



DEPARTMENT OF THE ENVIRONMENT

2025 MARYLAND 5-YEAR NETWORK ASSESSMENT



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EXECUTIVE SUMMARY

As required in 40 CFR Part 58.10(d), state air quality monitoring agencies must conduct a network assessment once every five years. The goals of this assessment are as follows:

- Determine if the network meets the monitoring objectives of 40 CFR 58 Appendix D.
- Determine whether new sites are needed.
- Determine whether existing sites are no longer needed and can be terminated.
- Determine whether new technologies are appropriate for incorporation into the ambient air monitoring network.
- Consider the ability of existing and proposed sites to support air quality characterization for areas with relatively high populations of susceptible individuals (e.g., children with asthma).
- For any sites that are being proposed for discontinuance, determine the effect on data users other than the agency itself, such as nearby States and Tribes or health effects studies.
- Identify needed changes to PM_{2.5} population-oriented sites.

Following this requirement, MDE evaluated the current network and determined that the Maryland state network is efficient and effective at meeting all requirements of 40 CFR 58 Appendix D. MDE has also made the following specific findings and recommendations:

- The minimum number of monitors for all parameters is either met or exceeded.
- No air toxics, CO, SO₂, NO₂, PM₁₀, or PAMS sites were found to be redundant.
- Based on county level data it was determined that the PM_{2.5} and ozone networks are adequately serving the sensitive populations of Maryland.

Table of Contents

1.	INTRODUCTION.....	12
2.	HISTORY OF AIR MONITORING NETWORK.....	15
3.	SPECIFIC POLLUTANT NETWORKS.....	19
3.1	Air Toxics Network.....	22
3.1.1	Compliance with Network Design Criteria.....	22
3.1.2	Assessment of Objective Types Assigned to Monitors.....	22
3.1.3	Identifying Redundant Sites.....	24
3.1.4	Identifying New Sites Needed.....	25
3.1.5	Effect of New or Proposed Network Design Regulations.....	25
3.1.6	Recommended Network Changes.....	25
3.2	CO Network.....	26
3.2.1	Compliance with Network Design Criteria.....	26
3.2.2	Assessment of Objective Types Assigned to Monitors.....	27
3.2.3	Identifying Redundant Sites.....	27
3.2.4	Identifying New Sites Needed.....	28
3.2.5	Effect of New or Proposed Network Design Regulations.....	28
3.2.6	Recommended Network Changes.....	28
3.3	Lead Network.....	29
3.3.1	Compliance with Network Design Criteria.....	29
3.4	NO₂ Network.....	30
3.4.1	Compliance with Network Design Criteria.....	30
3.4.2	Assessment of Objective Types Assigned to Monitors.....	32
3.4.3	Identifying Redundant Sites.....	32
3.4.4	Identifying New Sites Needed.....	33
3.4.5	Proposed Regulations.....	33
3.4.6	Recommended Network Changes.....	34
3.5	Ozone Network.....	35
3.5.1	Compliance with Network Design Criteria.....	35
3.5.2	Assessment of Objective Types & Spatial Scales Assigned to Monitors....	35
3.5.3	Identifying Redundant Sites.....	41
3.5.4	Identifying New Sites Needed.....	44
3.5.5	Ozone NAAQS & Monitoring Rule.....	44
3.5.6	Recommended Network Changes.....	44
3.6	PAMS Network.....	47
3.6.1	Compliance with Network Design Criteria.....	47
3.6.2	Assessment of Objective Types Assigned to Monitors.....	49
3.6.3	Identifying Redundant Sites.....	50
3.6.4	Identifying New Sites Needed.....	50
3.6.5	Effect of New or Proposed Network Design Regulations.....	50
3.6.6	Recommended Network Changes.....	50
3.7	PM_{2.5} Network.....	51
3.7.1	Compliance with Network Design Criteria.....	51
3.7.2	Assessment of Objective Types Assigned to Monitors.....	53

3.7.3 Identifying Redundant Sites	55
3.7.4 Identifying New Sites Needed	58
3.7.5 Effect of New or Proposed Network Design Regulations.....	58
3.7.6 Recommended Network Changes	58
3.8 PM ₁₀ Network	61
3.8.1 Compliance with Network Design Criteria	61
3.8.2 Assessment of Objective Types Assigned to Monitors	61
3.8.3 Identifying Redundant Sites	62
3.8.4 Identifying New Sites Needed	62
3.8.5 Proposed Changes to the PM ₁₀ NAAQS and Monitoring Rule	62
3.8.6 Recommended Network Changes	62
3.9 SO ₂ Network	63
3.9.1 Compliance with Network Design Criteria	63
3.9.2 Assessment of Objective Types Assigned to Monitors	64
3.9.3 Identifying Redundant Sites	65
3.9.4 Identifying New Sites Needed	66
3.9.5 Recommended Network Changes	66
4. SENSITIVE POPULATIONS.....	67
5. TECHNOLOGY	72
6. SUMMARY AND CONCLUSIONS.....	74
7. REFERENCES	75

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
Figure 2-1 Evolution of the number of air monitoring sites in Maryland.	15
Figure 2-2 Operating ranges of currently operating sites in the Maryland Network.....	17
Figure 3-1 Median concentration profiles of selected air toxics parameters compared by site, 2022-2024. Air toxics shown above were the only species with values above the detection limit. HCNR, HU – Beltsville, and Lake Montebello measure Hexane, Cyclohexane, Heptane, Styrene, 1-Ethyl-4-Methylbenzene, and 1,3,5-Trimethylbenzene but the medians are below the minimum detection limit.....	23
Figure 3-2 Locations of Maryland ozone monitors and large NOx point sources. Also shown is the scale of the monitoring location. Regional scale monitors are shown with 50 km radius ellipses, urban scale monitors are shown with 23 km radius ellipses, and neighborhood scale monitors are shown with four km radius ellipses..	37
Figure 3-3 Population density for Maryland ozone monitors. Monitoring sites designated as population exposure sites are shaded in red, all other sites are shaded in blue.	38
Figure 3-4 CMAQ modeled number of ozone exceedance days for July 2011. The number of measured exceedance days is overlaid in colored circles.....	39
Figure 3-5 Ozone design values (DV) for Maryland ozone monitors for 2022 to 2024. MSAs are shown and all sites within that MSA are grouped together. Monitors with the highest concentration monitoring objective are highlighted in teal.....	40
Figure 3-6 Ozone sites used in the redundant sites assessment.	41
Figure 3-7 PM _{2.5} Annual Design values for Maryland monitors for 2023 and 2024. Lake Montebello was not operational long enough to have a valid design value for 2023.....	54
Figure 3-8 Percent change in Maryland population from 2020 - 2024, along with locations of monitoring sites.	55
Figure 3-9 PM _{2.5} sites used in the redundant sites assessment... ..	56
Figure 4-1 Maryland county level sensitive populations (children and seniors from the 2020 census). MDE ozone and PM _{2.5} monitor locations are also shown.....	68
Figure 4-2 Maryland county, age-adjusted ED visits for asthma, per 10,000 population (2020). Ozone and PM _{2.5} monitor locations are also shown.	69
Figure 4-3 Maryland county level, age-adjusted rate of emergency department visits for asthma, with PM _{2.5} monitors, and spatial scales associated with those monitors.	

Only urban and regional scales are shown; the micro, middle, and neighborhood scales are too small for the map.70

Figure 4-4 Maryland county level asthma hospital ED visits per 10,000 population with ozone monitors and spatial scales associated with those monitors. Only urban and regional scales are shown; the micro, middle, and neighborhood scales are too small for the map.71

LIST OF TABLES

<u>Table</u>	<u>Page</u>
Table 3-1 Site pair Spearman correlations and median relative differences for air toxics with values larger than the MDL.	24
Table 3-2 Monitoring requirements for CO.	26
Table 3-3 Monitoring details for the CO network.	26
Table 3-4 Statistical relationships between CO site pairs.	28
Table 3-5 Lead Monitoring Requirements.	29
Table 3-6 NO ₂ monitoring requirements.	31
Table 3-7 Monitoring details for NO ₂ network.	31
Table 3-8 Statistical relationships between NO ₂ site pairs.	33
Table 3-9 Number of ozone SLAMS sites required (based on Table D-2, Appendix D to 40CFR Part 58, Ozone minimum monitoring requirements).	35
Table 3-10 Monitoring objectives and scales for ozone.	35
Table 3-11 Top 20 correlated site pairs in the Maryland ozone network.	42
Table 3-12 Mean removal bias for each site in Maryland’s ozone network.	43
Table 3-13 Decision matrix for the ozone network.	46
Table 3-14 Monitoring details for PAMS network.	48
Table 3-15 Summary of required PAMS monitoring locations and frequencies.	48
Table 3-16 Number of PM _{2.5} SLAMS Sites (based on TABLE D–5 OF APPENDIX D TO PART 58. PM _{2.5} Minimum Monitoring Requirements).	51
Table 3-17 Monitor Objective Types and scales assigned to monitors in the Maryland PM _{2.5}	52
Table 3-18 Twenty most correlated site pairs in the Maryland PM _{2.5} Network.	57
Table 3-19 Mean removal bias for each site in Maryland’s PM _{2.5} network.	58
Table 3-20 Decision Matrix for the PM _{2.5} Network.	60

Table 3-21 Number of PM ₁₀ SLAMS Sites Required (based on Table D-4, Appendix D to 40 CFR Part 58, PM ₁₀ Minimum Monitoring Requirements).	61
Table 3-22 Monitoring details for the PM ₁₀ network.	61
Table 3-23 SO ₂ population weighted emissions index	63
Table 3-24 Monitoring details for SO ₂ network.	64
Table 3-25 Statistical relationships between SO ₂ site pairs	65
Table 6-1 Summary of site specific network assessment recommendations	74

ACRONYMS & DEFINITIONS

AADT	Annual Average Daily Traffic
AQS	Air Quality System
ARP	American Rescue Plan Act of 2021
CAMD	Clean Air Markets Divisions
CBSA	Core Based Statistical Area
CFR	Code of Federal Regulations
CMAQ	Community Multi-scale Air Quality Model
CSA	Combined Statistical Area
CO	Carbon Monoxide
DCDOEE	District of Columbia Department of Energy & Environment
EGU	Electrical Generating Unit
FEM	Federal Equivalent Method typically used by local and state agency to measure particulate matter and determine NAAQS attainment status.
FIPS	Federal Information Processing Standards
FRM	Federal Reference Method typically used by local and state agency to measure particulate matter and determine NAAQS attainment status.
GAO	Government Accounting Office
HAPS	Hazardous Air Pollutants
IMPROVE	Interagency Monitoring of Protected Visual Environments
IRA	Inflation Reduction Act of 2022
MARAMA	Mid Atlantic Regional Air Management Association
MDE	Maryland Department of the Environment
MSA	Metropolitan Statistical Area typically used by the EPA to study air quality trends in major metropolitan areas across the U.S.
NAA	Non-attainment Area
NAAQS	National Ambient Air Quality Standards used for determining attainment status.
NACAA	National Association of Clean Air Agencies
NATTS	National Air Toxics Trend Station
NCore	National Core multi-pollutant monitoring stations
NESCAUM	Northeast States for Coordinated Air Use Management
NO	Nitrogen Oxide
NO ₂	Nitrogen Dioxide

NO _x	Oxides of Nitrogen (ozone precursor)
NO _y	Total Reactive Nitrogen Species (ozone precursor)
O ₃	Ozone
PAMS	Photochemical Assessment Monitoring Station
PWEI	Population Weighted Emissions Index
Pb	Lead
PM _{2.5}	Particulate matter with an equivalent diameter less than or equal to 2.5 μm.
PM ₁₀	Particulate matter with an equivalent diameter less than or equal to 10 μm.
SIP	State Implementation Plan
SLAMS	State or Local Air Monitoring Stations
SO ₂	Sulfur Dioxide
SPM	Special Purpose Monitor
tpy	tons per year
US EPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds
VADEQ	Virginia Department of Environmental Quality

1. INTRODUCTION

The Maryland Department of the Environment (MDE) Ambient Air Monitoring Program is required to conduct and submit a 5-year network assessment to the U.S. Environmental Protection Agency (EPA) Regional Administrator in 2025. This document fulfills this requirement as set forth by the ambient air monitoring regulations, 40 CFR 58.10(d) as amended by the U.S. Environmental Protection Agency (EPA) and finalized on October 17, 2006. These amendments require state, or where applicable local, monitoring agencies to conduct a network assessment once every five years, the first of which was due to the Regional Administrator in July 2010. The text of 40 CFR 58.10(d) requirements is as follows:

“(d) The State, or where applicable local, agency shall perform and submit to the EPA Regional Administrator an assessment of the air quality surveillance system every 5 years to determine, at a minimum, if the network meets the monitoring objectives defined in appendix D to this part, whether new sites are needed, whether existing sites are no longer needed and can be terminated, and whether new technologies are appropriate for incorporation into the ambient air monitoring network. The network assessment must consider the ability of existing and proposed sites to support air quality characterization for areas with relatively high populations of susceptible individuals (e.g., children with asthma), and, for any sites that are being proposed for discontinuance, the effect on data users other than the agency itself, such as nearby States and Tribes or health effects studies. For PM_{2.5}, the assessment also must identify needed changes to population-oriented sites. The State, or where applicable local, agency must submit a copy of this 5-year assessment, along with a revised annual network plan, to the Regional Administrator.”

EPA decided to require a periodic assessment because, ‘ambient air monitoring objectives have shifted over time—a situation which has induced air quality agencies to reevaluate and reconfigure monitoring networks. A variety of factors contribute to these shifting monitoring objectives:

- *Air quality has changed—for the better in most geographic areas—since the adoption of the federal Clean Air Act and National Ambient Air Quality Standards (NAAQS). For example, the problems of high ambient concentrations of lead and carbon monoxide have largely been solved.*
- *Populations and behaviors have changed. For example, the U.S. population has (on average) grown, aged, and shifted toward urban and suburban areas over the past four decades. In addition, rates of vehicle ownership and annual miles driven have grown.*
- *New air quality objectives have been established, including rules to reduce air toxics, fine particulate matter (PM_{2.5}) and regional haze.*

- *The understanding of air quality issues and the capability to monitor air quality have both improved. Together, enhanced understanding and capabilities can be used to design more effective air monitoring networks' [EPA, 2008].*

As a result of the above factors, there is the potential that existing networks do not reflect current or new monitoring needs but rather the network may *have unnecessary or redundant monitors or ineffective and inefficient monitoring locations for some pollutants*, [EPA, 2008]. Doing a network assessment is an opportunity to discover how to refocus network resources to protect today's population and environment.

The State of Maryland, through the efforts of its various governmental agencies and programs, has been measuring ambient air pollutant concentrations in the state for nearly 70 years. Currently, it is the responsibility of MDE's Ambient Air Monitoring Program to measure ambient concentrations of air pollutants in the state. A history of Maryland's monitoring sites is provided in Section 2. Throughout the years, the ambient air monitoring network has changed in response to the factors listed previously. It is anticipated that one of the results of this assessment will be to help MDE determine if past changes to the networks have been sufficient to support current and/or proposed future monitoring needs. Several of the more important features that have shaped the monitoring network are the state's climate, population density, and topography. These features have been known to contribute to the formation of some types of air pollutants and consequently have affected the state's design of historical and existing ambient air monitoring networks.

MDE's approach to performing this 5-year assessment was to address every item required by 40 CFR 58.10(d) within the limitations of available data and analytical techniques. The analytical techniques used in this 5-year assessment required assembling and using a wide variety of data. The temporal scope was typically 2021-2023, and the spatial scope sometimes included data and information from the contiguous states around Maryland. When out-of-state information was used, its relevance to the 5-year assessment was explained. Some input data and the results generated by the analytical techniques are displayed on maps to help aid in visual analysis, interpretation, and presentation of the results. All results are reported based on the type of completed assessment and the confidence that can be attributed to the techniques and data used. A detailed explanation of all analytical techniques and data used is addressed in each section of this 5-year assessment.

The 5-year assessment was organized in such a way that Section 3 is comprised of separate subsections for each individual pollutant network (i.e., air toxics, carbon monoxide, lead, nitrogen dioxide, ozone, PAMS, particulate matter (PM₁₀ and PM_{2.5}), and sulfur dioxide), which make up Maryland's ambient air monitoring network. Section 4 addresses the requirement of determining if ozone and particulate monitors are appropriately located in areas with high populations of sensitive individuals. Section 5 examines new technologies that are available to

measure ambient air pollutant concentrations. Section 6 summarizes the findings of the 5-year assessment and gives recommendations on how the networks might be modified in the next few years.

2. HISTORY OF AIR MONITORING NETWORK

Ambient air quality monitoring began in Maryland in 1955 following the passage of the Air Pollution Control Act of 1955, the first federal legislation involving air pollution. Early sampling was conducted using manual methods (mostly high-volume samplers). Parameters measured included total suspended particulates (TSP), soiling index, dustfall, and sulfation rate (an indicator of sulfur dioxide concentrations). TSP filters were analyzed for benzene solubles and the trace metals lead, chromium, iron, manganese, and nickel.

