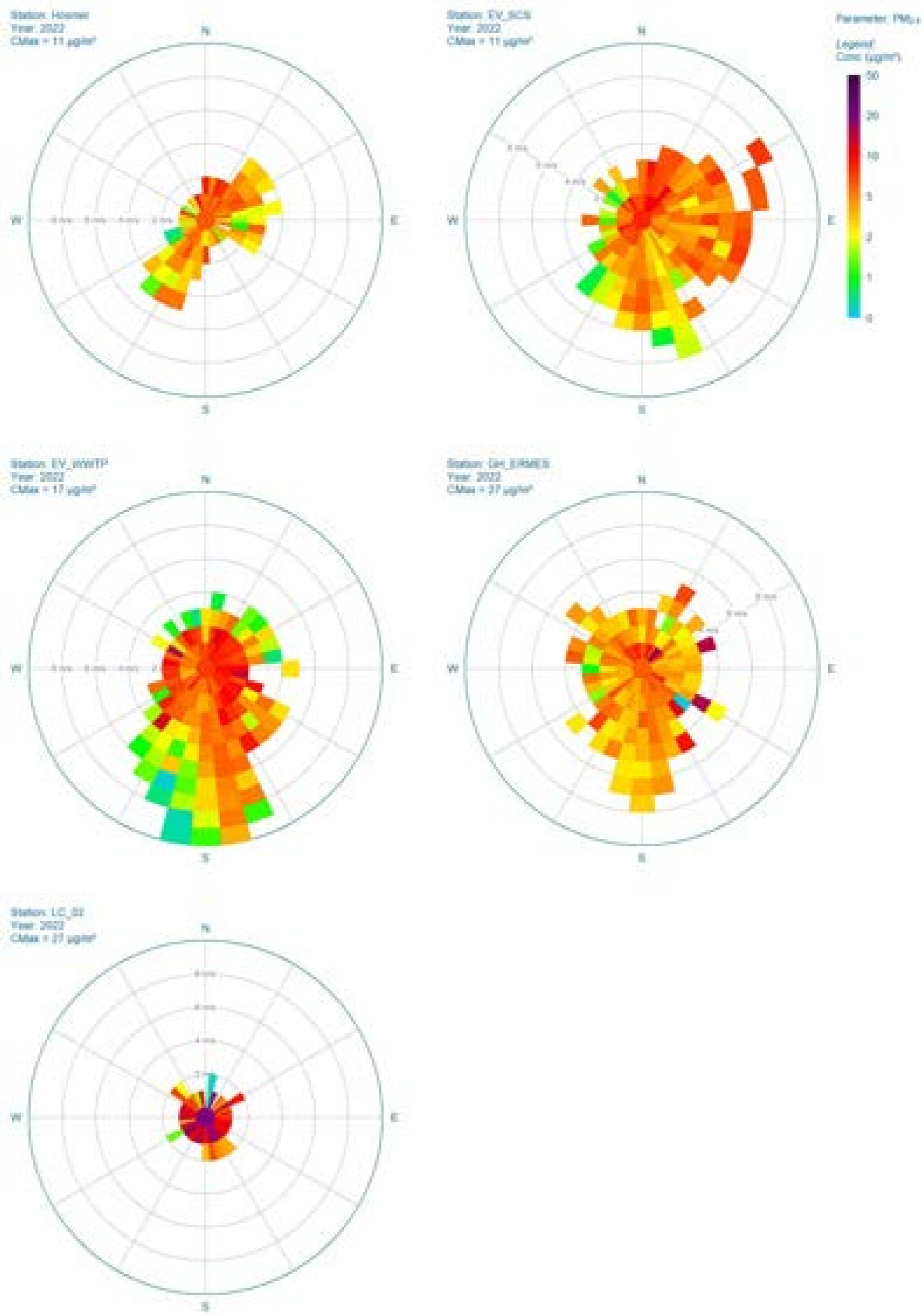


Figure 5: Polar concentration plots of $PM_{2.5}$ concentrations (µg/m³) in 2022.

3.5 Nitrogen Dioxide (NO_2)

Figure 6 shows the time series of the daily 1-hour maximum concentration of NO_2 at the EV_SCS station in 2022. All the values are well below the BC AAQO.

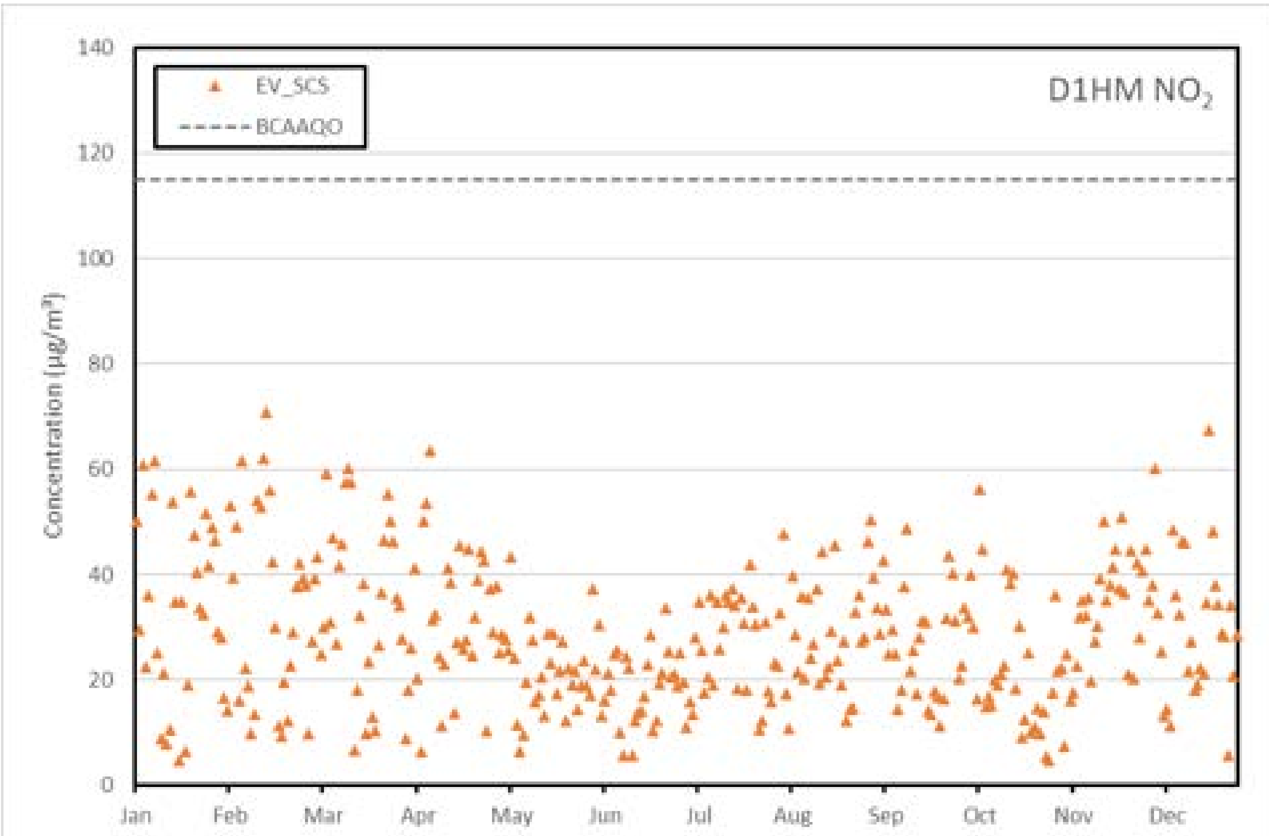


Figure 6: Daily 1-hour maximum (D1HM) NO2 concentrations from EV_SCS in 2022.

Note: Dashed line indicates BC AAQO of 113 µg/m^3.

3.6 Ozone (O_3)

One-hour and 8-hour rolling average concentrations of O_3 are presented in Figure 7 and Figure 8 respectively. There were no readings above the BC AAQO at both averaging periods for this parameter.

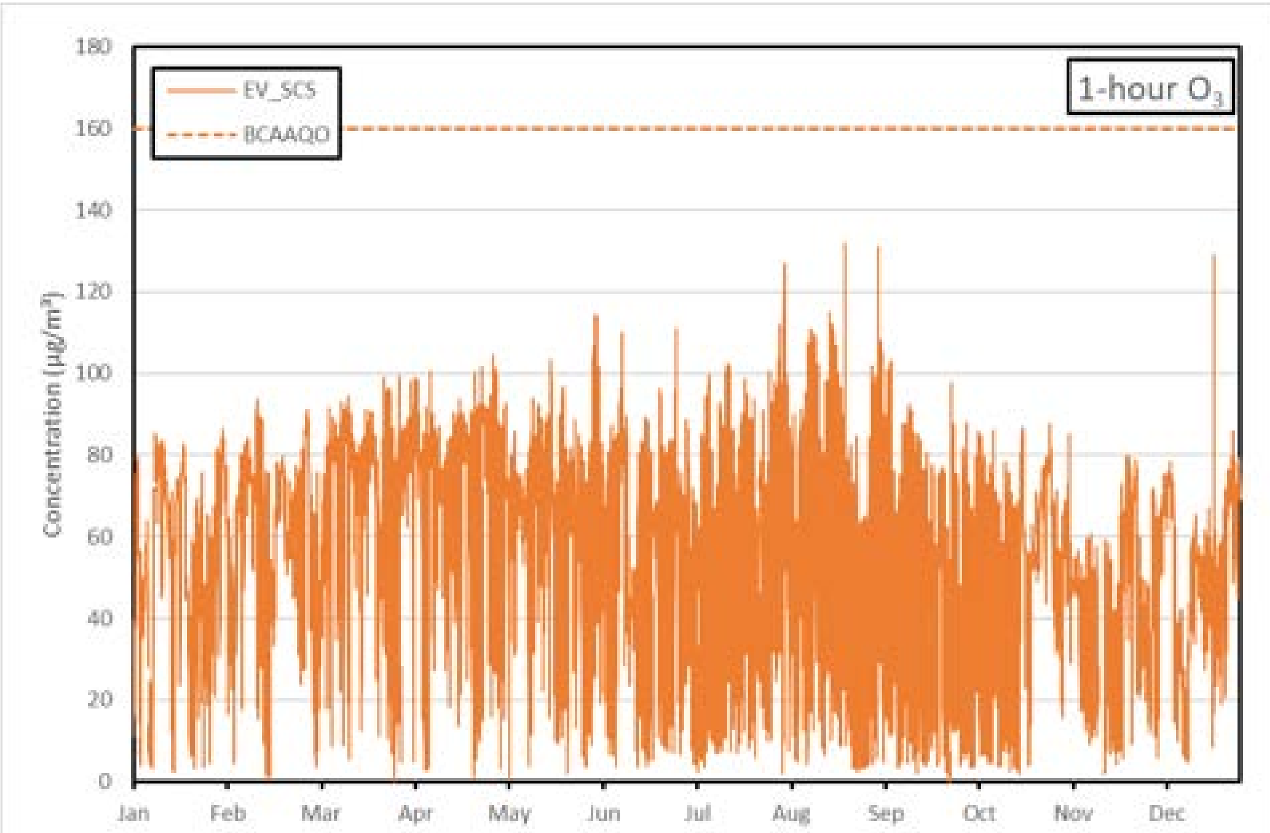


Figure 7: One-hour averages of O_3 at EV_SCS in 2022.

Note: Dashed line indicates 1-hour BC AAQO of 160 µg/m^3.

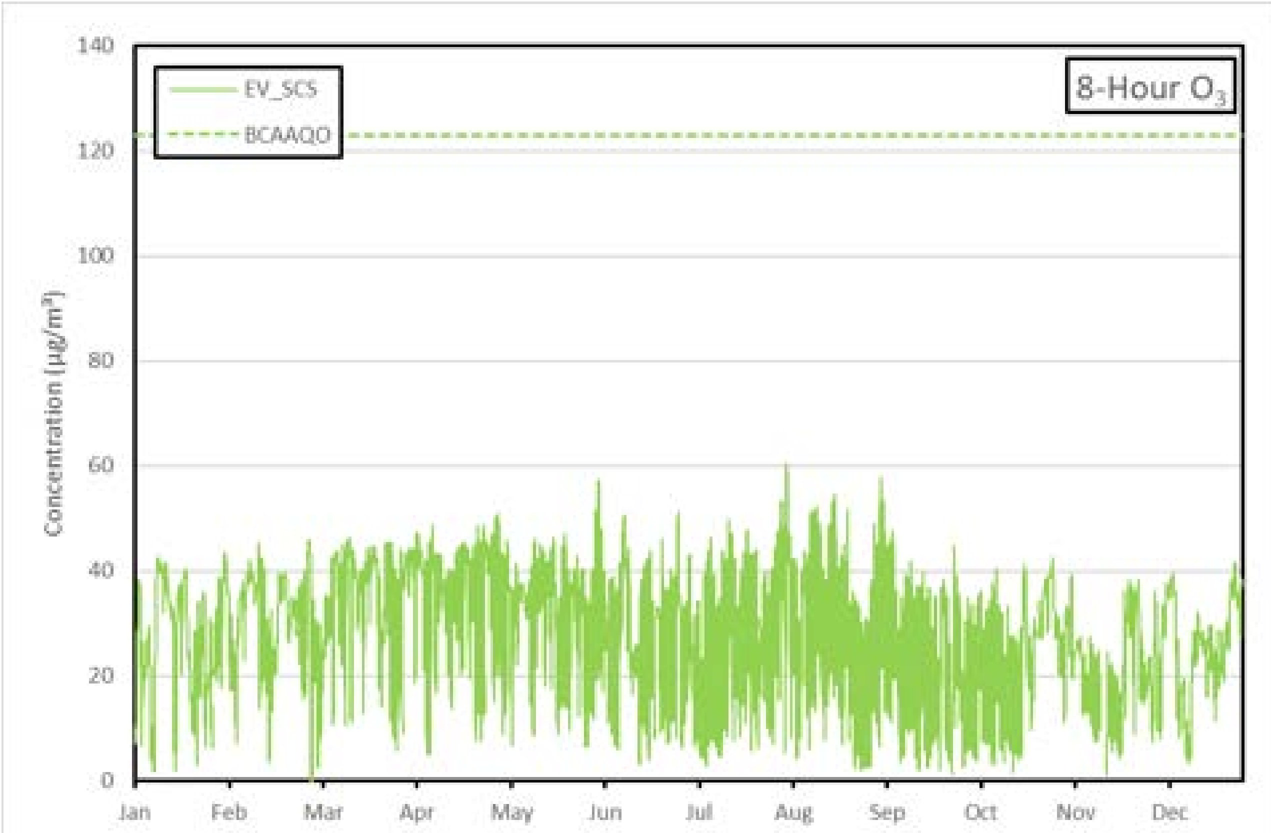


Figure 8: Rolling 8-hour averages of O3 at EV_SCS in 2022.

Note: Dashed line indicates 8-hour BC AAQO of 123 µg/m³.

3.7 Inter-annual Variability

An examination of inter-annual variability in annual average concentrations of PM_{10} and $PM_{2.5}$ at all stations is presented below.

The BC Wildfire Season Summary states "despite the late drought conditions, the 2022 wildfire season remained below normal in terms of number of fires and area burned statistics" (Government of British Columbia, 2022). This could suggest why there was a decrease in almost all PM_{10} and $PM_{2.5}$ annual concentrations recorded by the RAQMP stations in 2022. Comparing the statistics of area burned in 2022 (133,437 ha) to 2021 (868,000 ha), it is clear the wildfire spread in 2021 was more profound (Government of British Columbia, 2022). Smoke impact is further discussed in section 5.1.3.

3.7.1 PM_{10}

Figure 9 shows the plot of annual average PM_{10} concentrations at the five stations. GH_ERMES, which has the longest record, has been exhibiting a rising trend since 2011 but fell in 2022. Annual average PM_{10} concentrations have increased at LC_02 since the start of its operations but decreased in 2022 to comparable levels seen in 2019. Overall, PM_{10} concentrations in 2022 are lower than in 2021, with the exception of EV_SCS, which showed a slight increase. It should be noted that in December of 2021, the PM_{10} SHARP analyzer at EV_SCS was converted from a 5030i to a 5014i (uses beta detection only, nephelometer was removed) at the request of the BC ENV.

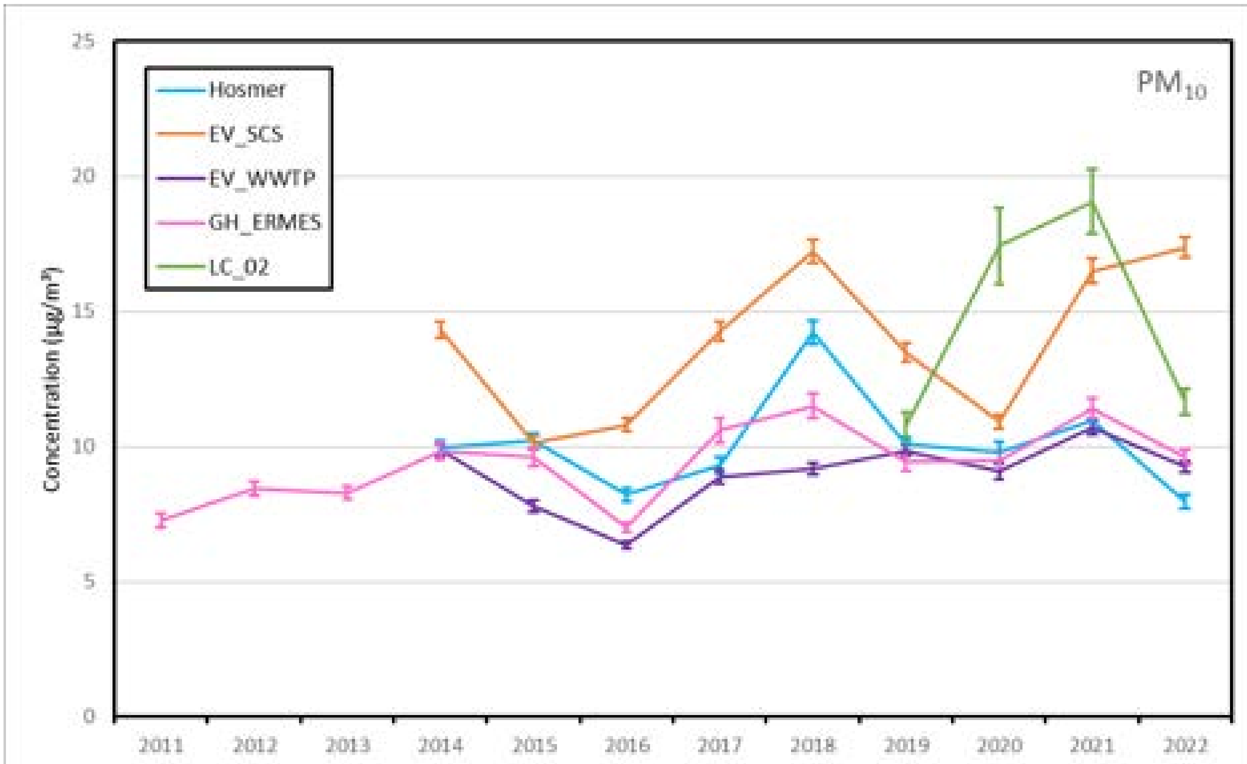


Figure 9: Time series of annual average PM10 concentrations.

Note: Error bars indicate the 95% confidence interval.

3.7.2 $PM_{2.5}$

$PM_{2.5}$ annual trends are not well-defined in Figure 10. LC_02 $PM_{2.5}$ annual average concentrations greatly increased since starting operations in 2019 but decreased in 2022. LC_02 was the only station that had the annual average $PM_{2.5}$ concentration above the BC AAQO of 8 µg/m³ in 2022.

Figure 10: Time series of annual average PM2.5 concentrations.

Note: Error bars indicate the 95% confidence interval. Dashed line indicates the annual BC AAQO of 8 µg/m³.

3.8 Data Completeness

Data completeness is the percentage of valid daily data divided by total daily data in the same time period. Permit conditions state that within each quarter, the daily data should be 60% complete and within each year, the daily data must be 75% complete. Quarterly and annual completeness requirements apply to $PM_{2.5}$ and PM_{10}.

Tables A-1 through A-3 in Appendix A provide the number of valid days of data per time period for PM_{10}, $PM_{2.5}$ and the monitored gaseous parameters. There are no completeness requirements for gaseous parameters, and there are no monthly or hourly completeness requirements for any parameter. The Hosmer Station is not required to meet these completeness objectives, as it is not part of any mine site permit.

3.8.1 PM_{10}

As seen in Table A-1, the annual completeness requirement of 75% and quarterly completeness requirement of 60% for PM_{10} data was met at EV_SCS, EV_WWTP, GH_ERMES and LC_02 stations. The Hosmer station is not required to meet these completeness objectives, as this station is not part of any mine site permit.

3.8.2 $PM_{2.5}$

Data completeness for $PM_{2.5}$ is presented in Table A-2 in Appendix A. EV_SCS, EV_WWTP, GH_ERMES and LC_02 stations satisfied the annual completeness requirement of 75% and quarterly completeness requirement of 60% for $PM_{2.5}$ data.

3.8.3 Gases

Data completeness for NO_2 and O_3 are found in Table A-3 in Appendix A. Completeness for all periods was at least 94%, however there are no data completeness requirements under EVO's permit for NO_2 and O_3.

3.8.4 Meteorological Parameters

Data completeness for meteorological parameters is included in Table A-4 in Appendix A. Completeness for EV_SCS, EV_WWTP, and GH_ERMES meteorological parameters in 2022 was at least 99%. The completeness criteria for LC_02 is based on inclusion into RAQMP in July 2022 with the completeness during this time period (July 26-December 31) being at least 92%.

4 METEOROLOGY RESULTS

Meteorological results for the RAQMP Stations are listed in the sections below. Appendix E discusses an alternative anemometer for EV_SCS and Appendix F discusses Hosmer siting evaluation.

4.1 Wind Speed and Direction

Figure 11 shows annual wind roses for the four stations in the RAQMP that collect meteorological data. Winds are predominantly from the South except at Hosmer, where southwesterly winds are the most common. Northwesterly winds are also pronounced at GH_ERMES. These flow patterns follow the channeling by the topography.

Of the four stations, winds are weakest at LC_02, whose annual mean wind speed is less than 1 m/s. Winds are strongest at EV_WWTP where winds average nearly 3 m/s.

None of the four stations show strong monthly or seasonal variation in wind pattern, however all four exhibit a diurnal increase in wind speed peaking at 13:00-14:00, as seen in Figure 12.

