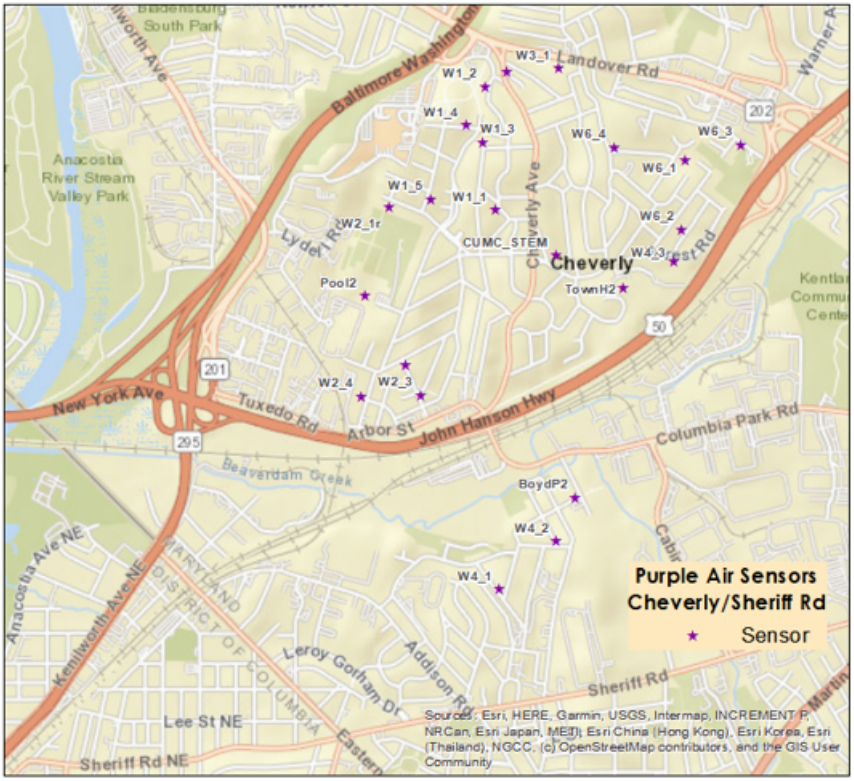
Maryland Department of the Environment's Air Quality Partnership Project in Cheverly, Maryland

This document summarizes a partnership effort to use data from a community-based, hyper-local air sensor network and local traffic data to target air emissions inspections and analyze air quality in the Cheverly, MD/Sheriff Road area

October 04, 2021

The Cheverly, MD/Sheriff Road Purple Air, Hyper-Local, Air Monitoring Network



Acknowledgements

Partners:

Town of Cheverly and community members

Cheverly Mayor Kayce Munyeneh and former Mayor Laila Riazi

Town of Cheverly Green Infrastructure Committee

Center for Community Engagement, Environmental Justice, and Health (CEEJH), Maryland Institute for Applied Environmental Health at the University of Maryland School of Public Health - Dr. Sacoby Wilson, Director

MDE Air Quality Compliance Program, MDE Ambient Air Monitoring Program, MDE Mobile Sources Control Program, MDE Air Quality Permits Program, and MDE Air Quality Planning Program

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Executive Summary

The Maryland Department of the Environment (MDE) has begun a partnership with the Town of Cheverly and the Center for Community Engagement, Environmental Justice, and Health (CEEJH), Maryland Institute for Applied Environmental Health at the University of Maryland School of Public Health. The purpose of the partnership is to conduct a project to monitor local air quality and determine whether any emissions sources in the Cheverly/Sheriff Road area are impacting it.

This partnership started when the town of Cheverly, along with the town of Capitol Heights, worked with the CEEJH to create a hyper-local air sensor network to analyze local air quality. MDE assisted in this effort by using its regulatory monitors to calibrate the sensors. Cheverly's air quality sensor network includes 22 PurpleAir, Inc. (PA) sensors estimating fine particulate matter ($PM_{2.5}$) concentrations, a high priority air pollutant.

MDE is engaged in this partnership in multiple ways. MDE implemented an intensive targeted inspection initiative in and around the Cheverly area, from June 1, 2021 through July 30, 2021 (June/July Initiative). MDE conducted inspections and observations at permitted emission sources and conducted area-wide scans and observations at non-permitted sources such as locations where diesel trucks or buses idle for long periods. Emissions from all of these sources have the potential to influence air quality in the Cheverly area. In general, the Cheverly area appears to have a high volume of truck traffic and idling buses. With the exception of three violations related to uncontrolled dust, the targeted inspection initiative conducted by MDE showed compliance with air quality laws and regulations in the Cheverly area.

MDE also evaluated the potential correlation between higher levels of measured $PM_{2.5}$ and traffic conditions. In order to determine how traffic may have been impacting air sensor measurements in the Cheverly area, MDE examined how traffic volume correlated with $PM_{2.5}$ readings and vice-versa. When data from the network of sensors is coupled with traffic data and information obtained from MDE's field inspections of mobile and stationary sources of air pollution, it can allow reasonable conclusions to be drawn regarding local air quality and what may be influencing it.

The analysis of $PM_{2.5}$ levels in the Cheverly area during the June/July Initiative focused only on two specific months and was therefore a limited study. An overall finding based on traffic data analysis and evaluation of sensor data, was that wind direction in combination with emission sources seemed to have a greater impact on the PA sensors' $PM_{2.5}$ levels than local Cheverly area traffic. A slightly higher $PM_{2.5}$ trend appeared in the Cheverly PA data during periods with winds from the west-southwest direction. This trend is potentially linked to $PM_{2.5}$ from the Washington, D.C. area and cars and trucks travelling on roadways in the upwind vicinity of Cheverly, which is adding to emissions from local sources.

MDE staff developed an analysis tool that identifies locations within the Cheverly area that are measuring higher levels of $PM_{2.5}$ or "hot spots". A daily "hot spot" map and other informational graphs were prepared using the PA $PM_{2.5}$ data, wind data and source locations. This information allowed MDE staff to investigate the relationship between upwind sources and traffic, and the PA $PM_{2.5}$ data. It is important to recognize that the "hot spots" identified are not "high risk hot spots" as $PM_{2.5}$ levels, on the days in question, were well below the daily $PM_{2.5}$ standard of 35.0 ug/m^3 set by EPA. It does show that some areas are experiencing higher levels of $PM_{2.5}$ pollution than other areas. MDE believes that one of the best ways to use the PA $PM_{2.5}$ sensor data and other sensor data is to use the data to do relative comparisons of areas or times when pollution is higher than average.

$PM_{2.5}$ levels in the Cheverly area appear to be mostly below both the daily and annual health-based standards set by EPA and consistent with other urban $PM_{2.5}$ levels across Maryland and the Mid-Atlantic region. The PA data does show short-term spikes of high $PM_{2.5}$ levels. These spikes do not greatly affect the daily average which is the time frame that the EPA chose in setting the standard. In setting the $PM_{2.5}$ standard, EPA concluded that if the daily standard is met, recognizing that there will be short-term spikes within that 24-hour period, that public health will still be protected with an ample margin of safety. EPA is currently in the process of considering revisions to the $PM_{2.5}$ standard, where the issue of short-term spikes will be considered again.

The data and analysis from the June/July Initiative provide a starting point for MDE to continue the partnership with the Cheverly area and CEEJH to conduct follow-up activities in the Cheverly area, including: continued use of the community-based air monitoring/sensor network and further community input to target inspection efforts and other analyses in the Cheverly area; implementation of the 2021 and 2022 Fugitive Dust Compliance Campaign; reduction in unnecessary, potentially illegal idling; provision of assistance to the mayor and the Cheverly Green Infrastructure Committee to ensure that air pollution issues are considered during the approval process for the District of Columbia (DC), Department of Transportation, Claybrick Road bus maintenance yard proposal; continued collaboration with the Metropolitan Washington Air Quality Committee (MWAQC) to implement emission reduction programs to continue the downward trend in air pollution emissions; increased efforts with CEEJH, other researchers, interested parties and EPA to improve techniques and tools for evaluating potentially inequitable exposure to air pollution; and identification of other potential partnership opportunities with the Cheverly area community.

Section 1. Background

The Maryland Department of the Environment (MDE) has begun a partnership with the Town of Cheverly and the Center for Community Engagement, Environmental Justice, and Health (CEEJH), Maryland Institute for Applied Environmental Health at the University of Maryland School of Public Health. The partnership has focused on conducting a project to monitor local air quality and determine whether any emissions sources in the Cheverly area are impacting it.

MDE has an expansive ambient air quality monitoring network, with monitors located around the state. The network is not designed to measure air quality within the Cheverly community directly, as Maryland's closest network monitors are approximately 9 to 20 miles from Cheverly. In the District of Columbia, there are also two monitors, which are located approximately 4 miles from Cheverly. This partnership started when the town of Cheverly, along with the town of Capitol Heights, worked with the CEEJH to create a hyper-local air sensor network to analyze local air quality.

Cheverly's air quality sensor network includes 22 PurpleAir, Inc. (PA) sensors. These sensors are placed primarily at residences near industrial sources and in common public spaces. This is the link to Cheverly's air quality sensor network component of the Cheverly Green Plan: https://sites.google.com/site/cheverlygreenplan/now-under-way-current-initiatives/the-air-we-breathe. The CEEJH team and members of the Cheverly Green Infrastructure Committee have provided the town with information and tools to interpret current air quality conditions and get a sense of what possible impacts could occur from future development of the area.

The PA sensors estimate fine particulate matter ($PM_{2.5}$) concentrations, a high priority air pollutant. $PM_{2.5}$ refers to tiny particles or droplets in the air that are two and a half microns or less in width. $PM_{2.5}$ is a human health concern because these particles are so small that they can get into the deep parts of your lungs. It has been linked to premature mortality and multiple respiratory problems, particularly among people with preexisting heart or lung diseases, children, and the elderly.

MDE is engaged in this partnership in multiple ways. To begin, MDE assisted in this effort by using its regulatory monitors to calibrate the PA sensors and analyze the $PM_{2.5}$ levels. MDE also implemented an intensive targeted inspection initiative in and around the Cheverly area, from June 1, 2021 through July 30, 2021 (June/July Initiative). MDE conducted inspections and observations at permitted emission sources and conducted area-wide scans and observations at non-permitted sources such as locations where diesel trucks or buses idle for long periods. Emissions from all of these sources have the potential to influence air quality in the Cheverly area.

The third MDE piece of this project was to evaluate the potential correlation between higher levels of measured $PM_{2.5}$ and traffic conditions. In order to determine how traffic may have been

impacting air sensor measurements in the Cheverly area, MDE examined how traffic volumes correlated with $PM_{2.5}$ readings and vice-versa.

Data from the network of sensors, when coupled with traffic data and information obtained from MDE's field inspections of mobile and stationary sources of air pollution, allows reasonable conclusions to be drawn regarding local air quality and what may be influencing it. The details of MDE's work on this Cheverly Partnership Project are described below, including, (1) the targeted inspection initiative, (2) work linking mobile sources and traffic to measured data, (3) analyses of $PM_{2.5}$ during the June/July Initiative, and (4) planned follow-up activities.

Section 2. Overview and Findings from the Targeted Inspection Initiative

As part of its contribution to the Cheverly area air quality partnership project, MDE implemented a two-month intensive targeted inspection initiative. Input from the Cheverly community played a major role in MDE's implementation of this effort. MDE has viewed the Cheverly area's targeted inspection initiative as a pilot and may implement similar efforts in other areas that have environmental justice concerns.

i. Overview of the Process

In conjunction with the placement of PA sensors in the Cheverly area, MDE conducted the intensive inspection initiative. On most days, MDE inspectors were able to inspect/observe approximately 6-10 sites and conduct area-wide scans. Compliance inspectors visited the Cheverly area several times each week (for a total of nineteen days) between June 1 and July 30, 2021, making overall observations, conducting focused inspections and outreach, and documenting their findings.[1] Note that some of the sources observed and inspected were not within the boundaries of Cheverly proper, but in adjacent areas such as Capitol Heights, where they were deemed potentially upwind and close enough to Cheverly to have potential air quality impacts.

Facilities inspected/observed included the following: Aggregate Industries, Chambers Crematory, Joseph Smith and Sons, Anchor Construction, Greyhound Bus, Pepsi Bottling Plant, K. Neil Trucks, Washington Woodworking, Whole Foods Distribution Center, Claybrick Road Construction Sites, Tuxedo Road Construction Site, Aggregate and Dirt Solutions, Brandywine Sand and Gravel, E. P. Henry, Prince George's County Hospital Center, Washington Metropolitan Area Transit Authority

[1] For reference in this report, an "inspection" is defined as an inspector making contact with facility personnel and conducting an on-site inspection. An "observation" is defined as an off-site observation, such as from an adjacent street, of a site where facilities could be observed during actual operations. This is very useful in air quality work as determinations can be made regarding visible emissions, dust, odors, etc. without contacting facility personnel.

(WMATA) Bus Facility, Warehouses on Claybrick Road, warehouse construction on Cabin Branch Drive and Columbia Pike, and a Giant Food Distribution Center.

Six schools were identified in the Cheverly Area: Saint Ambrose Catholic School, Gladys Noon Spellman Elementary School, Cooper Lane Elementary School, Bladensburg Elementary School, Rogers Heights Elementary School, and International High School. MDE staff conducted observations at five of the six schools for potential bus idling issues. International High School was not observed during this project since the students at this school are dropped off at the school via private vehicles, or they take public transportation. In addition to observing the specific facilities/schools listed above, inspectors were always on the look-out for other sources of particulate matter and dust such as other warehouses with idling trucks and dusty roads and lots.

The Compliance inspectors conducted outreach to facilities in the area to advise their owners/operators about the Cheverly PA sensor network, MDE's targeted inspection initiative, and the ongoing need to control dust emissions, which tend to peak in summer months. MDE emailed information about this initiative to contacts at companies that are formally regulated by MDE; placed information about the initiative on the MDE website; and contacted other facilities including warehouses, trucking companies, and Greyhound and WMATA bus stations. MDE does not formally permit or register some of these facilities; therefore, establishing contacts was an important part of conveying information to the facilities on this initiative. It also provided an opportunity for inspectors to inquire about any unusual activity that may have led to increased $PM_{2.5}$ concentrations downwind of their operations.

To carry out the initiative, MDE inspectors consulted the PA sensor network each day to determine if certain locations in the Cheverly area should be targeted for inspections.[2] Inspectors also worked with MDE meteorologists to better understand wind direction and how air pollution would likely move during each inspection day.

To ensure an open and transparent communication process with the community and other interested parties, MDE set up a relatively simple web site where inspectors logged inspection and observation activities each day and provided links to the more detailed inspection reports used to document all inspections. The web site was updated several times each week during the June/July Initiative.

ii. Observations/Findings

Overall, the inspections and observations showed that most facilities were in compliance with current state laws and regulations. Twenty-one facilities were identified as sources to inspect in the Cheverly area with eighteen in compliance at each observation/inspection that MDE conducted. Three facilities were issued Notices of Violation (NOVs) on July 15, 2021, for

[2] Built-in Wi-Fi enables the direct and regular reporting of observations to the PA network servers and past data is available at all registered PA sites across the entire PA network.

uncontrolled dust. These three sites are located outside of Cheverly itself. It should also be noted that dust is primarily larger particles (PM_{10}), not $PM_{2.5}$. Follow-up inspections of these sites after issuance of the NOVs determined that they had improved their dust control procedures with notable improvement in dust levels.

During the term of the targeted inspection initiative, MDE received seven citizen complaints from four citizens regarding idling trucks and odors. In general, the Cheverly area appears to have a high volume of truck traffic and idling buses. Two of the complaints from one of the citizens were about idling trucks at the Whole Foods Warehouse. MDE did multiple observations of the Whole Foods Warehouse during the targeted inspection initiative. No violations of air quality laws or regulations were noted during the targeted inspection initiative. In addition to the Whole Foods and Giant Distribution Centers, other food-related warehouse and distribution centers have trucks coming and going and moving around the lots at times. While some idling of trucks was observed, many of the trucks at the food facilities are refrigerated units, which must idle to keep food fresh. Idling for this purpose is exempt under state anti-idling laws. Inspectors also conducted observations at the schools listed above while the schools were open. The inspectors did not observe any buses idling at the schools.

The other five complaints received from citizens were about general odors in the air. MDE inspectors, when in the area, tried to detect odors and potential sources; however, the inspectors were not able to confirm any odors or possible source of odors.

For more specific information on each inspection/observation, MDE created a detailed inspection/observation report for each facility on every day that it was visited. These detailed inspection/observation reports (123 in total) can be viewed here: https://mde.maryland.gov/programs/Air/AirQualityCompliance/Pages/CheverlyTargetedInspectionInitiative.aspx.

Section 3. Linking Mobile Sources and Traffic to Measured Data

An important component of MDE's work on the Cheverly Partnership Project was to evaluate the potential correlation between high levels of measured $PM_{2.5}$ and traffic conditions. This evaluation was conducted during the same period that MDE implemented the targeted inspection initiative, in June through July 2021. In order to determine how traffic flow could be impacting air sensor measurements in the Cheverly area, MDE examined how traffic correlated with $PM_{2.5}$ readings and vice-versa. Appendices 1 and 2 provide more detailed analyses on the issues summarized below.

i. Area Characterization

The first step was for MDE staff to drive around the Cheverly area, conducting an area survey, including observing the neighborhoods, industry, and traffic patterns. They also documented local traffic and road conditions, businesses, construction activities, and any other factors that

had the potential to impact air quality. A description of this survey of the Cheverly area and adjacent areas follows.

On the morning of June 30, 2021, MDE staff surveyed the Cheverly area. They noted the number of traffic lanes, types of businesses, and various other features that could affect the PA sensor data.

The map below depicts the study area. It has been divided into seven distinct sections. Each section is described below. The map section numbers correspond with the section numbers in the text.

Figure 1: Map of Cheverly, Maryland and Surroundings

Section 1: Southeast of the town of Cheverly is Columbia Park Road, a 4-lane road with significant heavy-duty vehicle traffic. The area appears to be industrial with many warehouses and businesses that have tractor-trailer, box truck, dump truck, and cement truck traffic. Active construction was underway on a large commercial building in the area.

Section 2: Southwest of the town of Cheverly are all 2-lane roads, some wide and some narrow. Some roads are size-restricted, but some heavy-duty vehicles were using them. There is a dirt/gravel facility in the area, as well as a scrap yard. The scrap yard had a large amount of industrial activity, with a lot of heavy-duty vehicles loading/unloading.

Section 3: West of the town of Cheverly is the Tuxedo Industrial area. This area has a 2-lane road as its main thoroughfare on the south, and this road turns into a 4-lane road to the west. This road was full of heavy- and light-duty vehicles, and active road construction kept the road congested. This area is full of vehicle repair facilities and warehouses.

Section 4: The town of Cheverly, along Cheverly Ave, is predominantly a residential area. It does have some limited commercial and institutional activity, though, including a community center, pool, church, and schools. Many trees were observed on the streets and properties in the area. The only heavy-duty traffic was from garbage trucks and buses. There was some active road construction on the northwest end of the area.

Section 5: To the northwest, along Kenilworth Avenue, there is a mix of commercial and industrial activity. The Pepsi-Cola plant is located here, along with repair facilities, shops, and stores. A mix of traffic was observed consisting of predominantly light-duty vehicles, but many commercial vehicles were also seen in the area.

Section 6: North of Cheverly Avenue is Route 202, a 4-lane road with mostly commercial activity. The housing in the area is high-density, with apartment complexes. No notable industrial activity was observed. Mobile Staff observed substantial light-duty vehicle traffic but less heavy-duty vehicle traffic than everywhere else in the survey area except for Cheverly Avenue.

Section 7: To the northeast is the Landover area, which is primarily light commercial with some high and low density residential properties. Apartments are located around the main road, and small houses are found to the north end of the area. The main road through this section is Route 202. The traffic on this road is similar to the traffic on Route 202 in Section 6, above. This area has larger stores such as Aldi and Walgreens.