From 1957 to 1966 Maryland's air monitoring network grew to 32 sites. In 1967, monitoring was expanded to include carbon monoxide, photochemical oxidants, total hydrocarbons, and fluorides. By 1970, there were over 90 sites. In 1971, analysis of TSP filters for manganese and nickel was discontinued and continuous monitoring for carbon dioxide and total oxidants began. The following year, continuous monitoring was expanded to include photochemical oxidants, sulfur dioxide, nitrogen dioxide, nitric oxide, and total hydrocarbons. By 1976, the network reached an all-time peak of 164 sites in the network, and non-methane hydrocarbons and benzo-a-pyrene were added to the list of monitored parameters. Nitrogen oxides and cadmium were added in 1977, and the total number of sites at that time was 157. A chronological listing of the number of monitoring sites in Maryland from 1957 through 2024 is shown in Figure 2-1.

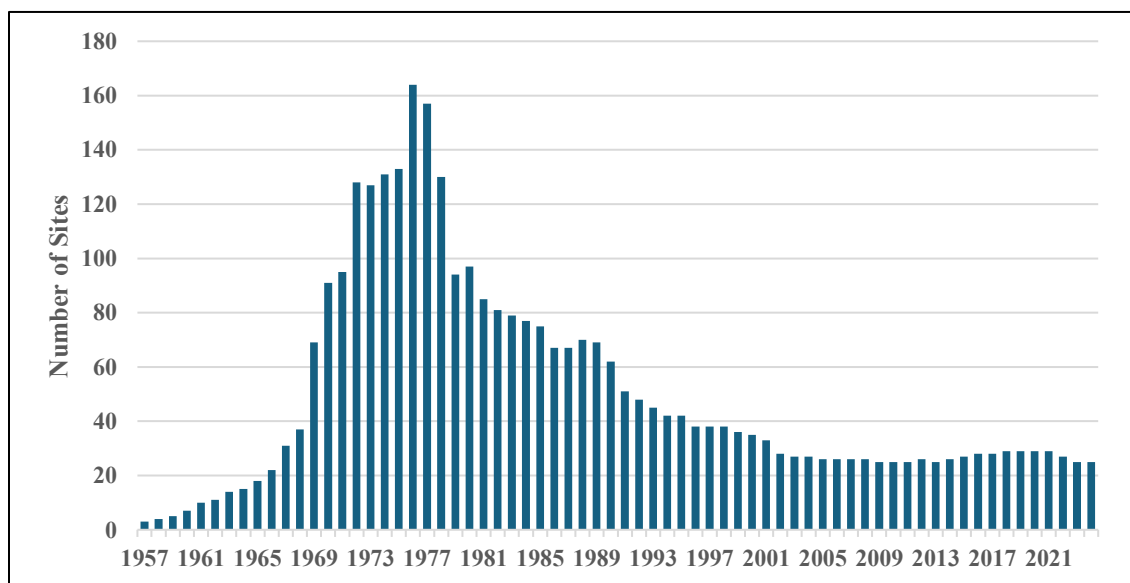


Figure 2-1 Evolution of the number of air monitoring sites in Maryland.

In 1979, EPA promulgated uniform monitoring requirements establishing reference or equivalent monitoring methods, minimum numbers of required monitoring sites, public AQI reporting, annual monitoring network reviews, quality assurance and quarterly and annual reporting of all data to EPA. With the establishment of these requirements and the

discontinuation of monitoring using non-standard methods, the number of monitoring sites dropped below 100.

Maryland began measuring inhalable particulates in 1984 using high-volume samplers with a 0–10-micron size selective inlet. In July 1987, EPA replaced TSP as the indicator for particulate matter with PM₁₀, and by 1992 there were 26 PM₁₀ monitoring sites. Concurrently, TSP monitoring was drastically reduced to support the lead (Pb) NAAQS only. Other trace metal analyses were also discontinued at that time.

Beginning in 1955, monitoring was accomplished through the cooperative efforts of local agencies and the State of Maryland. Carroll, Dorchester, Howard, Washington, and Wicomico County Health Departments supplied personnel for the operation of state-owned air sampling stations located within their jurisdictions. In addition, the following health departments operated their own air sampling stations and assisted in the operation of State-owned stations: Allegany, Anne Arundel, Baltimore, Frederick, Montgomery and Prince George's Counties. Baltimore City maintained its own sampling network and did not operate any state-owned stations. Over the intervening years, as the local jurisdictions gradually divested themselves of ambient air monitoring responsibilities for a variety of reasons, including budgetary limitations, many sites were discontinued. By 1989, the total number of sites state-wide had declined to 69. In the early 1990's, all ambient air monitoring activities were centralized in the Maryland Department of the Environment (MDE). The overall number of monitoring stations continued to decline throughout the 1990's as many single pollutant sites were either discontinued or consolidated as multipollutant sites.

By the late 1980's, Maryland had begun measuring air toxics at a handful of sites state-wide. After the passage of the Clean Air Act Amendments of 1990, three enhanced ozone monitoring sites, referred to as Photochemical Assessment Monitoring Stations (PAMS), were established in 1993 and 1994 to collect detailed information on volatile organic ozone precursors, nitrogen dioxide and meteorological parameters.

Following promulgation of the PM_{2.5} NAAQS in 1997, MDE implemented a network of 18 FRM PM_{2.5} samplers in 1999 and 2000. The PM₁₀ network was concurrently reduced. Two PM_{2.5} chemical speciation sites were also established in 2000 to provide further information about the composition of PM_{2.5} in Maryland. Semi-continuous monitoring for PM_{2.5} with TEOM instruments began around the same time to provide near real-time data for AQI reporting and EPA's AirNow website. In recent years, MDE has discontinued the TEOMs and is now utilizing BAM instruments for semi-continuous PM_{2.5} monitoring.

To better understand the origin and nature of air pollution transported into Maryland from the Ohio River Valley and other areas to the west, MDE established a research monitoring station at Piney Run Reservoir in Garrett County in 2004. This site is outfitted with research grade instrumentation to monitor trace levels of SO₂ and CO, semi-continuous organic and elemental carbon PM_{2.5}, semi-continuous sulfate PM_{2.5} (discontinued in 2014) and NO_y. Traditional semi-

continuous BAM PM_{2.5}, ozone, and PM_{2.5} chemical speciation are also measured. Similarly outfitted research sites were also established at the Howard University Campus near Beltsville in 2004 (as part of the National Core Monitoring station network or NCORE), and Horn Point on the Eastern Shore of Maryland, in 2012.

The operating distances of the current monitoring network are presented in Figure 2-2. The average age of site operation is 28 years, with a range of operations between 2 and 58 years. Most sites have been operating for more than ten years.

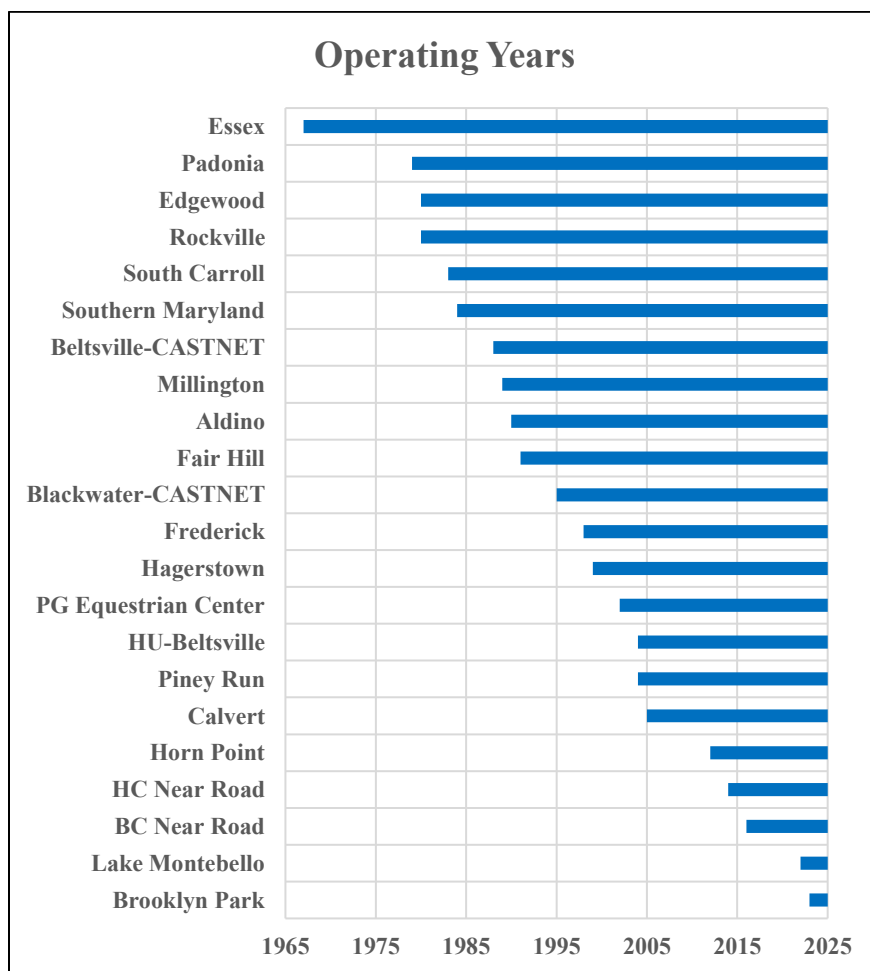


Figure 2-2 Operating ranges of currently operating sites in the Maryland Network.

Changes to the network since 2015

2015-2017

- O₃ monitoring at Davidsonville was terminated in 2015, and monitoring equipment was moved to Glen Burnie, starting there in 2016.
- In 2015, the PAMS monitoring rule was revised in conjunction with the strengthening of the ozone NAAQS. MDE was granted a waiver to terminate the collection of PAMS data at HU-

Beltsville in support of enhanced PAMS monitoring at Essex; MDE has continued PAMS monitoring at HU-Beltsville, though at a lesser time interval.

- PM_{2.5} monitoring at BCFD was discontinued in 2016, due to overlapping coverage and site accessibility issues.
- In 2016, EPA published 40 CFR Part 58 Revisions to Ambient Monitoring Quality Assurance and Other Requirements; Final Rule. This rule revision eliminated the requirement to measure Pb at urban NCore sites. MDE terminated the Pb monitor at HU-Beltsville due to low concentrations at the end of 2017.
- PM_{2.5} monitoring was discontinued in 2016 at Glen Burnie and Prince George's Equestrian Center due to overlapping coverage with the HU-Beltsville monitoring site.
- PM₁₀ monitoring at BCFD was discontinued in 2016 due to overlapping coverage.
- In 2016, monitoring for CO at Horn Point was terminated due to low concentrations.
- CO monitoring at the Oldtown was terminated in 2017, in favor of changing the monitoring scale of the nearby HCNR site from micro- to middle-scale.
- PM_{2.5} monitoring was discontinued at the Northwest Police Station monitoring site in 2017.

2018-2020

- SO₂ monitoring, while not required, started in 2018 at the Riviera Beach monitoring site due to EPA's designation of SO₂ non-attainment for the area based on modeling, and the nearby residents' concerns in response to that designation, and MDE's independent modeling analysis that showed the area not likely experiencing SO₂ levels above the standard.

2021-2023

- Following a site evaluation by EPA Region III staff, MDE consolidated Furley and Oldtown stations, both located in Baltimore City, into one comprehensive site, located at the Lake Montebello Water Filtration Plant, also in Baltimore City. Monitoring at this station includes O₃, air toxics, NO₂, PM_{2.5}, and PM₁₀.
- O₃ monitoring was terminated at the Furley monitoring site in 2021, and all equipment moved to the nearby Lake Montebello site for monitoring starting in early 2022.
- PM_{2.5}, PM₁₀, and NO₂ monitoring were terminated at the Oldtown monitoring site at the end of 2021, and all equipment moved to Lake Montebello.
- SO₂ monitoring was terminated at the Riviera Beach monitoring site in 2022; this monitoring was not required by EPA and consistently demonstrated low concentrations that did not exceed the 1-hour standard of 75ppb in its four years of operations.

2024-2025

- Due to changes in property ownership, PM₁₀ and O₃ monitoring were terminated at the Glen Burnie monitoring site, with all monitoring equipment moved to a new location in Brooklyn Park, four miles north of the former site in Glen Burnie.

3. Specific Pollutant Networks

Ambient air monitoring networks are typically classified by the pollutants they measure and usually consist of more than one monitoring location. MDE operates several pollutant networks (e.g., an ozone network, a sulfur dioxide network, a PM_{2.5} network, etc.). In addition, some of the networks measure groups of pollutants such as air toxics. In this section the assessment of network monitoring objectives, monitoring requirements, the identification of redundant monitoring sites, and the identification of new sites are addressed.

In 2009, EPA provided the states with software tools to identify redundant monitoring sites and possible locations for new monitoring sites. The Lake Michigan Air Director's Consortium (LADCO) updated the tools for 2015 [LADCO, 2015], with the EPA updating the tool for use with 2025 network assessments.

To determine whether Maryland monitoring networks meet the monitoring objectives defined in appendix D, MDE searched for inconsistencies in the monitoring objective types and the related scale of representation (scale) assigned to each monitor in each network. Inconsistencies can arise from the changes delineated above which may have occurred since the original assignment of scales and objectives. Inconsistencies can also arise from errors made in the original assignments. Six basic monitoring objectives with their AQS objective types have been defined in Appendix D to Part 58 1.1.1 as follows:

- Determine the highest concentration expected to occur in the area covered by the network (**Highest Concentration**)
- Measure typical concentrations in areas of high population density (**Population Exposure**)
- Determine the impact of significant sources or source categories on air quality (**Source Oriented**)
- Determine background concentration levels (**General/Background**)
- Determine the extent of regional pollutant transport among populated areas (**Regional Transport**)
- Measure air pollution impacts on visibility, vegetation damage, or welfare-based impact (**Welfare Related Impacts**)

'To clarify the nature of the link between general monitoring objectives, site types, and the physical location of a particular monitor, the concept of spatial scale of representativeness is defined. The goal in locating monitors is to correctly match the spatial scale represented by the sample of monitored air with the spatial scale most appropriate for the monitoring site type, air pollutant to be measured, and the monitoring objective. Thus, spatial scale of representativeness is described in terms of the physical dimensions of the air parcel nearest to a monitoring site throughout which actual pollutant concentrations are reasonably similar' [Appendix D to Part 58 1.2 (a) and Watson, 1997]. The scales of representativeness, as defined in Appendix D to Part 58 1.2 (b) for the monitoring site types described previously are as follows:

- **Micro** Concentrations in air volumes associated with area dimensions ranging from several meters up to about 100 meters.
- **Middle** Concentrations typical of areas up to several city blocks in size with dimensions ranging from about 100 meters to 0.5 kilometer.
- **Neighborhood** Concentrations within some extended area of the city that has relatively uniform land use with dimensions in the 0.5 to 4.0 kilometers range.
- **Urban** Overall, citywide conditions with dimensions on the order of 4 to 50 kilometers. This scale would usually require more than one site for definition.
- **Regional** Usually a rural area of reasonably homogeneous geography and extends from tens to hundreds of kilometers.
- **National/Global** Concentrations characterizing the nation and the globe as a whole.

Each of the previously mentioned scales is not appropriate for use with each pollutant. For example, *‘urban scale and regional scale are of little relevance to PM₁₀, because of the short transport distances for PM₁₀, especially when emitted near ground level. In contrast, because PM_{2.5} is a secondary pollutant, larger spatial scales are relevant, because monitors in such locations will reflect regional emissions trends and transport patterns.’* [CFR, 2006]. Each of the previously mentioned scales is not appropriate for use with each objective type. For example, population exposure is not an appropriate objective for characterizing regional scale sites, because to have regional scale, a site must be located away from population centers. Appropriate scales for each objective can be found in Table D-1 of Appendix D to Part 58. Note that different monitors located at the same site may have different objectives and scales depending on the pollutant that they measure.

Here are some examples of how discrepancies in monitoring objectives and their related representative scales were found:

- To determine if a site was correctly assigned the ‘Highest Concentration’ objective, the site’s design values were compared with the other sites in the network to determine if it did measure the highest concentration. Note that air quality modeling results were sometimes used to help locate new ‘Highest Concentration’ sites. Assigning the highest concentration objective for ozone monitors in Maryland has become less precise since the last network assessment, as extended high ozone episodes (multiple days with many monitors exceeding the NAAQS) have become less frequent and one day events at fewer or even individual monitors have tended to dominate on exceedance days.
- To determine if a site was correctly assigned ‘Population Exposure’ as an objective, land use in the area defined by the site’s scale was considered. Areas that have mixed land use may not serve as the best population exposure sites.

- To determine if a site was correctly assigned the ‘General/Background’ objective, the site’s design values were compared with other sites in the network to determine if it had one of the lowest values.
- Sites assigned to the ‘Population Exposure’ or the ‘General/Background’ objective should not be significantly influenced by nearby emissions sources. Maps identifying the locations of major point sources relative to the location of monitoring sites were used to identify which monitors were close to sources.
- Determining whether the scale was correctly assigned usually called for an appeal to the definition of scale: ‘... throughout which actual pollutant concentrations are reasonably similar ...’. Inferences about the variation of pollutant concentrations were made by visual inspection of land use homogeneity, visual inspection of the location of major sources in relation to monitoring sites, and application of air quality modeling results.