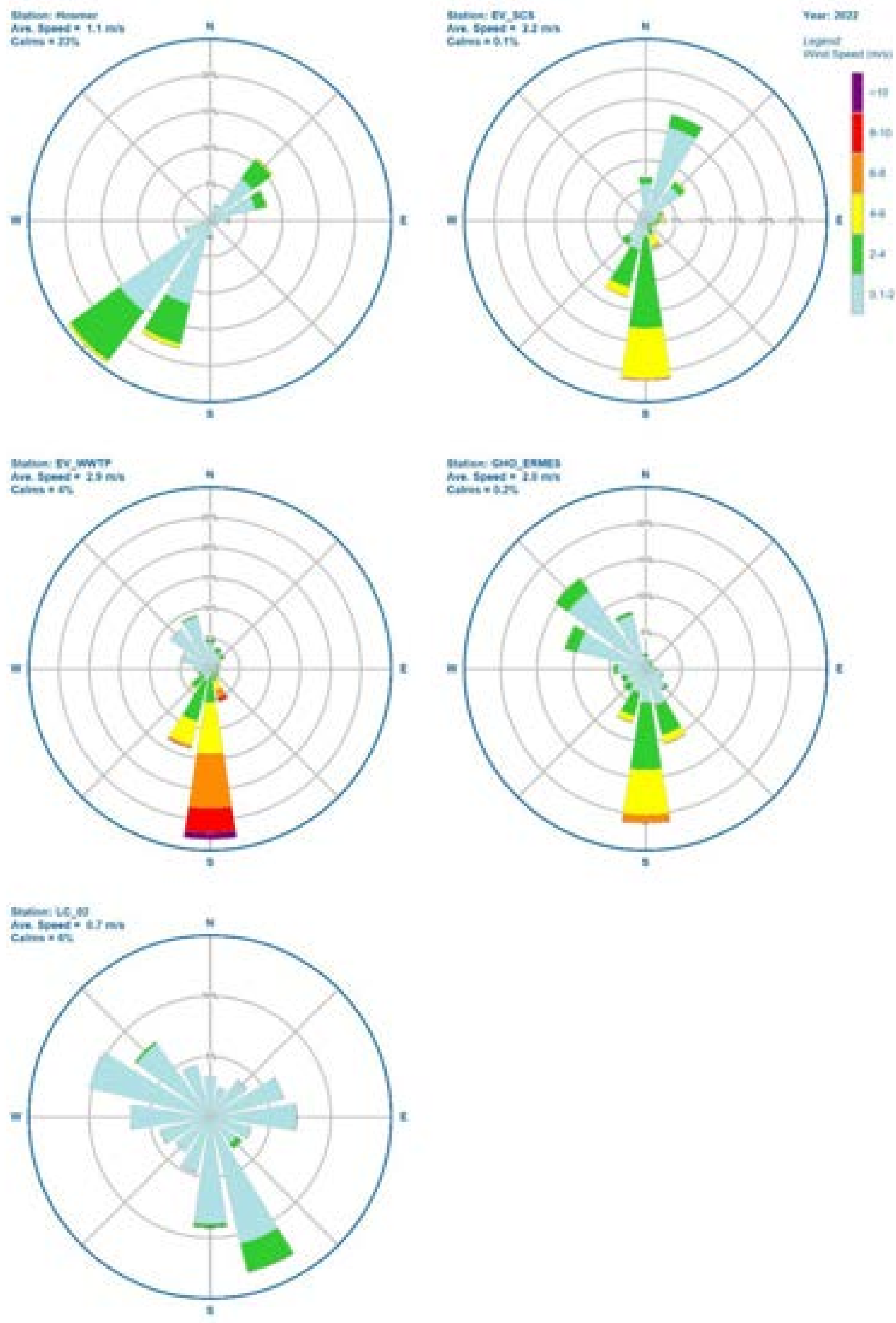


Figure 11: Wind roses at the stations in the RAQMP for 2022.

Note: EV_SCS data is from Sparwood Heights station. See Appendix E.

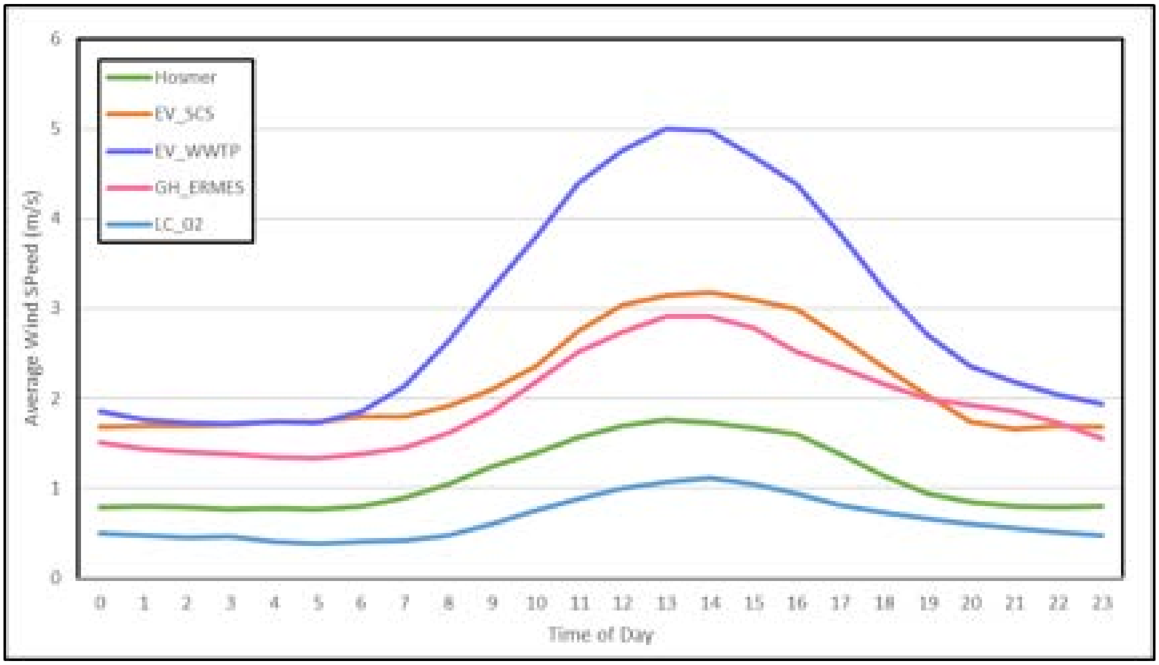


Figure 12: Mean hourly wind speed at the RAQMP stations in 2022.

4.2 Precipitation

Total monthly precipitation in 2022 within the RAQMP, represented by the GH_ERMES station, is shown in Figure 13. The 30-year mean and standard deviation of monthly precipitation totals observed at the Environment and Climate Change Canada meteorological station in Sparwood (1981–2010) are also shown.

Precipitation totals are within one standard deviation of the 30-year mean except in April when rainfall was less than half the expected amount, and in August when more than twice the average was received.

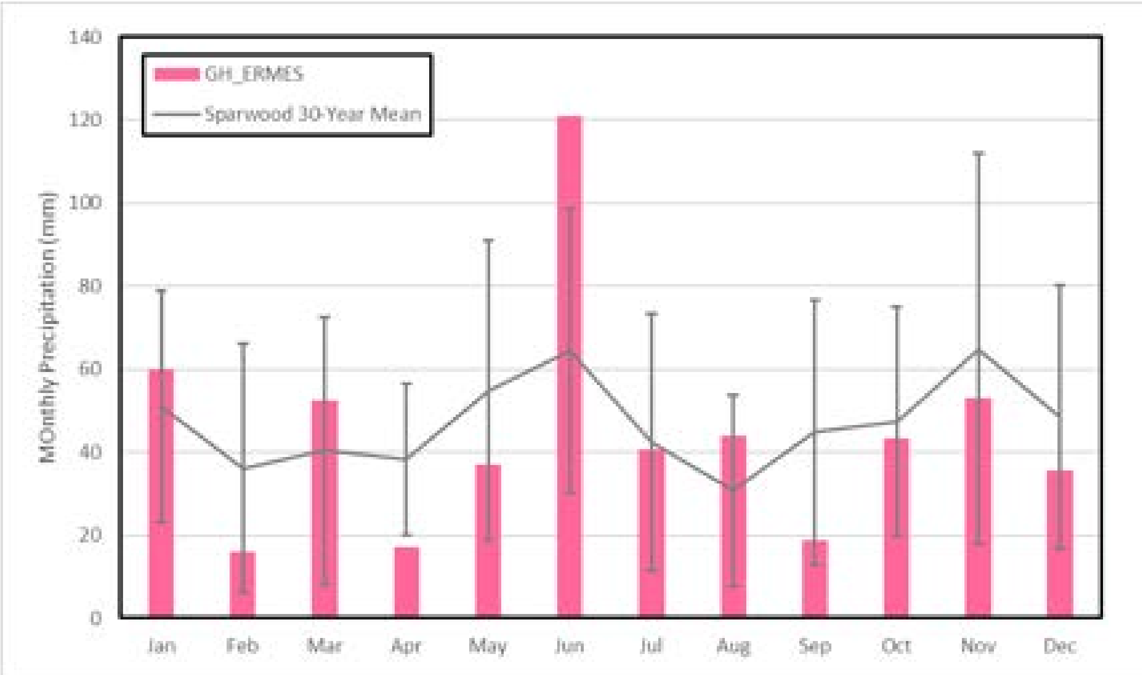


Figure 13: Monthly precipitation totals at GHO_ERMES in 2022 compared to the 30-year mean at the ECCC Weather Station in Sparwood

Note: Error bars indicate standard deviation

4.3 Air Temperature

Daily averaged air temperatures are presented in Figure 14 where they are compared to the 30-year mean and standard deviation at Sparwood. Differences between station temperatures are very small compared to daily fluctuations. Strong negative anomalies were observed from January to April, and again in November and December. July and August temperatures hovered above the mean.

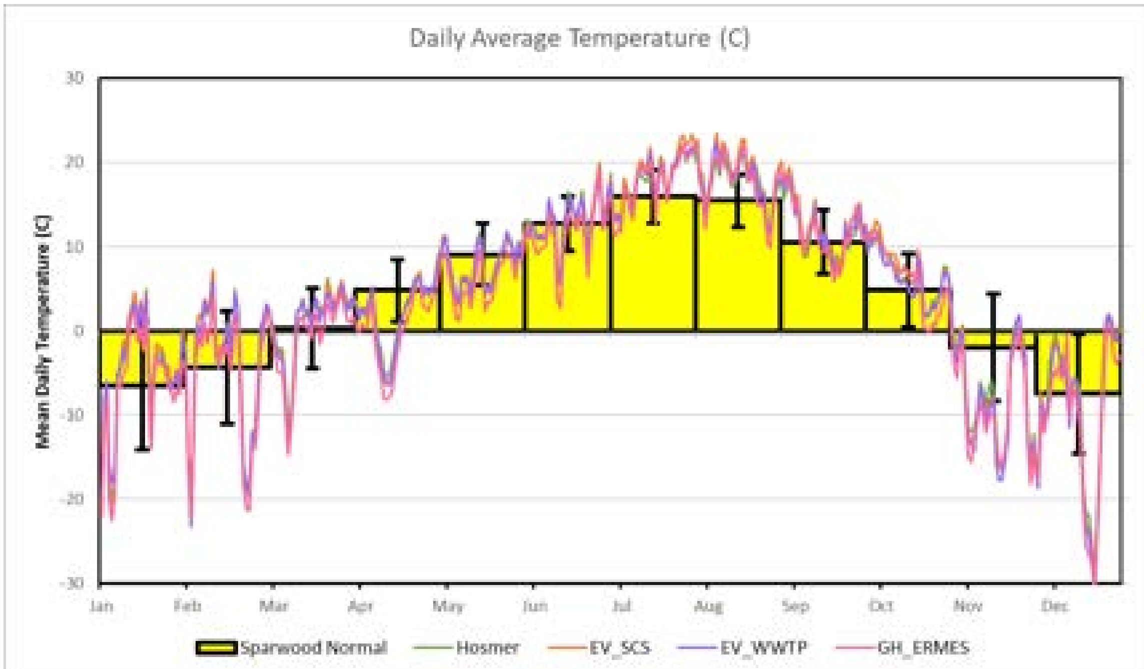


Figure 14: Daily averaged temperature for RAQMP Stations compared to the 30-year mean +/- 1 at the ECCC Station in Sparwood

Note: Error bars indicate standard deviation

5 MANAGEMENT OF AIR QUALITY

5.1 Excursions and Exceedances

As required in the monitoring plan, excursions and exceedances resulting from fugitive dust events and other causes are discussed in this section. To provide insights into these events, hourly concentrations are plotted together with hourly wind vectors where data are available. These plots are presented in Appendix B for PM_{10} and Appendix C for $PM_{2.5}$.

5.1.1 PM_{10} Events

A list of PM_{10} exceedances are provided in Table B-1. Plots of hourly PM_{10} concentrations during the exceedances are provided in Figure B-1 to B-4 in Appendix B.

All stations except Hosmer registered at least one exceedance of the 24-hour PM_{10} BC AAQO of 50 µg/m^3. The earliest occurred in August and the latest occurred in October, coinciding with periods with high temperatures and low precipitation. Most exceedances occurred in early September when all the stations registered their highest concentrations of the year.

LC_02 had the highest PM_{10} concentrations out of all of the stations, and had the most exceedances. The station's proximity to LCO's Coarse Coal Refuse Pile may be a contributing factor, however smoke from major wildfires in western North America could have also contributed to these exceedances. With the exception of one date (October 20), all exceedance days coincided with periods in which the RAQMP was affected by wildfire smoke. This observation was made based on maps of smoke extent provided by the U.S. National Oceanic and Atmospheric Administration (2022). The role of wildfires is further discussed in Section 5.1.3 below.

5.1.2 $PM_{2.5}$ Events

A list of $PM_{2.5}$ excursions and daily average concentrations is provided in Table C-1. Plots of hourly $PM_{2.5}$ concentrations are provided in Figure C-1 to C-5 in Appendix C.

Like PM_{10}, nearly all excursions of $PM_{2.5}$ above the BC AAQO of 25 µg/m^3 occurred in August to October. As will be discussed further in Section 5.1.3 below, smoke from wildfires is a likely cause of these excursions.

Two excursion days occurred on November 7 and 8 at the GH_ERMES station. Figure C-4 in Appendix C shows that $PM_{2.5}$ concentrations started rising in the afternoon of the 7th, then remained elevated until the morning of the next day. Winds were weak (<2 m/s) and coming from the North. No other station registered an excursion on that day, therefore it is likely that local fugitive sources such as unvegetated areas and inversion conditions around the station in Elkford were the source.

Excursions were highest and most frequent at LC_02, attributed partly to its location next to a large fugitive source. Two minor excursions (2 μg/m³ above the BC AAQO) that occurred in November and December were likely due to the proximity to this fugitive source.

5.1.3 Smoke from Wildfires

As stated in the Memorandum from the BC ENV to Teck Coal Ltd on August 31, 2022, the influence of wildfires on concentrations should be supported by guidance found in CCME (2012), specifically the section on Weight of Evidence (WOE) analyses. WOE refers to information generated by sources or methods outside the monitoring program that can account for exceedances.

Among the methods listed in the Memorandum and WOE analysis, satellite imagery provides a quick way to explain the elevated concentrations recorded within the RAQMP, particularly those events when more than one station registered an exceedance at the same time. For this purpose, maps created by the Office of Satellite and Product Operations of the National Oceanic and Atmospheric Administration (NOAA) using satellite images to delineate areas covered by smoke were downloaded from the Hazard Mapping System Fire and Smoke Product website (NOAA 2023). Each map indicates the areas with light (green shading), medium (yellow), and heavy smoke (red) within a given day.

To perform WOE analysis, shapefiles of the extent of smoke corresponding to the dates of exceedances or excursions were overlain on a regional map centered on the RAQMP area. These dates and maps are attached as Appendix D. Each map is a composite depicting the extent of smoke from multiple satellite images processed within that day. In each map, overlapping areas in red represent areas where heavy smoke persisted within the day, while areas in green indicate those that were affected by light smoke at least once.

A summary of the dates of excursions/exceedances and whether the RAQMP was inside an area with smoke is presented in Table D-1. As may be seen in the table, all the exceedances or excursions in August and September can be linked to large-scale smoke. Levels in August were mostly overlapping levels of light to medium smoke, coinciding with mild exceedances and excursions. The most serious levels were in early September, when the RAQMP region was inside heavy smoke for about two weeks.

All of the stations recorded their highest concentrations on September 3rd, and the satellite imagery shows the RAQMP region to be under heavy smoke on that day. Hourly plots indicate that particulate concentrations at all of the stations were well above the objective during most of the morning. Concentrations decreased in the afternoon when winds picked up, then went back up in the evening when wind speed decreased. Areas affected by smoke on that day included the RAQMP region, southern BC, a large portion of Alberta and Saskatchewan, and large parts of the western United States.

Peak station concentrations and impact from smoke decreased in the middle of September. The monitors in the RAQMP network were still affected until October 19, but only the LC_02 registered an excursion or exceedance. The exceedances on October 20th were likely due to residual effects of smoke from the previous day.

5.2 Public Air Quality Feedback

Teck records and investigates all feedback it receives from the public regarding air quality. Community feedback is received through a Teck Feedback Mechanism, a process which applies to the activities of Teck's coal operations and all personnel, including both employees and contractors. The process allows each of Teck's coal operations to receive feedback from communities about matters related to the operations that are of interest to them (including fugitive dust), and to effectively organize a response to that feedback. Teck's operations in the Elk Valley continue to recognize dust as a primary concern to nearby communities and takes all feedback seriously.

Out of forty-six (46) feedback entries received by Teck, twenty-two (22) were complaints about dirty vehicles owned either by Teck or its contractors. Nineteen (19) were related to general dust levels or poor visibility in the Elk Valley area (from various operations), three (3) were about deposits on Grave Lake, and two (2) were about other issues.

For LCO, there were six environmental incidents in 2022 (January 12, May 16, May 26, August 19, August 31 and October 15) related to public comments or LCO environmental department inspections related to fugitive dust observed on or near Grave Lake. Internal investigations were completed for all six events and spill reports were submitted to Emergency Management British Columbia (EMBC) and ENV for the May 26 and August 31 incidents.

During the investigation of the January 12 and August 19 events, it could not be determined that LCO operations were the cause of the observed dust deposition on Grave Lake. During the investigation of the May 16 and October 15 events, it was determined that both incidents were natural seasonal occurrences and not related to mining activities. Based on these outcomes the January 12, May 16, August 19 and October 15 events were not reported to EMBC or ENV as spills.

Teck investigated each complaint, and in instances where the person submitting the feedback identified themselves, responded directly to the person.

The following is a monthly summary of feedback from the community in 2022.

January: A complaint was registered with Teck Community Relations over dust found at Grave Lake by cottage owners. The lake was snow and ice covered at the time with the dust being noticeable on the surface of the snow. Warmer temperatures were prevalent with snow melt occurring during January 11 and 12, 2022. Teck LCO completed investigations and it was determined that the dust being viewed was an accumulation over the winter that became noticeable after a rapid thaw.

April and May: Out of eleven (11) complaints these months, ten (10) were about dirty vehicles and one (1) was about general dust levels in Elk Valley.

June: Eight (8) complaints were received this month, five (5) of which were about general dust levels in the community and the other three (3) were about dirty vehicles.

July: Five (5) complaints were received about general dust levels in the valley, and two (2) were about dirty vehicles. One (1) call was about dust deposits at a home, which was cleaned by Teck. Another call was about dust suppressant chemicals staining the driveway of a resident. Teck contacted the resident to provide instructions on cleaning the stain.

August: There were five (5) complaints this month; two (2) being about general dust levels in the valley, one (1) being about dust coming from the mining area, and two (2) concerning deposits on Grave Lake. On August 31, 2022, Teck prepared an End-of-Spill (EoS) report, which estimated about 0.72 grams of dust, regarding an incident that resulted in a dust film near the boat launch. As the film dissipated on its own, no further action was taken.

September to November: Out of twelve (12) feedback items in these months, nine (9) were about dirty vehicles, one (1) was about vehicles cutting through a gravel road and two (2) were comments about the Fugitive Dust Management Plan from community members.

Teck LCO submitted an EoS report for an incident on May 26, 2022, which released an estimated 76g of dust on Grave Lake that formed a film on the surface, which dispersed on its own.

5.3 Fugitive Dust Management Plans

Updated Fugitive Dust Management Plans (FDMPs) were submitted to BC ENV in 2022 and early 2023 addressing follow up comments received from the BC ENV in 2022. The FDMPs follow the Guidance on “Developing a Fugitive Dust Management Plan for Industrial Projects (BC EMPR and BC ENV, 2018)”. These updated plans address questions from BC ENV and include Trigger Action Response Plans (TARPs) for fugitive dust sources, details of the Community Feedback process at Teck, and the effect of fugitive dust on Human Health. In 2023, Teck looks forward to finalizing the FDMPs for all Teck facilities in the Elk Valley.

6 RECOMMENDATIONS

The RAQMP completed its prescribed 5-year review in December 2021. Because the monitoring program is achieving its objectives, no changes to the monitoring locations, equipment or schedules are recommended at this time. The review period has been revised to 3 years for the next review.

7 GENERAL STATEMENT OF LIMITATIONS

This report entitled "TECK COAL LTD. REGIONAL AIR QUALITY MONITORING PROGRAM: 2022 Annual Report", dated March 29, 2023, was prepared by RWDI AIR Inc. ("RWDI") for Teck Coal Ltd. ("Client"). The findings and conclusions presented in this report have been prepared for the Client and are specific to the project described herein ("Project"). This report was prepared using scientific principles, published methodologies and professional judgment in assessing available information and data. The findings presented within this document are based on available data within the limits of the existing information, budgeted scope of work, and schedule. The conclusions contained in this report are based on the information available to RWDI when this report was prepared; subsequent changes made by the Client after the date of this report have not been reflected in the conclusions.

This report was prepared for the exclusive use of Teck Coal Ltd. and the BC ENV. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties. RWDI accepts no responsibility for damages, if any, suffered by any third party as result of decisions made or actions based on this report.

8 REFERENCES

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APPENDIX A

Table A-1: 2022 PM_{10} Data Validity Statistics by Station

Period	Period (Month / Quarter / Year)	Hosmer[2]		EV_SCS		EV_WWTP		GH_ERMES		LC_02	
		Days / Hours	Percent Complete (%)	Days / Hours	Percent Complete (%)	Days / Hours	Percent Complete (%)	Days / Hours	Percent Complete (%)	Days / Hours	Percent Complete (%)
Valid monitoring days per month	January (31)	31	100%	31	100%	31	100%	28	90%	5	16%
	February (28)	21	75%	28	100%	26	93%	25	89%	28	100%
	March (31)	8	26%	31	100%	31	100%	31	100%	31	100%
	April (30)	26	87%	27	90%	30	100%	25	83%	30	100%
	May (31)	31	100%	31	100%	31	100%	30	97%	31	100%
	June (30)	18	60%	30	100%	30	100%	21	70%	30	100%
	July (31)	5	16%	31	100%	28	90%	31	100%	29	94%
	August (31)	15	48%	31	100%	31	100%	31	100%	31	100%
	September (30)	12	40%	30	100%	30	100%	30	100%	30	100%
	October (31)	23	74%	31	100%	30	97%	31	100%	31	100%
	November (30)	25	83%	30	100%	30	100%	30	100%	19	63%
	December (31)	27	87%	31	100%	28	90%	31	100%	22	71%
Valid monitoring days per quarter[1]	Q1 (90)	60	67%	90	100%	88	98%	84	93%	64	71%
	Q2 (91)	75	82%	88	97%	91	100%	76	84%	91	100%
	Q3 (92)	32	35%	92	100%	89	97%	92	100%	90	98%
	Q4 (92)	75	82%	92	100%	88	96%	92	100%	72	78%
Valid monitoring days per year[1]	2022 (365)	242	66%	362	99%	356	98%	344	94%	317	87%
Valid monitoring hours per quarter	Q1 (2160)	1446	67%	2146	99%	2121	98%	1990	92%	1548	72%
	Q2 (2184)	1864	85%	2101	96%	2170	99%	1875	86%	2182	100%
	Q3 (2208)	1267	57%	2189	99%	2129	96%	2174	98%	2173	98%
	Q4 (2208)	1924	87%	2191	99%	2124	96%	2151	97%	1811	82%
Valid monitoring hours per year	2022 (8760)	6501	74%	8627	98%	8544	98%	8190	93%	7714	88%

Notes: [1]: Permit conditions state that within each quarter, the daily data should be 60% complete and within each year, the daily data must be 75% complete.
[2]: Hosmer is not subject to any operation's permit and does not have a minimum completeness requirement.

