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February 16, 2024

Mr. Chris Hoagland
Director Air and Radiation Administration
Maryland Department of the Environment
1800 Washington Blvd.
Baltimore, MD 21230

RE: **CSX Transportation, Inc. (CSXT) Response to the *Collaborative Investigation of Coal Dust, Air Pollution, and Heath Concerns in Curtis Bay, South Baltimore, Maryland***

Dear Mr. Hoagland:

We appreciated the opportunity to meet with Maryland Department of the Environment (MDE) Air and Radiation Administration last month to present our preliminary conclusions in response to the report titled *Collaborative Investigation of Coal Dust, Air Pollution, and Health Concerns in Curtis Bay, South Baltimore Maryland* (Collaborative Report), which was prepared by a consortium of Curtis Bay community groups, MDE, and local universities. We take the concerns raised by the community seriously and are deeply committed to safe and environmentally sound operations at Curtis Bay Piers and throughout Maryland.

CSXT retained experts in particulate matter speciation, air quality monitoring, and toxicology to review and analyze the Collaborative Report and accompanying supplementary materials. The experts' formal responses (CSXT Expert Reports) are attached to this letter. The Collaborative Report is a novel attempt to identify sources of particulate matter in Curtis Bay, an effort that may warrant further study, but which, in its current form, is materially flawed and should not be used to inform regulatory decisions.[1] The Collaborative Report's preliminary findings are conclusory in nature and are not supported by the data presented in the Report. In short, the Collaborative Report (1) fails to present evidence showing that coal dust is present throughout the Curtis Bay community; (2) fails to show that particulate matter from coal handling operations at Curtis Bay Piers has a substantial impact on air quality in the Curtis Bay

[1] On December 14, 2023, MDE announced the release of the Collaborative Report. In the press release, Maryland Secretary of the Environment Serena McIlwain stated that MDE "will let the science and data identified in [the Collaborative Report] lead the way as we consider a new permit for the Curtis Bay coal terminal through the lens of environmental justice."

community; and (3) fails to present evidence demonstrating that the Curtis Bay community is overburdened by particulate matter air pollution as compared to other areas of Baltimore City.

CSXT therefore strongly objects to MDE using the Collaborative Report as a basis for the permitting of Curtis Bay Piers. As summarized below and demonstrated in the CSXT Expert Reports, the Collaborative Report relied on flawed approaches to draw unfounded conclusions about air quality and air pollution sources in Curtis Bay.[2] A permitting decision based on this Report would be arbitrary and capricious, and not in compliance with Maryland law.

Background on CSXT Curtis Bay Piers at the Port of Baltimore

CSXT owns and operates Curtis Bay Piers (Curtis Bay Piers or Terminal), a coal storage and transfer facility located at the Port of Baltimore. CSXT transports coal for customers by rail to the Terminal and loads the freight onto vessels in compliance with its federal common carrier obligations. CSXT does not combust or process coal at Curtis Bay Piers. The Terminal is located in a heavily industrialized area and surrounded by a variety of other permitted industries. As the Collaborative Report notes, there are approximately 70 MDE-regulated stationary sources of air pollution in the area including the Curtis Bay Energy medical waste incinerator, the BRESCO municipal solid waste incinerator, the Quarantine Road Landfill, the Patapsco Wastewater Treatment Plant, a coal-fired power plant, concrete crushing plants, asphalt manufacturing, chemical plants, and oil and gas terminals.[3] The Collaborative Report further states that heavy diesel truck traffic is a significant source of air pollution in Curtis Bay.[4]

Coal loading or unloading facilities are air emissions sources required to obtain a State Permit to Operate (State Permit) in accordance with COMAR 26.11.02.13A(38). Curtis Bay Piers is a minor source of particulate matter emissions and operates under a State Permit issued on October 1, 2018, which expired on September 30, 2023 and has been administratively extended.[5] CSXT's Air Quality Permit to Construct, issued in September 2022, contained reasonable precautions approved by MDE to prevent airborne particulate matter, including a Fenceline Monitoring Plan, a revised Fugitive Dust Plan, and improvements to the Terminal's dust suppression systems.[6] CSXT has worked diligently with MDE to implement a comprehensive fenceline monitoring program that goes above and beyond the requirements described in the Permit to Construct and to enhance the Terminal's Fugitive Dust Control Plan.

CSXT is committed to continuously improving operations at Curtis Bay Piers and has made significant investments over the last five years focused on advancing long-term operational safety, improving dust control, and collecting 100% of storm water for onsite reuse at the Terminal. We are sharing real time data from our fenceline monitoring system, installed to

[2] In addition, and as discussed in Attachment 4 to this letter, the Collaborative Report confuses visible soot emissions from a ship with coal dust from coal handling operations. The Collaborative Report mistakenly claims that a video of visible emissions from a ship docked at the Terminal is evidence that coal dust is lofted 100 to 300 meters above the surface.
[3] Collaborative Report, Sections 2 and Section 3.
[4] Collaborative Report, Section 2.
[5] CSXT submitted a timely and complete application for renewal of the State Permit on July 18, 2023, which is under review by MDE. The State Permit has been administratively extended per COMAR 26.11.02.08B which allows continued operation of a source pending final action on an application.
[6] Air Quality Permit to Construct, September 2022; *see also* MDE Fact Sheet Air Quality Permit to Construct for CSX Transportation – Curtis Bay Piers. MDE concluded that particulate matter emissions were likely to decrease as a result of the additional wet suppression systems and metal skirting required in the Permit to Construct.

continuously monitor particulate matter along the perimeter of the Terminal, on a publicly accessible website.

Overview of the CSXT Expert Reports

Attachment 1 contains an expert report prepared by Gary Casuccio and Keith Rickabaugh of RJ Lee Group, Inc, an industrial forensics analytical laboratory and scientific consulting firm. Mr. Casuccio is a senior scientist at RJ Lee Group and an expert in the characterization and speciation of particulate matter using electron microscopy techniques for environmental, industrial hygiene, and other applications. He also has significant expertise in source apportionment of particulate matter using receptor models and ambient air quality monitoring. Mr. Rickabaugh is the Technical Director of Materials and Analytical Services at RJ Lee Group and is an expert in sampling and laboratory analysis and industrial hygiene. RJ Lee Group conducted a scientific review of the information provided in the Collaborative Report as well as the monitoring data from the low-cost sensors, and concluded that the Collaborative Report's findings are incomplete, misleading, and flawed.

Attachment 2 contains an expert report prepared by Scott Adamson, a Managing Consultant and Certified Consulting Meteorologist at Trinity Consultants. Mr. Adamson is an expert in ambient air quality monitoring and air dispersion modeling. He specializes in the development and management of air quality and meteorological monitoring systems as well as data assurance and validation processes. Mr. Adamson is currently managing over 20 ambient air quality monitoring programs throughout the country, including the Cutis Bay Piers fenceline monitoring program. Mr. Adamson concluded that the Collaborative Report used unreliable data and flawed statistical methods to draw unfounded conclusions about air quality in Curtis Bay.

Attachment 3 contains an expert report prepared by Dr. Tamara House-Knight, Senior Toxicologist and Emerging Contaminant Technical Team Lead at GHD. Dr. House-Knight is an expert in human and environmental risk assessment. Her report focuses on the health effects of particulate matter air pollution. Dr. House-Knight's conclusions are based on her review of the Collaborative Report as well as the scientific literature on occupational exposure to coal dust. She concluded that exposure to coal dust does not equate to toxicity or development of adverse health effects and that there is insufficient evidence in the Collaborative Report to conclude that coal dust from the Terminal significantly contributes to overall $PM_{2.5}$ concentrations in Curtis Bay.

The conclusions presented in the CSXT Expert Reports are summarized below.

Executive Summary of the CSXT Expert Reports

A. The Collaborative Report Does Not Actually Measure Coal Dust

1. "Putative Coal Dust" is Not Coal Dust. A major flaw of the Collaborative Report is the researchers' assumption that "a combination of major contributions from PM_{10}, total suspended particles (TSP), and black carbon" are an indicator of coal dust.[7] The Collaborative Report labels this combination of common air pollutants as "putative coal dust." "Putative coal dust" is *not* coal dust. It is a term coined by the Collaborative Report researchers with no basis in public health or air quality research. The Collaborative Report's repeated use of this term

[7] Collaborative Report, Section 3 page 5.

creates the false impression that coal dust from Curtis Bay Piers is present in the community. In fact, none of the pollutants the Collaborative Report attributes to putative coal dust are unique to the storage and handling of coal.

a. PM_{10}, TSP, and black carbon are not pollutants specific to coal particles. The terms "PM_{10}" and "TSP" describe particulate matter with an aerodynamic size generally smaller than 10 micrometers (μm) (PM_{10}) and ~ 40 μm (TSP) that is not specific to any particular source of air pollution. Common natural and anthropogenic sources of PM_{10} and TSP include soil, pollen, wildfire smoke, fuel-burning, diesel exhaust, and construction sites.

b. Black carbon is not emitted as a result of coal storage and handling. The Environmental Protection Agency (EPA) describes black carbon as "sooty black material emitted from gas and diesel engines, coal-fired power plants, and other sources that *burn* fossil fuel"[8] Coal dust from the daily operations at Curtis Bay Piers is not combusted, and would not resemble black carbon from other urban sources in terms of composition, size or morphology of the particle. Moreover, because black carbon is ubiquitous in an urban environment,[9] it would be extremely difficult to isolate any one source of it.

2. <u>The Non-Negative Matrix Factorization Analysis Linking "Putative Coal Dust" to Curtis Bay Piers Is Unsupportable</u>. The Collaborative Report relied on a statistical model called non-negative matrix factorization (NMF) in an unsuccessful attempt to identify coal dust air pollution in Curtis Bay. This analysis relied on data from a limited group of common urban pollutants (PM_1, $PM_{2.5}$, PM_{10}, TSP, carbon monoxide, nitrogen oxide, nitrogen dioxide, and black carbon) in an attempt to isolate Curtis Bay Piers as the only source of coal particles in Curtis Bay. To achieve its intended result, the Collaborative Report postulated the existence of a "putative (or assumed) coal dust" factor consisting of "major contributions of PM_{10}, TSP, and black carbon." It then applied arbitrary and inconsistent interpretations of the results of the NMF analysis output to determine whether ambient particulate matter matched the putative coal dust profile *factor* as opposed to pollutant signatures associated with other common air pollution sources (such as dust, cars, local combustion, and regional). The Collaborative Report's use of NMF to apportion common air pollutants to coal dust in an urban environment was flawed for several reasons.

a. First, as discussed already, putative coal dust is not coal dust, and the pollutants the Collaborative Report attribute to coal dust (PM_{10}, TSP, and black carbon) are not a realistic profile for coal dust, which highlights a significant flaw in the Report's analysis. Moreover, black carbon is wholly unrelated to the storage and handling of coal. Thus measuring these pollutants individually or in combination is ineffective in identifying coal dust.

b. Second, the Collaborative Report relied on limited and non-specific air pollutants to develop source pollutant profiles. This limited the researchers' review of other potential sources of air pollution in the community.

[8] EPA Staff. Black Carbon Research and Future Strategies - Reducing emissions, improving human health and taking action on climate change. Washington D.C. : U.S. EPA, 2011 (emphasis added).
[9] Carbon black vs. black carbon and other airborne materials containing elemental carbon: Physical and chemical distinctions. Long, C.M., Nascarella, M.A., Valberg, P.A. 181, s.l. : Environmental Pollution, 2013.

c. Third, many of the source categories defined in the NMF analysis have the same pollutants. This can result in excessive collinearity among the source categories. The effectiveness of the NMF model is dependent on pollutants or pollutant relationships that are unique to each source to assist in the identification of a particular source or source type. Without unique pollutant profiles, the Collaborative Report researchers could not clearly distinguish among different source categories in their NMF analysis. In short, there is no evidence that the NMF results provide any insight on coal dust impact in the community.

d. Fourth, the putative coal dust factor was not defined consistently across the four locations examined in the NMF analysis. Notably, at Location 1, the Collaborative Report states there is a strong putative coal dust factor, but inexplicably included PM_1 and $PM_{2.5}$ in the putative coal dust factor, which is not consistent with the Collaborative Report's putative coal dust definition (i.e. a combination of major contributions from PM_{10}, TSP, and black carbon). The presence of PM_1 and $PM_{2.5}$ most likely indicates a significant contribution from other local and regional sources (including diesel and gasoline motor emissions) and not coal dust. This shows the NMF model lacks clarity because of source profile similarities.

e. Fifth, the interpretation of the NMF results was deficient because it did not identify a factor for diesel emissions, which are a recognized and significant source of black carbon emissions in the community. Polar plots presented in the Collaborative Report suggested impact from diesel vehicles, and black carbon data obtained from the mobile monitoring vehicle confirmed the presence of high concentrations of black carbon on Pennington Avenue, which was assumed to be related to diesel trucks emissions. Not considering a diesel emissions factor undermines the NMF evaluation by inaccurately attributing black carbon from diesel emissions to putative coal dust (which, as already noted, is not the same as coal dust because black carbon is not associated with coal storage and handling).

f. Sixth, the NMF evaluation used one-minute averaged monitoring data obtained from non-regulatory grade low-cost sensors, which are more prone to fluctuations compared to longer-averaged concentrations. Furthermore, measurement uncertainties have not been established for short-term one-minute averages.

Given these flaws, the NMF results cannot serve as the basis for any regulatory determination.

3. <u>The SEM/EDS Analysis of Passive Samplers and Tape Lift Samples was Inadequate and Flawed</u>. The Collaborative Report improperly relied on results from passive samplers and tape lift samples to support its conclusion that coal dust from Curtis Bay Piers is a substantial contributor to settled dust in the surrounding community. The results lack significance because of the small number of particles analyzed per sample. The SEM/EDS analysis results also do not support the Collaborative Report's finding that coal dust was found at all 8 monitoring sites and in 100 percent of the samples. Further, the SEM/EDS analysis did not follow the analytical protocols described in the Collaborative Report bringing into question whether any of the SEM/EDS data are of value.

Given the flaws in the SEM/EDS analysis, coal dust cannot be considered a 'substantial contributor' to air pollution in Curtis Bay. In fact, from a review of the limited SEM/EDS information provided for the limited number of particles presented in the Collaborative Report, it is not evident that all particles are even consistent with coal. The Collaborative Report itself recognized the limitations and issues associated with the small sample size and SEM/EDS analysis, noting: "*The strength of the systematic analysis is limited by the small sample size of 12 particles per PAPA [passive samplers] sample, as well as the findings of putative coal dust, causing some uncertainty to the identity of deposited particles*."[10]

4. The White Tape Collector Data is of No Value from a Coal Impact Perspective. The Collaborative Report also used white tape collectors in an attempt to demonstrate that coal dust was more prevalent near Curtis Bay Piers, and declined as the sample locations were located further away. Light microscopy was used to capture images of the particles and the color and morphology of the particles were compared to a control white tape collector with material from a bulk coal sample from the Terminal.

Limitations with the analysis included a lack of scale markers on the images making comparison of the images difficult; failure to include the images from Location B; and failure to perform speciation of the particles. Thus, no information on the presence or amount of coal on the samples was provided in the Collaborative Report.

Image analysis was also utilized to measure 'darkness' of each sample. However, this analysis is of no value because no particle speciation was performed. Further, darkness does not provide an indication of coal, as there are a variety of particles (naturally occurring and anthropogenic) that have a dark appearance. Therefore, this analysis provides no information on the presence or amount of coal on any of the samples. The Collaborative Report itself found that the darkness evaluation was misleading because of inconsistencies in the darkness scoring due to variable lighting environments ('…*not consistently reflected in the ImageJ darkness scoring*').

Given these issues, the SEM/EDS analysis and white tape collector results cannot serve as the basis for any regulatory determination.

B. The Air Quality Monitoring Network Described in the Collaborative Report Did Not Meet Standard Practices for Proper Quality Assurance or Quality Control

The Collaborative Report did not follow accepted methodologies or standard practices published by EPA for making defensible and representative air quality measurements. EPA's published guidance documents serve as best practices for developing quality environmental data collection programs for both regulatory-grade monitoring networks and non-regulatory grade networks that use low-cost sensors. The Collaborative Report's conclusions are based on particulate matter and gaseous pollutant monitoring data collected from an air quality monitoring network of ten low-cost air monitoring sensors placed in the community and in the industrially zoned area of Curtis Bay. Low-cost sensors are not used for regulatory monitoring and are not suitable for comparison or compliance demonstrations with the NAAQS. Further, some of the community monitors were not sited in accordance with EPA guidance resulting in biased measurements that are not representative of community exposure.

[10] Collaborative Report, Section 3, page 20.

Moreover, the community monitoring program failed to (1) develop a quality assurance project plan, (2) meet EPA criteria for collocation, and (3) include adequate quality controls. Quality assurance and quality controls procedures are critical for obtaining good quality, complete, and (most importantly) accurate data that can be used for making meaningful conclusions. The data validation process described in the Collaborative Report did not include EPA-published quality control checks such as expected range of the instrument, rate of change, data sticking, duplicate sensor comparison, buddy system, parameter-to-parameter checks, or corrective actions from collocation tests. Without these quality assurance and control protocols, data are susceptible to bias and error, resulting in less agreement between actual pollutant concentrations in the atmosphere and the concentrations reported by the sensor.

Of particular note, the low-cost sensors did not meet recommended performance metrics for PM_{10} when collocated with MDE's regulatory monitors. This failure should invalidate all PM_{10} data used in the Collaborative Report and all conclusions drawn based on that data.

C. One-minute Data Are Not a Reliable Indicator for Overall Air Quality

One-minute monitoring data should not be used to draw conclusions about air quality impacts from Curtis Bay Piers or overall air quality in Curtis Bay. There are no health-based standards for one-minute data and short-term averages are less precise than longer averaging periods. Pollutant concentrations can vary based on the time of day, week, or season and can often change rapidly due to influences from local emission sources and/or atmospheric conditions. One-minute averages are more susceptible to rapid fluctuation in the measurements, also known as noisy data signals, that are symptomatic of electrical interference, sensor precision, or rapid weather changes that can lead to low precision of the instrument and result in less agreement between the sensor's reported concentration and the true concentration in the atmosphere. It is unlikely that the low-cost sensor data relied on in the Collaborative Report produced stable one-minute data that could be used to identify pollution events.

D. The Collaborative Report Ignores a Multitude of Other $PM_{2.5}$ and PM_{10} Sources in the Community and in the Region

The Collaborative Report also fails to consider and analyze other known sources of particulate matter and black carbon in Curtis Bay and the Baltimore region.

1. Other Local Black Carbon Sources. The Collaborative Report's mobile testing van reported significantly higher black carbon results on Pennington Avenue than on Curtis Avenue. Because Pennington Avenue is further away from Curtis Bay Piers than Curtis Avenue, the Terminal could not have been the source of this marked increase. Rather, the Collaborative Report attributed the higher black carbon concentrations to diesel truck traffic.

Despite this known source of black carbon in the community, the NMF analysis discussed above failed to include diesel truck emissions. This failure, matched with the expansion of the putative coal dust definition to include smaller size particulates (PM_1 and $PM_{2.5}$), undermines the Collaborative Report's conclusions. As stated above, black carbon in the $PM_{2.5}$ range is produced from diesel and truck emissions, not from the mechanical handling of coal.

2. Failure to Account for Regional Sources of Particulate Matter. Moreover, the Collaborative Report ignores local and regional sources of particulate matter that potentially

impact the community. In the attached report, RJ Lee Group evaluated $PM_{2.5}$ and PM_{10} hourly concentrations reported by the low-cost sensors at several Curtis Bay community monitoring locations (Location 1, Location 4, Location 5, Location 9, and Location 10), and compared upwind/downwind concentrations.

The results indicate that, on average, the $PM_{2.5}$ concentrations are relatively consistent throughout the community monitoring network. In most instances, the upwind $PM_{2.5}$ concentrations, which indicates impact from background sources, were higher than the downwind concentrations, suggesting minimal or no impact on the community from the Terminal. The results suggest that there that is a significant source(s) of $PM_{2.5}$ southeast of Curtis Bay, which appears to correlate with the findings reported in the Collaborative Report. For example, polar plots included in the Collaborative Report indicated that the highest $PM_{2.5}$ concentrations were associated with background sources south of the Terminal.[11]

The results also show that the Terminal is not a significant source of PM_{10} in the community.

E. The Collaborative Report Does Not Indicate that Particulate Matter Concentrations in the Curtis Bay Community Exceed Applicable Air Quality Standards

The Collaborative Report states that both the World Health Organization (WHO) and the EPA have concluded "there is no safe level of $PM_{2.5}$ exposure."[12] This is an overstatement of what the agencies have concluded.

1. Applicable NAAQS Standards. The Clean Air Act tasks EPA with identifying certain air pollutants that cause or contribute to air pollution that is reasonably anticipated to endanger public health or welfare. EPA then proposes and promulgates "primary" and "secondary" national ambient air quality standards (NAAQS) based on the latest scientific knowledge "useful in indicating the kind and extent of all identifiable effects on public health or welfare, which may be expected from the presence of a pollutant in the ambient air." The primary standard is developed with the intent to protect the public health with an adequate margin of safety.

2. The Community Is in Attainment with NAAQS for $PM_{2.5}$ and PM_{10}. As discussed above, there are many sources of $PM_{2.5}$ in the community, including diesel truck emissions and dozens of other local and regional sources. The Collaborative Report does not, however, include sufficient data to support the finding that the Curtis Bay community is overburdened with $PM_{2.5}$ air pollution relative to other areas of Baltimore City.

Section Four of the Collaborative Report used data from the low-cost sensors collected between May 26, 2022, and July 16, 2023, to discuss the air pollution burden in the community. While there are flaws in the community monitoring data, even taken at face value, the data indicates that the particulate matter concentrations in the community meet annual and 24-hour NAAQS for $PM_{2.5}$ and are below the 24-hour NAAQS for PM_{10}.

The Collaborative Report presents $PM_{2.5}$ data from each low-cost sensor and concludes that "[f]ocusing on the first complete year of the entire dataset (5/26/22-5/25/23) of 24-hour

[11] Collaborative Report, Section 4, Figures 9 - 13, pages 7 and 8.
[12] Collaborative Report, Section 2, page 15.

average $PM_{2.5}$, including and excluding data from the smoke effect period, the annual mean $PM_{2.5}$ across all sensors is 8.6 µg/m³."[13] With respect to PM_{10}, data provided in the Collaboration Report indicates that the average 24-hour PM_{10} concentration across the community air monitoring network was 23.7 µg/m³.[14] The EPA does not have an annual PM_{10} standard; however there is a 24-hour PM_{10} standard of 150 µg/m³. The Collaborative Report indicated that, based on the low-cost sensor data, the Curtis Bay area appears to be in attainment for PM_{10}.

Although the Collaborative Report states that the community is in attainment with the NAAQS for $PM_{2.5}$ and PM_{10}, it postulates that the area is overburdened by air pollution. This statement ignores regional sources and is based only on the fact that $PM_{2.5}$ concentrations in Curtis Bay, as measured by the low-cost sensors, appear to be higher than those at MDE's Lake Montebello regulatory monitoring site by approximately 1-3 µg/m³.[15] But as the Collaborative Report itself noted "[i]ndependent evaluations by California's South Coast Air Quality Monitoring District (AQ-SPEC) have found the specific sensor type used in Curtis Bay measure $PM_{2.5}$ with a high bias compared to reference grade monitors by 1-3 µg/m³."[16] Thus, the $PM_{2.5}$ measurements are within the uncertainty of the sensors and do not support that Curtis Bay is overburdened by particulate matter air pollution as compared to other areas of Baltimore City.

We take the concerns raised by the community seriously and have carefully considered the data and conclusions presented in the Collaborative Report. We continue to invite members of the community to engage with us directly. We appreciate MDE's review and consideration of the enclosed CSXT Expert Reports and are available to meet to discuss the analyses presented therein. We look forward to our continued collaboration in finalizing the renewal of the State Permit to Operate for Curtis Bay Piers.

Sincerely,

Raghunath S. Chatrathi

Raghu Chatrathi

Cc Angelo Bianca, Deputy Director, Air and Radiation Administration, MDE
Steven Lang, Section Head, Compliance Assessment Section, Industrial Compliance Division, Air Quality Compliance Program, MDE
Diane Nelson, Director's Office - Air and Radiation Administration, MDE
Suna Sariscak, Chief, Air Quality Permits Program, Air and Radiation Administration, MDE
Ryan Auvil, Manager, Air Monitoring Program, MDE
Michael Strande, Deputy Counsel
Doris Weil, Assistant Attorney General

[13] Collaborative Report, Section 4, page 8.
[14] Collaborative Report, Section 4, page 9.
[15] Collaborative Report, Section 4, page 5.
[16] Collaborative Report, Section 4, page 16.

Attachments:

1. RJ Lee Group Report
2. Trinity Consultants Report
3. GHD Report
4. Misleading Photographs and Videos in the Collaborative Report

Attachment 1 -

RJ Lee Group Report

Response to Community Report Titled: *Collaborative Investigation of Coal Dust, Air Pollution, and Health Concerns in Curtis Bay, South Baltimore, Maryland, USA, 2022-2023*

Prepared at the request of CSX Transportation, Inc.

February 13, 2024

RJ Lee Group

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Executive Summary

In February 2022, a collaboration involving Curtis Bay residents, community organizations, the Maryland Department of the Environment (MDE), and academia initiated a study to investigate community concerns of dark dust found on homes assumed to be from the coal handling operations at CSXT Curtis Bay Terminal (Terminal) located in Curtis Bay. Results from the study were summarized in a report titled Collaborative Investigation of Coal Dust, Air Pollution, and Health Concerns in Curtis Bay, South Baltimore, Maryland, USA, 2022-2023 that became publicly available on December 14, 2023 (referred to in this report as the Collaborative Investigation report). The Collaborative Investigation report identified three preliminary findings:

- Coal dust is present throughout the community.
- Coal dust finds its way into the community on a day-to-day basis and is correlated with both activity at the coal terminal and wind direction.
- The Curtis Bay community is overburdened by air pollution, with the community sensor network measuring average particle pollution levels that are higher than at nearby MDE regulatory monitors.

RJ Lee Group has performed a critical review of the Collaborative Investigation report and concluded that the findings are incomplete, flawed, and misleading. The key takeaways from the critical review are as follows:

- There was no evidence presented in the Collaborative Investigation report to support the finding that coal dust is present throughout the community.
- There was no evidence in the Collaborative Investigation report to support the finding that coal particles from the Terminal have a substantial impact on air quality in the Curtis Bay community.
- There was no substantive evidence presented in the Collaborative Investigation report to support the finding that the community is overburdened by particulate matter (PM) air pollution as compared to other areas of Baltimore City. The Collaborative Investigation report indicates that the community is in attainment with the US Environmental Protection Agency (EPA) National Ambient Air Quality Standards (NAAQS) for $PM_{2.5}$ and PM_{10}.

1.0 Introduction

In February 2022, a collaboration[1] involving Curtis Bay community residents, non-profit organizations, MDE, and academia was formed to investigate concerns related to dark dust found on homes located near the Terminal in Curtis Bay. A study was conducted to evaluate air quality in the residential community as well as in industrially zoned areas in Curtis Bay. The study involved the following components: 1) collection and characterization of dust at several locations in the community; 2) continuous monitoring of PM in various size fractions and gaseous pollutants using low-cost sensors; and 3) episodic sampling of pollutants using a mobile monitoring vehicle. The measurement data were supplemented by photos, videos, experiences, and testimonials from residents.

Preliminary findings were summarized in the Collaborative Investigation report, which was made available for public review on December 14, 2023. The preliminary findings of the study are: 1) coal dust is present throughout the Curtis Bay community; 2) coal dust finds its way into the Curtis Bay community on a day-to-day basis and is correlated with both activity at the Terminal and wind direction; and 3) the Curtis Bay community is overburdened by air pollution, with the community sensor network measuring average particle pollution levels that are higher than at nearby MDE regulatory monitors.

Review of the Collaborative Investigation report indicates that the findings are incomplete, misleading, and flawed. In summary,

- There was no evidence presented in the Collaborative Investigation report to support the finding that coal dust is present throughout the community.
- There was no evidence in the Collaborative Investigation report to support the finding that coal particles from the Terminal have a substantial impact on air quality in the Curtis Bay community.
- There was no substantive evidence presented in the Collaborative Investigation report to support the finding that the community is overburdened by PM air pollution as compared to other areas of Baltimore City. The Collaborative Investigation report indicates that the community is in attainment with the NAAQS for $PM_{2.5}$ and PM_{10}.

The following sections provide a critical review of the Collaborative Investigation report.

2.0 Overview of Sources in the Curtis Bay Area

The Collaborative Investigation report states that the community of Curtis Bay bears the cumulative impacts of pollution from numerous sources, including: the Curtis Bay Energy medical waste incinerator, the BRESCO municipal solid waste incinerator, the Quarantine Road Landfill, the Terminal, the Patapsco Wastewater Treatment Plant, concrete crushing plants,

[1] The collaboration consists of MDE Air and Radiation Administration, the Community of Curtis Bay Association, the South Baltimore Community Land Trust, the CHARMED Center in the Department of Environmental Health and Engineering at the Johns Hopkins Bloomberg School of Public Health (BSPH), and the Department of Atmospheric and Oceanic Sciences at the University of Maryland (UMD).

asphalt manufacturing, chemical plants, and oil and gas terminals.[2] Further, the report states that hundreds of diesel trucks per day move materials along two diesel truck routes, Pennington and Curtis Avenues, through the heart of the residential community.[3] The number of sources potentially having an impact on the Curtis Bay community was also noted in a recent journal article that indicates there are around 70 MDE-regulated stationary sources of air pollution in the Curtis Bay area.[4] Figure 1 taken from the publication identifies the locations of sources of air pollution near the Curtis Bay community.

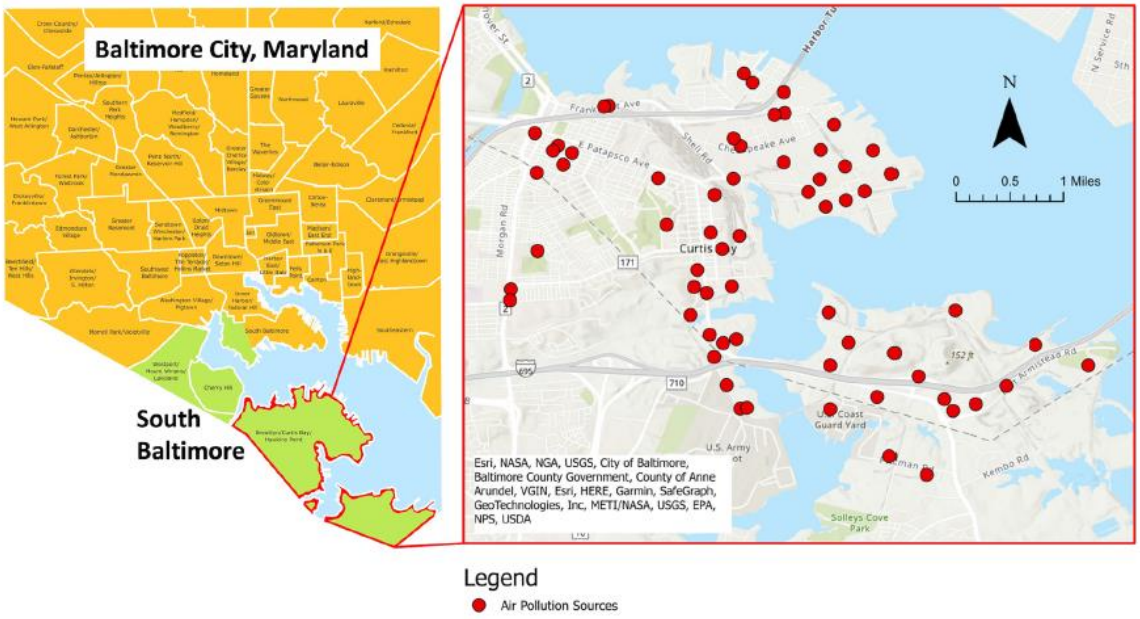

Figure 1. MDE-regulated stationary sources of air pollution in the Curtis Bay area.

In summary, there are a large number of other potential anthropogenic sources of air pollution in the Curtis Bay airshed, including: waste incineration, energy generation, oil/fuel processing and refinement, asphalt manufacturing, bulk material storage and transport, industrial animal agriculture, vehicular and rail transportation, other sources of coal including a coal-fired power plant, and natural sources such as soils, pollen and wildfires. However, the Collaborative Investigation report was primarily focused on the impact of coal dust from the Terminal.

[2] Collaborative Investigation report, Section 2.
[3] Collaborative Investigation report, Section 2. The Collaborative Investigation report's Executive Summary also states: "Heavy diesel truck traffic is a significant mobile source of pollution in Curtis Bay with levels of black carbon along Pennington and Curtis Avenues similar to levels on major Baltimore highways."
[4] Aubourg MA, Sawtell G, Deanes L, Fabricant N, Thomas M, Spicer K, Wagar C, Campbell S, Ulman A and Heaney CD (2023) Community driven research and capacity building to address environmental justice concerns with industrial air pollution in Curtis Bay, South Baltimore, Epidemiol. 3:1198321, at 04. doi: 10.3389/fepid.2023.1198321

3.0 Analysis of Passive Deposition and Tape Lift Samples Using Scanning Electron Microscopy

As part of the Collaborative Investigation report, an attempt was made to assess the impact of coal dust in the Curtis Bay community by collecting particulate samples using passive particulate sampling and surface particulate tape lift methods. The goal of this assessment was to evaluate whether dust settling in locations throughout the community included coal dust from the Terminal.[5] As discussed below, the sampling and analysis conducted for the Collaborative Investigation was flawed.

The samples were analyzed using scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDS) techniques. A review of the SEM/EDS data provided in the Collaborative Investigation report indicates that the results are incomplete and misleading. The following sections provide an overview of the sample collection and analysis methodology, results obtained, and deficiencies.

3.1 Sample Collection and SEM/EDS Analysis of Passive Samplers

The passive particulate samplers used in the Collaborative Investigation report consisted of ~8 mm (wide) by ~25 to 38 mm (length) double-sided sticky conductive carbon tape. The passive samplers were deployed at five locations (two segments of the tape at each location) in the community to monitor particle deposition. The samplers were left exposed to the ambient air from October 26 to October 29, 2023 (three-day sampling period). The locations where passive samplers were used to collect settled PM are provided in Figure 2, which was taken from the Community Investigation report.[6] Location E is located near the Ben Franklin High School and serves as a background site within the Curtis Bay community, relative to the Terminal and other industrial facilities.[7]

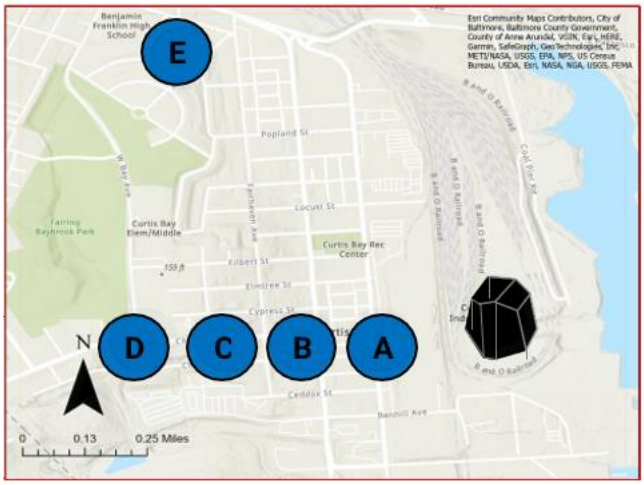

Figure 2. Passive sampler locations in Curtis Bay community. Sample collection was conducted over a three-day period (October 26, 2023 to October 29, 2023).

[5] Collaborative Investigation report, Section 3a, page 7.
[6] Collaborative Investigation report, Section 3a, page 8.
[7] Collaborative Investigation report, Section 3b, page 1.

After collection, the samples were prepared for the SEM/EDS analysis by taking a portion (~ 8 mm by ~8 mm) from each tape and mounting it on an SEM stub. The samples were analyzed at two laboratories[8] using what was described as a 'randomized, systematic' methodology to obtain 'semi-quantitative' data[9] related to the coal dust particle loading on each sample. The analytical process used by the UMD AIM lab analysts consisted of evaluating a 10-by-10 grid (100 grid areas total) that was superimposed on a low magnification (30-45x) image at the center of each mounted sample. The analyst then randomly selected 10 grid cells (10 percent of total grid area) and analyzed 5 to 10 particles between 5 and 100 µm in diameter from each cell using a field emission SEM equipped with an EDS system incorporating a silicon drift X-ray detector (SDD). Using this 'low magnification' analysis methodology, between 50 to 100 particles should have been imaged and analyzed using EDS techniques on each sample.[10]

The BSPH analysts also analyzed particles on the passive samplers using a field emission SEM equipped with an EDS system incorporating an SDD. The Collaborative Investigation report states that three grid cells were randomly selected at a magnification between 350x to 500x. Random sections of the three grid cells were then examined at a higher magnification (2500x) to characterize 3 to 5 particles between 500 nm to 50 µm in diameter[11] in the field of view.[12] Based on this 'high magnification' analysis protocol, 9 to 15 particles should have been analyzed per sample.