A copy of the more detailed report on Mobile's characterization survey can be found in Appendix 1.

ii. Traffic and PurpleAir $PM_{2.5}$ Data

MDE staff had to identify sources of traffic data in order to determine a basis for possible correlations of traffic to spikes in the PA sensors' data. The first source of data investigated was the Maryland Department of Transportation, State Highway Administration's (MDOT SHA) Highway Performance Monitoring System (HPMS) data. The HPMS uses permanently installed traffic devices that continuously collect data, all hours and days of the year. Unfortunately, the traffic count recorder located in the Cheverly area was out of service at the time and was not available for MDE's use on this project.

The next data option was the use of MDOT's well established Maryland 511 and Coordinated Highways Action Response Team (CHART), CHARTWeb system. CHARTWeb is Maryland's official 511 Traveler Information Service that provides travelers with reliable, current traffic and road closure information, as well as weather-related traffic events and conditions. MDOT's CHART

program operates a network of closed-circuit TV cameras that monitor traffic conditions in major areas of the state. The Cheverly area has 2 CHART cameras, one on MD Route 295 at MD Route 202, and the other at MD Route 50 at MD Route 202 (see Sections 6 and 7 on the above map). These are at the outer north and northeast corners of Cheverly, respectively. The locations of these 2 cameras are at the outermost boundaries of the study area, and as such, creating quantifiable data from the images was not possible for this project. Thus, MDE explored alternative resources.

MDE's Ambient Air Monitoring Program staff were instrumental in finding an alternative source of traffic-related data. They set up an algorithm to take screenshots of the Google Maps traffic conditions' map of the Cheverly area, showing traffic congestion data displayed as different colored roads. As shown in Figure 2, a green road represented light-to-no traffic, orange represented significant congestion, red represented heavy congestion, and maroon represented extremely heavy congestion.

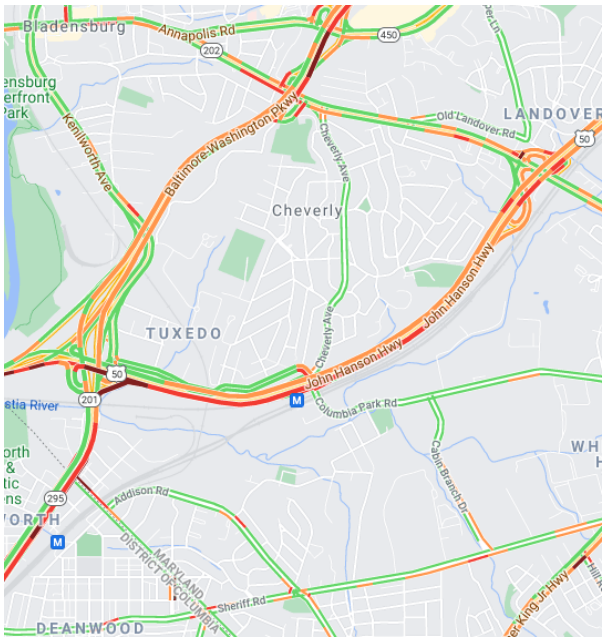

Figure 2: Sample traffic map, with orange, red, and maroon colors showing higher traffic

The algorithm then counted the different colored pixels associated with each colored road, with the proportion of pixel counts of a given color representing relative lows and highs in traffic volume in the area. Both screenshot and pixel count numbers were stored at 15-minute intervals, and they were compiled into a weekly chart that could be used to easily identify the time and intensity of traffic peaks.

The primary work of MDE Mobile Sources staff was focused on developing a weekly traffic report that took the $PM_{2.5}$ concentrations from the PA sensors and analyzed them to determine if they correlated with traffic data for the area. The traffic map and pixel count data described above

were utilized in developing the weekly reports. The reports were developed in two different ways. The first approach MDE staff utilized was to look at the times when the traffic data showed a high volume of traffic. Staff then looked at how that data lined up with the monitored $PM_{2.5}$ concentrations. The second approach staff took was to reverse the steps in the first approach and look at the times when the $PM_{2.5}$ concentrations were high and then look at what the volume of traffic looked like at those times.

The transport of traffic-related emissions by the wind was also considered. Sensors downwind of heavy traffic may display higher $PM_{2.5}$ concentrations than those upwind or off-line of the wind direction. Under the first approach described above, if the wind was blowing vehicle emissions away from homes and businesses in the Cheverly area, then the data was not useful for correlating a relationship between the mobile sources and the PA sensor data. When wind was blowing the pollution from the direction of the heavy traffic toward Cheverly area homes and businesses, however, there were instances where it did correlate with a slow rise in $PM_{2.5}$ at the PA sensors, especially during the morning rush hour. There were also instances where the traffic showed no connection with the PA sensor data despite high traffic and wind in the right direction. Also, a direct connection could not be made between the afternoon rush hour and the PA $PM_{2.5}$ concentrations.

Using the second approach described above, MDE staff looked at times when sensors were reading high $PM_{2.5}$concentrations, and there did not seem to be a connection with traffic data. Often, high spikes in $PM_{2.5}$ readings were late at night or early in the morning. At these times, there was usually little to no traffic congestion, suggesting that the sources of the high readings were factors external to traffic congestion.

An example of a weekly traffic report and related $PM_{2.5}$ sensor data analyses is provided in Appendix 2.

iii. Observations/Findings

Overall, wind direction in combination with emission sources other than nearby traffic seemed to have a greater impact on the PA sensors' $PM_{2.5}$ levels than local Cheverly area traffic. Pollution direction analyses indicated a potential contribution coming from the southwest, from the Washington, D.C. area, rather than coming from local traffic conditions/incidents.

Section 4. Fine Particle Levels During the June through July Initiative

An important contributor to the Cheverly Partnership Project was the Ambient Air Monitoring Program (Air Monitoring). This MDE Program undertakes a variety of functions ranging from measuring pollutants to collaborating with local universities. As part of this Cheverly Partnership Project, Air Monitoring staff collected and interpreted $PM_{2.5}$ PA sensor data for the Cheverly area

and nearby state-run $PM_{2.5}$ air monitoring data. Appendix 3 provides more in-depth technical analyses and information used to prepare the summary information provided next.

Advances in technology have revolutionized the ability to measure $PM_{2.5}$ at reasonable costs. PA has created a popular version of low-cost sensor technology that may be purchased for approximately $250 per sensor. PA sensors are built around low-cost laser particle counters which use light attenuation across a small chamber to estimate the ambient $PM_{2.5}$ concentrations and can report concentrations in as little as two-minute increments.

Distinct from the PA sensors, Maryland currently operates 25 air monitoring sites around the state that measure ground-level concentrations of ozone, $PM_{2.5}$ and other criteria pollutants,[3] air toxics, meteorological parameters, and research-oriented parameters. This total includes two "Haze Cams", cameras used to monitor visibility. These monitors are also known as either Federal Reference Method (FRM) or Federal Equivalent Method (FEM) and can cost in the range of hundreds of thousands of dollars to purchase, install, and maintain at a single air monitoring site.

As part of this $PM_{2.5}$ measurement initiative, the Air Monitoring Program used the Cheverly PA $PM_{2.5}$ data and FEM $PM_{2.5}$ monitoring data to do the following:

- Analyze the $PM_{2.5}$ data to identify potential hot spots in and around the Cheverly Community,
- Compare the levels of $PM_{2.5}$ in the Cheverly area to levels seen across the region,
- Provide a reasonable comparison of the PA $PM_{2.5}$ data to the daily and annual health-based standards established by the EPA,
- Investigate the relationship between the PA $PM_{2.5}$ sensors and the FEM $PM_{2.5}$ monitored data and start to explore how both of these valuable data collection tools can be used in tandem in the future to enhance Maryland's air monitoring network.

There are 23 $PM_{2.5}$ sensors registered with the Cheverly Green Plan (https://sites.google.com/site/cheverlygreenplan/now-under-way-current-initiatives/the-air-we-breathe), 22 of which were PA sensors. The additional AeroQual (AQY 1) sensor was located at the Town Hall and data from that sensor was not available for use in this project.

i. Hot Spot Analyses

MDE staff developed an analysis tool that identifies locations within the Cheverly area that are measuring higher levels of $PM_{2.5}$ or "hot spots". A daily hot spot map and other informational graphs were prepared using the PA $PM_{2.5}$ data, wind data and source locations. As described earlier, this information allowed MDE Compliance staff to investigate the relationship between upwind sources and traffic, and the PA $PM_{2.5}$ data.

[3] See U.S. Environmental Protection Agency, "Criteria Air Pollutants," available at https://www.epa.gov/criteria-air-pollutants, accessed September 24, 2021.

As shown in Figure 3 below, on this date, July 8, 2021, the winds were out of the southwest and there was a $PM_{2.5}$ hot spot in the southwest corner of the area. The $PM_{2.5}$ hot spot extended to the northeast, following the southwest winds. This $PM_{2.5}$ hot spot was directly downwind of the major roadways in the region and the more industrialized area found between Sheriff Road and the far southwest corner of the study area. The plume of pollution coming from the Washington, D.C. nonattainment area[4], an area made up of jurisdictions in Maryland, the District of Columbia and Virginia with many mobile and other emission sources, is also potentially contributing to this hot spot.[5] Examples of other graphs and charts used by MDE staff are included in Appendix 3.

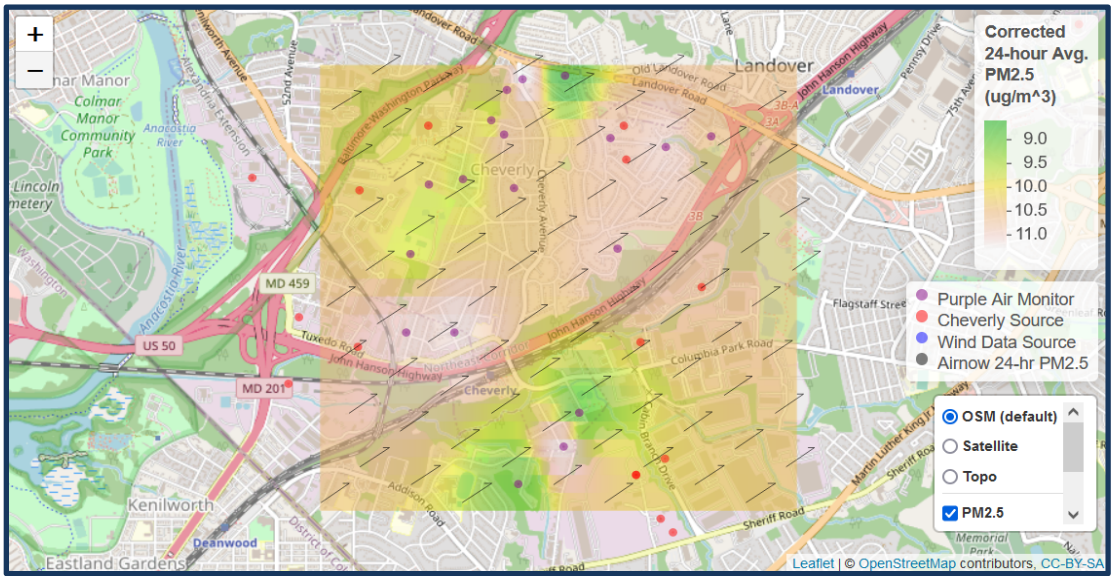

Figure 3: $PM_{2.5}$ Hot Spot Analysis for July 8, 2021

It is important to recognize that the hot spots shown in Figure 3 are not "high risk" hot spots as $PM_{2.5}$ levels on that day were well below the daily $PM_{2.5}$ standard of 35.0 ug/m^3 set by EPA. It does show that some areas are experiencing higher levels of $PM_{2.5}$ pollution than other areas. MDE believes that one of the best ways to use the PA $PM_{2.5}$ sensor data and other sensor data is to use the data to do relative comparisons of areas or times when pollution is higher than average.

ii. Comparison to the Daily Health-Based Standard

Figure 4 below compares adjusted daily PA $PM_{2.5}$ and FEM $PM_{2.5}$ data to the daily $PM_{2.5}$ standard set by EPA. The raw PA data was adjusted using an EPA-approved correction factor to account

[4] The Washington, DC-MD-VA 2015 ozone NAAQS nonattainment area was designated as a marginal nonattainment area for the 2015 ozone NAAQS (0.070 parts per million) by the United States Environmental Protection Agency (EPA) effective August 3, 2018.

[5] Possible instrument variability and uncertainty is discussed in Appendix 3.

for data accuracy problems associated with the PA sensors under conditions of high relative humidity. Both the highest reading from any PA sensor site on that day and the daily average from all PA sensor sites on that day are shown in Figure 4.

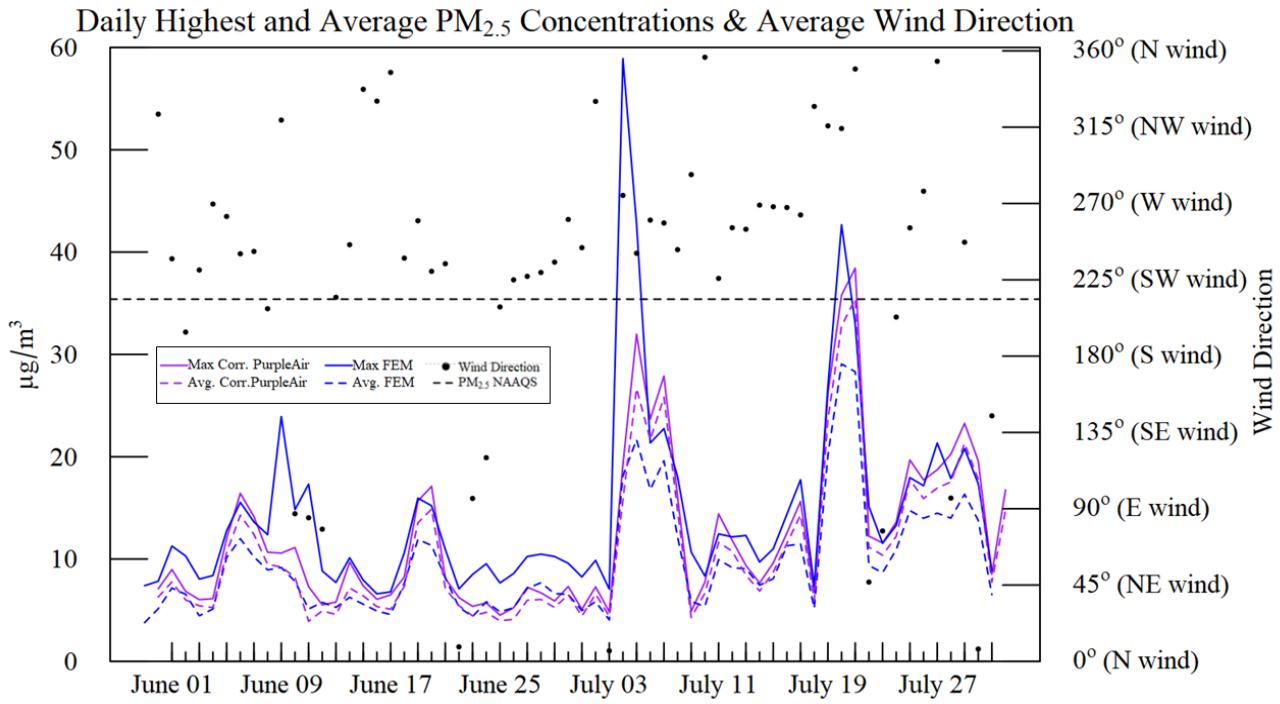

Figure 4: Comparison of Purple Air sensors' and Federal Equivalent Method monitors' daily $PM_{2.5}$ concentrations to the daily $PM_{2.5}$ Standard

The PA sensor data in the Cheverly area consistently showed levels well below the daily standard. The FEM data, which covers areas outside of the Cheverly area, showed similar results. Both data sets showed higher readings around July 4th and July 19th. Because of fireworks, high $PM_{2.5}$ readings are always recorded across the country around the 4th of July holiday. The high readings around July 19 appeared to be linked to the transport of wildfire smoke that originated in Central Canada and the Mountain West. The EPA standard allows for occasional exceedances of the standard over a 3-year period. The standard is still protective of public health if the 98th percentile of 24-hour $PM_{2.5}$ concentrations in one year, averaged over three years, is less than or equal to 35.0 µg/m^3.

The PA data does show short-term spikes of high $PM_{2.5}$ levels. These spikes do not greatly affect the daily average which is the time frame for which the EPA standard is set. In setting the $PM_{2.5}$ standard, EPA concluded that if the daily standard is met, recognizing that there will be short-term spikes within that 24-hour period, that public health will still be protected with an ample margin of safety. EPA is currently in the process of considering revisions to the $PM_{2.5}$ standard, where the issue of short-term spikes will be considered again.

During the period between June 1 and July 30, 2021, the PA sensors and the FEM monitors were checked hourly. After adjusting the PA sensor data using the EPA correction factor, it can be concluded that there were similar readings between the PA sensors and FEM monitors. This is an important conclusion.

iii. Comparison to the Annual Health-Based Standard

Figure 5 compares June- and July-adjusted PA $PM_{2.5}$ and FEM $PM_{2.5}$ data to the annual $PM_{2.5}$ standard set by EPA. For each PA sensor and the 15 closest FEM sites, both the 2-month average (June and July) and the estimated annual concentrations based upon the 2-month data are shown. The surrogate or estimated annual concentrations were calculated using the June and July average FEM and PA-adjusted data and historical annual data from the FEM network using the relationship between the June and July average concentration and the annual concentration. In other words, June and July averages were scaled. Since June and July typically have higher $PM_{2.5}$ concentrations than most other months, the surrogate annual average was lower than June and July alone. Nearly all sites are below the annual average standard of 12 $\mu g/m^3$, and the annual average surrogates for urban FEM monitors and Cheverly PA sensors remain similar.

