# Seasonal Report

## 2022 Fine Particles ($PM_{2.5}$)

## OVERVIEW

Continuing the downward trend of recent years, 2022 was very clean for fine particle (**$PM_{2.5}$**) pollution across the state of Maryland. $PM_{2.5}$ is one of six criteria pollutants which have a National Ambient Air Quality [Health] Standard (**NAAQS**) set by the Environmental Protection Agency (EPA). Fine particles come from many different sources including vehicle exhaust, power plants, industrial processes, and wildfires. They can even be created by reactions between different types of pollution, water vapor, and sunlight.

Due to their very small size (See **Figure 1**), $PM_{2.5}$ can travel deeply into the respiratory tract, reaching the lungs and causing adverse health effects and increased hospital admissions. Many scientific studies have found links between $PM_{2.5}$ exposure and a variety of health problems, including heart attacks, strokes, chronic kidney disease, COPD, dementia, diabetes, high blood pressure, lung cancer, pneumonia, aggravated asthma, irregular heartbeat, decreased lung function, and respiratory symptoms like coughing and trouble breathing.

When the midnight-to-midnight daily average $PM_{2.5}$ concentrations exceed 35.4 micrograms per cubic meter (**µg/m³**), or the equivalent of 100 on the Air Quality Index (**AQI**) (see color bar on bottom of page) it is deemed unhealthy for sensitive groups (**USG**) and is otherwise known as an "exceedance day". Maryland has seen a significant decrease in the number of $PM_{2.5}$ exceedance days over the past 15+ years (See **Figure 2**), due in large part to the adoption of regulations to reduce emissions. Since 2014, $PM_{2.5}$ exceedance days have become very rare, and in fact, ***Maryland had zero $PM_{2.5}$ exceedance days in 2022.***