Thus, according to the analytical methodology described in the Collaborative Investigation report, between 59 and 115 particles were to be characterized on each passive sampler using the 'low' and 'high' magnification analysis.

Particles identified as 'coal' were based on comparisons with National Institute of Standards and Technology coal standards and samples of coal from the Terminal.[13]

SEM/EDS results for the passive samples for the 'systematic' analysis are summarized in Table 1. As Table 1 demonstrates, the number of particles actually analyzed does not conform to the number of particles that should have been analyzed based on the systematic analysis methodology described in the Collaborative Investigation report. Further, the analysis of only 12 particles is insufficient[14] to obtain semi-quantitative results related to the 'proportion of coal dust particles'[15] in the samples.

[8] The samples were analyzed at the UMD AIM Lab and at the BSPH; Collaborative Investigation report, Section 3a, page 10.
[9] Collaborative Investigation report, Section 3a, page 10.
[10] Collaborative Investigation report, Section 3a, page 10.
[11] The Collaborative Investigation report states that particles between 500 nm and 50 µm in diameter were analyzed during the higher magnification analysis, but it is assumed based on the higher magnification used that the actual size range was 500 nm to 5 µm.
[12] Collaborative Investigation report, Section 3a, page 10.
[13] Collaborative Investigation report, Section 3a, page 10.
[14] Guidelines for the Application of SEM/EDX Analytical Techniques to Particulate Matter Samples, Section 4.6.2, EPA # 600/R-02/070.
[15] Collaborative Investigation report, Section 3a, page 10.

Table 1. SEM/EDS results for passive samples using the Collaborative Investigation 'systematic analysis' protocol.

Location	# Particles Required in Systematic Protocol	# Protocol Particles Analyzed	# "Coal" Particles Identified	# Images of "Coal" Particles	# EDS spectra of "Coal" Particles
A	59-115	12	5	0	0
B	59-115	12	4	2	3
C	59-115	12	4	1	1
D	59-115	12	7	0	0
E	59-115	12	4	1	1

In addition to the analysis described above, the Collaborative Investigation report states that the BSPH analysts also conducted an initial 'exploratory analysis' of the passive samples to investigate particle types deposited on the samples.[16] However, no information was provided on the methodology.

As Table 1 shows, for two of the samples (Samples A and D) there is no documentation[17] that any coal particles were detected using the 'systematic analysis'. It is worth noting that the number of coal particles identified at the background location (Location E) was similar to the number of coal particles reported for the other sampling locations (and was in fact the same number reported at Location B and Location C). Also, note that Location D, which is further from the Terminal than Locations A, B and C, had the highest number of reported "coal" particles. The results suggest other sources of coal particles or particles resembling coal in the community.

For all these reasons, there is insufficient evidence provided in the Collaborative Investigation report to support the claim that coal dust was identified on each of the passive samples.

In summary, the data in the Collaborative Investigation report do not support the conclusion that coal dust was a substantial contributor to settled dust in the community.[18] Importantly, the authors of the Collaborative Investigation report were apparently aware of the limitations and flaws associated with the SEM/EDS analysis of the passive samples and noted these deficiencies in the report: '*…The strength of the systematic analysis is limited by the small sample size of 12 particles per PAPA [passive samplers] sample, as well as the findings of putative coal dust, causing some uncertainty to the identity of deposited particles*'.[19]

[16] Collaborative Investigation report, Section 3a, page 10.
[17] See summary information in two right columns in Table 1 highlighting that no images or EDS spectra were provided in Collaborative Investigation report.
[18] Collaborative Investigation report, Section 3a, page 20.
[19] Collaborative Investigation report, Section 3a, page 20.

3.2 Sample Collection and SEM/EDS Analysis of Tape Lift Samples

The tape lift sampling procedure used in the Collaborative Investigation report was described as being adapted from the American Society for Testing and Materials Standard Practice for Sampling for Particulate Contamination by Tape Lift (ASTM E1216-21),[20] which is focused on the collection and analysis of particles ≥5 µm from sampling surfaces. The samplers were described in the Collaborative Investigation report as consisting of double-sided sticky conductive carbon tape (~8 mm [wide] x ~25 to 38 mm [length]). In total, five tape lift samples were collected from three locations identified in Figure 3, taken from the Collaborative Investigation report.[21] Tape lift samples were collected at Locations 1 and 2 on August 22, 2023 and at Locations 1, 2, and 3 on September 25, 2023.[22] No background tape lift samples were collected.

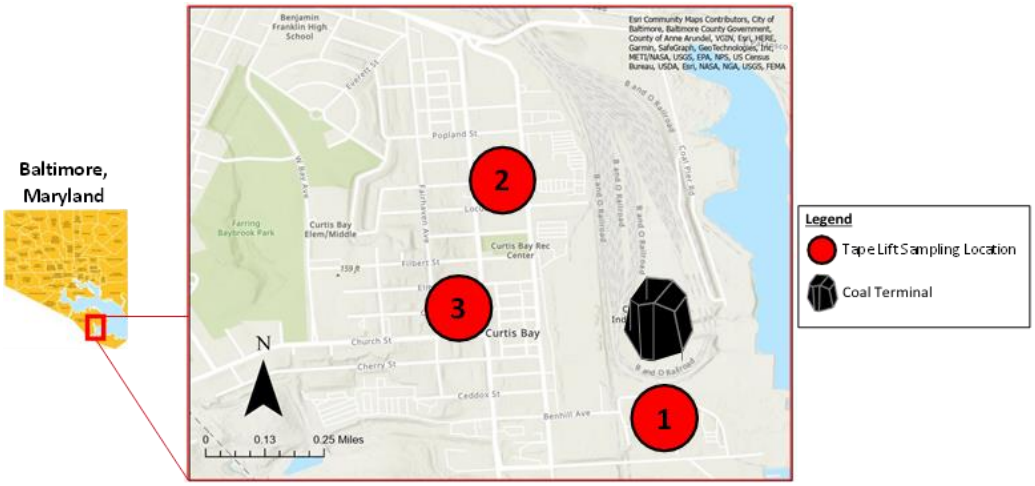

Figure 3. Tape lift sampling locations in Curtis Bay, MD.

The tape lift samples were described as being analyzed using the same 'randomized, systematic' analysis methodology used for passive samples, and as such, a minimum of 59 and up to 115 particles should have been analyzed during the 'low' and 'high' magnification SEM/EDS analyses. However, similar to the passive samples, the analytical methodology was not followed for the tape lift samples. Only 15 particles were analyzed from the Location 1 tape lift sample (August 22, 2023, sample), and only 14 particles were analyzed on the Location 2 tape lift sample (August 22, 2023, sample). The number of particles analyzed is insufficient[23] to obtain semi-quantitative results related to the 'proportion of coal dust particles'[24] in the samples.

Further, the tape lift sample from Location 3 (September 25, 2023, sample) was analyzed without the systemic analysis protocol using an 'exploratory analysis'; however, no information

[20] Collaborative Investigation report, Section 3a, page 9.
[21] Collaborative Investigation report, Section 3a, Figure 8, page 8.
[22] Collaborative Investigation report, Section 3a, pages 7-8.
[23] Guidelines for the Application of SEM/EDX Analytical Techniques to Particulate Matter Samples, Section 4.6.2, EPA # 600/R-02/070.
[24] Collaborative Investigation report, Section 3a, page 10.

was provided on the analytical methodology. SEM/EDS results provided for the tape lift samples are summarized in Table 2.

Table 2. SEM/EDS results for tape lift samples using the Collaborative Investigation 'systematic analysis' protocol.

Location	Sampling Date	# Particles Required in Systematic Protocol	# Protocol Particles Analyzed	# *"Coal"* Particles Identified	# Images of *"Coal"* Particles	# EDS Spectra of *"Coal"* Particles
1	Aug. 22, 2023	59-115	15	9	2	0
2	Aug. 22, 2023	59-115	14	6	4	1
1	Sept. 25, 2023	59-115	None Reported	None Reported	0	0
2	Sept. 25, 2023	59-115	None Reported	None Reported	0	0
3	Sept. 25, 2023	59-115	0	None Reported	0	0

In addition to the issues described above, this analysis also had other problems, including:

- There were no samples collected from a background location, which is a recommended practice to assist in the source impact in a study of this nature.[25, 26]
- There were no data discussed or provided for the tape lift samples collected from Locations 1 and 2 on September 25, 2023.

[25] Draft Guidance on Developing Background Concentrations for Use in Modeling Demonstrations, Section 2.1, EPA-454/P-23-001.
[26] Casuccio, G.S., et. al., The Use of CCSEM and Microimaging to Study Source/Receptor Relationships, Receptor Models in Air Resources Management, Air & Waste Management Association, 1989, ISBN 0-923204-01-6.

4.0 'White Tape Collectors' Used to Document Settled Dust Accumulation

Samplers described as 'white tape collectors' were deployed at four locations in Curtis Bay during the Collaborative Investigation. Figure 4, taken from the Community Investigation report,[27] shows the four sampling locations where the white tape collectors were deployed on May 3, 2023. At each location, five white tape collectors were used to collect settled dust over different durations: 3, 7, 13, 21, and 28 days.[28] The Collaborative Investigation report states that light microscopy was used to capture images of the particles, and the color and morphology of the particles were compared to a control white tape collector with material from a bulk coal sample obtained from the Terminal.[29]

Optical microscopy images of the control white tape collector, Location A, Location C, and Location D samples are presented in the Collaborative Investigation report.[30] There are no scale markers on the images, and the images appear to be collected at different magnifications, making comparison of the images difficult. An optical microscopy image from Location B was not included. The Collaborative Investigation report states that from a qualitative perspective, there were more black particles on the white tape collectors nearer to the Terminal, and it is implied that the black particles are related to coal dust from the Terminal.[31] However, it is important to note that the optical microscopy examination did not speciate particles and therefore, no information was provided related to the presence or amount of coal particles on these samples. It should also be emphasized that 'black particles' cannot be used to indicate

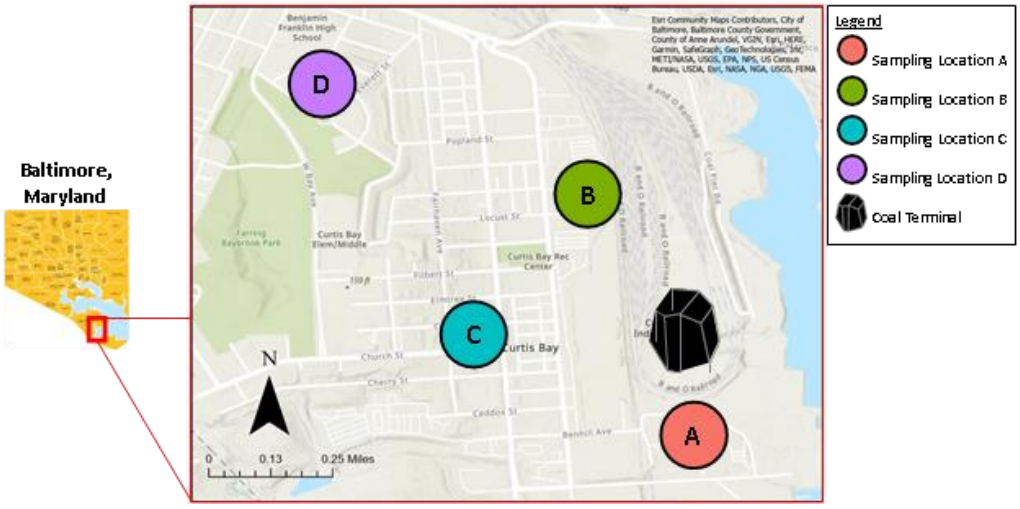

Figure 4. Approximate sampling locations of white tape collectors deployed to visibly accumulate settled dust over a 28-day period in the Curtis Bay community from May 3, 2023, to May 31, 2023.

[27] Collaborative Investigation report, Section 3a, Figure 1, page 1.
[28] Collaborative Investigation report, Section 3a, page 2.
[29] Collaborative Investigation report, Section 3a, page 4.
[30] Collaborative Investigation report, Section 3a, page 4.
[31] Collaborative Investigation report, Section 3a, page 7.

the presence of coal, as there are a variety of particles (both naturally occurring and anthropogenic) that have a dark appearance.[32,33]

In addition to light microscopy, the Collaborative Investigation researchers used image analysis techniques (ImageJ) to assign a darkness value to each of the tape strips in an attempt to compare dust accumulation between sampling locations and between exposure times.[34] However, this effort was of no value with respect to identifying coal dust because 'darkness' is not uniquely indicative of coal. Further, the Collaborative Investigation report noted the weaknesses of using the darkness scoring due to the variable lighting environment, stating '*the darkening of white tape strips by sampling location and time exposed is clearly evident, but not consistently reflected in the ImageJ darkness scoring*'.[35]

5.0 Use of Multi-Pollutant Air Sensor Network to Identify and Apportion Coal Dust and Other Sources of Air Pollution in Curtis Bay, South Baltimore, Maryland

Researchers involved in the Collaborative Investigation used what was described as an unsupervised classification technique referred to as non-negative matrix factorization (NMF) in an attempt to apportion specific pollutants to specific source types of air pollution in Curtis Bay. According to the report, NMF provides an objective way to assess whether a coal dust source profile (a term used to describe characteristics associated with a particular source's emissions) was present in the community as well as a systematic approach to understanding the frequency of coal dust in the data.

A significant flaw with the approach as implemented by Collaborative Investigation researchers is that they did not have a realistic profile for coal dust. Therefore, they developed the term ***Putative Coal Dust***, which was defined as 'a combination of major contributions from PM_{10}, total suspended particles (TSP), and black carbon.'[36] These descriptors are not unique to coal dust. PM_{10} contains fine and coarse particulate matter generally less than 10 µm in size and is composed of a multitude of naturally occurring and anthropogenic particles, including mineral particles found in soils (such as aluminum-silicates, calcium carbonate, and oxide); sulfur-containing particles such as ammonium sulfate and gypsum (calcium sulfate); organic and elemental carbon particles including vegetation; soot; coal; fly ash; metals, etc. TSP consists of PM_{10} and larger particles. Black carbon is described by the EPA as 'sooty black material emitted from gas and diesel engines, coal-fired power plants, and other sources that *burn* fossil fuel.'[37] Black carbon is ubiquitous in an urban environment, and is 'a collective term that describes a range of carbonaceous substances from partly charred plant residues to highly

[32] The Particle Atlas, Edition Two, Volume II, The Light Microscopy Atlas, Walter C. McCrone and John Gustav Delly, Ann Arbor Science Publishers Inc., Ann Arbor, Michigan, 1973.
[33] RJ Lee Group internal studies.
[34] Collaborative Investigation report, Section 3a, page 4.
[35] Collaborative Investigation report, Section 3a, page 7.
[36] Collaborative Investigation report, Section 3b, page 6.
[37] EPA science in ACTION: Black Carbon Research and Future Strategies - Reducing emissions, improving human health and taking action on climate change. Washington D.C.: U.S. EPA, October 2011.

graphitized soot that are generated as products of incomplete combustion.'[38] Coal dust from the daily operations at the Terminal is not combusted, and would not resemble black carbon from other urban sources in terms of composition, size, or morphology of the particle.

As discussed in the following sections, the NMF data provided in the Collaborative Investigation report have no merit because:

- The NMF input data sets were based on a limited number of 'pollutants,' which hindered the ability to gain a comprehensive understanding of the sources contributing to the airshed.
- PM_{10}, TSP, and black carbon are not specific to coal particles either individually or combined.
- Several of the source types have profiles (*factors*) based on the same pollutant(s), which can result in excessive collinearity (similarity with multiple source profiles).
- There was no *factor* provided for coal dust.
- The *factor* for '*Putative Coal Dust*' (i.e., assumed coal dust) is not specific to coal dust.
- The pollutant profile for what is referred to as '*Putative Coal Dust*' is not consistent.
- There was no *factor* provided for vehicular diesel emissions, which was identified in the Collaborative Investigation report as being a significant source of air pollution in the Curtis Bay area. Diesel emissions would be associated with black carbon and fine particulate matter.
- *Factor* intensities do not provide a clear indication of source impact. Apportioning source impacts in micrograms per cubic meter ($\mu g/m^3$) would be a more relevant indicator.

The following sections provide an overview of the NMF approach as well as the flaws with using this methodology to identify and apportion the potential impact of coal dust in the Curtis Bay community.

5.1 Description of the South Baltimore (Curtis Bay) Air Monitoring Network and NMF Approach

The South Baltimore Community Air Monitoring Network consisted of 10 locations, as highlighted in Figure 5, taken from the Collaborative Investigation report.[39] Monitoring locations are numbered from 1 to 10 based on their proximity to the Terminal, with Location 1 being the closest and Location 10 being the furthest away from the Terminal.[40] As previously noted, Location 8, located near Ben Franklin High School, serves as a community background site relative to the Terminal and other industrial facilities.[41] Location 9 was also located in the same

[38] Long, C.M., Nascarella, M.A., Valberg, P.A., Carbon black vs. black carbon and other airborne materials containing elemental carbon: Physical and chemical distinctions. Environmental Pollution, 181:271-86, 2013.
[39] Collaborative Investigation report, Section 3b, Figure 1, page 2.
[40] Collaborative Investigation report, Section 3b, page 1.
[41] Collaborative Investigation report, Section 3b, page 1.

general area as Location 8 and thus could also serve as a background site. Location 10 can be used as an additional background site because it is the farthest removed monitoring site and is located northeast of the Terminal, whereas the other monitors are located west and south of the Terminal.

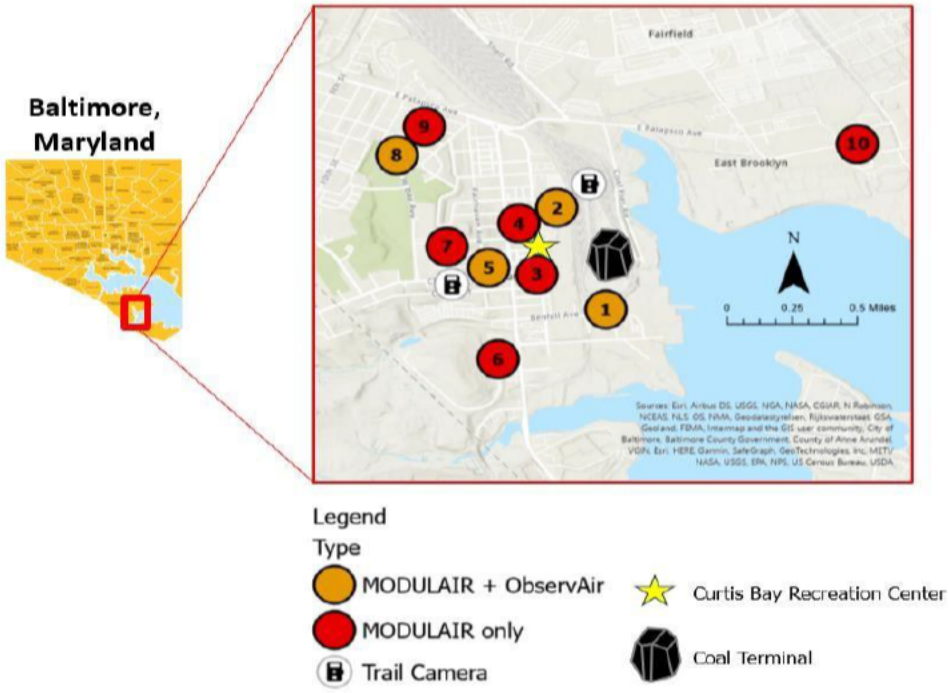

Figure 5. Locations of Curtis Bay air pollution monitors used in the South Baltimore Air Monitoring Network.

The dataset utilized with the Collaborative Investigation NMF approach included 8 pollutant categories measured by QuantAQ MODULAIRs and DSTech ObservAirs low-cost sensor monitors at 4 locations (Locations 1, 2, 5, and 8): PM_1, $PM_{2.5}$, PM_{10}, TSP, carbon monoxide (CO), nitrous oxide (NO), nitrogen dioxide (NO_2), and black carbon.

The NMF approach used in the study was briefly described in the report.[42] The process involved decomposing a matrix of pollutant-specific data, initially normalized from 0 to 1, into *factors*. The NMF pollution relationships (contributions of each pollutant to each *factor*) were produced for each of the four locations evaluated by settling on four *factors*, which was stated to be a 'satisfactory solution' after exploring three- to six-*factor* solutions. Based on the associations of pollutants, efforts were made to attribute the *factors* to specific source types based on the researchers' knowledge of the area.[43]

However, this approach was inadequate to identify the impact of coal particles in the Curtis Bay community. First and most importantly, ***'Putative Coal Dust' is not coal dust***. As noted, the *'Putative Coal Dust' factor* was defined as consisting of *major* contributions of PM_{10}, TSP, and

[42] Collaborative Investigation report, Section 3b, page 5.
[43] Collaborative Investigation report, Section 3b, page 6.

black carbon[44]. This is not an appropriate profile for coal emissions and highlights a significant flaw in the analysis. The term '*Putative Coal Dust*' is a non-specific term that does not appear in the peer-reviewed literature. The Collaborative Investigation researchers also did not provide any justification for using black carbon as a major indicator of coal emissions from a coal handling facility. As discussed previously, black carbon is associated with incomplete combustion, not coal handling.

Other *factors* developed in the report included **Dust**, which was described as having *high* contributions from PM_{10} and TSP; **Regional**, which was described as being comprised of *relatively high* contributions from fine particulate matter such as PM_1, $PM_{2.5}$, and black carbon; **Local Combustion**, which was described as having a *relatively high* contribution of NO, but quickly oxidizing to NO_2, in addition to contributions from black carbon and fine particles;[45] **Cars**, which were defined as having a *presence* of fine particles and a *dominant* contribution of CO; and **Diurnal Combustion**, which was defined as having high contributions of NO_2 and followed a diurnal pattern. Defining the *factors* with qualitative terms such as 'major', 'high', 'relatively high', 'presence', and 'dominant' illustrates the lack of clarity with the NMF approach.

Of significant concern is that there was no *factor* for vehicular diesel emissions, which would also be associated with black carbon emissions. The lack of a diesel *factor* is a significant omission and oversight given that diesel emissions related to vehicular traffic were stated throughout the Collaborative Investigation report as being a significant source of black carbon in the Curtis Bay area.

With respect to collinearity, several of the *factors* developed in the Collaborative Investigation report have the same pollutant(s) as a component of their *factor*. For example, both the '*Putative Coal Dust*' and Dust *factors* are associated with PM_{10} and TSP. '*Putative Coal Dust*', Regional, and Local Combustion each have a black carbon component as part of their *factor*. Fine particulate matter (PM_1 and $PM_{2.5}$) was associated with the Regional, Local Combustion, and Cars *factors*. Apportioning the same pollutants with multiple *factors* will lead to uncertainties as pollutants could be attributed to more than one type of source.

The NMF approach used in the report produced relationships among the pollutants (*factors*) that were then interpreted and assigned by the researchers to a source type that was assumed to be representative of the source. This approach is prone to misinterpretations, especially given the collinearities in pollutants that exist among the source categories. Ideally, the interpretation of source *factors* would be conducted with reference to measured data on pollutants attributable to each source, which was not done in the Collaborative Investigation. Further, it appears that because the researchers were focused on coal particle impacts from the Terminal, they overlooked potential background confounding sources in the Curtis Bay area. This is a significant deficiency of the Collaborative Investigation report given the high density of sources in the Curtis Bay airshed.[3,4] Further, it is stated that the NMF approach was based on sampling 25% of the dataset, but the Collaborative Investigation report provides no details

[44] Collaborative Investigation report, Section 3b, page 6.
[45] Not defined but assumed to be PM_1 and $PM_{2.5}$.

regarding which data were included in this evaluation.[46] Finally, unlike similar source apportionment models such as Positive Matrix Factorization (PMF), NMF does not consider the uncertainties associated with pollutants, and neglecting uncertainties may impact the reliability of the results.[47,48]

5.2 Evaluation of NMF Results

The Collaborative Investigation report provides a summary of generated NMF *factors* for Locations 1, 2, 5, and 8 (see Figure 6 taken from the Curtis Bay Collaborative Investigation report[49]). As previously noted, the *factors* were defined by the Collaborative Investigation researchers as being representative of: 1) '*Putative Coal Dust*'; 2) Diurnal Combustion; 3) Local Combustion; 4) Regional; 5) Cars; 6) Dust; and 7) Residual.

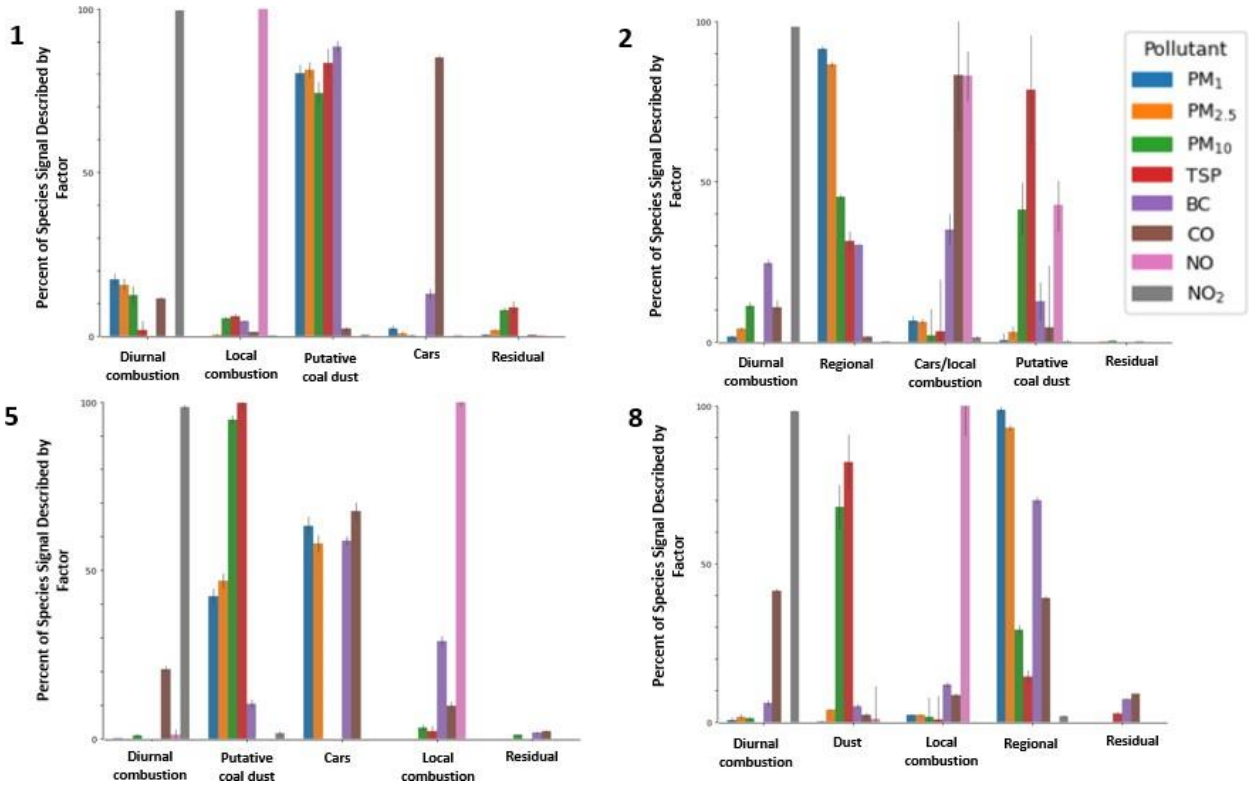

Figure 6. Non-negative matrix factorization (NMF) *factor* compositions at Locations 1, 2, 5, and 8 in the South Baltimore Air Monitoring Network. Taken from the Collaborative Investigation report.

[46] Collaborative Investigation report, Section 3b, page 5.
[47] Shi et al., Effect of Uncertainty on Source Contributions from the Positive Matrix Factorization Model for a Source Apportionment Study, Aerosol and Air Quality Research, 16: 1665–1674, 2016.
[48] Yang, L. H., et al., Investigating the Sources of Urban Air Pollution Using Low-Cost Air Quality Sensors at an Urban Atlanta Site, Environmental Science & Technology, Environmental Science & Technology 2022, 56 (11), 7063-7073, doi: 10.1021/acs.est.1c07005
[49] Collaborative Investigation report, Section 3b, Figure 5, page 6.

The NMF results provided in Figure 6 of the Collaborative Investigation report lack clarity for several reasons. The y-axis is described as 'Percent of Species Signal Described by Factor', not a specific quantity of pollutant. Providing NMF data based on normalized pollutant concentrations can be misleading. For instance, a high 'species percentage' may correspond to a small ambient concentration. The Collaborative Investigation report does not present concentrations in $\mu g/m^3$ for each pollutant in the source profiles or the profiles' contributions to the overall ambient air quality, which would allow comparison of actual pollutant concentration.

Additionally, source types were not consistently defined. For example, at Location 1, which is located in the industrial zoned area of Curtis Bay, the Collaborative Investigation report states that there is the presence of a strong '*Putative Coal Dust' factor*, consisting of PM_1, $PM_{2.5}$, PM_{10}, TSP, and black carbon contributing nearly 70% each to the total *factor*.[50] However, the '*Putative Coal Dust' factor* was previously defined as being comprised of a combination of major contributions from PM_{10}, TSP, and black carbon. The PM_1 and $PM_{2.5}$ components of this *factor* could indicate impacts from the *Regional factor*, which is not listed as a source at Location 1 and further illustrates the issue of collinearity discussed previously. Further, since no *factor* was developed for a vehicular diesel source, it is possible that the '*Putative Coal Dust' factor* at Location 1 may represent a combination of Regional, Dust, and vehicular diesel sources and illustrates that the interpretation of NMF data can be subjective.

At Location 2, which is also located in the industrial zoned area of Curtis Bay, the '*Putative Coal Dust' factor* is associated with a contribution from NO, which does not make sense. The Collaborative Investigation report notes this issue and states that it suggests the presence of nearby diesel emissions.[51] Given this acknowledgement that diesel emissions may have contributed to the '*Putative Coal Dust' factor*, it is inappropriate that the Collaborative Investigation researchers did not include a *factor* for diesel emissions. It was noted numerous times in the Collaborative Investigation report that diesel trucks are a significant component of vehicular activity in Curtis Bay.[52] Further, polar plots prepared by the Collaborative Investigation researchers at Location 3 suggest impacts from vehicles.[53] Also notable is that Location 2 has a *Regional factor* that includes black carbon, which as discussed with Location 1, suggests issues with collinearity at this site.

At Location 5, the '*Putative Coal Dust' factor* was associated with significantly less black carbon as compared to Location 1, but is similar to the amount observed at Location 2. However, unlike Location 2, there was no *Regional factor* listed at Location 5 even though there is a significant PM_1 and $PM_{2.5}$ contribution. Alternatively, the '*Putative Coal Dust' factor* could be interpreted as a combination of *Regional* and *Dust factors*. Further, the *Cars factor* at this location has a significant component of black carbon, which is not consistent with the definition of the *Cars factor* and may indicate diesel truck emissions impact.

[50] Collaborative Investigation report, Section 3b, page 7.
[51] Collaborative Investigation report, Section 3b, page 7.
[52] '*Hundreds of diesel trucks per day move materials along two diesel truck routes, Pennington and Curtis Avenues, through the heart of the residential community with homes, small businesses and a recreation center in between*.', Collaborative Investigation report, Section 2. See also Executive Summary and Section 4, page 22.
[53] Collaborative Investigation report, Section 4, page 6.

At Location 8, the Collaborative Investigation report states that the presence of a '*Putative Coal Dust' factor* is less clear due to significantly smaller contributions from black carbon and higher contributions from PM_{10} and TSP.[54] The Collaborative Investigation researchers try to rationalize this by stating that since this location was farthest from the Terminal, it was less likely to have a '*Putative Coal Dust'* profile because larger particles associated with PM_{10} and TSP would settle prior to arriving at the Location 8 monitor. This is an unconvincing explanation, as there was a significant contribution of PM_{10} and TSP with some black carbon, but that was assigned to the *Dust factor*. Further, the *Regional factor* contains a significant component of black carbon. The combination of fine particles (PM_1 and $PM_{2.5}$) with black carbon is most likely associated with vehicular diesel emissions.

To further illustrate how the NMF results can be misinterpreted, Figure 7, taken from the Collaborative Investigation report,[55] provides a plot of the time series of all NMF *factors* associated with pollutant concentrations during what is described as the 'terminal bulldozer event' that occurred from 12:00 pm to 3:00 pm on February 3, 2023. The plot shows that there were four distinct peaks observed in the '*Putative Coal Dust' factor* that occurred at approximately 12:00, 1:00, 1:15, and 2:00 pm. During all four of these time periods, the report indicated that the NMF results were associated with '*Putative Coal Dust'*. It was also stated that there were co-incident increases in the *Near Combustion factor* (which is a *factor* that was not identified previously in the Collaborative Investigation report).

However, review of the low-cost sensor data in Figure 8, taken from the Collaborative Investigation report,[56] suggest that the higher concentrations are correlated with other non-coal sources. For example, the '*Putative Coal Dust' factor* was defined as being comprised of a combination of major contributions from PM_{10}, TSP, and black carbon, and since there are no PM_{10} or TSP spikes in concentrations reported at 12:00 pm, it suggests a different source or combination of sources was the cause of this spike. Review of the data for the spikes that occurred at approximately 1:00, 1:15, and 2:00 pm, indicate that there is no or minimal black carbon, which again suggests other sources were responsible for this spike.

[54] Collaborative Investigation report, Section 3b, page 7.
[55] Collaborative Investigation report, Section 3b, Figure 11, page 14.
[56] Collaborative Investigation report, Section 3b, Figure 12, page 15.

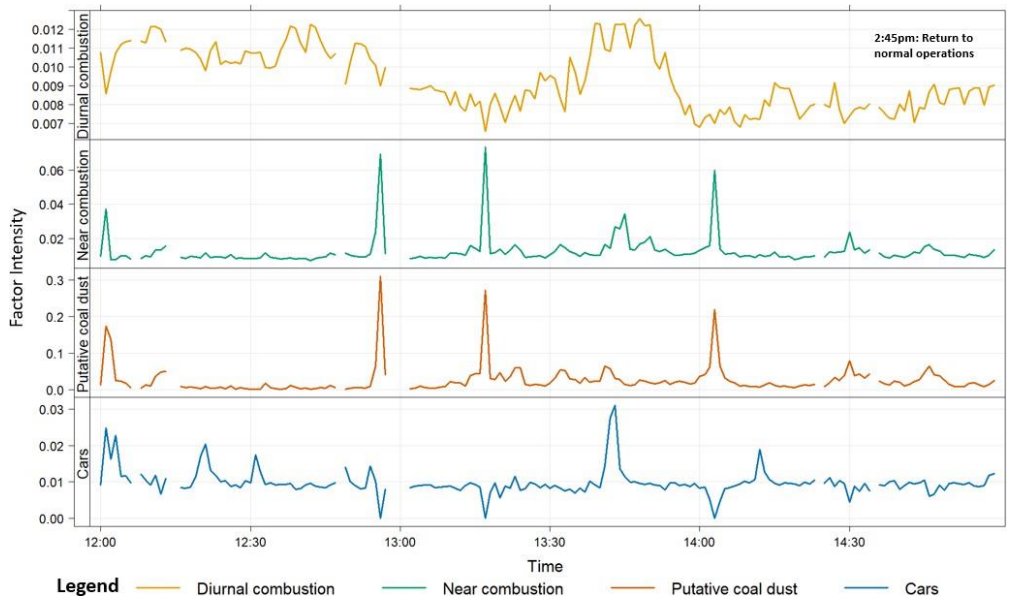

Figure 7. Time series of NMF *factors* (diurnal combustion, near combustion, *'Putative Coal Dust'*, and cars) during the terminal bulldozer event (12pm-3pm) at Location 1, February 3, 2023.