3.1 Air Toxics Network

EPA Region III developed a regional air toxics network jointly with the state and local agencies in the late 1980's and early 1990's with the goal of characterizing ambient air toxics levels throughout Region III. There are four monitoring sites where air toxics samples are currently collected in Maryland. Two of these are urban sites; Lake Montebello, and Essex, which have operated for the last 30 years. The HU-Beltsville site is a suburban site and has operated for over 20 years. The remaining site, Howard County Near Road, has been operational since 2014. None of the sites are designated as National Air Toxics Trends Stations (NATTS) by EPA.

Assessment of the air toxics network was more difficult than the other networks due to the following:

- 37 air toxics compounds needed to be assessed, not just one, as was the case with the other networks.
- Of the 37 air toxics compounds measured during 2022-2024, nineteen species had median concentrations above their MDL and so statistical tests for redundancy could be applied to these species.
- Most air toxics data follow highly skewed distributions making the use of statistical tests and statistical estimators, which assume a normal distribution of data, inappropriate for use with the air toxics data.

3.1.1 Compliance with Network Design Criteria

There are no federal or Maryland state regulations governing the design of air toxics networks. In addition, there are no NAAQS established for any of the measured air toxic compounds.

3.1.2 Assessment of Objective Types Assigned to Monitors

Although no design values exist for air toxics monitoring, MDE assigned scales and objective types to the currently operating air toxics monitors. Population exposure was the objective assigned at neighborhood scale for Lake Montebello, Essex, and HU-Beltsville, while Howard County Near Road was assigned source oriented/highest concentration objective at the micro scale, due to its proximity to a major interstate highway. Essex and Lake Montebello are in densely populated areas in or around Baltimore City. Land use in the vicinity of HU-Beltsville is not as homogenous as the urban sites. The immediate surroundings at the HU-Beltsville site consist primarily of undeveloped woodlands on the research campus of Howard University. There is a commercial-industrial strip to the west along nearby U.S. Route 1, and residential neighborhoods to the north, east, and south. A chart showing the median concentrations of air toxics compounds from each of the air toxics sites is provided in Figure 3-1. Only air toxic compounds with annual median concentrations greater than the minimum detection limit (MDL),

the lowest concentration of a compound that a specific analytical method can reliably detect, are presented. Air toxics associated with mobile source emissions, including benzene, toluene and m & p-xylene, have higher concentrations at the Howard County Near Road and Essex sites, than what is measured at the HU-Beltsville and Lake Montebello sites, likely due to location. The Essex site is located on a small but active parking lot in Baltimore County, Lake Montebello in a suburban residential area of Baltimore City near an arterial road, and the Howard County Near Road site is located adjacent to a major interstate highway.

All the air toxics monitoring sites are useful for characterizing ambient levels of air toxics within their respective communities as well as for determining trends and the effectiveness of specific emission reduction activities. In addition, the HU-Beltsville site is located less than 3 km from the terminus of the newly constructed Inter-County Connector (ICC) and these measurements may prove useful for evaluating the air quality impacts of the ICC and associated development.

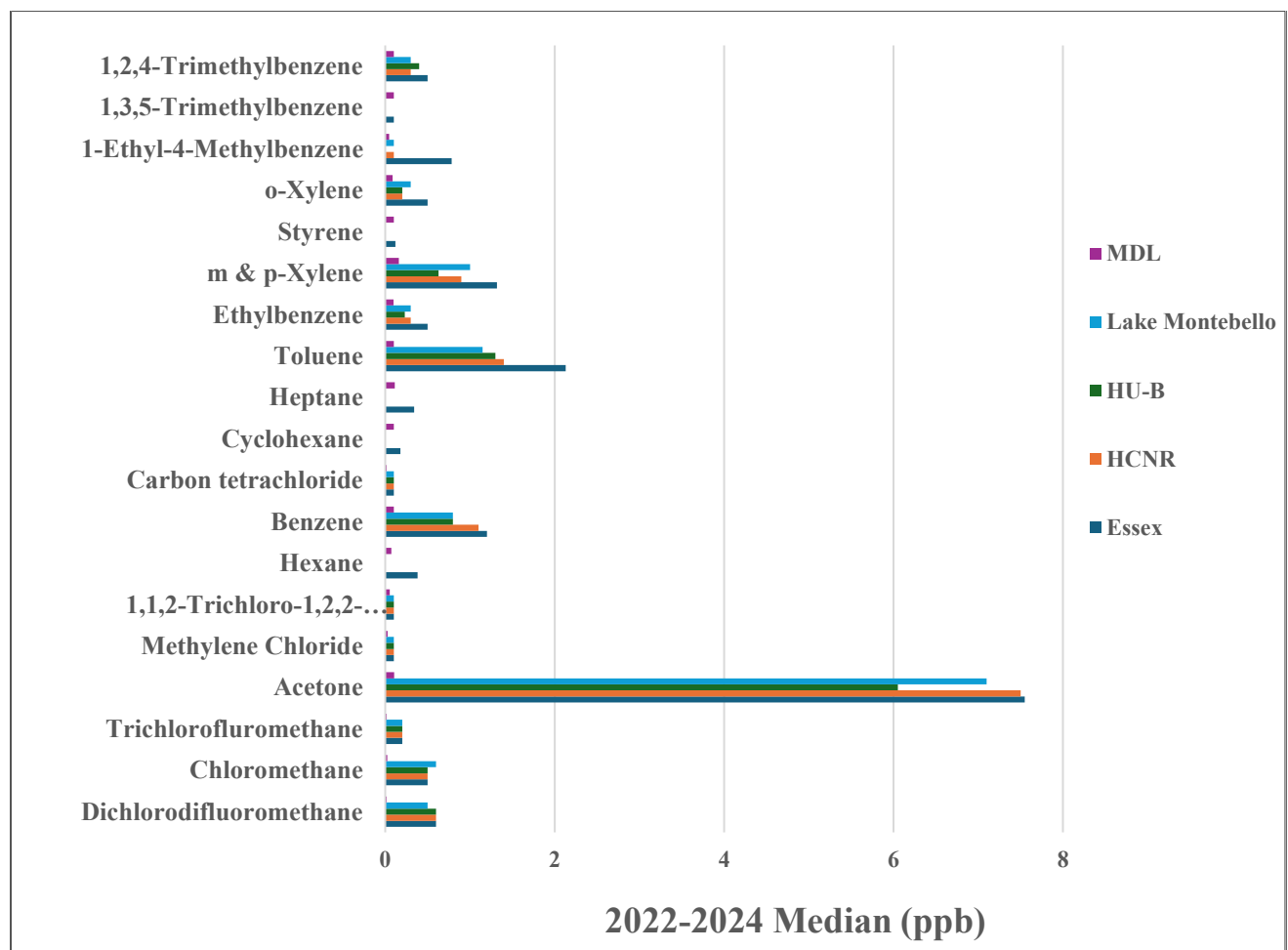


Figure 3-1 Median concentration profiles of selected air toxics parameters compared by site, 2022-2024. Air toxics shown above were the only species with values above the detection limit. HCNR, HU-B, and Lake Montebello measure Hexane, Cyclohexane, Heptane, Styrene, 1-Ethyl-4-

Methylbenzene, and 1,3,5-Trimethylbenzene but the medians are below the minimum detection limit (MDL).

3.1.3 Identifying Redundant Sites

Following a similar evaluation method that was used to assess other pollutant networks, Spearman correlation coefficients were calculated for inter-site pairs of each air toxics pollutant evaluated to determine if there was a relationship between air toxics measurements at different sites (Spearman correlations were used instead of Pearson correlations, because the air toxics data does not follow a Gaussian distribution). Table 3-1 lists the Spearman correlation coefficients as well as the median relative differences. The median is a more appropriate measure of central tendency when the data is skewed. The median relative difference between site pairs X and Y was calculated as follows:

$$\text{Median Relative Difference} = 100 * \text{Median} \left[\frac{2|X_1 - Y_1|}{X_1 + Y_1}, \frac{2|X_2 - Y_2|}{X_2 + Y_2}, \dots, \frac{2|X_n - Y_n|}{X_n + Y_n} \right]$$

Data collected from 2022-2024 were included in this analysis and only data in which each site pair measurement was above the MDL was used to calculate the correlation and median relative difference.

Most correlations were small (averaging ~ 0.4), with some on the 0.7 – 0.8 range when paired values are at the MDL. The median relative differences between HU-Beltsville and HCNR were lower than other site pairs, likely due to proximity, though the monitoring objectives and siting locations were different between this pair. Nothing in these site pair results suggested that any of the pairs were measuring redundant air toxic concentrations.

Table 3-1 Site pair Spearman correlations and median relative differences for air toxics with values larger than the minimum detection limit (MDL).

Air Toxics Species	Essex - HCNR		Essex - HUB		Essex - Lake Montebello		HCNR - HUB		HCNR - Lake Montebello		HUB - Lake Montebello	
	Spearman	Med Rel Diff	Spearman	Med Rel Diff	Spearman	Med Rel Diff	Spearman	Med Rel Diff	Spearman	Med Rel Diff	Spearman	Med Rel Diff
Dichlorodifluoromethane	0.86	0%	0.8	0%	0.74	13%	0.82	0%	0.72	0%	0.74	0%
Chloromethane	0.74	15%	0.71	15%	0.42	15%	0.73	0%	0.51	15%	0.58	15%
Trichlorofluoromethane	0.25	0%	0.25	0%	0.23	0%	0.24	0%	0.17	0%	0.19	0%
Acetone	0.71	23%	0.67	21%	0.78	17%	0.65	19%	0.7	20%	0.58	20%
Methylene Chloride	0.39	0%	0.53	0%	0.22	0%	0.41	0%	0.13	0%	0.28	0%
1,1,2-Trichloro-1,2,2-trifluoroethane	0.39	0%	0.53	0%	-0.02	0%	-0.07	0%	0.02	0%	0.15	0%
Hexane	0.25	200%	0.22	200%	0.25	200%	0.57	0%	0.3	0%	0.28	0%
Benzene	0.53	30%	0.73	36%	0.77	28%	0.63	26%	0.61	26%	0.62	22%
Carbon tetrachloride	0.25	0%	0.32	0%	0.25	0%	0.43	0%	0.18	0%	0.33	0%
Cyclohexane	0.11	200%	0.11	200%	0.2	200%	1	0%	0.34	200%	0.34	200%
Heptane	0.32	200%	0.42	200%	0.48	200%	0.2	200%	0.28	200%	0.35	200%
Toluene	0.35	49%	0.63	53%	0.63	54%	0.56	29%	0.41	42%	0.36	38%
Ethylbenzene	0.1	71%	0.49	51%	0.36	58%	0.43	53%	0.31	55%	0.22	63%
m & p-Xylene	0.15	57%	0.54	55%	0.38	61%	0.44	48%	0.41	53%	0.21	58%
Styrene	0.59	180%	0.63	92%	0.53	191%	0.66	142%	0.56	67%	0.52	178%
o-Xylene	0.17	87%	0.54	81%	0.37	70%	0.4	67%	0.31	67%	0.24	67%
1-Ethyl-4-Methylbenzene	0.14	200%	0.33	200%	0.35	155%	0.4	200%	0.21	200%	0.21	200%
1,3,5-Trimethylbenzene	0.2	200%	0.23	200%	0.26	200%	0.4	200%	0.32	200%	0.27	200%
1,2,4-Trimethylbenzene	0.11	81%	0.19	75%	0.32	91%	0.18	87%	0.17	108%	-0.02	120%

3.1.4 Identifying New Sites Needed

The EPA did not supply or develop any tools for identifying new air toxics site locations, and without any objective network design criteria, there is no clear-cut approach for doing so. In general, the existing sites could be moved or additional air toxics monitoring sites could be established to characterize ambient air toxics levels in other areas of the state, provided adequate funding is available, although it is unlikely that concentrations of most air toxics would be any greater than those measured in the highly urban environment of Baltimore City or at the Howard County Near Road site.

3.1.5 Effect of New or Proposed Network Design Regulations

None have been proposed for air toxics as of the time this report was written.

3.1.6 Recommended Network Changes

It is recommended that EPA Region III and the states jointly reassess the goals and objectives of the regional air toxics network. A part of this assessment should focus on what air toxic compounds should be reported and whether existing sites should be continued as trends sites or moved to characterize other areas of the individual states.

3.2 CO Network

3.2.1 Compliance with Network Design Criteria

EPA revised the minimum monitoring requirements for CO on August 12, 2011. One CO monitor is required to be collocated with a near-road NO₂ monitor in urban areas having a population of 1 million or more. MDE added a CO monitor to the Howard County Near Road NO₂ monitoring site at the Interstate 95 South (I-95S) rest area between MD-32 and MD-216. This monitor began collecting data April 1, 2014. Operation of the existing CO sites in Maryland is required until MDE requests discontinuation of a site in the Annual Network Plan and the EPA Regional Administrator approves the request. A summary of the monitoring requirements is provided in Table 3-2.

Table 3-2 Monitoring requirements for CO.

Requirement	Appendix D 40 CFR Part 58	Required in Maryland	Number of monitors active in Maryland
One CO monitor collocated with a Near Road NO ₂ in urban area with a population >= 1 million	4.2.1	1	1
One CO monitor at each Type 2 PAMS site	5.3, Table D-6	1	1
One CO monitor at each NCore site	3(b)	2	2

Maryland has four CO monitoring sites, and their type, objectives, and representative scales are summarized in Table 3-3. There are currently two primary NAAQS for CO, an 8-hr standard of 9 ppm and a 1-hr standard of 35 ppm. All CO monitoring sites meet the NAAQS (Table 3-3).

Table 3-3 Monitoring details for the CO network.

Site Name	AQS ID	Monitor Scale	Monitor Objective	Type	2023 Design Value 1-hr (ppm)	2023 Design Value 8-hr (ppm)
Essex	240053001	Middle Scale	Highest Concentration	SLAMS	1.8	1.2
Piney Run	240230002	Regional Scale	Regional Transport	SLAMS NCORE	1.1	0.9
Howard County Near Road	240270006	Middle Scale	Highest Concentration Source Oriented	SLAMS	1.1	0.9
HU - Beltsville	240330030	Urban Scale	General/Background	SLAMS NCORE	1.1	0.8

3.2.2 Assessment of Objective Types Assigned to Monitors

Essex and the Howard County Near Road sites are assigned highest concentration objectives. The design values at Essex are the highest in the Maryland network.

Micro scale and middle scale measurements are useful site classifications for SLAMS sites because most people have the potential for exposure at these scales. Appendix D to part 58 4.2.3.1 states that in certain cases, middle scale measurements may apply to areas that have a total length of several kilometers, such as “line” emission source areas. This type of emission source area would include air quality along a commercially developed street or shopping plaza, freeway corridors, parking lots, and feeder streets. Two SLAMS stations in Maryland, Essex and Howard County Near Road, have the representative scale of middle (0.1-0.5 km). The Howard County Near Road site was previously designated as microscale but was changed to middle scale to better reflect the intended objective.

The HU-Beltsville site is an NCore site, and its representative scale is urban; the site is in a suburban area, not close to large CO sources, and this justifies the urban representative scale as well as the general/background monitoring objective. Piney Run is an NCore site located in a rural area at high elevation (781 m above sea level) in Western Maryland. The site location justifies the regional representative scale.

3.2.3 Identifying Redundant Sites

Statistical relationships between site pairs were examined to determine redundant sites. Daily maximum CO data from each site were examined for 2021-2023. Pearson’s correlation coefficients and average relative differences among site pairs are provided in Table 3-4. Average relative differences between site pairs (X and Y) were calculated with the following equation:

$$100 * \sum_{i=1}^n \frac{|X_i - Y_i|}{(X_i + Y_i)/2}$$

All correlations (r) are smaller than or equal to 0.71, suggesting that the site pairs are not well correlated. The distance between Howard County Near Road and HU-Beltsville is approximately 10 kilometers, and this pair shows the largest correlation (r = 0.71). However, the differences between the observations are large enough (~13%) that the sites should not be considered redundant. One site is also suburban with the other near-source.

Table 3-4 Statistical relationships between CO site pairs.

X	Y	Distance (km)	r	n	Average Relative Difference
Essex	Piney Run	221	0.14	992	23%
Essex	Howard County Near Road	37	0.34	1007	14%
Essex	HU-Beltsville	45	0.71	1011	15%
Piney Run	Howard County Near Road	196	0.29	1009	20%
Piney Run	HU-Beltsville	196	0.28	1012	9%
Howard County Near Road	HU-Beltsville	10	0.39	1028	13%

3.2.4 Identifying New Sites Needed

Given that CO concentrations at all sites are well below the NAAQS and the network requirements are being met, there is no pressing need to identify potential new sites.

3.2.5 Effect of New or Proposed Network Design Regulations

None have been proposed for CO as of the time this report was written.

3.2.6 Recommended Network Changes

There are no recommended changes to the network at this time.

3.3 Lead Network

3.3.1 Compliance with Network Design Criteria

The latest revision to the lead (Pb) NAAQS was finalized on October 15, 2008, lowering the primary and secondary standards from 1.5 µg/m³ to 0.15 µg/m³. The final rule became effective on January 26, 2011 (Table 3-5). EPA Region III and MDE review the Maryland lead inventory annually to see if any facilities exceed the criteria and need to be modeled and/or monitored.