Table A-2: 2022 $PM_{2.5}$ Data Validity Statistics by Station

Period	Period (Month / Quarter / Year)	Hosmer[2]		EV_SCS		EV_WWTP		GH_ERMES		LC_02	
		Days / Hours	Percent Complete (%)	Days / Hours	Percent Complete (%)	Days / Hours	Percent Complete (%)	Days / Hours	Percent Complete (%)	Days / Hours	Percent Complete (%)
Valid monitoring days per month	January (31)	31	100%	31	100%	31	100%	30	97%	5	16%
	February (28)	23	82%	27	96%	27	96%	28	100%	28	100%
	March (31)	30	97%	29	94%	31	100%	31	100%	31	100%
	April (30)	27	90%	24	80%	30	100%	29	97%	30	100%
	May (31)	31	100%	31	100%	31	100%	31	100%	31	100%
	June (30)	30	100%	30	100%	30	100%	29	97%	30	100%
	July (31)	31	100%	31	100%	28	90%	31	100%	29	94%
	August (31)	28	90%	27	87%	31	100%	31	100%	31	100%
	September (30)	30	100%	27	90%	30	100%	30	100%	30	100%
	October (31)	30	97%	31	100%	31	100%	31	100%	31	100%
	November (30)	30	100%	30	100%	30	100%	28	93%	19	63%
	December (31)	27	87%	31	100%	31	100%	31	100%	22	71%
Valid monitoring days per quarter[1]	Q1 (90)	84	93%	87	97%	89	99%	89	99%	64	71%
	Q2 (91)	88	97%	85	93%	91	100%	89	98%	91	100%
	Q3 (92)	89	97%	85	92%	89	97%	92	100%	90	98%
	Q4 (92)	87	95%	92	100%	92	100%	90	98%	72	78%
Valid monitoring days per year[1]	2022 (365)	348	95%	349	96%	361	99%	360	99%	317	87%
Valid monitoring hours per quarter	Q1 (2160)	2067	96%	2093	97%	2130	99%	2137	99%	1548	72%
	Q2 (2184)	2091	96%	2043	94%	2178	100%	2129	97%	2182	100%
	Q3 (2208)	2131	97%	2092	95%	2144	97%	2176	99%	2173	98%
	Q4 (2208)	2142	97%	2189	99%	2184	99%	2143	97%	1811	82%
Valid monitoring hours per year	2022 (8760)	8431	96%	8417	96%	8636	99%	8585	98%	7714	88%

Notes: [1]: Permit conditions state that within each quarter, the daily data should be 60% complete and within each year, the daily data must be 75% complete.
[2]: Hosmer is not subject to any operation's permit and does not have a minimum completeness requirement.

Table A-3: 2022 NO_2 and O_3 EV_SCS Station Data Validity Statistics

Period	Period (Month / Quarter / Year)	NO_2 (Hours)	Percent Complete (%)	O_3 (Hours)	Percent Complete (%)
Valid monitoring hours per month	January (744)	731	98%	731	98%
	February (672)	667	99%	664	99%
	March (744)	740	99%	740	99%
	April (720)	715	99%	715	99%
	May (744)	741	100%	741	100%
	June (720)	716	99%	716	99%
	July (744)	733	99%	733	99%
	August (744)	740	99%	740	99%
	September (720)	715	99%	715	99%
	October (744)	739	99%	739	99%
	November (720)	710	99%	676	94%
	December (744)	741	100%	734	99%
Valid monitoring hours per quarter	Q1 (2160)	2138	99%	2135	99%
	Q2 (2184)	2172	99%	2172	99%
	Q3 (2208)	2188	99%	2188	99%
	Q4 (2208)	2190	99%	2149	97%
Valid monitoring hours per year	2022 (8760)	8688	99%	8644	99%

Notes: NO_2 and O_3 monitoring is not included under EVO's permit and are not subject to data completeness requirements.

Table A-4: 2022 Meteorological Station Data Validity Statistics by Station

Period	Period (Year)	Station	Wind Speed and Direction		Temperature		Relative Humidity		Barometric Pressure		Precipitation	
			Hours	Percent Complete (%)	Hours	Percent Complete (%)	Hours	Percent Complete (%)	Hours	Percent Complete (%)	Hours	Percent Complete (%)
Valid monitoring hours per year	2022 (8760)	Hosmer	8590	98%	8760	100%	8760	100%	8760	100%	N/A	N/A
		EV_SCS	8701	99%	8746	100%	8746	100%	N/A	N/A	N/A	N/A
		EV_WWTP	8685	99%	8733	100%	8733	100%	N/A	N/A	N/A	N/A
		GH_ERMES	8630	99%	8755	100%	N/A	N/A	N/A	N/A	8752	100%
	July 26 - December 31, 2022 (3816)	LC_02[1]	3518	92%	3614	95%	3614	95%	N/A	N/A	N/A	N/A

Notes: N/A – Station does not report this data.
[1] LC_02 started monitoring wind speed and direction, temperature, and relative humidity starting July 26, 2022

Table A-5: 2022 PM_{10} Concentrations Averaged by Period and Station

	Period	Hosmer (µg/m³)	EV_SCS (µg/m³)	EV_WWTP (µg/m³)	GH_ERMES (µg/m³)	LC_02 (µg/m³)
Annual Hourly Mean	2022	7.9	17.4	9.2	9.6	11.7
Annual Hourly Standard Deviation	2022	10.7	17.2	9.2	12.9	21.2
Annual Daily Mean	2022	7.6	17.4	9.2	9.6	11.7
Annual Daily Standard Deviation	2022	6.7	12.5	7.8	8.8	19.1
Daily average by day of week	Monday	6.9	18.1	9.1	9.7	12.0
	Tuesday	7.4	17.9	9.6	10.4	11.7
	Wednesday	9.4	19.3	9.5	10.3	12.2
	Thursday	8.1	18.0	9.4	10.2	10.8
	Friday	7.4	17.5	9.1	9.2	10.5
	Saturday	7.0	15.3	8.6	9.1	12.0
	Sunday	6.8	15.6	9.6	8.5	12.8
Daily average by season	Spring (MAM)	4.4	14.9	6.1	10.5	4.0
	Summer (JJA)	9.3	19.8	11.5	10.1	11.9
	Autumn (SON)	10.3	23.8	13.7	12.7	24.0
	Winter (DJF)	7.3	10.9	5.5	4.8	6.3

Table A-6: 2022 $PM_{2.5}$ Concentrations Averaged by Period and Station

	Period	Hosmer (µg/m³)	EV_SCS (µg/m³)	EV_WWTP (µg/m³)	GH_ERMES (µg/m³)	LC_02 (µg/m³)
Annual Hourly Mean	2022	6.1	6.9	6.2	5.6	10.6
Annual Hourly Standard Deviation	2022	8.4	8.5	8.3	8.0	20.7
Annual Daily Mean	2022	6.0	6.8	6.2	5.6	10.6
Annual Daily Standard Deviation	2022	6.9	7.3	7.3	6.3	18.7
Daily average by day of week	Monday	6.3	7.0	6.4	5.8	11.0
	Tuesday	5.5	6.7	6.2	5.9	10.7
	Wednesday	6.2	7.2	6.4	5.6	11.0
	Thursday	5.9	6.6	5.9	5.4	9.6
	Friday	5.6	6.2	5.9	5.4	9.4
	Saturday	6.2	6.6	5.9	5.6	10.9
	Sunday	6.5	7.2	6.8	5.5	11.9
Daily average by season	Spring (MAM)	2.9	3.3	3.1	3.6	3.3
	Summer (JJA)	6.1	7.7	6.7	5.2	10.2
	Autumn (SON)	10.7	11.6	11.2	9.8	22.9
	Winter (DJF)	4.3	4.5	3.9	3.9	5.7

Table A-7: 2022 NO_2 and O_3 EV_SCS Station Concentrations Averaged by Period

	Period	EV_SCS	
		NO_2 (µg/m^3)	O_3 (µg/m^3)
Annual Hourly Mean	2022	11.3	53.4
Annual Hourly Standard Deviation	2022	9.8	26.2
Annual Daily[1] Mean	2022	28.0	73.4
Annual Daily[1] Standard Deviation	2022	13.3	16.3
Daily average[1] by day of week	Monday	26.5	70.4
	Tuesday	26.6	71.6
	Wednesday	28.2	70.9
	Thursday	32.0	75.1
	Friday	26.5	75.3
	Saturday	29.2	78.0
	Sunday	27.4	72.5
Daily average[1] by season	Spring (MAM)	28.9	82.7
	Summer (JJA)	24.0	80.9
	Autumn (SON)	26.9	65.1
	Winter (DJF)	32.3	64.6

Notes:
Where conversions have been made between ppb and µg/m^3, calculations have been based on 25°C and 1 atm
[1] Refers to daily 1-hour maximum concentration for NO_2 and daily 8-hour maximum for O_3.

Table A-8: 2022 PM_{10} Concentration Percentiles by Station

Averaging period	Percentile	Hosmer (µg/m³)	EV_SCS (µg/m³)	EV_WWTP (µg/m³)	GH_ERMES (µg/m³)	LC_02 (µg/m³)
Hourly	0	0.0	0.0	0.0	0.0	0.0
	10	0.4	2.2	1.6	2.0	1.2
	25	1.6	6.3	3.3	3.4	2.8
	50	4.6	13.4	6.8	6.3	6.0
	75	10.2	22.5	12.2	11.7	12.6
	90	19.2	35.2	19.2	19.2	24.5
	95	26.2	48.9	24.0	26.0	34.9
	98	38.5	72.8	34.8	42.3	69.7
	100	153.0	207.1	106.0	308.9	257.2
Daily	0	0.3	1.3	0.3	0.3	0.6
	10	1.8	4.4	2.6	2.8	1.9
	25	3.1	8.2	4.3	4.3	3.1
	50	5.5	14.8	7.3	7.0	6.5
	75	9.7	23.8	11.7	11.3	13.2
	90	15.5	32.2	18.5	18.9	23.1
	95	19.4	38.9	23.0	28.1	34.9
	98	29.8	49.1	30.7	37.7	66.3
	100	41.2	92.5	61.4	71.8	202.7

Table A-9: 2022 $PM_{2.5}$ Concentration Percentiles by Station

Averaging period	Percentile	Hosmer (µg/m³)	EV_SCS (µg/m³)	EV_WWTP (µg/m³)	GH_ERMES (µg/m³)	LC_02 (µg/m³)
Hourly	0	0	0	0.0	0	0
	10	0.7	0.9	0.8	1.2	0.9
	25	1.5	2.2	1.8	2.1	2.2
	50	3.4	4.7	3.9	3.6	5.1
	75	7.4	8.7	7.6	6.5	11.1
	90	13.7	13.9	12.9	10.9	22.1
	95	18.7	18.8	17.4	14.9	33.1
	98	29.8	30.0	28.1	24.6	66.3
	100	107.1	86.2	96.4	160.2	255.4
Daily	0	0.3	0.6	0.2	0.4	0.4
	10	1.3	1.3	1.5	1.9	1.5
	25	2.6	2.7	2.5	2.7	2.5
	50	4.3	4.9	4.4	3.9	5.5
	75	6.9	8.4	7.2	6.3	11.7
	90	11.5	12.9	11.5	9.7	20.9
	95	15.9	15.6	15.8	12.9	33.5
	98	25.9	27.4	25.8	26.6	64.2
	100	65.6	70.0	71.2	65.7	199.1

Table A-10: 2022 EV_SCS Station NO_2 and O_3 Concentration Percentiles

Averaging period	Percentile	EV_SCS	
		NO_2 (µg/m³)	O_3 (µg/m³)
Hourly	0	0.6	0.1
	10	3.1	14.2
	25	4.5	31.9
	50	7.8	56.6
	75	14.9	74.8
	90	25.0	84.8
	95	32.4	89.7
	98	41.2	97.7
	100	69.6	131.7
		Daily 1-hour Maximum	**Daily 8-hour Maximum**
Daily	0	4.6	0.0
	10	12.0	51.9
	25	17.9	64.1
	50	26.8	75.3
	75	36.6	84.9
	90	46.0	91.5
	95	52.7	97.5
	98	59.0	102.1
	100	69.6	118.3
	4th highest[1]	-	90.6

Notes:
Where conversions have been made between ppb and µg/m³, calculations have been based on 25°C and 1 atm
[1] Provided for comparison with BC AAQO of 123 µg/m³ for the daily 8-hour maximum O_3 concentration.

Table A-11: 2022 $PM_{2.5}$ 98th Percentile of Daily Average Concentration by Station

Station Name	98th percentile of daily averaged $PM_{2.5}$ (µg/m³)
Hosmer	**25.9**
EV_SCS	**27.4**
EV_WWTP	**25.8**
GH_ERMES	**26.6**
LC_02	**64.2**

Note: Values in boldface are above the BC AAQO of 25 µg/m³.

APPENDIX B

Table B-1: List of Days with PM_{10} Exceedances in 2022

Station Name	Month	Day	PM_{10} Concentration ($\mu g/m^3$)
EV_SCS	August	3	61
	August	16	54
	September	3	93
	September	4	83
	September	12	66
	September	13	54
EV_WWTP	September	3	61
	September	4	55
GH_ERMES	September	3	72
	September	4	52
LC_02	August	2	60
	September	2	100
	September	3	203
	September	4	141
	September	5	50
	September	7	57
	September	11	72
	September	12	122
	September	13	84
	September	14	68
	October	20	63

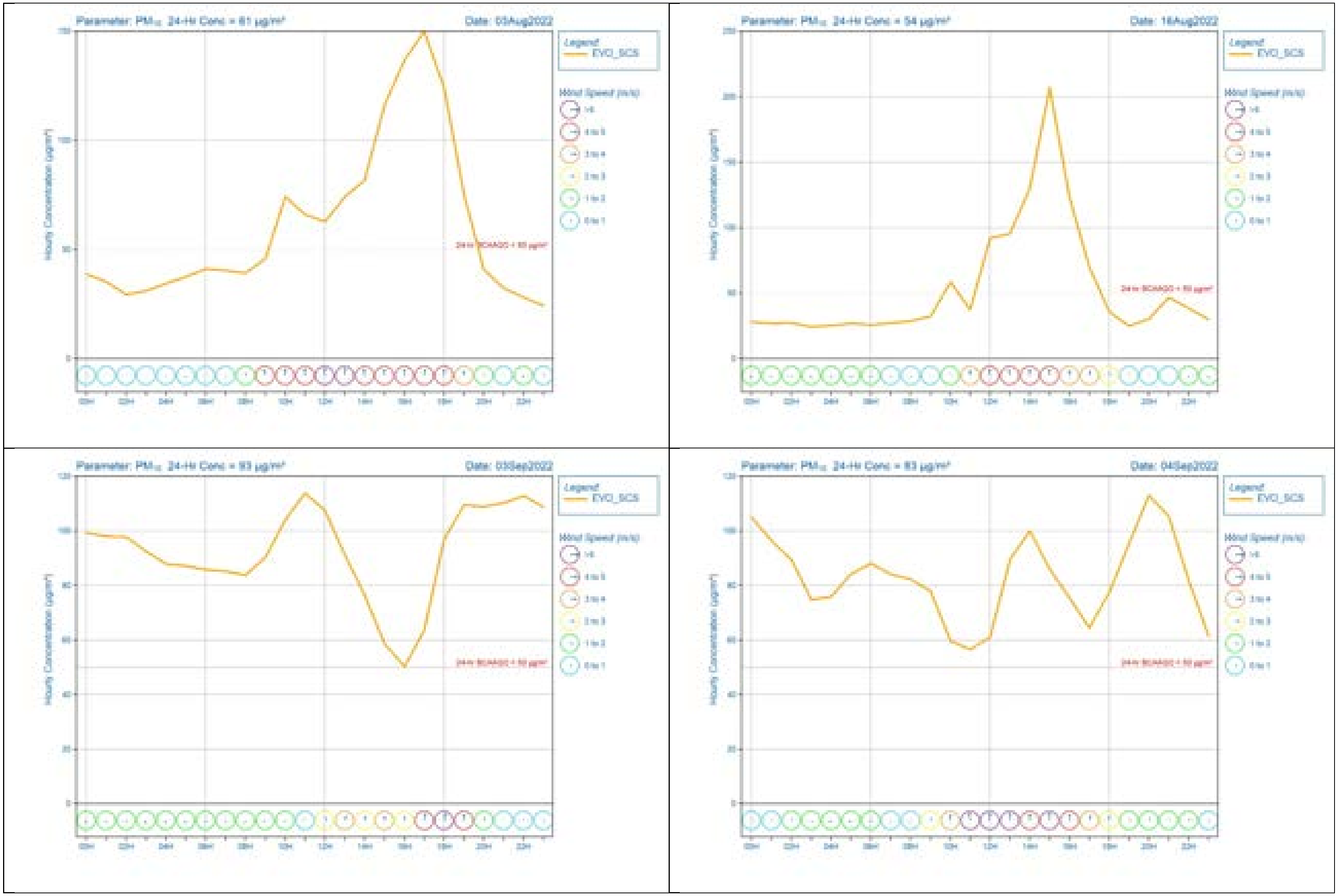

Figure B-1: Hourly winds and PM_{10} concentrations at EV_SCS during days with exceedances in 2022.

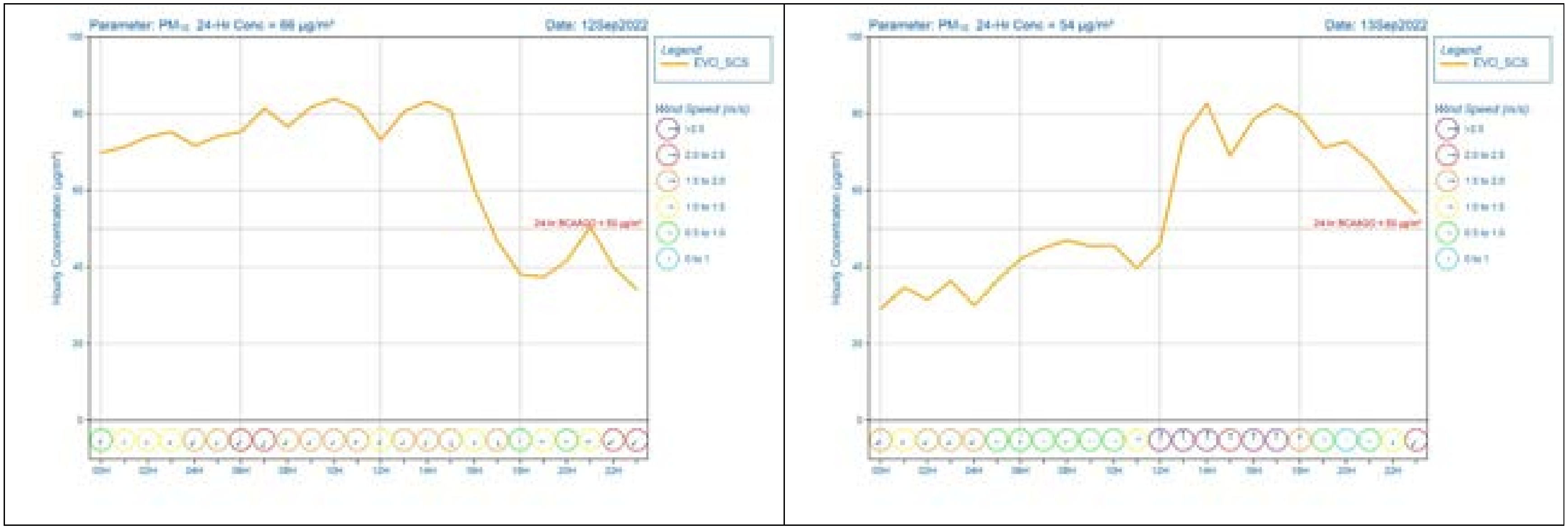

Figure B-1 (continued): Hourly winds and PM_{10} concentrations at EV_SCS during days with exceedances in 2022.

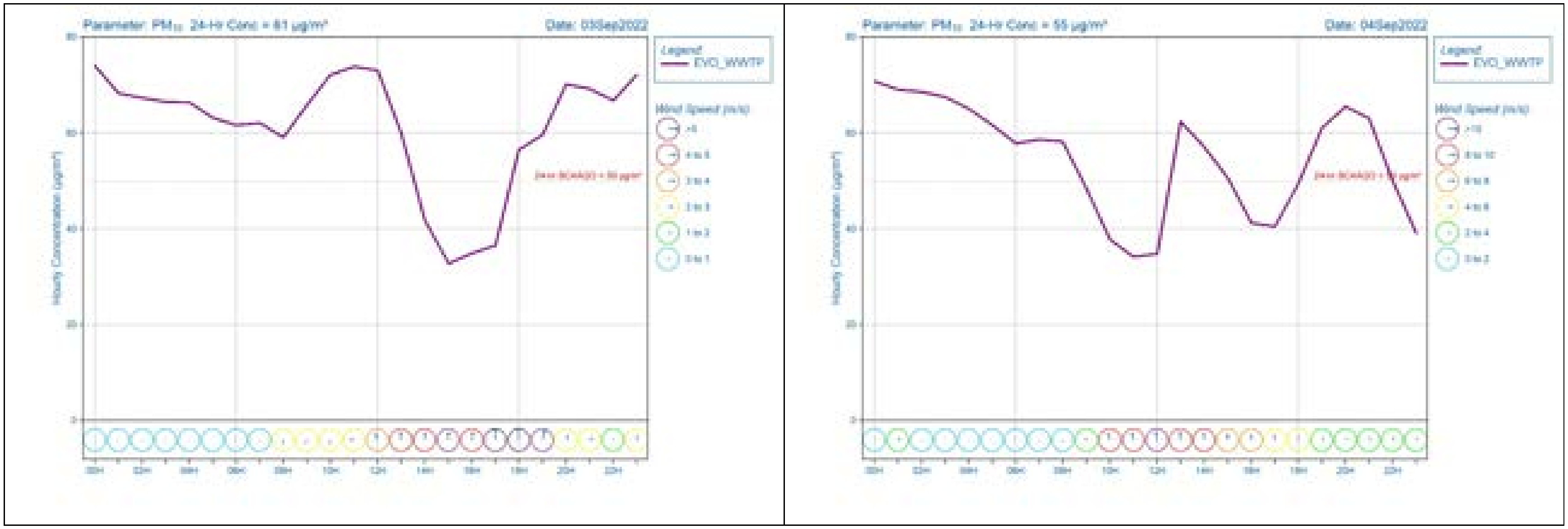

Figure B-2: Hourly winds and PM_{10} concentrations at EV_WWTP during days with exceedances in 2022.