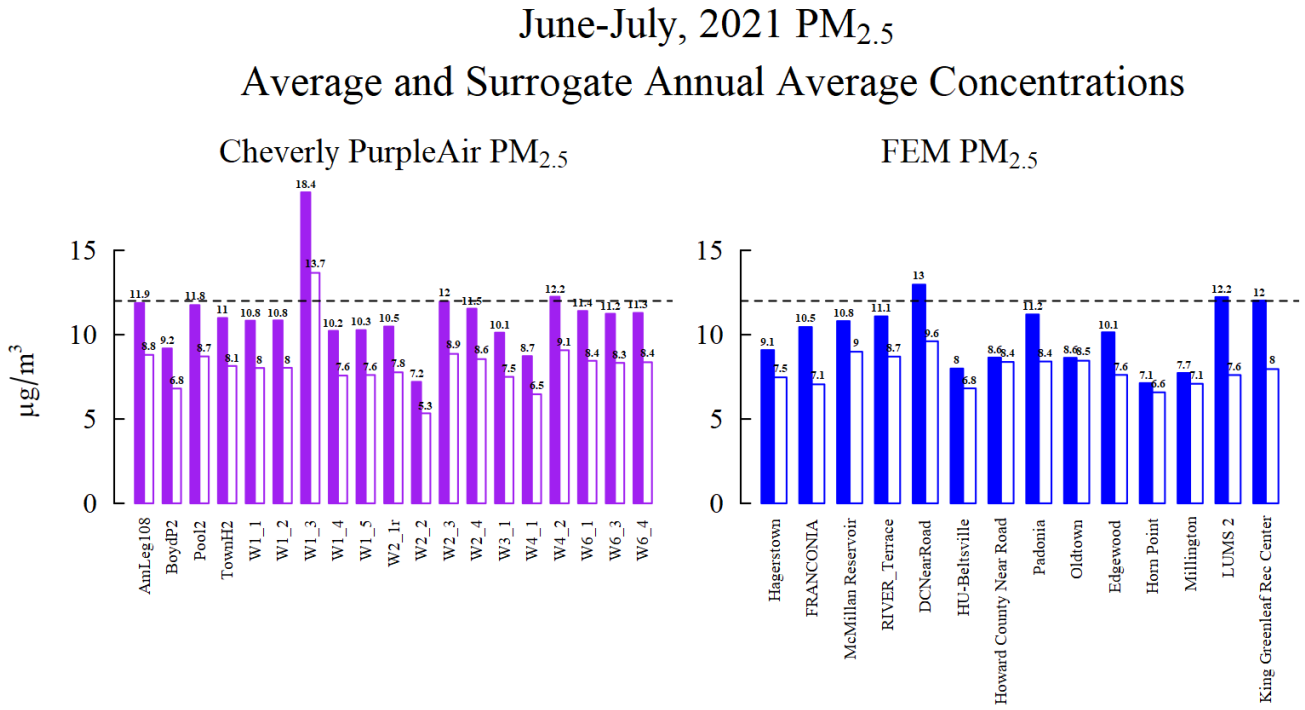

Figure 5: Comparison of Purple Air sensors' (left) and Federal Equivalent Method monitors' (right) June and July average $PM_{2.5}$ concentrations (solid bars) to the estimated annual $PM_{2.5}$ Standard (hollow bars).

iv. Observations/Findings

The analysis of $PM_{2.5}$ levels in the Cheverly area for the June/July Initiative focused on just two months and was therefore a limited study. MDE often uses annual data or multi-year data to do air quality analyses. That said, the analyses that were conducted provided quite a few findings that are both interesting and important. MDE plans to continue to refine and strengthen the analyses presented in this document. Some of the more important observations are listed below:

- $PM_{2.5}$ levels in the Cheverly area appear to be mostly below both the daily and annual health-based standards set by EPA and consistent with other urban $PM_{2.5}$ levels across Maryland and the Mid-Atlantic region.
- There do appear to be $PM_{2.5}$ hot spots within the Cheverly area. These hot spots are not "high risk" hot spots as $PM_{2.5}$ levels are below the daily standard. MDE will continue to analyze these hot spots and look for ways to reduce $PM_{2.5}$ levels within hot spot areas.
- A slightly higher $PM_{2.5}$ trend appeared in the Cheverly PA data during periods with winds from the west-southwest direction. This trend is potentially linked to PM2.5 from the Washington, D.C. area and cars and trucks travelling on roadways in the upwind vicinity of Cheverly, which is adding to emissions from local industrial sources.
- Comparisons of the Cheverly PA data and the regional FEM data show that overall, the Cheverly area $PM_{2.5}$ levels were consistent with regional $PM_{2.5}$ levels throughout the area. This indicates that the primary contributor to $PM_{2.5}$ levels in the Cheverly area and the rest of the State is most likely regional sources such as upwind coal-fired power plants and mobile sources spread across upwind neighboring states.
- Short-term $PM_{2.5}$ spikes (shorter than one hour) were often recorded. These short-term spikes do not significantly impact the hourly or daily levels. EPA's daily standard is designed to protect public health even with short-term spikes. This is an issue that will continue to be analyzed by MDE and EPA as EPA continues to review analyses to support a revised $PM_{2.5}$ standard.
- The Cheverly raw PA $PM_{2.5}$ data is almost always higher than the regulatory FEM monitors but comparable during low concentrations and lower relative humidity. Once the EPA correction factor for high relative humidity is applied, the PA and FEM data are relatively consistent.
- Corrected daily PA data in the Cheverly area resulted in more days with lower $PM_{2.5}$ levels than other regional regulatory FEM monitors.
- The Cheverly PA data is 2-4 $\mu g/m^3$ higher than rural FEM monitors over the entire study period (the mean $PM_{2.5}$ concentration of all PA monitors over the 2-month study was 11.1 $\mu g/m^3$, compared with FEM monitors in Figure 5), but similar in concentration to other urban/suburban FEM monitors. This was particularly true for other FEM monitors in and around the DC region (Franconia, McMillan Reservoir, River Terrace, DC Near Road, and King Greenleaf Rec Center). The closest FEM monitor to Cheverly was also the monitor

with the highest $PM_{2.5}$ concentration over the study period and was similarly higher than both Cheverly PA sensors and urban FEM monitors.

- The lack of higher $PM_{2.5}$ hot spots in the Cheverly area was surprising. This is most likely because $PM_{2.5}$ levels are most often linked to more regional sources and not local sources. MDE has already begun to work with CEEJH to identify measurement and analysis tools to better understand potential inequities between different areas based upon local emission sources. Techniques to analyze both diesel exhaust and cumulative exposure are already being investigated.

Section 5. Planned Follow-Up Activities in the Cheverly Area

During the two-month targeted inspection initiative (June/July initiative), MDE's staff in the Air and Radiation Administration (ARA) identified seven specific areas and several other potential opportunities to do follow-up work in the Cheverly/Sheriff Road area. These follow-up activities will be discussed with the community, and other potential future action areas may also be identified. Each follow-up activity is discussed below.

i. Continued use of the Community-Based Air Monitoring/Sensor Network and Further Community Input to Target Inspection Efforts and Other Analyses in the Cheverly Area

MDE/ARA will continue to review the sensor data each week to help target inspections for both stationary sources and mobile sources. MDE/ARA will also continue to conduct both source-specific and area-wide observations in the area and will maintain the targeted inspection web page, which can be found using the link below. The web page provides overviews of inspection activities and more detailed source-specific compliance inspection reports. See https://mde.maryland.gov/programs/Air/AirQualityCompliance/Pages/CheverlyTargetedInspectionInitiative.aspx. Although inspections will continue in the future, they will be conducted on a reduced frequency compared to what took place during the June/July initiative. The frequency will be increased, however, should the analysis of the air sensor data point to a pollution source potentially influencing any sensors.

ii. Implementation of the 2021 and 2022 Fugitive Dust Compliance Campaign

In the fall and winter of 2021/2022, MDE/ARA will initiate a campaign in the Cheverly area to reduce fugitive dust emissions. This issue was identified as a priority based upon the June/July initiative and community input. The campaign will be initiated in fall 2021 and will include an effort to provide both stationary sources and area construction sites with information on Maryland's regulatory requirements and measures that may be taken to minimize emissions of fugitive dust. The effort could also include assigning a high priority to initiating and finalizing any applicable enforcement actions, with a focus on the use of supplemental environmental projects (SEPs) to mitigate any environmental damage and with strong consideration given to the imposition of financial penalties to deter future violations.

Because fugitive dust is a greater problem in the warmer spring and summer months, the campaign will continue through the summer of 2022. During the June/July initiative, MDE/ARA issued three notices of violations (NOVs) for fugitive dust in the Cheverly area. Follow-up inspections of these sites after issuance of the NOVs determined that they had improved their dust control procedures with notable improvement in dust levels.

iii. Reduction in Unnecessary, Potentially Illegal Idling

Starting in the fall of 2021, MDE/ARA will initiate an effort to address unnecessary, potentially illegal idling. This effort is a direct result of the June/July initiative where significant amounts of diesel truck traffic and idling were observed. There were also citizen reports received during the initiative on this issue. Reducing diesel emissions is a very high priority, as diesel particulate is a highly toxic air pollutant.

This effort will involve both distributing anti-idling materials at facilities and other locations where idling takes place and coordinating with applicable law enforcement agencies to pursue enforcement actions when violations of Maryland's law are observed. Idling appears to occur frequently throughout the Cheverly area at industrial sources, other businesses, warehouses, distribution facilities and other locations. MDE will be partnering with the Maryland Department of Transportation (MDOT) on this initiative.

iv. Provision of Assistance to the Mayor and the Cheverly Green Infrastructure Committee to Ensure that Air Pollution Issues are Considered During the Approval Process for the District of Columbia (DC), Department of Transportation, Claybrick Road Bus Maintenance Yard Proposal

Concerns about a proposal for the District Department of Transportation (DDOT) to buy and develop a Claybrick Road Bus Maintenance Yard were raised by the mayor of Cheverly and residents of the Cheverly area at several meetings with MDE that occurred during the June/July initiative. MDE/ARA initiated discussions on this issue with Washington, D.C. government agencies (the D.C. Department of Energy & Environment (DOEE) and DDOT). If the proposal to buy and develop the Claybrick Road property goes through, DOEE and DDOT have agreed to conduct air quality analyses that go above and beyond all federal and D.C. requirements. DOEE and DDOT have also agreed to allow MDE to work with them on these analyses. These steps to go above and beyond compliance, will help to ensure that air pollution issues, equity issues, and citizen concerns associated with the proposal are taken into account.

v. Continued Collaboration with the Metropolitan Washington Air Quality Committee (MWAQC) to Implement Emission Reduction Programs to Continue the Downward Trend in Emissions

MDE/ARA will continue to work with Virginia, Washington, D.C., and MWAQC to reduce emissions in the Washington, D.C. ozone nonattainment area. Pollutants that contribute to ozone formation are also components of $PM_{2.5}$. The Washington, D.C. ozone nonattainment area

includes five counties in both Maryland and Virginia, and Washington, D.C. When the wind is blowing from the southwest, data indicates a likely contribution coming from the Washington, D.C area into Cheverly.

The current emission reduction trend for this area is shown below in Figure 6. Nitrogen oxide (NO_x), volatile organic compound (VOC) and sulfur dioxide (SO_2) emissions are linked to ozone and $PM_{2.5}$ air pollution. SO_2 is the primary contributor to $PM_{2.5}$. NO_x is the primary contributor to ozone.

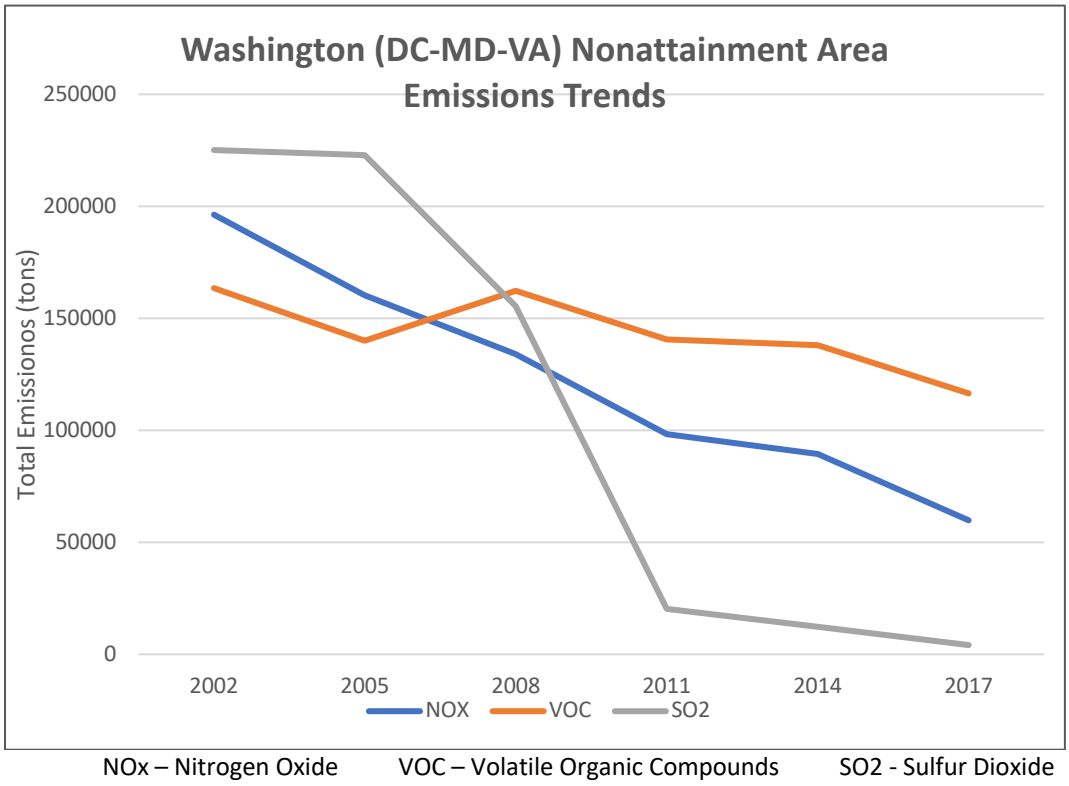

Figure 6: Air Pollution Emission Reduction Trends in the Washington, D.C. Area

vi. Increased Efforts with CEEJH, Other Researchers, Interested Parties and EPA to Improve Techniques and Tools for Evaluating Potentially Inequitable Exposure to Air Pollution

MDE/ARA will continue to work with other partners to conduct research and to utilize new techniques and tools to analyze potentially higher exposures to air pollution in areas that have environmental justice concerns. The June/July initiative focused primarily on fine particle air pollution and highlighted the need to also focus on other pollutants and issues that may be linked more directly to local sources and transportation related emissions.

MDE/ARA has already begun to investigate tools and techniques to potentially analyze regional and community-based exposure issues associated with diesel exhaust and exposure to multiple air pollutants.

vii. Identification of Other Potential Partnership Opportunities

MDE/ARA will also discuss additional partnership opportunities with the mayor of Cheverly and other community leaders, partnerships that have been successfully implemented in communities similar to Cheverly.

a) Diesel Emissions Reductions

The first partnership opportunity involves working closely with the Cheverly community leaders to find funding to implement diesel emission reduction programs in and around Cheverly. MDE/ARA has been working with the Port of Baltimore and several communities around the Port to find funding to implement programs to reduce diesel emissions. Since its inception, $15 million has been provided for diesel clean-up projects linked to the Port of Baltimore. By 2030, an additional $15 million is expected to be provided to further the effort to reduce diesel emission and improve air quality and public health in communities neighboring the Port. There appear to be similar opportunities in the Cheverly area that MDE/ARA would like to explore with community leaders.

b) Idle-Free Maryland

The second partnership opportunity comes from the "Idle Free Maryland" Program. This program is described at: https://mde.maryland.gov/programs/Air/MobileSources/idlefreeMD/Pages/index.aspx. The partnership would involve MDE/ARA working with local schools to develop and implement an idle reduction program involving both school buses and vehicles idling in pick-up lines. An idle reduction education effort is also routinely included as part of these programs. This kind of effort is already being implemented at approximately 65 schools and six green centers across the State. An anti-idling program may be included as part of a school's green culture description when applying for green school status under the "Maryland Green Schools" program coordinated by the Maryland Association for Environmental and Outdoor Education (MAEOE), https://maeoe.org/green-schools-and-green-centers/green-schools-program

c) Community Leaders & Local Businesses

A third partnership involves the opportunity to build a relationship between the community leaders and local businesses. There are examples of successful community/business partnerships across the state. They take varying forms, but the common thread among them is regular meetings between the parties. The meetings allow community concerns to be shared with the business community and provide the business community the opportunity to communicate their plans with community leaders. MDE is often invited to these meetings when regulatory related issues arise. To bring about such a relationship, MDE could help facilitate a meeting with local businesses,

starting with those regulated by MDE and expanding from there, with the focus being on businesses that have operations with higher emissions.

d) Transportation Infrastructure Planning

A fourth partnership opportunity involves transportation planning. MDE would be happy to set up a meeting with the Town of Cheverly, MDOT and Prince George's County to discuss transportation projects that are important to the Town and the air quality impacts from regional transportation plans and projects. The meeting could also begin to define how to best work as a team to have Cheverly specific projects considered as part of the regional transportation planning process.

In the greater Washington, D.C. area, the National Capital Region Transportation Planning Board (TPB) coordinates the development of the regional long-range transportation plan (LRTP), which includes an air quality analysis to ensure that transportation projects are consistent with state implementation plans (SIPs) for reducing air pollutants. On at least a bi-annual basis, the TPB, including representatives from local governments such as Prince George's County, updates the Transportation Improvement Program (TIP), which sets a schedule for obligating federal funds to local and state transportation projects. These transportation plans and projects can affect air quality in the greater Washington, D.C. area, including in Prince George's County and Cheverly.

Some examples of regional TIP projects are found here: https://www.mwcog.org/about-us/newsroom/2012/06/26/transportation-improvement-program-lays-out-six-year-16-billion-spending-plan-for-region-public-comment-funding-tip/. For more information on the TPB and the National Capital Region's transportation planning process, please see https://www.mwcog.org/tpb/, https://mdot.maryland.gov/tso/Pages/Index.aspx?PageId=27, and https://www.mwcog.org/transportation/about-tpb/getting-involved/.

Section 6. Conclusion

The targeted inspection initiative conducted by MDE showed overall compliance with air quality laws and regulations in the Cheverly area. Twenty-one facilities were identified as sources to inspect in the Cheverly area with eighteen in compliance at each observation/inspection conducted. Three facilities were issued Notices of Violation (NOVs) on July 15, 2021, for uncontrolled dust (primarily PM_{10}, not $PM_{2.5}$). These three sites are located outside of Cheverly, in the direction of Sheriff Road. Follow-up inspections of these sites after issuance of the NOVs determined that they had improved their dust control procedures with notable improvements in dust levels.

An important component of MDE's work on the Cheverly Partnership Project was to evaluate the potential correlation between high levels of measured $PM_{2.5}$ and traffic conditions. This

evaluation was conducted during the same period that MDE implemented the targeted inspection initiative in June through July of 2021. In order to determine how traffic could be impacting air sensor measurements in the Cheverly area, MDE examined how traffic correlated with $PM_{2.5}$ readings and vice-versa.

The analysis of $PM_{2.5}$ levels in the Cheverly area for the June/July Initiative focused on just two months and was therefore a limited study. MDE often uses annual data or multi-year data to do air quality analyses. That said, the analyses that were conducted provided quite a few important and interesting findings. MDE plans to continue to refine and strengthen the analyses presented in this document. An overall finding based on traffic data analysis and evaluation of sensor data, was that wind direction in combination with emission sources in the greater Washington, D.C. area seemed to have a greater impact on the PA sensors' $PM_{2.5}$ levels than nearby, Cheverly area traffic. A slightly higher $PM_{2.5}$ trend appeared in the Cheverly PA data during periods with winds from the west-southwest direction. This trend is potentially linked to $PM_{2.5}$ from the Washington, D.C. area and cars and trucks travelling on roadways in the upwind vicinity of Cheverly, which is adding to emissions from local industrial sources.

MDE/ARA will continue to work with other partners to conduct research and to utilize new techniques and tools to analyze potentially higher exposures to air pollution in areas that have environmental justice concerns. The June/July initiative focused primarily on fine particle air pollution and highlighted the need to also focus on other pollutants and issues that may be linked more directly to local sources and transportation-related emissions.

Appendix 1
Cheverly Area Survey

On 6/30, from 7am through 10:30am, MDE Mobile Sources Control Program (Mobile) staff drove around the Cheverly area to get a feel for the area. They took note of the number of traffic lanes, types of businesses, and various other aspects that may affect the PurpleAir, Inc. (PA) data. This report summarizes their findings.

Below is a map, breaking the area up into 7 different sections that seemed to have differing characteristics from the areas around it. For ease of understanding, each section will be described separately.