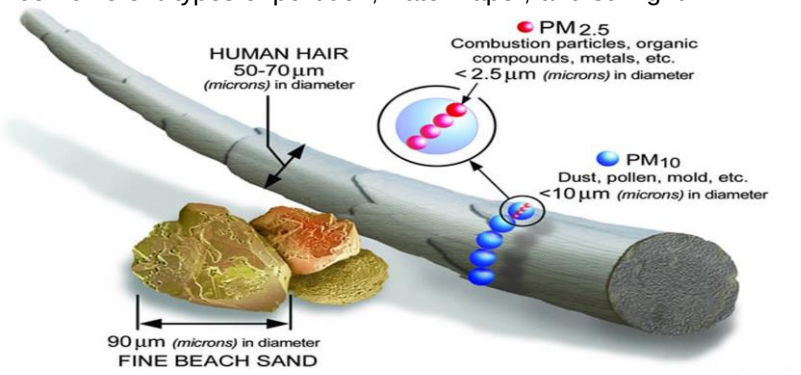


***Figure 1**: Particulate matter size comparison, courtesy of the EPA.*

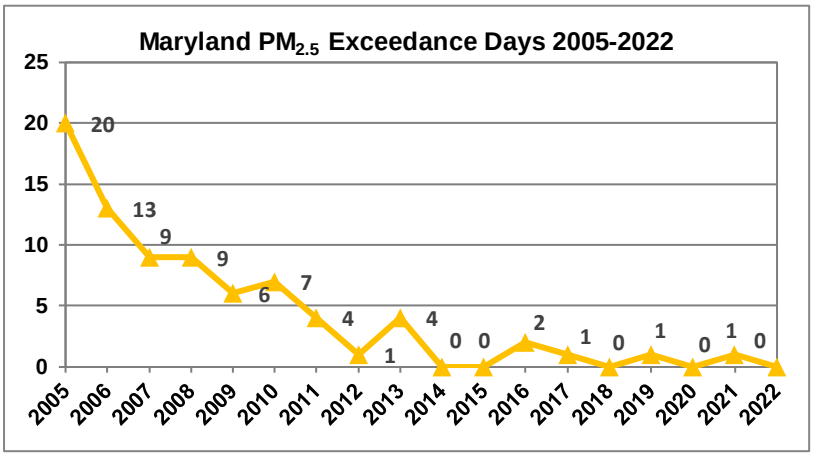


***Figure 2**: Annual number of days that the AQI surpassed 100 at any $PM_{2.5}$ monitor in Maryland, 2005-2022.*

## SEASONAL HIGHLIGHTS & STATS

Looking at the maximum daily (24-hour) $PM_{2.5}$ concentrations across the state, Maryland had 295 "Good" AQI days in 2022, or 80% of the year. (**Figure 3**) Though this was fewer Good days compared to the exceptional year of 2020, it follows the steady, increasing trend of annual Good days over the past 15+ years. With the number of $PM_{2.5}$ exceedance days in Maryland at record lows, a good alternative is to look at the number of "haze days". A haze day is defined as when the $PM_{2.5}$ daily maximum concentration exceeds 25 µg/m³ (78 AQI). On these days, the air can be perceptibly hazy. As seen in **Figure 4**, Maryland saw only one day which fits this criterion in 2022. **This annual number is the lowest in Maryland's recorded history!**

Summertime $PM_{2.5}$ exceedances have essentially become a thing of the past, with the most recent occurring in 2011! Due to continued reductions in atmospheric pollutants, primarily sulfur dioxide and nitrogen oxides, elevated $PM_{2.5}$ concentrations are now more influenced by the vertical structure of the air temperature above the surface, and specifically by **temperature inversions**, with higher concentrations largely seen in winter months. (see **Figure 5** below)

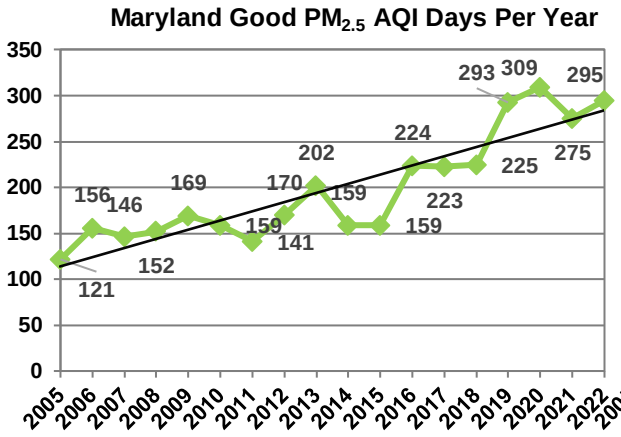


***Figure 3**: Number of days where the highest $PM_{2.5}$ monitor remained at or below an AQI of 50 (Good) in Maryland, 2005-2022. Black trend line is included.*

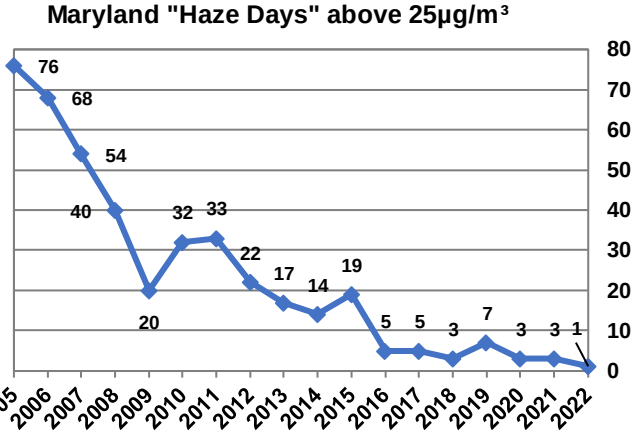


***Figure 4**: Number of days where $PM_{2.5}$ concentrations reached 25 µg/m³ or greater at any monitor in Maryland, 2005-2022.*

| AQI 0-50 Good | 51-100 Moderate | 101-150 USG* | 151-200 Unhealthy | 201-300 Very Unhealthy | 301-500 Hazardous |
|---|---|---|---|---|---|