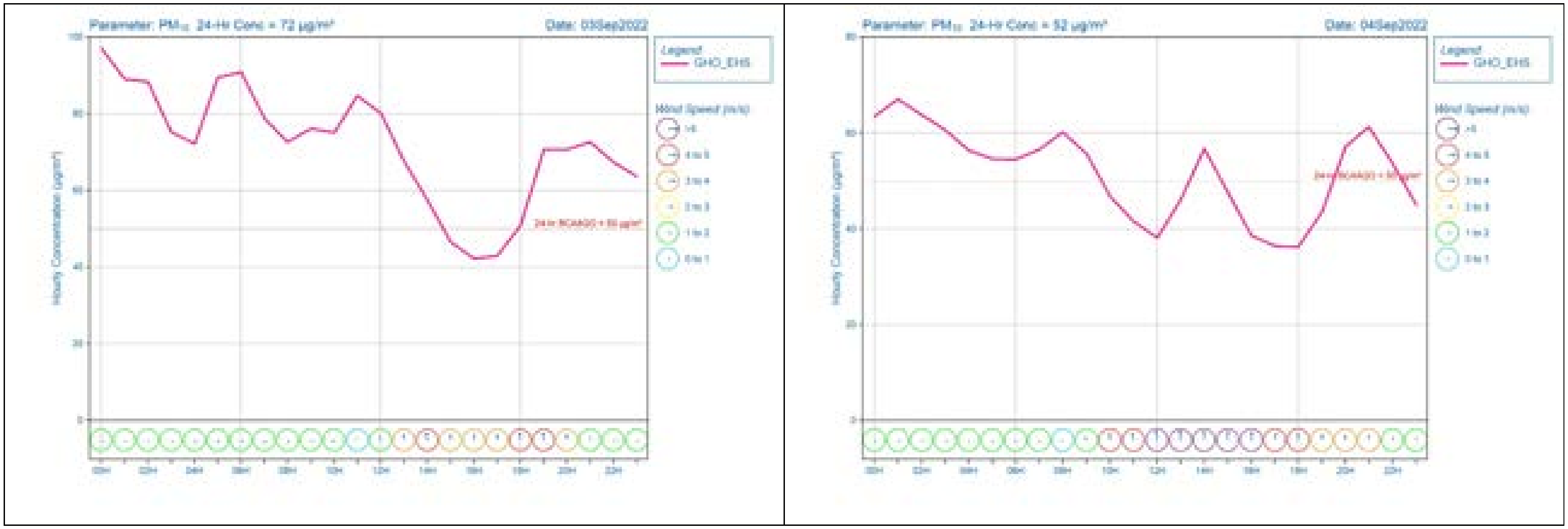

Figure B-3: **Hourly winds and PM_{10} concentrations at GH_ERMES during days with exceedances in 2022.**

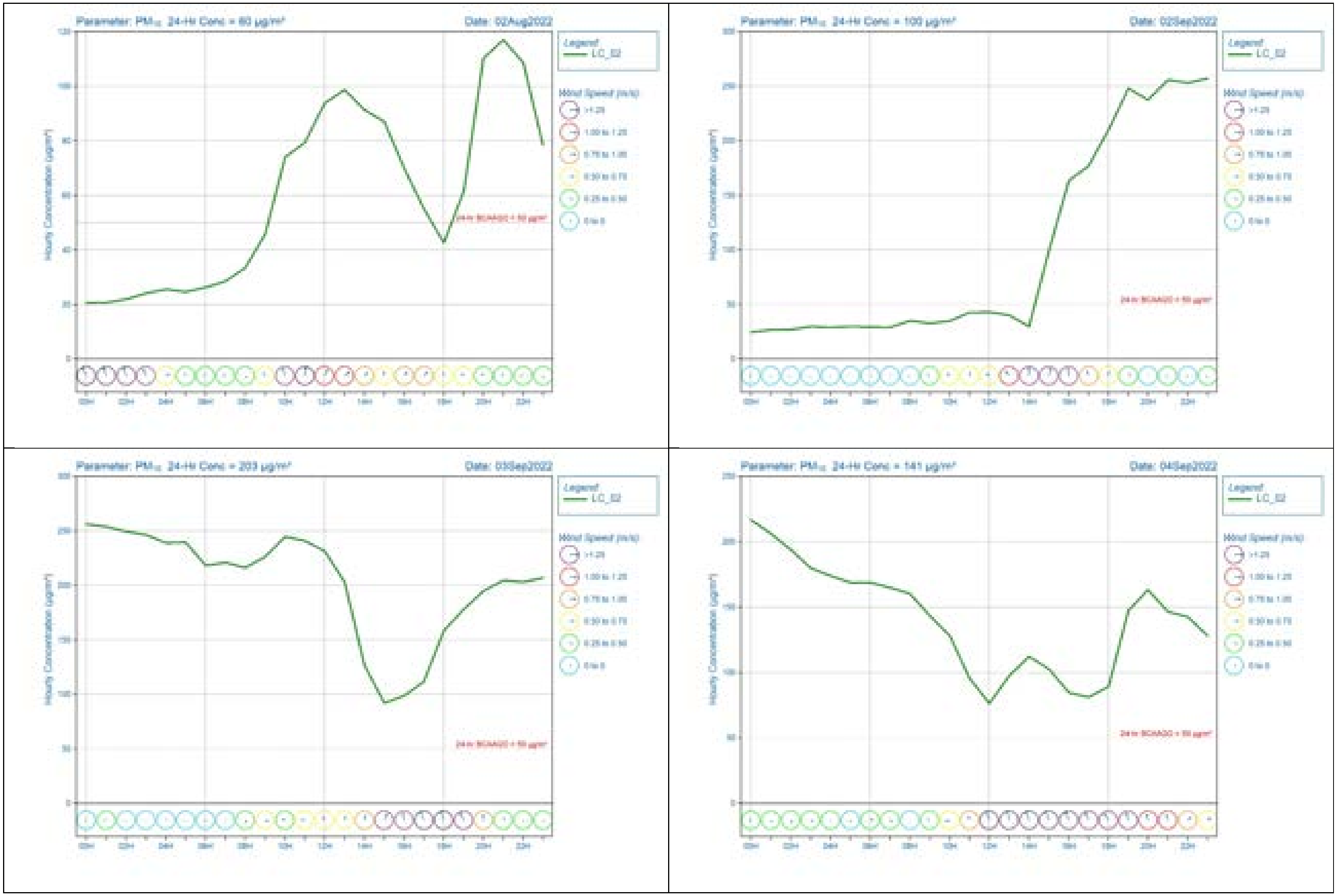

Figure B-4: Hourly winds and PM_{10} concentrations at LC_02 during days with exceedances in 2022.

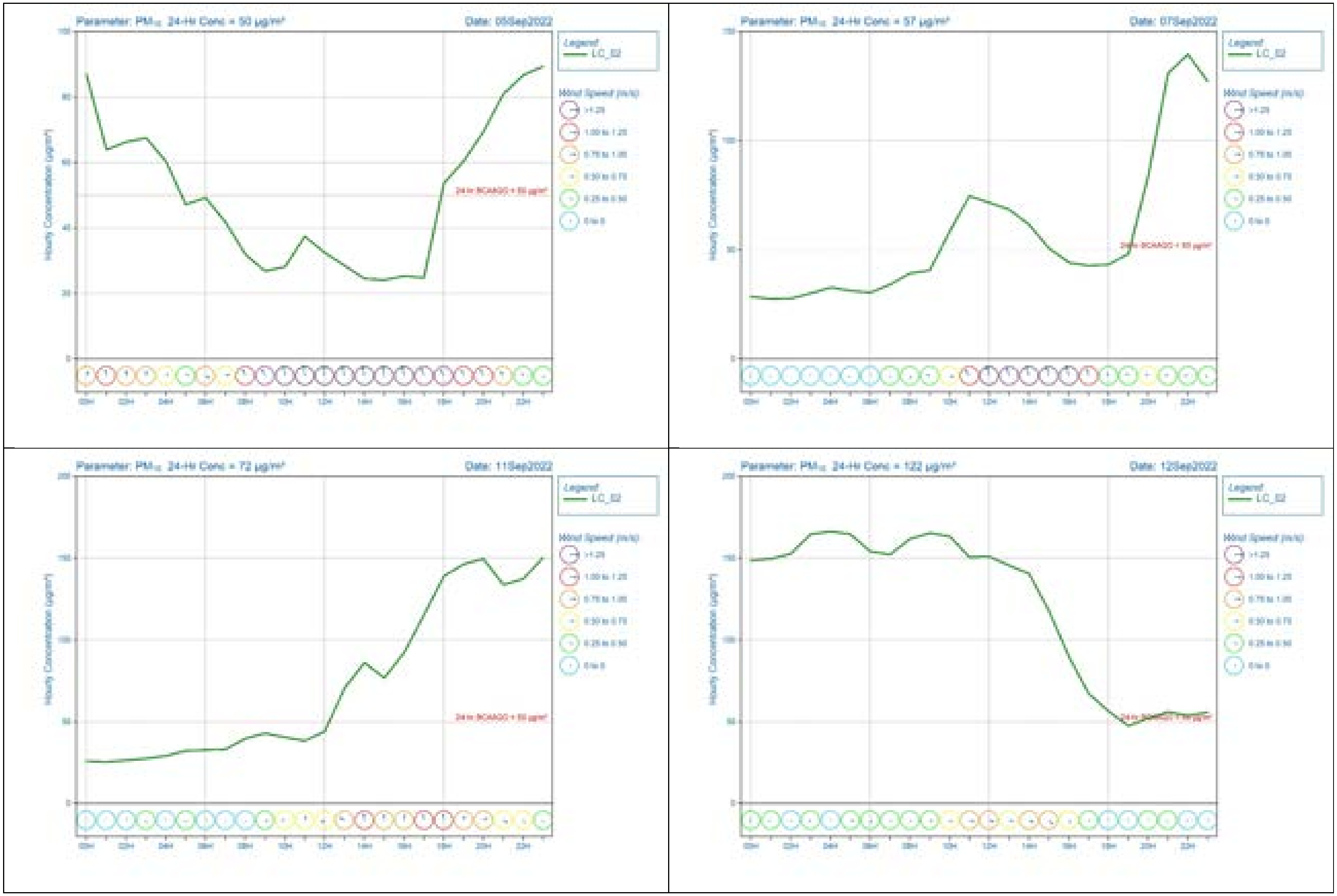

Figure B-4 (continued): **Hourly winds and PM_{10} concentrations at LC_02 during days with exceedances in 2022.**

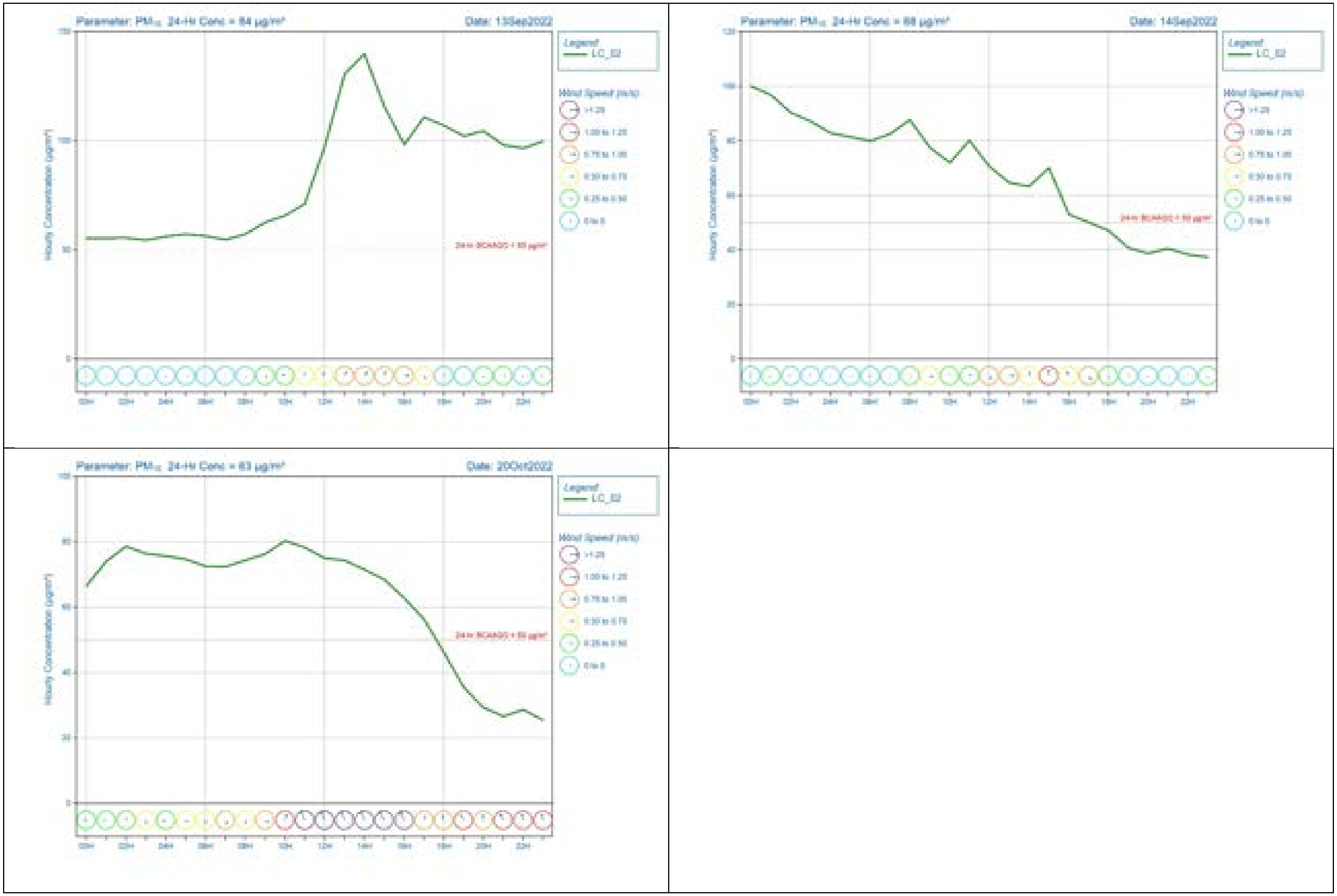

Figure B-4 (continued): Hourly winds and PM_{10} concentrations at LC_02 during days with exceedances in 2022.

APPENDIX C

Table C-1: List of Days with $PM_{2.5}$ Excursions in 2022.

Station	Month	Day	$PM_{2.5}$ Concentration (μg/m³)	Station	Month	Day	$PM_{2.5}$ Concentration (μg/m³)	Station	Month	Day	$PM_{2.5}$ Concentration (μg/m³)
Hosmer	September	2	32	EV_WWTP	September	2	40	LC_02	August	2	58
	September	3	66		September	3	71		August	3	33
	September	4	63		September	4	64		August	14	30
	September	5	26		September	5	26		August	15	29
	September	11	27		September	7	28		August	21	28
	September	12	45		September	11	30		September	1	27
	September	13	32		September	12	47		September	2	97
	September	14	26		September	13	35		September	3	199
	October	20	25						September	4	138
				GH_ERMES	September	2	38		September	5	49
EV_SCS	August	3	27		September	3	66		September	6	46
	September	3	70		September	4	45		September	7	55
	September	4	64		September	11	27		September	11	71
	September	5	33		September	12	40		September	12	119
	September	7	29		September	13	31		September	13	82
	September	11	29		November	7	34		September	14	66
	September	12	44		November	8	30		September	15	36
	September	13	35						September	16	34
	September	14	26						October	9	34
	October	20	27						October	10	29
									October	19	40
									October	20	61
									November	15	27
									December	12	25

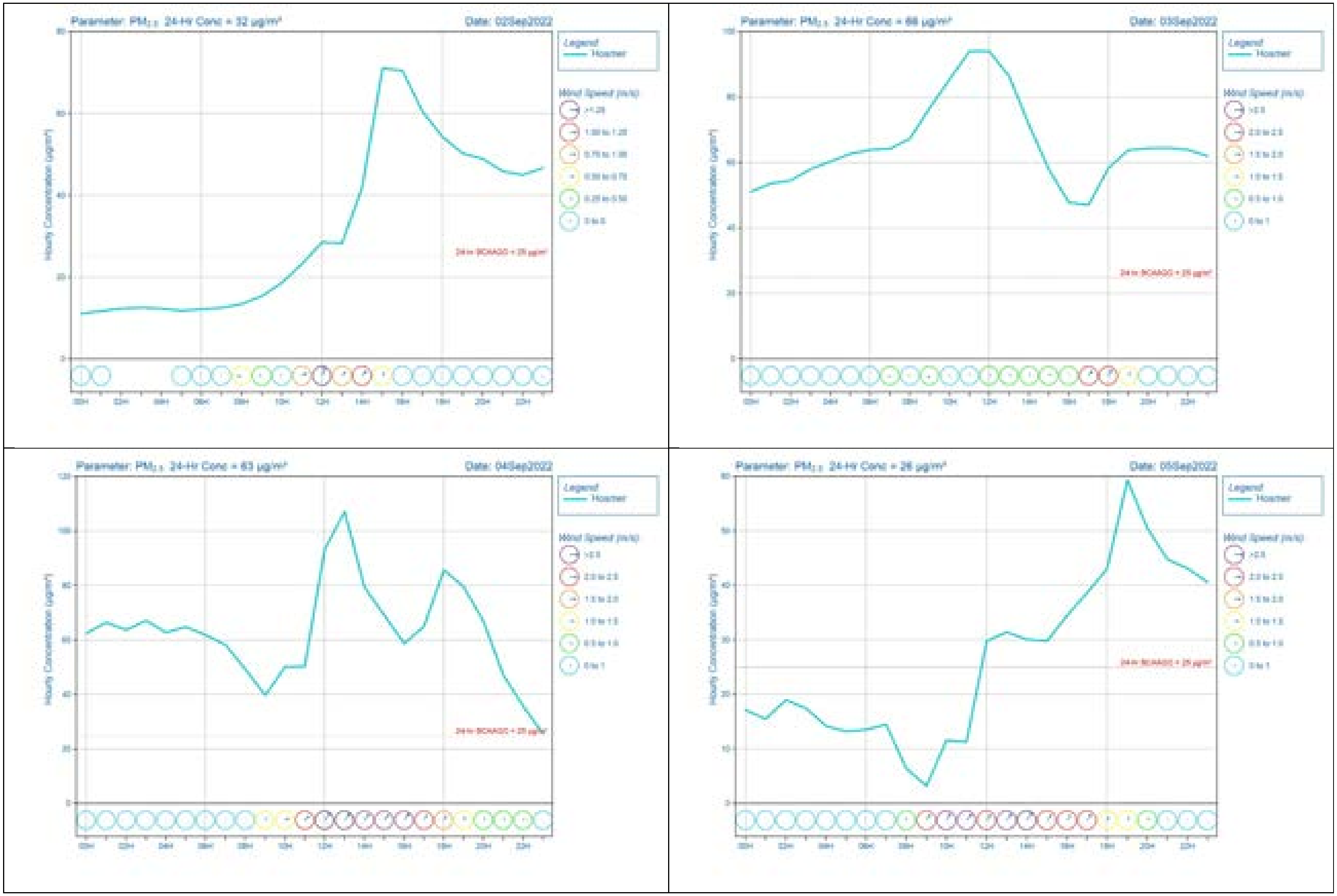

Figure C-1: **Hourly winds and $PM_{2.5}$ concentrations at Hosmer during days with excursions in 2022.**

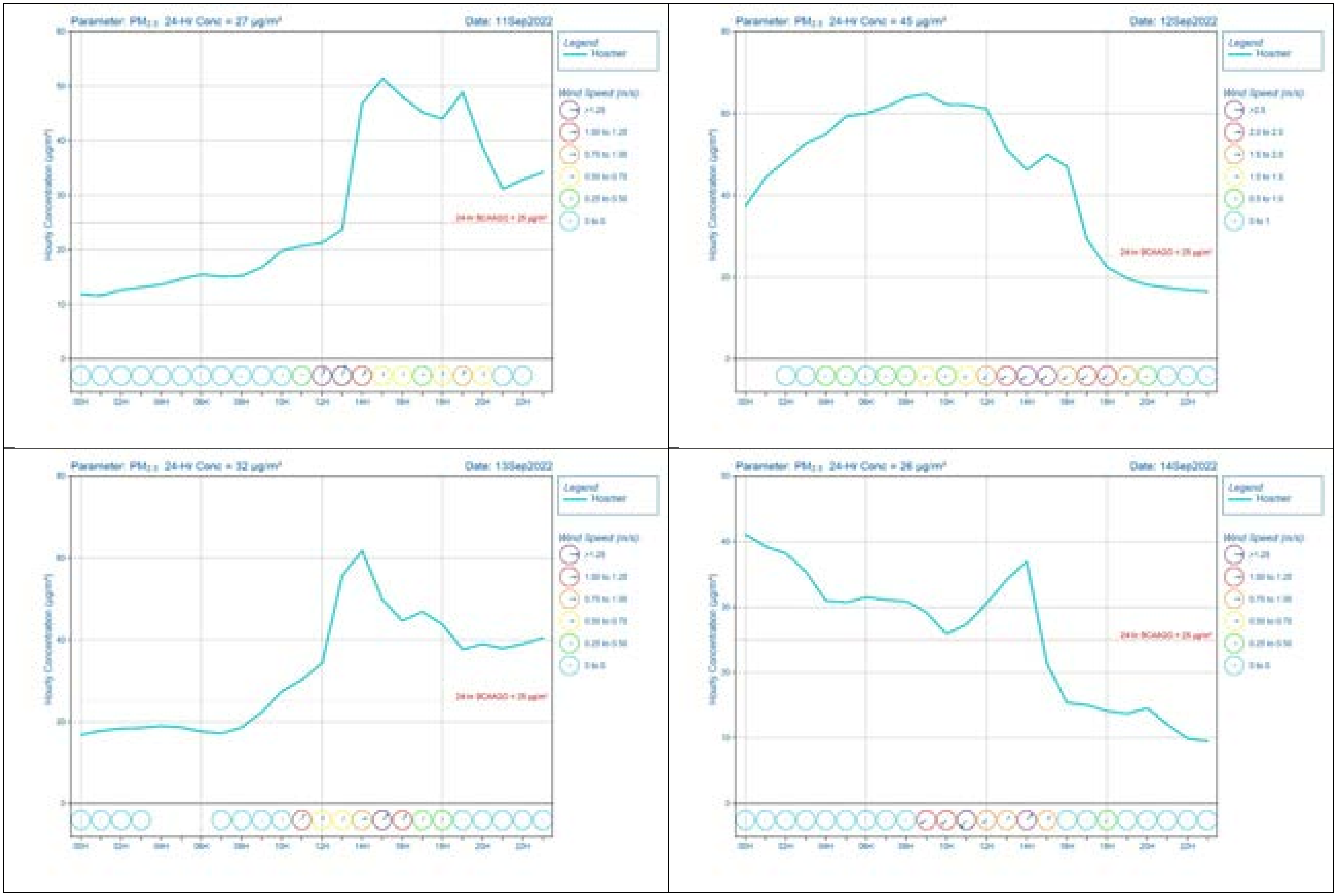

Figure C-2 (continued): Hourly winds and $PM_{2.5}$ concentrations at Hosmer during days with excursions in 2022.

Figure C-3 (continued): Hourly winds and $PM_{2.5}$ concentrations at Hosmer during days with excursions in 2022.

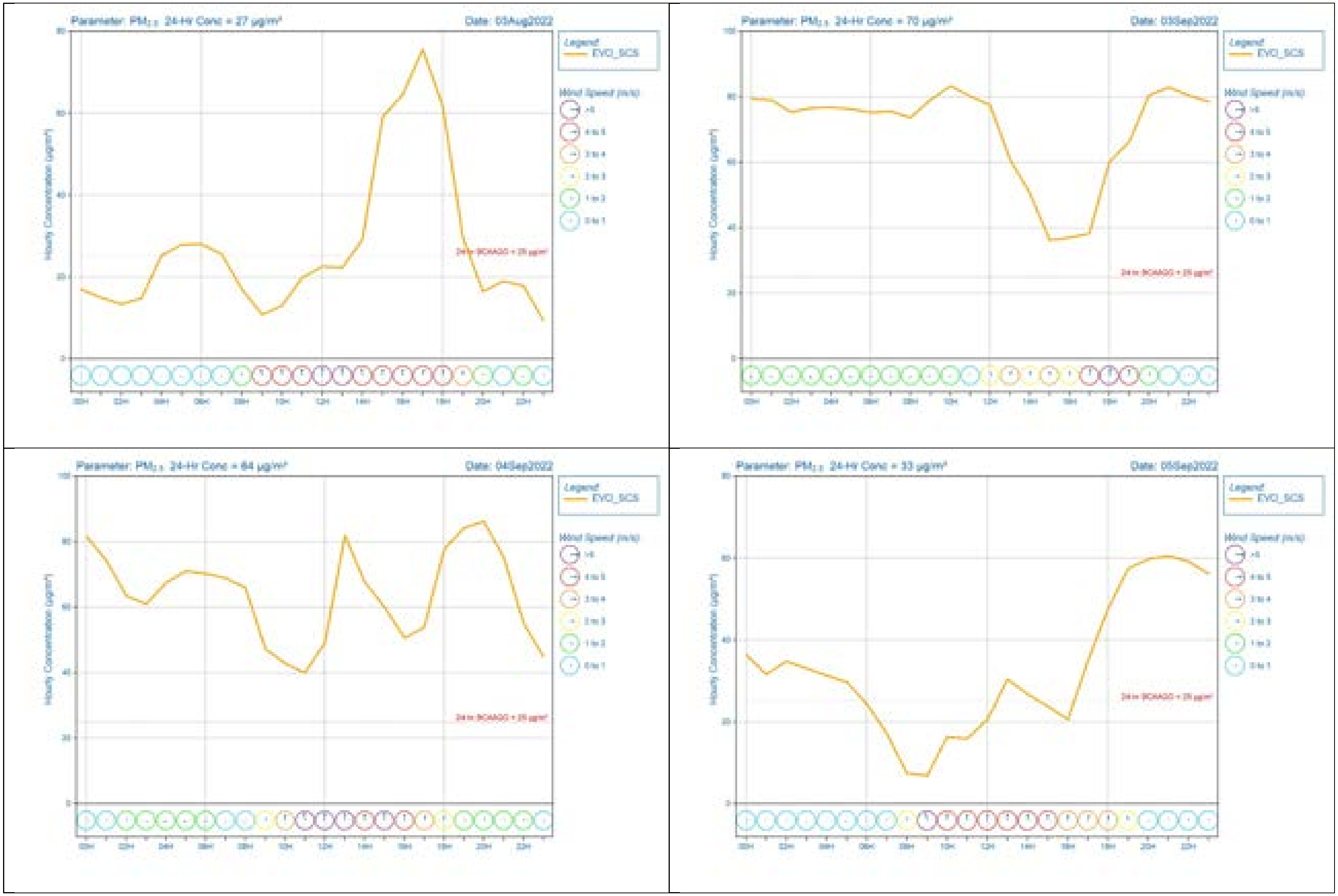

Figure C-2: Hourly winds and $PM_{2.5}$ concentrations at EV_SCS during days with excursions in 2022.