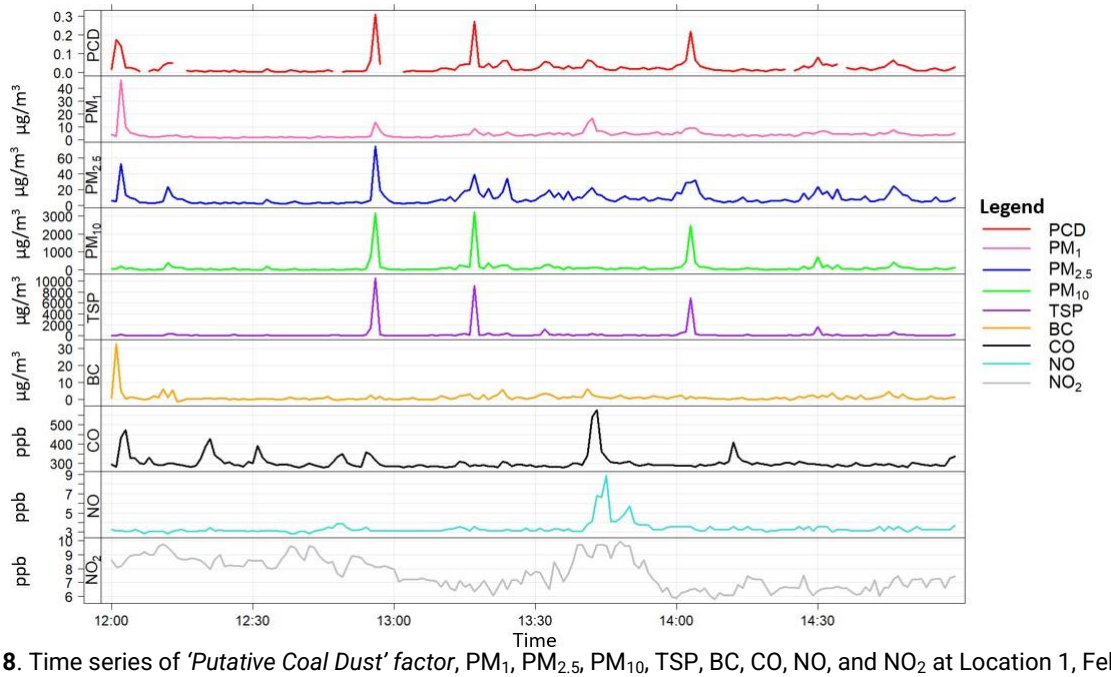

Figure 8. Time series of *'Putative Coal Dust' factor*, PM_1, $PM_{2.5}$, PM_{10}, TSP, BC, CO, NO, and NO_2 at Location 1, February 3, 2023 'terminal bulldozer event' (12pm - 3pm).

Thus, there appears to be no justification to conclude that the spikes that were observed were related to coal dust based on the Collaborative Investigation report criteria. This example illustrates the flaws surrounding the use of NMF in the Collaborative Investigation report.

In summary, the interpretation of the *factors* is inconsistent, highly interpretative, and not specific to coal dust. The fact that the Collaborative Investigation report did not consider vehicular diesel emissions further limits the validity of the NMF results.

5.3 Inconsistencies and Issues Associated with the NMF Approach

The definition for the '*Putative Coal Dust' factor* is not consistent throughout the Collaborative Investigation report. It was originally defined as being comprised of a combination of major contributions from PM_{10}, TSP, and black carbon; however, it was previously noted that Location 1 had a 'strong putative coal dust factor' consisting of PM_1, $PM_{2.5}$, PM_{10}, TSP, and black carbon. Additionally, in a recent publication related to the Collaborative Investigation, a different "framework" of probable source types was suggested to define "types of pollution events" as noted below.[4]

- Fugitive coal dust emission: elevated PM_{10} and/or TSP and black carbon
- Diesel combustion emissions: elevated PM_1 and/or $PM_{2.5}$, black carbon, CO, CO_2 and/or NO_x
- Non-combustion particulate matter: PM_1 and/or $PM_{2.5}$
- Road dust or other coarse-mode particulate matter: PM_{10} and/or TSP

To successfully use a mathematical approach to apportioning pollutants, the definitions of source profiles need to have characteristics or relationships unique to the source, and the definitions need to be consistent. Further, it is necessary to have speciation data (signature) to support the *factors* to minimize or eliminate confounders. For example, there is no documentation to support identifying coal dust as a combination of major amounts of PM_{10}, TSP and black carbon.

As noted previously, the lack of a diesel *factor* in the NMF analysis in the report is unacceptable given that it was noted several times that diesel traffic is a significant source in the community and indicates that the NMF approach is flawed.

It is also imperative when working with mathematical techniques to communicate and qualify the strengths and limitations of the techniques utilized. For example, the NMF evaluation was done using 1-minute monitoring data, which is more prone to fluctuations (i.e., noise) in the data as compared to longer-averaged concentrations.[57] With respect to the MODULAIR low-cost sensor(s) PM_1, $PM_{2.5}$ and PM_{10} data, the manufacturer does not provide specifications related to the accuracy of measurements at 1-minute intervals.[58,59]

Finally, when performing studies of this nature, it is important to evaluate data from a commonsense perspective. In this instance, it simply does not make sense that there would be no *Dust* or *Regional factors* at Locations 1, 2 and 5, as 'dust' is ubiquitous and regional influences are typical in an airshed, and in some instances is the result of national and

[57] Trinity Consultants report, Response to the Collaborative Investigation of Coal Dust, Air Pollution, and Health Concerns in Curtis Bay, South Baltimore, Maryland, USA, 2022-2023; Section 4.1.
[58] Trinity Consultants report, Response to the Collaborative Investigation of Coal Dust, Air Pollution, and Health Concerns in Curtis Bay, South Baltimore, Maryland, USA, 2022-2023; Section 2.3.1.
[59] MODULAIR Product Specification Sheet accessed Feb 05, 2024: https://assets.quant-aq.com/downloads/spec-sheets/modulair.latest.pdf

international transport of particles (e.g., the recent Canadian wildfire smoke affecting air quality throughout the Eastern United States).[60]

5.4 Evaluation of the *'Putative Coal Dust' Factor* with Respect to Wind Direction

As part of the Collaborative Investigation report, '*Putative Coal Dust' factor* intensities at Locations 1, 2, and 5 and *Dust* (*factor* assigned to background Location 8) were compared with wind directions "upwind" and "downwind" of the Terminal, with respect to bulldozer, ship, and train activity.[61] This analysis was flawed for several reasons.

First, any air quality sampling "downwind" of the Terminal also includes impacts to air quality from other sources that are "upwind" of the Terminal as well as sources between the monitor and the terminal. Relatedly, the downwind location sampling did not account for mobile sources, coal/fuel oil combustion, or vegetive burning, which in many urban environments can be the largest contributors to $PM_{2.5}$.[62]

Second, the results suggest that other background sources were responsible for measured dust. The results, illustrated as boxplots, showed that in most instances the background location (Location 8) *Dust factor* intensities were similar to or even higher than *Dust factor* intensities at Locations 1, 2 and 5 when 'reported winds' were from the direction of the Terminal, suggesting other background sources in the area.

Third, it is not stated what meteorological data were used in this evaluation. It is assumed that the wind data were obtained at the location of each monitor, which could lead to errors in the interpretation of the results.[63]

Finally, because the '*Putative Coal Dust' factor* was not validated as representative of coal dust emissions (as discussed in the prior section), any comparisons of source impact of coal dust with respect to wind direction are presumptive and potentially misleading. Notwithstanding, the issues with how the wind direction data were collected and analyzed, the collinearity issue related to the '*Putative Coal Dust' factor* with other sources makes it unreliable to attribute pollutants measured at the sampling locations to activities at the Terminal.

The potential impact of background sources is explored in more detail in Section 7.

6.0 Mobile Monitoring of Black Carbon in Curtis Bay

A mobile pollutant measurement platform developed jointly by the UMD and National Oceanic and Atmospheric Administration's Air Resources Laboratory was used to measure black carbon concentrations on heavily traveled roads in Curtis Bay (Pennington Avenue and Curtis Avenue)

[60] US EPA, Reconsideration of the National Ambient Air Quality Standards for Particulate Matter, Federal Register, Vol 88, No. 18, January 27, 2023: https://www.govinfo.gov/content/pkg/FR-2023-01-27/pdf/2023-00269.pdf
[61] Collaborative Investigation report, Section 3b, Figures 16, 17, 18, 19, pages 20, 21, 22, 23.
[62] United States Environmental Protection Agency. *Policy Assessment for the Reconsideration of the National Ambient Air Quality Standards for Particulate Matter, May 2022* (EPA-452/R-22-004).
[63] Trinity Consultants report, Response to the Collaborative Investigation of Coal Dust, Air Pollution, and Health Concerns in Curtis Bay, South Baltimore, Maryland, USA, 2022-2023, Section 2.3.3.

on April 27, 2023. The mobile vehicle can record black carbon measurements along with time-resolved GPS coordinates, which enables concentrations to be plotted with the location of the vehicle.

Results from the Collaborative Investigation report showed that black carbon concentrations were 'remarkably' higher and more variable on Pennington Avenue.[64] The Collaborative Investigation report noted that the high density of diesel trucks combined with stop-and-go traffic on Pennington Avenue appears to be the dominant cause.[65] The fact that the black carbon measurements are significantly higher on Pennington Avenue, which is further from the Terminal than Curtis Avenue, supports the conclusion that diesel trucks were the most likely source of the black carbon emissions.

The Collaborative Investigation report also states that black carbon levels above 1.63 µg/m^3 are a 'potential health threat',[66] but no information or citation is included to justify this statement. Furthermore, caution should be used when attempting to apply short-term measurements of concentrations to projecting health effect outcomes. Peak concentration instantaneous measurements do not put into context the frequency, duration, and level of the exposure.

Another complication with air sampling using a mobile monitoring vehicle is that measurements are only obtained where the vehicle has access to locations to monitor for pollutants. This limits the ability to obtain measurements on private properties and at other locations where the vehicle cannot reach to evaluate other potential sources, such as potential upwind black carbon sources like ships or other industrial facilities in South Baltimore.

Finally, the Collaborative Investigation report identifies 'coal dust, fires and diesel exhaust' as major sources of black carbon with no support for the claim.[67] This statement, with respect to coal, is not substantiated. In fact, it is inconsistent with the results obtained by the mobile monitoring vehicle discussed above, which do not support coal dust as a major source of black carbon.

7.0 Evaluation of the Community-wide Air Pollution 'Burden' in Curtis Bay, South Baltimore, Maryland and the Evaluation of 'Background'

The Collaborative Investigation reported $PM_{2.5}$ daily average concentrations across all monitor locations from 5/26/22 to 5/25/23 in the network excluding wildfire days. Results indicate an annual mean $PM_{2.5}$ concentration of 8.6 µg/m^3,[68] which is below current EPA primary and secondary annual NAAQS for $PM_{2.5}$. The report also states that the Curtis Bay community is in attainment for the 24-hour $PM_{2.5}$ NAAQS. In summary, the monitoring network results suggest that the area is in attainment for $PM_{2.5}$.

[64] Collaborative Investigation report, Section 4, page 20.
[65] Collaborative Investigation report, Section 4, page 22.
[66] Collaborative Investigation report, Section 4, page 20.
[67] Collaborative Investigation report, Section 4, page 18.
[68] Collaborative Investigation report, Section 4, page 8.

With respect to PM_{10}, the wildfire excluded days data collected throughout the community indicate that there were no days in exceedance of the 24-hour PM_{10} NAAQS.[69]

Even though Curtis Bay appears to be in attainment with the NAAQS for $PM_{2.5}$ and PM_{10}, one of the Collaborative Investigation report's preliminary findings is that the Curtis Bay community is overburdened by air pollution,[70] with the community sensor network measuring average $PM_{2.5}$ concentrations that are higher than at nearby MDE regulatory monitors. Comparing the average $PM_{2.5}$ concentration to the Baltimore area monitors averaged from 5/26/22 to 5/25/23 shows a higher concentration of $PM_{2.5}$ (see Table 3).

Table 3. Comparison of average $PM_{2.5}$ concentrations using low-cost monitors in Curtis Bay to Baltimore MDE regulatory monitors from 5/26/22 to 5/25/23.[71]

	$PM_{2.5}$ (µg/m³)	
	Baltimore Area Monitors	Curtis Bay Monitors
Wildfire Days Not Included	6.7	8.6

The presumption of the 'air pollution burden' was based on the fact that $PM_{2.5}$ concentrations in Curtis Bay appeared to be higher than those at nearby MDE monitoring sites by ~1-3 µg/m³.[72]

There are several issues with the 'air pollution burden' finding. First, low-cost sensor monitors are not as accurate as Federal Reference Method (FRM) and Federal Equivalent Method (FEM) monitors, which are used for regulatory purposes. Notwithstanding, the low-cost sensors have been evaluated with FRM and FEM monitors and, as stated in the Collaborative Investigation report, '*Independent evaluations by California's South Coast Air Quality Monitoring District (AQ-SPEC) have found the specific sensor type used in Curtis Bay measure $PM_{2.5}$ with a high bias compared to reference grade monitors by 1-3 µg/m³.*'[73] Thus, the results from the MODULAIR low-cost monitors appear to be within the margin of error of the average concentrations determined from the MDE monitoring sites.[74]

Second, when investigating air pollution burden, it is important to consider all major sources in an airshed. The Collaborative Investigation report states that the pollution burden comes from many different pollution sources in the area, including diesel truck traffic, and that, although $PM_{2.5}$ is largely regarded as a regional pollutant, there may be local contributors as well. To investigate this hypothesis, the Collaborative Investigation report evaluated $PM_{2.5}$ concentrations when the wind direction was downwind versus upwind of the Terminal and found that the $PM_{2.5}$ mean concentrations were statistically significantly higher downwind at all sites, except Location 10 (Wagner's Point). However, this investigation was done based on

[69] Collaborative Investigation report, Section 4, page 10.
[70] Collaborative Investigation report, Section 1, Key Findings.
[71] The $PM_{2.5}$ concentration for the Baltimore area monitors in Table 3 was an average from the Edgewood, Essex, Howard County (near road), Lake Montebello, and Padonia monitor locations.
[72] Collaborative Investigation report, Section 4, page 5.
[73] Collaborative Investigation report, Section 4, page 16.
[74] Trinity Consultants report, Response to the Collaborative Investigation of Coal Dust, Air Pollution, and Health Concerns in Curtis Bay, South Baltimore, Maryland, USA, 2022-2023, Section 1.1.

different datasets. For example, $PM_{2.5}$ concentrations were available for 389 days at Location 5 but only 101 days at Location 7,[75] which may skew the results.

A better approach would be to evaluate the $PM_{2.5}$ concentrations over the same timeframe. To this end, hourly $PM_{2.5}$ and PM_{10} concentrations were evaluated by RJ Lee Group at several Curtis Bay community locations and compared upwind/downwind concentrations with respect to the Terminal. The data used in this evaluation were obtained with the Curtis Bay community low-cost sensor MODULAIR monitors.[76] The assessment was conducted with data collected from June 22, 2023, to August 7, 2023, which corresponds to the period when data were available from each of the community monitor locations at Location 1, Location 4, Location 5, Location 9, and Location 10. Meteorological data (wind direction and speed) were obtained from the Terminal 10-meter meteorological station.[77]

Table 4 provides a summary of $PM_{2.5}$ concentrations at the community monitor locations used in the evaluation. Hourly $PM_{2.5}$ data for each monitor in 16 wind arcs were averaged for the comparison. Results indicate that, on average, the $PM_{2.5}$ concentrations are relatively consistent throughout the network. In most instances, the 'upwind' $PM_{2.5}$ concentrations, which indicate impact from background sources, were lower than the 'downwind' concentrations, suggesting minimal or no impact from the Terminal, or sources between the Terminal and the monitors. Furthermore, the results suggest that there is a significant contributor of $PM_{2.5}$ southeast of the community. Additional supporting information is illustrated in pollution rose diagrams for $PM_{2.5}$ provided in Appendix A.

These findings appear to be consistent with some of the findings reported in the Collaborative Investigation report. For example, Location 6, which is located southeast of the Terminal near Pennington Avenue had the second highest mean $PM_{2.5}$ concentration in the Curtis Bay network.[78] The Collaborative Investigation report noted that, using polar plots, the highest $PM_{2.5}$ concentrations appear to be associated with high winds from the south of the monitor.[79]

[75] Collaborative Investigation report, Section 4, Table 4, Page 5.
[76] Data were obtained from the community monitors and the CSXT meteorological station.
[77] Trinity Consultants report, Response to the Collaborative Investigation of Coal Dust, Air Pollution, and Health Concerns in Curtis Bay, South Baltimore, Maryland, USA, 2022-2023, Section 2.3.3.
[78] Collaborative Investigation report, Section 4, Table 4, Page 5.
[79] Collaborative Investigation report, Section 4, page 7.

Table 4. $PM_{2.5}$ concentrations at Locations 1, 4, 5, 9 and 10 averaged by wind direction from June 22, 2023, to August 7, 2023. 'Monitor Impacted' is downwind from the Terminal based on wind direction.

Wind Direction (From)	Wind Arc (Degrees)	Monitor Impacted	South Gate Location 1 (µg/m3)	Rec Center Location 4 (µg/m3)	Cypress Location 5 (µg/m3)	Ben Franklin Location 9 (µg/m3)	Wagner's Point Location 10 (µg/m3)
North	349˚-11˚	1	9.1	9.0	8.6	9.7	9.0
North Northeast	12˚ -33˚	1	8.0	8.0	7.9	9.2	8.2
Northeast	34˚-56˚	None	6.7	6.7	6.8	6.4	7.0
East Northeast	57˚-78˚	5	5.6	5.7	6.0	6.8	6.0
East	79˚-101˚	5	4.5	4.2	4.3	5.1	5.3
East Southeast	102˚-123˚	5	14.5	14.1	14.4	13.4	13.8
Southeast	124˚-146˚	4,9	12.5	12.2	12.5	12.2	12.0
South Southeast	147˚-168˚	4,9	13.2	13.3	13.5	14.2	14.2
South	169˚-191˚	None	9.5	9.1	9.2	10.7	10.3
South Southwest	192˚-213˚	None	9.5	9.1	9.4	11.1	10.7
Southwest	214˚-236˚	None	12.2	13.1	12.8	14.2	13.0
West Southwest	237˚-258˚	10	10.5	10.3	10.5	11.9	11.4
West	259˚-281˚	10	13.9	13.2	13.1	14.3	14.6
West Northwest	282˚-303˚	10	10.7	10.7	10.3	12.0	11.5
Northwest	304˚-326˚	10	7.8	7.8	7.7	9.5	9.0
North Northwest	327˚-348˚	1	8.8	8.8	8.5	9.7	9.3

A similar 'upwind/downwind' evaluation was performed using PM_{10} data from the Curtis Bay network, and a summary of the average PM_{10} concentrations in 16 wind arcs is provided in Table 5.

Table 5. PM_{10} concentrations at Locations 1, 4, 5, 9 and 10 averaged by wind direction from June 22, 2023, to August 7, 2023. 'Monitor Impacted' is downwind from the Terminal based on wind direction.

Wind Direction (From)	Wind Arc (Degrees)	Monitor Impacted	South Gate Location 1 (µg/m3)	Rec Center Location 4 (µg/m3)	Cypress Location 5 (µg/m3)	Ben Franklin Location 9 (µg/m3)	Wagner's Point Location 10 (µg/m3)
North	349˚- 11˚	1	14.0	15.2	16.8	22.3	19.5
North Northeast	11˚ -33˚	1	14.4	16.3	19.6	24.7	23.8
Northeast	34˚-56˚	None	13.4	15.0	18.7	16.1	20.6
East Northeast	57˚-78˚	5	11.1	12.1	15.9	18.0	20.2
East	79˚-101˚	5	10.4	10.1	13.8	17.2	20.1
East Southeast	102˚-123˚	5	20.2	20.2	21.7	24.5	26.5
Southeast	124˚-146˚	4,9	17.4	17.0	18.7	21.4	20.9
South Southeast	147˚-168˚	4,9	17.9	18.8	20.2	24.7	24.0
South	169˚-191˚	None	14.2	15.2	17.1	22.2	21.4
South Southwest	192˚-213˚	None	15.2	17.0	19.4	26.7	26.1
Southwest	214˚-236˚	None	16.9	19.4	20.8	26.9	25.7
West Southwest	237˚-258˚	10	16.3	17.1	19.0	25.0	25.4
West	259˚-281˚	10	20.0	21.3	23.1	26.6	27.8
West Northwest	282˚-303˚	10	17.7	19.4	20.4	28.0	30.1
Northwest	304˚-326˚	10	14.0	16.6	18.5	25.6	25.3
North Northwest	327˚-348˚	1	14.4	15.7	17.1	22.8	20.2

Results of this evaluation suggest that the Terminal is not a significant source of PM_{10} in the Curtis Bay community. This finding also appears to correlate with some of the findings in the Collaborative Investigation report, where winds from the northwest were associated with the highest 1-minute PM_{10} concentrations at Location 6.[80] Additional supporting information related to the RJ Lee Group findings is provided in Appendix A.

[80] Collaborative Investigation report, Section 4, Figure 19, page 12.

8.0 Summary

The conclusion that the Terminal is a substantial contributor of coal dust in the Curtis Bay community is not supported by data provided in the Collaborative Investigation report. The SEM/EDS analysis results did not support the preliminary finding that coal dust was found at all eight monitoring sites and 100 percent of the samples. Further, the SEM/EDS analysis did not follow the analytical protocol described in the Collaborative Investigation report, bringing into question whether any of the SEM/EDS data are of value.

The use of the 'white tape collectors' were of no real value from a coal particle impact perspective because no particle speciation was performed. Therefore, there is no information on the amount of coal on any of the samples. Darkness does not provide an indication of coal, as there are a variety of particles (naturally occurring and anthropogenic) that have a dark appearance.

The NMF analysis also provides no support for the Collaborative Investigation report's conclusions because of major flaws with the approach including, but not limited to: 1) there was no *factor* provided for coal dust; 2) '*Putative Coal Dust*' is not coal dust but is instead a term developed by the Collaborative Investigation researchers; 3) *'Putative Coal Dust'* was defined as consisting of major contributions of PM_{10}, TSP and black carbon, which is not an appropriate profile for coal dust; 4) PM_{10} and TSP are not source-specific and contain particles from a variety of sources; 5) there was no *factor* identified for diesel emissions, which were identified in the Collaborative Investigation report as being a significant source of black carbon and $PM_{2.5}$ in the community; and 6) the analysis was based on the use of 1-minute average data, which are more prone to fluctuations in concentrations than longer averaged concentrations.

The Community Investigation report's 'air pollution burden' finding also lacks support. The conclusion was based on the perceived differences in $PM_{2.5}$ concentrations in the community compared to concentrations in the general Baltimore area. However, the community concentrations were based on low-cost monitors, whereas the Baltimore data were based on regulatory monitors. Accounting for measurement inaccuracy associated with the low-cost sensors, the results appear to be within the uncertainties of the monitors. Furthermore, the results indicate that the community is in attainment with current NAAQS for $PM_{2.5}$. Review of average $PM_{2.5}$ concentrations based on wind direction suggests that the air quality in the community is primarily affected by local and regional background (non-Terminal) sources. Furthermore, vehicular sources primarily associated with truck traffic are a significant source of particulate matter in air in the community but were largely ignored by the researchers.

Many of the conclusions included in the Collaborative Investigation report were presumptive in nature and not supported by data. Based on scientific review of the information provided in the Collaborative Investigation report and data from the low-cost monitors, the Terminal is not a substantial contributor to an air pollution burden to the Curtis Bay community.

Appendix A

Evaluation of Background $PM_{2.5}$ and PM_{10} Concentrations Using Pollution Rose Diagrams

February 13, 2024

RJ Lee Group

Evaluation and Interpretation of $PM_{2.5}$ and PM_{10} Concentrations Using Pollution Roses

RJ Lee Group evaluated potential background $PM_{2.5}$ and PM_{10} sources (non-Terminal sources) impacting the Curtis Bay community using pollution roses[81] incorporating data obtained from several of the community low-cost particulate monitors and wind direction/speed from Terminal 10-meter meteorological station.[82] The $PM_{2.5}$ and PM_{10} data used in the evaluation were based on 1-hour averages from the community monitors identified as Location 1 (South Gate), Location 4 (Rec Center), Location 5 (Cypress), Location 9 (Ben Franklin High School), and Location 10 (Wagner's Point). The monitor locations in relation to the Terminal are shown in Figure A1, taken from the Collaborative Investigation report.[83] The data evaluated were collected from June 22 to August 7, 2023, which corresponds to the time period when data from each of the five community monitors was available. Days impacted by the Canadian wildfires, as identified in the Collaborative Investigation report, were not included in the data evaluation (June 28-30 and July 11-13).[84]

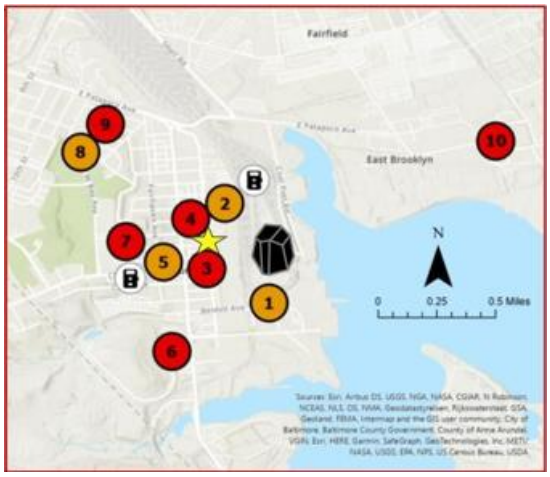

Figure A1. Locations of Curtis Bay air pollution monitors used in the South Baltimore Air Monitoring Network. $PM_{2.5}$ and PM_{10} data were obtained from monitors identified as Locations 1, 4, 5, 9 and 10.

The 1-hour averaged $PM_{2.5}$ and PM_{10} data were plotted with respect to wind direction using a modified pollution rose diagram. The pollution rose diagrams illustrate which wind directions correspond to the average $PM_{2.5}$ and PM_{10} concentrations in each wind sector. Plots of this nature are useful in identifying areas where higher levels of $PM_{2.5}$ and PM_{10} are occurring. Data that was collected with wind from the directions of the Terminal would indicate potential impact at the monitor from the Terminal as well as potential contributions from other upwind (background) sources. Data collected from a monitor with a wind direction that is not downwind of the Terminal would indicate impact from background sources.

[81] California Air Resources Board, https://ww2.arb.ca.gov/resources/fact-sheets/wind-rose-and-pollution-rose-diagrams.
[82] The 10-meter tower became fully operational at the CSX Terminal on March 22, 2023, Collaborative Investigation report, Section 2.
[83] Collaborative Investigation report, Section 3b, Figure 1, page 2.
[84] Collaborative Investigation report, Section 4, page 2.

Figure A2 presents examples of the pollution rose format used in this evaluation. This non-study data illustration represents particulate matter concentrations from a hypothetical location (Monitor A) and shows that higher concentrations are associated with three wind sectors: wind originating from East-Northeast (57°-78°), South (169°-191°), and West (259°-281°). The concentric rings in the chart represent air concentrations in micrograms per cubic meter (µg/m^3). In this example, the highest average concentration (12 µg/m^3) came from the East-Northeast direction and indicates that the higher concentrations are associated with sources East-Northeast of the monitor. Sources from the West (11 µg/m^3) and South (10 µg/m^3) of the monitor were also elevated as compared to the other wind directions. Although this pollution rose displays sources of higher particulate matter from the East-Northeast, West, and South, it is not clear whether the higher particulate concentrations are associated with the source of interest or background without knowing the location of the monitor in relation to the source of interest and data on other sources (background) that may be impacting Monitor A.

Insight on the impact of particulate emissions from the source of interest can be evaluated by comparing the relationships of concentrations in the wind sectors to 'background' monitor(s).[85] Comparing the concentrations to the Background Monitor in Figure A2, the East-Northeast and West concentrations are less than or equal to the concentrations measured at the Background Monitor, which indicates that the concentrations are related to background sources. Comparing the concentrations from the South direction suggests a minor impact from a source located to the south of Monitor A because the concentration is higher than the Background Monitor concentration in that wind sector.

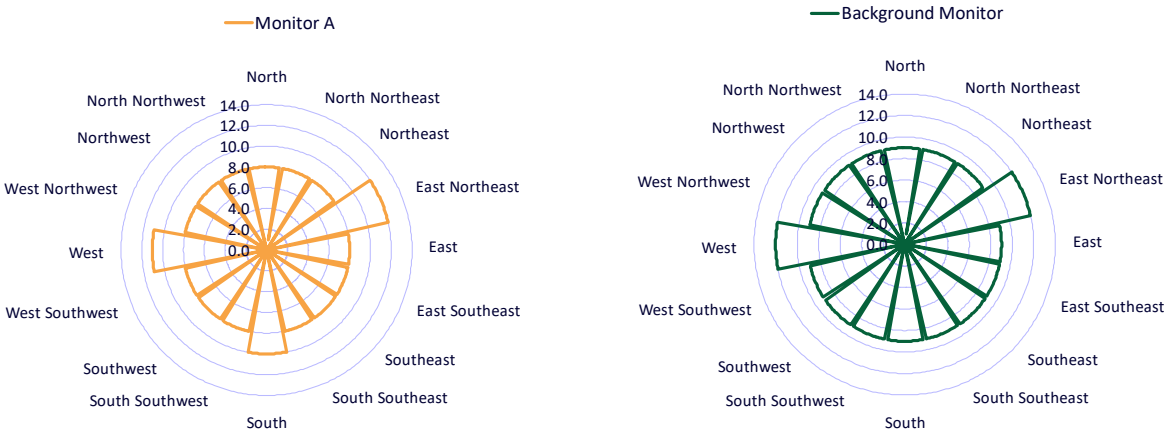

Figure A2. Example pollution rose diagrams showing relationships in average particle concentrations by wind direction at Monitor A (left) to the Background Monitor (right).

The following pollution roses provide insight on potential impact of $PM_{2.5}$ and PM_{10} emissions from the Terminal in the community. In this evaluation, Location 9 (Ben Franklin) and Location 10 (Wagner's Point) are used as 'background' monitors.

[85] A background monitor is used to collect data in a location where the source of interest is expected to have minimal or no impact.

Average $PM_{2.5}$ Concentrations by Wind Direction at Background Monitors

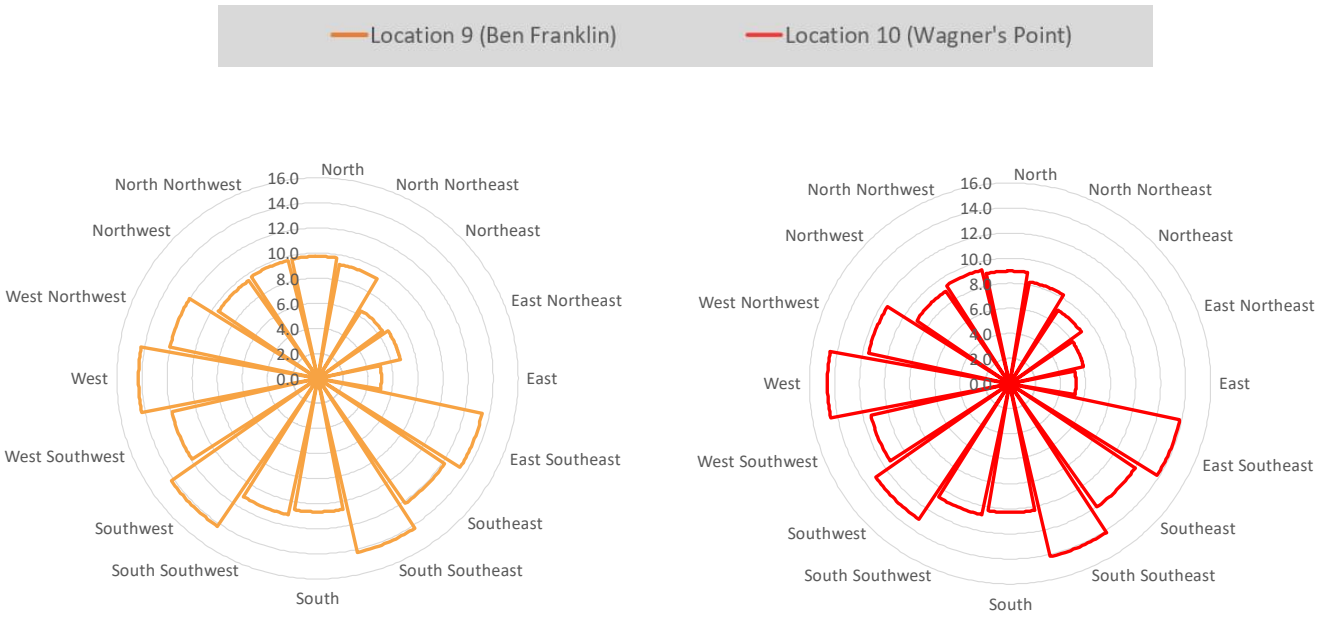

Figure A3. Pollution rose diagrams showing 1-hour average $PM_{2.5}$ (µg/m^3) concentrations for background monitors Location 9 (Ben Franklin) and Location 10 (Wagner's Point). Data were from low-cost MODULAIR community monitors from June 22 to August 7, 2023.

The background monitors of Location 9 (Ben Franklin) and Location 10 (Wagner's Point) have similar pollution rose patterns for $PM_{2.5}$. Higher $PM_{2.5}$ concentrations are associated with winds originating from the southeasterly directions as well as from the westerly directions.

Impact from the Terminal at Location 9 would be from the Southeast and South-Southeast directions. However, the average $PM_{2.5}$ concentrations at Location 10 have a similar pattern as Location 9, suggesting minimal or no impact from the Terminal or other local sources between the Terminal and the monitor at Location 9. At Location 10, particulate impact from the Terminal would be from the Southwest and South-Southwest directions. In these wind sectors, Location 9 concentrations are higher than at Location 10, suggesting no impacts from the Terminal or other local sources between the Terminal and the monitor at Location 10.

Average PM_{10} Concentrations by Wind Directions at Background Monitors

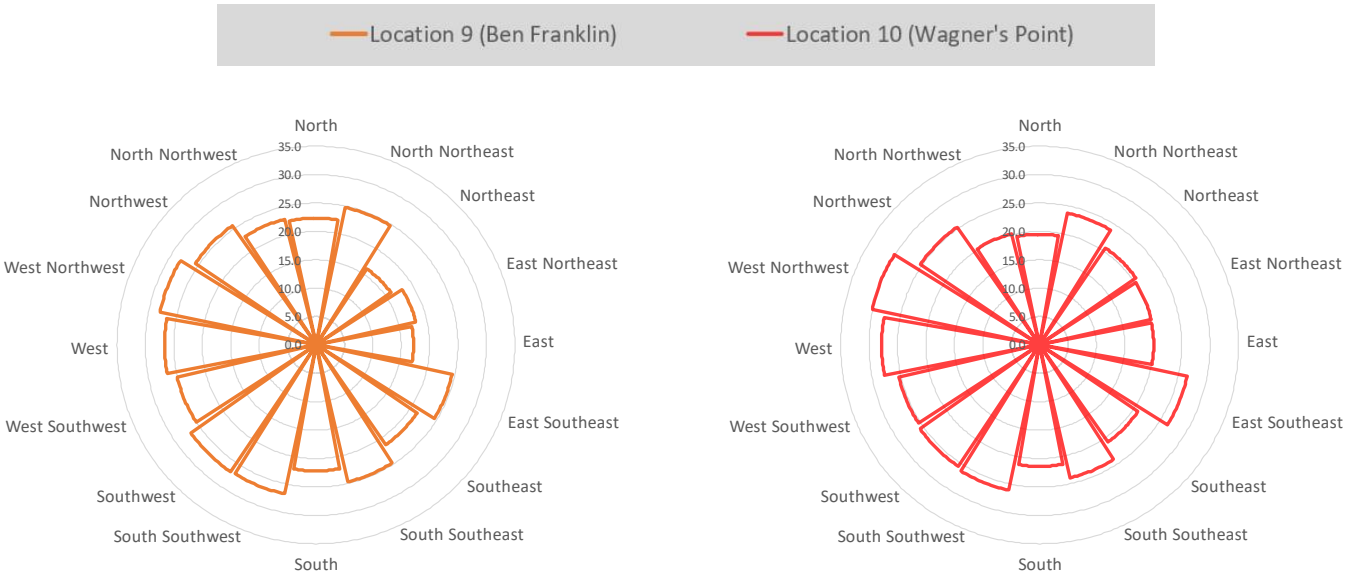

Figure A4. Pollution rose diagrams showing 1-hour average PM_{10} (µg/m^3) concentrations for background monitors Location 9 (Ben Franklin) and Location 10 (Wagner's Point). Data were from low-cost MODULAIR community monitors from June 22 to August 7, 2023.

In Figure A4, the background PM_{10} concentrations are more consistent in the wind sectors as compared to the $PM_{2.5}$ data in Figure A3. The pollution rose diagrams suggest no significant impact from the Terminal or other local sources between the Terminal and the monitors at Location 9 and Location 10.