Figure 1: Cheverly, Maryland and Vicinity
(adapted from https://www.google.com/maps)

Section 1: Columbia Park Road

- Columbia Park road has 4 lanes, with significant traffic

- This area is industrial/heavy commercial, with many heavy duty vehicles on the main road, or idling on side roads: tractor-trailers, box trucks, dump trucks, cement trucks.
    - Many loading depots
    - Generally smelly, an industrial smelling in the area
- Active construction is underway on a large commercial building on Columbia Park Rd
- Metro station seems low-volume, with a small parking lot with 4 bus stops

Section 2: Joseph Smith & Sons (JS&S) + Surrounding Area

- All roads were 2 lane, some wide, some narrow. Some were size-restricted roads, but many trucks were using them due to traffic into JS&S
- This area has low density, low property value residential in the west next to industrial/heavy commercial in the east.
- Dirt/Gravel Facility to the north, and also one next to Joseph Smith & Sons
- Joseph Smith and Sons is the largest industrial activity, but not the only business.
- Many idling trucks were waiting to get into the scrap yard, and many trucks were driving about the area.
- Many trucks were loading gravel/dirt in the area, large mounds of dirt/gravel, dirt on the road with a street sweeper and heavy duty vehicles kicking up a lot of it
    - Whole eastern half of the area has a hazy look to it

Section 3: Tuxedo Industrial Area

- 2-lane road is the main southern-end thoroughfare, with a 4-lane road on the west side.
- Plenty of heavy duty vehicles
- Mostly vehicle repair facilities, bus repair facilities/heavy duty truck repair.
- The “Greyhound Bus Stop” on Google maps is actually “Greyhound Maintenance Garage”
- Active road construction, generating dust along the southern end of this area, multiple heavy duty trucks idling waiting to get past

Section 4: Cheverly Ave/Cheverly Proper

- Purely middle-class residential area, with community center/pools/churches being the closest thing to commercial activity. Otherwise, it’s only houses.
- Many trees, greenery, folks walking outdoors.
- Cheverly Ave has 1 lane in each direction with a yellow dividing line, smaller sub-roads off of Cheverly Ave have no lane markers
- Very few heavy duty vehicles, limited only to buses and garbage trucks.
- Some road construction underway on a couple side roads

Section 5: Kenilworth Ave

- Kenilworth Avenue is a 4- to 6-lane road with industrial & commercial businesses
- Less industrial than Sections 2&3, but not purely commercial
- Industrial transitions to lighter commercial as approaching Bladensburg

Section 6: Route 202, North of Cheverly Ave

- 4-lane road
- Businesses are only shops/restaurants, no industrial activity. Less heavy duty traffic than sections 1, 2, 3, and 5.
- Higher density residential, apartments, condos, etc.

Section 7: Landover

- Light commercial, 4 lane roads becoming 6 lane roads
    - Aldi, Walgreens, similar commercial activity in the area
- In addition to apartments, small low-density residential (i.e., small houses)

Final Impressions:

Heaviest industrial areas are in sections 1 & 2, with section 3 in close second, and section 5 coming in last, but still quite industrial. All industrial areas have plenty of heavy-duty traffic, with sections 1 & 2 having a lot of heavy-duty vehicles idling or driving around on side roads/smaller roads. Active construction and plenty of gravel/dirt moving has put a lot of dust in the air; this is noticeable when driving through those areas.

Cheverly proper is suburban with only houses and plenty of greenery, surrounded on the west and south by industrial/heavy commercial, and on the north by light commercial & higher density housing.

Photos:

Active Construction in Section 1

Active Construction In Section 1

One of two entrances to Joseph Smith & Sons (Section 2)

Gravel/Dirt Facility in Section 2

Scrap Pile in Section 2

Cheverly Avenue (Section 4)

Typical side-road off Cheverly Ave. (Section 4)

Google Streetview images for further reference:

Kenilworth Ave, mix of Commercial & Industrial (Section 5)

MD-202, mostly commercial. 6 Lane Road. Aldi, Walgreens on left, apartments on right

Appendix 2

Cheverly Traffic Report

7/12/2021 – 7/18/2021

Traffic Spikes & Maps

- Monday 7/12 morning rush hour between 6:45 am & 8:45 am, peaking around 8:00 am.
  - Heavy congestion all along the Route 295 southbound stretch bordering Cheverly.
  - Heavy traffic all along southbound Rt 50 bordering Cheverly.
  - Heavy congestion on Kenilworth Ave near the Rt 50 & 295 interchange**.**
  - Wind was southwesterly, 255 degrees

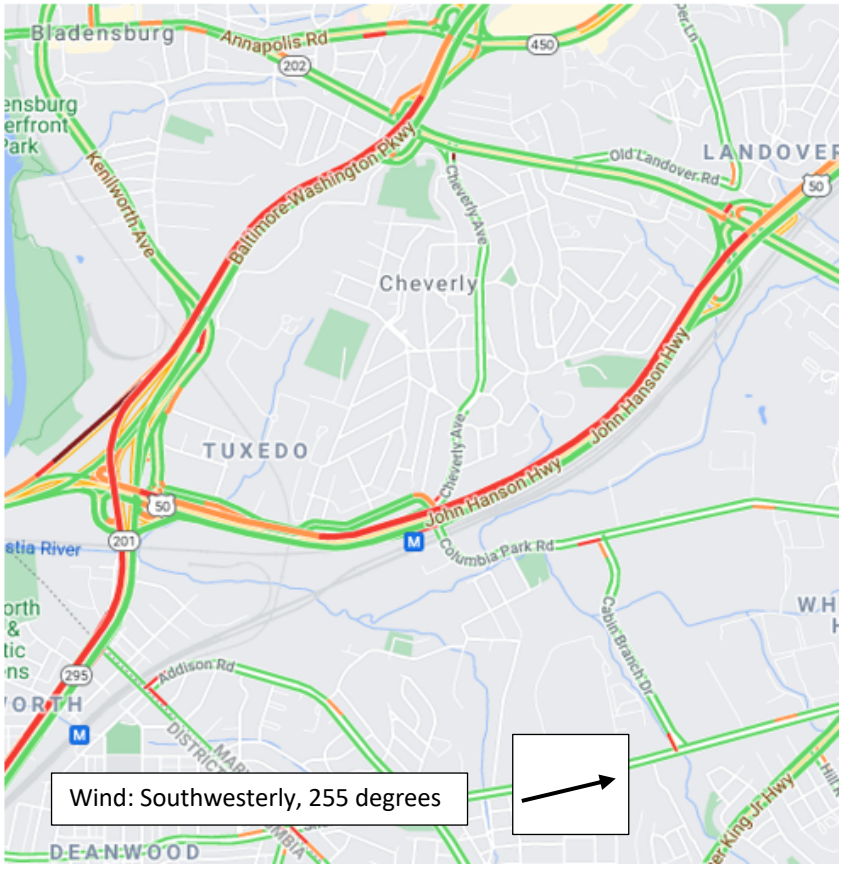

Figure 1: Cheverly Traffic Map – 7/16/2021 5:15 pm

Traffic Spikes & Maps (continued)

- Tuesday 7/13 rush hour between 7:00 am & 9:00 am, peaking around 7:45 am.
    - Heavy traffic all along the 295 southbound lanes through Cheverly.
    - Heavy traffic along southbound Route 50 bordering Cheverly.
    - Traffic congestion on Kenilworth Ave near the Rt. 50 & 295 interchange.
    - Wind was southwesterly, 265 degrees.

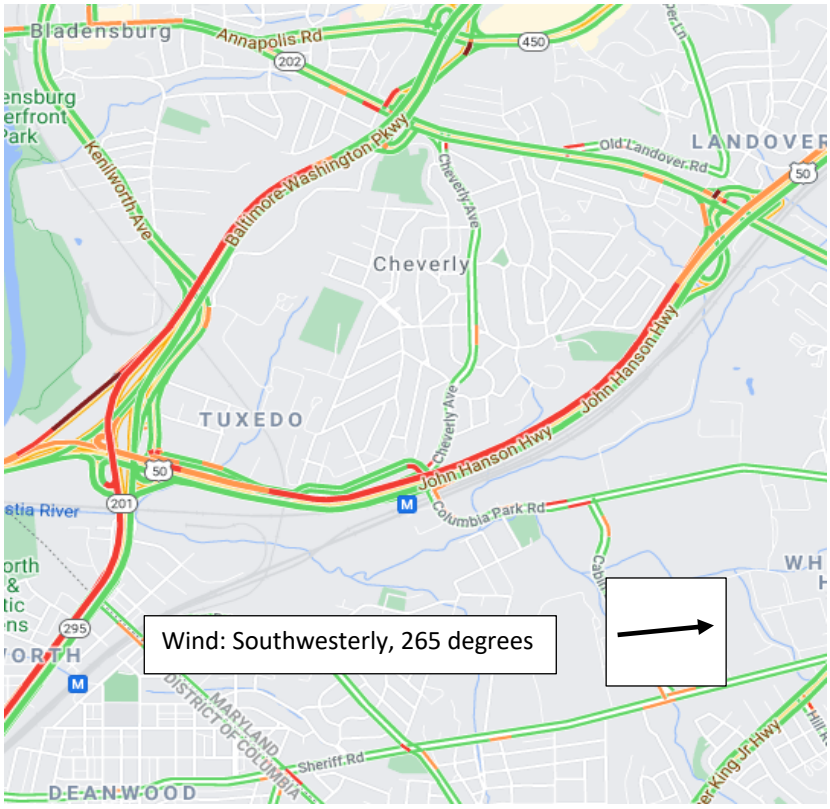

Figure 2: Cheverly Traffic Map – 7/13/2021 7:45am

Traffic Spikes & Maps (continued)

- Friday 7/16 afternoon traffic between 1:30 pm & 6:00 pm, peaking around 5:15 pm.
    - Heavy congestion along the southwestern portion of 295 with several accidents at the 295 & Rt 50 interchange around 3:00 pm.
    - Also, heavy traffic all along Rt 50 bordering Cheverly.
    - Traffic congestion on Kenilworth Ave near the Rt. 50 & 295 interchange.
    - Wind was southwesterly, 255 degrees.

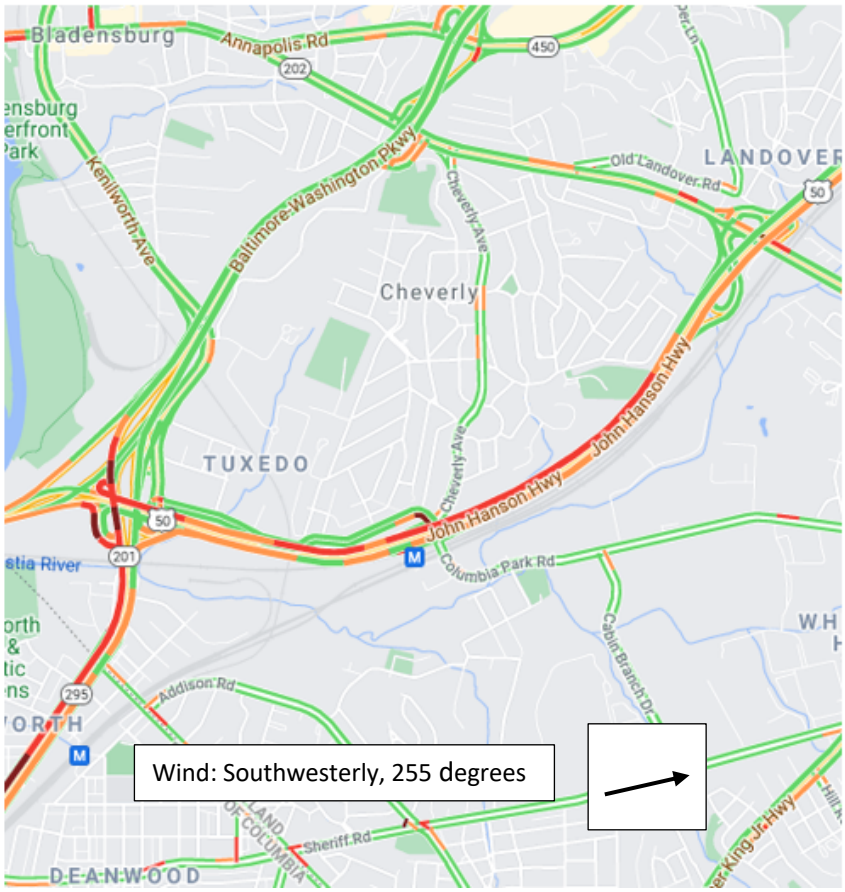

Figure 3: Cheverly Traffic Map – 7/16/2021 5:15 pm

Correlation with Purple Air Data

Main Traffic Spikes

- 7/12 Morning Rush Hour
    - All monitors indicate a rise in particulate starting around 7:00 am and peaking around 11:00 am.
    - Wind was southwesterly, so heavy traffic southwest of Cheverly could correlate with the particulate spike on this morning.

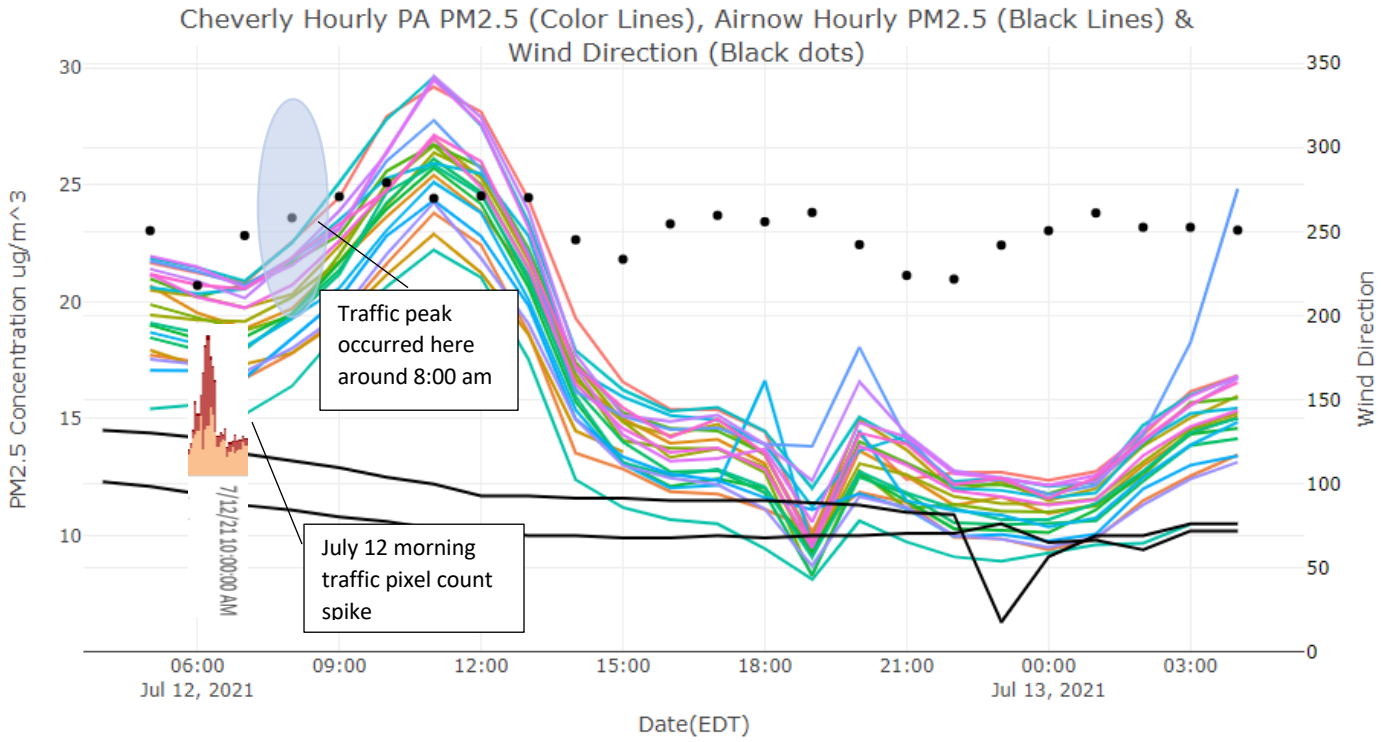

Figure 4: Cheverly Hourly PM2.5 Data – 7/12/21

Correlation with Purple Air Data (continued)

- 7/13 Morning Rush Hour
  - Monitors started to rise around 1:00 am and continued to rise and then peaked between 8 & 9 am.
  - All monitors started to drop around 11:00 am
  - Wind was coming from the west & southwest during this time, so some correlation with the heavy traffic volume is evident even though monitors were rising before the morning rush hour.

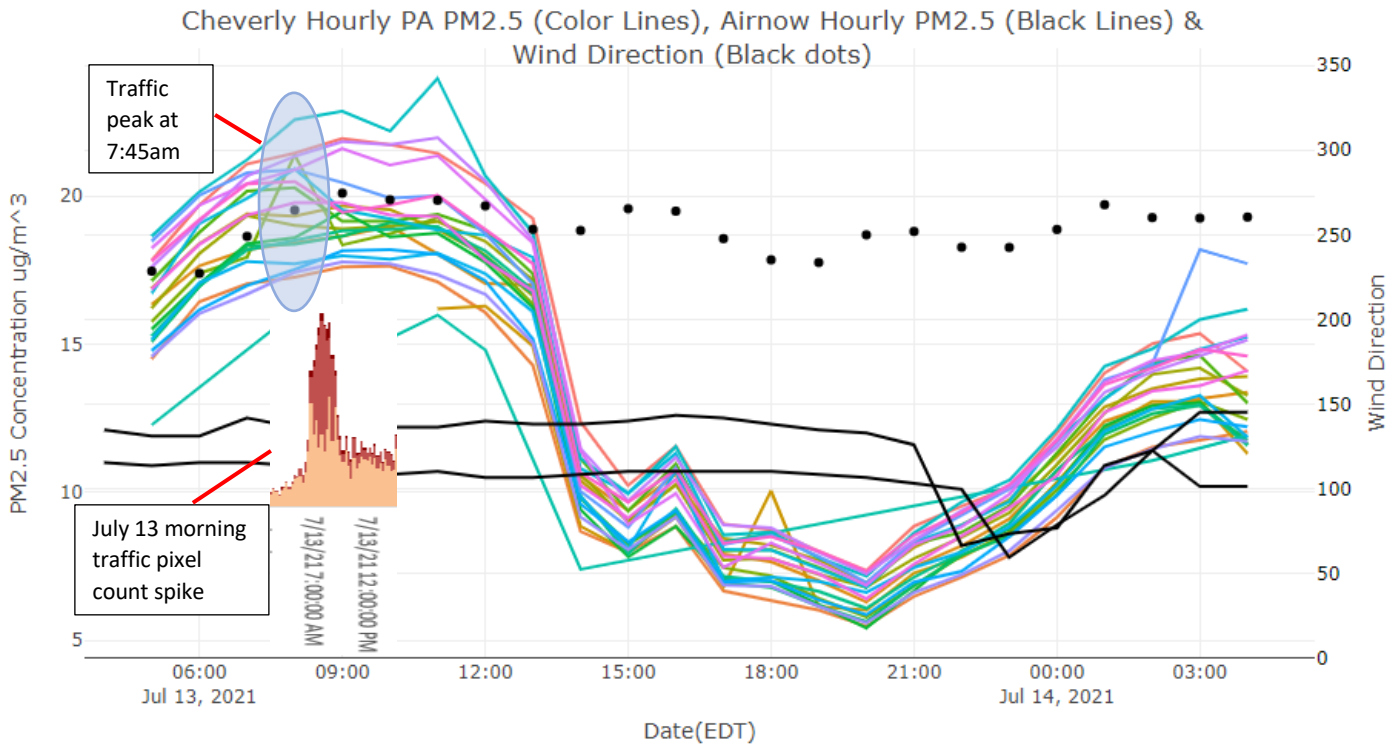

Figure 5: Cheverly Hourly PM2.5 Data – 7/13/21

Correlation with Purple Air Data (continued)

- 7/16 Afternoon Traffic
  - Monitors indicate PM2.5 was slowly & steadily increasing throughout the afternoon with slight peaks at 4 & 7 pm.
  - Wind from the west & southwest and the heavy traffic south & west of Cheverly could have contributed to the slow, steady rise.