Table 3-5 Lead Monitoring Requirements

Requirement	Appendix D 40 CFR Part 58	Required in MD	Number in MD
One source-oriented SLAMS site located to measure the maximum Pb concentration resulting from each non-airport Pb source which emits 0.50 or more tons per year (tpy)	4.5(a)	0	0
One source-oriented SLAMS site located to measure the maximum Pb concentration resulting from airport which emits 1.0 or more tpy	4.5(a)	0	0

On March 28, 2016, EPA published 40 CFR Part 58 Revisions to Ambient Monitoring Quality Assurance and Other Requirements; Final Rule. This rule revision eliminated the requirement in section 3 of appendix D to measure Pb at urban NCore sites either as Pb in Total Suspended Particles (Pb-TSP) or as Pb PM₁₀. In order to discontinue Pb measurements at urban NCore sites, Part II.I Network Design Requirements of the publication states:

“With specific regard to Pb monitoring at urban NCore sites, monitoring agencies should request permission from the EPA Regional Administrator to discontinue non-source-oriented monitoring following the collection of at least 3 years of complete data at each affected site.”

With approval from the EPA Region III Administrator, MDE terminated the Pb monitor at HU-Beltsville due to low concentrations (see the [2018 Monitoring Network Plan](#).)

3.4 NO₂ Network

3.4.1 Compliance with Network Design Criteria

On January 22, 2010, EPA strengthened the health-based National Ambient Air Quality Standard (NAAQS) for nitrogen dioxide (NO₂) by setting a new 1-hour NAAQS at 100 ppb. The existing annual average NAAQS of 53 ppb has been retained as well. In addition to establishing a new 1-hour NO₂ NAAQS, EPA revised the NO₂ monitoring requirements in urban areas. A summary of the monitoring requirements is presented in Table 3-6.

Near Road Monitoring

There are three MSA's with populations greater than 2,500,000 that are either wholly or partially in Maryland that each qualify for two near road NO₂ monitors. For the Baltimore-Columbia-Towson, MD MSA, MDE currently operates two near road NO₂ monitoring stations, the Howard County Near Road site, located on I-95 South, between MD Routes 32 and 216, and the Baltimore County Near Road site, located at the Maryland Transit Administration maintenance facility at the interchange of I-695 and I-795.

For the Washington-Arlington-Alexandria, DC-VA-MD-WV MSA, the requirements will be met by monitors installed in Washington, DC, by the District of Columbia Department of Energy and Environment (DDOE), and in Northern Virginia by the Virginia Department of Environmental Quality (VADEQ.) For the Philadelphia-Camden-Wilmington, PA-NJ-DE-MD MSA, the requirements will be met by monitors installed by the Pennsylvania Department of Environmental Protection (PADEP).

Community Wide Monitoring

There are three MSA's with populations greater than 1,000,000 that are either wholly or partially in Maryland, that each qualify for one community wide NO₂ monitor. MDE's NO₂ monitors at the Essex and Lake Montebello sites fulfill this requirement for the Baltimore-Columbia-Towson, MD MSA.

For the Washington-Arlington-Alexandria, DC-VA-MD-WV MSA, the requirements will be met by monitors installed in Washington, DC by the District of Columbia Department of the Environment (DDOE) and in Northern Virginia by the Virginia Department of Environmental Quality (VADEQ). For the Philadelphia-Camden-Wilmington, PA-NJ-DE-MD MSA, the requirements will be met by monitors installed by the Pennsylvania Department of Environmental Protection (PADEP).

Sensitive & Vulnerable Populations

EPA Region III has not required MDE to install any additional monitors to meet this requirement.

Table 3-6 NO₂ Monitoring Requirements.

Requirement	Appendix D 40 CFR Part 58	Required in Maryland	Number of monitors active in Maryland
Near Road NO ₂ monitoring in CBSA with a population > 2,500,000	4.3.2(a)	2	2
Area-wide NO ₂ monitoring in CBSA with a population > 1,000,000	4.3.3	1	2
Regional Administrator required monitoring	4.3.4	Variable	0

MDE has six NO₂ monitoring sites in Maryland and their type, objectives, and representative scale are summarized in Table 3-7. There are currently two primary standards for NO₂. For the primary hourly standard, the three-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 100 ppb. For both the annual primary and secondary standards, the annual average must not exceed 53 ppb.

40 CFR 58 Appendix D 4.3.3 requires one NO₂ monitoring station in each CBSA, to monitor a location of expected highest concentration, representing the neighborhood or larger spatial scale. PAMS sites that collect NO₂ data, situated in areas of expected high concentrations, at the neighborhood or larger spatial scale may be used to satisfy this minimum monitoring requirement, when the monitor is operated year-round. The Essex site addresses this criterion (Table 3-7). Design values are presented in Table 3-7 for NO₂ monitoring sites. All locations have design values that are below both the annual and one hour NAAQS.

Table 3-7 Monitoring details for NO₂ network.

Site Name	AQS ID	Representative Scale	Monitor Objective	Type	2024 Annual Design Value (ppb)	2022-2024 1-hr Design Value (ppb)
Essex	240053001	Neighborhood	Population Exposure	SLAM S	9	38
Piney Run	240230002	Regional	Regional Transport	SLAM S NCore	2	9
Howard County Near Road	240270006	Micro	Highest Concentration Source Oriented	SLAM S	15	44
HU-Beltsville	240330030	Urban	General/Background	SLAM S NCore	6	36
Lake Montebello	245105253	Middle	Highest Concentration	SLAM S	8	43
Baltimore County Near Road	240050009	Micro	Highest Concentration Source Oriented	SLAM S	13	41

3.4.2 Assessment of Objective Types Assigned to Monitors

The microscale is the most appropriate spatial scale for near-road NO₂ monitoring stations, to effectively characterize the maximum expected hourly concentrations due to mobile source emissions on major roadways. For other monitoring stations, either microscale or middle scale may be used to characterize maximum expected hourly NO₂ concentrations. (40 CFR 58 Appendix D 4.3.5 a). Baltimore County Near Road and Howard County Near Road both have been assigned microscale.

Middle scale sites represent air quality in areas up to several city blocks and may include locations of expected maximum concentrations due to proximity to major NO₂ point, area, and/or non-road sources. The Lake Montebello site has been assigned middle scale, due to its location near a busy arterial roadway, close to downtown Baltimore.

Neighborhood scale sites represent air quality conditions throughout relatively uniform land use areas ranging from 0.5 - 4 kilometers. Emissions from stationary point and area sources, under certain plume conditions, may result in high NO₂ concentrations at the neighborhood scale (40 CFR 58 Appendix D 4.3.5 a.3). Essex has been assigned neighborhood scale due to its location in a parking lot that may experience peaks in NO₂, but typically measures values expected in an urban environment.

Urban scale sites represent concentrations throughout large portions of an urban area. These measurements are useful for assessing trends in area-wide air quality, and hence, the effectiveness of large-scale air pollution control strategies. The HU-Beltsville site has been assigned urban scale due to its location in a suburban environment, not close to major NO₂ point sources.

The Piney Run site in Western Maryland is directly in the path of transported aloft emissions of NO₂ from neighboring states; its representative scale is regional. Piney Run is in a rural area at high elevation (781 m above sea level), not close to any large NO₂ sources, which justifies the regional representative scale, and its regional transport monitoring objective.

3.4.3 Identifying Redundant Sites

Statistical relationships between site pairs were examined to determine redundant sites. Daily maximum NO₂ data from each site were examined for 2022-2024. Pearson's correlation coefficients and average relative differences among site pairs are provided in Table 3-8. Average relative differences between site pairs (X and Y) were calculated with the following equation:

$$100 * \sum_{i=1}^n \frac{|X_i - Y_i|}{(X_i + Y_i)/2}$$

All correlations (r) are 0.78 or less, most significantly less, suggesting most site pairs are not strongly correlated. The mean absolute differences among all site pairs in parts per billion ranged from 5.3 – 24.2 and are large enough that the sites should not be considered redundant, even between sites that are moderately correlated ($r^2 = \sim 0.7$). Using these statistical relationships, no redundant sites were found.

Table 3-8 Statistical relationships between NO₂ site pairs.

X	Y	Distance (km)	r	n	Mean Absolute Difference (ppb)
HU-Beltsville	Essex	45	0.75	1025	6.2
Lake Montebello	Essex	10	0.78	683	5.3
Lake Montebello	HU-Beltsville	40	0.72	654	7.1
Piney Run	HU-Beltsville	196	0.43	1009	11.5
Piney Run	Essex	221	0.30	1038	16.6
Piney Run	Lake Montebello	211	0.40	669	16.8
HU-Beltsville	HCNR	10	0.46	1003	13.2
HCNR	Essex	37	0.47	1031	9.3
HCNR	Lake Montebello	31	0.49	659	9.8
HCNR	Piney Run	196	0.26	1021	24.2
BCNR	HU-Beltsville	37	0.67	1030	11.5
BCNR	Essex	24	0.73	1058	7.0
BCNR	Lake Montebello	14	0.68	691	8.1
BCNR	Piney Run	197	0.30	1044	22.9
BCNR	HCNR	27	0.63	1036	5.8

3.4.4 Identifying New Sites Needed

Because all sites are measuring below the NAAQS and all monitoring requirements are met, no new sites are being considered at this time.

3.4.5 Proposed Regulations

There are no proposed changes to the regulations at this time.

3.4.6 Recommended Network Changes

There are no recommended changes to the network at this time.

3.5 Ozone Network

3.5.1 Compliance with Network Design Criteria

Ozone monitoring requirements are determined by the MSA population and design value, as specified in Table D-2 of 40 CFR Part 58 Appendix D. Table 3-9 shows that the MDE monitoring network meets or exceeds the minimum requirements. In many areas ozone levels decrease significantly in the colder periods and only need to be monitored during the designated “ozone season”. For Maryland, the ozone season is specified as March 1 through October 31. The monitoring objectives and spatial scales are discussed in greater detail in section 3.5.2.

Table 3-9 Number of ozone SLAMS sites required (based on Table D-2, Appendix D to 40CFR Part 58, Ozone minimum monitoring requirements).

MSA Name	Population	Monitors Deployed by State ^A							Total Monitors	Required ≥ 85% NAAQS
		DE	DC	MD	VA	WV	PA	NJ		
Baltimore-Towson, MD	2,859,024	0	0	7	0	0	0	0	7	3
Hagerstown-Martinsburg, MD-WV	311,295	0	0	1	1	1	0	0	3	1
Washington-Arlington-Alexandria, DC-VA-MD-WV	6,436,489	0	3	7	4	0	0	0	14	3
Philadelphia-Camden-Wilmington- Newark, PA-DE-NJ-MD	6,330,422	4	0	1	0	0	7	8	20	3
Total	15,937,230	4	3	16	5	1	7	8	44	10

A - Based on tables available at <https://www.census.gov/data/tables/time-series/demo/pepost/2020s-total-metro-and-micro-statistical-areas.html>. All areas had their maximum site ≥ 85% Ozone NAAQS.

3.5.2 Assessment of Objective Types and Spatial Scales Assigned to Monitors

There are 20 ozone monitoring locations in Maryland and their objectives and representative scales are summarized in Table 3-. There are four extra monitors in Table 3- than shown in Table 3-, because these four monitors are not contained within an MSA (Piney Run, Millington, Blackwater-CASTNET, and Horn Point). The Blackwater and Beltsville sites are owned and operated by EPA Clean Air Markets Division as part of the Clean Air Status and Trends Network (CASTNET) but can be used by MDE in meeting EPA ozone network design requirements. These sites are therefore included in this assessment but are not subject to any recommendations for closure or relocation.

Table 3-10 Monitoring objectives and scales for ozone.

Site Name	Monitor Objective	Measurement Scale	MSA
Aldino	Highest Concentration	Urban	Baltimore-Columbia-Towson, MD
Beltsville-CASTNET	Regional Transport	Regional	Washington-Arlington-Alexandria, DC-VA-MD-WV
Blackwater-CASTNET	Regional Transport	Regional	NA
Brooklyn Park	Population Exposure	Neighborhood	Baltimore-Columbia-Towson, MD
Calvert	Population Exposure	Urban	Washington-Arlington-Alexandria, DC-VA-MD-WV
Edgewood	Highest Concentration	Urban	Baltimore-Columbia-Towson, MD
Essex	Highest Concentration Population Exposure	Neighborhood	Baltimore -Columbia-Towson, MD
Fair Hill	Regional Transport	Urban	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD
Frederick	Population Exposure	Urban	Washington-Arlington-Alexandria, DC-VA-MD-WV
Hagerstown	Highest Concentration Population Exposure	Urban	Hagerstown-Martinsburg, MD-WV
Horn Point	General/Background	Regional	NA
HU-Beltsville	Highest Concentration Population Exposure	Urban	Washington-Arlington-Alexandria, DC-VA-MD-WV
Lake Montebello	Population Exposure	Neighborhood	Baltimore-Columbia-Towson, MD
Millington	Population Exposure	Urban	NA
Padonia	Population Exposure	Neighborhood	Baltimore-Columbia-Towson, MD
PG Equestrian Center	Population Exposure	Urban	Washington-Arlington-Alexandria, DC-VA-MD-WV
Piney Run	Regional Transport	Regional	NA
Rockville	Population Exposure	Urban	Washington-Arlington-Alexandria, DC-VA-MD-WV
South Carroll	Population Exposure	Urban	Baltimore-Columbia-Towson, MD
Southern Maryland	General/Background	Regional	Washington-Arlington-Alexandria, DC-VA-MD-WV

The ozone monitoring rule (Appendix D to Part 58 4.1 b) states: “*Within an O₃ network, at least one O₃ site for each MSA, or CSA if multiple MSAs are involved, must be designed to record the maximum concentration for that particular metropolitan area. More than one maximum concentration site may be necessary in some areas.*” Note that the AQS classifies maximum concentration monitors as highest concentration monitors (and will be referred to throughout the document as such). The Maryland ozone network has six monitors assigned as highest concentration. Two of these monitors are in the Baltimore-Columbia-Towson, MD MSA, two monitors are in the Washington-Arlington-Alexandria, DC-VA-MD-WV MSA, and one is in the Hagerstown-Martinsburg, MD-WV MSA. The Fair Hill monitor is the only ozone monitor in Maryland in the Philadelphia-Camden-Wilmington, PA-DE-MD MSA and the site is located in a rural area and representative of regional transport. An out-of-state monitor is classified with the objective of highest concentration for the Philadelphia-Camden-Wilmington, PA-NJ-DE-MD MSA.

The ozone monitoring rule requires that one of three scales be assigned to ozone monitor sites: urban, neighborhood, or regional. Sites associated with these scales are shown in Table 3- and Figure 3-. Neighborhood scale sites should be located to measure typical city concentrations and should not be near the influence of major NO_x sources. The map in Figure 3- shows no major NO_x sources within the spatial scales of the four neighborhood sites (Brooklyn Park, Essex, Lake Montebello, and Padonia).

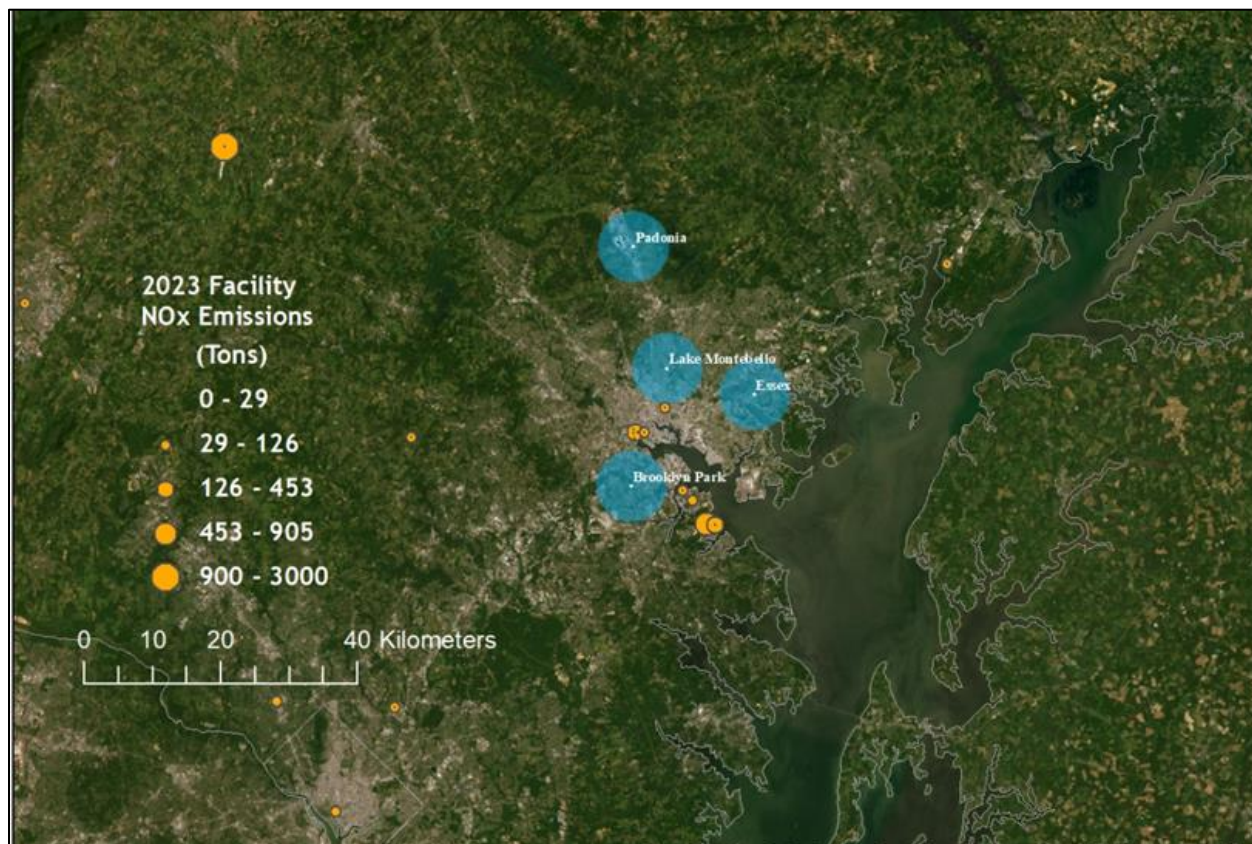


Figure 3-2 Locations of ozone monitors in the Greater Baltimore area and large NO_x point sources. Also shown is the scale of the monitoring location. Regional scale monitors are shown with 50 km radius ellipses, urban scale monitors are shown with 23 km radius ellipses, and neighborhood scale monitors are shown with four km radius ellipses.