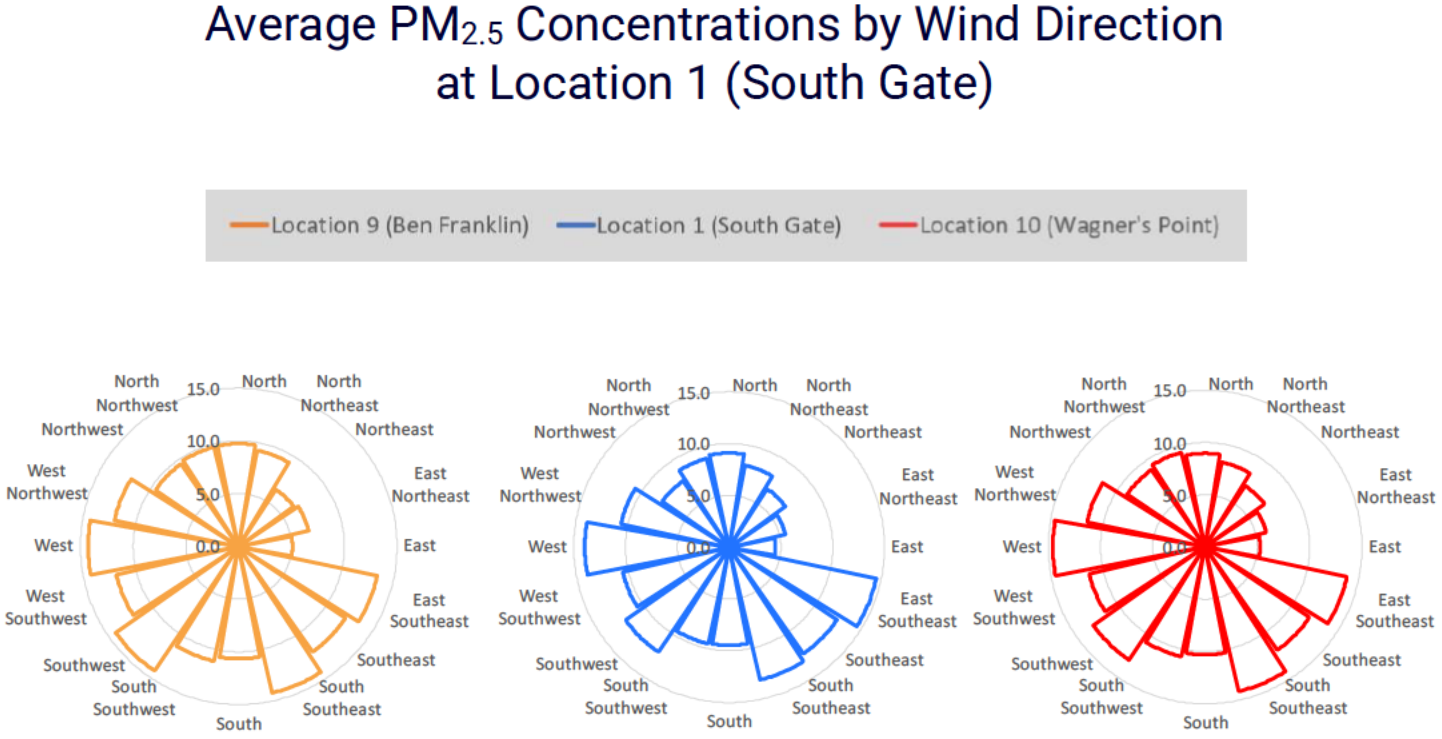

Figure A5. Pollution rose diagrams showing 1-hour average $PM_{2.5}$ (µg/m^3) concentrations for Location 1 (South Gate) and background monitors at Location 9 (Ben Franklin) and Location 10 (Wagner's Point). Data were from low-cost MODULAIR community monitors from June 22 to August 7, 2023.

Figure A5 shows pollution rose diagrams for Location 1 (South Gate) and background monitors at Location 9 (Ben Franklin) and Location 10 (Wagner's Point). The Location 1 (South Gate) monitor is the closest monitor to the Terminal. At Location 1, the Terminal would have a potential impact with winds originating from the northerly directions (North-Northwest, North, and North-Northeast). Review of the average $PM_{2.5}$ pollution rose indicates that concentrations from the northerly directions (8.7 µg/m^3) are the same or *less* than background concentrations at Location 9 (9.6 µg/m^3) and Location 10 (8.8 µg/m^3). Further, the $PM_{2.5}$ concentrations from the northerly directions (8.7 µg/m^3) are significantly lower than concentrations from the southeastern (13.4 µg/m^3), western (10.7 µg/m^3), and southwestern directions (12.2 µg/m^3), indicating impact from background local and/or regional sources at this monitor.

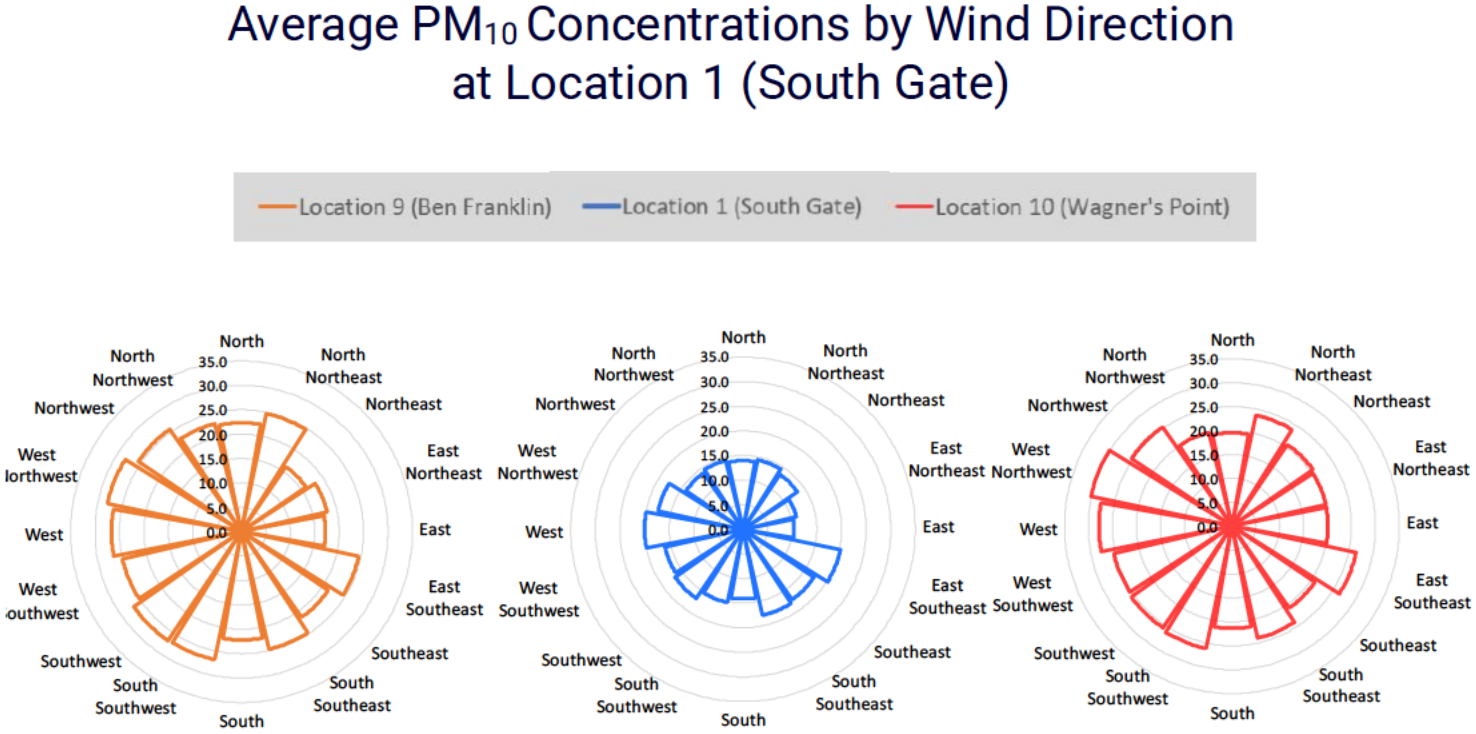

Figure A6. Pollution rose diagrams showing 1-hour average PM_{10} (µg/m^3) concentrations for Location 1 (South Gate) and background monitors at Location 9 (Ben Franklin) and Location 10 (Wagner's Point). Data were from low-cost MODULAIR community monitors from June 22 to August 7, 2023.

Figure A6 shows pollution rose diagrams for Location 1 (South Gate) and background monitors at Location 9 (Ben Franklin) and Location 10 (Wagner's Point). The Location 1 (South Gate) monitor is the closest monitor to the Terminal. At this location, the Terminal would have a potential impact with winds originating from the northerly directions (North-Northwest, North, and North-Northeast). Review of the average PM_{10} pollution rose indicates that concentrations from the northerly directions (15.3 µg/m^3) are the same or *less* than background concentrations at Location 9 (24.7 µg/m^3) and Location 10 (22.1 µg/m^3). Further, the PM_{10} concentrations from the northerly directions (15.3 µg/m^3) are lower than concentrations from the southeastern (18.5 µg/m^3), western (20.0 µg/m^3), and southwestern directions (16.1 µg/m^3), indicating impact from background local and/or regional sources at this monitor.

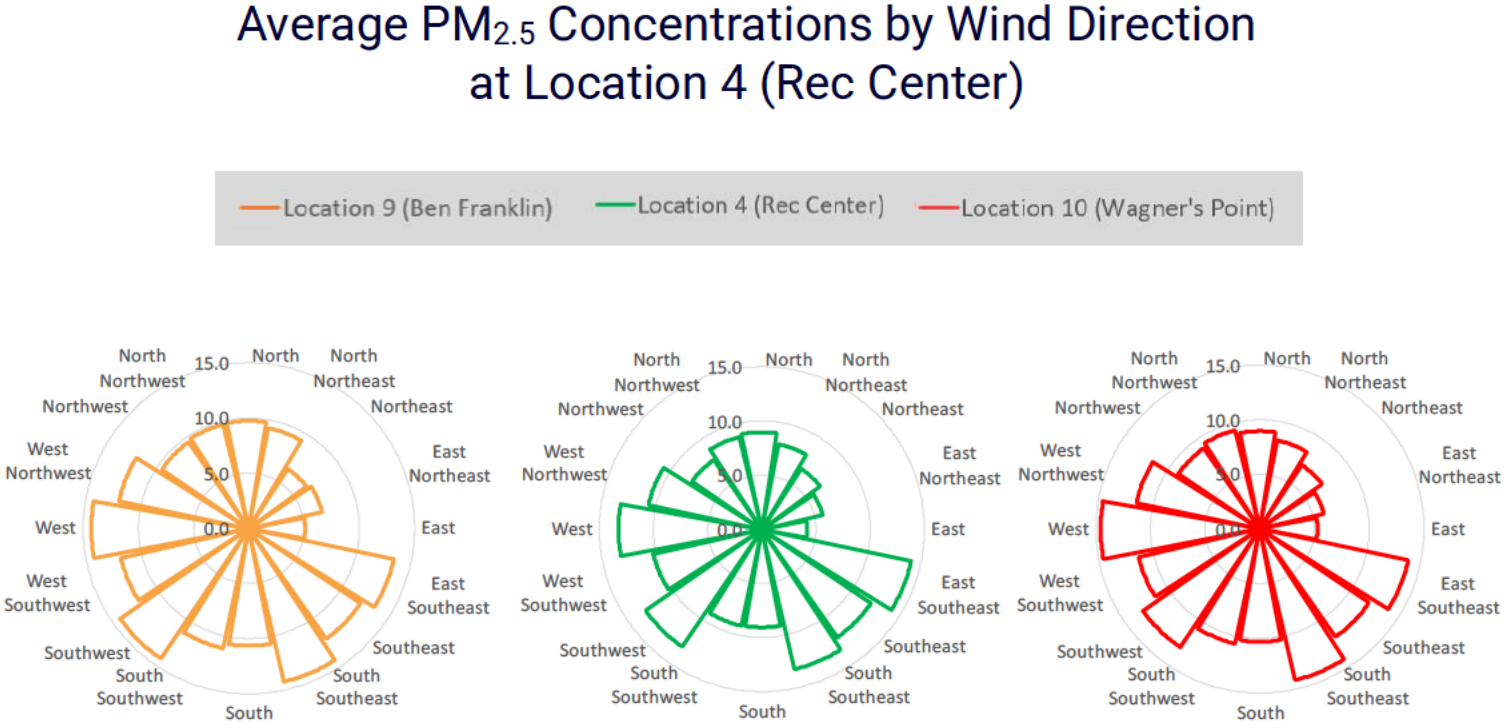

Figure A7. Pollution rose diagrams showing 1-hour average $PM_{2.5}$ (µg/m^3) concentrations for Location 4 (South Gate) and background monitors at Location 9 (Ben Franklin) and Location 10 (Wagner's Point). Data were from low-cost MODULAIR community monitors from June 22 to August 7, 2023.

Figure A7 shows pollution rose diagrams for Location 4 (Rec Center) and background monitors at Location 9 (Ben Franklin) and Location 10 (Wagner's Point). At the Location 4 (Rec Center) monitor, the Terminal would impact the monitor with winds originating primarily from the Southeast and South-Southeast directions. Review of the average $PM_{2.5}$ pollution rose indicates that concentrations from the Southeast and South-Southeast directions (12.7 µg/m^3) are *less* than background concentrations at Location 9 (13.2 µg/m^3) and Location 10 (13.1 µg/m^3). This indicates impact from background local and/or regional sources at this monitor.

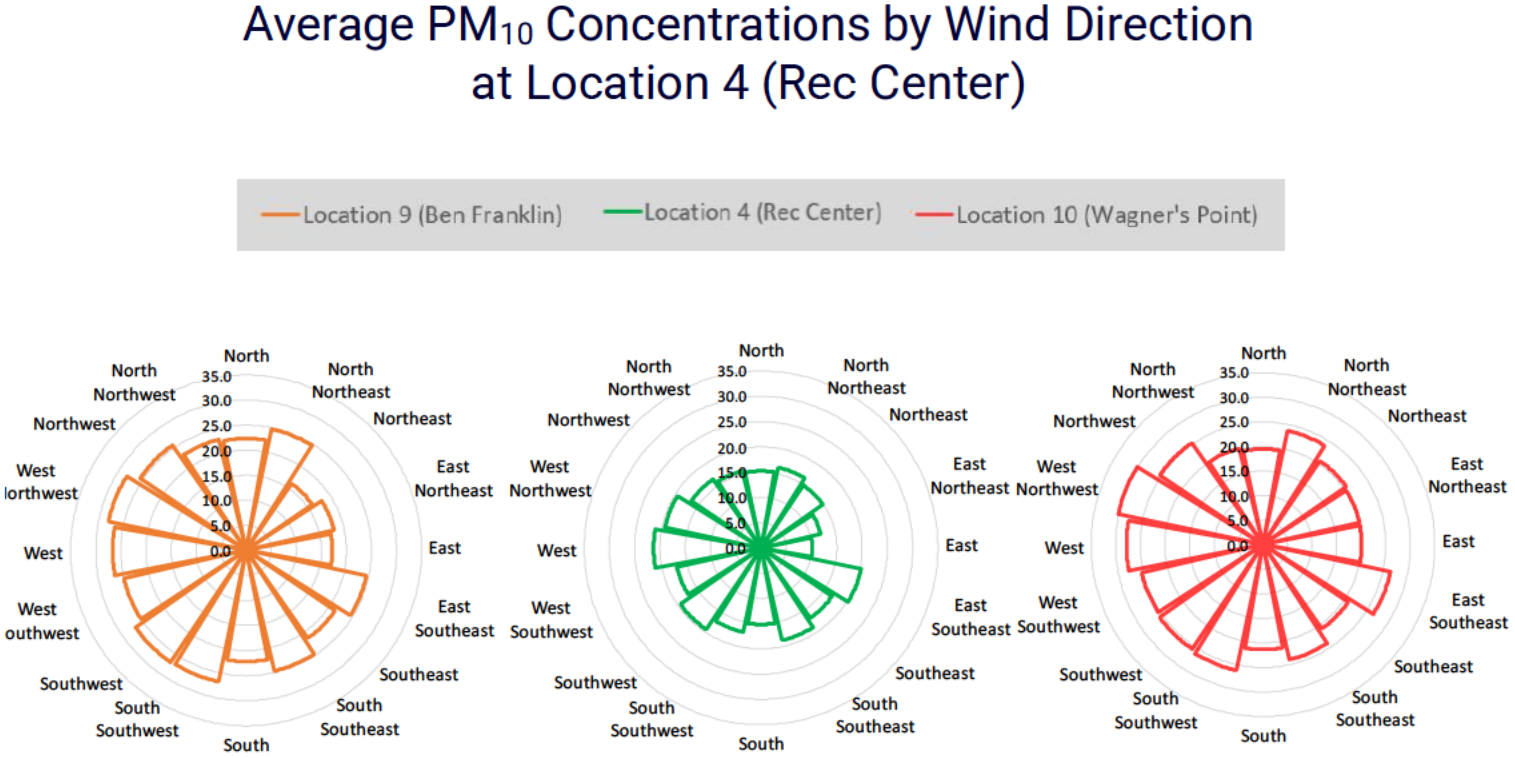

Figure A8. Pollution rose diagrams showing 1-hour average PM_{10} (µg/m^3) concentrations for Location 4 (Rec Center) and background monitors at Location 9 (Ben Franklin) and Location 10 (Wagner's Point). Data were from low-cost MODULAIR community monitors from June 22 to August 7, 2023.

Figure A8 shows pollution rose diagrams for Location 4 (Rec Center) and background monitors at Location 9 (Ben Franklin) and Location 10 (Wagner's Point). At the Location 4 (Rec Center) monitor, the Terminal would impact the monitor with winds originating primarily from the Southeast and South-Southeast directions. Review of the average PM_{10} pollution rose indicates that concentrations from the Southeast and South-Southeast directions (17.9 µg/m^3) are *less* than background concentrations at Location 9 (23.1 µg/m^3) and Location 10 (22.4 µg/m^3). This indicates impact from background local and/or regional sources at this monitor.

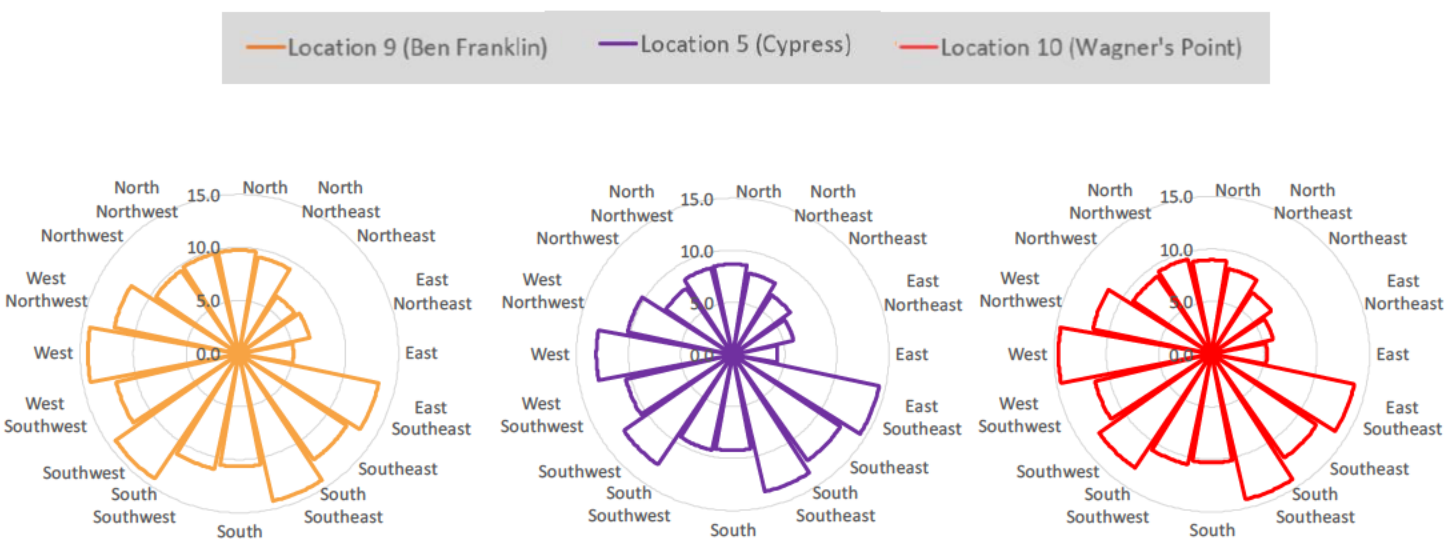

Figure A9. Pollution rose diagrams showing 1-hour average $PM_{2.5}$ (µg/m^3) concentrations for Location 5 (Cypress) and background monitors Location 9 (Ben Franklin) and Location 10 (Wagner's Point). Data were from low-cost MODULAIR community monitors from June 22 to August 7, 2023.

Figure A9 shows pollution rose diagrams for Location 5 (Cypress) and background monitors at Location 9 (Ben Franklin) and Location 10 (Wagner's Point). At the Location 5 (Cypress) monitor, the Terminal would impact the monitor with winds originating primarily from the East-Northeast, East, and East-Southeast directions. Review of the average $PM_{2.5}$ pollution rose indicates that concentrations from the East-Northeast (6.0 µg/m^3) and East (4.3 µg/m^3) are the same or *less* than background concentrations at Location 9 (6.8 µg/m^3 and 5.1 µg/m^3 respectively) and Location 10 (6.0 µg/m^3 and 5.3 µg/m^3 respectively). For $PM_{2.5}$, the concentrations in these wind sectors are less than background for East-Northeast and East.

Review of the average $PM_{2.5}$ pollution rose indicates that concentrations from the East-Southeast (14.4 µg/m^3) are slightly higher than background concentrations at Location 9 (13.4 µg/m^3) and Location 10 (13.8 µg/m^3). This suggests a possible impact from the Terminal and/or other sources between the Terminal and the monitor. However, if you compare the $PM_{2.5}$ concentrations at Location 1 (South Gate, see Figure A5) to Location 5 (Cypress), the concentrations are similar (14.5 µg/m^3 and 14.4 µg/m^3, respectively). This suggests another source southeast of the monitors at Location 1 and Location 5.

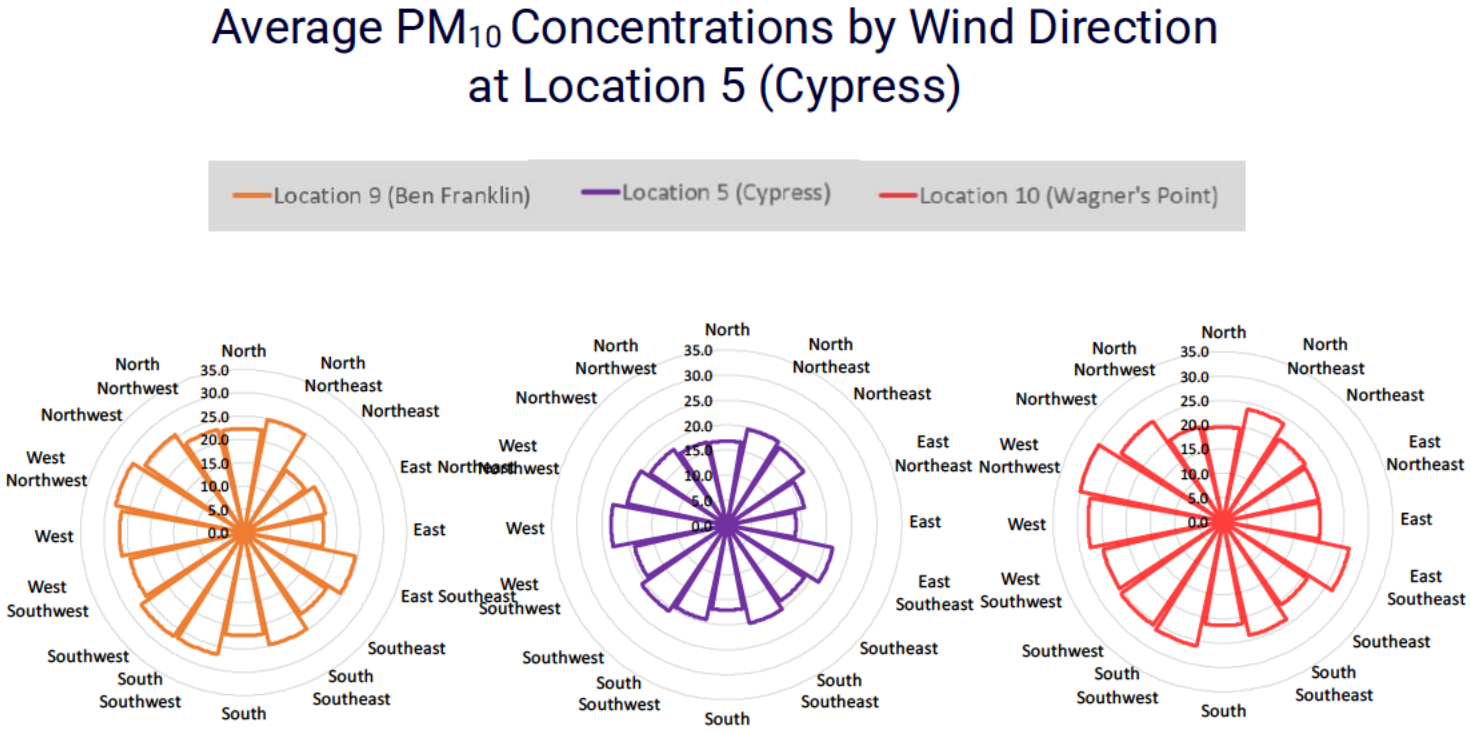

Figure A10. Pollution rose diagrams showing 1-hour average PM_{10} (µg/m^3) concentrations for Location 5 (Cypress) and background monitors at Location 9 (Ben Franklin) and Location 10 (Wagner's Point). Data were from low-cost MODULAIR community monitors from June 22 to August 7, 2023.

Figure A10 shows pollution rose diagrams for Location 5 (Cypress) and background monitors at Location 9 (Ben Franklin) and Location 10 (Wagner's Point). At the Location 5 (Cypress) monitor, the Terminal would impact the monitor with winds originating primarily from the easterly directions (East-Northeast, East, and East-Southeast). Review of the average PM_{10} pollution rose indicates that concentrations from the easterly directions (17.1 µg/m^3) are *less* than background concentrations at Location 9 (19.9 µg/m^3) and Location 10 (22.3 µg/m^3). This indicates impact from background local and/or regional sources at this monitor.

Summary of $PM_{2.5}$ and PM_{10} Pollution Rose Findings

Overall, the $PM_{2.5}$ concentrations from the pollution rose at Location 1 (South Gate), Location 4 (Rec Center), and Location 5 (Cypress) are all less than background (Location 9 and Location 10) when winds are coming from the Terminal. Furthermore, if you look at all wind directions, the concentrations are similar for each wind arc. This indicates that all three locations are impacted by background regional sources and not the terminal, see Figure A11.

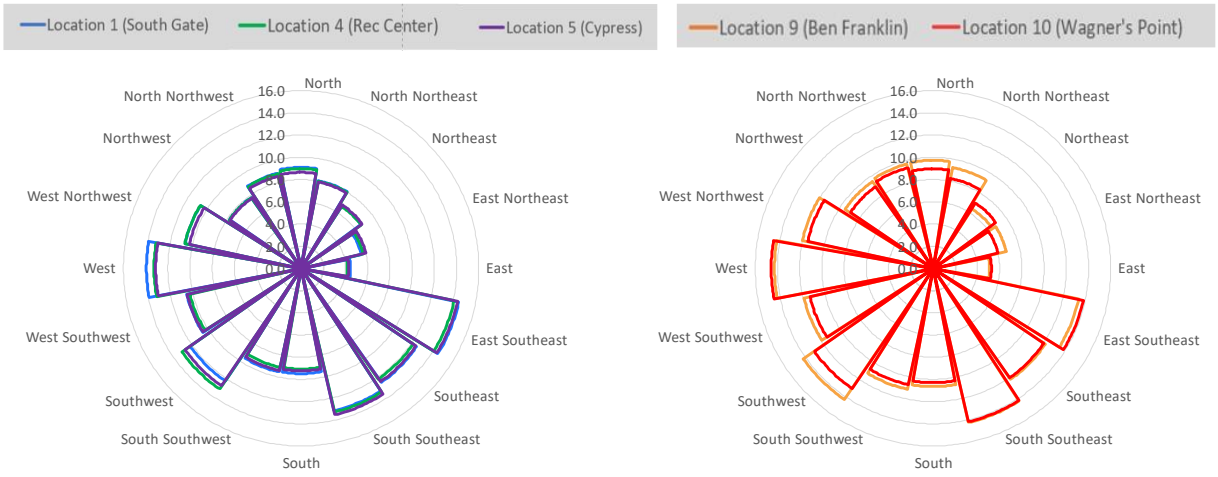

Figure A11. Pollution rose diagrams showing 1-hour average PM_{10} ($\mu g/m^3$) concentrations for Location 1 (South Gate), Location 4 (Rec Center) and Location 5 (Cypress) (left) and Background Locations 9 (Ben Franklin) and Location 10 (Wagner's Point) (right). Data were from low-cost MODULAIR community monitors from June 22 to August 7, 2023.

Overall, the PM_{10} concentrations from the pollution roses at Location 1 (South Gate), Location 4 (Rec Center), and Location 5 (Cypress) are all less than background (Location 9 and Location 10) when winds are coming from the Terminal. Furthermore, the average PM_{10} concentrations for all wind arcs at Location 1 (15.9 $\mu g/m^3$), Location 4 (17.1 $\mu g/m^3$), and Location 5 (18.9 $\mu g/m^3$) are significantly less than the background monitors at Location 9 (24.2 $\mu g/m^3$) and Location 10 (23.8 $\mu g/m^3$).

Appendix B

Bios of Gary S. Casuccio, MS and Keith Rickabaugh, CIH

February 13, 2024

RJ Lee Group

Gary S. Casuccio
RJ Lee Group
800 Presque Isle Dr.
Pittsburgh, PA 15239

Background

Mr. Casuccio has over 40 years' experience as a research scientist and project manager at the RJ Lee Group. He specializes in environmental studies focused on individual particle analysis/identification and apportionment, and has worked as a consultant and advisor to the to the EPA on particle analysis using scanning electron microscopic (SEM) techniques for over thirty years. He has conducted studies with NASA related to the analysis of particulate samples in the cabin area of the Space Shuttle and more recently in the various compartments of the International Space Station. He designed experimental procedures and conducted analyses on ambient samples collected during the aftermath of the Kuwait Desert Storm for the U.S. Army and was the PI for the microscopy analyses portion of an environmental assessment conducted by the U.S. Army in Iraq, Afghanistan, Kuwait and Saudi Arabia. He has worked closely with the EPA and the California Department of Public Health (CDPH) to advance the use of passive samplers combined with automated SEM techniques to speciate particulate matter and provide ambient concentrations of PM_{10}; $PM_{2.5}$ and $PM_{10\text{-}2.5}$. He was the PI for a study related to design of a test system to evaluate the release of ultrafine silver particles in water discharge from washing machines for a major consumer appliance manufacturer. Communicated with engineers and performed lab studies related to silver anode sanitization tests that were conducted to address critical questions asked by EPA. He also been a PI on air quality projects involving monitoring and evaluating SO_2, NO_x and H_2S concentrations in ambient air, and he is currently working with the researchers at the Center for Inhalation Toxicology at West Virginia University and with NIOSH to monitor and evaluate emissions generated from combustion from non-industrial sources from a toxicological perspective.

Mr. Casuccio holds a B.S. in Physics, a M.S. in Physics and Atmospheric Science. Mr. Casuccio has been an instructor of short courses on SEM, automated SEM and receptor modeling for the American Association for Aerosol Research (AAAR) and the EPA. He has published extensively in peer-reviewed literature and is a reviewer for several academic journals.

Areas of Expertise

Experimental design and project management
Development of methodologies for sampling and analysis of environmental samples
Ambient and indoor air quality monitoring
PM_{10}; $PM_{2.5}$; $PM_{10\text{-}2.5}$; PM_1; nuisance dust
Particle analysis/identification
Source apportionment using receptor models
Nanomaterials characterization
Chamber studies to monitor and evaluate emissions from combustion
Worker Exposure

Keith Rickabaugh, CIH
RJ Lee Group
800 Presque Isle Dr.
Pittsburgh, PA 15239

Background

Keith Rickabaugh is the Technical Director of Materials and Analytical Services at RJ Lee Group, Inc. He has over 25 years of experience in using applied sciences and instrumental analysis techniques. This experience includes the planning, implementation, and oversight of analytical and field sample protocols for high-profile environmental projects. He is experienced in working with Federal, State, and local regulatory authorities regarding numerous environmental issues. Mr. Rickabaugh has developed analytical procedures, broad testing programs and instrumental methods to characterize a wide variety of chemicals and particulates.

He has a B.S. in Materials Science and Engineering from Penn State University and an MBA from Robert Morris University. Keith is also a Certified Industrial Hygienist (CIH) in comprehensive practice by the American Board of Industrial Hygiene (ABIH).

Areas of Expertise

Sampling and laboratory analysis
Industrial Hygiene
Project management
Particle analysis/identification
Product stewardship
Nanomaterials characterization

Attachment 2 -

Trinity Consultants Report

REPORT OF TRINITY CONSULTANTS
FOR

CSX Transportation

Response to the Collaborative Investigation of Coal Dust, Air Pollution, and Health Concerns in Curtis Bay, South Baltimore, Maryland, USA, 2022-2023

February 13, 2024

Scott Adamson, CCM

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF ABBREVIATIONS

BAM	Beta Attenuation Monitor
CCM	Certified Consulting Meteorologist
CFR	Code of Federal Regulations
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CSXT	CSX Transportation
FEM	Federal Equivalent Method
FRM	Federal Reference Method
MBE	Mean Bias Error
MDE	Maryland Department of the Environment
NAAQS	National Ambient Air Quality Standards
NMF	Non-negative Matrix Factorization
NO	Nitrogen Oxide
NO_2	Nitrogen Dioxide
O_3	Ozone
PM	Particulate Matter
PM_1	Particulate Matter less than 1 micrometer
PM_{10}	Particulate Matter less than 10 micrometers
$PM_{2.5}$	Particulate Matter less than 2.5 micrometers
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
R^2	Coefficient of Determination
RMSE	Root Mean Square Error
SCAQMD	South Coast Air Quality Management District
SD	Standard Deviation
TSP	Total Suspended Particulate
US EPA	United States Environmental Protection Agency

1. SUMMARY OF OPINIONS

I have reviewed the report titled *Collaborative Investigation of Coal Dust, Air Pollution, and Health Concerns in Curtis Bay, South Baltimore, Maryland, USA, 2022-2023* (Community Investigation Report). It is my opinion that the Community Investigation Report uses unreliable data and flawed statistical methods to draw conclusions about air quality in Curtis Bay. My conclusions are based on my experience in air quality monitoring and regulation,[1] as well as my review of the Community Investigation Report, the accompanying supplementary materials (Supplemental Materials Document),[2] the article titled *Community-driven research and capacity building to address environmental justice concerns with industrial air pollution in Curtis Bay, South Baltimore* (Article),[3] and the transcript of the Curtis Bay community meeting held on December 14, 2023. My opinions are summarized below:

1.1 Summary of Opinion 1: The Air Monitoring Described in the Community Investigation Report Did Not Meet Standard Practices for Proper Quality Assurance or Quality Control

The Community Investigation Report did not follow accepted methodologies or standardized practices published by the United States Environmental Protection Agency (US EPA) for making defensible and representative air quality measurements. US EPA's published guidance documents serve as best practices[4] for developing quality environmental data collection programs for both regulatory-grade monitoring networks[5] and non-regulatory grade networks[6] that use low-cost sensor technology.