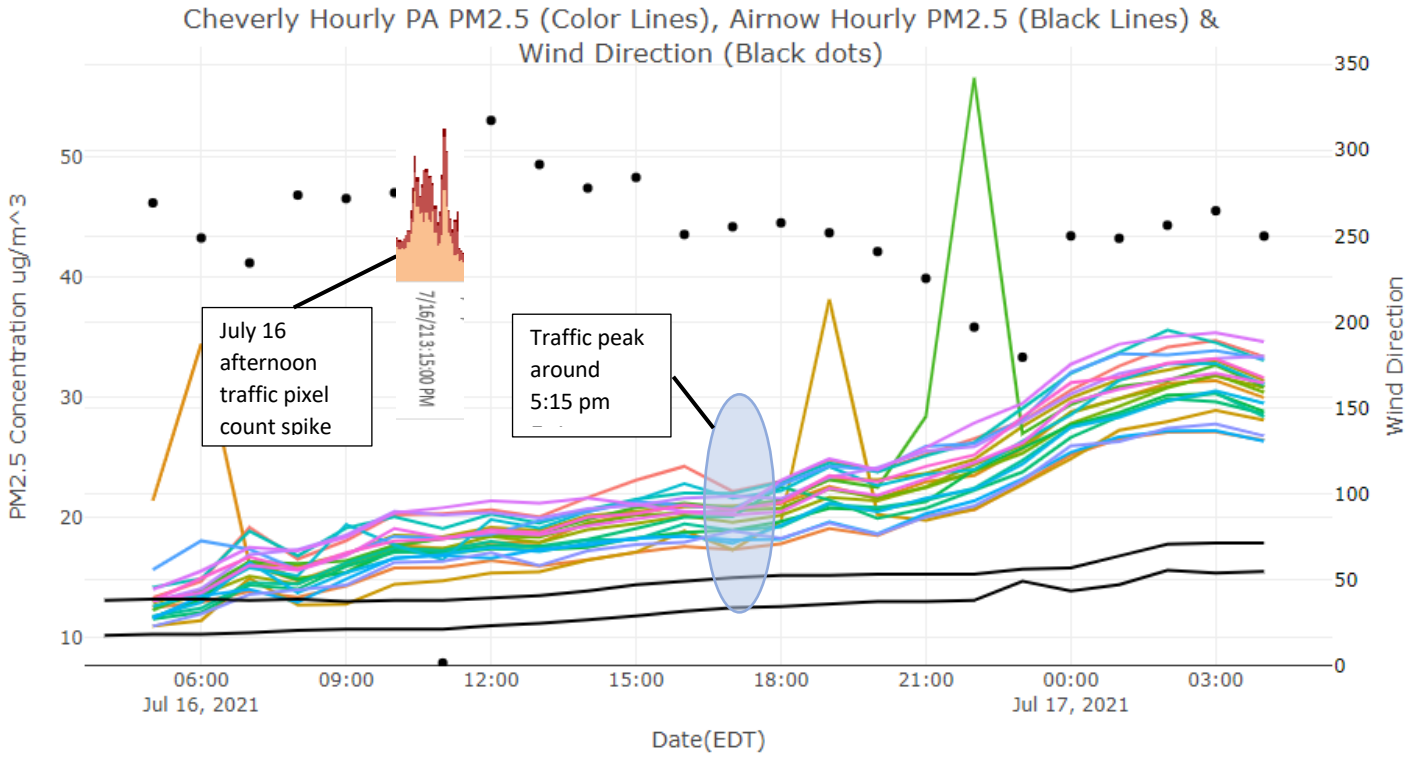

Figure 6: Cheverly Hourly PM2.5 Data – 7/16/21

Notable Pollution Spikes

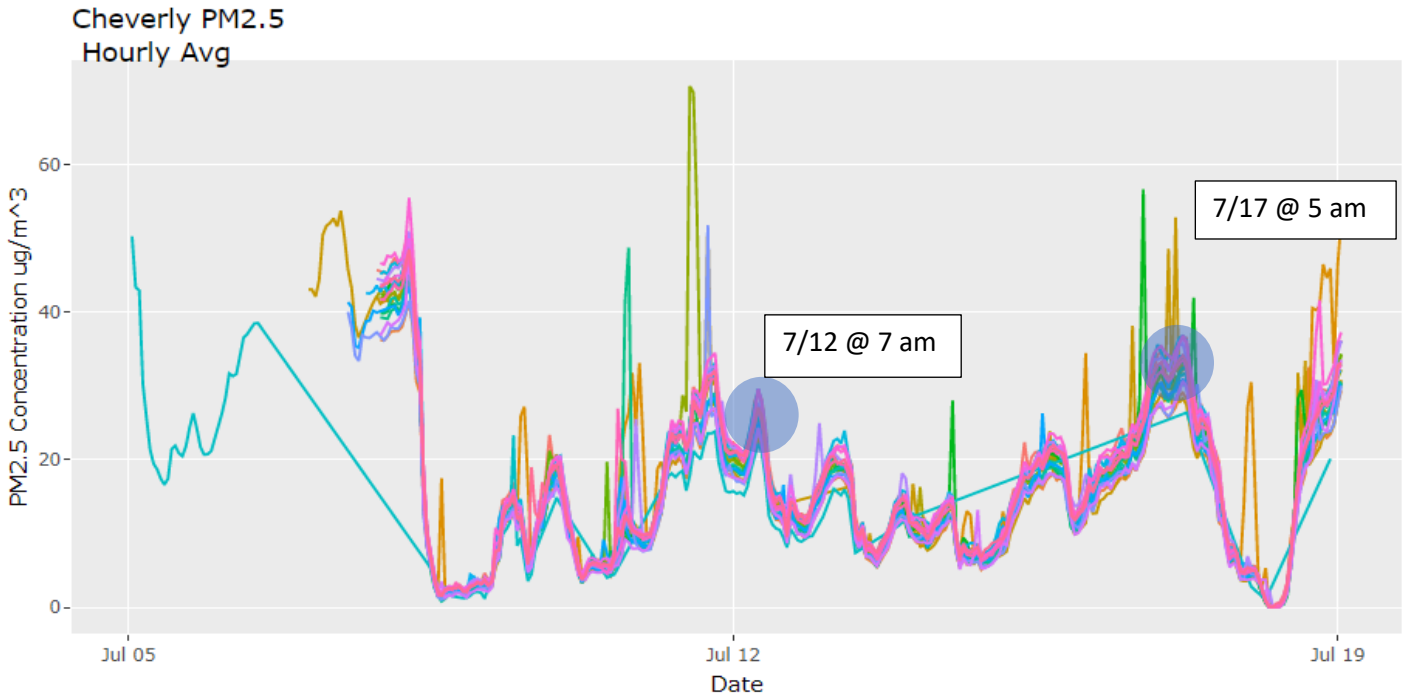

Figure 7: Hourly PM2.5 Data – 7/5 through 7/19

1. 7/12 at 7 am there was a spike in all monitor readings with a relative high for the week. Wind at the time was southwesterly around 260 degrees. Traffic was heavy on most of Rt. 50 bordering Cheverly and on other roads southwest of Cheverly near the interchange. This traffic could have contributed to the spike in monitor readings.

Notable Pollution Spikes (continued)

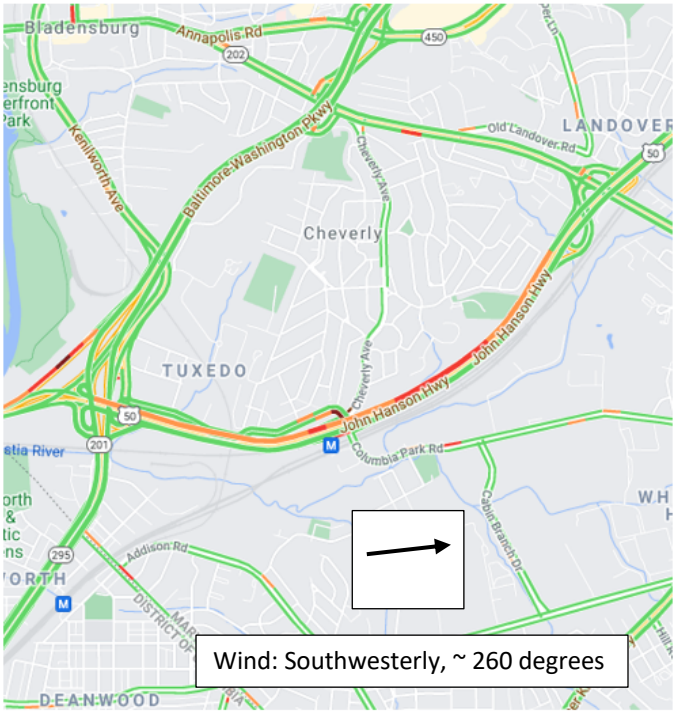

Figure 8: Cheverly Traffic Map – 7/12/2021 7:00 am

2. 7/17 at 5 am monitors recorded high readings for the week. Wind was southwesterly around 250 degrees. Traffic was light to moderate in the area and was not congested southwest of Cheverly. Traffic on the main roads does not appear to have contributed to this PM2.5 spike indicated by the sensors.

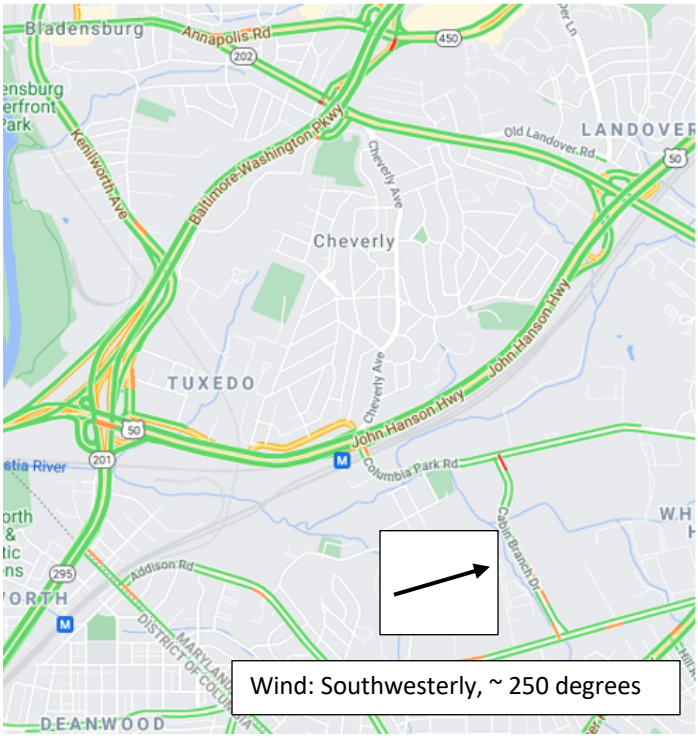

Figure 9: Cheverly Traffic Map – 7/17/2021 5:00 am

Spikes on Pollution Map

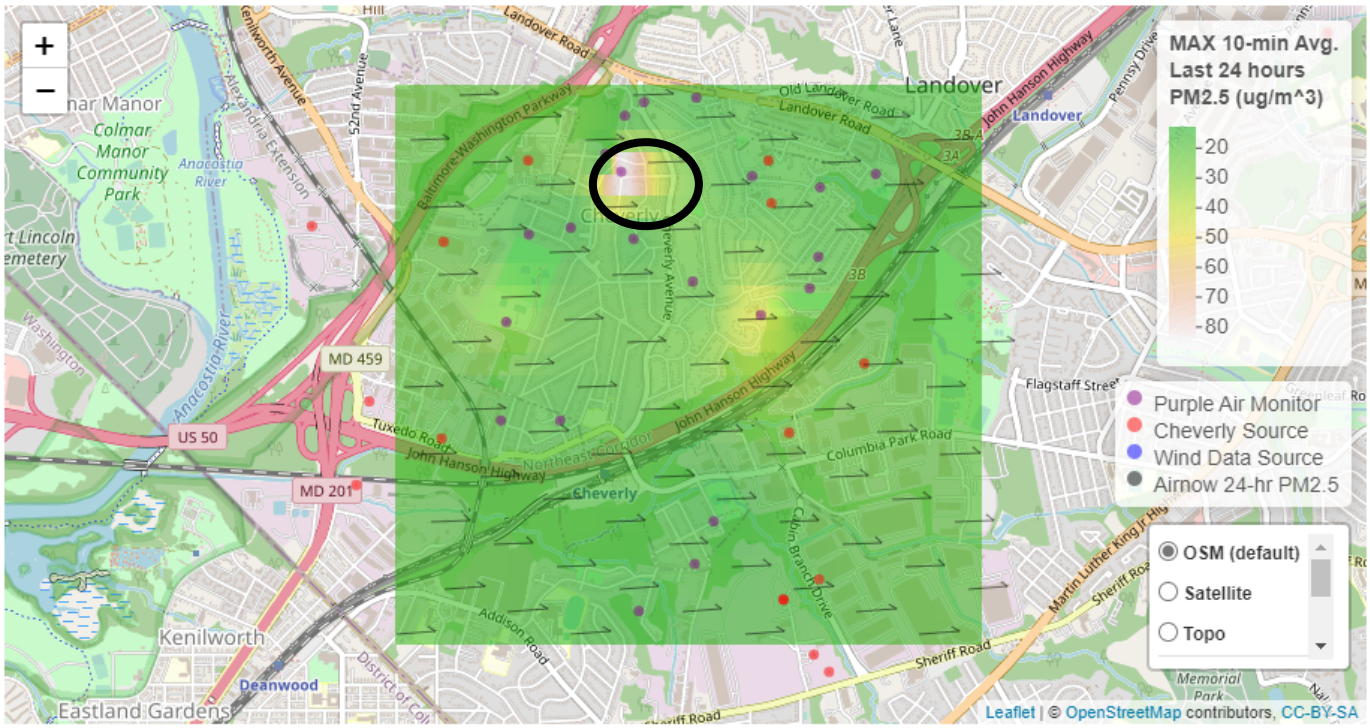

Figure 10: 7/14 10-minute max, AQM_W1_3 had a relative max

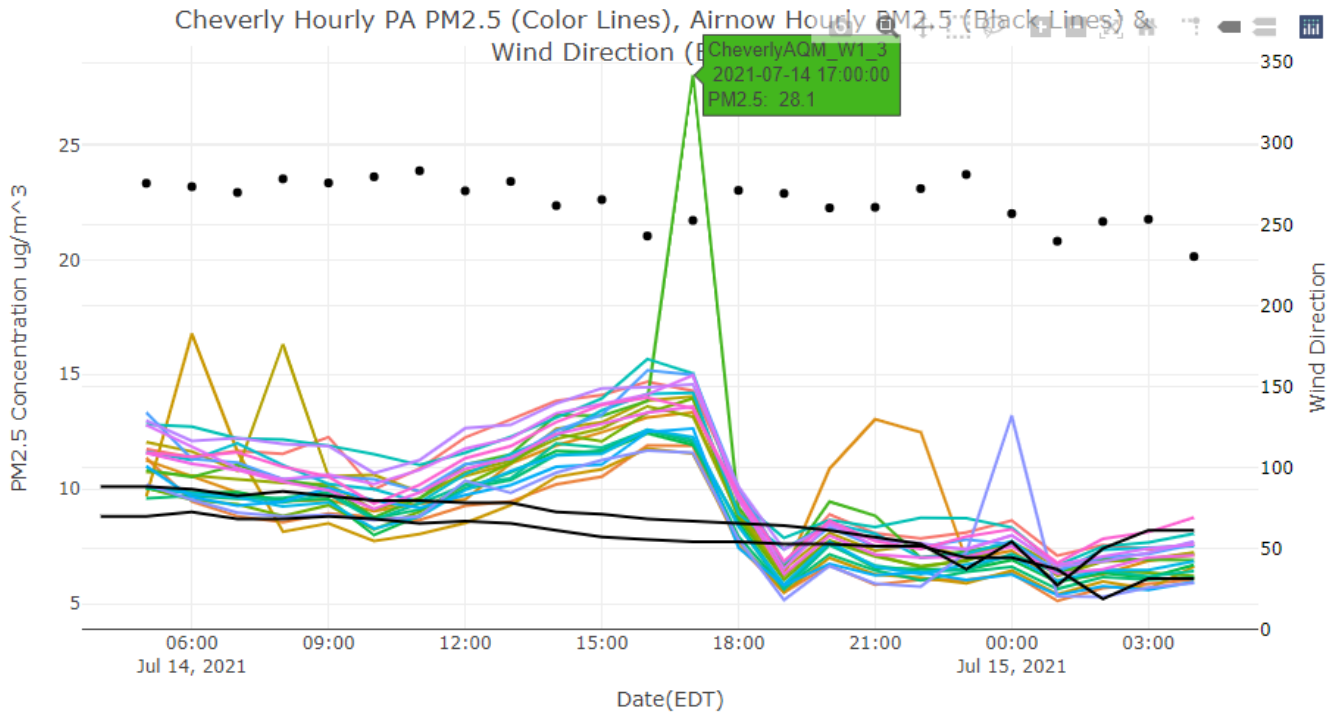

Figure 11: 7/14 Hourly Data, W1_3 peak

- There was no notable traffic congestion causing the AQM_W1_3 monitor to spike at 5 pm on 7/14.

Spikes on Pollution Map (continued)