Maryland’s ozone monitoring network objectives include population exposure, highest concentration, regional transport, and background. Population data were examined using EPA tools to assess the population exposure objective. CMAQ model output and monitored design values were utilized to assess the background objective and the highest concentration objective. The results of these assessments are described below.

Nine of the 20 ozone monitor sites have population exposure designations as an objective. EPA developed NetAssess2025 app to assist air monitoring agencies in developing their 5-year network assessments (<https://rconnect-public.epa.gov/NetAssess2025/>, documentation of the app

can be found at <http://ladco.github.io/NetAssessApp/tools.html>). NetAssess2025 incorporates a tool to calculate the population served by each monitor to assist states in developing network assessments. The area served tool uses Voronoi polygons to show the area represented by a monitoring site. The shape and size of each polygon is dependent on the proximity of the nearest neighboring sites to any particular site. Data from the 2010 Decennial Census were used to determine which census tract centroids were within each polygon. The population represented by the polygon is calculated by summing the populations of these census tracts. The population density is determined by dividing the summed population by the area of the Voronoi polygon in km^2 . Voronoi polygon population densities for Maryland's ozone monitoring network are shown in Figure 3-3. The population exposure sites are highlighted in red; some of the population exposure sites are associated with much lower population densities, but these include more rural areas of Maryland. Ultimately, all monitors represent some degree of population exposure, although it may not be the stated primary monitoring objective.

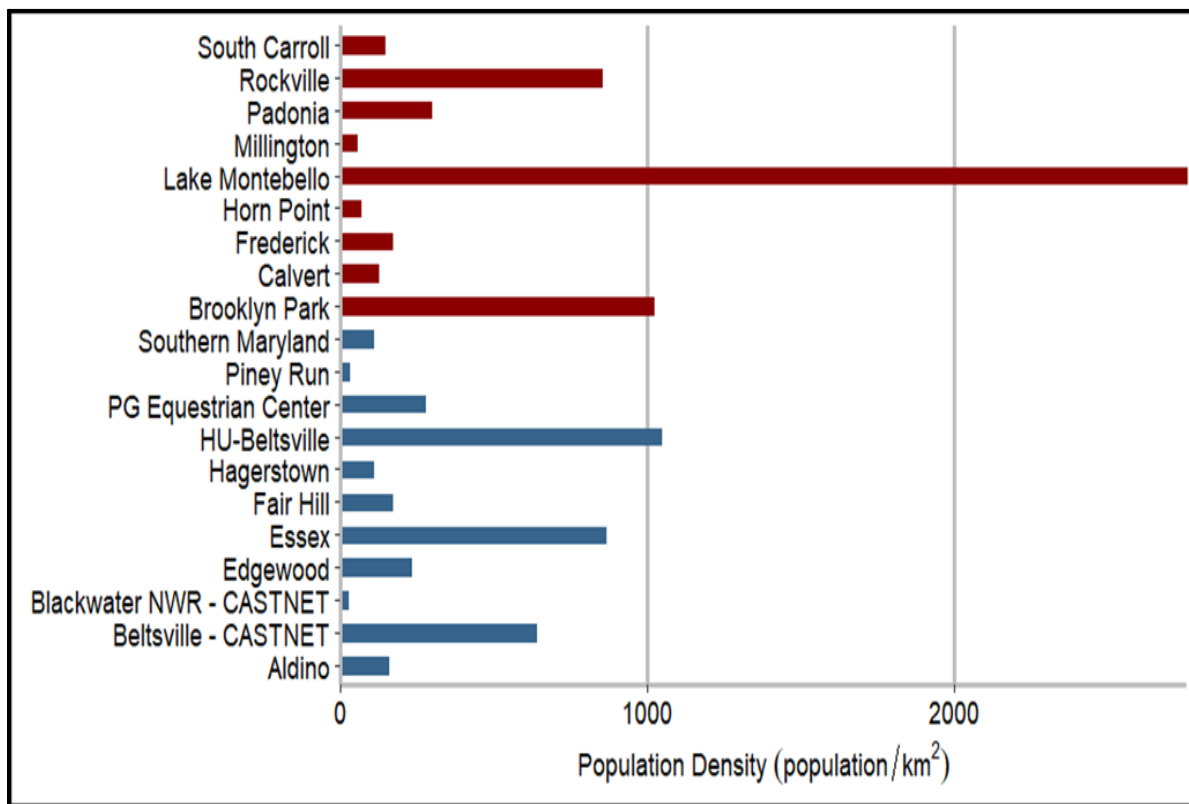


Figure 3-3 Population density for Maryland ozone monitors. Monitoring sites designated as population exposure sites are shaded in red, all other sites are shaded in blue.

CMAQ model output was examined as a method to assess the background monitoring and highest concentration objectives for the ozone network. CMAQ output for July 2016 (with 2016 emissions) was examined, with the number of modeled maximum daily 8-hour average ozone (MDA8) exceedances calculated for each grid cell for the modeling area covering Maryland,

Delaware, and part of Pennsylvania and New Jersey. AQS data for July 2016 were analyzed and the number of MDA8 exceedances were calculated for each monitor. Figure 3-4 shows the number of ozone exceedance days in July from the CMAQ model run, overlaid with the measured number of exceedance days from surface monitors. Southern Maryland is classified as a background site and experiences fewer ozone exceedances, so the background classification is appropriate. Blackwater-CASTNET, Aldino, Edgewood, Essex, HU-Beltsville, Beltsville-CASTNET, PG Equestrian Center, and Hagerstown are classified as highest concentration monitors, and appear to measure the most ozone exceedances for the areas they represent. Brooklyn Park (formerly Glen Burnie), assigned the population exposure designation, also recorded a moderately high number of ozone exceedance days for the selected year and month.

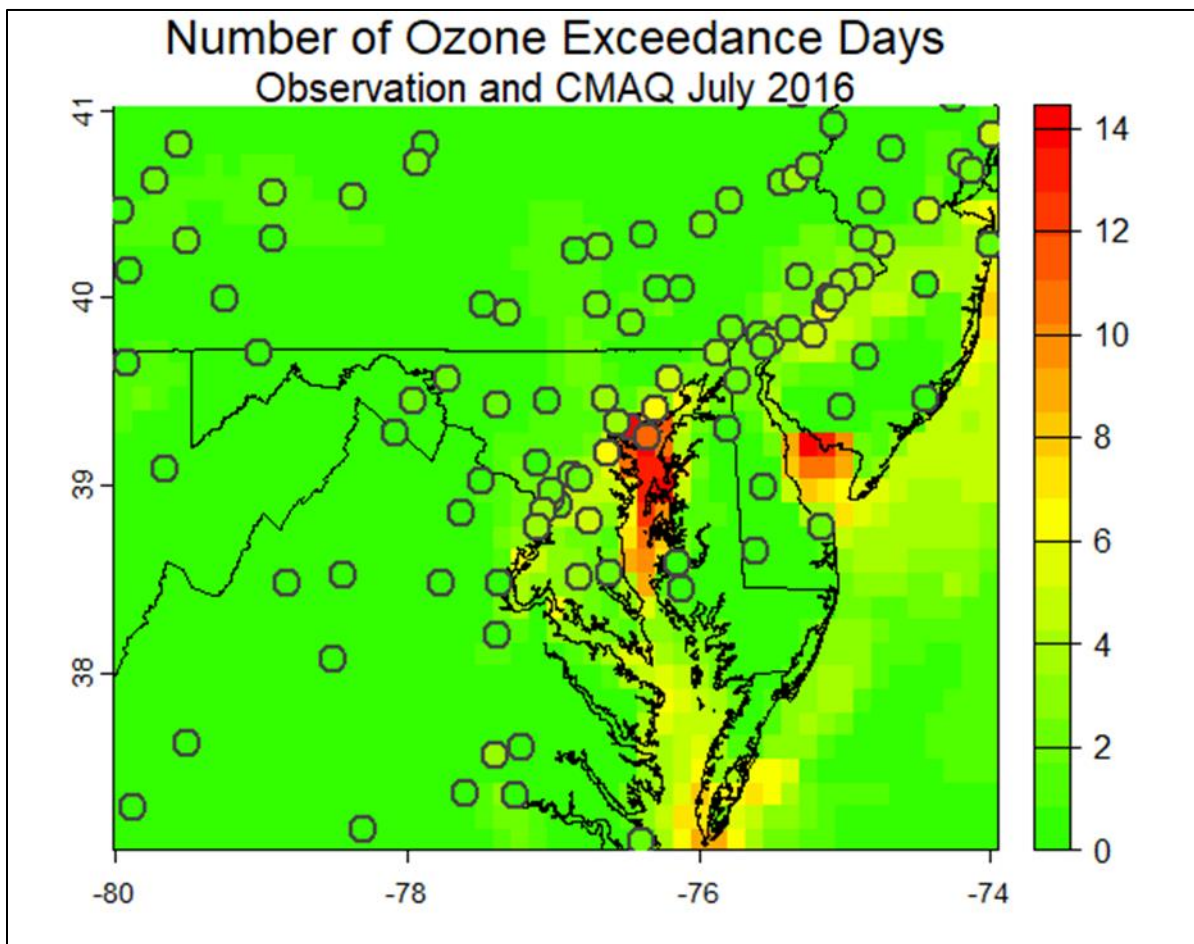


Figure 3-4 CMAQ modeled number of ozone exceedance days for July 2016. The number of measured exceedance days is overlaid in colored circles.

Monitored design values from 2022-2024 in each MSA were examined to assess the highest concentration and general/background monitoring objectives. These monitored design values are provided in Figure 3-5. The Edgewood, Aldino, and Essex sites have the highest ozone design

values in the Baltimore-Columbia-Towson, MD MSA, and this confirms their highest ozone monitoring objectives. Essex has the highest ozone design value in 2023, due to the impact of a series of smoke events. HU-Beltsville, Beltsville-CASTNET, and PG Equestrian Center are designated as highest concentration sites in the Washington-Arlington-Alexandria, DC-VA-MD-WV MSA. These sites also have the highest design values in this MSA. Assigning the highest concentration objective for ozone monitors in Maryland has become less precise since the last network assessment because extended high ozone episodes (multiple days with many monitors exceeding the NAAQS) have become less frequent and one day events at fewer or even individual monitors have tended to dominate on exceedance days. Southern Maryland is classified as a General/Background monitor, and it has moderate ozone design values. The scale is appropriate because the location is typically downwind of the greater DC metropolitan area and the I-95 corridor. Piney Run, a rural NCore site, helps characterize regional ozone transport.

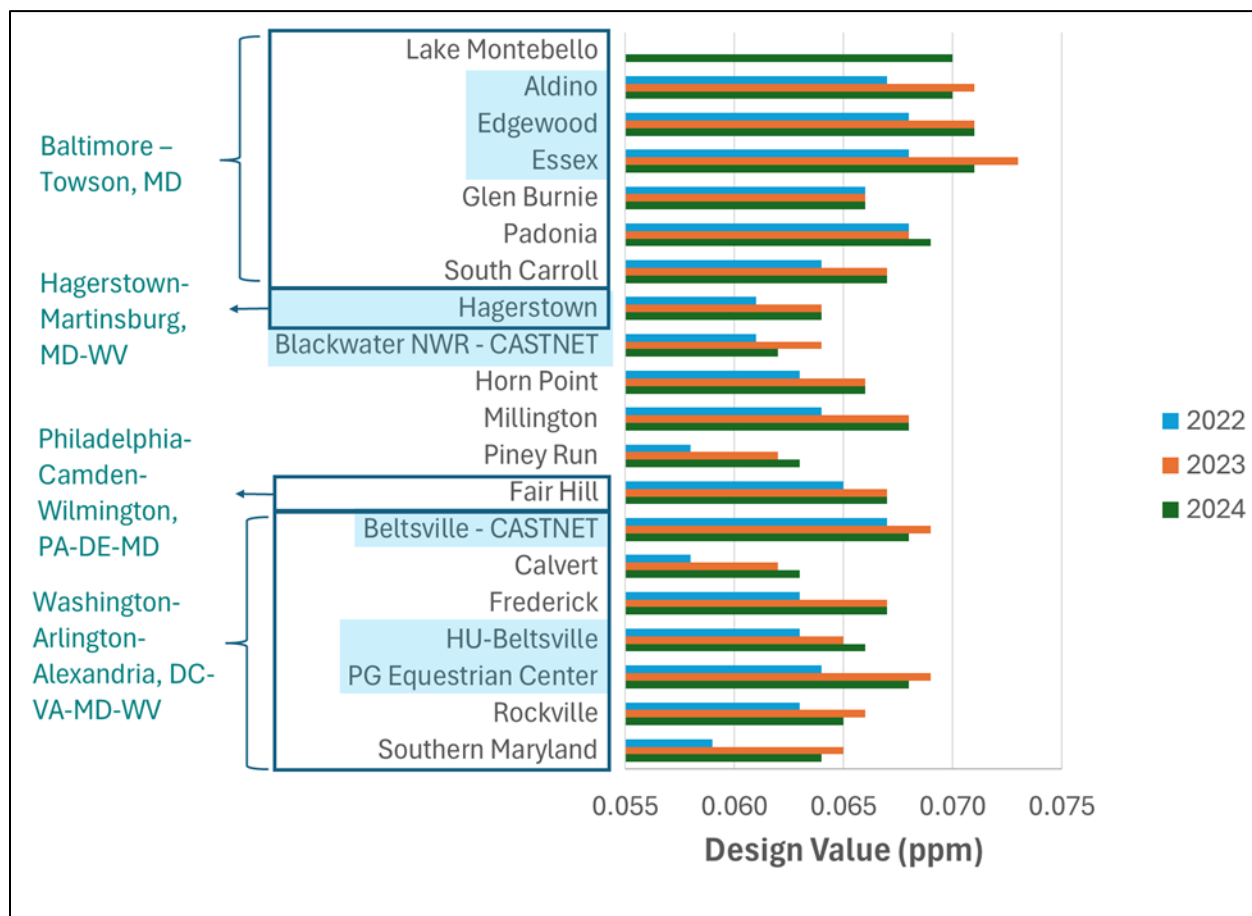


Figure 3-5 Ozone design values (DV) for Maryland ozone monitors for 2022 to 2024. MSAs are shown and all sites within that MSA are grouped together. Monitors with the highest concentration monitoring objective are highlighted in teal.

3.5.3 Identifying Redundant Sites

To examine possible redundant sites an analysis examining correlations and percent differences between site pairs was performed. For each site in Maryland, daily maximum 8-hour ozone was tallied and paired with ozone data from sites within 45 km of the Maryland site (all sites included in this analysis are shown in Figure 3-. Pearson correlation values (r-values) and average relative differences between site pairs (X and Y) were calculated with the following equation:

$$100 * \sum_{i=1}^n \frac{|X_i - Y_i|}{(X_i + Y_i)/2}$$



Figure 3-6 Ozone sites used in redundant sites assessment.

Sites that measure nearly the same concentrations of ozone are those that are both highly correlated (large r) and have the smallest inter-site average relative differences. Sites with the top 20 highest correlations (r-values) are presented in Table 3-11. All site pairs have correlations of at least 0.93 and their mean differences between 1.8-3.7ppb. High correlations of ozone are due to the regionality of the pollutant. While specific sites are impacted by localized emissions which may lead to exceedances, ozone episodes remain largely regional in nature due to transported background concentrations and fluctuations due to weather, resulting in high correlations.

The Fairhill and Aldino sites have the highest correlation, however their mean difference is near average compared to other Maryland sites. When considering possible removal, meteorology impacting the site must also be examined. Both locations are near the Chesapeake Bay and are influenced by Bay Breezes. However, certain wind speeds and wind directions can

dictate which site experiences high ozone versus the other. Additionally, the two sites are in separate NAA's with Aldino in the Baltimore-Columbia-Towson, MD MSA, and Fairhill in the Philadelphia-Camden-Wilmington, PA-NJ-DE-MD MSA. Given these reasons, the sites will not be considered for removal.