The data validation process did not include US EPA-published quality control checks such as expected range of the instrument, rate of change, data sticking, duplicate sensor comparison, buddy system, parameter-to-parameter checks, or corrective actions from collocation tests.[7] These quality controls checks are critical for obtaining good quality, complete, and (most importantly) accurate data that can be used for making meaningful conclusions. Without these quality control checks, data are susceptible to bias and error, resulting in less agreement between actual pollutant concentrations in the atmosphere and the concentrations reported by the sensor.[8]

To evaluate low-cost sensor performance and improve data accuracy, low-cost sensors should be collocated with a Federal Equivalent Method (FEM) monitor under real world conditions for a period of time.[9] Collocation tests were conducted for particulate matter (PM) less than 10 microns (PM_{10}), PM less than 2.5 microns ($PM_{2.5}$), and carbon monoxide (CO). No other gaseous pollutants were documented to have had

[1] My CV is provided in Appendix A.
[2] Supplementary Material: Community-driven research and capacity building to address environmental justice concerns with industrial air pollution in Curtis Bay, South Baltimore (September 12, 2023), Aubourg MA, Sawtell G, Deanes L, et al. https://www.frontiersin.org/articles/10.3389/fepid.2023.1198321/full#supplementary-material
[3] Community-driven research and capacity building to address environmental justice concerns with industrial air pollution in Curtis Bay, South Baltimore (September 12, 2023), Aubourg MA, Sawtell G, Deanes L, et al. https://www.frontiersin.org/articles/10.3389/fepid.2023.1198321/full
[4] Best Practices for Review and Validation of Ambient Air Monitoring Data (August 2021), US EPA. data-validation-guidance-document-final-august-2021.pdf (epa.gov)
[5] Quality Assurance Handbook for Air Pollution Measurement Systems Volume II (January 2017), US EPA [EPA-454/B-17-001].
[6] The Enhanced Air Sensor Guidebook (December 2022), US EPA [EPA/600/R-22/213]. https://www.epa.gov/air-sensor-toolbox/how-use-air-sensors-air-sensor-guidebook
[7] Section 3.7.2 Checks to Ensure Quality Assurance and Quality Control, The Enhanced Air Sensor Guidebook (December 2022), US EPA [EPA/600/R-22/213].
[8] Ibid (6).
[9] Ibid (6).

collocation tests. For PM_{10} in particular, the collocation tests indicated poor performance of the low-cost sensor as compared to the FEM monitor.[10] In fact, none of the US EPA-recommended or generally accepted performance metrics[11] [12] were met by the low-cost sensors when testing for PM_{10}. The Supplemental Materials Document acknowledges this failed collocation test,[13] but provides no discussion of corrective action or steps taken to address the issue. Because the PM_{10} data were collected using sensors that did not meet US EPA-recommended performance metrics,[14] all PM_{10} data should be considered invalid and not used to draw conclusions about pollutant concentrations in Curtis Bay.[15]

1.2 Summary of Opinion 2: Curtis Bay is in Compliance with the Annual and 24-hour NAAQS for $PM_{2.5}$ and the 24-hour NAAQS for PM_{10}

Section 4 of the Community Investigation Report compares PM data collected from low-cost sensors, to the annual and 24-hour PM_{10} and $PM_{2.5}$ National Ambient Air Quality Standards (NAAQS). As discussed in this report, the PM data collected from the low-cost sensors are flawed and do not reliably demonstrate PM levels in Curtis Bay.[16] [17] Yet, even taken at face value, the PM data provided in the Community Investigation Report demonstrate that PM concentrations[18] in Curtis Bay are below the annual and 24-hour $PM_{2.5}$ NAAQS and the 24-hour PM_{10} NAAQS.[19] Therefore, the PM data collected from the low-cost sensors do not support the Collaborative Investigation Report's finding that the Curtis Bay community is overburdened by particulate matter air pollution as compared to other areas of Baltimore City.[20]

1.3 Summary of Opinion 3: One-minute Data Are Not a Reliable Indicator for Overall Air Quality

One-minute data should not be used to draw conclusions about air quality impacts from Curtis Bay Piers. Pollutant concentrations can vary based on the time of day, week, or season and can often change rapidly due to influences from local emission sources and/or atmospheric conditions.[21]
Furthermore, one-minute averages are more susceptible to rapid fluctuation in the measurements, also known as noisy data signals, that are symptomatic of electrical interference, sensor precision, or rapid weather changes that can lead to low precision of the instrument resulting in less agreement between the sensor's reported concentration and the true concentration in the atmosphere. Higher-time resolution data (i.e., one-minute data) need to be used with caution, and US EPA recommends enhanced testing of instruments collecting one-minute data to demonstrate the stability and reliability of the measurements.[22] In

[10] 40 CFR Part 53 Ambient Air Monitoring Reference and Equivalent Methods.
[11] Performance Testing Protocols, Metrics, and Target Values for Fine Particulate Matter Air Sensors: Use in Ambient, Outdoor, Fixed Site, Non-Regulatory Supplemental and Informational Monitoring Applications (February 2021), US EPA [EPA/600/R-20/280]. https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=350785&Lab=CEMM
[12] American Society for Testing and Materials ASTM D8406-22
[13] See Section 3.1 of Supplemental Materials Document (September 2023), Aubourg MA, Sawtell G, Deanes L, et al.
[14] Ibid (5).
[15] Collocation tests were also not performed for nitrogen oxide (NO) or nitrogen dioxide (NO_2).
[16] See *infra* Section 3.2 Collocation Tests Do Not Meet US EPA Testing Criteria or Protocols.
[17] See *infra* Section 3.3 Quality Control Procedures are Inadequate for Monitoring Programs.
[18] On Page 15 of Section 4 of the Community Investigation Report, the annual mean PM_{10} and 99th-percentile of daily (24-hour) PM_{10} concentrations are compared to the World Health Organization's Air Quality Guideline values. These values are not regulatory air quality standards.
[19] Pages 2-5 of Section 4 of the Community Investigation Report.
[20] See page 2 of the Executive Summary of the Community Investigation Report finding that "The Curtis Bay community is overburdened by air pollution, with the community sensor network measuring average particle pollution levels that are higher than at nearby MDE regulatory monitors."
[21] Ibid (6).
[22] Ibid (11).

fact, FEM monitors often do not produce stable and reliable one-minute data.[23] It is therefore unlikely that the low-cost sensor data relied on in the Community Investigation Report—which, as discussed above, did not undergo proper quality assurance or control—produced stable one-minute data that could be used to identify pollution events.

Thus, one-minute data are not reliable for making meaningful conclusions and are not an indication of overall air quality for a community or region.

1.4 Summary of Opinion 4: Improper Use of Non-Negative Matrix Factorization (NMF)

The Community Investigation Report used a statistical model called non-negative matrix factorization (NMF) in an attempt to use air monitoring data collected in the community to quantify the contribution of selected pollution sources to air quality in Curtis Bay. The NMF model was used to identify six pollution source types based on a combination of pollutants believed to be attributed to each source type. NMF, like any statistical model, has limitations to the outcomes it produces since the model is dependent on the uniqueness of the pollutants (or pollutant species) that are used to identify a particular source or source type. Pollutants or species that are too available in a region or are characteristic of multiple emission source types will weaken the NMF analysis since there would be cross contamination from multiple sources in the sample measurement.

While NMF may be a useful tool for evaluating source contribution, its use in the Community Investigation Report was flawed. Notably, the combinations of pollutants attributed to each type of source are too similar to actually distinguish among each source (this could be attributed to the fact that the pollutants used to differentiate sources are prevalent in urban areas and are characteristic of the emissions from multiple types of sources in the region). Because the sources' fingerprints are so similar, an attempt to predict any one source's contribution to air quality becomes less reliable. Further, the NMF analysis ignored contributions from certain sources that contribute significantly to air pollution in the community, notably diesel combustion.

The Community Investigation Report is further flawed by using one-minute NMF data to establish a threshold that has no basis in public health principles. The term "exceedance"[24] is then misapplied throughout the report, quantifying instances where NMF values attributed to "putative coal dust" surpass this threshold. This threshold, a statistical measure commonly employed for outlier identification, does not equate to a public health standard. The NMF analysis is misapplied to support the Community Investigation Report's conclusions regarding the coal terminal's impact on community air quality.

[23] Ibid (11).
[24] The term "Exceedance" is used in air quality monitoring programs to define whether a measurement is above the level of an air quality standard. The definition for Exceedance can be found in 40 CFR Section 50.1(l).

2. OPINION #1: THE COMMUNITY AIR MONITORING PROGRAM DID NOT MEET STANDARD PRACTICES FOR PROPER QUALITY ASSURANCE OR QUALITY CONTROL

The Community Investigation Report describes a hyper-local network consisting of ten QuantAQ Modulair[25] (Modulair) sensors that make real-time measurements of PM with a diameter less than 1 micron (PM_1), $PM_{2.5}$, PM_{10}, as well as Total Suspended Particles (TSP). Additionally, Modulair sensors are capable of measuring carbon monoxide (CO), carbon dioxide (CO_2), nitrogen oxide (NO), nitrogen dioxide (NO_2), ozone (O_3), and meteorological conditions like temperature and relative humidity. Each Modulair sensor in the network was linked to a Davis Instruments sonic anemometer that recorded wind speed and direction. All parameter measurements were transmitted via cellular data connection to the QuantAQ Cloud at one-minute intervals.

Modulair air monitoring sensors are often referred to as low-cost sensors because of their lower cost compared to regulatory monitoring equipment.[26] Low-cost sensors are not used for regulatory monitoring and are not suitable for comparison or compliance demonstrations with the NAAQS.[27] [28] According to US EPA, *"Data from new air sensor instruments should not be used in a regulatory context at this time unless those instruments meet all applicable regulatory requirements."*[29] To make comparisons with the NAAQS, monitoring equipment needs to be designated as either Federal Reference Method (FRM) or Federal Equivalent Method (FEM).[30] The use of low-cost sensor technology is generally accepted for non-regulatory supplemental and informational monitoring and to engage the public in participatory science. [31] [32] [33]

US EPA has published guidance documents that serve as best practices for developing a quality environmental data collection program for both regulatory-grade monitoring networks[34] as well as non-regulatory grade networks that use low-cost sensor technology.[35] US EPA encourages community organizations that participate in the scientific process by collecting and analyzing air quality monitoring data and interpreting results to establish protocols and procedures for collecting quality data that can support meaningful conclusions.[36] The Community Investigation Report did not provide reference to any standards or guidance for the community sensor network nor does the report demonstrate that the researchers followed US EPA's best practices in developing the community sensor network. Notably, as discussed in the following sections, the community monitoring program failed to (1) develop a quality assurance project plan (QAPP), (2) meet US EPA criteria for collocation, and (3) include adequate quality controls. Because of these failures, I conclude that the quality of the community monitoring data cannot support the conclusions regarding air quality in the Community Investigation Report.

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[25] QuantAQ Modulair https://www.quant-aq.com/products/modulair
[26] US EPA Air Sensor Toolbox. https://www.epa.gov/air-sensor-toolbox
[27] 40 CFR Part 50 Appendices.
[28] 40 CFR Section 50.1(g); see also Community Report at Section 4, page 16 stating that "regulatory decisions regarding the NAAQS are based on data collected by approved monitors – either Federal Reference Method or Federal Equivalency Method."
[29] Idsal, Anne L. (2020, June 22). *Air Sensors* [Memorandum]. US EPA. https://www.epa.gov/sites/default/files/2020-07/documents/air_sensors_memo_june_22.2020.pdf
[30] Ibid (10).
[31] See Section 1, Sensor Guidebook Ibid (6).
[32] US EPA Participatory Science for Environmental Protection https://www.US EPA.gov/participatory-science
[33] Ibid (29).
[34] Ibid (5).
[35] Ibid (6).
[36] Handbook for Citizen Science Quality Assurance and Documentation (March 2019), US EPA. https://www.epa.gov/sites/default/files/2019-03/documents/508_csqapphandbook_3_5_19_mmedits.pdf

2.1 Lack of a Quality Assurance Project Plan

The community air monitoring network, as described in the Community Investigation Report, did not reference a monitoring plan or quality assurance project plan (QAPP) that was reviewed or approved by MDE. A QAPP is a formal document describing Quality Assurance (QA), Quality Control (QC), and other technical activities that will be implemented to ensure that monitoring results satisfy stated performance criteria.[37] [38] A QAPP is a requirement under Appendix A to Part 58 of Title 40 of the Code of Federal Regulations (CFR), which details quality assurance obligations and contains Standard Operating Procedures for all monitoring and monitoring maintenance/calibration and audit activities performed in support of regulatory monitoring programs. According to US EPA, the QAPP provides sufficient detail to demonstrate that: [39] [40]

- The project's technical and quality objectives are identified and agreed upon;
- The intended measurements, data generation, or data acquisition methods are able to achieve the project objectives;[41]
- Assessment procedures are sufficient for confirming that data of the type and quality needed and expected are obtained;[42] and
- The limitations on the use of the data are identified and documented.

Federal and state agencies typically require preparation of a QAPP in developing an air monitoring program. For example, US EPA requires preparation of a QAPP for regulatory NAAQS compliance monitoring programs.[43]

US EPA also provides guidance for preparing QAPPs for non-regulatory air monitoring. The agency developed the *Enhanced Air Sensor Guidebook*[44] (Sensor Guidebook) to simplify the QAPP development process for non-regulatory grade air monitoring networks using low-cost sensors. Section 3.1 of the Sensor Guidebook provides a five-step roadmap for planning and conducting air monitoring using sensors:

1. Establish the question to be answered by the monitoring program.
2. Develop a detailed plan for the monitoring program.
3. Setup the monitoring network with an understanding of placement of the monitors to make representative measurements with minimal interference from the immediate surroundings.
4. Collect data while being proactive in ongoing quality control testing to ensure proper functionality as intended and designed.
5. Evaluate the data through an analysis approach that is objective and provides an accurate interpretation of the results.

[37] US EPA Guidance for Quality Assurance Project Plans (QA/G-5). https://www.epa.gov/sites/default/files/2015-06/documents/g5-final.pdf
[38] US EPA Guidance for the Preparation of Standard Operating Procedures for Quality-Related Documents (QA/G-6). https://www.epa.gov/sites/default/files/2015-06/documents/g6-final.pdf
[39] US EPA Guidance on Systematic Planning Using the Data Quality Objectives Process (QA/G-4). https://www.epa.gov/sites/default/files/2015-06/documents/g4-final.pdf
[40] US EPA Guidance for Data Quality Assessment: Practical Methods for Data Analysis (QA/G-9). https://www.epa.gov/sites/default/files/2015-06/documents/g9-final.pdf
[41] Ibid (39).
[42] Ibid (40).
[43] 40 CFR Part 58 Appendix A.
[44] Ibid (6).

MDE also requires the use of QAPPs in air monitoring. MDE states in their Quality Management Plan,[45] for example, that *"Organizations or individuals contracted by MDE to perform environmental data collection or assessment are required to follow specified QA/QC protocols. These requirements are specified in the agreement within the Scope of Work and should also be described in detail in the QAPP. Some contracts, memoranda of understanding (MOU) and grants may include QA/QC-specific language. In all instances, an approved QAPP includes data quality standards and specifications."* Notably, MDE required CSXT to submit a QAPP[46] in connection with Fenceline Monitoring Plan[47] required as a condition in the Permit to Operate.[48] [49]

The Community Investigation Report does not reference preparation of a QAPP for the community air monitoring program, and it is not clear that one exists. Failure to prepare a QAPP is not only inconsistent with US EPA and MDE best practices but is also inconsistent with the approach MDE has taken toward monitoring air quality in Curtis Bay in the past. Just as MDE required the QAPP prepared by CSXT for its fenceline monitoring program, the Agency should have required a QAPP for the community air monitoring program consistent with US EPA guidance.[50] [51] Without a QAPP, the quality of the community's data and thus the strength of the Community Investigation Report's conclusions cannot be verified.

2.2 Collocation Tests Do Not Meet US EPA Testing Criteria or Protocols

In addition to lacking an overall plan for ensuring data quality, the Community Investigation Report failed to follow other accepted data quality control practices. For example, monitoring organizations routinely conduct quality control and calibration verification tests to ensure equipment is operating properly and therefore capturing accurate measurements and producing high-quality data. Low-cost sensors cannot be calibrated or adjusted the same as FEM monitors but can be operated side-by-side (collocated) with FEM monitors to establish a relationship and determine if the sensor is producing comparable measurements to the regulatory monitor.

US EPA has developed recommended acceptable test protocols and criteria for $PM_{2.5}$ sensors being compared to FEM monitors in a guidance document titled *Performance Testing Protocols, Metrics, and Target Values for Fine Particulate Matter Air Sensors*.[52] The document describes protocols and procedures for setting up low-cost air sensors next to FEM monitors and how the measurement data from both the low-cost sensor and the FEM monitor should be used for determining the relationship between the two datasets. Section 2.1.3 of the guidance recommends installing three sensors of the same make, model, and firmware version for conducting a collocation test. Table 4-2 of the US EPA guidance document, presented below in Figure 1, provides the recommended target values for acceptable $PM_{2.5}$ sensor data.

[45] Quality Management Plan (September 2020) Maryland Department of the Environment. https://mde.maryland.gov/Documents/MDE%20QMP%20Mgmt%20Plan%20Signed.pdf
[46] Quality Assurance Project Plan for Continuous PM_{10}, $PM_{2.5}$, and Meteorological Measurements at CSXT Transportation, Inc. Curtis Bay Piers Facility, Revision 0 (November 2023)
[47] The Fenceline Monitoring Plan was submitted to MDE on November 7, 2022, for review and approval. On March 7, 2023, MDE provided a partial approval of the Fenceline Monitoring Plan for the proposed equipment to be used within the air monitoring network.
[48] The QAPP was submitted to MDE on November 9, 2023, for review and approval.
[49] State Permit to Operate No. 510-2263
[50] Ibid (37).
[51] Ibid (39).
[52] Ibid (11).

Figure 1 Recommended Performance Metrics and Target Values for $PM_{2.5}$ Air Sensors Used in Ambient, Outdoor, Fixed Site Applications

Performance Metric		Target Value		Associated Section Describing Calculation
		Base Testing	Enhanced Testing*	
Precision	Standard Deviation (SD)	≤ 5 µg/m³		3.1.3 and 3.2.3
	-OR-			
	Coefficient of Variation (CV)	≤ 30%		3.1.3 and 3.2.3
Bias	Slope	1.0 ± 0.35	No target values recommended; report results	3.1.4 and 3.2.4
	Intercept (b)	-5 ≤ b ≤ 5 µg/m³		3.1.4 and 3.2.4
Linearity	Coefficient of Determination (R^2)	≥ 0.70		3.1.4 and 3.2.4
Error	Root Mean Square Error (RMSE) or Normalized Root Mean Square Error (NRMSE)	RMSE ≤ 7 µg/m³ or NRMSE ≤ 30%†		3.1.5 and 3.2.5

*No specific target values are recommended due to limited feasibility, lack of consensus regarding testing protocols, and inconsistency in sensor evaluation results that can result due to the limited amount of data that will be collected and variation in the tester's choice of PM surrogate. See Appendix D for further discussion.
†A sensor will meet this target if either the RMSE or NRMSE meet this criterion. See Appendix D for further discussion.

Source: US EPA Performance Testing Protocols, Metrics, and Target Values for Fine Particulate Matter Air Sensors (February 2021)

US EPA has recognized that the protocols established, to date, for low-cost sensors have been tailored to $PM_{2.5}$ and O_3 and that no standardized approach has been explicitly established for other gaseous pollutants.[53] However, US EPA still recognizes that performance evaluation of low-cost sensors that measure pollutants besides or in addition to $PM_{2.5}$ and O_3 should be performed prior to deployment to meet the objectives of the monitoring program.[54] Furthermore, the American Society for Testing and Materials has also developed performance evaluation protocols for ambient air quality sensors for a variety of different pollutants. These protocols include field testing using the collocation method or delivering known concentrations to the sensors.[55]

Each of the performance metrics in Figure 1 is critical to determining if a sensor repeatedly and accurately measures data. A sensor that meets these metrics shows an acceptable level of agreement between the sensor's reported concentration and the true concentration in the atmosphere[56]. There are four general metrics that are tested during a collocation test: precision, bias, linearity, and error[57]. Each of these tests are important for understanding sensor performance but should not be a standalone test.

[53] Duvall, R.M. et al, Deliberating Performance Targets: Follow-on workshop discussing PM_{10}, NO_2, CO, and SO_2 air sensor targets (February 2021).
[54] Ibid (53).
[55] Ibid (12).
[56] Ibid (11).
[57] Ibid (11).

- **Precision** tests whether the sensor can make the same measurements consistently under the same conditions.
- **Linearity** tests whether the sensor can consistently make the same measurements over the sensor's range.
- **Bias** tests how close the sensor's measurements are to the truth.
- **Error** tests the sensor's overall accuracy.

Results of the collocation tests that were conducted as part of the Community Investigation Report are presented in an Appendix to the Report and in the Supplemental Materials Document. The Community Investigation Report collocated the QuantAQ Modulair low-cost sensors with FEM monitors at two MDE monitoring locations (Howard County Near Road and Pocomoke City). Section 2 of the Supplemental Materials Document indicates that "two low-cost sensors of the same type" were used in the collocation tests. It is unclear if the tests involved collocating two low-cost sensors at the same location as the FEM or collocated only one low-cost sensor with each FEM. In any case, three sensors of the same type were not collocated as US EPA recommends. Adherence to the protocols and recommendations set by US EPA in the Sensor Guidebook is critical for understanding the accuracy and limitations of the measurements made by the sensors. As further discussed in sections 2.2.1 and 2.2.2, US EPA collocation best practices were not followed,[58] therefore, the accuracy of the data collected by the low-cost sensors are suspect.

2.2.1 Howard County Near Road Collocation Results

The Howard County Near Road monitoring station is equipped with a Met One Model BAM-1020.[59] [60] Modulair $PM_{2.5}$ data from the community monitoring network appear to have been reduced to hourly averages to match the output reported by the BAM-1020. Results of the collocation test indicate the slope and intercept (which test bias) and the root mean square error (RMSE) (which tests error) were within US EPA's recommended acceptable test criteria for bias and error. However, the coefficient of determination (R^2) (which tests linearity) was 0.604, which is outside the recommended target value of ≥0.70. This shows poor linearity of the low-cost sensor compared to the BAM-1020 FEM monitor. Poor linearity indicates that the sensor cannot make consistent (or accurate) measurements as actual concentrations in the atmosphere increase or decrease across the measurement range. These values are not correctable through applying factors from linear regression.

Further, the collocation test scatter plot (Supplementary Figure 2 in the Supplemental Materials Document) shows what appear to be outliers in the data sequence that could use extra scrutiny to understand the conditions in which these outliers exist and how they would affect measurement data during the field campaign. Neither the Community Investigation Report, the Article, nor the Supplemental Materials Document address the low-cost sensor's failure to meet US EPA-recommended acceptance test criteria for linearity or discuss corrective actions taken to ensure data collected by the low-cost sensors meet the standards set by US EPA for making accurate measurements.

2.2.2 Pocomoke Collocation Results

The Pocomoke City monitoring station collocation test compared a Modulair low-cost sensor with a Teledyne-API T640X FEM monitor for PM_{10} and $PM_{2.5}$.[61] [62] [63]

[58] Ibid (11).
[59] Met One Beta Attenuation Mass (BAM) Monitor Model 1020 https://metone.com/products/bam-1020/
[60] Met One BAM 1020 FEM Designation: EQPM-0308-170
[61] Teledyne API Model T640 https://www.teledyne-api.com/products/particulate-instruments/t640
[62] Teledyne T640x PM_{10} Mass Monitor FEM Designation: EQPM-0516-239
[63] Teledyne T640x $PM_{2.5}$ Mass Monitor FEM Designation: EQPM-0516-238

For $PM_{2.5}$, one-minute data were used for the collocation test, and US EPA-recommended performance metrics were met. Review of the scatter plot in the Supplemental Materials Document (Supplementary Figure 3) shows that lower $PM_{2.5}$ concentrations are closer to the 1:1 line, indicating data from the low-cost sensor and FEM sensor were more correlated, while higher concentrations were less correlated. More specifically, there are periods in which the Modulair low-cost sensor had outliers when compared to the T640X measurements that were included in the dataset without explanation of why they occurred and what would be done to address them.

There is no indication in the Community Investigation Report about what conditions existed for these outliers and how the outliers would be addressed during the data collection phase of the project. If the conditions that produced these outliers existed during actual data collection, then data collected under those conditions introduce error into the analysis that would not exist if the outliers had either been removed from the data or addressed.

For PM_{10}, the collocation test indicated poor performance of the low-cost sensor compared to the FEM monitor, with none of the recommended performance metrics being met for the low-cost sensor (R^2 = 0.31, slope = 1.80, intercept = 12.3, RMSE = 31.5). The results show PM_{10} had a poor measurement relationship with the FEM monitor due to underperforming correlation and linearity and an average error of 31.5 $\mu g/m^3$. The failed collocation test is acknowledged in the Supplemental Materials Document, but with no discussion of corrective action or steps taken to address the test failure. Because no US EPA-recommended performance metrics were met and no corrective action was apparently taken, all PM_{10} data should be considered invalid. Further, PM_{10} was an indicator pollutant used in the NMF analysis for identifying sources of "putative coal dust" and "dust" to draw conclusions of source contribution within the Curtis Bay community. Invalid PM_{10} data would also invalidate those conclusions.

2.3 Quality Control Procedures are Inadequate for Monitoring Programs

In addition to ensuring sensors accurately measure real-world conditions, air monitoring sensors also need periodic quality control checks to ensure they are functioning correctly and generating high-quality data. The Sensor Guidebook provides guidance on quality control checks (see section 3.7.2 and Table 3-2) that should be regularly reviewed for consistency to determine validity of the data. The Community Investigation Report did not include descriptions or documentation of adequate quality control checks recommended by US EPA, such as expected range of the instrument, rate of change, data sticking, duplicate sensor comparison, buddy system, and parameter-to-parameter checks. These quality controls checks are critical for finding systematic issues with the sensors. Below is a brief description of each US EPA-recommended quality control check as provided in the guidance: [64]

- **Range.** This test checks a sensor-reported concentration with the known or expected concentration range to determine if a measurement is inconsistent with physical expectations.
- **Rate of change.** This test is critical for identifying erroneous spikes in the data or unexpected increases in concentration data.
- **Sticking data.** This quality control check looks at persistence of sensor-reported values to ensure the values have normal rates of change and are not being repeated due to internal data logging issues.

[64] Table 3-2, Sensor Guidebook. Ibid (6).

- **Duplicate sensor comparisons.** This check incorporates sensors with a dual channel measurement or collocates multiple sensors. The differences between the dual channels or sensors are used to identify systematic errors.
- **Buddy system.** These are external consistency checks in which data from a sensor or monitoring network are compared to other data sources or monitoring sites to determine if there are atypical behaviors in the sensor data.
- **Parameter to parameter.** These checks compare multiple air quality parameters and atmospheric parameters measured at the site for known or expected physical or chemical relationships.

Section 3b of the Community Investigation Report includes a subsection titled "Quality Assurance/Quality Control (QA/QC) of Air Monitoring Data" (see Page 3 of Section 3 in the Community Investigation Report) that describes how data were flagged and vetted before use in the final analysis dataset. As discussed below, these QA/QC procedures were insufficient to ensure the quality of the data.

2.3.1 TSP and PM_{10} Quality Control Checks are Insufficient.

The Community Investigation Report developed criteria for flagging and removing TSP and PM_{10} concentrations from the final data set when a combination of conditions existed simultaneously. These conditions included TSP concentrations above 500 µg/m^3, PM_{10} concentrations above 200 µg/m^3, and relative humidity above 80%.[65]

An issue with this approach is that data scanning and quality control are limited to periods in which relative humidity is only above 80% and do not take into consideration data spikes or outliers that exist when relative humidity is below 80%. For example, a condition could exist when an erroneous spike is detected when TSP is above 500 µg/m^3, PM_{10} is above 200 µg/m^3, and relative humidity is at 79%. This data point would not meet the criteria for flagging but could be just as invalid as the same condition existing at 80% relative humidity. Each of the five control checks US EPA describes in the Sensor Guidebook provide a different check to consider and flag data for inconsistencies that are reviewed for invalidation.[66]

The Community Investigation Report's approach also ignores guidance from the sensor's manufacturer for assessing data accuracy and error. The Modulair sensor specification sheet[67] includes measurement error statistics for 1-hour and 24-hour average PM_{10} and $PM_{2.5}$ measurements that were derived from collocation tests conducted by Quant-AQ, where the Modulair PM module was compared to Teledyne T640 and TSI Scanning Mobility Particle Sizer (SMPS™) spectrometers. By providing data for these specific particle sizes and time intervals, the manufacturer's measurement error statistics create a blueprint for assessing sensor accuracy and error that the Community Investigation Report failed to use without explanation.

In addition, the Community Investigation Report failed to exclude data that exceeded the sensor's range. The Modulair specification sheet has a published operating range of 0 to 2,000 µg/m^3 for PM_{10}, $PM_{2.5}$, and PM_1.[68] Although measurements from the device could be higher than 2,000 µg/m^3, the manufacturer's range should be considered in the data validation process as a basis for flagging measurements outside of this range for not being reliable. The Community Investigation Report did not appear to consider the sensor's range when reviewing and validating the data. For example, PM_{10} data in Figure 12 of the Community Investigation Report shows three data spikes above 2,000 µg/m^3.[69]

[65] Page 4 of Section 3b of the Community Investigation Report.
[66] Ibid (6).
[67] Quant-AQ, Product Specification Sheet Modulair-PM, (Accessed January 2024) https://assets.quant-aq.com/downloads/spec-sheets/modulair-pm.latest.pdf
[68] Ibid (67).
[69] See Figure 12 in Section 3b (Page 15) of the Community Investigation Report.

2.3.2 Black Carbon Quality Control Checks are Insufficient.

Black carbon concentrations were omitted from the final data set when internal relative humidity changed by more than 1% in a minute. Black carbon concentrations were also omitted when erratic values were observed after periods when the unit lost power (60 minutes of data were omitted after data gaps over 15-minutes; 15-minutes of data were omitted after 2.5-minute data gaps). The last documented quality control check included omitting black carbon data when the battery voltage was below 7.5 Volts and when the black carbon concentrations were equal to exactly -5 µg/m^3. These quality control checks are specific to power outages and atmospheric conditions that affect the monitor but are incomplete because there is no documentation as to quality control checks for sensor range, rate of change, or data sticking.

2.3.3 Site Selection

Placement of air monitors or sensors is an important consideration when designing and establishing an air monitoring network and for understanding how representative the measurements are to public exposure. US EPA has considerable guidance[70] [71] [72] [73] on the placement of monitors and sensors to prevent sampling bias. Sensor placement should consider height above ground, physical influences, and minor sources located near the sensor. Obstructions such as buildings or trees reduce the airflow around monitoring equipment and can result in the measurement of higher concentrations downwind of the obstructions.[74] This in turn could lead to erroneous measurements of wind direction (with errors of up to 180 degrees), wind speed, temperature, and relative humidity. Placing sensors too close to other unidentified emission sources (such as vehicles, barbeques, vents, smoke from cigarettes or campfires, and excavation activities) could also artificially influence monitoring equipment on a micro-scale localized basis.[75]

The Community Investigation Report also fails to include a station that represents a true background for the region. Background monitoring stations are typically placed away from the impact or influence of the source in question to obtain measurements representative of other nearby sources of air pollution such as industry, transportation, and area-wide pollution from homes and businesses. Having true background air monitoring data is essential for understanding a source's influence or contribution to air quality by adjusting for regional sources of pollution.

Site selection and documentation of sensor placement is not available in the Community Investigation Report or the Supplemental Materials Document. Placement of the sensors is key in understanding the representativeness of the sensors for the areas in which they are measuring air quality. Without detailed locations, pictures, or descriptions of sensor placement, it is difficult to know if the sensors were properly placed to make measurements representative of the Curtis Bay community or if the measurements are too subjective to a specific location.

Based on publicly available data obtained through the QuantAQ sensor map and data download portal,[76] I conducted a simplified site selection analysis of the community network monitoring program. In addition to pollutant concentrations, the data available from the portal included wind speed, wind direction, and latitude

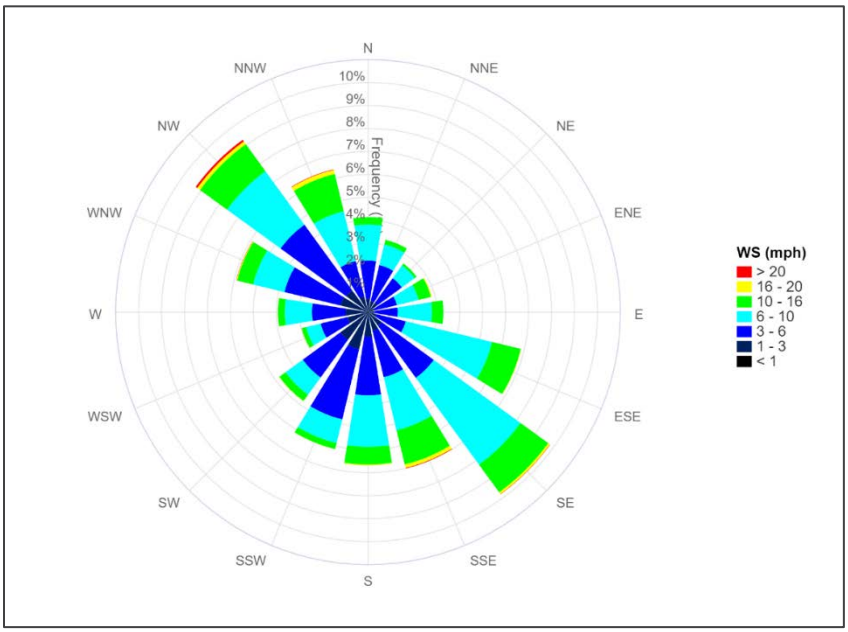
[70] See Section 3.5, Sensor Guidebook. Ibid (6).
[71] See Section 7.0, US EPA (January 2017) QA Handbook Volume II.
[72] 40 CFR Part 58, Appendix E
[73] Quality Assurance Handbook for Air Pollution Measurement Systems Volume IV (March 2008), US EPA [EPA-454/B-08-002]. https://www.epa.gov/sites/default/files/2020-10/documents/volume_iv_meteorological_measurements.pdf
[74] Ibid (71).
[75] Ibid (6).
[76] QuantAQ Map https://app.quant-aq.com/map

and longitude coordinates. The analysis was based on the locations provided in the data, though the coordinates were low resolution so precise locations were not identified for some of the sensors.

Wind data from each of the community network monitoring stations were also compared with data collected from the CSXT 10-meter meteorological tower between March 22, 2023 through July 31, 2023. The CSXT meteorological tower is located along the east side of the Curtis Bay Piers facility and was sited to meet US EPA siting and exposure criteria for meteorological sensors.[77] The wind data comparisons are depicted using wind rose plots. Wind rose plots (or wind rose) are a graphical tool to show the distribution of wind speed and wind direction around a compass. Wind directions represent the origin of the wind (the direction wind is blowing from).

Figure 2 presents the wind rose plot for the CSXT meteorological tower for the period of March 22 through July 31, 2023. This period was selected due to the overlap in data analyzed by the Community Investigation Report. The wind rose plot shows predominant wind flow from the northwest and southeast. Wind roses were generated for the community network sensors for the same period and are available in Appendix B. Siting of each low-cost sensor location used in the Community Investigation Report will be discussed in the following subsections.

Figure 2 CSXT Meteorological Station Wind Rose (March 22, 2023 through July 31, 2023)



2.3.3.1 Location 1 Site Selection

The closest community monitor to the CSXT Terminal is Location 1. Air monitoring equipment at Location 1 is on the rooftop of an auto performance and tuning shop adjacent to the CSXT Terminal. Figure 3 presents a map and the associated wind rose for Location 1.

The sensors are placed on a lower-tier rooftop with a higher-tier roof located immediately west of the sensors. This arrangement is problematic for two reasons. First, the sensors are not placed a sufficient distance from the higher-tier rooftop and would be in the wake of the building during westerly winds,

[77] See Section 1.0, US EPA (March 2008) QA Handbook Volume IV.

resulting in a cavity forming downwind of the tier. This can lead to potentially higher PM concentrations in the wake of the higher-tier building and skew wind measurements made at the site. This issue is depicted in Figure 4, which includes a map showing Location 1 with a wind rose overlaid onto the map. The wind rose shows much lower wind speeds than the CSXT meteorological tower and shows winds predominantly out of the west, south, and east. The lack of agreement with the CSXT meteorological tower suggests the Location 1 sensor is making hyper-local measurements affected by its placement in the building's wake. The sensor is likely not high enough above the roofline to be out of the wake of the building.

Second, the air monitoring sensor at Location 1 was placed on a building that services vehicles. The auto performance and tuning shop is therefore itself a source of particulate and gaseous pollutants similar to those being measured by the air monitoring sensor. It is therefore difficult to distinguish among measurements of pollutants from the auto performance and tuning shop building, the CSXT Terminal, the scrap metal recycling facility south of the monitor, or other nearby industrial sources.