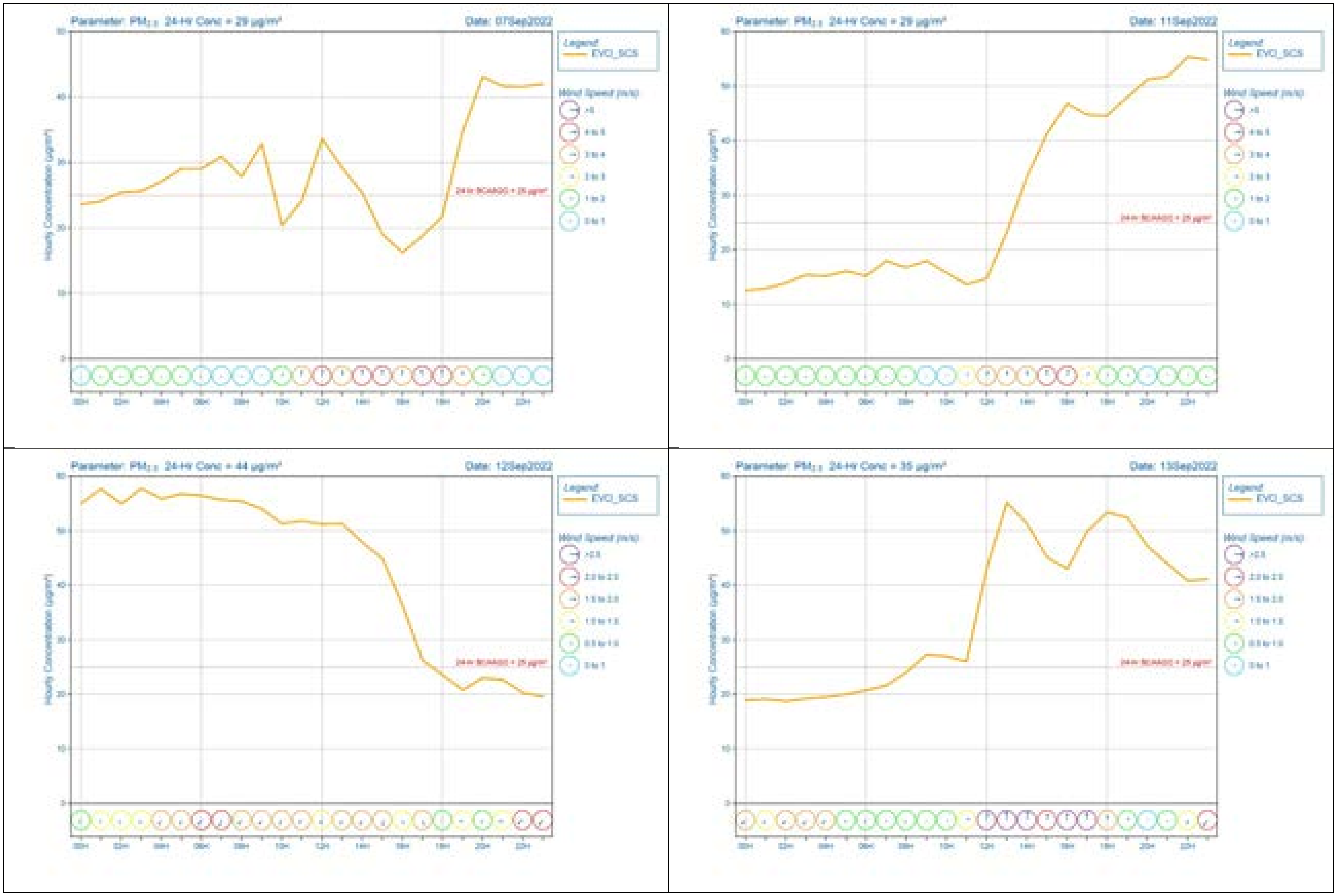

Figure C-2 (continued): Hourly winds and $PM_{2.5}$ concentrations at EV_SCS during days with excursions in 2022.

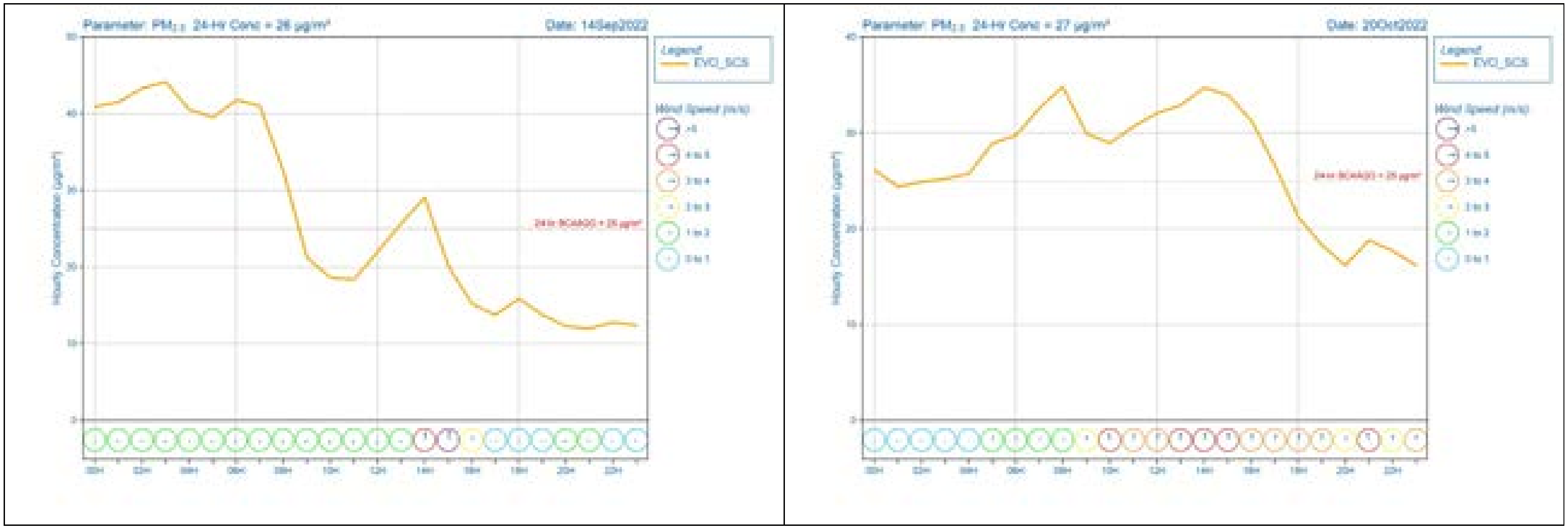

Figure C-2 (continued): Hourly winds and $PM_{2.5}$ concentrations at EV_SCS during days with excursions in 2022.

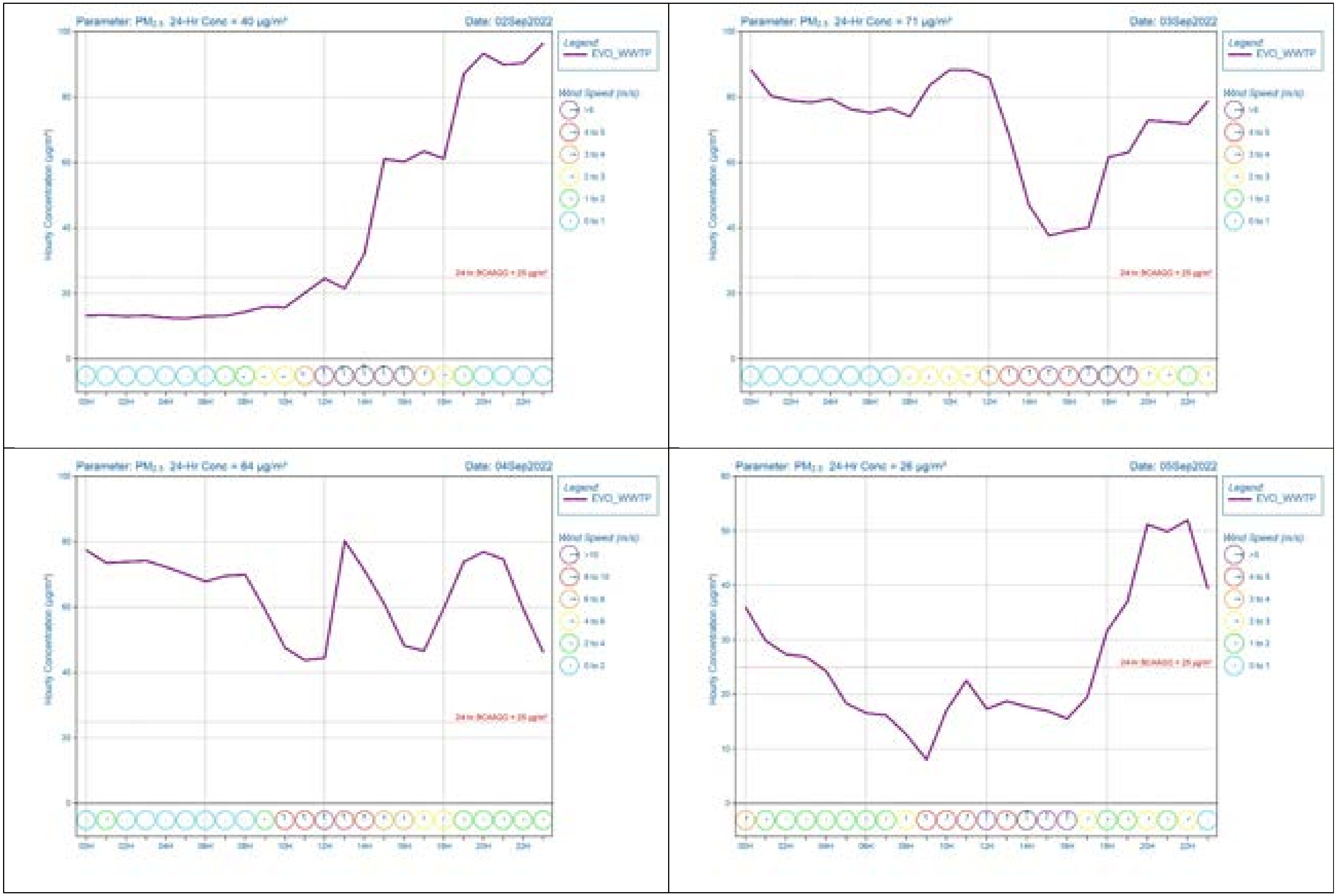

Figure C-3: **Hourly winds and $PM_{2.5}$ concentrations at EV_WWTP during days with excursions in 2022.**

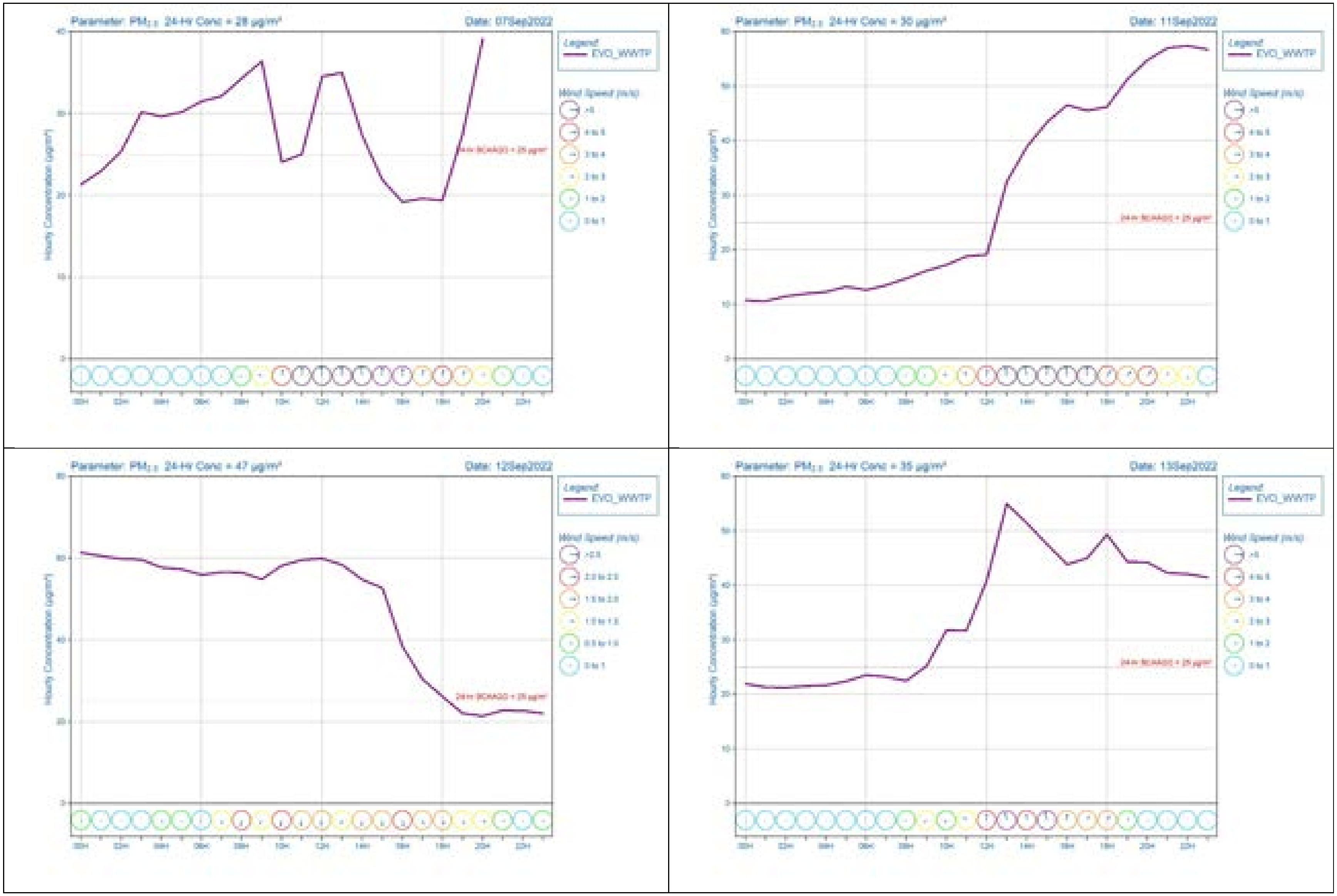

Figure C-3 (continued): Hourly winds and $PM_{2.5}$ concentrations at EV_WWTP during days with excursions in 2022.

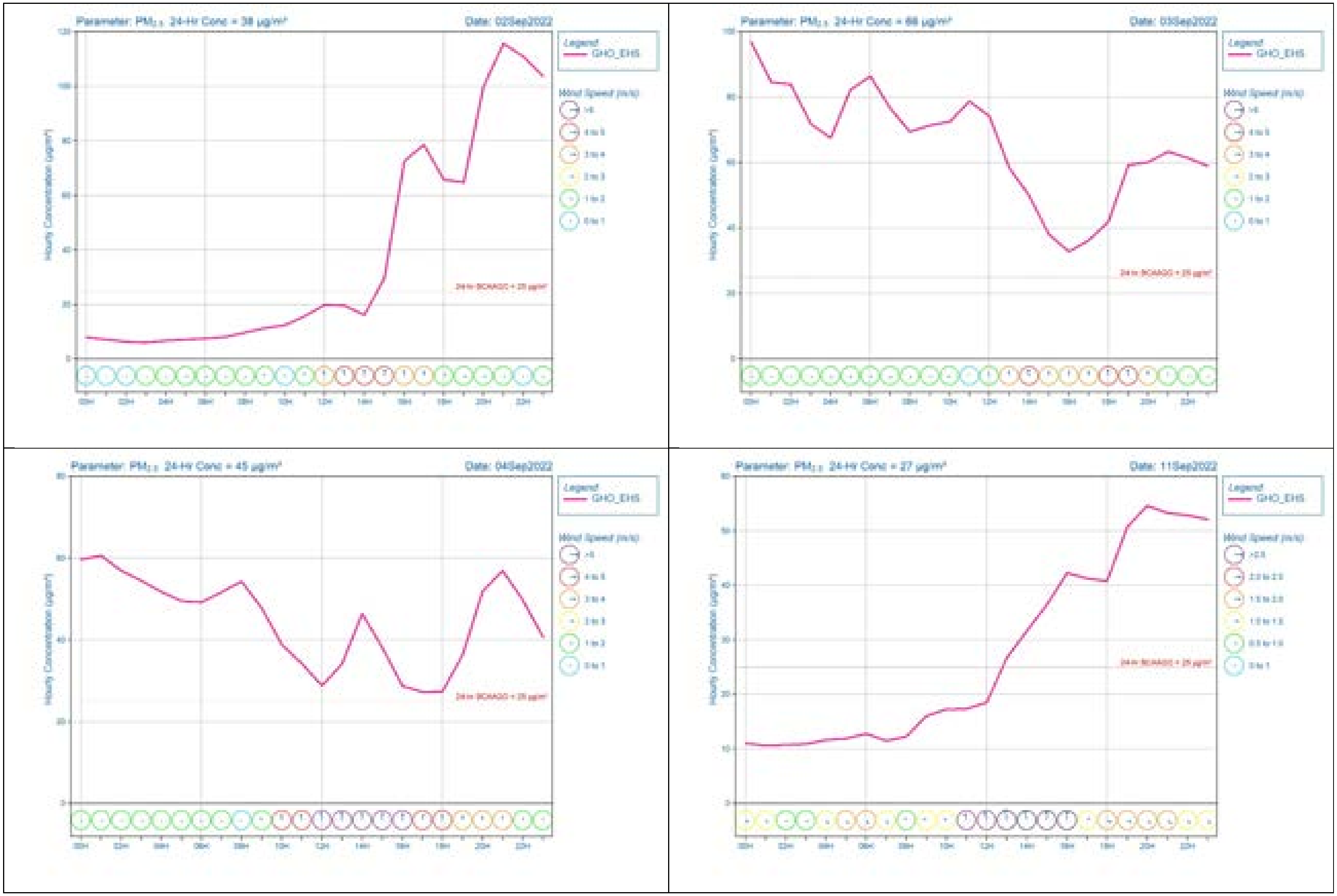

Figure C-4: **Hourly winds and $PM_{2.5}$ concentrations at GH_ERMES during days with excursions in 2022.**

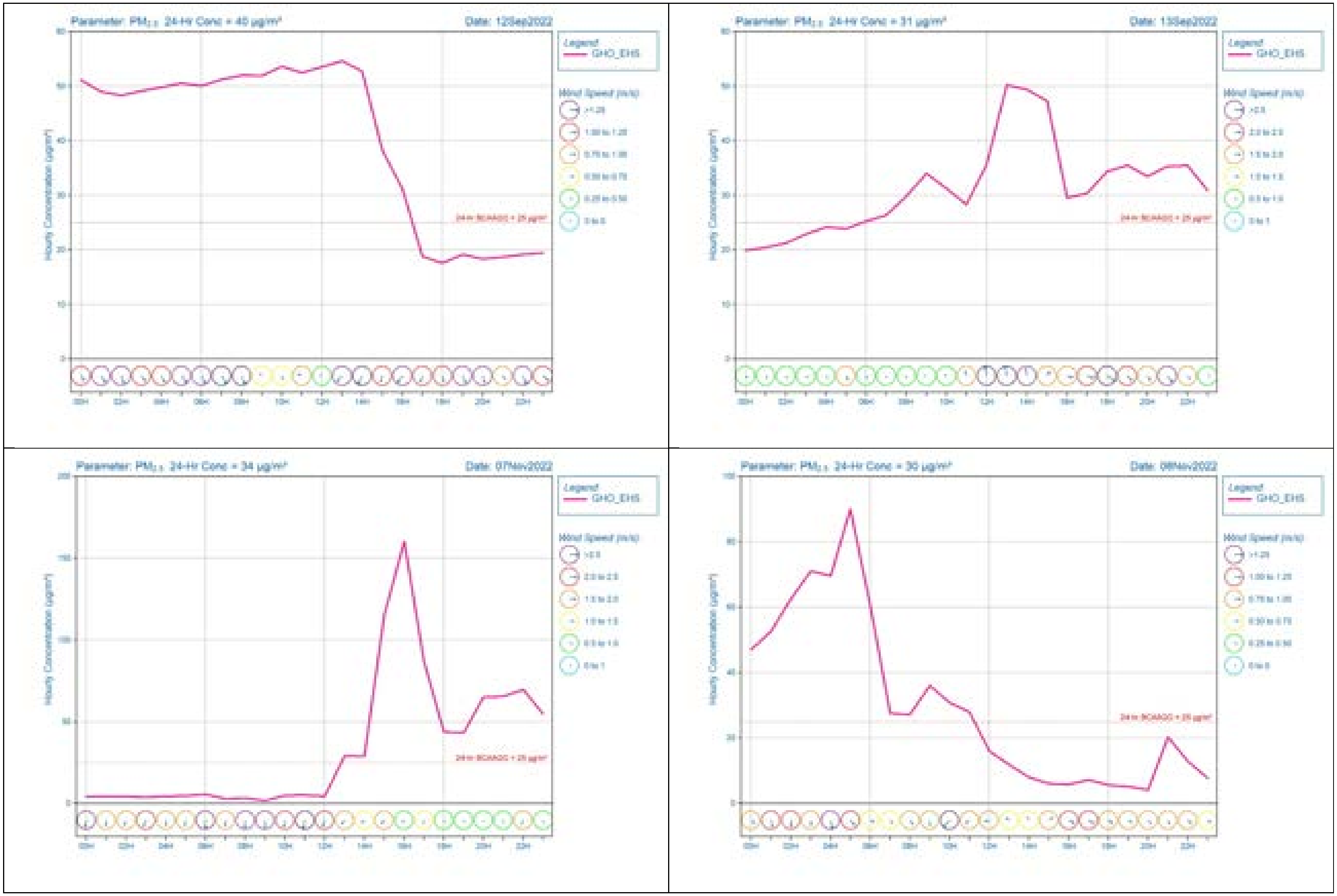

Figure C-4 (continued): Hourly winds and $PM_{2.5}$ concentrations at GH_ERMES during days with excursions in 2022.