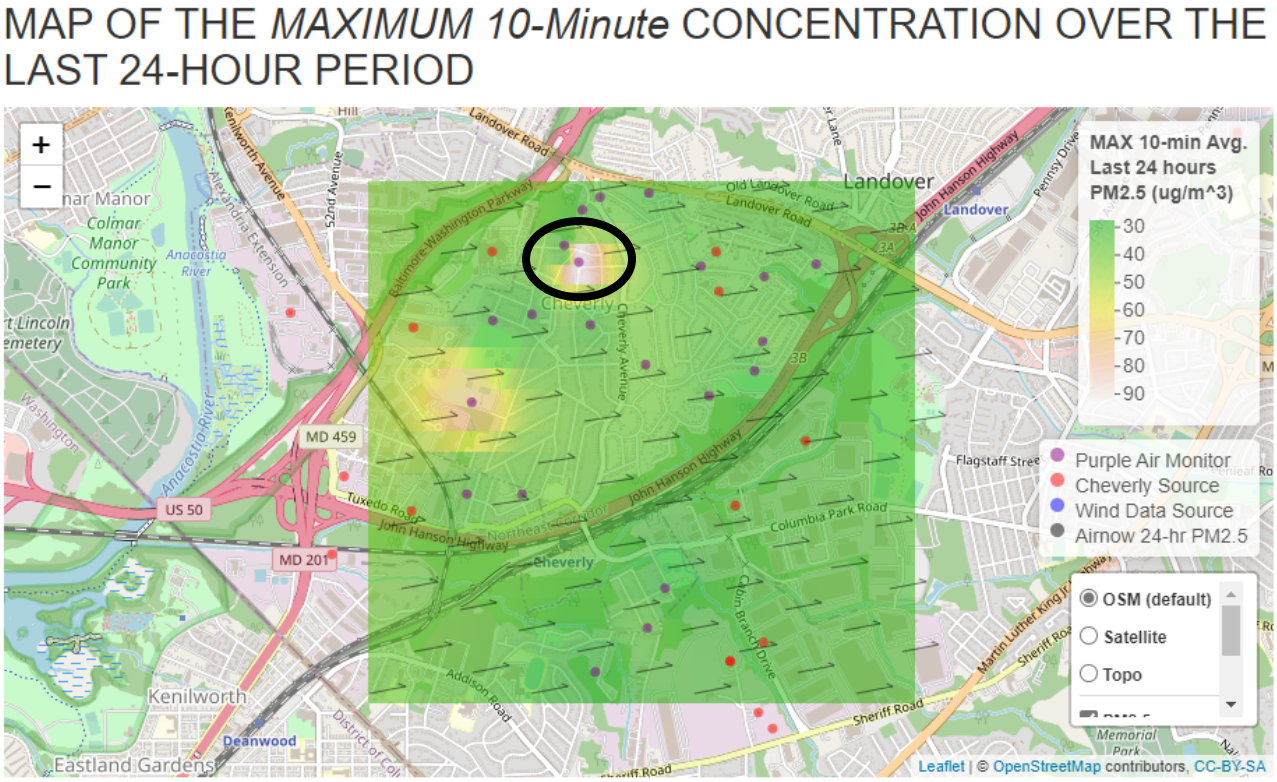

Figure 12: 7/16 10-minute max, AQM_W1_3 had a relative max

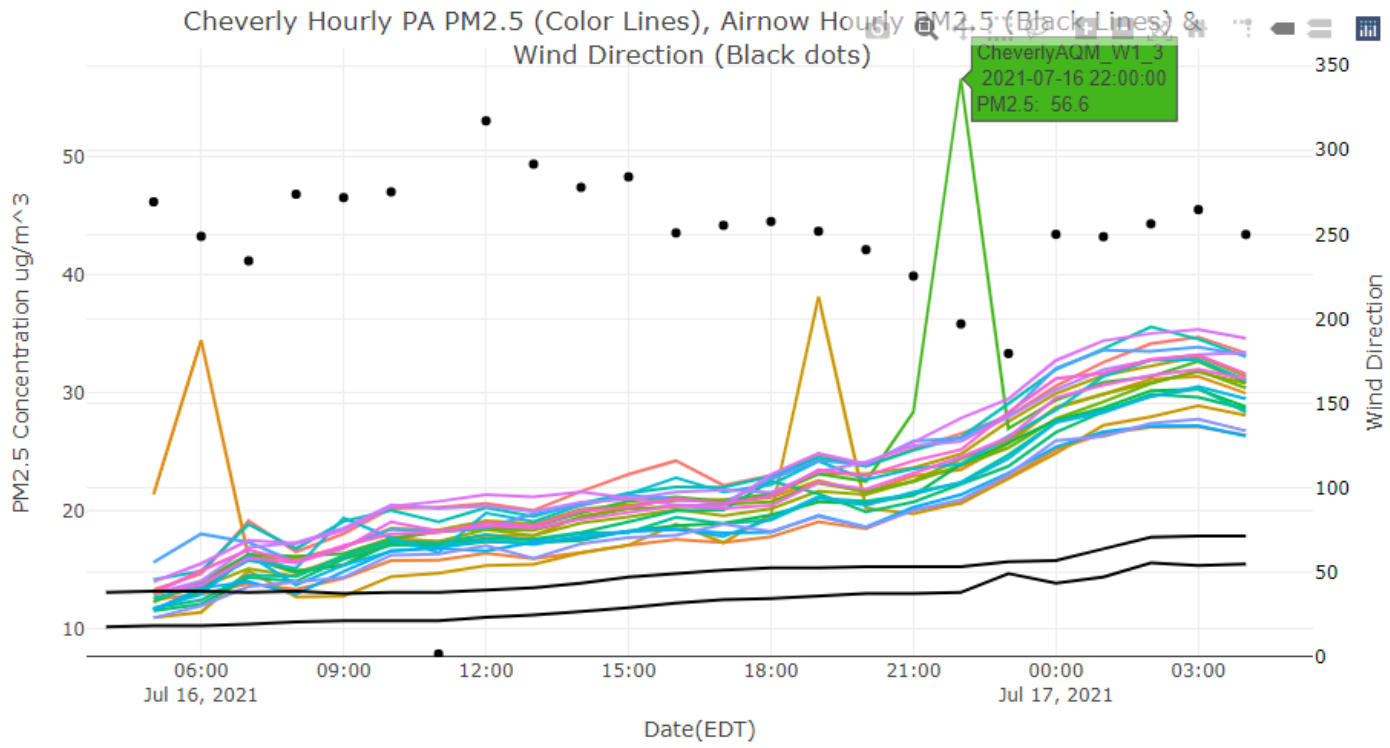

Figure 13: 7/16 Hourly Data, W1_3 peak

- There was no notable traffic congestion causing the AQM_W1_3 monitor to spike at 10 pm on 7/16.

Spikes on Pollution Map (continued)

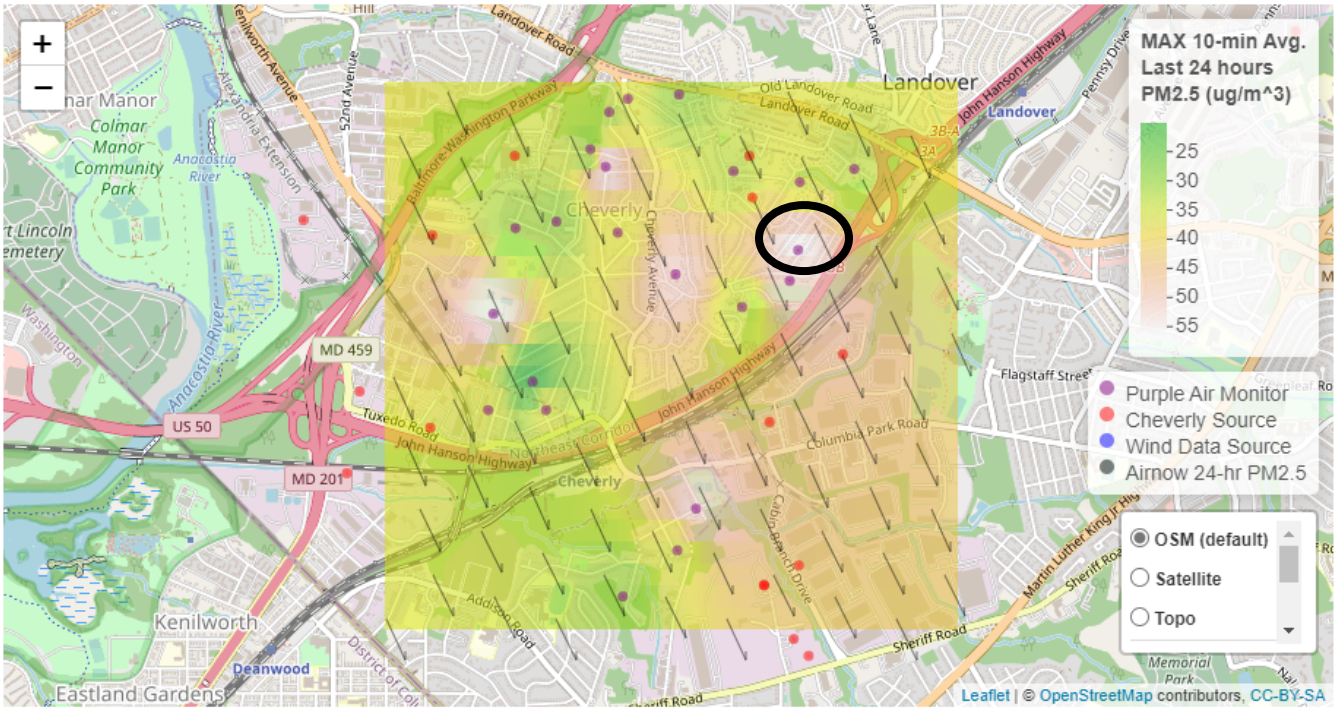

Figure 14: 7/18 10-minute max, AQM_W6_2 had a relative max

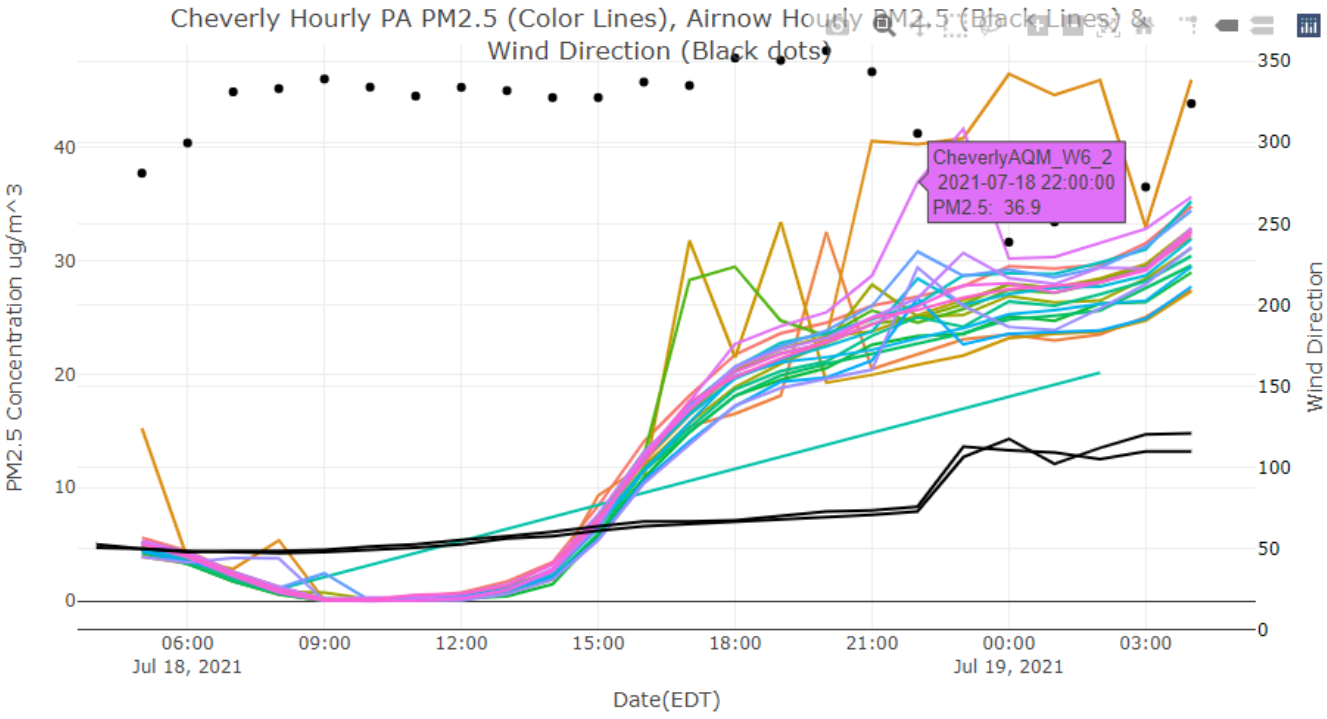

Figure 15: 7/18 Hourly Data, W6_2 peak

- There was no notable traffic congestion causing the AQM_W6_2 monitor to spike at 9 pm on 7/16.
  - Winds were from the northwest at the time of the spike and there is a source directly northwest of this monitor.

Appendix A: Additional Charts

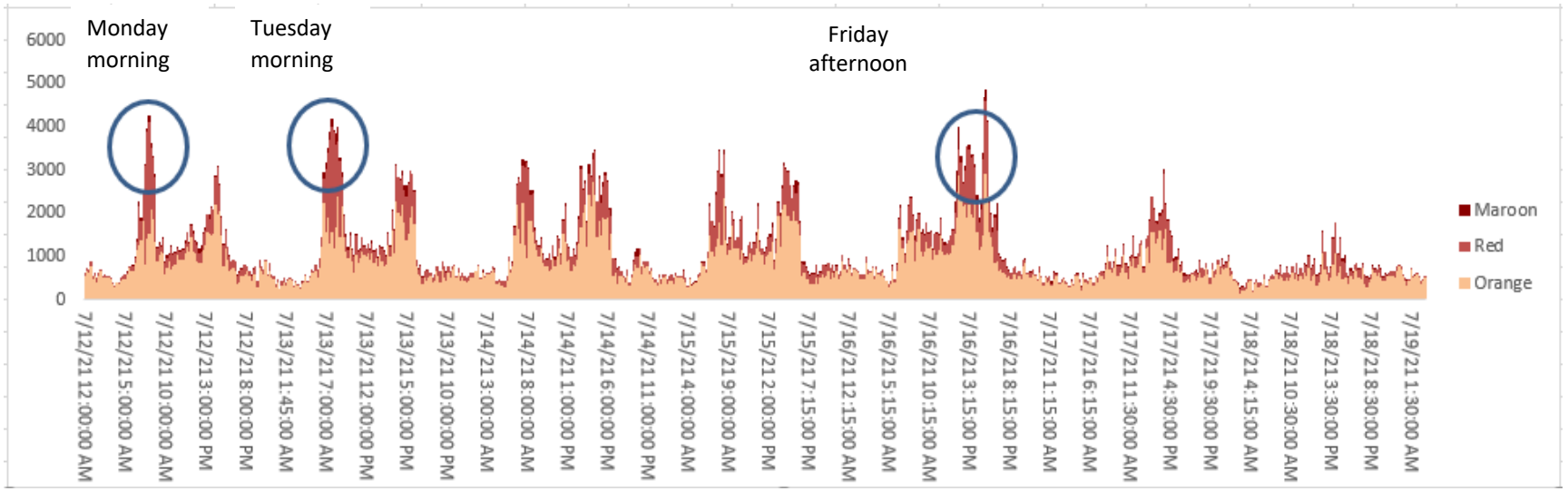

Figure A1: Non-Green Traffic Pixel Counts by Date – 7/12 through 7/18

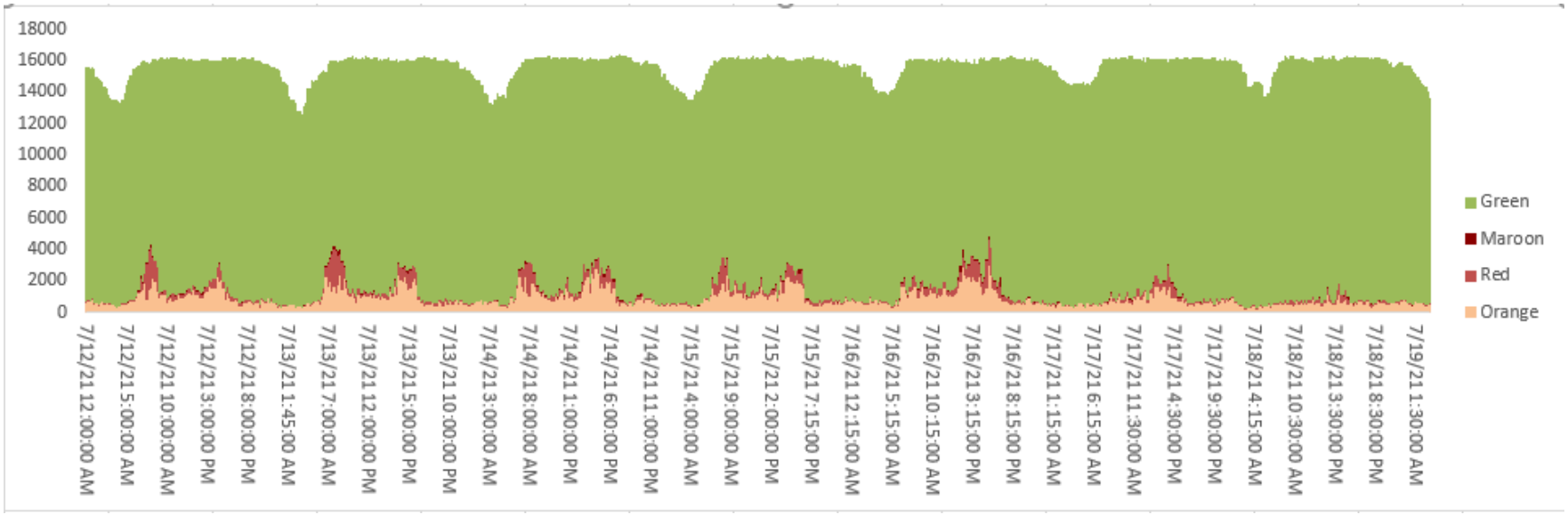

Figure A2: All-Color Traffic Pixel Counts by Date

Appendix 3: Air Quality Analysis via PurpleAir Sensors & FEM Monitors

Fine particle matter ($PM_{2.5}$) refers to tiny particles or droplets in the air that are two and a half microns or less in width. $PM_{2.5}$ is a human health concern because these particles can get into the deep parts of the lungs. Advances in technology have revolutionized the ability to measure $PM_{2.5}$ at reasonable costs. PurpleAir Inc. has created a popular version of this "cheap" sensor technology. PurpleAir (PA) sensors are built around low cost laser particle counters which use light attenuation across a small chamber to estimate the ambient $PM_{2.5}$ concentrations and report concentrations in as little as two minute increments. Dust (PM_{10}), which is much larger in size than $PM_{2.5}$ is also estimated by the PA sensors, but was not analyzed here. Built-in Wi-Fi enables the direct and regular reporting of observations to the PA network servers and past data is available at all registered PA sites across the entire PA network.

There are 23 PA network sensor sites associated with "Cheverly" with 22 of these sensors registered with the Cheverly Green Plan (https://sites.google.com/site/cheverlygreenplan) in Cheverly, MD. The additional site was a legacy sensor reporting bad data and was not used. Data from the AeroQual "AQY 1" sited at the Town Hall (Table 1) was not available via the PA network. The light attenuation method employed by the PA sensors make measurements susceptible to a high bias in high relative humidity environments. As a result, artificially high $PM_{2.5}$ concentrations may occur during periods of high relative humidity. A relative humidity correction to the raw PA concentrations is recommended by the Environmental Protection Agency (EPA) (Barkjohn et al. 2020) and was employed here as the "corrected" dataset. This corrected dataset is limited to 18 of the 22 sensors reporting relative humidity. The application of the corrected data to median hourly concentrations of all Cheverly sensors is shown in Figure 1. The greatest impact of the correction occurs at high concentrations, which is predominantly reflective of the relative humidity influence on the PA sensors.

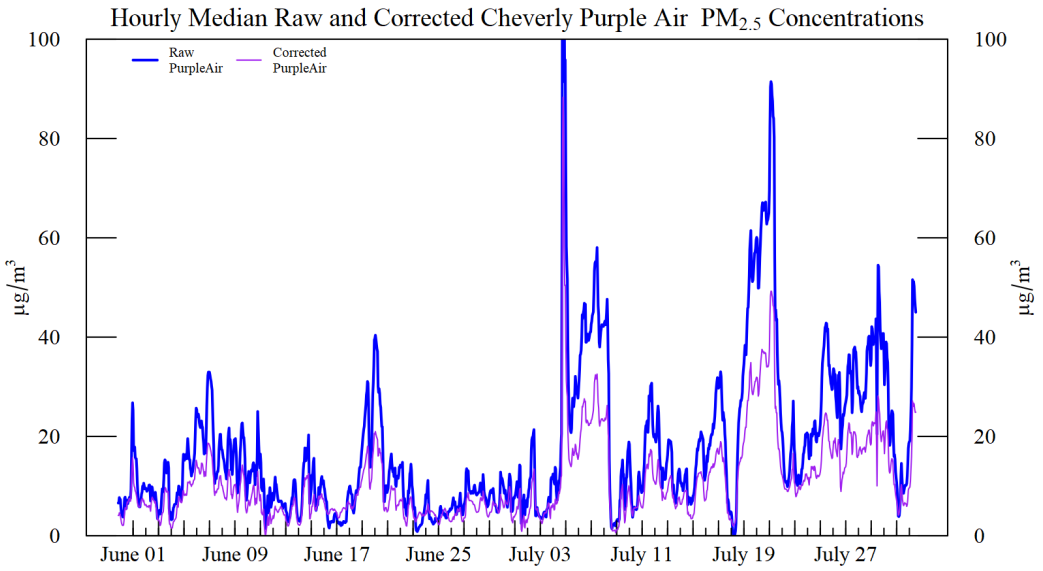

Figure 1. Application of the EPA relative humidity correction on median Cheverly Purple Air (PA) $PM_{2.5}$ concentrations. The purple line (EPA correction applied) reduces many of the highest concentrations while having a limited impact on low concentrations. This is a reflection of the impact periods of high relative humidity have on the PA output.

Beginning in late May 2021 two-minute resolution data from the 22 PA sensors were provided in operational reports to MDE compliance inspectors. In this end-of-project report, a retroactive review was performed. Hourly data were retrieved from the PA network for the period June 1 – July 31, 2021. Raw $PM_{2.5}$ data (Channel A) from the PA sensors was retrieved. No quality checks using Channel B were performed within this pilot study. Comparison hourly data from regional $PM_{2.5}$ federal equivalent monitors (FEM) run by state agencies were retrieved from EPA's AirNow from a bounding box area encompassed by 38.5°N, 77.8°W and 39.7°N, 75.7°W (Figure 2). The large box used for FEM monitor selection enabled an assessment of the Cheverly community relative to other areas and provided a larger sample of FEM data. FEM data used in this manner is considered preliminary until certified by the respective responsible agencies but is otherwise considered the benchmark standard for near real-time $PM_{2.5}$ measurements. Hourly wind measurements were retrieved from the Washington DC Near-road site (38.89°N,-76.95°W), located approximately two miles south of the southern boundary of Cheverly (Rt. 50), along DC Rt. 295.