Figure 3 Location 1 Map and Wind Rose

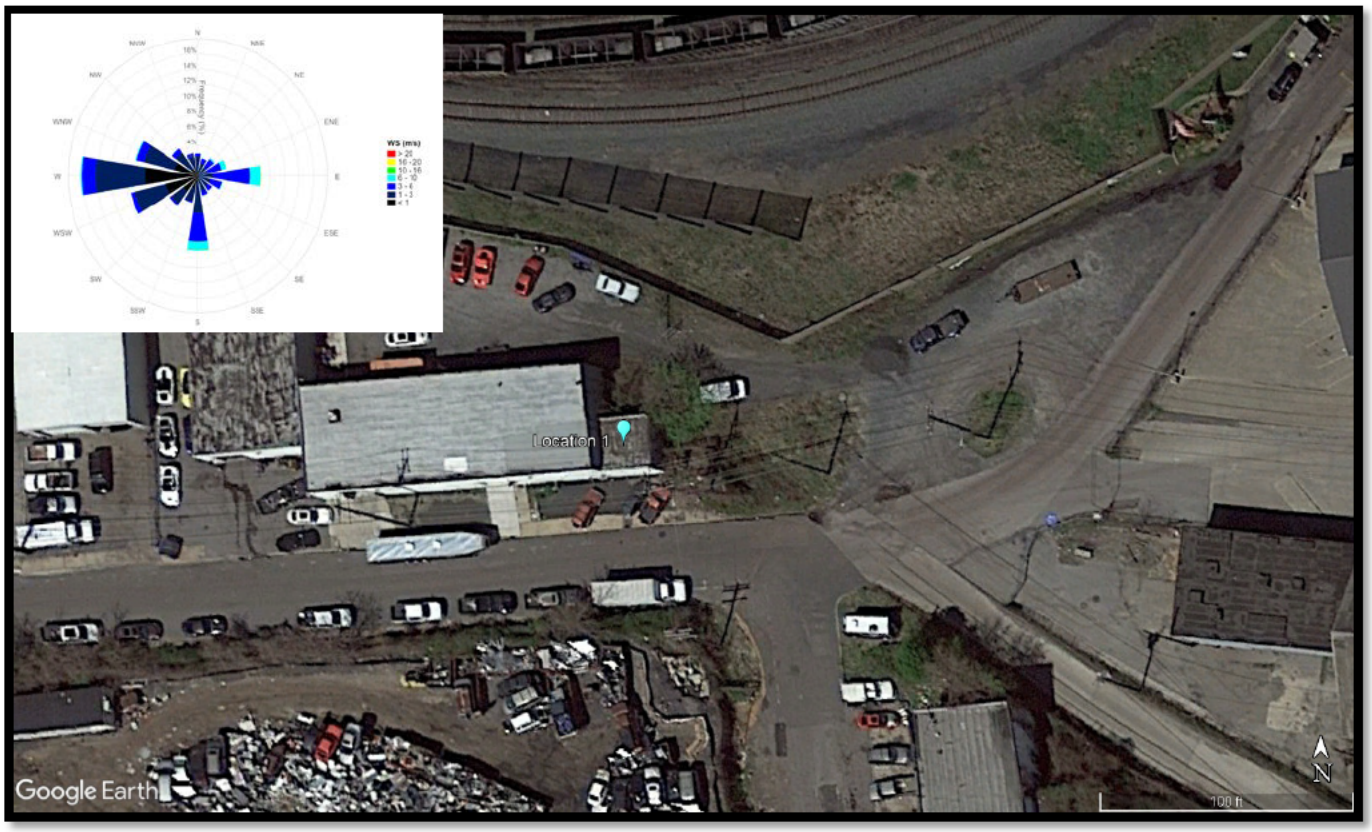
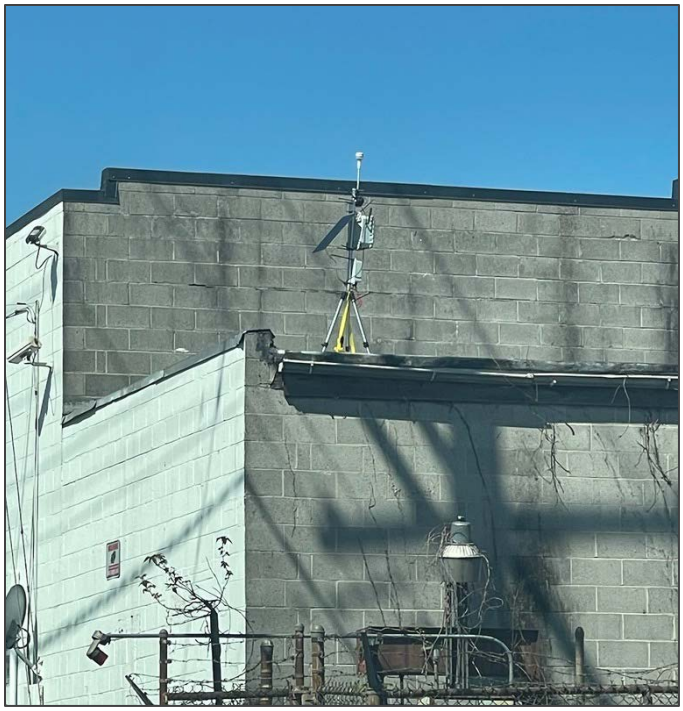


Figure 4 Picture of Location 1 Sensor Installation



2.3.3.2 Location 2 Site Selection

Air monitoring equipment at Location 2 is mounted to a fence on Locust Street just west of the CSXT Terminal. Figure 5 presents a map showing Location 2 with a wind rose overlaid onto the map. A photograph of the sensor location is presented in Figure 6.

The wind rose shows a predominant wind flow out of the south-southeast with over 35 percent of the winds coming from that direction. This is much higher than the regional air flow as measured by the CSXT meteorological tower and could indicate either a sensor issue or an obstruction channeling the air flow around the sensor. A sensor issue or obstruction could skew or bias air pollution measurements from this location.

Figure 5 Location 2 Map and Wind Rose

Figure 6 is a picture of the sensor installation at Location 2. The picture shows the instrument mounted on a chain linked fence that allows air flow around the sensor. The wind sensor is not pictured. Photographs of the installation from each of the cardinal directions would be useful for understanding what may be causing the channeling effect shown in the data.

Figure 6 Picture of Location 2 Sensor Installation

Source: Aubourg MA, Sawtell G, Deanes L, et al. (September 2023)

2.3.3.3 Location 3 Site Selection

Air monitoring equipment at Location 3 is mounted to a pole on Church Street west of the CSXT Terminal. Figure 7 presents a map showing Location 3 with a wind rose overlaid onto the map. Photographs of the sensor at Location 3 from the Community Investigation Report and Google Earth are presented in Figure 8. The picture shows the instrument mounted on a pole, which allows air flow around the sensor.

The wind rose shows predominant wind flows out of the east-southeast and west with a third predominant flow from the south. Other than the wind flow from the south, which could be caused by a sensor reporting issue, the wind pattern looks to be representative of wind directions at this location given that buildings north and south of the sensor are channeling the wind flow. However, concentration data at the location may be skewed by the adjacent air conditioning unit, which could act as a source of heat and PM. This site would likely be considered a microscale monitoring location as defined by US EPA for community monitoring. [78]

Figure 7 Location 3 Map and Wind Rose

[78] 40 CFR Part 58 Appendix D 1.2(b)(1).

Figure 8 Picture of Location 3 Sensor Installation

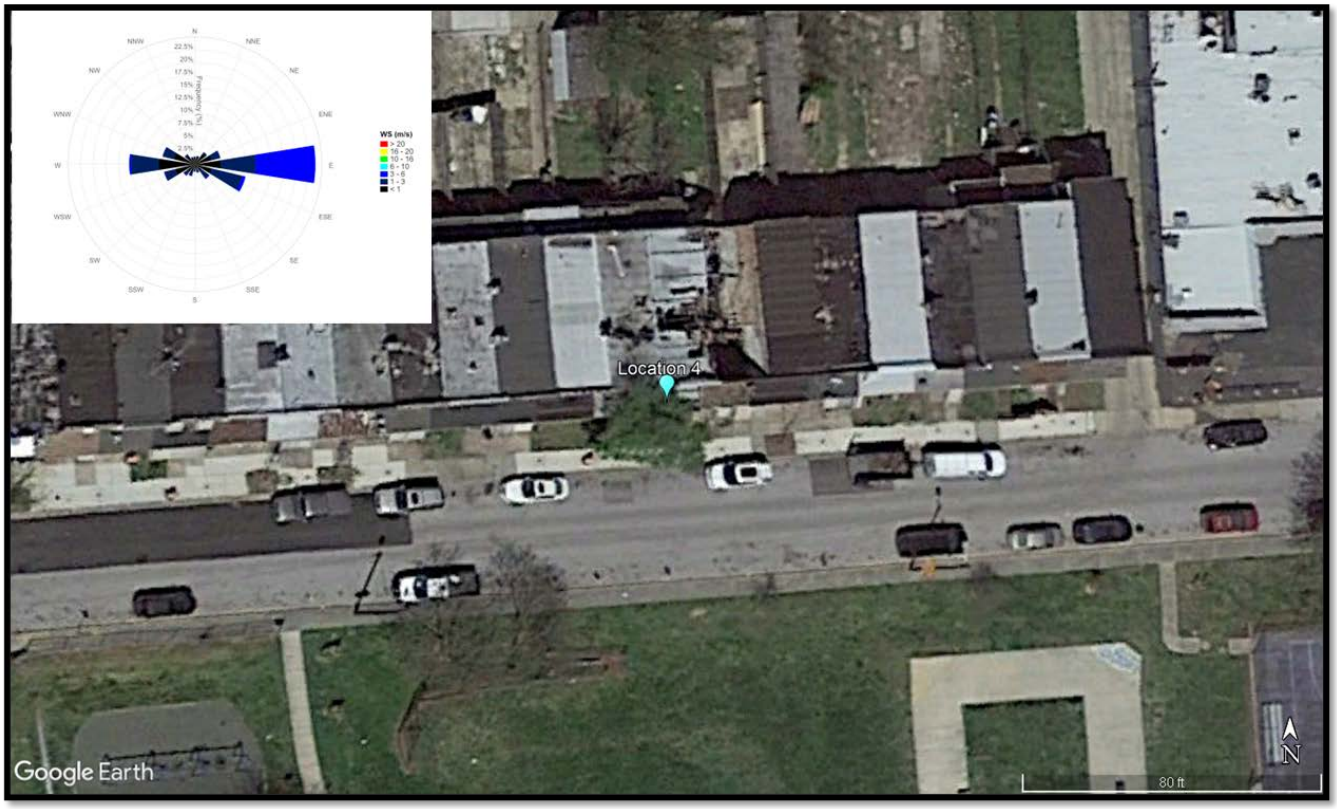
Source: Figure 2 in Section 3b of the Community Investigation Report

Source: Google Earth

2.3.3.4 Location 4 Site Selection

Location 4 is situated at a home on Hazel Street approximately a block and a half west of the CSXT Terminal. Figure 9 presents a map showing Location 3 with a wind rose overlaid onto the map. The wind rose shows predominant wind flows out of the east and west. There are no photographs or Google Images available of the installation, but based on the satellite image in Figure 9, it is possible that wind directions and speeds are skewed by the buildings located close by. The satellite image shows a park across the street that has enough open green space with limited obstructions to have winds that follow a more regional pattern as measured by the CSXT meteorological tower.

Figure 9 Location 4 Map and Wind Rose



2.3.3.5 Location 5 Site Selection

Air monitoring equipment at Location 5 is placed on the porch of a house located on Cypress Street and Fairhaven Avenue approximately a quarter of a mile west of the CSXT Terminal. Figure 10 presents a map showing Location 5 with a wind rose overlaid onto the map. The wind rose shows a predominant wind flow out of all eastern directions with no winds from the west. This pattern indicates an obstruction is influencing the wind sensor.

Figure 11 shows two pictures of the sensor installed at Location 5 from Google Earth Street View. The pictures show the instrument mounted on the porch of a house. There is an air conditioning unit located within 6 feet of the sensor and a grill located just under the sensor. As discussed above, air conditioning units can be sources of heat and PM, and grills can also emit pollutants. As a result, Location 5 is not conducive to making measurements representative of the surrounding area since it has both improper exposure to wind flow and is adjacent to minor sources of air pollution that can affect the measurements.

Figure 10 Location 5 Map and Wind Rose

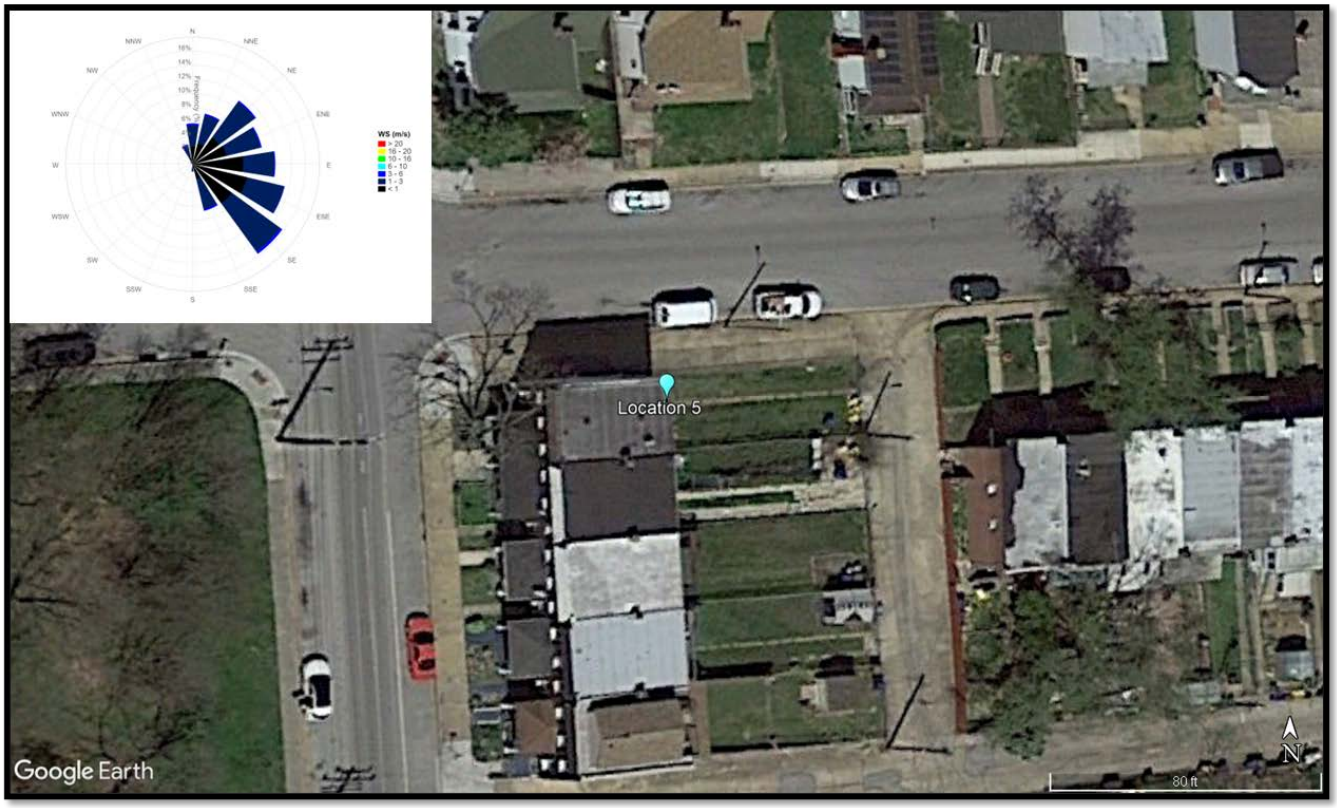


Figure 11 Pictures of Location 5 Sensor Installation

Source: Google Earth

Blue circles indicating location of sensors.

2.3.3.6 Location 6 Site Selection

Coordinates for Location 6 place the sensors in the middle of an excavation equipment rental company just over a third of a mile southwest of the CSXT Terminal. Figure 12 presents a map showing Location 6 with a wind rose overlaid onto the map. Although the location depicted in the map was the location obtained from the sensor data, I do not believe this is the actual placement of the sensor given it is located in the middle of what appears to be a driveway through the property.

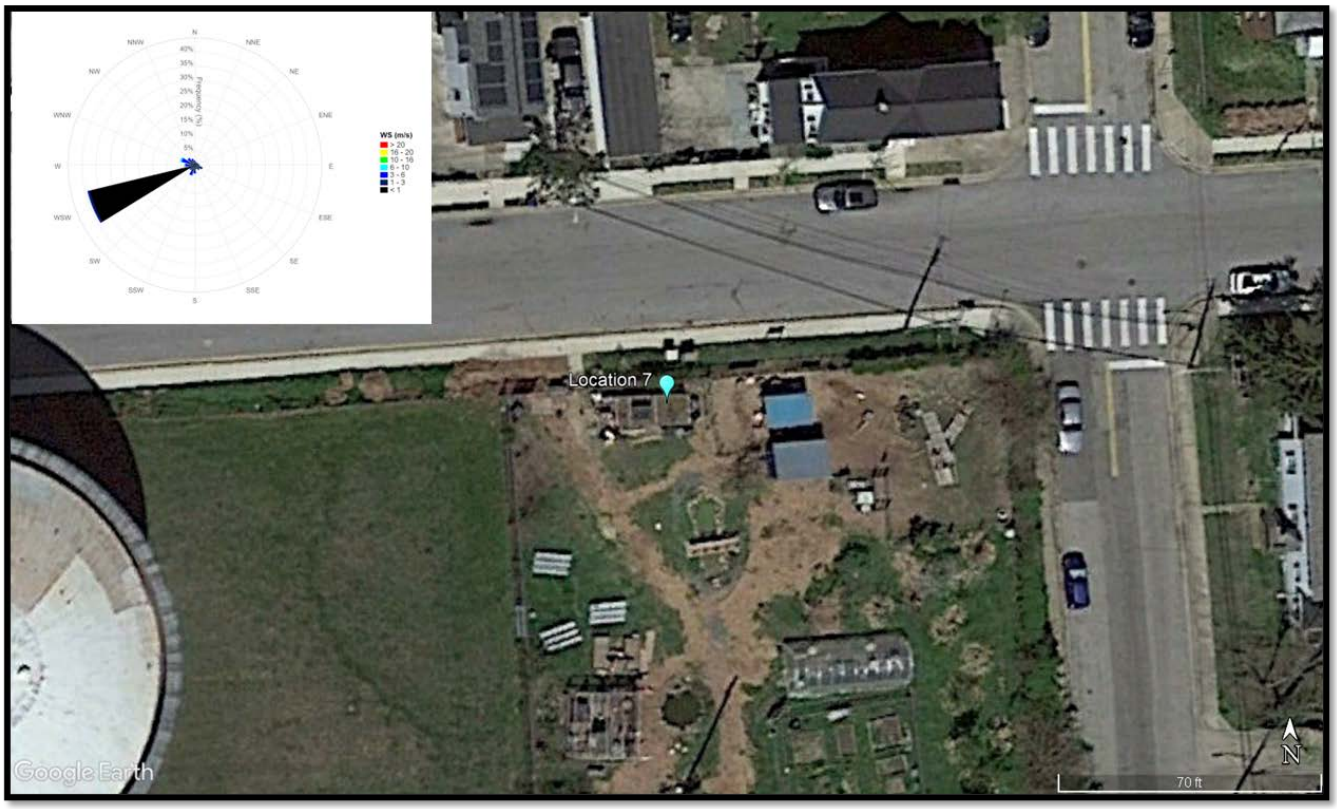
The wind rose shows predominant wind flow out of the southeast and north. This wind rose has a similar shape to the CSXT wind rose but with much lower wind speeds likely due to the sensor's height above the ground. The map also shows that this location has unpaved roads. Given the use of heavy equipment at Location 6 and the lack of paved roads, concentration readings at this sensor are likely skewed by dust emissions.

Figure 12 Location 6 Map and Wind Rose

2.3.3.7 Location 7 Site Selection

Coordinates for Location 7 place the sensors at the Filbert Street Garden on Filbert Street about four tenths of a mile west of the CSXT Terminal. Figure 13 presents a map showing Location 7 with a wind rose overlaid onto the map. The wind rose shows 40 percent of all winds measured at the site were out of the west-southwest. There are a few issues with this data. First, located approximately 50 yards west-southwest of the wind sensor is a large water tank that would act as an obstruction shadowing wind from that direction. Second, given the large percentage of winds from one direction and that the wind rose does not show predominant wind flow that follows regional wind patterns (as indicated by the CSXT meteorological tower), it can be concluded that this sensor is affected by channeling. The validity of the data sampled by this sensor location is in question since the winds do not exhibit a wind pattern reflective of regional conditions as measured by the CSXT meteorological tower.

Figure 13 Location 7 Map and Wind Rose



2.3.3.8 Location 8 Site Selection

Coordinates for Location 8 place the sensors in the back yard of a residence on Monroe Circle near the Benjamin Franklin High School about three quarters of a mile northwest of the CSXT Terminal. Figure 14 presents a map showing Location 8 with a wind rose overlaid onto the map. The wind rose shows predominant wind flows out of the west-northwest. Although not exact, the pattern is reminiscent of the regional wind patterns as measured by the CSXT meteorological tower and could be representative of the location. However, additional pictures showing the installation and photographs of each of the cardinal directions from the sensor would help determine if there was proper wind exposure at the site.

Figure 14 Location 8 Map and Wind Rose

2.3.3.9 Location 9 Site Selection

Coordinates for Location 9 place the sensors at the Benjamin Franklin High School approximately three quarters of a mile northwest of the CSXT Terminal. Figure 15 presents a map showing Location 9 with a wind rose overlaid onto the map. The wind rose shows predominant wind flows out of the southwest and east-northeast. Due to the proximity of Location 8 and Location 9 to one another (about 150 yards from one another), the wind flow patterns between these two locations should be fairly consistent. However, while Location 8 shows predominant flows out of the northwest, Location 9 (with no structures or obstructions within 40 yards of the site) shows less than 2 percent of winds coming from the northwest. With proper site selection, the wind flow patterns between Location 8 and Location 9 should have similar wind flow patterns. Without photographs of the installation or calibration forms confirming proper installation of Location 8 or Location 9, it is difficult to know which of these sites are making improper measurements.

Figure 15 Location 9 Map and Wind Rose

2.3.3.10 Location 10 Site Selection

Coordinates for Location 10 place the sensors at approximately three quarters of a mile east of the CSXT Terminal. Figure 16 presents a map showing Location 10 with a wind rose overlaid onto the map. The wind rose shows predominant wind flows out of the west-northwest and east-southeast. This pattern is similar to the CSXT meteorological tower but with more of an east-west wind flow. The map shows a building approximately 60 feet to the north of the monitoring site but otherwise very few obstructions. Wind speeds are lower than what is measured at the CSXT meteorological tower, but that is to be expected because the sensor is not at the 10-meter height. This location appears to have been properly sited away from the influence of obstructions and may be considered representative of the location for which it made measurements.

Figure 16 Location 10 Map and Wind Rose

In summary, the site selection analysis (using location data available from the community sensor network) identified issues with site selection and sensor placement for several of the community monitoring stations (Location 1, Location 2, Location 4, Location 5, Location 6, Location 7, and Location 8 or 9 or both). Each of these locations has shortcomings with respect to sensor placement, which can lead to concentration data that are unduly influenced by obstructions and minor sources and that are not representative of community-wide exposure.

3. OPINION #2: CURTIS BAY IS IN ATTAINMENT WITH HEALTH-BASED STANDARDS FOR PM_{10} AND $PM_{2.5}$

US EPA states in its air quality regulations that comparisons to the PM NAAQS should be made using data collected over a calendar year with FEM monitoring equipment. [79] [80] To calculate design values,[81] data need to be reduced to hourly averages[82] and daily (24-hour, midnight to midnight) average concentrations in accordance with the definitions found in 40 CFR Part 50 Appendix N ($PM_{2.5}$) and Appendix K (PM_{10}).[83]

Section 4 of the Community Investigative Report did not follow US EPA regulations or guidance in comparing measured air quality in Curtis Bay to the PM NAAQS. The air quality measurements were collected using Modulair sensors rather than FEM monitors. Further, the comparisons were made using data that were collected over a 14-month period (data were collected between May 16, 2022 and July 16, 2023) rather than a calendar year.

Modulair sensors are non-regulatory air measurement devices that do not meet FEM standards. South Coast Air Quality Management District's (SCAQMD) Air Quality Sensor Performance Evaluation Center (AQ-SPEC) conducted a field evaluation of the Modulair sensor in 2021[84] (Field Evaluation). The results of the Field Evaluation show this particular model of sensor overestimated $PM_{2.5}$ concentrations with a mean bias error (MBE[85]) of 2.9 to 4.8 µg/m^3 for 24-hour concentrations and underestimated PM_{10} concentrations with an MBE of 13.0 to 22.1 µg/m^3 for 24-hour concentrations. The results of the Field Evaluation also showed PM_{10} had poor testing results for the sensor when compared to US EPA performance metrics[86].

Despite the fact that the low-cost sensors used in the community air monitoring network have an inherent bias to overestimate $PM_{2.5}$ concentrations and underestimate PM_{10} concentrations when compared with FEM monitors, the data demonstrated that PM concentrations in the Curtis Bay area are below the levels of the annual and 24-hour NAAQS for $PM_{2.5}$ and 24-hour NAAQS for PM_{10}.[87]

On February 7, 2024, US EPA finalized an update to the annual $PM_{2.5}$ NAAQS, reducing the NAAQS value to 9 µg/m^3.[88] The Community Investigation Report calculated a mean $PM_{2.5}$ concentration for the period May 26, 2022 through July 26, 2023 as 10.1 µg/m^3 in Curtis Bay (daily averages across all network locations), which is above the updated primary annual $PM_{2.5}$ NAAQS. Yet when excluding data affected by smoke from Canadian wildfires,[89] the Community Investigation Report calculated an annual $PM_{2.5}$ design value of 9.0 µg/m^3 for the same period. This calculation is incorrect as it uses 14 months of data but is still compliant with the updated NAAQS. Furthermore, the annual average $PM_{2.5}$ concentrations was also calculated for the

[79] 40 CFR Part 50, Appendix N
[80] 40 CFR Part 50, Appendix K
[81] A design value is the value that is compared to the level of the NAAQS for the particular pollutant and specific time averaging period to determine if an exceedance has occurred.
[82] US EPA (January 2017) QA Handbook Volume II, Section 6.0 recommends at least 45 minutes of data in any given hour to calculate an hourly average.
[83] US EPA, Air Quality Design Values. https://www.US EPA.gov/air-trends/air-quality-design-value
[84] Quant-AQ MODULAIR-PM – Field Evaluation (2021), South Coast Air Quality Management District Air Quality Sensor Performance Evaluation Center (SCAQMD AQ-SPEC). https://www.aqmd.gov/aq-spec/sensordetail/quantaq---modulair-pm
[85] *"Mean Bias Error (MBE): the difference between the sensors and the reference instruments. MBE indicates the tendency of the sensors to underestimate (negative MBE values) or overestimate (positive MBE values)."* (Ibid 11).
[86] Ibid (11).
[87] Community Investigation Report, Section 4 pages 3 through 5.
[88] https://www.epa.gov/newsreleases/epa-finalizes-stronger-standards-harmful-soot-pollution-significantly-increasing
[89] It is unclear whether the dates selected for wildfire exclusion in the Community Investigation Report were the dates MDE is evaluating as exceptional events.

period of May 26, 2023 through May 25, 2023 across all sensors, resulting in an annual concentration of 8.6 µg/m³. These data suggest the Curtis Bay area is currently attaining the health-based standard for $PM_{2.5}$.

NAAQS comparisons were also made for 24-hour $PM_{2.5}$ and PM_{10}. The 24-hour $PM_{2.5}$ NAAQS is attained when the 3-year average of the annual 98th percentile 24-hour concentration is less than or equal to 35 µg/m^3, and the 24-hour PM_{10} NAAQS is attained when the 3-year average 24-hour PM_{10} concentration does not exceed 150 µg/m^3. When excluding exceptional events from wildfires, the 98th percentile for daily concentrations was 26.8 µg/m³, which is below the current 24-hour $PM_{2.5}$ NAAQS. PM_{10} had a maximum of three exceedances of the PM_{10} 24-hour NAAQS during the monitoring period. This occurred at Location 6[90] in the community network, which is not the closest monitoring station to the CSXT Terminal. By contrast, Location 1 of the community network is situated between the CSXT Terminal and Location 6 and had no days above the 24-hour PM_{10} standard when exceptional event data from wildfire smoke was removed.

The Community Investigation Report also provides projections of future air quality results.[91] Each monitoring year is unique in the atmospheric conditions and emission sources that impact a monitoring network. Therefore, projections of future design values are not appropriate, nor is there an approved US EPA methodology for projecting future concentrations.

3.1.1 Curtis Bay Air Quality Burden

The Community Investigation Report also concludes that the Curtis Bay community is overburdened by air pollution.[92] Section 4 of the Community Investigation Report compares monitored data collected by the community sensor network to the MDE Lake Montebello FEM monitoring station for $PM_{2.5}$ and the MDE Glen Burnie monitoring station for PM_{10}. The comparisons show the community monitoring network had an annual average $PM_{2.5}$ concentration that was 1 to 3 µg/m³ higher than the Lake Montebello monitoring station. As discussed above, performance evaluation of the Modulair sensors performed by AQ-SPEC found that the sensors overestimate $PM_{2.5}$ with a MBE between 2.9 and 4.8 µg/m³.[93] Because the difference in measurements between the community network low-cost sensors and Lake Montebello FEM sensors is less than the known MBE for the low-cost sensors, the $PM_{2.5}$ concentrations measured by the community monitoring network are statistically the same as the Lake Montebello monitoring station concentrations.

For PM_{10}, comparing the known MBE for PM_{10} (13.0 to 22.1 µg/m^3 for 24-hour concentrations, as measured by the AQ-SPEC[94]) to maximum 24-hour PM_{10} concentrations as measured by the community monitoring network (see Table 8 in the Community Investigation Report) would not increase the community network concentrations enough to result in additional exceedance days of the PM_{10} standard. In other words, if the low-cost sensors truly underestimated PM_{10} concentrations, adjusting for the error would still not increase the number of PM_{10} exceedance days from the low-cost sensors.

[90] See *Supra* Section 2.3.3.6 Location 6 had site selection issues.
[91] Section 4, Tables 1 & 2, Community Investigation Report.
[92] Key finding 3, Community Investigation Report.
[93] Ibid (2).
[94] Ibid (84).

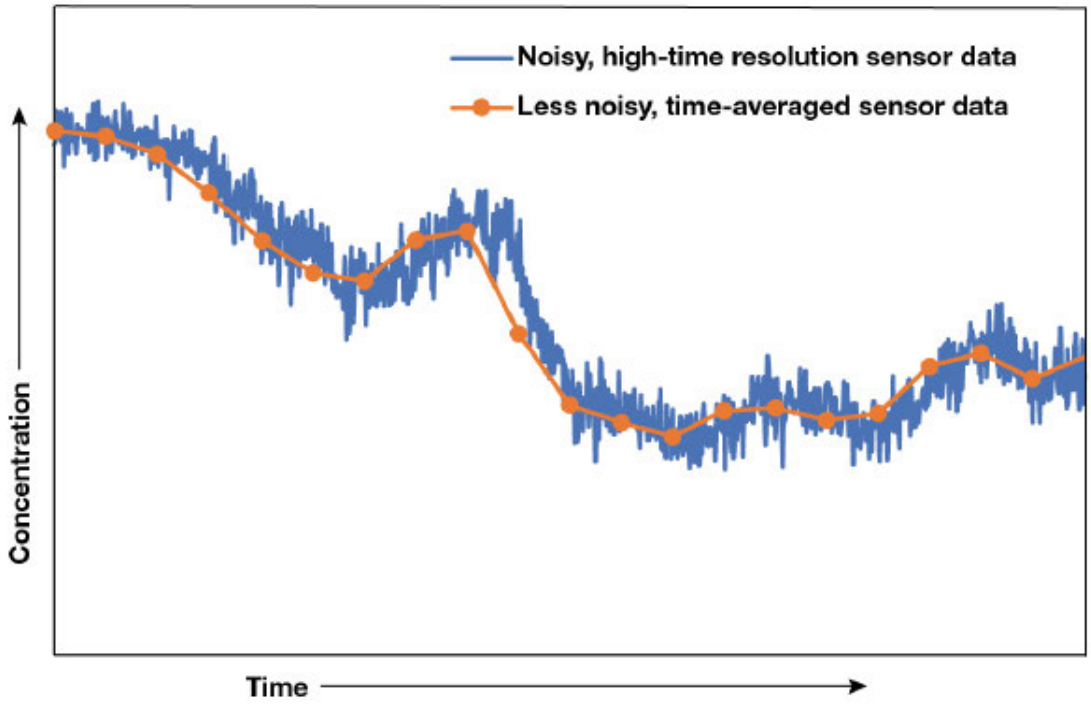
4. OPINION #3 ONE-MINUTE DATA ARE NOT A RELIABLE INDICATOR FOR OVERALL AIR QUALITY

Conclusions drawn from the ambient air quality monitoring data in the Community Investigation Report were based on one-minute data for which there are no health-based standards. Some of these conclusions are based on one-minute PM_{10} measurements already identified as not meeting the performance metrics recommended by US EPA.

4.1 Monitoring Data Noise

One-minute data are typically collected as raw data measurements for applying quality control tests for data validation purposes before data get averaged into the proper averaging interval.[95] One-minute data are often less precise and more susceptible to internal and external factors such as electrical interference and weather changes.[96] These factors interfere with the signal within the sensor, leading to rapid fluctuation in the measurement data and thus increasing the variability and reducing the confidence in the data. This variability in signal is referred to as instrument noise and can lead to erroneously high or low values[97] with rapidly changing values referred to as data spikes. Figure 17 presents an example of noisy measurement data as presented by the Sensor Guidebook.

Figure 17 Example of Noisy Measurement Data



Source: US EPA *Enhanced Air Sensor Guidebook* (2022)

[95] US EPA (January 2017). QA Handbook Vol II, Section 14.0, Rev 0.
[96] Ibid (6)
[97] Hagler, G.S., Yelverton, T.L., Vedantham, R., Hansen, A.D. and Turner, J.R. (2011). Post-processing Method to Reduce Noise while Preserving High Time Resolution in Aethalometer Real-time Black Carbon Data. Aerosol Air Qual. Res. 11: 539-546.

An example of noisy data within the Community Investigation Report is observed in Figure 9 (Figure 17 below) and Figure 10 (Figure 18 below) of Section 3. These two charts show the Dust Factor (defined as a factorization of PM_{10} and TSP) and Regional Factor (defined as a factorization of PM_1, $PM_{2.5}$, and black carbon) for the same period and same monitoring site. Other than black carbon, the remaining pollutants are variations in particle size for particulate matter.

Dust Factor data (Figure 17 below) show a frequent oscillation of data from value to value. The data also show numerous data spikes (or outliers) above the mean+3SD threshold line. This frequent oscillation of data is characteristic of the linearity and mean error issues shown in the collocation tests of the Modulair sensors. This indicates that the Dust Factor is erroneously including noisy data, and the Community Investigation Report is drawing conclusions based on the noisy data.

Figure 18 Dust Factor Time Series for Location 8

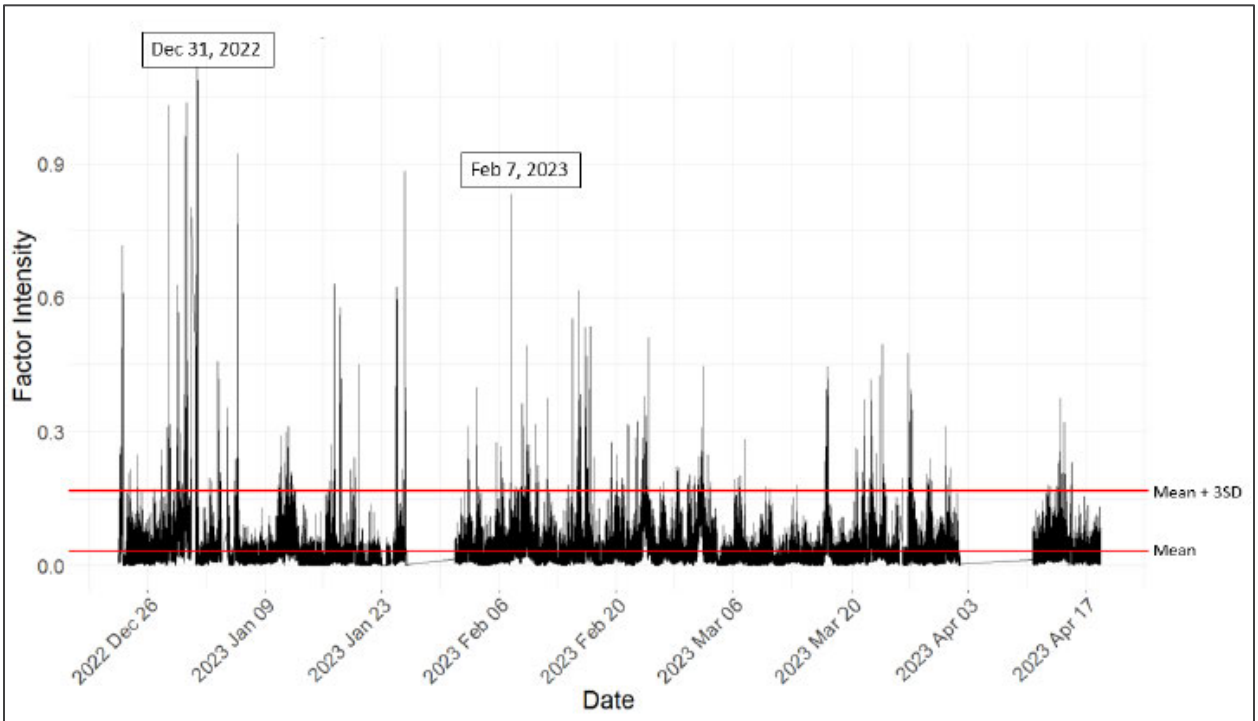


Figure 9. Time series of dust factor and threshold exceedances at Location 8, South Baltimore Air Monitoring Network, December 22, 2022-April 18, 2023 (n = 127,995 minutes). ***Note.*** Mean, mean + 3 standard deviation thresholds are denoted with red horizontal lines. Dates of observed dust peaks annotated.

Source: Figure 9 in the Community Investigation Report

Regional Factor data (Figure 18) show a less frequent and lower magnitude of value-to-value oscillation in data, which is similar in the characteristic response of the Modulair sensors during the collocation tests. Although the NMF Factor data in Figures 17 and 18 are not concentration measurements made by the sensor, the instability of the one-minute data is a limitation of the sensors and introduces unreliability into the NMF Factor, thus calling the conclusions into question.