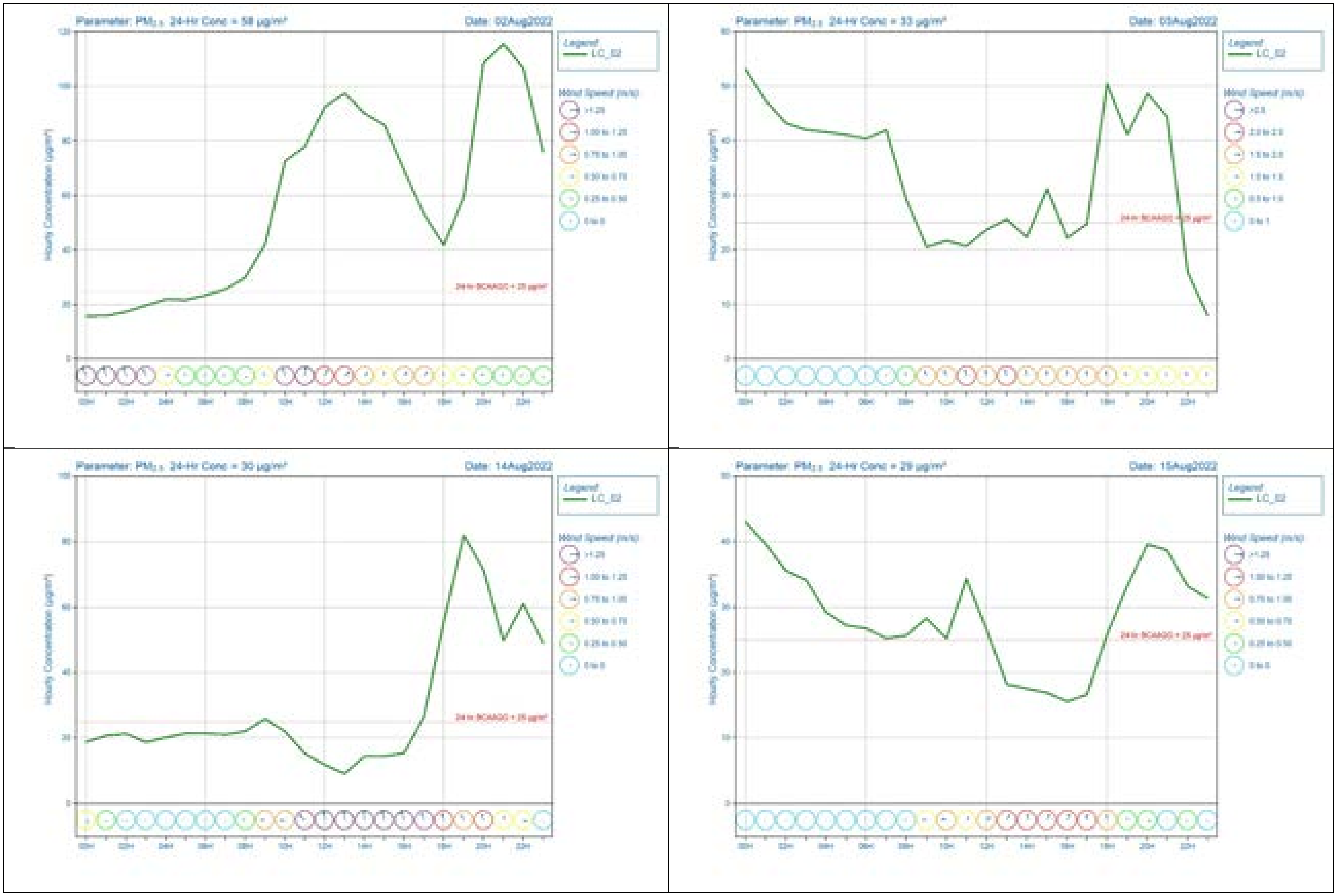

Figure C-5: **Hourly winds and $PM_{2.5}$ concentrations at LC_02 during days with excursions in 2022.**

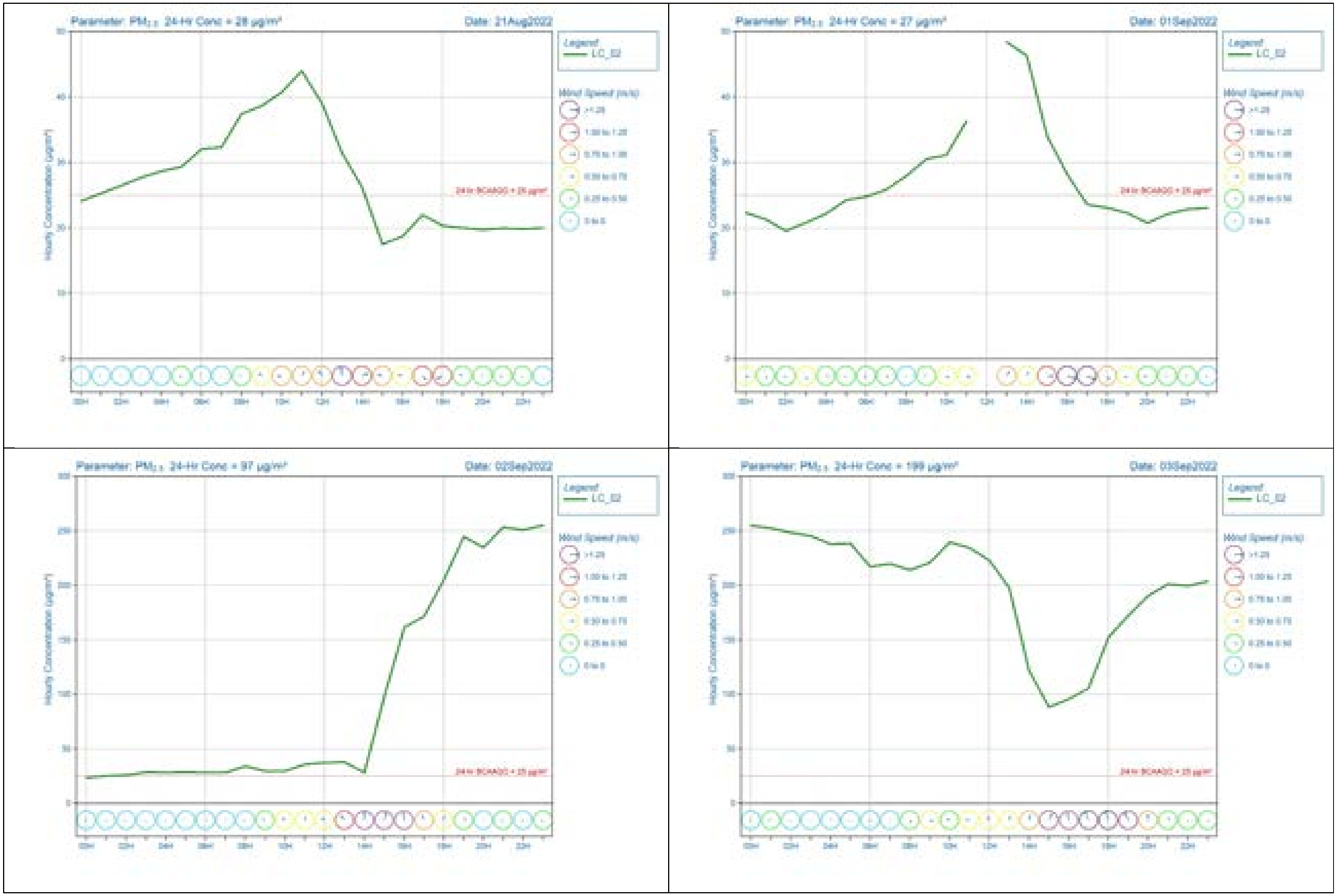

Figure C-5 (continued): Hourly winds and $PM_{2.5}$ concentrations at LC_02 during days with excursions in 2022.

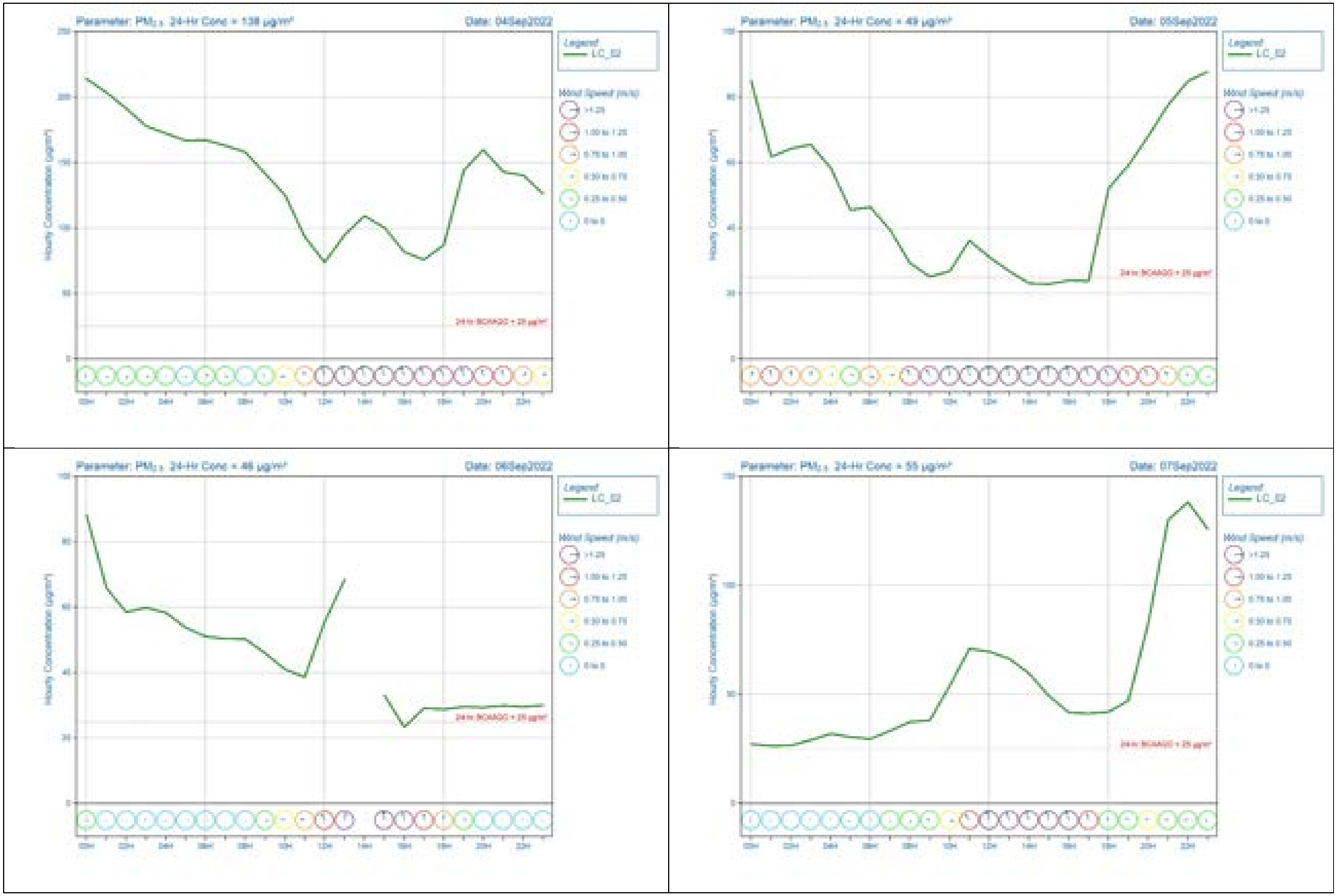

Figure C-5 (continued): Hourly winds and $PM_{2.5}$ concentrations at LC_02 during days with excursions in 2022.

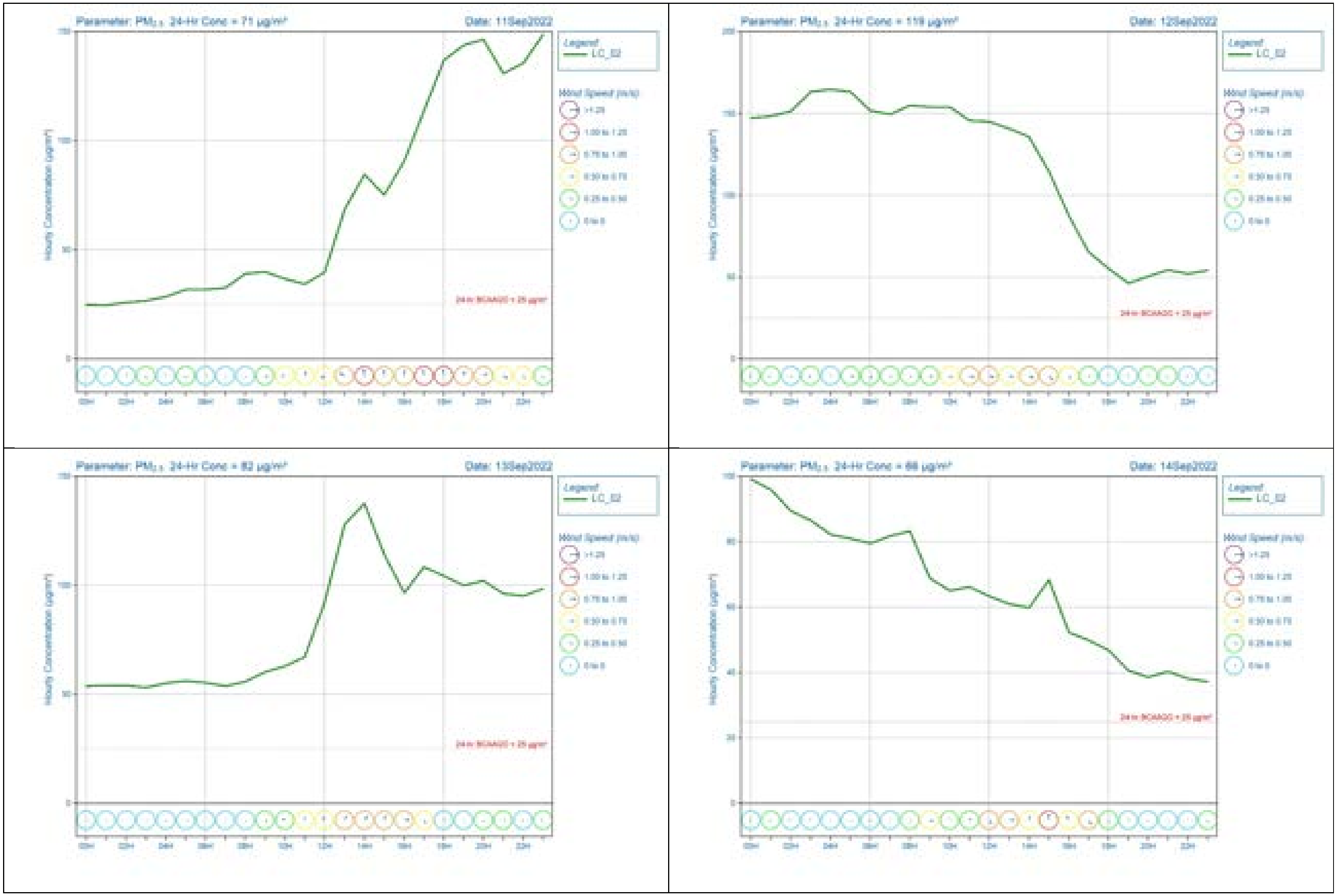

Figure C-5 (continued): Hourly winds and $PM_{2.5}$ concentrations at LC_02 during days with excursions in 2022.

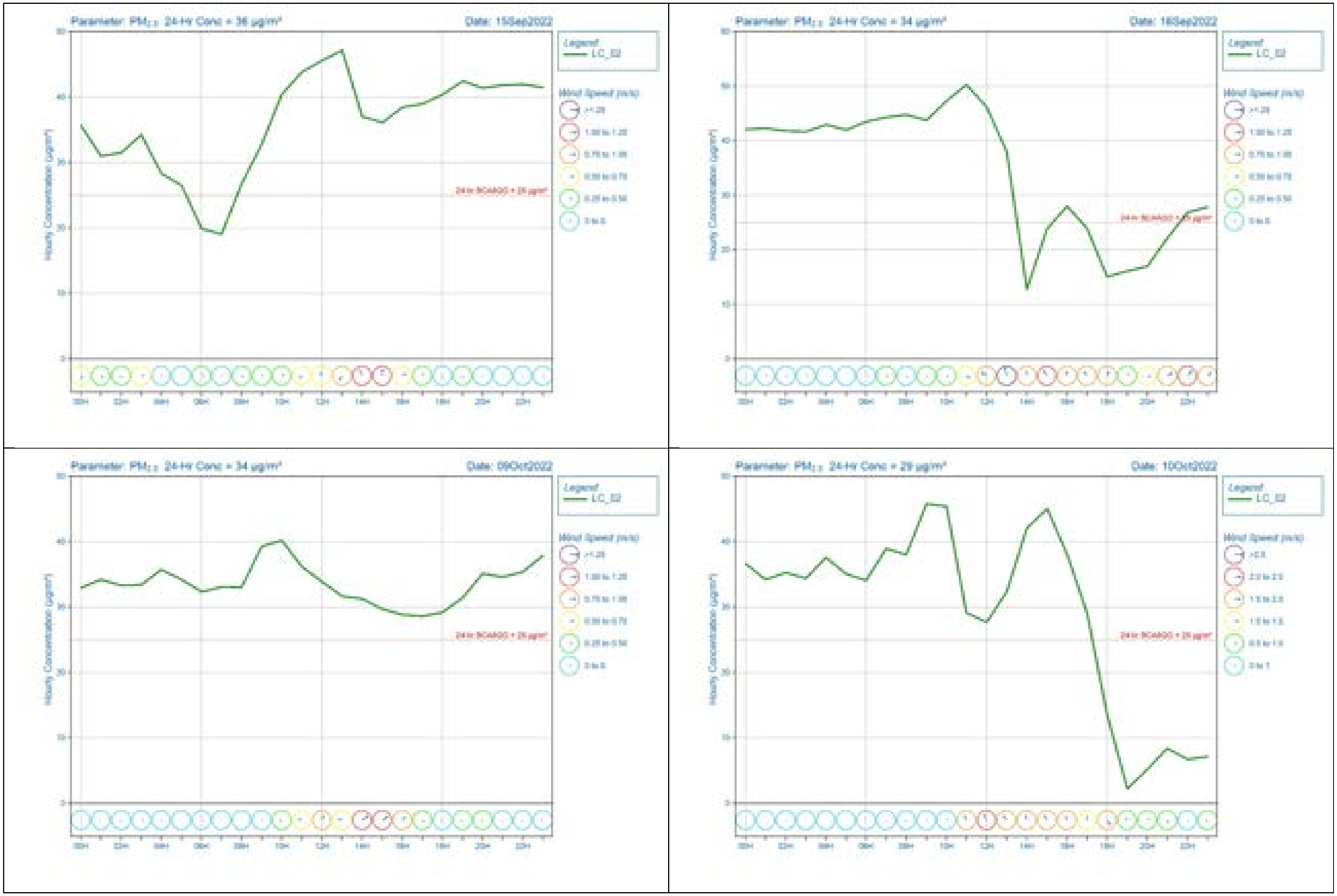

Figure C-5 (continued): Hourly winds and $PM_{2.5}$ concentrations at LC_02 during days with excursions in 2022.

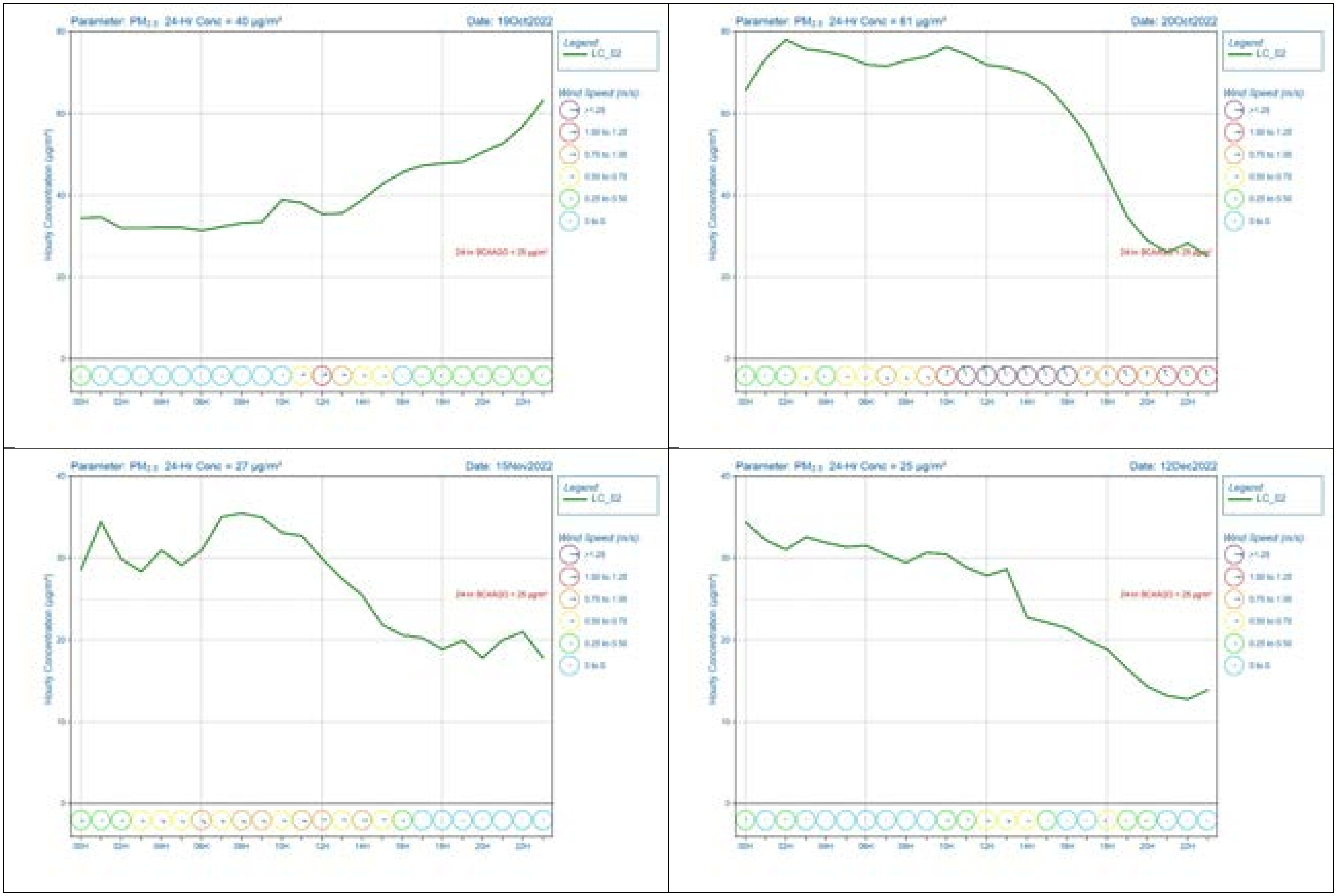

Figure C-5 (continued): Hourly winds and $PM_{2.5}$ concentrations at LC_02 during days with excursions in 2022.

APPENDIX D

Table D-1: Days with PM_{10} exceedance or $PM_{2.5}$ excursion and large-scale smoke from wildfires affecting the RAQMP.