*USG: Unhealthy for Sensitive Groups


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# Seasonal Report

## 2022 Fine Particles ($PM_{2.5}$)

### FEATURED EPISODE: December 30th, 2022

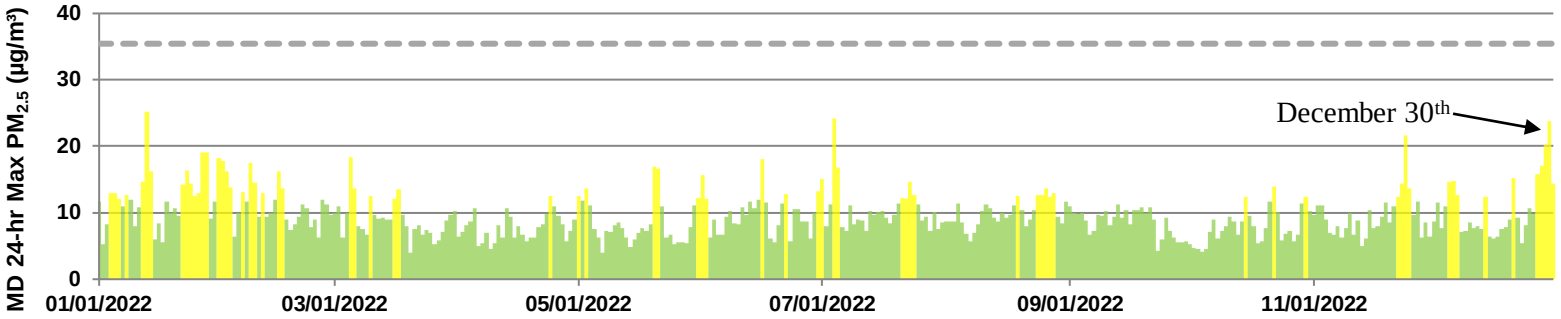


***Figure 5:*** *Maximum daily 24-hour $PM_{2.5}$ (µg/m³) in Maryland from January 1 – December 31, 2022. Bars are color coded by AQI. Exceedance day level threshold is noted by the dashed line. December 30th, 2022, 24-hour maximum $PM_{2.5}$ indicated in chart above, on right.*

Typically, air temperature decreases with elevation; a **temperature inversion** is defined as an *increase* in temperature with height. Common in winter, inversions can act as lids, trapping pollutants near the surface, resulting in more days with elevated $PM_{2.5}$ concentrations. One of the higher daily $PM_{2.5}$ averages for 2022 occurred at the Lake Montebello monitoring site in Baltimore. A daily average of 23.7 µg/m³ was recorded on December 30th, with the peak hour for the day occurring just after midnight. In **Figure 6**, $PM_{2.5}$ is seen increasing in tandem with a temperature drop on the evening of the 29th, due to increased wood burning in fireplaces and trapped air pollution from cars and industrial activity. As temperatures rise and the inversion lifts after 4AM, $PM_{2.5}$ levels decrease.