Table 1. A list of all $PM_{2.5}$ sensors in the Cheverly, MD area as listed on the Cheverly Green Plan webpage (see text) as of August 31, 2021.

	Install Date	Place	Type	ID
1	July 17, 2020	Town Hall	PurpleAir	CheverlyAQM-TownH2
2	July 14, 2020	Town Hall	AeroQual AQY 1	
3	July 2, 2020	Cheverly Pool	PurpleAir	CheverlyAQM-Pool2
4	Sep 8, 2020	Ward 1 residence	PurpleAir	CheverlyAQM_W1_1
5	Dec 28, 2020	American Legion	PurpleAir	CheverlyAQM_AmLeg108
6	March 5, 2021	Ward 2 residence	PurpleAir	CheverlyAQM_W2_1
7	March 6, 2021	Ward 2 residence	PurpleAir	CheverlyAQM_W2_2
8	March 6, 2021	Ward 4 residence	PurpleAir	CheverlyAQM_BoydP2
9	March 6, 2021	Ward 1 residence	PurpleAir	CheverlyAQM_W1_2
10	March 6, 2021	Ward 4 residence	PurpleAir	CheverlyAQM_W4_1
11	March 13, 2021	Ward 4 residence	PurpleAir	CheverlyAQM_W4_2
12	March 13, 2021	Ward 4 residence	PurpleAir	CheverlyAQM_W4_3
13	March 13, 2021	Ward 1 residence	PurpleAir	CheverlyAQM_W1_3
14	March 20, 2021	CUMC STEM Program	PurpleAir	CheverlyAQM_CUMC_STEM
15	March 20, 2021	Ward 6 residence	PurpleAir	CheverlyAQM_W6_1
16	March 20, 2021	Ward 6 residence	PurpleAir	CheverlyAQM_W6_2
17	March 27, 2021	Ward 1 residence	PurpleAir	CheverlyAQM_W1_4
18	March 27, 2021	Ward 2 residence	PurpleAir	CheverlyAQM_W2_3
19	April 3, 2021	Ward 6 residence	PurpleAir	CheverlyAQM_W6_3
20	April 10, 2021	Ward 3 residence	PurpleAir	CheverlyAQM_W3_1
21	April 10, 2021	Ward 6 residence	PurpleAir	CheverlyAQM_W6_4
22	April 10, 2021	Ward 1 residence	PurpleAir	CheverlyAQM_W1_5
23	April 10, 2021	Ward 2 residence	PurpleAir	CheverlyAQM_W2_4

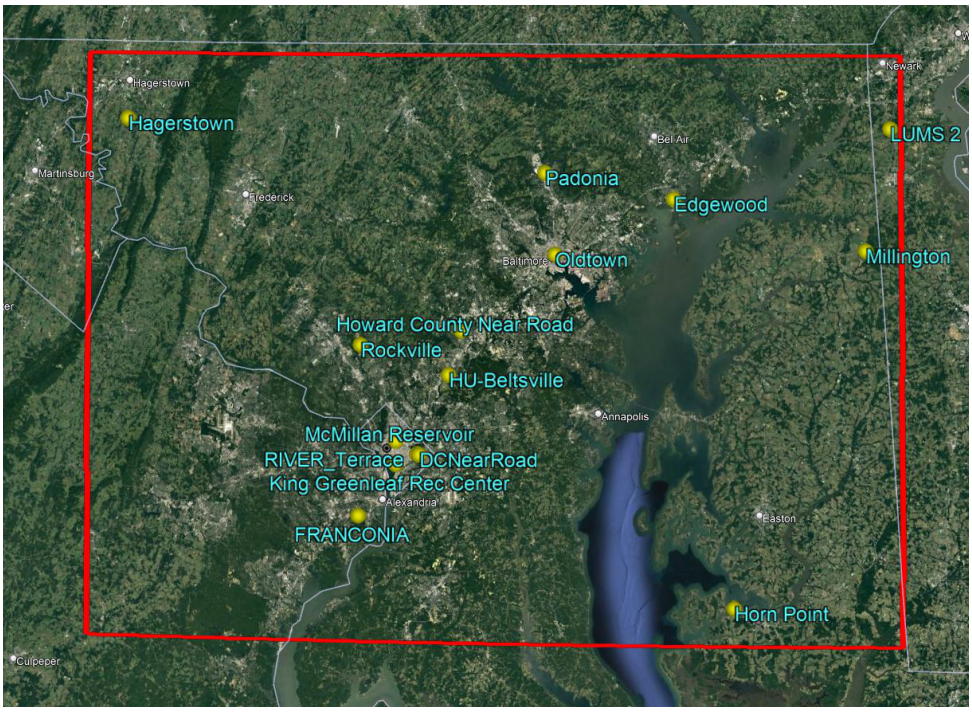

Figure 2. Domain bounded by 38.5°N, 77.8°W and 39.7°N, 75.7°W used to select FEM monitors. Monitors are yellow dots, with names matching those in the main document given in light blue.

$PM_{2.5}$ concentrations from the Cheverly PA sensors were compared to concentrations at FEM monitors. Use of the EPA correction on the PA sensors' values was employed for comparison to FEM monitors in the region and to understand the impact of humidity on the PA $PM_{2.5}$ measurements. Wind direction was used to assess any correlation with higher $PM_{2.5}$ concentrations (see Figure 3 for an explanation of wind direction measurements). While high resolution PA data of typically 10-minute average or less revealed transient spikes in PA $PM_{2.5}$ concentrations well above baseline, hourly data over the entire project period revealed a regional dominance of $PM_{2.5}$ concentrations overall. The Cheverly Project PA $PM_{2.5}$ concentrations were generally consistent with the regional $PM_{2.5}$ concentrations and were similar to other urban FEM monitors. Marginally higher $PM_{2.5}$ concentrations existed with winds from the southwest within the Cheverly PA network, perhaps indicating a sub-regional (e.g., Washington DC (DC)) influence.

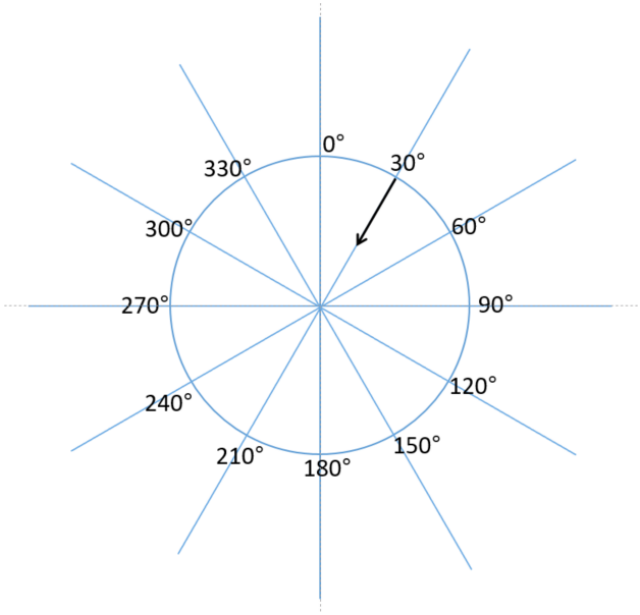

Figure 3. Wind direction is officially defined as where the wind is coming from compared to the compass rose and/or cardinal direction and compass degrees. In this fashion, wind coming from the north is defined as 0° or 360° and a wind from the south is 180°. The black arrow in the above figure illustrates a wind from 30°, or the north-northeast, phrased as a "north-northeast wind" in the vernacular.

Results

Hourly $PM_{2.5}$ concentrations from the PA sensors in Cheverly were compared to regional FEM $PM_{2.5}$ monitors. The maximum concentration among all 18 PA corrected $PM_{2.5}$ data and 15 FEM $PM_{2.5}$ monitors at each hour between May 31 and August 1, 2021 (the June – July, 2021 study period), were compared (Figure 4). Generally maximum $PM_{2.5}$ concentrations between the instrument groups were similar. A significant departure in the PA data was noted around June 17. This was due to a single sensor (CheverlyAQM_W1_3) reading high compared to surrounding sensors. The high readings were deemed poor data quality, a probable sensor issue, and unlikely represented reality. This circumstance highlights the susceptibility for degraded quality and interpretability of any single PA sensor. Additional steps for objective quality assurance and control for the PA sensors would be needed to discount data at an individual sensor during any data analysis campaign (project). Outside of this period (~June 17-20), the datasets were well correlated indicating non-local influences dominated the maximum $PM_{2.5}$ trends.

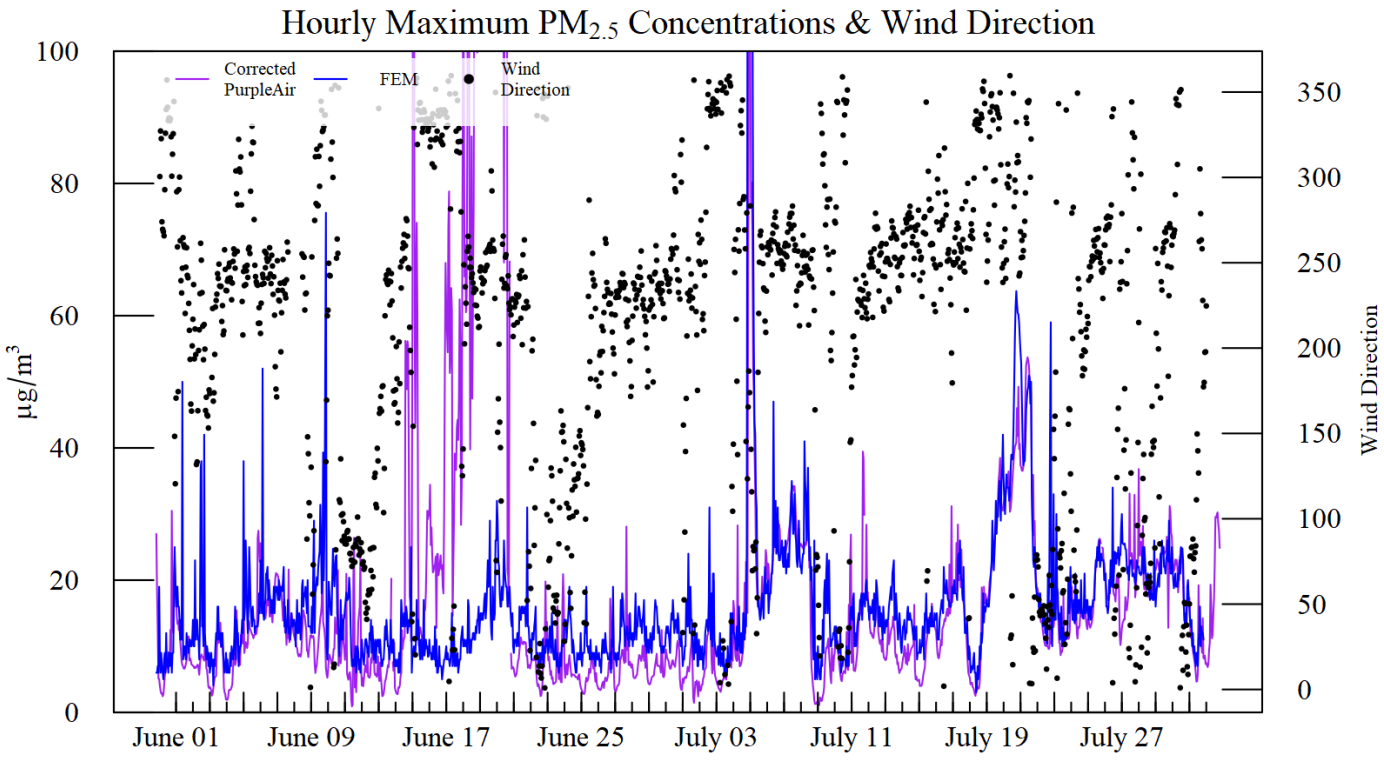

Figure 4. Maximum hourly $PM_{2.5}$ concentration among all Cheverly Maryland PurpleAir (PA) data with the EPA relative humidity correction applied (purple), and a comparison to maximum $PM_{2.5}$ concentration of 15 federal equivalent monitors (FEM; blue) found surrounding the Cheverly area. Wind direction (black dots) is also given. Hourly concentrations on July 4 exceeded 400 µg/m³ in the FEM monitors but were omitted for clarity of the lower values. A bad PA sensor accounts for the high readings from June 17-20.

The hourly group median among the PA sensors and FEM $PM_{2.5}$ monitors circumvented issues with large outliers due to bad data seen in the hourly maxima dataset and was a representative value for the community of monitors and sensors, capable of a non-skewed assessment of community-scale or sensor/monitor group $PM_{2.5}$ concentrations (Figure 5). The median hourly value among the two groups was well correlated. Given a mix of both urban and rural FEMs included, a slight high bias of the corrected PA values (purple line) over the median FEM noted in Figure 5 is inconclusive since rural sites within the FEM data site generally pull the median lower.

The raw PA data was close to FEM $PM_{2.5}$ concentrations during periods of lower absolute concentrations, though significant departure existed during periods of higher relative humidity and concentration (e.g., July 20). The EPA correction significantly reduced the difference between the raw PA sensor data and FEM monitors, increasing the overall effectiveness and comparability of the PA observations (Figure 5). This finding showed a dramatic impact of relative humidity on PA sensor data interpretation. The tight correlation also indicates that hourly concentrations are primarily driven by regional, rather than hyperlocal, sources since Cheverly values are very similar to regional FEM concentrations. While high resolution data of typically

10-minute average or less revealed transient spikes in PA $PM_{2.5}$ concentrations above baseline, these spikes were not seen universally throughout the Cheverly network in hourly data (which would have been captured using median values). Instead, a regional dominance of $PM_{2.5}$ concentrations existed through the project period, noted by the closely matching median and maximum concentrations of local Cheverly PA sensors and regional FEMs.

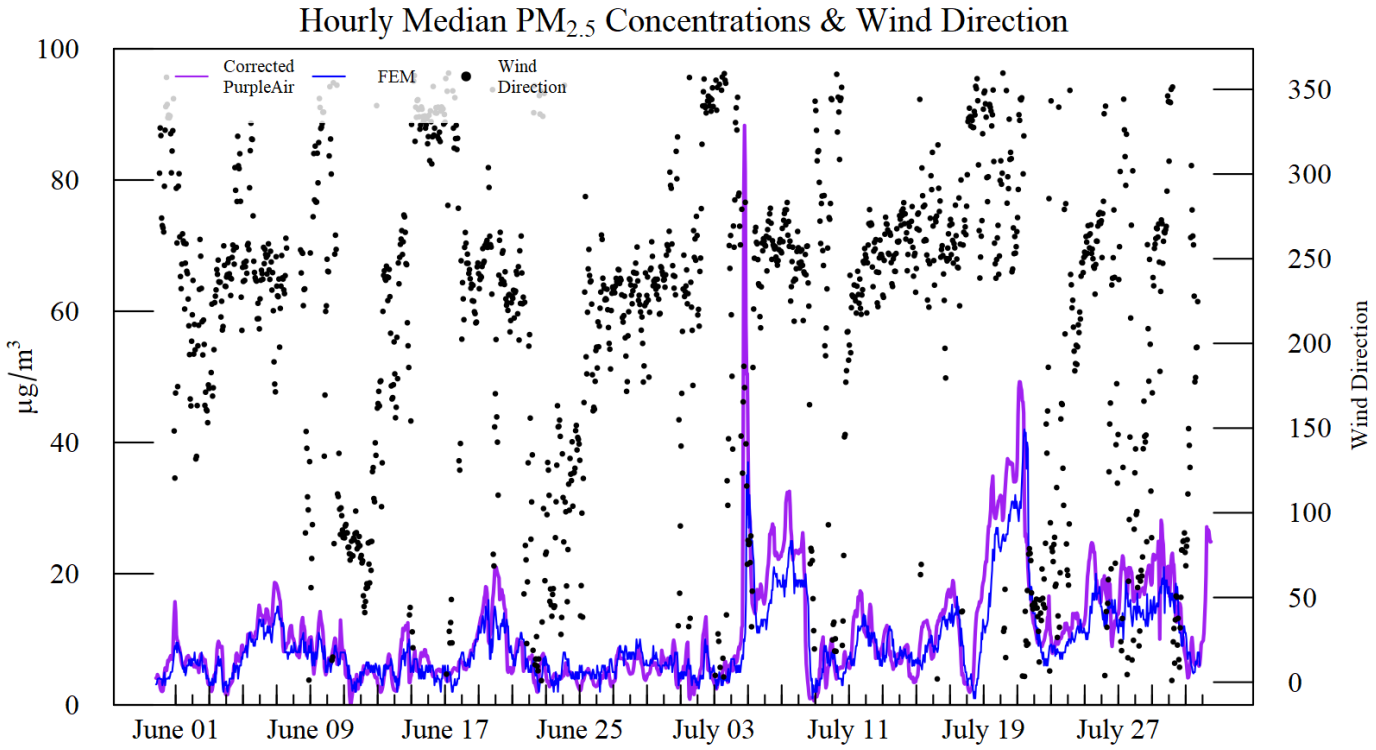

Figure 5. Median hourly $PM_{2.5}$ concentration among all Cheverly Maryland PurpleAir raw data (purple), of the same with the EPA relative humidity correction applied (purple), and a comparison to median concentration of 15 federal equivalent monitors (FEM; blue) found surrounding the Cheverly area. Wind direction (black dots) is also given.

The group maximum and average of daily average $PM_{2.5}$ concentration among PA raw, PA corrected, and FEM monitors were also compared. Daily average concentrations are comparable to the federal National Ambient Air Quality Standard (NAAQS). In this case, the reduction in the raw concentration was again noted, with the greatest correction in concentration occurring during the highest measured concentrations (e.g., July 4). Corrected daily maximum and group average PA data is shown against daily maximum and group average FEM monitors in Figure 6. It should be noted that on days such as June 19, or July 4, 19 or 20, the PA raw daily average was essentially halved. Based on the FEM data, the EPA corrected data produced superior results except during the July 4 case. This may indicate that in exceptional cases of high $PM_{2.5}$, in this case due to fireworks, the relative humidity correction may be overdone, but overall, the correction is necessary for data comparison to FEM monitors.

Overall, the daily average Cheverly area $PM_{2.5}$ concentrations were consistent with other regionally monitored areas. The two instrument methodologies each had periods experiencing the highest daily $PM_{2.5}$ concentrations. However, there were a greater number of days where FEM monitors measured higher daily average $PM_{2.5}$ concentrations than did the corrected PA data (Figure 6). The FEM monitors experienced three days above the federal NAAQS for $PM_{2.5}$ while the corrected PA data experienced two. While FEM monitors cover a wider region, this suggests the Cheverly area may not be a "hot spot" for $PM_{2.5}$ pollution related to the NAAQS benchmark. Consistent with hourly data, daily data between corrected PA sensors and FEM monitors were well correlated and the highest daily maximum concentration followed a similar trend, indicating a regional pollution signal.