Figure 19 Regional Factor Time Series for Location 8

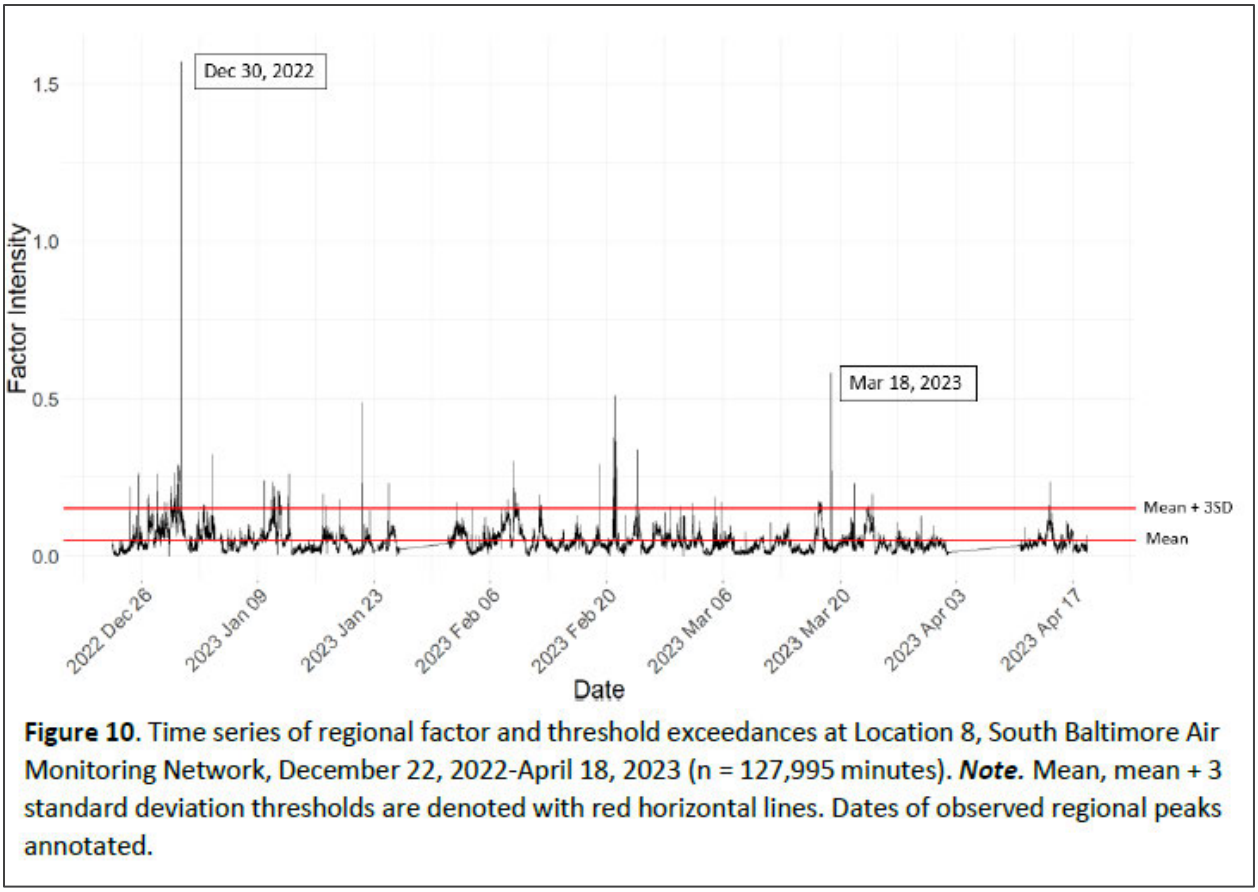


Figure 10. Time series of regional factor and threshold exceedances at Location 8, South Baltimore Air Monitoring Network, December 22, 2022-April 18, 2023 (n = 127,995 minutes). ***Note.*** Mean, mean + 3 standard deviation thresholds are denoted with red horizontal lines. Dates of observed regional peaks annotated.

Source: Figure 10 in the Community Investigation Report

Spikes in concentration data can be difficult to interpret, as the resulting concentration spikes could have contributions from emission sources, systematic errors, or a hyper-localized source such as vehicles, barbeques, vents, smoke from a cigarette or campfire, or excavation activities. These spikes are more difficult to identify and interpret when the sensors have poor stability in the measurements. Furthermore, short-term concentrations are not necessarily an indication of overall air quality for a neighborhood but rather a hyper-local or short-term condition that was captured by the sensor.[98]

[98] US EPA, A Guide to Siting and Installing Air Sensors (accessed January 2024) https://www.US EPA.gov/air-sensor-toolbox/guide-siting-and-installing-air-sensors

5. OPINION #4: IMPROPER USE OF NON-NEGATIVE MATRIX FACTORIZATION (NMF)

Ambient air quality monitoring equipment is not capable of differentiating among air pollutant sources. In other words, the sensors measure the targeted pollutant in the atmosphere and are unable to distinguish the contribution from sources of the pollutant. The Community Investigation Report used a statistical model called non-negative matrix factorization (NMF) in an attempt to quantify the contribution of pollution sources in Curtis Bay to air monitoring data collected by the community monitoring network.

The NMF model can be used to reduce a dataset containing several variables and reducing it into two categories: source types and source contributions. [99] The source type is defined by a unique composition of pollutants (otherwise described as a fingerprint) that can be used to identify a specific pollution source. The source contribution category attempts to determine how much a pollution source is contributing to a sample measurement. The usefulness of the NMF model in this context depends on the uniqueness of the pollutants (or species) used to identify a particular source or source type. Pollutants that are too available in a region or are characteristic of multiple emission source types will weaken the NMF analysis since there would be cross contamination from multiple sources in the sample measurement.

To illustrate this point, below are pollutants and the associated NMF source types used in the Community Investigative Report:

- **PM_{10}** – "Putative Coal Dust" and "Dust"
- **$PM_{2.5}$** – "Local Combustion", "Cars", and "Regional"
- **PM_1** – "Local Combustion", "Cars", and "Regional"
- **Total Suspended Particulate (TSP)** – "Putative Coal Dust" and Dust"
- **Black Carbon (BC)** – "Putative Coal Dust", "Local Combustion", and Regional"
- **Carbon Monoxide (CO)** – "Cars"
- **Nitrogen Oxide (NO)** – "Local Combustion"
- **Nitrogen Dioxide (NO_2)** – "Diurnal Combustion" and "Local Combustion".

As previously described, the utility of the NMF analysis in this context depends on the uniqueness of each source's pollutant fingerprint. Pollutant data measured by the community air monitoring network are not distinguishable or unique enough to differentiate among sources, reducing the effectiveness of their NMF analysis and calling into question the conclusions the researchers draw from it. Moreover, the source categories' fingerprints themselves are not defined consistently. For example, Figure 5 in the Community Investigation Report presents the composition of a variety of NMF Factors for monitoring stations 1, 2, 5, and 8. However, the compositions of the different factors do not seem to show a consistent composition or 'fingerprint' to the different source categories.

Moreover, the Community Investigation Report omits a NMF Factor for diesel trucks or diesel combustion, which the report identifies as being one of the "major sources" of pollution in the community.[100] [101]

[99] Zhang, Y.X.; Sheesley, R.J.; Bae, M.S.; Schauer, J.J. (2009). Sensitivity of a molecular marker based positive matrix factorization model to the number of receptor observations. Atmos. Environ., 43(32): 4951-4958.
[100] See Page 7 of Section 3b of the Community Investigation Report *"At Location 2, the putative coal dust factor appears to be diluted by a ~40% contribution from NO, suggesting nearby diesel emissions."*
[101] See Page 19 of Section 3b of the Community Investigation Report *"For bulldozer activity, the only statistically significant case is for black carbon. This is consistent with the fact that bulldozers are diesel-fueled, and diesel combustion emits black carbon and smaller size fraction particles."*

The Community Investigative Report fails to maintain clear distinctions among source categories in certain sections. For instance, while the Community Investigation Report outlines six source categories for the NMF analysis, it only presents four of the categories in the actual NMF analysis per monitoring site, introducing an additional "Residual" category instead. Similarly, at Location 2, the NMF analysis combines two source categories (cars and local combustion). These discrepancies underscore the inadequacy of the Community Investigation Report's NMF analysis in effectively discerning sources and drawing conclusions regarding any specific source's impact on air quality.

Moreover, based on my conclusion in Opinion 1 that the Community Investigative Report's PM_{10} data are invalid, the entire NMF analysis is invalid because it relies on this PM_{10} data to define multiple source categories. Per the Community Investigative Report, NMF Factors were based on a variety of different combinations of gaseous and PM measurements collected on a one-minute data resolution. Three of these NMF categories use PM_{10} data as an input, which was shown by the Community Investigation Report and the Supplemental Materials Document to have a poor linear relationship when compared to the FEM monitor with a coefficient of determination (R^2) of 0.31. Again, this is well below the US EPA-recommended performance metrics of ≥0.7 when compared with an FEM monitor. It is unclear whether concentration data from the sensors were accepted as reported by the device or if correction factors were applied in the processing of data. If data were accepted as reported by the device, none of the Factor data that utilize PM_{10} measurements should be considered for making conclusions based on the sensor not being able to meet US EPA-recommended performance metrics.

Furthermore, the Community Investigation Report erroneously attributes certain emission events to spikes in “putative coal dust” emissions. The Community Investigation Report describes an event on February 3, 2023, in which a bulldozer became stuck on the southern pile of the terminal. Figure 19 was extracted from the Community Investigation Report and provides a chart of one-minute data comparing the derived “Putative Coal Dust” Factor with corresponding pollutant concentration measurements of TSP, PM_{10}, $PM_{2.5}$, PM_1, black carbon, CO, NO, and NO_2 from noon (12:00) local time (LT) until approximately 15:00 LT on the date of the event. The “Putative Coal Dust” Factor spiked shortly after 12:00 on February 3, 2023, corresponding to a spike in black carbon, $PM_{2.5}$, PM_1, and CO. But the “Putative Coal Dust” Factor spike did not have a corresponding spike in TSP or PM_{10} concentrations, as would have been expected based on the putative coal dust definition developed by the researchers. Furthermore, spikes in the “Putative Coal Dust” Factor at approximately 12:50, 13:15 and 14:05 LT only have spikes in TSP, PM_{10}, and $PM_{2.5}$ without a corresponding black carbon spike, which would indicate the “Dust” Factor category would also have a spike rather than the PCD Factor.

This example raises questions as to the Community Investigation Report’s vetting and interpretation of the data. From the NMF Factor definitions as provided in the Community Investigative Report, NMF categories such as Regional, Cars, or Local Combustion Factors would have been expected to spike rather than the “Putative Coal Dust” Factor.

Figure 20 Community Investigation Report Time Series from February 3, 2023, Event

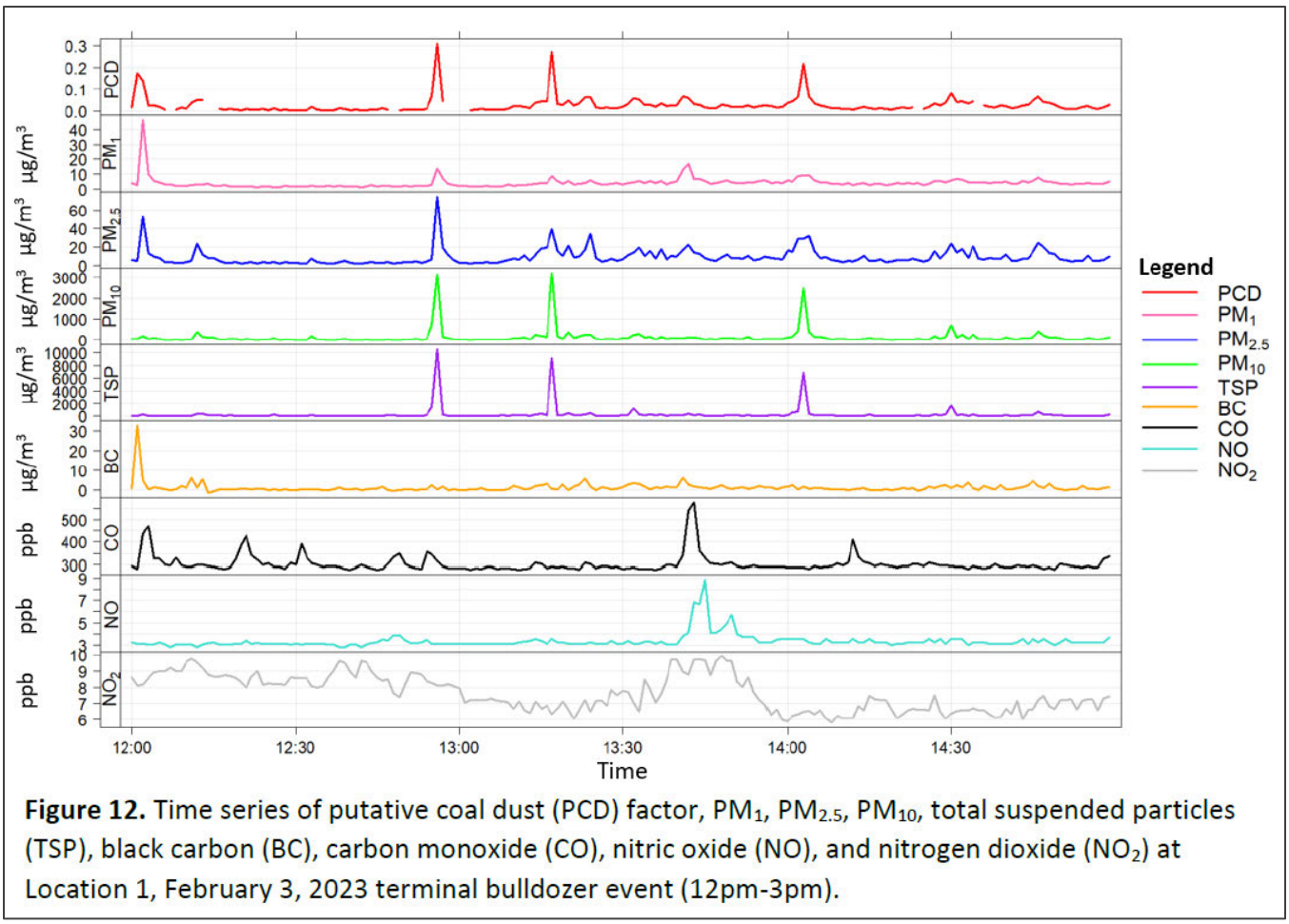


Figure 12. Time series of putative coal dust (PCD) factor, PM_1, $PM_{2.5}$, PM_{10}, total suspended particles (TSP), black carbon (BC), carbon monoxide (CO), nitric oxide (NO), and nitrogen dioxide (NO_2) at Location 1, February 3, 2023 terminal bulldozer event (12pm-3pm).

Source: Figure 12 in the Community Investigation Report

5.1 Improper Use of the Term "Exceedance"

The term "exceedance" in the air quality lexicon indicates an air pollution episode in which a verified measurement is greater than an air quality standard set by US EPA or other air quality agencies.[102] [103] The Community Investigation Report improperly uses this term and provides a count and duration of so-called 'exceedances' for their *Factor Index* terms.

An air quality report conveying a number of exceedances would indicate that there are episodes in which a verified measurement is greater than a predetermined regulatory standard and that the verified measurement matches the time averaging period set for the threshold. An example of a NAAQS exceedance would be if the 24-hour PM_{10} concentration were to go above 150 µg/m^3 or a 24-hour $PM_{2.5}$ concentration were to go above 35 µg/m^3. This does not indicate a violation of the standard but an exceedance of the standard. Concentration values measured on a one-minute or one-hour basis for PM_{10} or $PM_{2.5}$ may be above their respective 24-hour or annual levels of the air quality standard, but an exceedance does not exist since the averaging periods do not match. Furthermore, if a 24-hour or annual average is above the level of

[102] Sensor Guidebook, Appendix F: Glossary Ibid (6).
[103] 40 CFR Section 50.1(l)

the NAAQS, this is considered an exceedance and does not constitute a NAAQS violation. A NAAQS violation occurs when the design value[104] of the pollutant is in excess of the level of the NAAQS. The verified measurement also needs to match the time averaging period set for the standard.

The Community Investigation Report defines its own standard without any regulatory basis and compares one-minute NMF data to this standard to determine the number of "exceedances" measured in the Curtis Bay community. Their standard is defined as the mean plus three standard deviations (mean + 3SD), with any one-minute concentration data or *Factor* Indices above this threshold being considered as an "exceedance." The threshold used by the Community Investigation Report (mean + 3SD) is a statistical measure for identifying outliers[105], but in no way should be considered as a measure for defining a standard or an indicator of poor air quality, or inferred to be a health-based regulatory standard.

[104] Ibid (83).
[105] Study.com Determining Outliers Using Standard Deviation. https://study.com/skill/learn/determining-outliers-using-standard-deviation-explanation.html

6. CONCLUSION

It is my opinion that the conclusions in the Community Investigation Report are not supported by verified or reliable data. As discussed in Section 2 of my report, the community monitoring program was conducted in a manner that did not follow US EPA-recommended procedures or best practices for designing, installing, implementing, validating, and evaluating air quality data. The air monitoring program used low-cost sensors that are susceptible to moisture and electrical interferences leading to noisy data and were documented as not meeting US EPA-recommended performance testing metrics. The monitoring program also used flawed and misleading statistical analysis to interpret the data and draw unfounded conclusions about community air quality.

The Community Investigation Report misused NMF in an attempt to use air monitoring data collected in the community to quantify the contribution of some pollution sources in Curtis Bay. Furthermore, this NMF model was improperly used in conjunction with a statistical measure, typically used for identifying outliers, to create a standard of poor air quality. This standard was not based on public health, nor were any regulatory standards or health-based studies cited or referenced to justify the use of this standard.

Lastly, the Community Investigation Report did not cite a QAPP that was reviewed and accepted by an oversite agency that documents planning, implementation, and quality control procedures for the community air monitoring network. The procedures outlined in a QAPP and US EPA guidance are critical to ensure that the air monitoring data are usable, accurate, and technically sound for drawing conclusions and informing decisions made using a weight-of-evidence approach. To emphasize the importance of a QAPP, MDE requires the use of QAPPs in its Quality Management Plan for its environmental data operations before project implementation. Any air monitoring studies that draw conclusions or drive decisions should also be required to operate under an approved QAPP.

The data and conclusions drawn from the Community Investigation Report are inconclusive at best and do not follow established or accepted scientific methodology for collecting data that is reliable, accurate, or representative of air quality in the Curtis Bay community.

APPENDIX A. CV FOR SCOTT ADAMSON, CCM

Scott Adamson, CCM

Managing Consultant — **Salt Lake City**

AREAS OF SPECIALIZATION

- Meteorological Monitoring Systems
- SLAMS, SPM, and PSD Monitoring Regulations
- Exceptional Event Rule Analysis
- Emergent Pollutant Monitoring and Analysis
- Quality Assurance Project Plans
- Air Quality and Meteorological Monitoring Systems
- Data Quality Assurance and Validation
- Exceptional Event Technical Analyses
- Ambient Monitoring Network Assessments
- Software Solutions Development
- Database Development with Microsoft Access
- Toxics Regulation and Human Health Risk Analyses
- Atmospheric Dispersion Modeling Using the AERMOD, CALPUFF, and AESCREEN Dispersion Modeling Systems

SUMMARY OF EXPERIENCE

A Board-Certified Consulting Meteorologist (CCM) based in the Greater Salt Lake City, Utah area serving as a Managing Consultant within Trinity Consultants' Monitoring Services and Integration Department. Primary role over the past 15 years of experience has been to assist clients in a wide range of industries including utilities, aerospace, papermill, refineries, oil & gas, mineral products, and government agencies with the need to collect and analyze ambient meteorological and air quality data. Air monitoring experience includes network/station planning and design, agency negotiations, equipment procurement, station installations, equipment maintenance, performance auditing, and operator training.

EDUCATION

B.S., Meteorology, University of Utah

AFFILIATIONS

Air and Waste Management Association (A&WMA)
American Meteorological Society (AMS)

CERTIFICATION

AMS Board Certified Consulting Meteorologist (CCM) - #714

TECHNICAL EXPERTISE

Ambient Air Monitoring Network Management - Currently managing over 20 ambient air quality monitoring projects throughout the United States from Wyoming, Utah, New Mexico, Idaho, South Carolina, Illinois, and California. Mr. Adamson has extensive experience with SLAMS, PSD, and special purpose monitoring programs/studies. He acted as primary investigator for the annual Upper Green River Wyoming Ozone Study from 2010 through 2020. This studies focus is on the spatial and temporal distribution of ozone and precursor pollutants and how they relate to atmospheric conditions and snowfall within the Upper Green River Basin. Successfully negotiated regulatory agencies the use of lower-cost sensors for air quality analyses and compliance notifications for better understanding of impacts of industry on the Environmental Justics communities.

Permitting/Dispersion Modeling – Mr. Adamson has experience in the development, evaluation, application, and execution of dispersion models in support of PSD and NSR permit applications using the AERMOD and CALPUFF modeling systems. He has experience preparing minor source air quality permit applications incorporating process descriptions, emission inventories, regulatory review, regulatory applicability, and air quality impact analyses. In support of PSD permit applications, Mr. Adamson has recently completed Class II, Class I, and NAAQS dispersion modeling analyses for several refineries, a proposed 580MW combined-cycle electric generation facility, and a silicon manufacturing plant in Mississippi. Mr. Adamson is actively involved in several other AERMOD dispersion modeling projects associated with NSR permits to demonstrate compliance with the state or national ambient air quality standards (NAAQS) for proposed water pipeline pump stations, hydrotreating facilities, produced water evaporation pond facilities, a mineral company's solar evaporation facility, several sand and aggregate facilities, and a large chemical industrial complex in the Caribbean.

Computer Programming - Mr. Adamson has written software to graphically display and predict plume dispersion and particulate fallout during solid rocket booster tests. With respect to air dispersion modeling, he has written software to manipulate meteorological data into formats suitable for input into dispersion models. In addition, Mr. Adamson developed and implemented Trinity's Data Scanning and Alert System (DSAS), a software application which conducts live inspection of meteorological and air quality monitoring site data. The program is used as a tool to assist Trinity staff identify data outliers, problems with site equipment, and site communication issues.

Air Quality and Meteorological Instrumentation - Mr. Adamson is familiar with wind direction, wind speed, vertical wind speed, evaporation, temperature, relative humidity, precipitation, barometric pressure, snow depth, and solar and net radiation sensors as well as all types of ambient air quality analyzers including $NO/NO_2/NO_x/NO_y$, O_3, $PM_{2.5}/PM_{10}$, SO_2, CO, and CH_4/NMHC/THC.

Mr. Adamson provides technical expertise in the quality assurance and analysis of meteorological and air quality data. This includes successful justification for data exclusion of PM_{10} concentrations measured near a coal-fired power plant as part of an exceptional event demonstration. He has developed and maintained databases as part of large research projects including a regional ozone study.

EMPLOYMENT HISTORY

2007 – January 2022	Trinity Consultants
January 2022 – August 2022	Ramboll
August 2022 – present	Trinity Consultants