The Blackwater and Horn Point sites also were very highly correlated and had the smallest mean difference (1.8ppb), but Horn Point is outfitted to measure meteorological influences on pollution on the Eastern Shore and Blackwater is an EPA CASTNET site, so neither site will be considered for removal.

The Southern Maryland and Calvert site pair also show high correlation and small percent differences. However, both monitors have shown independent behavior on high ozone days. Typically, they do not observe significant ozone concentrations which may lead to similar readings on more background-type days and thus are highly correlated. This same argument can be used for the South Carroll and Frederick Airport pairing which received the third highest r-value (0.9685). Additionally, South Carroll and Frederick Airport are in separate NAA's. Therefore, removal of any site in either pairing will not be considered at this time.

Table 3-11 Top 20 correlated site pairs in the Maryland ozone network.

Site 1	Site 2	Distance (km)	n	r	Mean Diff (ppb)
Fair Hill	Aldino	33	700	0.9703	2.7
Horn Point	Blackwater NWR	16	1072	0.9687	1.8
South Carroll	Frederick Airport	29	700	0.9685	2
Essex	Lake Montebello	10	448	0.9649	2.2
HU-Beltsville	Beltsville	6	964	0.9636	2.6
Calvert	Southern Maryland	17	688	0.9621	2.3
Beltsville	Aurora Hills	28	1027	0.9611	3.5
Edgewood	Aldino	19	673	0.9536	3.7
Essex	Edgewood	19	649	0.9527	3.3
Frederick Airport	Hagerstown	33	684	0.9505	2.7
Padonia	Lake Montebello	14	463	0.9496	2.7
Padonia	South Carroll	35	710	0.949	2.5
Piney Run	Laurel Hill	37	1044	0.9464	2.7
Essex	Beltsville	43	985	0.9444	3.1
Hagerstown	Martinsburg	24	679	0.9434	3.3
Essex	Aldino	36	685	0.9428	2.8
Beltsville	Franconia	38	1018	0.9417	3.1
Calvert	Horn Point	42	686	0.9412	3.2
PG Equestrian Center	Franconia	31	700	0.9399	3
Beltsville	Lake Montebello	39	436	0.9372	3.1

To assist States and Tribal monitoring agencies in preparing for their 2025 5-year Network Assessments as described in 40 CFR §58.10(d), EPA made available a Network Assessment application (Ambient Air Monitoring Network Assessment Tools “NetAssess2025”). One of these tools is the removal bias tool which is used to examine redundancies within the network [LADCO, 2015]. The bias estimation finds the nearest neighbors to each selected site and then uses the data from the neighboring sites to estimate concentrations at the site. It then compares the estimates to the actual concentrations measured at the selected site to determine the Removal Bias. If the bias is small, that may indicate that the monitor is redundant and could be removed. The mean removal bias for Maryland sites ranged from -2.9 – 2.4 ppb (Table 3-12). As seen in Table 3-12, Blackwater NWR observed the least amount of bias (-0.1 ppb). As discussed in the previous section, Blackwater NWR is a CASTNET site and, as such, is not considered for removal. Of the other four sites from the top five in Table 3-12, all located in densely populated urban and suburban areas (Figure 3-3), Rockville, Lake Montebello, and Padonia have population exposure monitoring objectives, while Essex is assigned highest concentration; given these monitoring objectives, removal would be a severe detriment to Maryland’s ozone network. MDE is not currently considering the removal of any ozone monitoring sites.

Table 3-12 Mean removal bias for each site in Maryland’s ozone network.

Site	Mean Removal Bias (ppb)
Aldino	-2.9
Beltsville	-2.1
Piney Run	-1.9
Fair Hill	-1.8
PG Equestrian Center	-1.8
Frederick Airport	-1.3
Hagerstown	-1.1
South Carroll	-0.6
Southern Maryland	-0.5
Horn Point	-0.4
Millington	-0.4
Essex	-0.3
Padonia	-0.2
Blackwater NWR	-0.1
Lake Montebello	0.1
Rockville	0.2
HU-Beltsville	0.8
Calvert	1.2
Edgewood	2.4

3.5.4 Identifying New Sites Needed

The EPA provided a tool for the 2010 network assessment to determine if new sites were needed for the ozone monitoring network, however no such tool was provided for the 2025 assessment. In 2010, MDE also examined CMAQ modeled output of days exceeding the ozone standard to identify areas that are likely to exceed the ozone NAAQS and do not have nearby monitors. Figure 3-4 shows the number of exceedance days in 2016 using emissions and meteorology for 2016 as input to the CMAQ model. The modeling indicates that there are no gaps in the ozone monitoring network and that additional monitors would not capture any ozone hot spots. The Maryland ozone network is appropriately scattered across the state with more weighting along the urban corridor and around the Chesapeake Bay where ozone is of most concern. It is not recommended that any additional monitors be installed at this time.

3.5.5 Ozone NAAQS & Monitoring Rule

On October 1, 2015, EPA strengthened the National Ambient Air Quality Standards (NAAQS) for ground-level ozone to 70 parts per billion (ppb) from 75 ppb, retaining the 8-hour form of the standard. EPA updated both the primary ozone standard, to protect public health, and the secondary standard, to protect the public welfare to the 70 ppb level. Elements of the changed standard also included streamlining and modernizing the Photochemical Assessment Monitoring Stations (PAMS) network to use monitoring resources more efficiently, updating the Federal Reference Method for ozone, and lengthening the ozone season in certain areas (EPA, 2014). All required changes were implemented by MDE since that time, and are reflected in this assessment, as well as all preceding MDE Annual Network Plans.

3.5.6 Recommended Network Changes

Any changes to the ozone network, particularly site removals, must be considered in relation to the site's overall value to the ozone network. A decision matrix was used to determine the relative value of each site in the ozone network. The decision matrix ranks the sites according to a weighted score which is the sum of normalized, individual criterion scores multiplied by a subjectively determined weighting factor:

The score for each criterion was calculated with the following equation [Cavender, 2009]:

$$\text{Score} = 100 * \text{weight} * (V_i - V_{\min}) / (V_{\max} - V_{\min})$$

Here V_i , V_{\min} and V_{\max} represent the value of the given criteria and the minimum and maximum values of criteria for all sites.

The criteria chosen for this network were:

- 2024 population and population density within Voronoi polygons associated with each site– important relative to the population oriented monitoring requirement.
- The number of parameters measured at the site.
- The site-average correlation coefficient among site pairs within 50 km of the site of interest (from section 3.5.3) – needed to quantify uniqueness of the concentrations measured relative to other sites/monitors.
- The site-average relative concentration difference (from section 3.5.3) – needed to quantify uniqueness of the concentrations measured relative to other sites/monitors.
- The site-specific 2024 design value (DV_{2024}) represented as a percentage of NAAQS.

The score for the correlation with other sites was calculated as follows:

$$\text{Score} = 100 * \text{weight} * (V_{\text{max}} - V_i) / (V_{\text{max}} - V_{\text{min}})$$

The weight for the correlation was calculated differently than the rest because the less correlated a site is with its neighbors the more unique and valuable it is.

The ozone DV % NAAQS was calculated as follows:

$$\text{Ozone DV ratio to NAAQS} = DV_{2024} / 70 \text{ ppb}$$

The results of the scoring are shown in Table 3-12. Brooklyn Park and Piney Run had the lowest scores but since Piney Run is outfitted to measure meteorological influences and transportation from the Ohio River Valley, and Brooklyn Park is a new site, neither of these sites are candidates for removal.

Table 3-13 Decision matrix for the ozone network.

Site	2024 Design Values (ppm)	2023 Population		2023 Population Density		Total Monitors		Average Correlation with other Sites		Average Relative Concentration		Ozone DV ratio to NAAQS		Score
		Weight:	0.50	Weight:	0.50	Weight:	0.50	Weight:	1.00	Weight:	1.00	Weight:	1.00	
		raw	point	raw	points	raw	points	raw	points	raw	points	raw	points	
Aldino	0.070	135962	6	153	2	1	0	0.93	40	0.0032	39	1.00	92	179
Beltsville - CASTNET	0.068	279891	17	636	11	1	0	0.93	40	0.0032	45	0.97	67	180
Blackwater NWR - CASTNET	0.062	56310	0	21	0	1	0	0.93	40	0.0026	92	0.89	0	132
Brooklyn Park		707452	50	1019	18	3	8							77
Calvert	0.063	178869	9	123	2	1	0	0.93	40	0.003	58	0.90	8	118
Edgewood	0.071	158091	8	231	4	2	6	0.92	60	0.0037	0	1.01	100	178
Essex	0.071	296853	18	863	15	12	31	0.93	40	0.0031	47	1.01	100	252
Fair Hill	0.067	111461	4	166	3	2	6	0.94	20	0.003	56	0.96	58	147
Frederick Airport	0.067	252431	15	166	3	1	0	0.94	20	0.0027	81	0.96	58	177
Hagerstown	0.064	219907	13	106	2	2	6	0.95	0	0.0027	83	0.91	17	120
Horn Point	0.066	78969	2	63	1	3	19	0.95	0	0.0025	100	0.94	42	163
HU - Beltsville	0.066	375952	25	1044	19	13	50	0.91	80	0.0037	3	0.94	42	218
Lake Montebello	0.070	596624	41	2762	50	6	31	0.92	60	0.0033	38	1.00	92	312
Millington	0.068	103662	4	51	1	2	6	0.91	80	0.0035	19	0.97	67	176
Padonia	0.069	334014	21	294	5	3	13	0.92	60	0.0034	29	0.99	83	211
PG Equestrian Center	0.068	241558	14	276	5	1	0	0.90	100	0.0035	20	0.97	67	206
Piney Run	0.063	145110	7	25	0	8	31					0.90	8	46
Rockville	0.065	707321	50	852	15	2	6	0.90	100	0.0034	23	0.93	33	228
South Carroll	0.067	215609	12	141	2	1	0	0.92	60	0.0031	54	0.96	58	187
Southern Maryland	0.064	167921	9	106	2	1	0	0.94	20	0.0027	88	0.91	17	134

3.6 PAMS Network

3.6.1 Compliance with Network Design Criteria

The purpose of the PAMS program is to provide an air quality database that will assist in evaluating and modifying control strategies for attaining the ozone NAAQS. Under October 1, 2015 revisions to the PAMS monitoring rule, state and local monitoring agencies are required to collect and report PAMS measurements at each NCore site located in a CBSA with a population of 1,000,000 or more, beginning – after an extension - on June 1, 2021. Each PAMS is expected to measure:

- (1) Hourly averaged speciated volatile organic compounds (VOCs),
- (2) Three 8-hour averaged carbonyl samples per day on a 1 in 3-day schedule, or hourly averaged formaldehyde,
- (3) Hourly averaged O₃,
- (4) Hourly averaged nitrogen oxide (NO), true nitrogen dioxide (NO₂), and total reactive nitrogen (NO_y),
- (5) Hourly averaged ambient temperature,
- (6) Hourly vector-averaged wind direction,
- (7) Hourly vector-averaged wind speed,
- (8) Hourly averaged atmospheric pressure,
- (9) Hourly averaged relative humidity,
- (10) Hourly precipitation,
- (11) Hourly averaged mixing-height,
- (12) Hourly averaged solar radiation, and
- (13) Hourly averaged ultraviolet radiation.

These measurements must be collected, at a minimum, during the months of June, July and August.

The revised PAMS monitoring rule allows for the EPA Regional Administrator to grant a waiver for the collection of required PAMS measurements at an alternative location where the monitoring agency can demonstrate that the alternative location will provide representative data useful for regional or national scale modeling and the tracking of trends in ozone precursors (VOC's). MDE was granted a waiver to terminate the collection of PAMS data at HU-Beltsville in support of enhanced PAMS monitoring at Essex and maintain the 25-year historical record of ozone precursor trends there. This change, which included relocating the Total Reactive Nitrogen Species (NO_y) monitor from HU-Beltsville to Essex, was approved on May 31, 2017. An additional supporting rationale for this waiver request was that the HU-Beltsville NCore site is located in the Washington-Arlington-Alexandria, DC-VA-MD-WV MSA, and there is another NCore site located at McMillan Reservoir, approximately 17 miles south in Washington, D.C.,

where required PAMS measurements will continue to be made. The Essex site is in the Baltimore-Columbia-Towson, MD MSA, the only other CBSA in Maryland with a population greater than 1,000,000. The Baltimore-Columbia-Towson, MD MSA has a current ozone design value above the 2015 ozone NAAQS; therefore, the Essex site better meets the distribution of PAMS sites intended in the revised PAMS monitoring rule. The PAMS network for the Baltimore NAA is described in Table 3-14.

Table 3-14 Monitoring details for PAMS network.

Site Name	Parameters observed	Monitoring objective
Essex	O ₃	Highest concentration Population exposure
	VOCs	Maximum precursor Population exposure
	NO ₂	Population exposure
	CO	Highest concentration
	Air Toxics	Population exposure
	NO _y - NO	Maximum precursor
	SO ₂	Highest concentration

Table 3-15 Summary of required PAMS monitoring locations and frequencies.

Measurement	Where required	Sampling frequency (all daily except for upper air meteorology)	Status
Speciated VOC	Two sites per area	During the PAMS monitoring period: (1) Hourly auto GC, or (2) Eight 3-hour canisters, or (3) 1 morning and 1 afternoon canister with a 3hour or less averaging time plus Continuous Total Nonmethane Hydrocarbon measurement.	Met at Essex (auto GC)) and HU-Beltsville (canisters).

Carbonyl Sampling	In areas classified as serious or above for the 8-hour ozone standard	3-hour samples every day during the PAMS monitoring period.	Met at Essex.
No _x	All PAMS sites	Hourly during the ozone monitoring season.	Met at Essex and HU-Beltsville.
No _y	One site per area	Hourly during the ozone monitoring season.	Met at HU-Beltsville.
CO (ppb level)	One site per area	Hourly during the ozone monitoring season.	Met at Essex and HU-Beltsville.
Ozone	All sites	Hourly during the ozone monitoring season.	Met at Essex and HU-Beltsville.
Surface met	All sites	Hourly during the ozone monitoring season.	Met at Essex and HU-Beltsville.
Upper air meteorology	One representative location within PAMS area	Sampling frequency must be approved as part of the annual monitoring network plan required in 40 CFR 58.10.	Met at HU-Beltsville.

The October 15, 2015, revisions required states with Moderate and above 8-hour O₃ nonattainment areas and states in the Ozone Transport Region (OTR) to develop and implement an Enhanced Monitoring Plan (EMP) detailing enhanced O₃ and O₃ precursor monitoring activities to be performed. At a minimum, the EMP shall be reassessed and approved as part of the 5-year network assessments required under 40 CFR §58.10(d). The EMP will include monitoring activities deemed important to understanding the O₃ problems in the state.

EPA approved the following measurements, which Maryland had proposed in the CY 2019 Annual Network Plan, as basic elements of MDE's required EMP:

- Year-round ozone monitoring at Piney Run, Essex, HU-Beltsville, and Horn Point beginning in 2020.
- Additional VOC measurements at HU-Beltsville, beginning in June 2019, consisting of eight 3-hour canister samples collected every third day, June through August.
- Operation of radar wind profilers at Piney Run, HU-Beltsville, and Horn Point beginning in 2020.

Continued collection and reporting of these measurements will be contingent on receipt of sufficient additional EPA funding directed specifically towards these EMP activities.

3.6.2 Assessment of Objective Types Assigned to Monitors

The Essex PAMS monitoring site is, at times, downwind of Baltimore City and industrial areas with relatively high ozone precursor emissions. The site is situated in a parking lot near a roadway, and this may influence measured values of VOCs, NO_x, and CO, although fresh, well-mixed mobile emissions are prevalent throughout the area, especially during the morning rush hour. The objectives for the Essex site are maximum precursor, to measure emissions impact for all PAMS parameters, and highest concentration, both of which are correct designations.

3.6.3 Identifying Redundant Sites

With the consolidation to a single PAMS site, redundancy is no longer a concern, as only one monitoring location remains operational.

3.6.4 Identifying New Sites Needed

The monitoring requirements for the minimum number of PAMS sites per area are currently being met. No additional sites are under consideration at this time.

3.6.5 Effect of New or Proposed Network Design Regulations

No impact expected.

3.6.6 Recommended Network Changes

No changes to the PAMS network are recommended at this time.

3.7 PM_{2.5} Network

3.7.1 Compliance with Network Design Criteria

The number of required PM_{2.5} monitors in each MSA is determined by the MSA population and design value, as specified in Table D-5 of Appendix D to 40 CFR Part 58. Table 3-16 shows that the MDE monitoring network meets or exceeds the minimum requirements.

Table 3-16 Number of PM_{2.5} SLAMS Sites (based on Table D-5 of Appendix D TO Part 58).

MSA Name	Population	2024 Annual Design Value (µg/m ³)	2024 Daily Design Value (µg/m ³)	Required SLAMS Monitors	Monitors Active in MD/Total ^{A,B}	Required ≥ 85% NAAQS
Baltimore-Columbia-Towson, MD	2,859,024	8.2	21	3	5/5	3
Hagerstown-Martinsburg, MD-WV	311,295	8.7*	24*	1	1/2	1
Washington-Arlington-Alexandria, DC-VA-MD-WV	6,436,489	8.1*	21*	2	2/11	3
Philadelphia-Camden-Wilmington-Newark, PA-NJ-DE-MD	6,330,422	10.3*	27*	3	1/21	3

A - Based on tables available at <http://www.epa.gov/airtrends/values.html> 0/1.