Date of Exceedance/Excursion		Station					Smoke Present in RAQMP
Month	Day	Hosmer	EV_SCS	EV_WWTP	GH_ERMES	LC_02	
August	2					×	✓
August	3					×	✓
August	14					×	✓
August	15					×	✓
August	16					×	✓
August	21					×	✓
September	1					×	✓
September	2	×		×	×	×	✓
September	3	×	×	×	×	×	✓
September	4	×	×	×	×	×	✓
September	5	×	×	×		×	✓
September	6					×	✓
September	7		×	×		×	✓
September	11	×	×	×	×	×	✓
September	12	×	×	×	×	×	✓
September	13	×	×	×	×	×	✓
September	14	×	×			×	✓
September	15					×	✓
September	16					×	✓
October	9					×	✓
October	10					×	✓
October	19					×	✓
October	20	×	×			×	
November	7				×		
November	8				×		
November	15					×	
December	12					×	

Note: × = Exceedance or excursion recorded at station

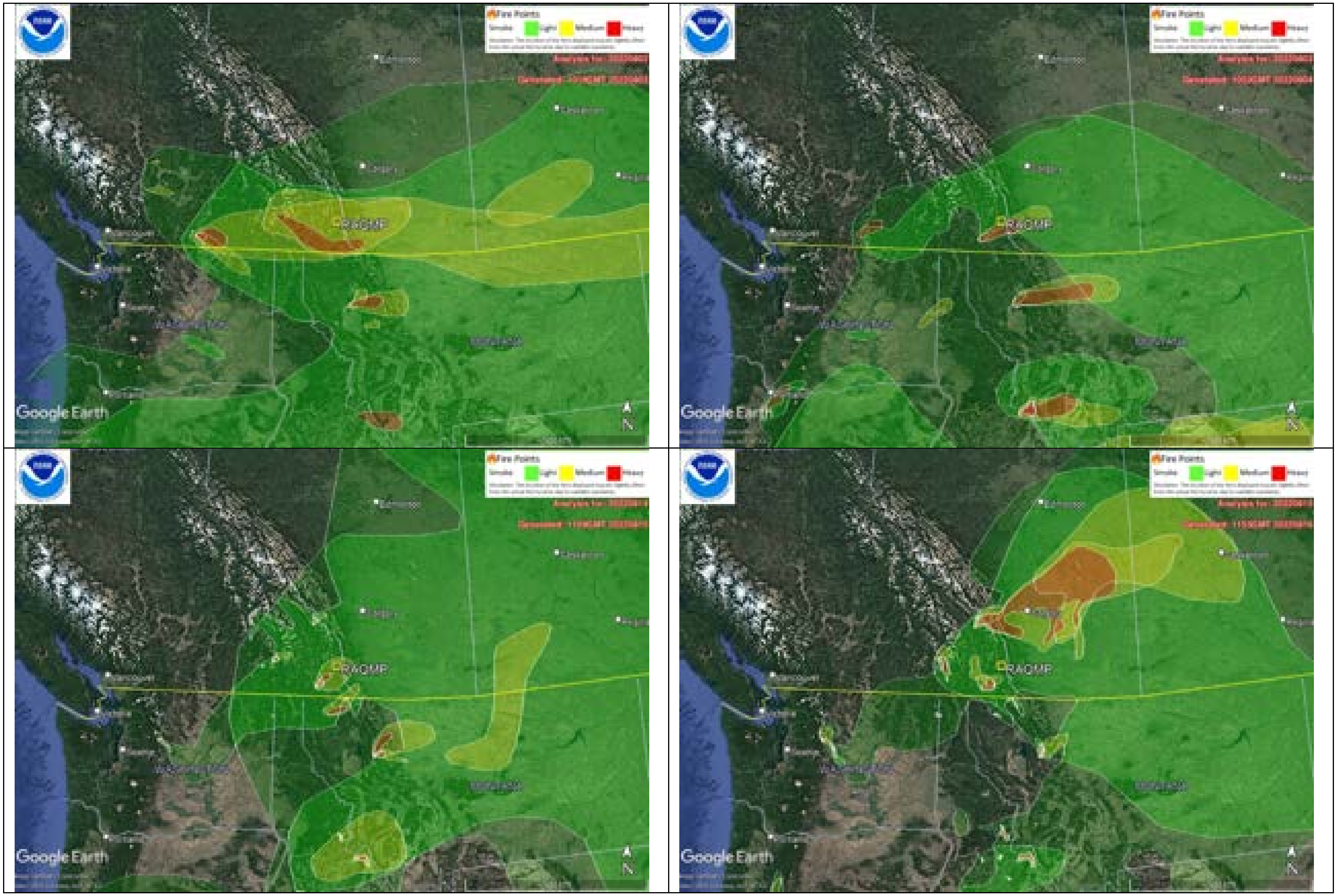

Figure D-1: **Daily composite maps of extent of smoke from wildfires in 2022 (from NOAA Hazard Mapping System Fire and Smoke Product). Note: Dates are indicated below legend.**

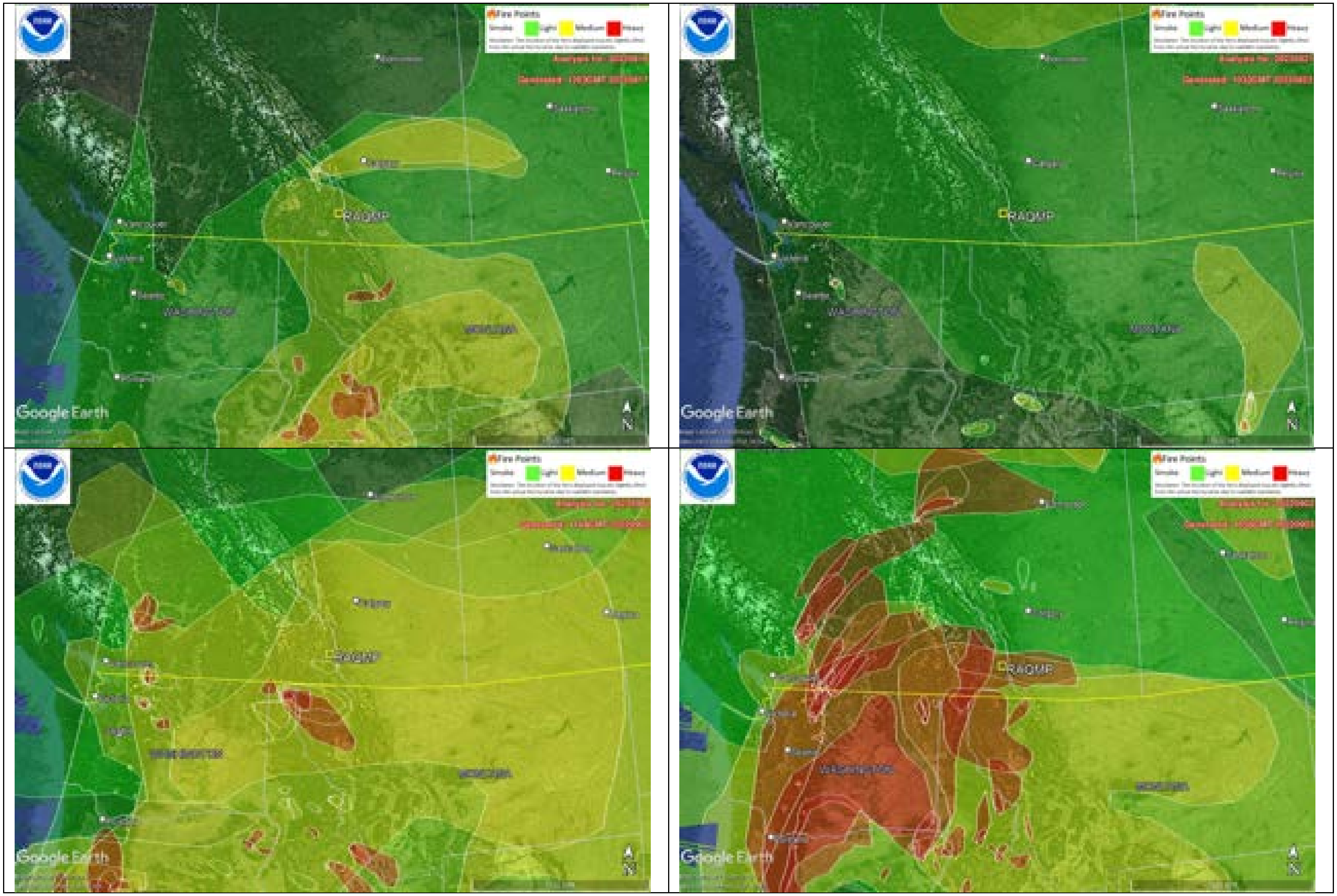

Figure D-2 (continued): Daily composite maps of extent of smoke from wildfires in 2022 (from NOAA Hazard Mapping System Fire and Smoke Product). Dates are indicated below legend.

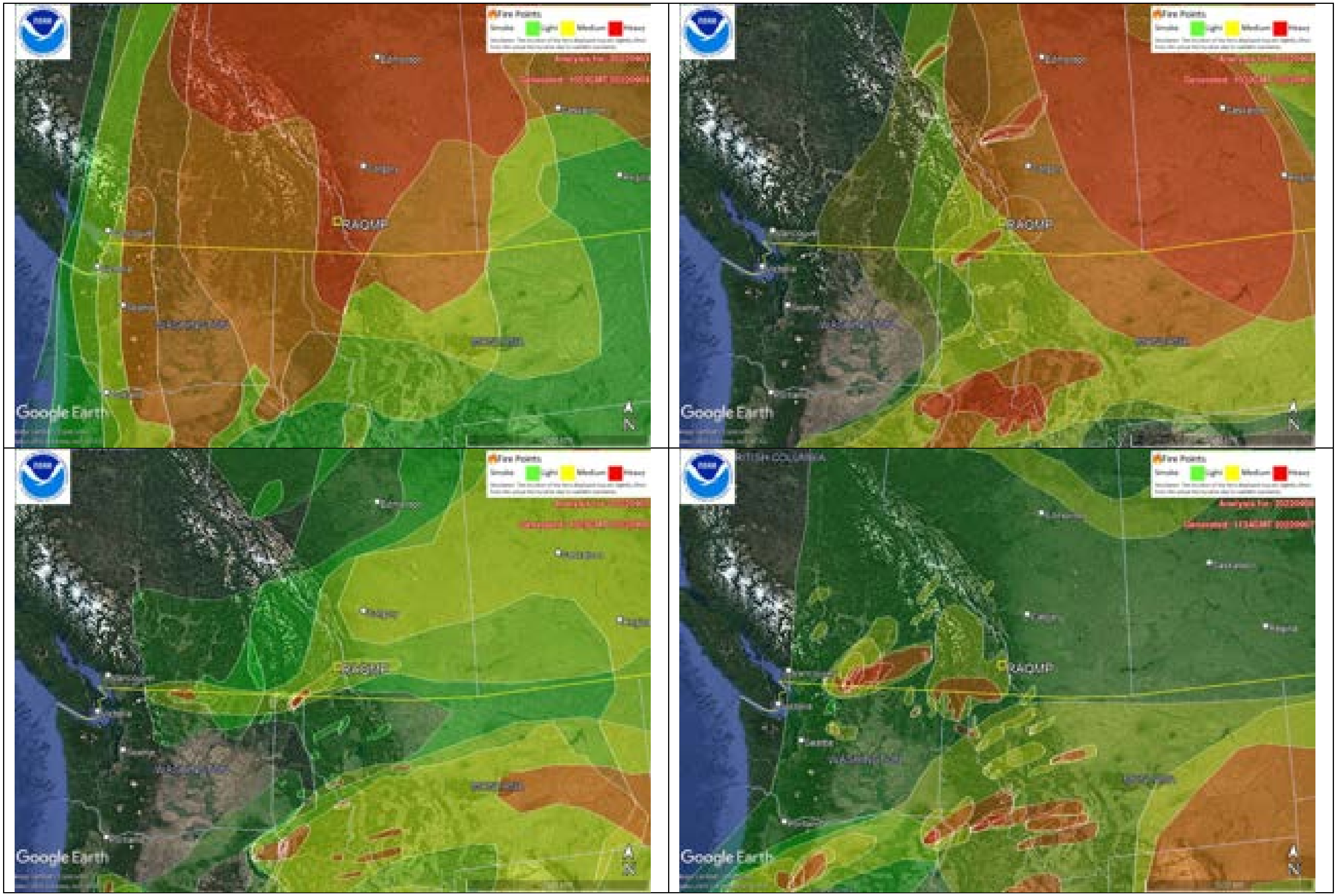

Figure D-3 (continued): Daily composite maps of extent of smoke from wildfires in 2022 (from NOAA Hazard Mapping System Fire and Smoke Product). Dates are indicated below legend.

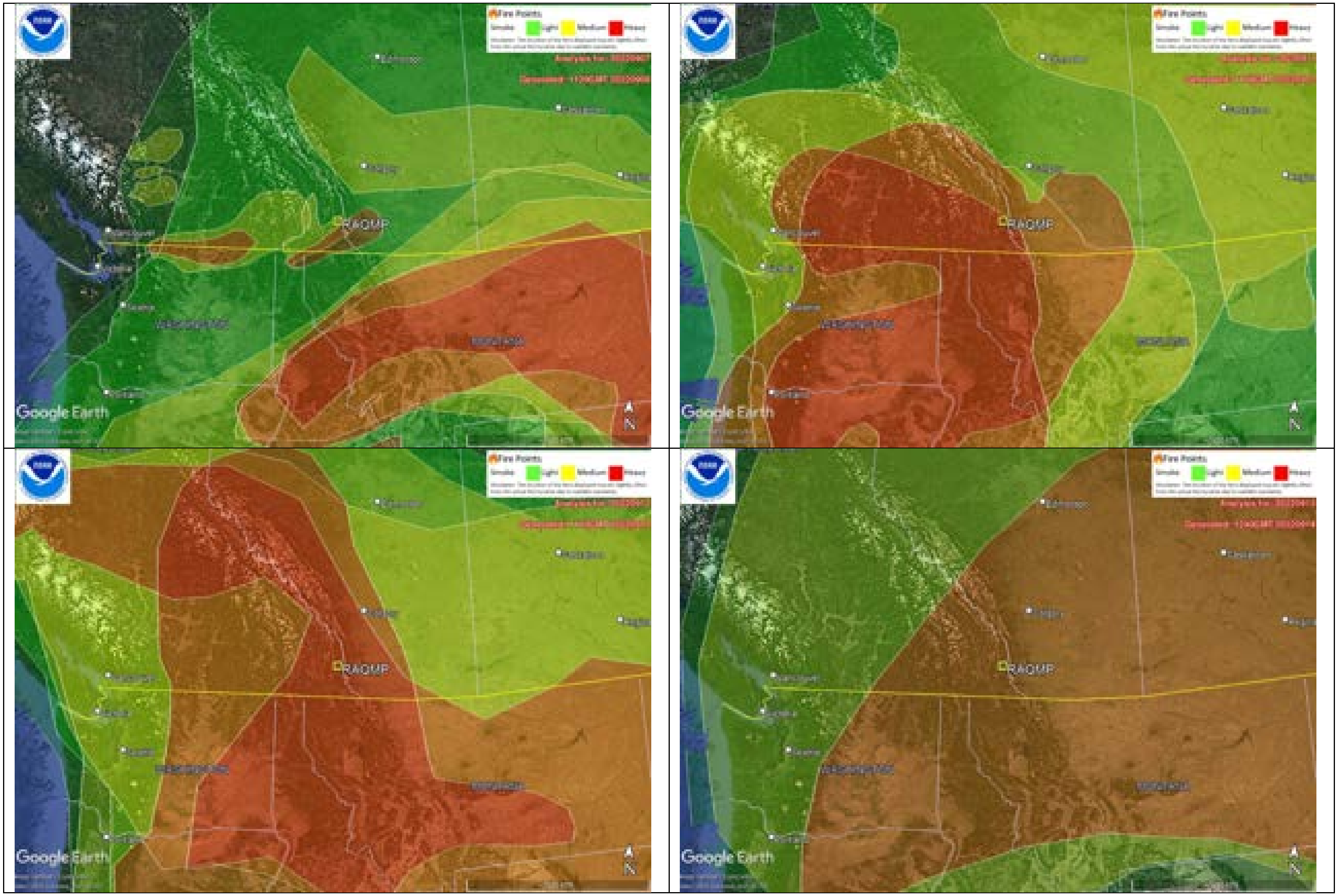

Figure D-4 (continued): Daily composite maps of extent of smoke from wildfires in 2022 (from NOAA Hazard Mapping System Fire and Smoke Product). Dates are indicated below legend.

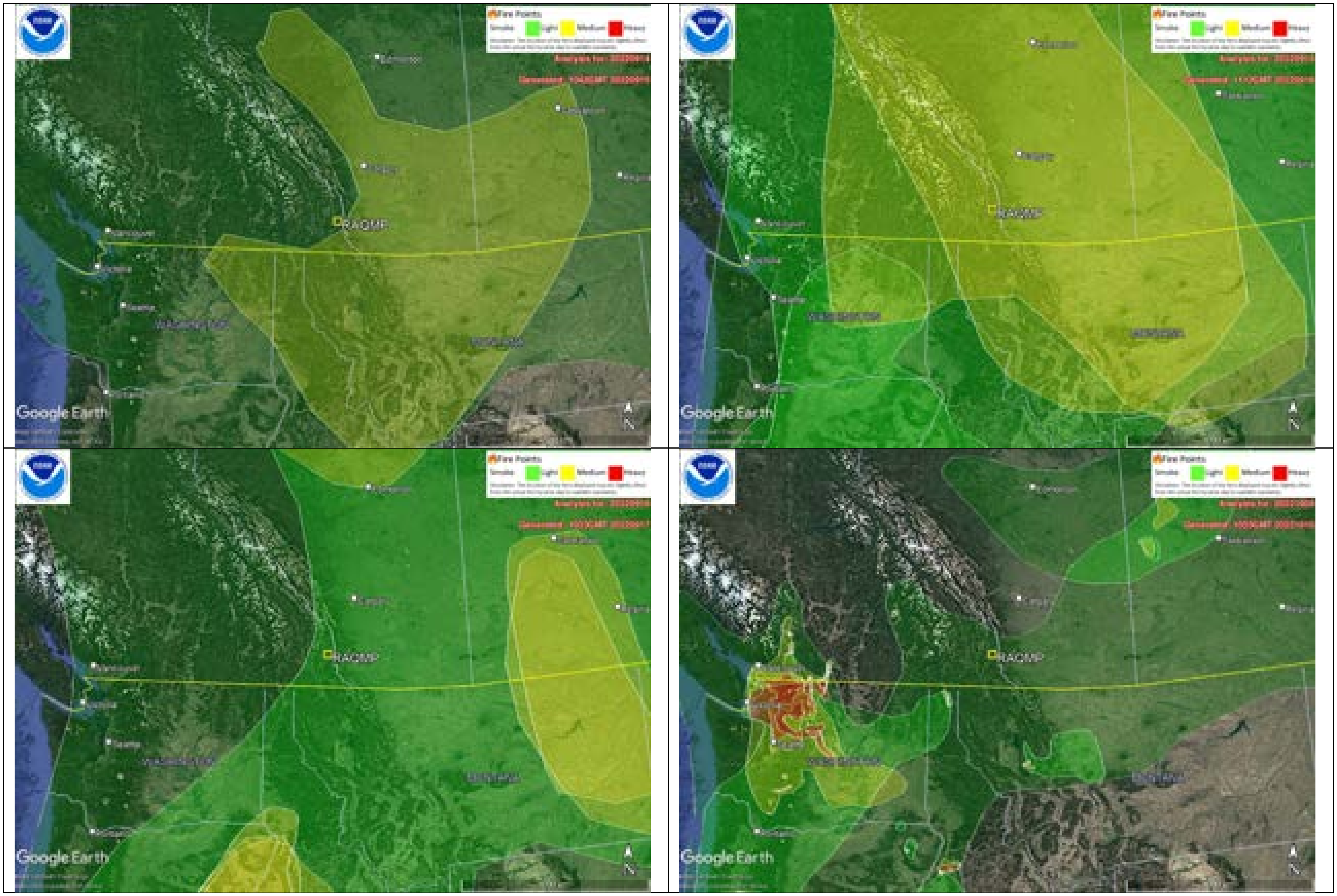

Figure D-5 (continued): Daily composite maps of extent of smoke from wildfires in 2022 (from NOAA Hazard Mapping System Fire and Smoke Product). Dates are indicated below legend.

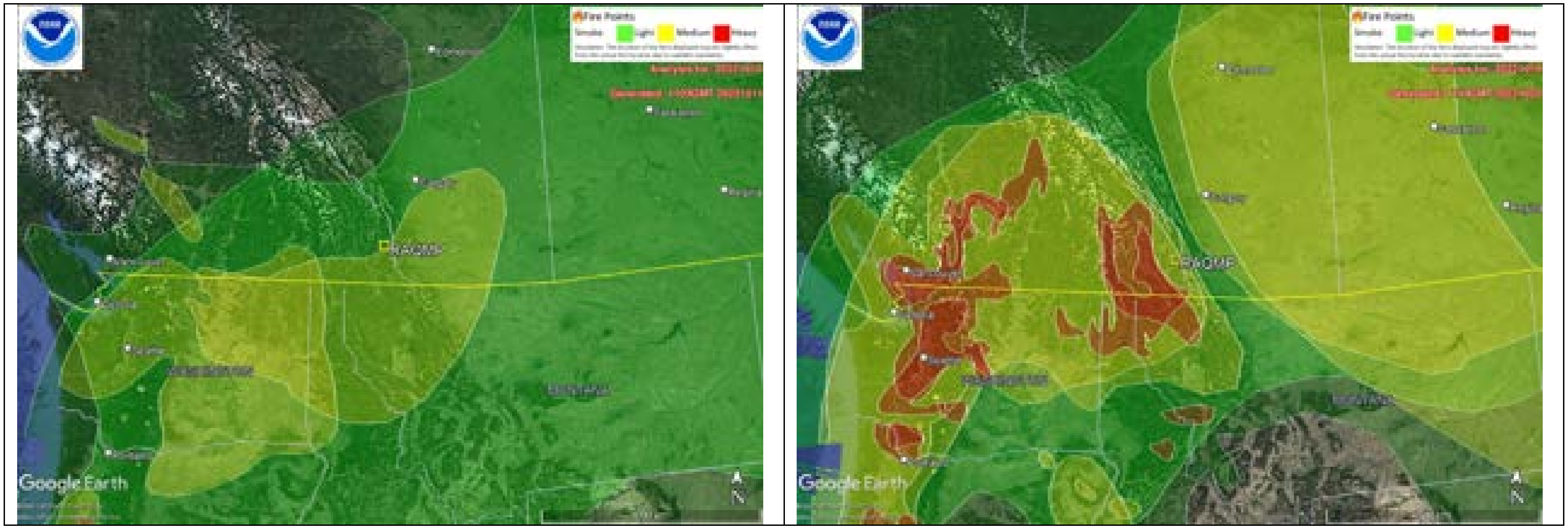

Figure D-6 (continued): Daily composite maps of extent of smoke from wildfires in 2022 (from NOAA Hazard Mapping System Fire and Smoke Product). Dates are indicated below legend.

APPENDIX E

ALTERNATIVE ANEMOMETER FOR SPARWOOD CENTENNIAL SQUARE STATION

In the August 31, 2022, Memorandum from the BC Ministry of Environment (ENV) to Teck, which commented on the 2021 RAQMP Report, ENV identified that the Sparwood Centennial Square (SCS) station anemometer data cannot be replaced with data from the anemometer at Sparwood Heights station. This was proposed in response to ENV commenting that the SCS anemometer does not comply with BC siting guidelines. We believe that despite the unfavourable position of the SCS station anemometer, it still generates useful data that would allow a meaningful comparison of its winds with those of the other stations. At best, the data can be used for its purpose, which is to accompany the ambient air quality data collected at the station and allow an interpretation of its results.

When reviewing alternatives to the SCS anemometer, wind data at the four stations in the area shown in Figure E-1 were collected. SCS, Sparwood Heights, EVO Michel Creek Road Residence (MCRR), and the Environment and Climate Change Canada (ECCC) Sparwood CS station were considered. Wind roses at 10-degree direction intervals for each station from 2019 to 2022 are presented in Figure E-2.

The three Teck monitoring stations are within 1.5 km of the ECCC station. All four are inside the same flat area in Sparwood inside the Elk Valley where the Crahan Creek and Crowsnest Highway branch off from the town. As such, the stations are subject to the same general flow conditions and terrain effects.