APPENDIX B. COMMUNITY MONITORING NETWORK WIND ROSES

Figure 21 Location 1 Windrose

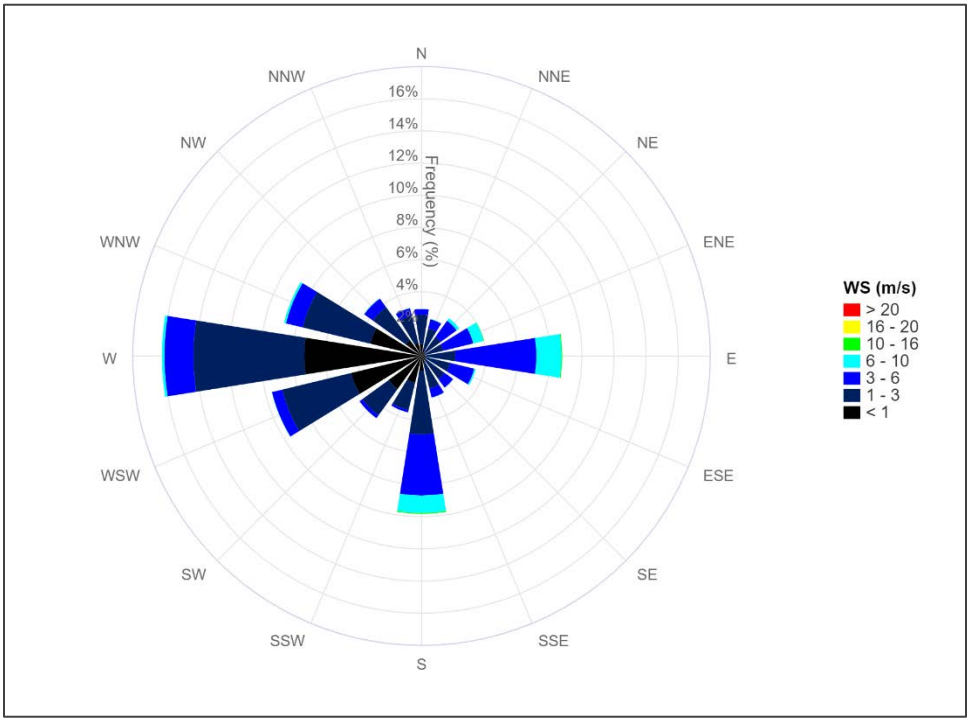


Figure 22 Location 2 Wind Rose

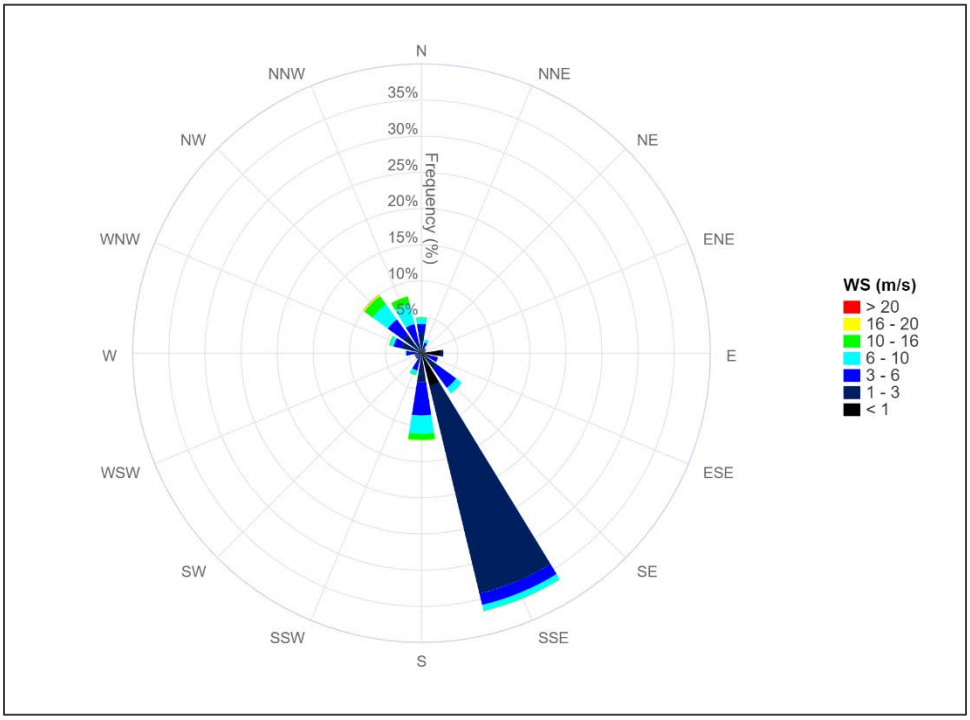


Figure 23 Location 3 Wind Rose

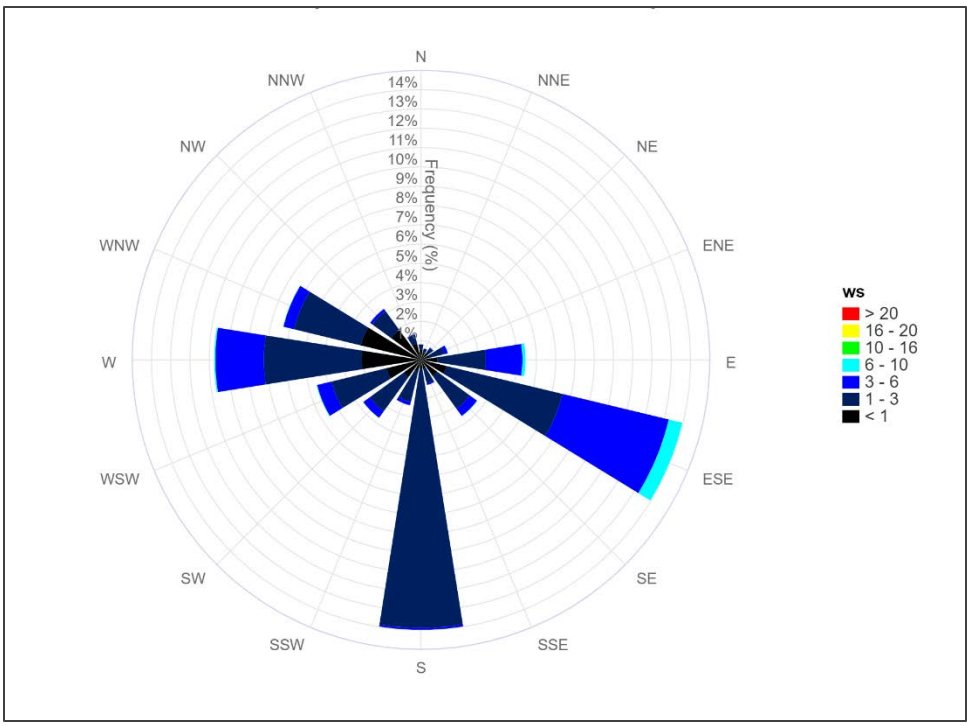


Figure 24 Location 4 Wind Rose

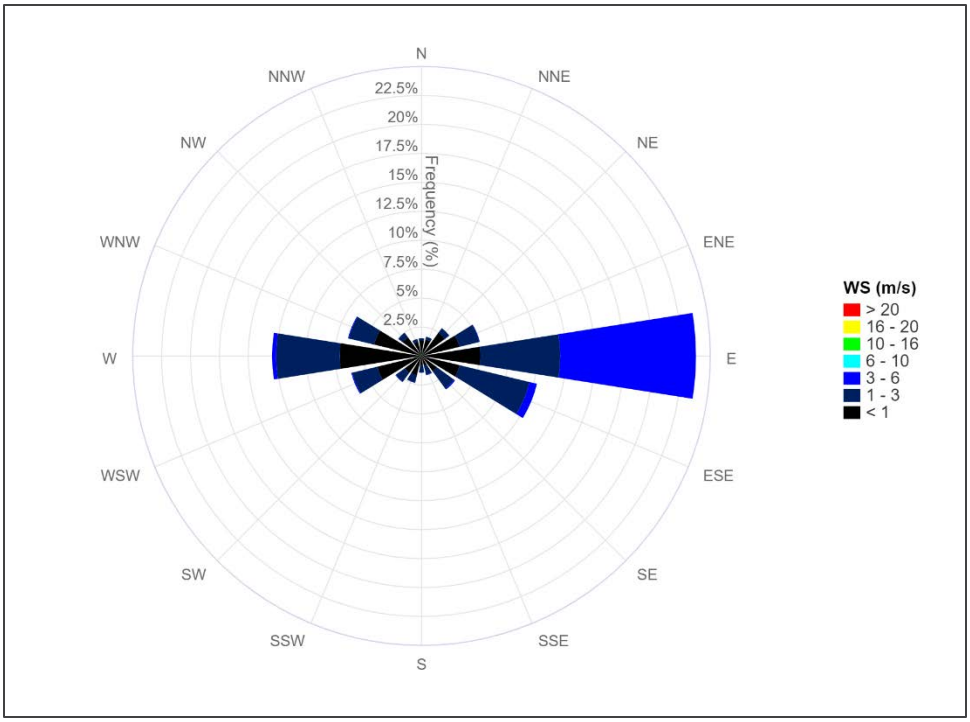


Figure 25 Location 5 Wind Rose

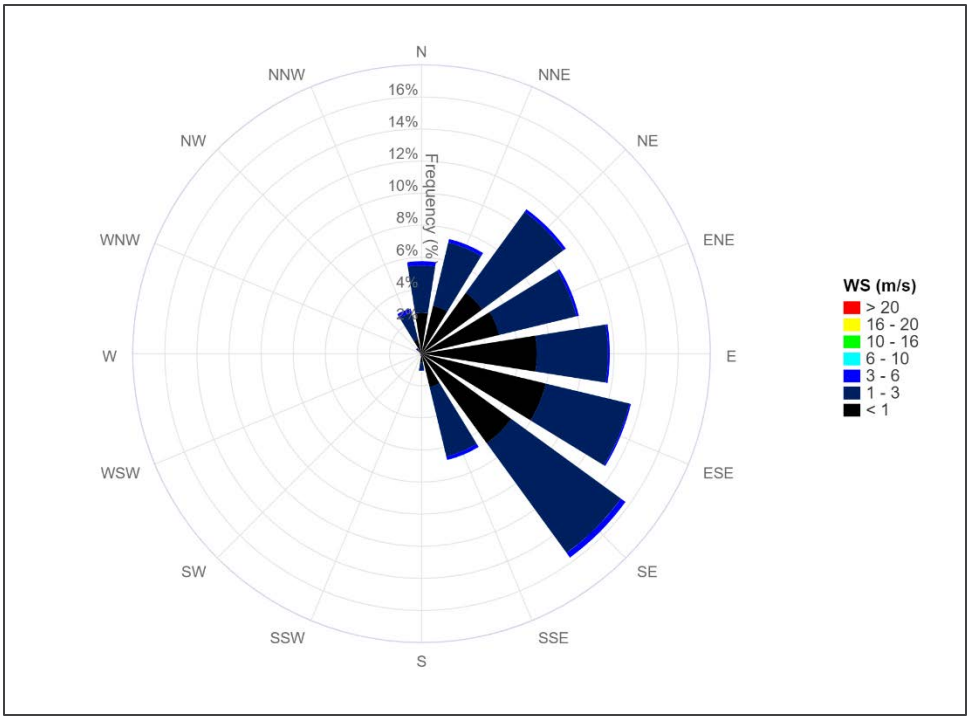


Figure 26 Location 6 Wind Rose

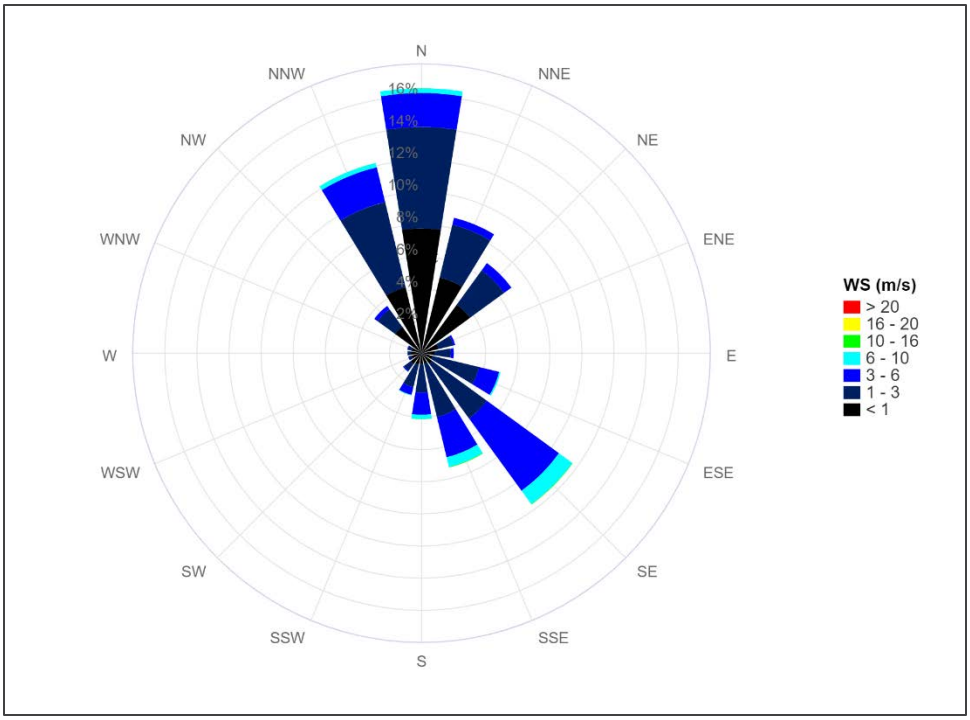


Figure 27 Location 7 Wind Rose

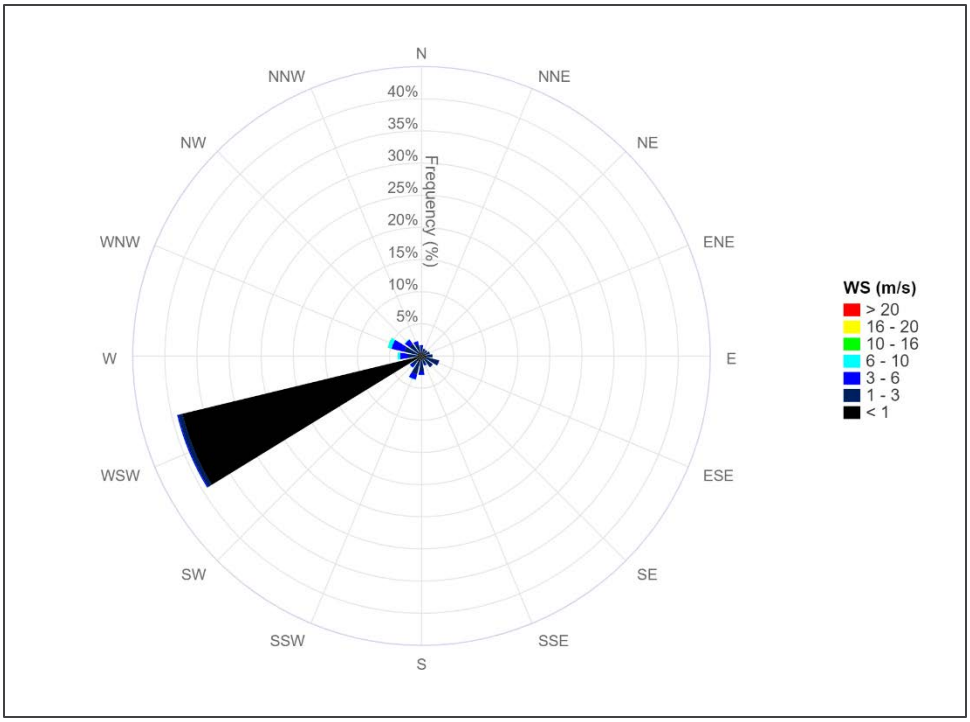


Figure 28 Location 8 Wind Rose

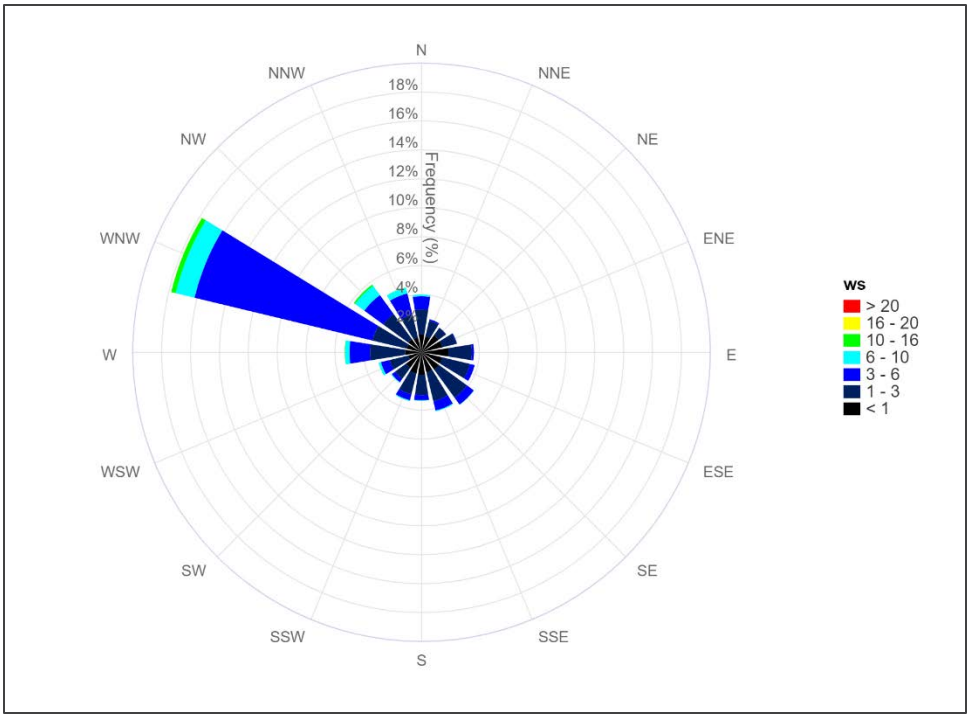


Figure 29 Location 9 Wind Rose

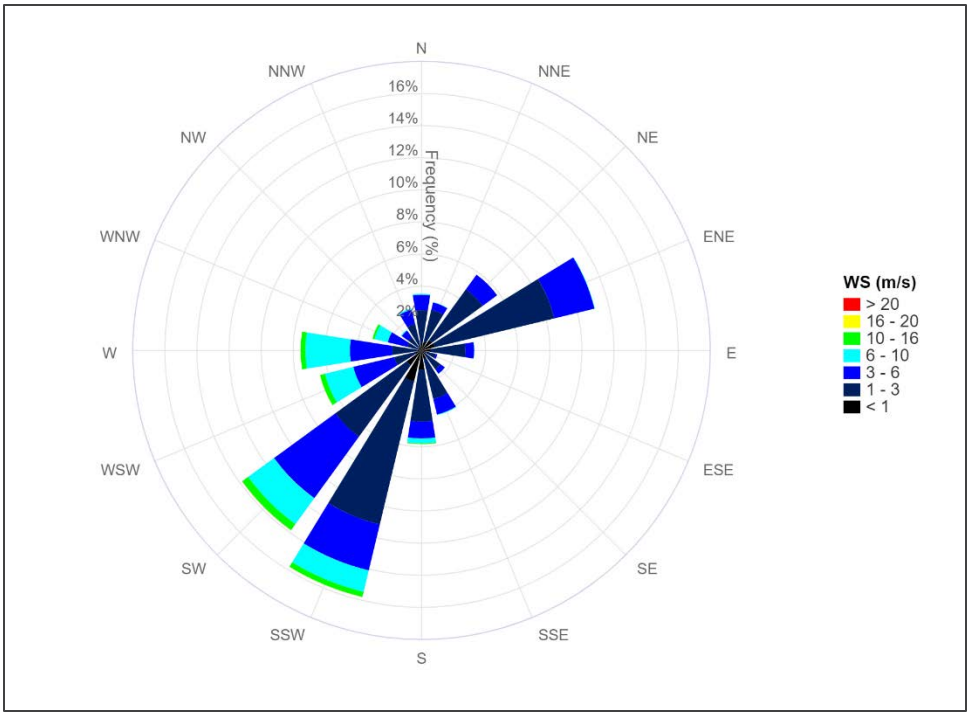
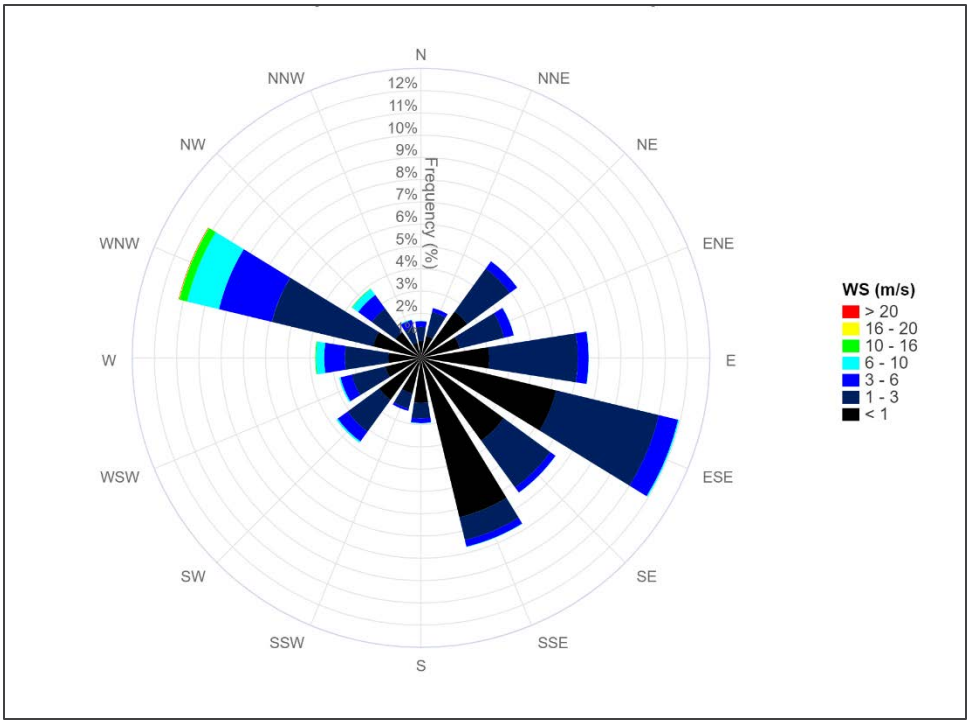


Figure 30 Location 10 Wind Rose



Attachment 3 -

GHD Report

Critical Review and Response

Collaborative Investigation of Coal Dust, Air Pollution, and Health Concerns in Curtis Bay, South Baltimore, Maryland, USA, 2022-2023

Prepared for CSX Transportation, Inc.

February 12, 2024

→ **The Power of Commitment**

Contents

1. Introduction

GHD has reviewed the report titled *Collaborative Investigation of Coal Dust, Air Pollution, and Health Concerns in Curtis Bay, South Baltimore, Maryland, USA, 2022-2023* (Collaborative Report) (CBCR 2023).

In February 2022, a collaborative group was formed to investigate concerns raised by Curtis Bay residents about dark dust on homes and property that they attribute to the transport of coal via rail in South Baltimore and the coal handling operations at CSXT Curtis Bay Piers (Terminal). The group included members from the Community of Curtis Bay Association, the South Baltimore Community Land Trust, the Maryland Department of the Environment (MDE) Air and Radiation Administration, the CHARMED Center at the Department of Environmental Health and Engineering at the Johns Hopkins Bloomberg School of Public Health, and the Department of Atmospheric and Oceanic Sciences at the University of Maryland. The group collected and characterized dust from several locations in the community; deployed multipollutant low-cost air sensors to measure particulate matter and gaseous pollutants; collected data using a mobile air monitoring vehicle; and collected photos, videos, experiences, and testimonials from residents.

The group presented the following preliminary findings in the Collaborative Report:

- Coal dust is present throughout the community;
- Coal dust finds its way into the community on a day-to-day basis and is correlated with both activity at the Terminal and wind direction; and
- The Curtis Bay community is overburdened by air pollution; with the community sensor network measuring average particle pollution levels that are higher than at nearby MDE regulatory monitors.

The Collaborative Report also importantly identifies many other sources of air pollution in the Curtis Bay area, including the Curtis Bay Energy medical waste incinerator, the BRESCO municipal solid waste incinerator, Quarantine Road Landfill, Patapsco Wastewater Treatment Plant, a coal-fired power plant, concrete crushing plants, asphalt manufacturing, chemical plants, and oil and gas terminals. Moreover, the Collaborative Report emphasizes that heavy diesel truck traffic is a significant mobile source of pollution in Curtis Bay, with levels of black carbon along Pennington Avenue and Curtis Avenue similar to levels on major Baltimore highways. (CBCR 2023, Executive Summary and Section 2).

1.1 Purpose of this Report

GHD concludes based on its review of the Collaborative Report that statements regarding exposure to particulate matter (PM) and health effects are incomplete and misleading. This Report addresses the following concerns:

- the Collaborative Report overstates that no safe level of exposure to fine particulate matter ($PM_{2.5}$) exists; and
- The Collaborative Report does not distinguish between health effects associated with exposure to $PM_{2.5}$ and health effects associated with exposure to coal dust.

2. Scope and Limitations

This Report has been prepared by GHD for CSX Transportation and may only be used and relied on by CSX Transportation.

GHD otherwise disclaims responsibility to any person other than CSX Transportation arising in connection with this Report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this Report were limited to those specifically detailed in the Report and are subject to the scope limitations set out in the Report.

The opinions, the conclusions, and any recommendations in this Report are based on conditions encountered and information reviewed at the date of preparation of the Report. GHD has no responsibility or obligation to update this Report to account for events or changes occurring subsequent to the date that the Report was prepared.

3. Summary of Critical Review

3.1 Recommended Air Quality Guidelines/Standards for PM Exposure

The Collaborative Report states that the World Health Organization (WHO) (WHO 2021) and the United States Environmental Protection Agency (EPA) (USEPA 2019; USEPA 2022) support that there is no safe level of $PM_{2.5}$ exposure (CBCR 2023, Section 2). This is an overstatement of what these agencies have concluded.

World Health Organization

The Collaborative Report references PM guidelines set by the WHO. The WHO publishes air quality guideline levels (AQG) for various common air pollutants for indoor and outdoor environments globally (WHO 2021, Executive Summary, page xiv). These values are not legally enforceable and are intended to be used as a global reference tool to aid governmental and non-governmental agencies around the world in setting standards and goals for air quality management (WHO 2021, Section 1.1, page 3). Nevertheless, the WHO guidelines are discussed below in order to respond to the Collaborative Report's use of these guidelines to assess air quality and draw conclusions.

WHO states that the "objective of these guidelines is to offer quantitative health-based recommendations" for air quality management to protect populations (including vulnerable and/or susceptible groups) from the adverse effects of air pollution (WHO 2021, Section 1.1, pages 3-4).

In 2021, WHO released updated AQG levels for several air pollutants, including $PM_{2.5}$ and PM_{10}, to incorporate new environmental data and scientific research since the previous update in 2005. Based on available information, WHO recommends an annual $PM_{2.5}$ ambient AQG level of 5 ug/m^3 and a short-term, 24-hour average $PM_{2.5}$ AQG level of 15 ug/m^3 (WHO 2021, Executive Summary, page xvii). For PM_{10}, the recommended annual AQG level is 15 ug/m^3, and the recommended short-term, 24-hour average AQG level is 45 ug/m^3 (WHO 2021, Executive Summary, page xvii). WHO defines a long-term AQG level as "the lowest exposure level of an air pollutant above which the guideline development group is confident that

there is an increase in adverse health effects" (WHO 2021, Executive Summary, page ix). A short-term AQG level is defined "as a high percentile of the distribution of daily values" (WHO 2021, Executive Summary, page ix). WHO explains that variations in long-term exposure to a pollutant often is typically associated with greater health effects than short-term exposure, so "long-term AQG levels for most health outcomes are more health protective than short-term AQG levels" (WHO 2021, Section 2.5.2, page 65). As a result, "the long-term AQG level is used to derive a short-term AQG level whenever the same health effect is considered (*e.g.* mortality) for both long- and short-term exposures" (WHO 2021, Section 2.5.2, page 65). WHO conservatively determined that evidence supports a positive association between short-term exposure to $PM_{2.5}$ and all-cause mortality and cardiovascular, respiratory, and cerebrovascular mortality at >5 ug/m^3 (WHO 2021, Section 3.2.2, page 77). Therefore, there is limited evidence to conclusively support that there are adverse health effects below this concentration level.

US Environmental Protection Agency

The Clean Air Act (CAA) (Section 108 (42 U.S.C. 7408)) requires EPA to identify "criteria air pollutants" that cause or contribute to air pollution and to issue air quality standards for those pollutants. The statute directs EPA to list those air pollutants that are reasonably "anticipated to endanger public health or welfare" and the "presence of which in the ambient air results from numerous or diverse mobile or stationary sources" (42 U.S.C 7408(a)(1)). Once these pollutants have been identified, Section 109 of the CAA directs EPA to promulgate "primary" (health-based) and "secondary" (welfare-based) National Ambient Air Quality Standards (NAAQS) based on the latest scientific knowledge "useful in indicating the kind and extent of all identifiable effects on public health or welfare, which may be expected from the presence of a pollutant in the ambient air" (42 U.S.C 7408(a)(2)). The primary standards for each air pollutant are developed with the intent to protect the public health with an adequate margin of safety. Secondary standards "provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings" (USEPA 2024).

EPA has developed legally enforceable NAAQS values for $PM_{2.5}$ and PM_{10} (USEPA 2024c). The primary standard for each pollutant is developed to provide public health protection, including for protecting the health of sensitive populations such as people with asthma, children, and the elderly.

In 2019, EPA released the Integrated Science Assessment for Particulate Matter (ISA Report), which is "a comprehensive evaluation and synthesis of the policy-relevant science 'useful in indicating the kind and extent of identifiable effects on public health or welfare which may be expected from the presence of [a] pollutant in ambient air,' as described in Section 108 of the CAA" (USEPA 2019, Section P.2., page P-9). In its re-evaluation of health effects and risks associated with PM exposure, EPA concluded that epidemiological studies indicate a linear, no-threshold concentration-relationship between short-term $PM_{2.5}$ exposure and mortality at higher concentrations (USEPA 2019, Section 1.7.1.1.3, page 1-62). However, confidence in the shape of the curve decreases at concentrations below 8 ug/m^3, suggesting lack of consistent evidence of health effects at lower $PM_{2.5}$ exposures (USEPA 2019, Section 1.7.1.1.3, page 1-62).

Following the 2019 assessment of the NAAQS for PM (USEPA 2019), the primary and secondary NAAQS for PM were retained without revisions (USEPA 2020). On February 7, 2024, following an additional review of the NAAQS for PM that began in 2022, EPA announced that it was revising the level of the primary annual NAAQS for $PM_{2.5}$ (or soot) from 12.0 ug/m^3 to 9.0 ug/m^3 (USEPA 2024b). In finalizing the revised $PM_{2.5}$ standard, EPA announced that it evaluated and retained the annual secondary NAAQS for $PM_{2.5}$ of 15.0 ug/m^3 and the primary 24-hour $PM_{2.5}$ NAAQS of 35 ug/m^3 (USEPA 2024a). EPA also evaluated and

retained the primary and secondary 24-hour NAAQS for PM_{10}, concluding that it provides public health protection against exposures to coarse particles and that the current evidence does not call into question the adequacy of that standard (USEPA 2024a). The primary and secondary 24-hour NAAQS for PM_{10} is 150 ug/m^3 (USEPA 2024b).

The primary PM NAAQS are health-based standards set with vulnerable populations in mind and based on the latest scientific knowledge. Development of ambient air quality levels or standards suggest that there is a level of PM exposure that is expected to not result in adverse health effects in individuals in the general population, including those with pre-existing health conditions that make them more susceptible to $PM_{2.5}$-related effects (*e.g.*, asthma, heart disease, and lung disease) (USEPA 2019, Section P.1., page P-2). As stated in the May 2022 *Policy Assessment for the Reconsideration of the National Ambient Air Quality Standards for Particulate Matter* (USEPA 2022, Section 1.2, page 1-5), the CAA does not require primary NAAQS to be set at zero-risk level; however, the law requires that primary NAAQS values be based on the latest scientific knowledge and provide an adequate margin of safety to protect public health (Section 109(b)(1) of the CAA [42 U.S.C. 7409]).

The Collaborative Report reported that, averaging daily $PM_{2.5}$ concentrations from low-cost community sensors in the Curtis Bay network for the first complete year of reporting (5/26/22 to 5/25/23), 24-hour PM_{10} and annual and 24-hour $PM_{2.5}$ levels were all below the NAAQS. The 24-hour average $PM_{2.5}$ was 8.6 ug/m^3, which is below the newly revised primary $PM_{2.5}$ NAAQS as well as the secondary $PM_{2.5}$ NAAQS (CBCR 2023, Section 4, page 8). Similarly, excluding wildfire smoke affected data, the Collaborative Report concluded that there were no days that average 24-hour PM_{10} concentrations exceeded the PM_{10} NAAQS value (CBCR 2023, Section 4, page 9).[1]

3.2 Particulate Matter Air Pollution and Health

Interpretation of research findings on exposure to PM and associated risks is complicated by the complex nature of PM (WHO 2021, Section 3.2, page 74). PM is not a single pollutant (CARB 2024). In general, PM may be derived from different emission sources, resulting in a complex mixture of solids and aerosols with diverse chemical and physical characteristics (CARB 2024). PM may be defined as primary particles (directly emitted from sources) or secondary particles (formed in the atmosphere through chemical reactions of gases such as sulfur dioxide, nitrogen oxides, and other organic compounds from natural and anthropogenic sources) (CARB 2024). Natural sources of PM include trees and vegetation, while anthropogenic sources include industrial processes and motor vehicle exhaust (CARB 2024). PM is categorized based on aerodynamic diameter. EPA defines $PM_{2.5}$ as particles with aerodynamic diameters less than or equal to 2.5 micrometers (um) (USEPA 2019, Section 2.1, page 2-2). PM_{10} includes particles with aerodynamic diameters generally greater than 2.5 um and less than or equal to 10 um (USEPA 2019, Section 2.1, page 2-2).

$PM_{2.5}$

Extensive research has shown that exposure to PM, specifically $PM_{2.5}$, is associated with short- and long-term health effects. Strong evidence supports a relationship between $PM_{2.5}$ exposure and certain health effects, such as some respiratory effects, cardiovascular effects, and mortality (USEPA 2019, Section 1.7, page 1-60). However, these studies do not identify any particular $PM_{2.5}$ component that causes these effects. In the ISA report, EPA states:

[1] The reliability and validity of the data collected by the community air monitoring sensors are discussed in the Trinity Consultants report.

This evaluation found that many components and sources representative of combustion-related activities (e.g., motor vehicle emissions, coal combustion, oil burning, vegetative burning) are associated with a range of health effects. The 2009 PM ISA, therefore, concluded that "many [components] of PM can be linked with differing health effects and the evidence is not yet sufficient to allow differentiation of those components or sources that are more closely related to specific health outcomes."

. . . Overall, recent studies continue to demonstrate that many PM2.5 components and sources are associated with health effects ranging from subclinical (e.g., changes in heart function, such as HRV, or circulating biomarkers) to the more overt (i.e., ED visits, hospital admissions, and mortality). The results of these studies confirm and further support the conclusion of the 2009 PM ISA that many $PM_{2.5}$ components and sources are associated with many health effects and that the evidence does not indicate that any one source or component is consistently more strongly related with health effects than $PM_{2.5}$ mass.

(USEPA 2019, Section 1.5.4, page 1-50 to 1-51). As EPA has found, in a non-occupational setting, it is difficult to accurately link particular components of $PM_{2.5}$ with particular health outcomes.

PM_{10}

The experimental and epidemiological data provide inconsistent evidence of health effects as a result of PM_{10} exposure. The ISA Report concludes that for PM_{10}, the evidence for association of health effects and PM_{10} exposure was either *suggestive of, but not sufficient to infer, a causal relationship* or *inadequate to infer the presence* or *absence of a causal relationship* (USEPA 2019, Section 1.7.1.2, pages 1-63 to 1-64). In the 2020 and 2024 re-evaluations of PM NAAQS values, EPA concluded that the available scientific evidence and information did not call into question the adequacy of the primary PM_{10} standard and retained that standard without revision (USEPA 2024c, Section III, Page 341).

As discussed in the Collaborative Report, the Terminal handles unrefined coal that is transported by railcar and stored before being loaded on vessels. Coal dust at a coal handling facility is produced primarily from mechanical means, including unloading of rail cars, loading of vessels, shaping the coal into piles, and vibration while transporting via the conveyor system. These activities result in potential emission of larger coal particles from coal handling, but not products that would be released as a result of coal combustion, which are associated with smaller particulate sizes such as $PM_{2.5}$.

Occupational Exposure Studies

The predominant constituent of coal is carbon. Coal may also contain in varying proportions clays, carbonates, sulfide ores, oxide ores, quartz, phosphates, and heavy minerals (WHO 1997, Section 1.1.2, page 339). Numerous studies conducted on coal dust due to occupational exposures during coal mining as detailed by the National Institute for Occupational Safety and Health (CDC 2011 and WHO 1997) have shown that coal dust is not inherently toxic.

Observance of health effects as a result of exposure to any substance is dependent on both the potential hazard of that substance and the duration and intensity of exposure to that substance. Based on studies of high-level occupational exposure of coal miners working in mines, consistent repeated exposure to coal dust in excess of 2 milligrams per cubic meter (2 mg/m^3) for at least 10 years is associated with a specific spectrum of respiratory diseases, including pneumoconiosis, progressive massive fibrosis, emphysema, chronic bronchitis, and accelerated loss of lung function, and is highly correlated to estimates of cumulative dust exposure and dust or dust components remaining in the lung (CDC 2011). Occupational exposure

limits for coal dust that have been developed by different agencies to protect worker health (see OSHA Permissible Exposure Limits – Annotated Table Z-3) (OSHA 2024) range from a high of 10 mg/m^3 to a low of 0.1 mg/m^3 depending on silica content. These values consider up to 8 hours of continuous exposure to coal dust that would not be expected to result in adverse health effects.

The lowest permissible occupational exposure value of 0.1 mg/m^3 (100 ug/m^3) for coal dust is 11 times higher than the newly promulgated primary NAAQS for $PM_{2.5}$ of 9.0 ug/m^3. Therefore, it is not expected that coal dust concentrations in ambient air that meets the $PM_{2.5}$ NAAQS would result in increased health risks to individuals in the surrounding community.

WHO has also determined that there was no consistent evidence supporting an exposure-response relationship between coal dust and cancer and concluded that coal dust *cannot be classified as to its carcinogenicity to humans* (WHO 1997, Section 5.5, page 393).

4. Conclusion

After review of the Collaborative Report, it must be emphasized that exposure does not equate to toxicity or development of adverse health effects. Based on EPA and WHO air quality standards or levels, there are ambient air concentrations of $PM_{2.5}$ that are not expected to result in adverse health effects in the general population, including sensitive populations. As mentioned previously, the Collaborative Report identifies several sources of air particulate in the Curtis Bay area, including the Curtis Bay Energy medical waste incinerator, the BRESCO municipal solid waste incinerator, Quarantine Road Landfill, Patapsco Wastewater Treatment Plant, a coal-fired power plant, concrete crushing plants, asphalt manufacturing, chemical plants, and oil and gas terminals (CBCR 2023, Section 2). Based on my review of the Collaborative Report, there is insufficient evidence to conclude that coal dust from the Terminal significantly contributes to overall $PM_{2.5}$ concentrations or adverse health effects in Curtis Bay.

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Tamara R. House-Knight PhD; DABT

Senior Toxicologist/Risk Assessor

Location

North Little Rock, AR, USA

Experience

Over 15 years

Qualifications/Accreditations

- Diplomate of the American Board of Toxicology (DABT), 2016
- PhD, Interdisciplinary Toxicology, 2004
- BS, Biology, 1999

Key technical skills

- Crisis Communication

Other related areas of Interest

Certifications

- OSHA 40-hour HAZWOPER, Refresher, 2021

Memberships

- Society of Toxicology
  [Ethical, Legal, Forensics, and Societal Issues Specialty Section]
  [Toxicologists of African Origin Special Interest Group]
- ITRC Chemicals of Emerging Concern Team

Relevant experience summary

Dr. House-Knight specializes in human and environmental risk assessment. She has been involved in assessing human health risks for redevelopment projects and brownfield sites.

Dr. House-Knight has provided toxicological support following chemical exposures to client employees and health care workers and responding to hundreds of worker exposure incidents involving a wide variety of chemicals. She works with industrial and pharmaceutical clients to meet regulations in the U.S. (Toxic Substances Control Act and OSHA Hazard Communication Standard) and European Community (REACH). In addition, she has assisted with community relations/public participation following environmental releases.

Dr. House-Knight has provided toxicological support for litigation teams related to causation involving asbestos, petroleum products, VOC (benzene, trichloroethylene) and coal ash exposures.

Dr. House-Knight currently serves as the GHD lead of the Americas Emerging Contaminants Technical Team.

Project experience

Role: Toxicologist
Location: Kansas, USA

Worked with Kansas Department of Health and Environment (KDHE) in Region VII to develop environmental clean-up levels for orthochlorobenzyl chloride (OCBC) protective of human health after a train derailment.

Role: Toxicologist
Location: Various Corporations, USA

Assisted with litigation support involving mesothelioma and lung cancer claims due to asbestos exposure. This work included reading of depositions, preparation of trial exhibits, and frequent contact with multiple law firms.

Role: Toxicologist
Location: Various Corporations, USA

Assisted with litigation support involving benzene exposure. This work included reading of depositions, preparation of trial exhibits, and frequent contact with multiple law firms.

Role: Toxicologist
Location: Various Corporations, USA

Review of existing and preparation of new Safety Data Sheets (SDS) to meet Occupational Safety and Health Administration (OSHA) and Globally Harmonized System (GHS) requirements.

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Role: Toxicologist/Risk Communication
Location: Billings, Montana

Provided toxicological information and explanation of environmental sampling data to local residents during an environmental oil release and subsequent clean-up activities.

Role: Risk Assessor
Location: Fort Smith, Arkansas

Prepared human health risk assessments evaluating potential risks associated with exposure to trichloroethylene in groundwater and indoor air and provided risk communication to affected residents and workers. Evaluated the potential for significant vapor intrusion, using multiple lines of evidence that incorporated sampling of multiple media and other relevant site information (e.g., geology) from a historic chlorinated VOC groundwater plume that extended off-site into a residential neighborhood. The work was performed with oversight from Arkansas Department of Environmental Quality.

Role: Toxicologist
Location: Jacksonville, Florida

Provided emergency toxicology service to answer questions regarding human health and ecological concerns resulting from accidental chemical releases to employees and emergency room personnel.

Role: Risk Assessor
Location: Decatur, Georgia

Assisted with data review and preparation of human health risk assessment related to historical release of PFAS in soil and groundwater. Identified available toxicity and physical/chemical data from literature sources to evaluate potential human health and food chain exposures to PFAS. The conceptual site model of potential exposures was focused primarily on residential and recreational exposures to outdoor media (soil, sediment, surface water), but also included human dietary exposures via fish.

Role: Risk Assessor
Location: Ontario, Canada

Provide product registry support services related to California Proposition 65 requirements for goods and/or products produced by an industrial client.

Role: Toxicologist
Location: USA

Assisted with review and evaluation of potential human health risks associated with exposure to potential hazardous chemicals in a company's product.

Role: Toxicologist
Location: USA

Assisted with review and evaluation of potential risks associated with exposure to cattle ingesting grasses and surface water after petroleum release and subsequent remediation.

Published papers

- Knight TR, Kurtz A, Bajt ML, Hinson JA and Jaeschke H. 2001. Vascular and hepatocellular and peroxynitrite formation during acetaminophen toxicity: role of mitochondrial oxidant stress. Toxicological Sciences 62:212-219.
- Gujral JS, Knight TR, Farhood A, Bajt ML and Jaeschke H. 2002. Mode of cell death after acetaminophen overdose in mice: apoptosis or oncotic necrosis? Toxicological Sciences 67:322-328.
- Knight TR and Jaeschke H. 2002. Acetaminophen-induced inhibition of Fas receptor-mediated liver cell apoptosis: mitochondrial dysfunction versus glutathione depletion. Toxicology and Applied Pharmacology 181:133-141.
- Knight TR, Ho Y-S, Farhood A and Jaeschke H. 2002. Peroxynitrite is a critical mediator of acetaminophen hepatotoxicity in murine livers: protection by glutathione. Journal Pharmacology and Experimental Therapeutics 303:468-475.
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- Aleksunes LM, Slitt AL, Maher JM, Dieter MZ, Knight TR, Goedken M, Cherrington NJ, Chan JY, Klaassen CD, Manautou JE. 2006. Nuclear factor-E2-related factor 2 expression in liver is critical for induction of NAD(P)H:quinone oxidoreductase 1 during cholestasis. Cell Stress Chaperones 11(4):356-363 (Winter).
- Knight TR, Choudhuri S, Klaassen CD. 2007. Constitutive mRNA expression of various glutathione S-transferase isoforms in different tissues of mice. Toxicological Sciences 100(2):513-524.
- Knight TR, Choudhuri S, Klaassen CD. 2008. Induction of hepatic glutathione S-transferases in male mice prototypes of various classes of microsomal enzyme inducers. Toxicological Sciences 106(2):329-338.
- Cui JY, Choudhuri S, Knight TR, Klaassen CD. 2010. Genetic and epigenetic regulation and expression signatures of glutathione S-transferases in developing mouse liver. Toxicological Sciences 116(1):32-43.
- Gentry PR, House-Knight T, Harris A, Greene T, Campleman S. 2014. Potential occupational risk of amines in carbon capture for power generation. International Archives of Occupational and Environmental Health 87(6): 591-606.
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Career history

2021 - present	GHD, Senior Toxicologist/Risk Assessor
2012 - 2021	Ramboll US Corporation, Managing Consultant/Toxicologist
2005 - 2012	Center for Toxicology and Environmental Health (CTEH), Project Toxicologist
2004 - 2005	University of Kansas Medical Center (KUMC), Postdoctoral Fellow

Attachment 4 –

Misleading Photographs and Videos in the Collaborative Report

Appendix 4: Misleading Photographs and Videos Included in the Collaborative Report

1. Photograph of the Curtis Bay Recreation Center does not show the current view of the Terminal.

Figure 2 in the Executive Summary of the Collaborative Report is a photograph that purports to show the view of the Terminal from the playground at the Curtis Bay Recreation Center. No date is provided on the photograph in Figure 2. While the photograph in the Collaborative Report may represent an historic perspective, it does not accurately portray the current viewshed from the Curtis Bay Recreation Center. Below is a current photograph of the Terminal taken from the recreation center playground that shows the large warehouse located at 4501 Curtis Avenue that partially obscures the view of the Terminal.

Figure A1. Photograph of the Curtis Bay Recreation Center taken on Dec 21, 2023 showing warehouse in background.

2. Figure 4 in the Collaborative Report's Executive Summary is not a photograph of visible dust from coal handling operations at the Terminal. It is a photograph showing emissions from a ship docked at the Terminal.

The Collaborative Report's Executive Summary states that the report presents photographs and videos from residents describing their experience with coal dust from the Terminal. Figure 4 of the Executive Summary purports to show a "[p]lume of visible dust at coat terminal, June 1, 2021." This photograph does not show a plume of coal dust from the Terminal on June 1, 2021.

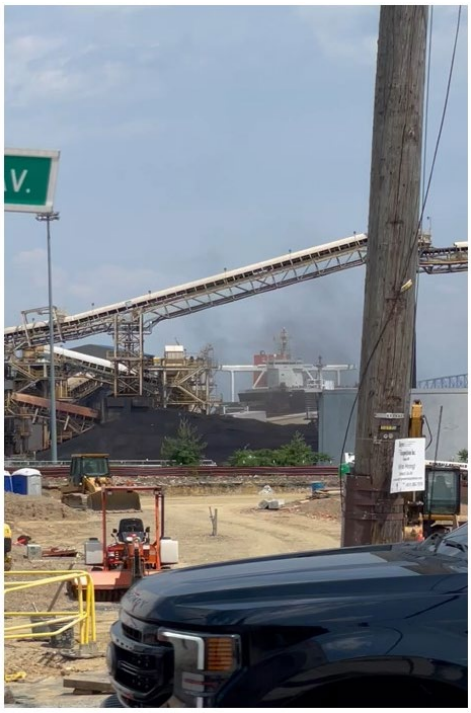

Figure 4. Plume of visible dust at the coal terminal, June 1, 2021.

There are multiple inaccuracies associated with the Collaborative Report's use of this photograph as "evidence" that coal dust is coming from the Terminal. First, the date provided in the Collaborative Report is incorrect. The photograph was taken on June 1, 2022, not June 1, 2021. Second, and more importantly, CSXT previously responded to an MDE inquiry regarding this photograph (and accompanying video) and confirmed that it shows exhaust from the ship docked at the Terminal, not coal dust. Specifically,

- On June 3, 2022 CSXT received an email from MDE requesting information about the source of the visible emissions at the Terminal on June 1, 2022. The email included a video taken by Dr. Christopher Heaney on June 1, 2022 purporting to show fugitive coal dust emissions coming from the Terminal. The video is available here: https://photos.app.goo.gl/copag7iZUqhygVCF7. MDE requested that CSXT provide an

explanation of the source of visible emissions shown in the video as well as a log of wet suppression operations on June 1, 2022.

- CSXT responded to MDE's email that the video shows exhaust from the ship docked at the Terminal and provided additional photograph evidence that the visible emissions were coming from the ship. CSXT also provided MDE with the dust suppression records for June 1, 2022 and a description of the activities taking place at the Terminal on that date.

Nonetheless, the video taken by Dr. Heaney is incorrectly referenced in the Collaborative Report as "evidence" of coal dust leaving the Terminal. Specifically, Section 3, page 6, of the Collaborative Report falsely claims that "Video evidence shows that coal dust is lofted to 100 to 300 m above the surface." The visible emissions in the video are emissions from the ship, but the Collaborative Report confuses these emissions with coal dust. The video was also referenced at the public meeting held on December 14, 2023. Repeated reference to this video in the report and at the public meeting demonstrates confusion around different types of air pollution sources: point sources, fugitive sources, and combustion sources.

3. Close-up photographs of "Dark Dust" on resident homes lack identifying information and are not conclusive of any coal contribution.

Figure 3 of the Executive Summary contains 15 close-up photographs of "dark dust on residents[']homes in Curtis Bay, taken between April and December 2023." The Collaborative Report does not provide any location information for these photographs nor the dates that these photographs were taken. The photographs of 'dark dust' are not conclusive of any coal contribution. It appears that at least one of the photographs was previously noted by the Curtis Bay Community Association to have been taken immediately following the 2021 explosion at Curtis Bay Piers. *See* photographs available at https://ilovecurtisbay.com/environmentaljustice/