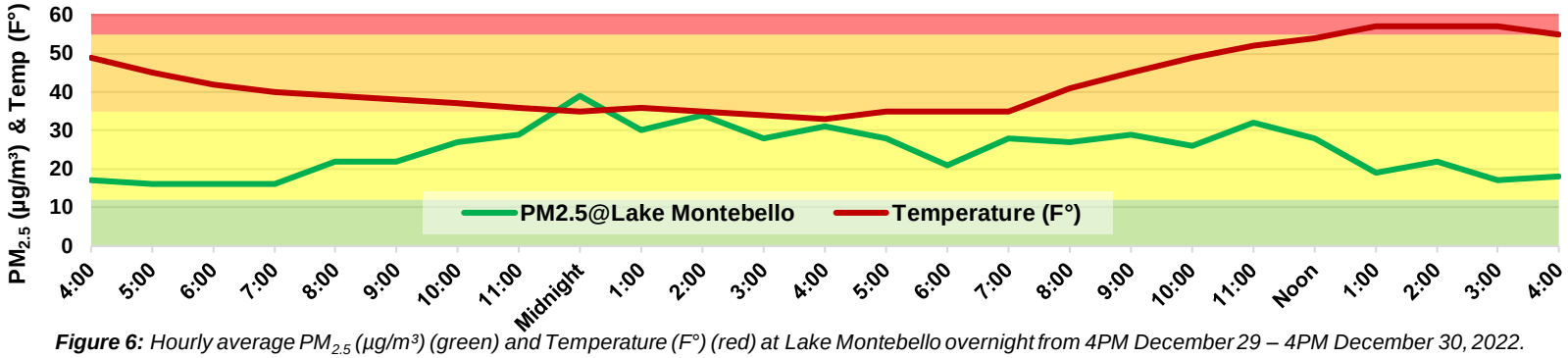


***Figure 6:*** *Hourly average $PM_{2.5}$ (µg/m³) (green) and Temperature (F°) (red) at Lake Montebello overnight from 4PM December 29 – 4PM December 30, 2022. Bands are color coded by AQI.*

### Consumer Air Sensors vs. Regulatory Monitors

The number and variety of consumer grade sensors to measure $PM_{2.5}$ has increased dramatically over the past few years. While many are precise, sensors typically aren't as accurate as maintained and calibrated, regulatory monitoring equipment used by agencies like MDE. In response to concerns about accuracy, the EPA developed a **conversion factor** for one of the more popular sensors, PurpleAir. $PM_{2.5}$ measurements are often inflated as moisture content increases in the air, causing higher readings when it's more humid in a phenomenon known as **hygroscopy.** Conversion factors can correct for this, and many sensors include adjustments to make use of conversion factors. *Care should be taken when using data that has not been adjusted for humidity*. **Figure 7** below compares data from MDE's Lake Montebello monitor and a nearby consumer-grade sensor for December 30th, 2022. Measured $PM_{2.5}$ concentrations from the consumer sensor are generally higher than the MDE Lake Montebello monitor. After applying the EPA correction, individual hours may still vary, but both produce the same daily 24µg/m³ average, compared to 43µg/m³ without correction.

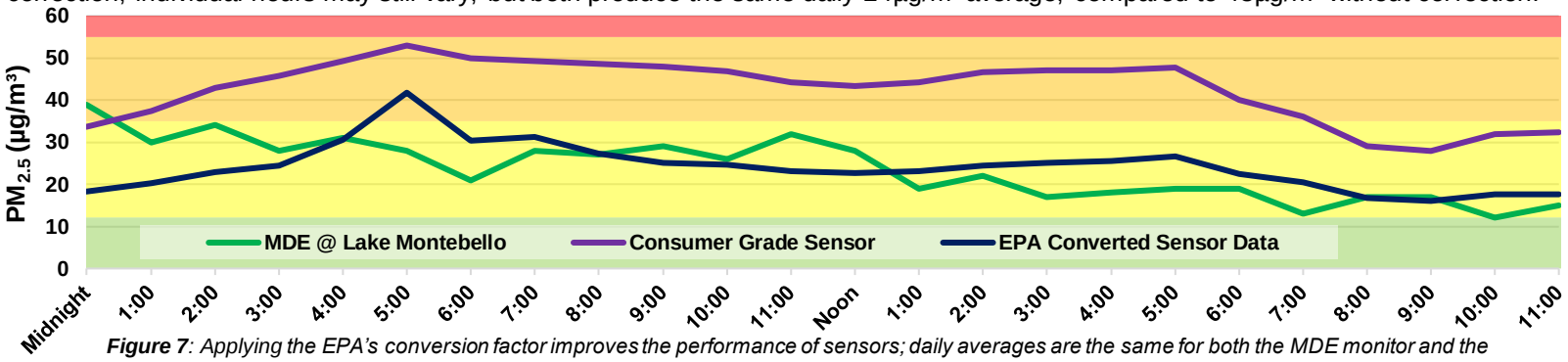


***Figure 7****: Applying the EPA's conversion factor improves the performance of sensors; daily averages are the same for both the MDE monitor and the converted sensor data for the day. For more information on sensors and their performance, please visit the EPA's Air Sensor Toolbox at https://www.epa.gov/air-sensor-toolbox* ***MDE does not endorse or sponsor any commercial product or service.*** *Bands are color coded by AQI.*

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