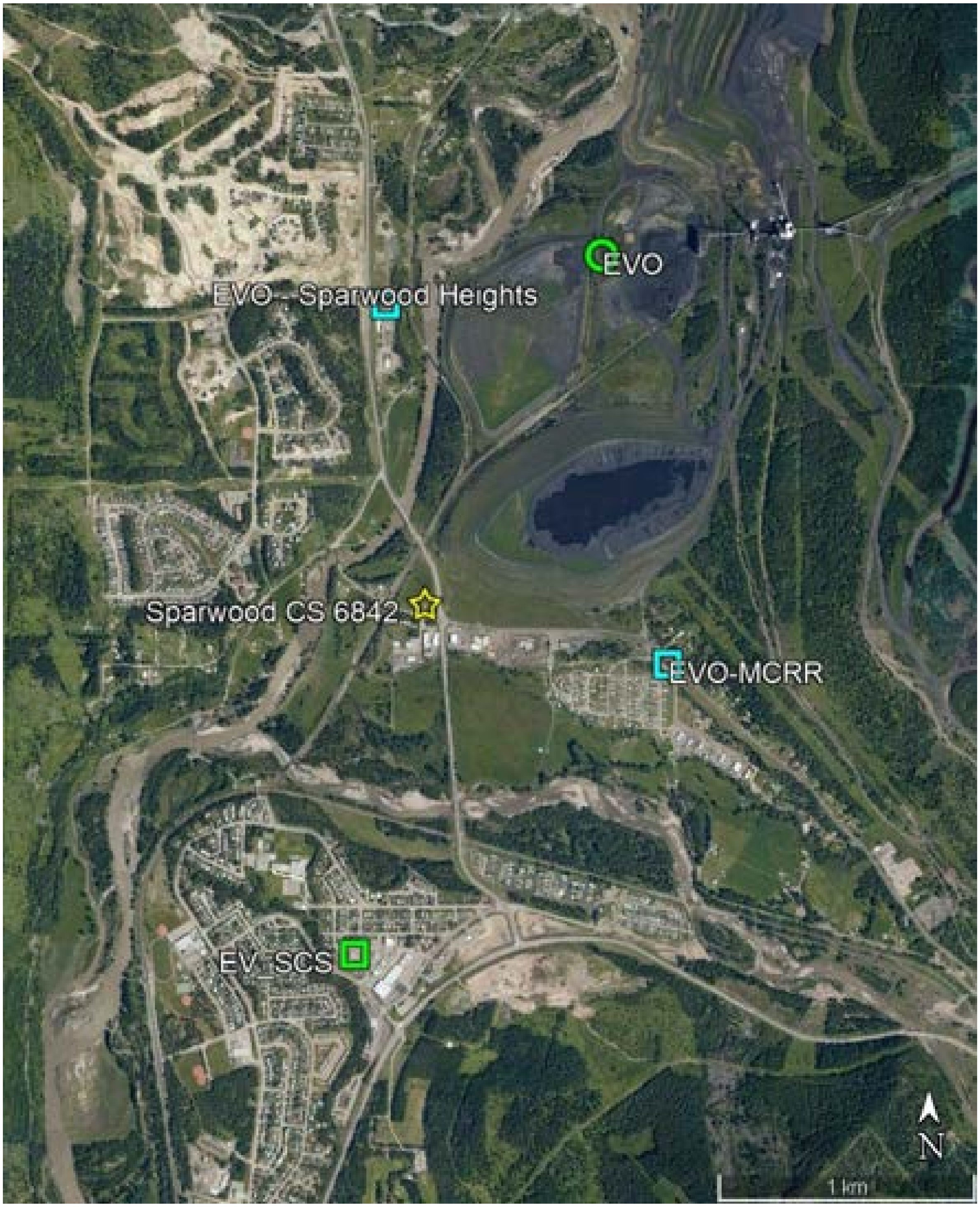

Figure E-1: Map of Monitoring Stations near the EVO Mine Site (designated EVO on the figure)

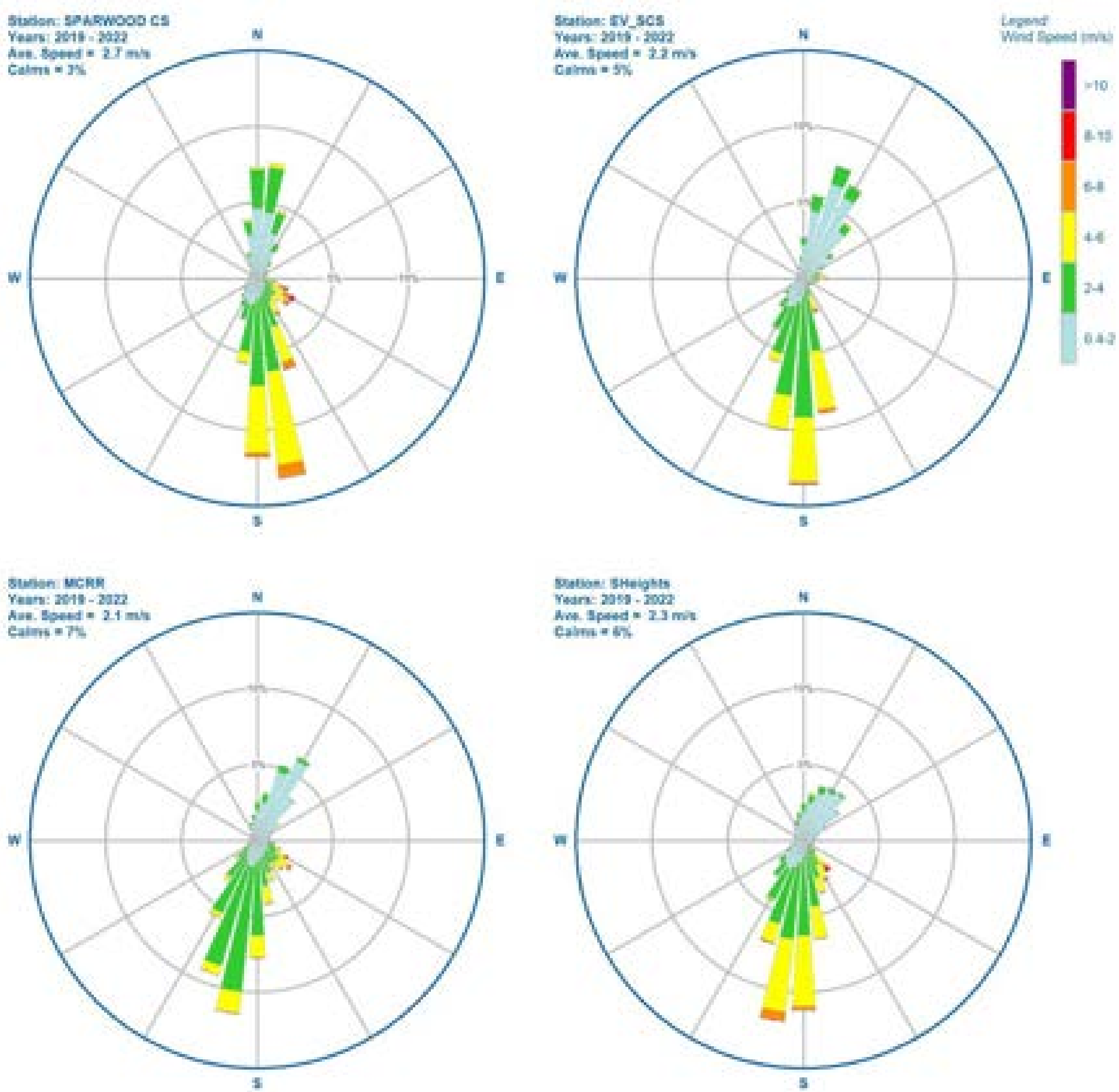

Figure E-2: **Wind roses (2019 to 2022) at stations near EVO: ECCC Sparwood CS (top left), SCS (top right), MCRR (bottom left), and Sparwood Heights (bottom right).**

The four wind roses are similar to each other. The dominant wind direction at SCS is 180 degrees, which is between the 170 degrees at the ECCC station, and the 190 degrees at both MCRR and Sparwood Heights. The secondary dominant direction of 20 degrees at SCS also falls between 10 degrees at the ECCC station and 30 degrees at the other two stations. Typical winds at SCS are only about 10 degrees counterclockwise different from those at the ECCC station, with a less than 20-degree difference at the other two stations.

The mean wind speed at SCS (2.2 m/s) is within the range of means at the four stations (2.1 m/s at MCRR, 2.6 m/s at ECCC Sparwood CS). Finally, the frequency of calms at SCS (5%) is lower than at MCRR (7%) and Sparwood Heights (6%), and within a similar range at ECCC Sparwood CS (3%).

A review of prospective locations in the vicinity of the SCS station indicates that installing an anemometer tower at such a downtown location that is free from the influence of buildings or trees will either create a nuisance, lack power connections, or pose challenges with obtaining consent.

Alternatively, increasing the height of the tower at its present location on the roof of the building has already been previously ruled out as structurally infeasible due to the manner the building was constructed, and installing the anemometer on a new tower next to the building would require the new tower to be built much higher than the building. Without a wind tunnel test, the suggested guidance regarding the required minimum tower height is “2.5 times the height of the building” (US EPA 2000, p. 3-4). Using this guidance and given the estimated height of the building (8 m), the tower would need to be at least 20 m tall, or twice the standard height of anemometer towers.

Testing how representative the data is, will involve a comparison of its wind roses with those of the nearby stations, including the ECCC Sparwood CS station. As demonstrated above and in Figure E-2, the SCS station compares favourably with data from ECCC Sparwood CS station.

Thus, the ECCC station provides a practical solution that can supplement wind data from the SCS anemometer.

Teck therefore proposes to use data from ECCC station to supplement the wind data coming from the SCS anemometer. The aim of installing an anemometer tower near the station, is to capture representative meteorological conditions concurrent with the ambient air quality data. Teck proposes to use data from the ECCC Sparwood CS station instead. The ECCC station has the following advantages:

- At 1.4 km away, it is closer to SCS than both the Sparwood Heights station (2.5 km) and the MCRR station (1.7 km).
- There are no hills between SCS and the ECCC station, and their elevations are in fact reported by Google Earth as exactly equal (1138 m). There is a shallow river between them whose surface elevation is about 10 m lower, but heavy tree cover on both banks of the river effectively reduces the depth of the channel.
- There are no issues related to the siting of the ECCC station, and the similarity of its wind frequencies to those of SCS and the other two nearby stations with no siting problems demonstrates its representativeness over the area.
- All the key data required for ambient monitoring is measured by the ECCC station. The station data is freely available, and quality assured. The data is also up to date (available within one month of collection), and generally complete.

The station is located southwest of the EVO mine, the same general direction to SCS from the EVO mine. As stated by the ENV in comment 3 of the Memo RE: Subject Matter Expert Review of the 2021 Annual Report for the Teck Coal Regional Air Quality Monitoring Program (RAQMP): “it would be ideal for the meteorological station to be located along the emissions trajectory from EVO to Centennial Square to support impact assessments.” As seen in Figure 1, the ECCC station meets this requirement. It is to be noted that the anemometer data for EV_SCS can be supplemented with EV_MCRR data in addition to ECCC station data if needed.

Teck looks forward to collaborating with ENV to finalize the alternative locations to supplement EV_SCS anemometer data.

REFERENCE:

US Environmental Protection Agency, 2000. Meteorological Monitoring Guidance for Regulatory Modeling Applications. Office of Air Quality Planning and Standards. Research Triangle Park, NC 27711. EPA-454/R-99-005. February 2000.

APPENDIX F

HOSMER SITING EVALUATION

BC Ministry of Environment (ENV) requested a siting evaluation of the Hosmer station in a Memorandum to Teck on August 31, 2022. The evaluation was to be based on guidance found in the Canadian Standards Association (2022) R101:22 guidance document on hydrometeorological stations (hereafter CSA2022).

This Appendix discusses the results of an evaluation of the site based on criteria found in CSA2022. As the siting evaluation was requested in the context of low wind speeds and the vegetation surrounding the station, the evaluation focuses on the wind data at the Hosmer station.

The Hosmer Station

The Hosmer station was installed to monitor air quality in the vicinity of the Marten Wheeler project site. Planning for the station started in May 2012. The general location along Stephenson Road was determined to be close enough to the project site, but far from the direct influences of the railway line and Highway 3. After evaluating two locations, the final site was selected and approved by the ENV on March 15, 2013. Data collection started on November 2013.

The site was installed inside an elliptical clearing about 100 m long and 80m wide, with the long axis oriented southwest to northeast. The station anemometer is positioned about 25 m from the southern end of the ellipse. The tower is 50 ft (15.2 m) tall, more than the standard height of 10 m for anemometer towers attached to ambient air quality monitoring stations. This height was decided in view of the presence of trees around the tower.

An aerial image of the station location is provided in Figure F-1, and a picture of the tower is found in Figure F-2.

Figure F-1: Location of Hosmer station anemometer.

Figure F-2: Anemometer tower at Hosmer.

Evaluation

CSA2022 has five classes of site conditions, with Class 1 being the most favourable for monitoring, and Class 5 the least. An evaluation of the Hosmer site using the criteria in Table 7 of CSA2022 is presented as Table 1.

Table 1: Evaluation of Hosmer anemometer site based on CSA2022 criteria.

Criteria	Hosmer	Class
Sensor height	15 m	1
Aircraft movement	>100 m away	1
Obstacles	>22°	5
Narrow and high obstacles	>60° angular width	5
Objects to be ignored	n/a	n/a
Wind doming	n/a	1
Roughness class	Index = 7 (forest)	4

From this evaluation, the Hosmer station appears to fall under a Class 5 site, despite scoring well with some criteria. The main issue is the proximity of the tower to the surrounding trees to the south, some of which are as tall as the tower.

The implications of this evaluation will be discussed below.

Trends in Winds Speeds at Hosmer Station

In light of the comments provided by the ENV about wind speeds at Hosmer station, additional analysis of the wind data at the station was performed. Figure F-3 shows the mean wind speed annual trends at the station, in addition to two Environment and Climate Change Canada (ECCC) stations in Sparwood (located about 18 km to the North, being the closest with hourly wind data).

The results show that mean wind speeds at the Hosmer station are much lower than the two ECCC stations. While the wind speeds at the two ECCC stations have been increasing since 2014, the opposite is occurring at Hosmer station. Assuming that the anemometers at the ECCC stations have better siting than that at Hosmer, the lower wind speed trend could be due to vegetation growth around the station.

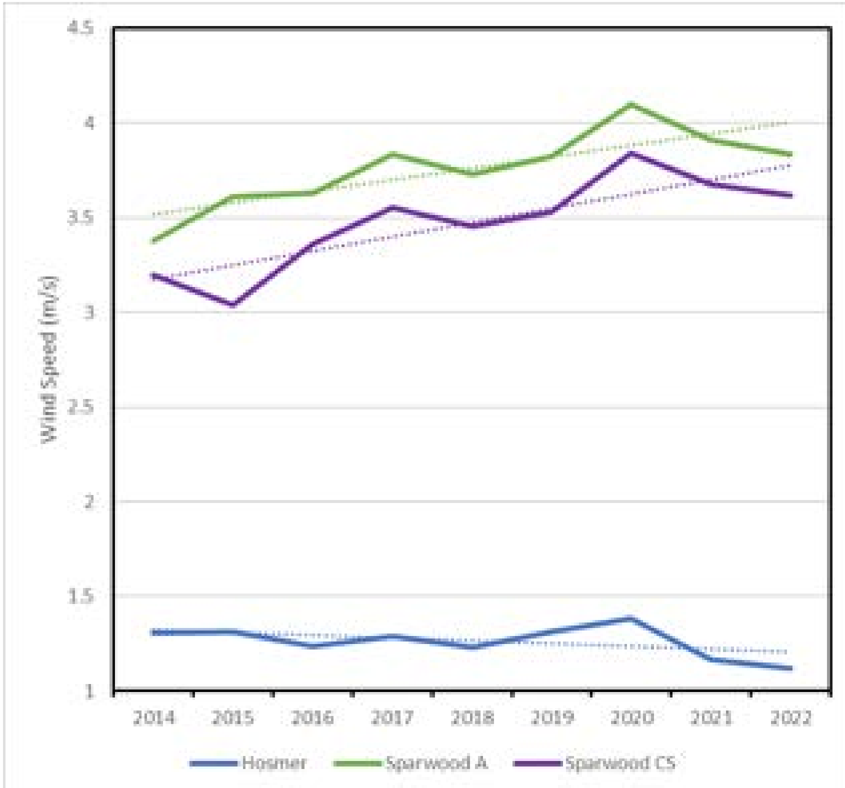

Figure F-3: Annual average wind speeds at Hosmer and ECCC stations in Sparwood.

Wind Direction Trends at Hosmer Station

Figure F-4 compares the wind roses from the three-year period (2014 to 2016), which is at the onset of station operation, to the most recent three-year period (2020 to 2022). There is a slight shift in the dominant wind direction by about 5 degrees clockwise that could be attributed to same vegetation growth South of the station. As this 5 degree direction shift is roughly equivalent to the rated accuracy of the wind direction sensor, this shift would be considered minor. There is also a reduction in the range of wind directions from the northeast, but this may be an artifact of the decrease in wind speeds and increase in calm conditions.

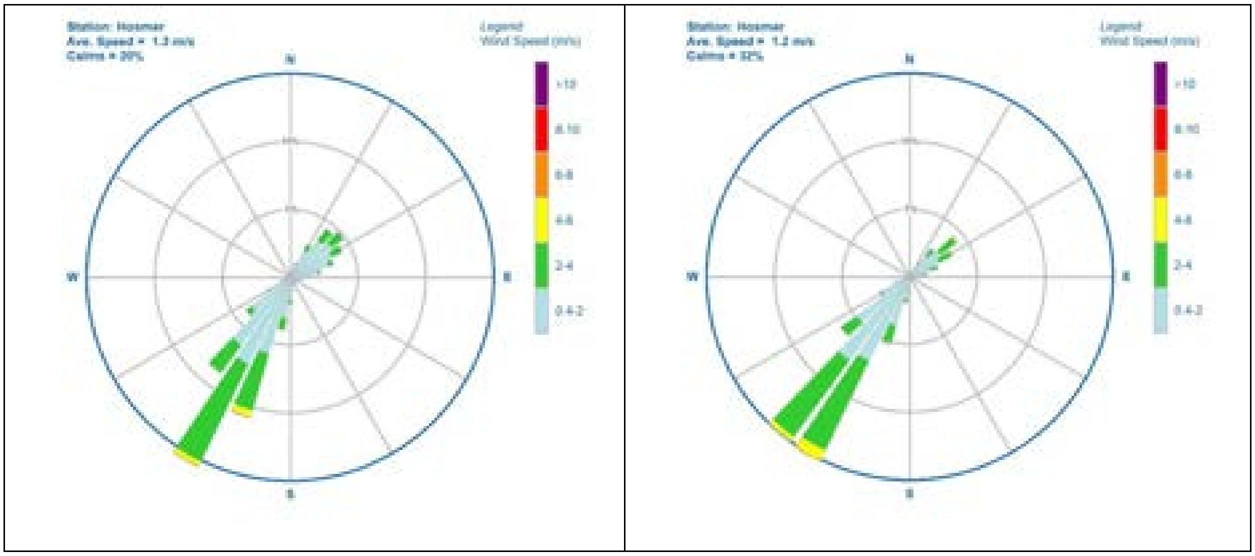

Figure F-4: Hosmer Station Wind Roses. Left: 2014 to 2016, Right: 2020 to 2022.

Concluding Notes

1. An evaluation of the conditions at Hosmer station using the criteria found in Table 7 of CSA2022, found that the station is classified as a Class 5 site (least representative to local conditions).
2. Despite this classification, CSA2022 does not actually preclude its use as a monitoring station. As stated by Section 5.1.3, station siting is an "exercise in finding a compromise between multiple constraints" (p. 23). The selection of the Hosmer site was based on a compromise between conforming to the BC siting criteria as closely as possible, and the need to install a station near the Marten Wheeler project site. In the same section, CSA2022 states: "Not being able to meet the highest Class should not deter operators from station installations."
3. A representative from ENV was aware of the limitations of using this location for the station, and a decision was made to proceed with installation. In an email to Andres Soux of RWDI dated March 3, 2013, a representative from the ENV acknowledged that "no station can be perfect," and recommended a taller tower. Site selection was difficult at the time and relocating the station to a nearby alternative site is not expected to be more favourable today.
4. An evaluation of wind patterns at the station, suggest that wind speeds are lower relative to nearby ECCC station wind trends, possibly due to vegetation growth near the Hosmer station in recent years. Despite this finding, the effect on wind direction appears to be minor when comparing the trends over the years. Given this information, it is possible to correct the wind speeds to account for these changes. Section 5.9.4 (Exposure Correction) of the Guide to Instruments and Methods of Observation published by the World Meteorological Organization provides instructions on correcting the wind speed resulting from problems with obstacles near an anemometer. Further work is needed to determine the feasibility of this method.

Teck appreciates ENV's feedback, and looks forward to collaborating with ENV on a solution for the Hosmer station.

REFERENCES:

Canadian Standards Association, 2022. *National Standard of Canada CSA R101:22. Automated hydrometeorological monitoring stations: Site selection, instrument installation, and instrument maintenance*. CSA R101:22.

World Meteorological Organization. 2021. *Guide to Instruments and Methods of Observation. Volume I – Measurement of Meteorological Variables*. 2021 edition.

APPENDIX G

Operation	Station Name	Station location (Latitude, Longitude)	Permit, RAQMP, or independent	Monitoring Objectives	Air quality								Meteorology								
					TSP	PM_{10}	$PM_{2.5}$	NO_2	CO	SO_2	O_3	PAH	Wind speed and direction	Air temperature	Relative Humidity	Barometric Pressure	Precipitation	Snow depth	Snow Water Equivalent	Net radiation	Incoming Solar Radiation
Fording River	Aspoil	50.19797°N, 114.88866°W	Independent	Monitoring meteorological parameters across the mine									X	X	X		X	X			
	Brownie	50.19916°N, 114.81633°W	Independent	Monitoring meteorological parameters across the mine									X	X	X		X	X		X	
	South Station (E297832)	50.14868°N, 114.85660°W	Permit (1501)	Monitoring meteorological parameters across the mine		X								X	X	X	X	X			X
Greenhills	Office (E297170)	50.08483°N, 114.87085°W	Permit (6249)	Monitoring meteorological parameters across the mine									X	X	X	X	X				
	Pumphouse Greenhills Creek (E206190)	50.04490°N, 114.85612°W	Permit (6249)	Monitoring Particulate concentrations and temperature	X									X							
	Elkford Rocky Mountain Elementary School (GH_ERMES / E290310)	50.007794°N, 114.933420°W	Permit (6249) and RAQMP	Monitoring particulate concentrations and met parameters in and around Elkford	X	X	X						X	X			X				
Line Creek	LCO Plant Continuous (LCO1)	49.88685°N, 114.84479°W	Independent	Monitoring particulate concentrations and meteorological parameters in and around plant	X	X	X						X	X	X						
	L10A (E206189) [(1)]	49.891055°N, 114.845795°W	Permit (5352)	Monitoring TSP concentrations around the plant	X																
	LCO Plant Weather (E297050)	49.891053°N, 114.845684°W	Permit (5352)	Monitoring meteorological parameters in the vicinity of the plant									X	X			X				
	MSA Hi Vol (E304612) [(1)]	49.954°N, 114.753°W	Permit (5352)	Monitoring TSP concentrations around the plant	X																
	MSA Weather Station (E297052)	49.953°N, 114.753°W	Permit (5352)	Monitoring meteorological parameters in the vicinity of the plant									X	X			X				
	Line Creek Continuous – Near Grave Lake (LC_02)	49.874703°N, 114.839622°W	Permit (5352)	Monitoring particulate concentrations in and around local community and Grave Lake.	X	X	X						X	X	X						
Elkview	Whispering Winds Trailer Park (EV_WWTP / E0250184)	49.79851°N, 114.88864°W	Permit (1807) and RAQMP	Monitoring particulate concentrations and met parameters in and around local community	X	X	X						X	X	X						

Operation	Station Name	Station location (Latitude, Longitude)	Permit, RAQMP, or independent	Monitoring Objectives	Air quality								Meteorology								
					TSP	PM_{10}	$PM_{2.5}$	NO_2	CO	SO_2	O_3	PAH	Wind speed and direction	Air temperature	Relative Humidity	Barometric Pressure	Precipitation	Snow depth	Snow Water Equivalent	Net radiation	Incoming Solar Radiation
	Sparwood Heights (SH)	49.75541°N, 114.88604°W	Independent	Monitoring particulate concentrations and met parameters in and around local community	X	X	X						X	X	X	X	X				
	Michel Creek Road Residences (MCRR)	49.74288°N, 114.87084°W	Independent	Monitoring particulate concentrations and met parameters in and around local community	X	X	X						X	X	X						
	Sparwood Centennial Square (EV_SCS / E262137)	49.732786°N, 114.88766°W	Permit (1807) and RAQMP	Monitoring particulate concentrations and met parameters in and around local community	X	X	X	X	X	X	X	X	X	X	X						X
	Michel By-Products Plant (E206193)	49.70575°N, 114.82867°W	Permit (1807)	Monitoring particulate concentrations and met parameters in and around local community	X	X	X						X	X	X						
	Soil Treatment Facility	49.77284°N, 114.81936°W	Independent	Monitoring meteorological parameters across the mine									X	X			X	X			
	Erickson Creek	49.68871°N, 114.77261°W	Independent	Monitoring meteorological parameters across the mine										X	X		X	X	X		
Coal Mountain (Care and Maintenance)	Andy Good Spoil (E297251)	49.52367°N, 114.68423°W	Permit (4751)	Monitoring particulate concentrations and met parameters in the Michel basin.	X	X	X						X	X			X	X			
Hosmer Regional Station		49.59026°N, 114.95923°W	Independent	Monitoring background concentration in the Elk Valley and located away from the mine.	X	X	X					X	X	X	X	X					

Notes:

(1): TSP at these locations are measured using a Hi-Volume sampler per the National Air Pollution Surveillance schedule.