B- Total number of monitors includes those located in other States.

* Highest values not observed in Maryland.

Minimum Requirements for Collocated PM_{2.5}

Collocation requirements for PM_{2.5} are based on the number of PM_{2.5} monitors within a Primary Quality Assurance Organization (PQAO) and by measurement method (FRM or FEM) as specified in 40 CFR Part 58 Appendix A 3.2.5 and Appendix D 4.7.2. MDE is its own PQAO so all monitors in Maryland are counted in the collocation requirements. A minimum of 15% (round up) of the monitors must be collocated. MDE has twelve PM_{2.5} monitoring stations, therefore at least two must be collocated. MDE currently operates three stations with collocated PM_{2.5} monitors; one FRM-FRM-FEM (Howard University) where the FRM is primary, one FRM-FEM where the FRM is primary (Lake Montebello), and one is FRM-FEM where the FEM is primary (Padonia). A new T640x monitor will be collocated with the primary FEM monitor at Essex.

Requirements for Continuous PM_{2.5} Monitoring

At least one-half (round up) of the minimum number of sites per MSA must operate continuous PM_{2.5} monitors. MDE operates eleven continuous PM_{2.5} monitors; four in the

Baltimore-Columbia-Towson, MD MSA, two in the Washington-Arlington-Alexandria, DC-VA-MD-WV MSA, one in the Philadelphia-Camden-Wilmington, PA-NJ-DE-MD MSA, one in the Hagerstown-Martinsburg, MD-WV MSA, one in the Cambridge, MD MSA, and one in the Cumberland, MD-WV MSA. The other site (Millington) is in an area not designated as an MSA.

Requirements for Near Road PM_{2.5} Monitoring

For MSA’s with a population of one million or greater, at least one PM_{2.5} monitor is to be located at a near road NO₂ station. The Howard County Near Road site fulfills this requirement for the Baltimore-Columbia-Towson, MD MSA. Also, within the Baltimore-Columbia-Towson, MD MSA, MDE operates an additional near road NO₂ station at the Baltimore County Near Road site, though there is not any PM_{2.5} monitoring at this site. MDE does not operate near road NO₂ stations in any other MSA; requirements for near road monitoring in the Washington-Arlington-Alexandria, DC-VA-MD-WV MSA, and Philadelphia-Camden-Wilmington PA-NJ-DE-MD MSA are met by monitoring sites in Washington, DC and Pennsylvania.

Requirements for PM_{2.5} Chemical Speciation

Each state shall continue to conduct chemical speciation monitoring and analyses at sites designated to be part of the PM_{2.5} Chemical Speciation Network (CSN), consisting of PM_{2.5} and supplemental sites. MDE conducts chemical speciation monitoring at Essex and HU-Beltsville, but only HU-Beltsville is officially designated as part of the CSN.

Other Requirements for PM_{2.5} Monitoring

The required monitoring sites must be located to represent area-wide air quality. These will typically be either neighborhood or urban scale, although micro or middle scale may be appropriate in some urban areas. At least one monitoring site must be neighborhood scale or greater in an area of expected maximum concentration and one site must be sited in an area of poor air quality. Each State shall have at least one PM_{2.5} site to monitor the regional background and at least one PM_{2.5} site to monitor regional transport. Each NCore station must operate a PM_{2.5} monitor. Table 3-17 shows that MDE meets all these additional requirements.

Table 3-17 Monitor Objective Types and Scales Assigned to PM_{2.5} Monitors in Maryland

Site Name	Measurement Scale	Monitor Objective	MSA
Edgewood	Neighborhood	Population Exposure	Baltimore-Columbia-Towson, MD
Essex (FRM)	Neighborhood	Population Exposure	Baltimore-Columbia-Towson, MD
Essex (FEM)	Neighborhood	Population Exposure	Baltimore-Columbia-Towson, MD
Fair Hill	Neighborhood	Population Exposure	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD
Hagerstown	Urban	Highest Concentration	Hagerstown-Martinsburg, MD-WV

Horn Point	Regional	General/Background	Cambridge, MD
Howard Co. Near Rd	Microscale	Highest Concentration/ Source Oriented	Baltimore-Columbia-Towson, MD
HU-Beltsville (FRM)	Urban	Population Exposure	Washington-Arlington-Alexandria, DC- VA-MD-WV
HU-Beltsville (FRM)	Urban	Population Exposure	Washington-Arlington-Alexandria, DC- VA-MD-WV
HU-Beltsville (FEM)	Urban	Population Exposure	Washington-Arlington-Alexandria, DC- VA-MD-WV
Lake Montebello (FRM)	Middle	Highest Concentration	Baltimore-Columbia-Towson, MD
Lake Montebello (FEM)	Middle	Highest Concentration	Baltimore-Columbia-Towson, MD
Millington	Neighborhood	Population Exposure	NA
Padonia (FRM)	Neighborhood	Population Exposure	Baltimore-Columbia-Towson, MD
Padonia (FEM)	Neighborhood	Population Exposure	Baltimore-Columbia-Towson, MD
Piney Run	Regional	Regional Transport	Cumberland, MD
Rockville	Neighborhood	Population Exposure	Washington-Arlington-Alexandria, DC- VA-MD-WV

3.7.2 Assessment of Objective Types Assigned to Monitors

The site objective types required for PM_{2.5} monitoring include highest concentration, population exposure, general/background, source oriented, and regional transport. There are twelve PM_{2.5} monitoring locations in Maryland and their objectives and measurement scale are summarized in Table 3-17. Highest concentration sites are located to determine the maximum concentrations. Population exposure-oriented sites have neighborhood or urban scales of representation, should not be influenced by single sources, and are located where large numbers of people live, work, or play [Watson,1997]. Background sites have urban or regional scales of representation, should measure the lower concentrations in the state/region, should not be along transport paths, and should be located away from major sources [Watson, 1997]. Source oriented sites are located to assess the impact of a particular source on ambient air quality. Regional transport sites are located on the paths of pollutants that are regional in nature, to assess the impact on local concentrations.

All population exposure sites are assigned to the proper spatial scales, either urban or neighborhood. Each state is required to install and operate at least one PM_{2.5} site to monitor regional background and at least one PM_{2.5} site to monitor regional transport. The background site for the network is Horn Point on the Eastern Shore of Maryland, though it did not measure the lowest design values (Figure 3-7), which were measured Piney Run for 2023 and 2024. Piney Run is designated the regional transport site for PM_{2.5} and because of the mountaintop location in western Maryland (typically upwind of Maryland), this is an appropriate designation. The Frederick Airport station would be a good location to install a PM_{2.5} monitor in the future, should one become available, as the western-central part of Maryland has fewer PM_{2.5} monitors and a

growing population (Figure 3-8). This location would provide for better near real-time mapping of PM_{2.5} concentrations in Maryland.

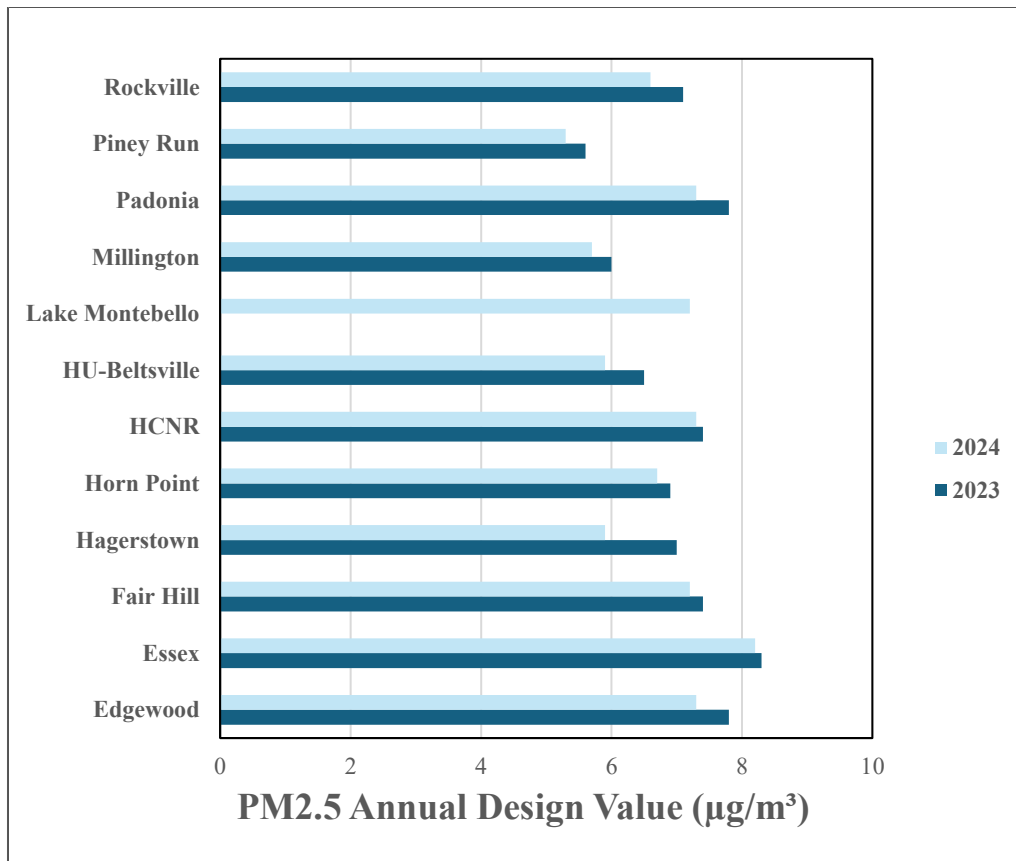


Figure 3-7 PM_{2.5} Annual Design values for Maryland monitors for 2023 and 2024. Lake Montebello was not operational long enough to have a valid design value for 2023.

The population change in Maryland counties from 2020-2024 (Figure 3-8) was also examined using data from the US Census. County population changes range from -3 to 10% and most counties in Maryland have positive population growth. The largest growth occurred in Frederick and Queen Anne’s counties; both areas have PM_{2.5} monitors in proximity, though may benefit from having one within the county boundaries given the population growth, particularly in Frederick County. Changes in population do not necessitate any changes to population-oriented sites at this time.

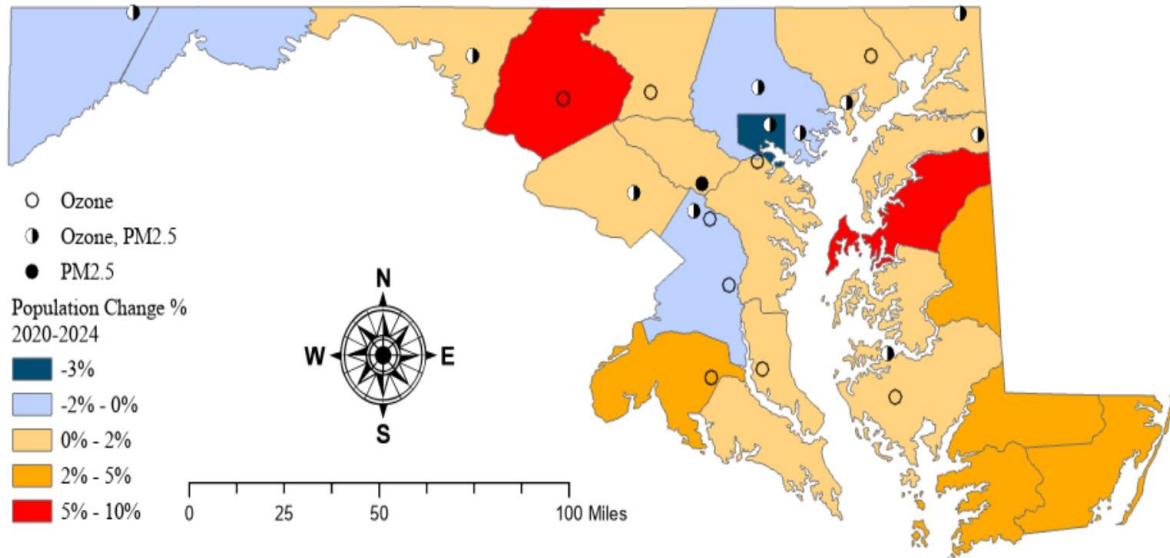


Figure 3-8 Percent change in Maryland population from 2020 - 2024, along with locations of monitoring sites. Please note that the percentage change = $(\text{Pop2024} - \text{Pop2020})/\text{Pop2020}$

3.7.3 Identifying Redundant Sites

The methodology used to determine which existing PM_{2.5} sites are candidates for relocation or removal is described in this section. Correlations and mean concentration differences among site pairs were used to determine if sites were measuring similar concentrations and thus considered redundant. EPA's NetAssess2025 v1.1, Ambient Air Monitoring Network Assessment Tools were used in this analysis. PM_{2.5} parameter code 88502 (Acceptable PM_{2.5} AQI & Speciation Mass) was not included in the analysis. Data collected in Maryland, Pennsylvania, Virginia, West Virginia, Delaware, and the District of Columbia from 2011-2013 were used in the assessment (see Figure 3-9). For each PM_{2.5} site in Maryland, site pairs within 50 km of that site were included in the analysis. Because there were no sites within 50 km of Piney Run, it was not included in this analysis

Data capture was satisfactory for most sites with over 90% of the site comparisons including at least 274 days (25%) of data in the 2022-2024 period. There were five site pairs with fewer than 200 days of data, all involving Essex, due to changes in the monitoring equipment at that location. These deficiencies were judged as not large enough to prevent their use in this part of the assessment.



Figure 3-9 PM_{2.5} sites used in the redundant sites assessment.

To examine possible redundant sites, an analysis examining correlations and mean differences between site pairs was performed. For each site in Maryland, daily average PM_{2.5} was tallied and paired with PM_{2.5} data from sites within 50 kilometers of the Maryland site. Pearson correlation values (r-values) and mean differences between site pairs (X and Y) were calculated with the following equation:

$$100 * \sum_{i=1}^n \frac{|X_i - Y_i|}{(X_i + Y_i)/2}$$

Sites that measure nearly the same concentrations of PM_{2.5} are those that are both highly correlated (large r) and have the smallest inter-site average relative percent concentration differences. The site-pairs having the 20 highest correlations are listed in Table 3-18, together with their distances and percentage concentration differences. All site pairs have correlations of at least 0.81, 0.69 considering all site pairs, and the percent differences range from 0-27%. High correlations were due to the regional nature of PM_{2.5} pollution and the broad impacts of weather and seasonality have on all sites simultaneously.

Table 3-18 Twenty most correlated site pairs in the Maryland PM_{2.5} Network.

Site 1	Site 2	Distance (km)	r	n	Percent Difference
HU - Beltsville	Aurora Hills	27	0.9751	333	18%
HCNR	Aurora Hills	36	0.969	337	6%
Essex	Edgewood	19	0.9673	171	13%
Fair Hill	New Garden	17	0.9627	1007	3%
McMillan Reservoir	HU - Beltsville	19	0.9589	811	18%
Padonia	Essex	21	0.9574	175	5%
Newark	Fair Hill	9	0.955	490	11%
HU - Beltsville	Lee District Park	37	0.9543	798	14%
HCNR	HU - Beltsville	10	0.9537	795	11%
HCNR	Lee District Park	47	0.9498	1041	3%
Essex	HCNR	37	0.9487	171	11%
Essex	HU - Beltsville	45	0.9475	165	22%
Lums Pond	Millington	28	0.9462	1000	20%
HU - Beltsville	Springfield NR	41	0.9448	793	26%
King Greenleaf	HU - Beltsville	23	0.9417	800	27%
McMillan Reservoir	HCNR	28	0.9416	1052	6%
MLK	Fair Hill	27	0.9415	1047	7%
Padonia	Edgewood	29	0.9414	1017	8%
Fair Hill	Marcus Hook	40	0.9392	936	8%
Lums Pond	Fair Hill	20	0.9382	995	0%

The removal bias tool (developed by EPA and LADCO) can be used to examine redundancies within the network [LADCO, 2015]. The bias estimation uses the nearest neighbors to each site to estimate the concentration at the location of the site, as if the site had never existed. This is done using the Voronoi Neighborhood Averaging algorithm with inverse distance squared weighting. The squared distance allows for higher weighting on concentrations at sites located closer to the site being examined. The bias was calculated for each day at each site by taking the difference between the predicted value from the interpolation and the measured concentration. A

negative average bias suggests that the estimated concentration of the site is smaller than the actual measured concentration and high concentrations may not be appropriately captured [LADCO, 2015]. The mean removal bias ranged from -0.32 – 3.46 $\mu\text{g}/\text{m}^3$ (Table 3-19). Padonia has the smallest positive mean removal bias (0.13 $\mu\text{g}/\text{m}^3$), suggesting that removal of the PM_{2.5} monitor would not impact Maryland’s ability to measure maximum concentrations in that area. Since other measurements are collected at this site, and it’s located in a population center, it is not under consideration for removal.