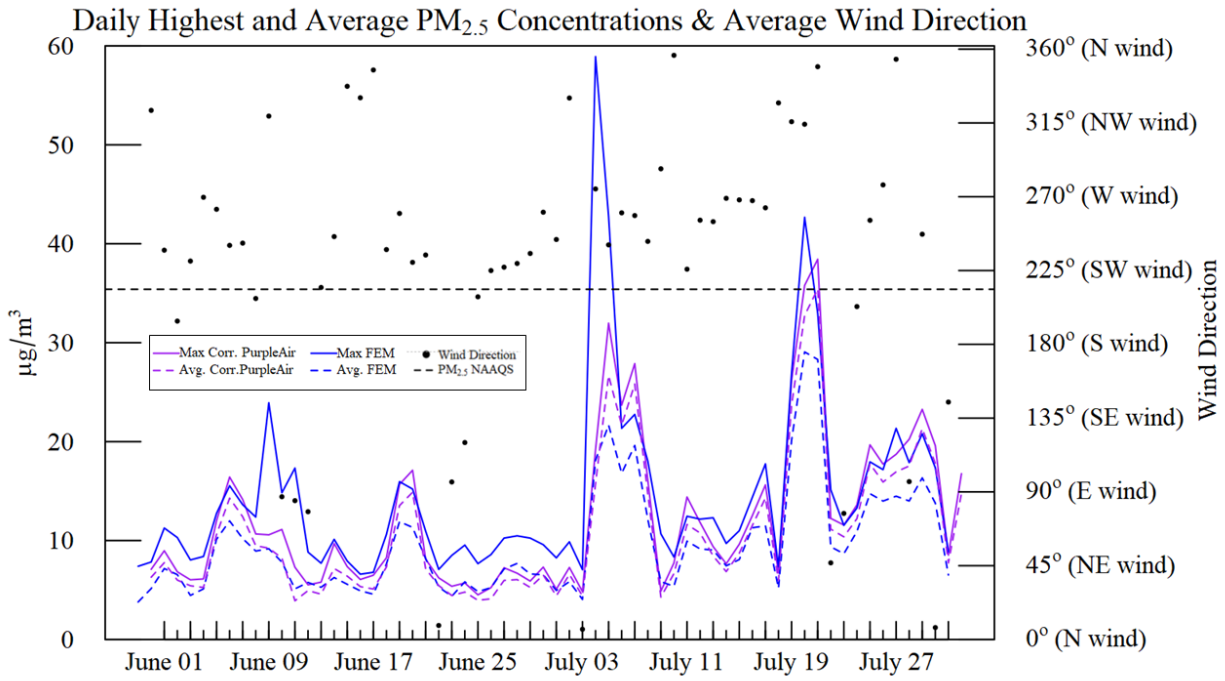

Figure 6. Highest daily average $PM_{2.5}$ concentration among all Cheverly Maryland PurpleAir sensors using the EPA correction for relative humidity (purple) and a comparison to maximum daily concentration of 15 federal equivalent monitors (FEM; blue) found surrounding the Cheverly area. Wind direction (black dots) is also given. Note that wind direction was derived from hourly wind components and therefore may not necessarily represent the most frequent hourly wind direction during the day.

Hourly median Cheverly PA concentrations (EPA correction applied) were slightly higher with winds from the southwest. Hourly winds from the DC near-road monitor were first binned into 30-degree segments from true north clockwise (e.g., 0°-30°, 30°-60°, … 330°-360°) and then compared with the maximum corrected PA data from Cheverly for each matching hour (Figure 7). Overall, the greatest number of observations occurred from the west-southwesterly direction (225°-270°). The highest mean and median occurred in the 240°-300° sectors. The 99th percentile was largest from the 150°-180° sector, suggesting infrequent but large hourly concentrations may

occur in this wind direction sector. The 99th percentile from the sectors comprising 180° to 270° (the southwest sector) had much lower 99th percentiles. This was interpreted as indicating slightly higher but relatively steady $PM_{2.5}$ concentrations when the wind blew from the west-southwest sector.

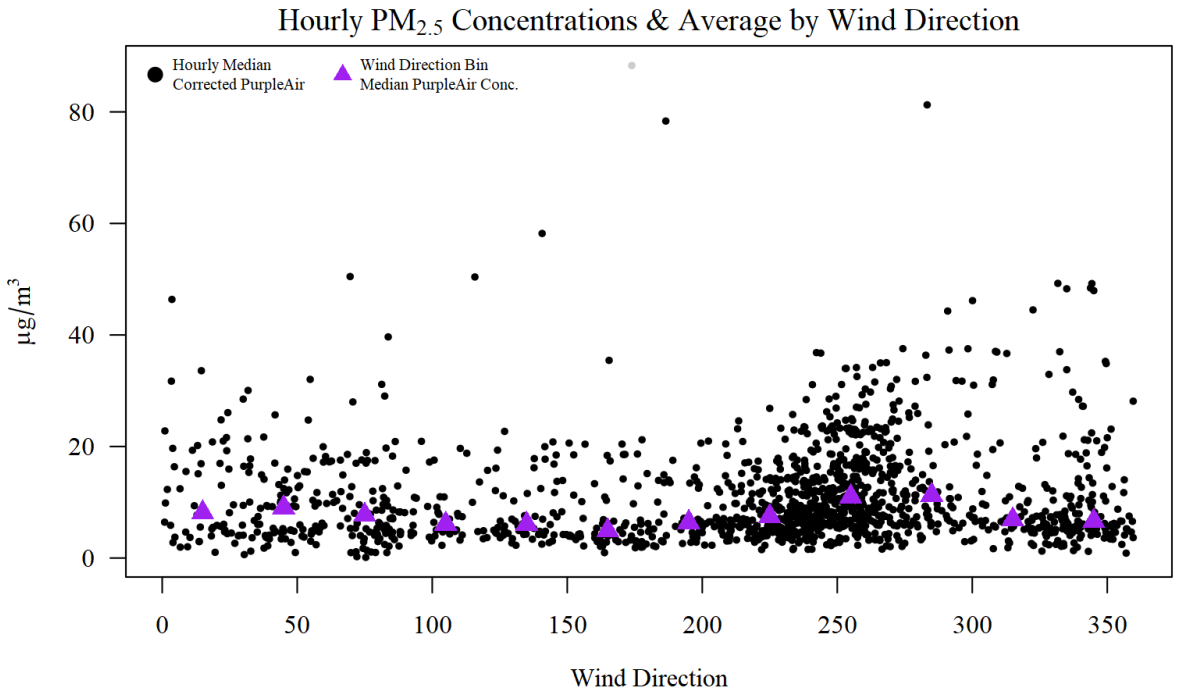

Figure 7. Scatterplot of the highest median hourly PA $PM_{2.5}$ concentration at any Cheverly sensor with EPA correction applied as a function of hourly wind direction from May 31-August 1 (June – July), 2021 (1463 points). Winds were binned into 30° partitions starting at due north (0°or 360°). The greatest number of observations occurred with winds from the southwest (~250°). The 240-270° direction also experienced the greatest median (purple triangle) concentrations.

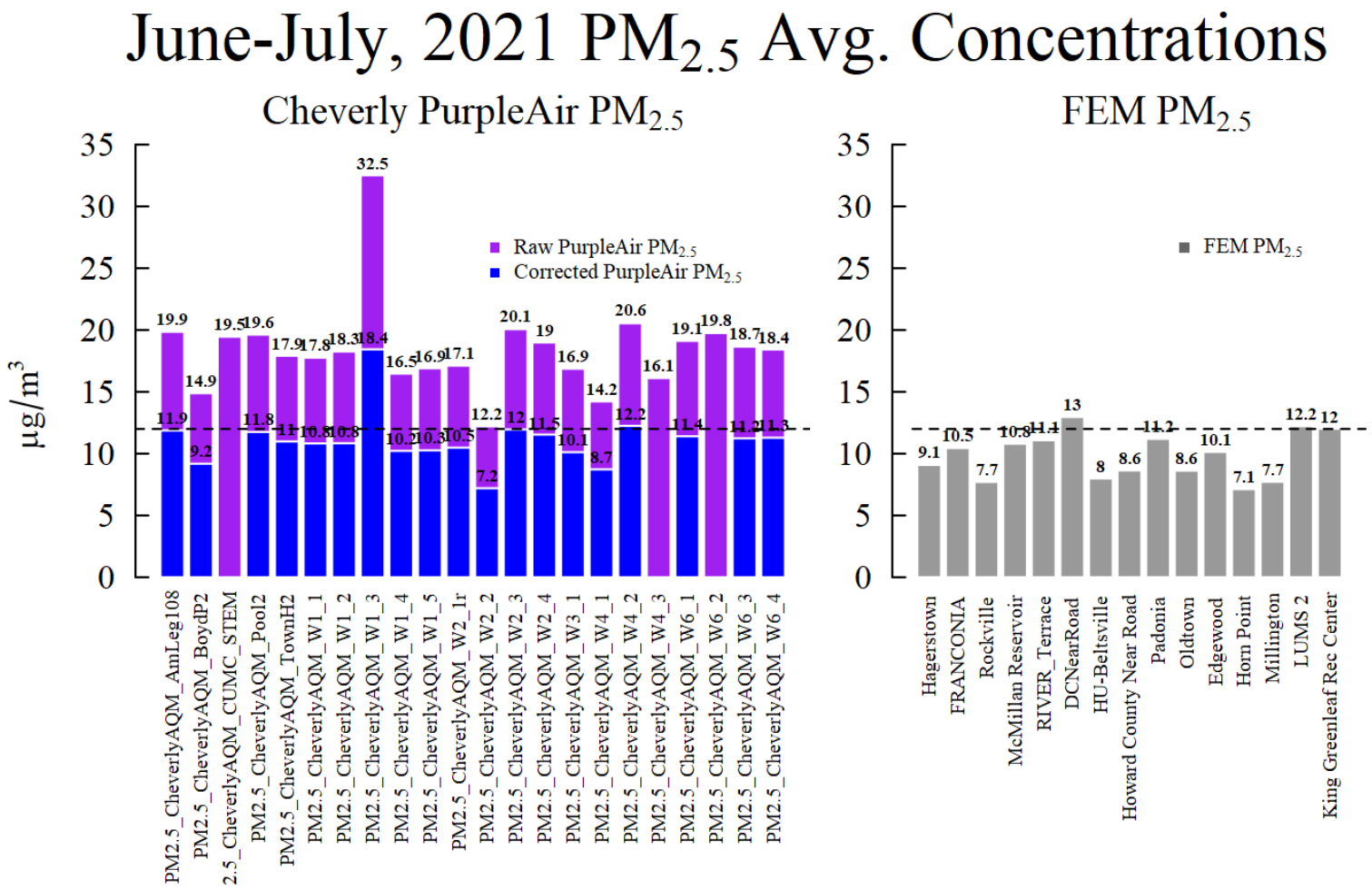

Figure 8. Average concentrations May 31 – August 31, 2021 (June – July 2021), at Cheverly PurpleAir sensors (left) and federal equivalent method (FEM) monitors (right). The purple bars show the average of the raw concentrations from all 22 PurpleAir sensors in Cheverly. The overlain blue bars show the average concentration after applying the EPA relative humidity correction. The three sensors without blue bars had no relative humidity reported, thus no correction was available. The dashed line shows the value of the annual federal $PM_{2.5}$ standard of 12µg/m³.

Table 2. Average $PM_{2.5}$ concentrations at the PurpleAir sensors and FEM monitors over the course of this Cheverly project intensive campaign, May 31- August 1, 2021 (June – July, 2021).

Average $PM_{2.5}$ Concentrations, from June – July, 2021

PurpleAir Sensor Name	$PM_{2.5}$ ($\mu g/m^3$)	PurpleAir Sensor Name	$PM_{2.5}$ ($\mu g/m^3$)	FEM Monitor Name	$PM_{2.5}$ ($\mu g/m^3$)
PM2.5_CheverlyAQM_AmLeg108	19.9	PM2_5CORR_CheverlyAQM_AmLeg108	11.9	Hagerstown	9.1
PM2.5_CheverlyAQM_BoydP2	14.9	PM2_5CORR_CheverlyAQM_BoydP2	9.2	FRANCONIA	10.5
PM2.5_CheverlyAQM_CUMC_STEM	19.5	PM2_5CORR_CheverlyAQM_CUMC_STEM		Rockville	7.7
PM2.5_CheverlyAQM_Pool2	19.6	PM2_5CORR_CheverlyAQM_Pool2	11.8	McMillan Reservoir	10.8
PM2.5_CheverlyAQM_TownH2	17.9	PM2_5CORR_CheverlyAQM_TownH2	11.0	RIVER_Terrace	11.1
PM2.5_CheverlyAQM_W1_1	17.8	PM2_5CORR_CheverlyAQM_W1_1	10.8	DCNearRoad	13.0
PM2.5_CheverlyAQM_W1_2	18.3	PM2_5CORR_CheverlyAQM_W1_2	10.8	HU-Beltsville	8.0
PM2.5_CheverlyAQM_W1_3	32.5	PM2_5CORR_CheverlyAQM_W1_3	18.4	Howard County Near Road	8.6
PM2.5_CheverlyAQM_W1_4	16.5	PM2_5CORR_CheverlyAQM_W1_4	10.2	Padonia	11.2
PM2.5_CheverlyAQM_W1_5	16.9	PM2_5CORR_CheverlyAQM_W1_5	10.3	Oldtown	8.6
PM2.5_CheverlyAQM_W2_1r	17.1	PM2_5CORR_CheverlyAQM_W2_1r	10.5	Edgewood	10.1
PM2.5_CheverlyAQM_W2_2	12.2	PM2_5CORR_CheverlyAQM_W2_2	7.2	Horn Point	7.1
PM2.5_CheverlyAQM_W2_3	20.1	PM2_5CORR_CheverlyAQM_W2_3	12.0	Millington	7.7
PM2.5_CheverlyAQM_W2_4	19.0	PM2_5CORR_CheverlyAQM_W2_4	11.5	LUMS 2	12.2
PM2.5_CheverlyAQM_W3_1	16.9	PM2_5CORR_CheverlyAQM_W3_1	10.1	King Greenleaf Rec Center	12.0
PM2.5_CheverlyAQM_W4_1	14.2	PM2_5CORR_CheverlyAQM_W4_1	8.7		
PM2.5_CheverlyAQM_W4_2	20.6	PM2_5CORR_CheverlyAQM_W4_2	12.2		
PM2.5_CheverlyAQM_W4_3	16.1	PM2_5CORR_CheverlyAQM_W4_3			
PM2.5_CheverlyAQM_W6_1	19.1	PM2_5CORR_CheverlyAQM_W6_1	11.4		
PM2.5_CheverlyAQM_W6_2	19.8	PM2_5CORR_CheverlyAQM_W6_2			
PM2.5_CheverlyAQM_W6_3	18.7	PM2_5CORR_CheverlyAQM_W6_3	11.2		
PM2.5_CheverlyAQM_W6_4	18.4	PM2_5CORR_CheverlyAQM_W6_4	11.3		

Average $PM_{2.5}$ concentrations over the entire project period June through July, 2021 are shown in Figure 8 and Table 2. A correction to the raw PA concentrations in Cheverly (left side, purple bars) was calculated from hourly relative humidity corrections over the campaign. Similar to previously discussed above, the relative humidity correction substantially reduced the overall project period average at all sensors reporting relative humidity (left side blue). Three sensors lacking relative humidity do not display blue bars in Figure 7.

Comparison of the period average of all FEM monitors (right side grey bars) to the corrected PurpleAir concentrations gives a context of local Cheverly $PM_{2.5}$ relative to regional concentrations. Generally, Cheverly $PM_{2.5}$ concentrations were between 9 and 12 $\mu g/m^3$ over the June – July intensive measurement campaign, with most sensors falling between 10.5 and 11.5 $\mu g/m^3$, which was below the annual standard of 12 $\mu g/m^3$. Generally, the Cheverly area has greater $PM_{2.5}$ concentrations than many rural areas of Maryland (e.g., Hagerstown, Horn Point, Millington) as well as some suburban sites (e.g., Rockville, HU-Beltsville). Still, FEM monitors nearest to the Cheverly area (e.g., Franconia, McMillan Reservoir, River Terrace, DCNearRoad, and King Greenleaf Rec Center), which are representative of metropolitan Washington, DC air quality as well as urban and suburban areas of Baltimore (e.g., Padonia and Edgewood) and northern Delaware (e.g., LUMS2), are equal to or greater than many Cheverly PA sensors. This suggests little additional burden to the Cheverly area compared to other urban/suburban sites. The concentration at the DCNearRoad site was noteworthy as having the highest average $PM_{2.5}$ over this period among all sensors and monitors (CheverlyAQM_W1_3 was excluded due to bad data, as noted earlier). This could suggest the influence of roadway emissions on $PM_{2.5}$ concentrations in that region. The DCNearRoad site was also the closest FEM monitor to the Cheverly area but, remained higher over the study period, and thus may not have been representative of the typical $PM_{2.5}$ concentration in Cheverly. Thus, potential roadway influences are acknowledged, but they are not readily apparent in the PA data.

The group mean of all PA monitors over the 2-month study was 11.1 $\mu g/m^3$ as calculated on a by-sensor basis as given in figure 8 and table 2. Comparison of each FEM mean to 11.1 provided a range of differences between 1.9 $\mu g/m^3$ higher in the FEM dataset to 4.0 $\mu g/m^3$ greater in the Cheverly data. The concentration at the DCNearRoad site was the greatest relative to Cheverly, while Horn Point, a remote, rural location on the southern eastern shore was the lowest compared to Cheverly.

In a different approach, a mean and median of each group were calculated by first determining the mean and median by day, then taking the mean and median of these groups. In this method, corrected PA mean and median were 10.9 and 8.2 $\mu g/m^3$. FEM monitors' mean and median were 9.6 and 7.8 $\mu g/m^3$, giving 1.3 and 0.4 $\mu g/m^3$ more $PM_{2.5}$ in Cheverly. However, this conclusion is

reversed if the FEM group uses, for example, only DC area monitors (e.g., Franconia, McMillan Reservoir, River Terrace, DCNearRoad, and King Greenleaf Rec Center). The mean and median of these FEM monitors are 11.5 and 8.8 $\mu g/m^3$, higher than Cheverly by 0.6 $\mu g/m^3$ showing the influence of comparing rural monitors.

All of these sensor-to-monitor comparisons assume the relative humidity correction applied is accurate for this area. Slight alterations in the correction equation specific to our region may result in over or under correction to current PA $PM_{2.5}$ data, and as such the corrected values in the long-term average should be used cautiously on a one-to-one comparison. This also does not consider the intrinsic precision of the PA instruments themselves. These points are particularly important given the relative closeness of many of the site concentration $PM_{2.5}$ averages.

Overall key takeaways are as follows:

1) The Cheverly raw PA $PM_{2.5}$ data is almost always higher than the regulatory FEM $PM_{2.5}$ monitors but similar and comparable during low concentrations and lower relative humidity.

2) Daily PA $PM_{2.5}$ data using the EPA recommended relative humidity correction in the Cheverly area resulted in more days with LOWER $PM_{2.5}$ concentrations than other regional regulatory FEM $PM_{2.5}$ monitors.

3) The PA $PM_{2.5}$ data from Cheverly follows regional trends. It was found that the short-term spikes (shorter than one hour) do not significantly impact the hourly EPA corrected $PM_{2.5}$ data universally across the Cheverly community and suggests influences from local sources during this time period were not meaningfully above the regional load once hourly and daily averaging was considered.

4) There is a slightly higher $PM_{2.5}$ concentration in the Cheverly PA data during periods with winds from the west-southwest direction. However, a longer period of PA data collection would be needed to qualify the significance of the marginally higher concentration of this finding.

5) The Cheverly PA $PM_{2.5}$ data is 2-4 $\mu g/m^3$ higher than rural FEM $PM_{2.5}$ monitors over the entire June – July intensive measurement period but similar, if not lower, in concentration compared to other urban/suburban FEM $PM_{2.5}$ monitors. This was particularly true for other FEM $PM_{2.5}$ monitors in and around the DC region (Franconia, McMillan Reservoir, RIVER_Terrace, DCNearRoad, King Greenleaf Rec Center).

6) The closest FEM $PM_{2.5}$ monitor to Cheverly was the highest monitor or sensor over the June – July intensive measurement period but was equally higher than Cheverly PA and urban FEM monitors.

This analysis focused on $PM_{2.5}$ and makes no suggested or implied conclusions for PM_{10} (dust), PM_1 (ultra-fine particulates), or volatile organic compounds (VOCs), nor these pollutants' related impacts.

References

Barkjohn, K. K., Gantt, B., & Clements, A. L. (2020). *Development and Application of a United States wide correction for* $PM_{2.5}$ *data collected with the PurpleAir sensor* [Preprint]. Aerosols/In Situ Measurement/Validation and Intercomparisons. https://doi.org/10.5194/amt-2020-413