Table 3-19 Mean removal bias for each site in Maryland’s PM_{2.5} network.

Name	Mean Removal Bias ($\mu\text{g}/\text{m}^3$)
Lake Montebello	-0.32
Essex	-0.28
HCNR	-0.26
Padonia	0.13
Rockville	0.56
Edgewood	0.76
HU - Beltsville	0.94
Horn Point	0.99
Hagerstown	1.74
Fair Hill	1.85
Millington	1.89
Piney Run	3.46

3.7.4 Identifying New Sites Needed

EPA provided a tool for the 2025 network assessment to determine if new sites were needed for the PM_{2.5} monitoring network, which was used in this assessment. Because there is good correlation among most sites, small average percent differences among sites, and all sites measure below the NAAQS, MDE does not recommend adding any new monitors to the network at this time.

3.7.5 Effect of New or Proposed Network Design Regulations

None have been proposed for PM_{2.5} as of this writing.

3.7.6 Recommended Network Changes

Modifications to the PM_{2.5} network suggested up to this point in the network assessment need to be considered in relation to the candidate site's overall value to the PM_{2.5} network, as well as, EPA regulations governing network design and System Modification, 40 CFR Part 58.14. A decision matrix was developed to determine the relative value of each site in the PM_{2.5} network (Table 3-20). The decision matrix ranks the sites according to a weighted score which is the sum of normalized, individual criterion scores multiplied by a subjectively determined weighting factor.

The score for each criterion was calculated with the following equation [Cavender, 2009]:
Score = 100 * weight * (Vi - Vmin) / (Vmax - Vmin) where Vi, Vmin, and Vmax represent the value of the given criteria and the minimum and maximum values of criteria for all sites. The score for the correlation with other sites was calculated as follows: Score = 100 * weight * (Vmax - Vi) / (Vmax - Vmin) The weight for the correlation was calculated different than the rest because the less correlated a site is with its neighbors the more unique and valuable it is. The PM_{2.5} DV % NAAQS was calculated as follows: PM_{2.5} DV ratio to NAAQS = DV2023 / 9 µg/m³.

The criteria chosen for the network were:

- 2023 population and population density within Voronoi polygons associated with each site – important relative to the population oriented monitoring requirements.
- Percent of annual NAAQS – monitors that measure over or near the NAAQS are more important.
- Number of parameters measured at the site – relevant to decisions about site closure but not highly weighted, because the PM_{2.5} monitor could be removed without closing the site.
- Site-average correlation coefficient and site-average relative percent concentration difference – needed to quantify uniqueness of the concentrations measured relative to other sites/monitors.

Table 3-20 Decision Matrix for the PM_{2.5} Network.

Site	2023 Design Values (µg/m³)		Total Population 2023		Population density 2023		Number of Parameters		Average Correlation with other sites		Average Relative Concentration Difference		PM _{2.5} annual DV %NAAQS		Score
			weight:	0.5	weight:	0.5	weight:	0.5	weight:	1	weight	1	weight:	1	
	24-hr	Annual	raw	points	raw	points	raw	points	raw	points	raw	points	raw	points	
Piney Run	5.6	16	183,021	7	24	0	8	27					5.6	0	34
Hagerstown	7.0	20	401,860	20	133	2	2	0	0.90	64	0.32	71	7.0	52	209
Rockville	7.1	19	884,661	48	548	12	2	0	0.87	100	0.36	44	7.1	56	260
HU - Beltsville	6.5	17	469,629	24	630	14	13	50	0.94	23	0.25	21	6.5	33	164
HCNR	7.4	20	566,909	29	573	12	4	9	0.93	36	0.21	11	7.4	67	164
Padonia	7.8	21	412,594	20	254	5	3	5	0.94	28	0.21	11	7.8	81	151
Lake Montebello	7.5	23	915,976	50	2,251	50	6	18	0.96	0	0.19	7	7.5	70	196
Essex	8.3	20	486,780	25	879	19	12	45	0.96	3	0.16	0	8.3	100	192
Edgewood	7.3	20	253,520	11	219	4	2	0	0.94	19	0.23	16	7.3	63	113
Horn Point	6.9	17	248,091	10	64	1	4	9	0.92	44	0.32	35	6.9	48	148
Fair Hill	7.4	21	117,965	3	130	2	2	0	0.94	25	0.32	36	7.4	67	133
Millington	6.0	16	72,207	0	39	0	2	0	0.94	28	0.38	50	6.0	15	93

Scores derived from the decision matrix, Table 3-20, range from a high of 260 at Rockville to a low of 34 at Piney Run. The low score at Piney Run was influenced by the lack of nearby sites to compare with it for the correlation and average percent difference. Millington and Edgewood had the second and third lowest scores. Given that the location of the Millington site would serve the growing population of Queen Anne’s County, were the scale to be changed to regional, and Edgewood’s location near a potential source of PM_{2.5} from activity at the Aberdeen Proving Ground, it’s not recommended to close either site at this time.

3.8 PM₁₀ Network

3.8.1 Compliance with Network Design Criteria

The number of required PM₁₀ monitors in each CBSA is determined by the CBSA population and design value, as specified in Table D-5 of Appendix D to 40 CFR Part 58. Table 3-21 shows that the MDE monitoring network meets or exceeds the minimum requirements. A minimum of 15% (round up), or at least one of the PM₁₀ monitors must be collocated as specified in 40 CFR Part 58 Appendix A 3.3.1. MDE has four PM₁₀ monitors and two are collocated, thereby meeting this requirement.

Table 3-21 Number of PM₁₀ SLAMS Sites Required (based on Table D-4, Appendix D to 40 CFR Part 58, PM₁₀ Minimum Monitoring Requirements).

MSA Name	Population	Monitors Required ^A	Active Monitors in MD/Total ^B
Washington-Arlington-Alexandria, DC-VA-MD-WV	6,436,489	2-4	1/7
Baltimore-Columbia-Towson, MD	2,859,024	2-4	3/3
Hagerstown-Martinsburg, MD-WV	311,295	0-1	0/0
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	6,330,422	2-4	0/4

A – All of the listed MSA’s have PM₁₀ ambient concentrations well below 80% of the PM₁₀ NAAQS.

B –Based on data and tables available at <http://www.epa.gov/air-trends>

3.8.2 Assessment of Objective Types Assigned to Monitors

In contrast with design requirements for other pollutant networks, there are no required objectives or objective types for PM₁₀ monitoring. Monitoring details for the PM₁₀ network are provided in Table 3-22. Monitoring scales appropriate for PM₁₀ include micro, middle, neighborhood, or urban.

Table 3-22 Monitoring details for the PM₁₀ network.

AQS Code	Site Name	Measurement Scale	Monitor Objective	MSA
240031004	Brooklyn Park	Neighborhood	Population Exposure	Baltimore-Columbia-Towson, MD
240330030	HU-Beltsville	Neighborhood	Population Exposure	Washington-Arlington-Alexandria, DC-VA-MD-WV

245105253	Lake Montebello	Middle	Population Exposure	Baltimore-Columbia-Towson, MD
240053001	Essex	Neighborhood	Population Exposure	Baltimore-Columbia-Towson, MD

All PM₁₀ monitoring sites, Brooklyn Park, HU – Beltsville, and Lake Montebello have population exposure as the monitoring objective, though each have a unique measurement scale - neighborhood, urban, and middle, respectively. All are appropriate for population exposure. The monitors located at Brooklyn Park and Lake Montebello operate on a one-in-six-day schedule, and HU – Beltsville operates on a one-in-three-day schedule. Brooklyn Park has a co-located PM₁₀ monitor, also operated on a one-in-six-day schedule. MDE’s PM₁₀ monitors are manual Federal Reference Monitors.

3.8.3 Identifying Redundant Sites

Because the minimum number of PM₁₀ sites is operating in the Baltimore MSA, no sites can be removed.

3.8.4 Identifying New Sites Needed

Given that PM₁₀ concentrations at all sites are well below the NAAQS and the network requirements are being met, there is no need to identify potential new sites at this time.

3.8.5 Proposed Changes to the PM₁₀ NAAQS and Monitoring Rule

No changes to either the NAAQS or the monitoring rule have been proposed at this time.

3.8.6 Recommended Network Changes

MDE does not recommend any changes to the network at this time.

3.9 SO₂ Network

3.9.1 Compliance with Network Design Criteria

The minimum number of required SO₂ monitors in each MSA is proportional to the product of the total amount of SO₂ emissions in the MSA and its population, as specified in 40 CFR Part 58, Appendix D, Section 4.4. The resulting value is defined as the Population Weighted Emissions Index (PWEI). SO₂ emissions shown in Table 3-23 are from the 2020 National Emissions Inventory (NEI).

Table 3-23 SO₂ population weighted emissions index.

CBSA Name	Population	2020 NEI SO₂ (tons/year)	PWEI (millions of people tons per year)	Monitors Required	Monitors Active in MD/Total
Baltimore-Columbia-Towson, MD	2,859,024	5,594	15,993	0	1/1
Hagerstown-Martinsburg, MD-WV	311,295	674	210	0	0/0
Lexington Park, MD	211,382	185	39	0	0/0
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	6,330,422	1,575	9,970	1	0/8
Salisbury, MD	131,570	159	21	0	0/0
Washington-Arlington-Alexandria, DC-VA-MD-WV	6,436,489	5,049	32,498	1	1/2

There are four SO₂ monitoring sites located in Maryland and their types, objectives, scales of representativeness, and design values are presented in Table 3-24. All sites are well below the NAAQS 1-hour standard (75 ppb).

Table 3-24 Monitoring details for SO₂ network.

Site Name	AQS ID	Representative Scale	Monitor Objective	CBSA	Type	2022-2024 1-hr Design Value (ppb)
Essex	240053001	Neighborhood	Highest Concentration	Baltimore-Columbia-Towson, MD	SLAMS	4
Horn Point	240190004	Regional	General/Background	Cambridge, MD	SLAMS	1
HU-Beltsville	240330030	Urban	General/Background	Washington-Arlington-Alexandria, DC-VA-MD-WV	SLAMS/NCore	2
Piney Run	240230002	Regional	Population Exposure	NA	SLAMS/NCore	3

3.9.2 Assessment of Objective Types Assigned to Monitors

The appropriate scales for SO₂ SLAMS monitoring are the micro, middle, neighborhood, and urban scales. Essex was assigned the neighborhood scale because of its proximity to large SO₂ sources. The monitoring objective for Essex is highest concentration. Given the proximity of Essex to SO₂ sources and relatively high design value compared to other monitoring sites, the highest concentration objective is appropriate.

The HU-Beltsville site is an NCore site and its representative scale is urban. HU-Beltsville is in a suburban area that is not close to large SO₂ sources, and this justifies the urban representative scale as well as the general background monitoring objective. Piney Run is an elevated NCore site located in Western Maryland in the path of SO₂ emissions which can be transported from neighboring states; its representative scale is regional. Piney Run is located in a

rural area at high elevation (781 m above sea level) not close to large SO₂ sources which justifies the regional representative scale and the regional transport monitoring objective. Horn Point is assigned a regional scale and population exposure monitoring objective. The regional scale is appropriate because this site is located in a rural area.

3.9.3 Identifying Redundant Sites

Statistical relationships between site pairs were examined to determine redundant sites. Daily maximum SO₂ data from each site was examined for 2022-2024. Pearson’s correlation coefficients and average absolute differences among site pairs are provided in Table 3-25. Average absolute differences between site pairs (X and Y) were calculated with the following equation:

$$100 * \sum_{i=1}^n \frac{|X_i - Y_i|}{(X_i + Y_i)/2}$$

Low correlations between sites illustrate the source sensitivity of SO₂ emissions and lack of redundant sites.

Table 3-25 Statistical relationships between SO₂ site pairs.

X	Y	Distance (km)	r	n	Mean Absolute Difference
Essex	Horn Point	85	0.18	1050	0.54
Essex	Piney Run	221	0.33	981	0.52
Essex	HU-Beltsville	45	0.2	1041	0.68
Horn Point	Piney Run	276	0.24	987	0.38
Horn Point	HU-Beltsville	82	0.2	1043	0.37
Piney Run	HU-Beltsville	196	0.35	975	0.48

3.9.4 Identifying New Sites Needed

MDE does not plan on installing any new SO₂ monitoring sites at this time.

3.9.5 Recommended Network Changes

MDE does not recommend any changes to the network at this time.

4. SENSITIVE POPULATIONS

The Clean Air Act of 1990 set limits to protect public health, including the health of sensitive populations such as asthmatics, children and the elderly. The Air Quality Criteria Document for Ozone and related photochemical oxidants [U.S. EPA, 2006] states that the elderly population (>65 years of age) appears to be at increased risk of ozone-related mortality and hospitalizations, and children (<18 years of age) experience other potentially adverse respiratory health outcomes with increased ozone exposure. The Integrated Science Assessment for Particulate Matter [U.S. EPA, 2019] concluded that “Many populations (e.g., healthy, diseased, etc.) and lifestages (e.g., children, older adults, etc.) have been shown to be at risk of a health effect in response to short- or long-term PM exposure, particularly PM_{2.5}. However, of the populations and lifestages examined, current scientific evidence indicates that only some populations may be at disproportionately increased risk of a PM_{2.5}-related health effect, including nonwhite populations, children, people with specific genetic variants in genes in the glutathione transferase pathway, people who are overweight or obese, people with pre-existing cardiovascular and respiratory diseases, people of low socioeconomic status (SES), and people who smoke or were former smokers.”

The U.S. census provides population counts in specific age groupings, and these were used to examine populations of children and senior citizens. The children and senior citizen populations are defined as the population with ages less than 18 and greater than 65, respectively. The populations composed of children and the elderly are presented Figure 4-1 [U.S. Census Bureau 2025]. The county populations are color-coded by percentiles and counties with the lowest sensitive population counts are shown with lighter colors, while counties with the highest sensitive population counts are shown with darker colors. PM_{2.5} and ozone monitors are also highlighted on the map. The largest sensitive populations in the state reside in Montgomery, Prince George’s, and Baltimore counties, and there are PM_{2.5} and ozone monitors in each of these counties.

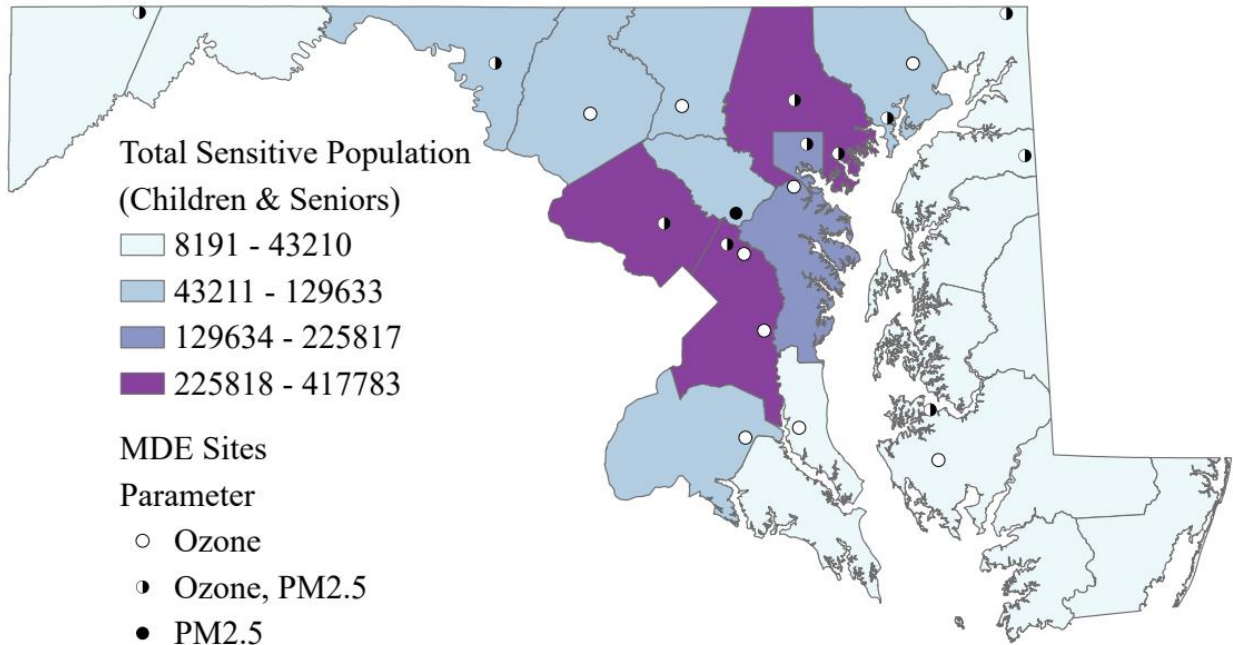


Figure 4-1 Maryland county level sensitive populations (children and seniors from the 2020 census). MDE ozone and PM_{2.5} monitor locations are also shown.

The Maryland Department of Health maintains an environmental health public tracking website (<https://maps.health.maryland.gov/ephtportal>). This site provides data on asthma Emergency Department visits by county, and the age-adjusted rates of hospital ED visits per 10,000 people are shown in Figure 4-2 [MDH, 2025]. The highest rates of ED visits for asthma per 10,000 people in the state occur in Baltimore City and Dorchester County, both of which contain PM_{2.5} and ozone monitoring sites.

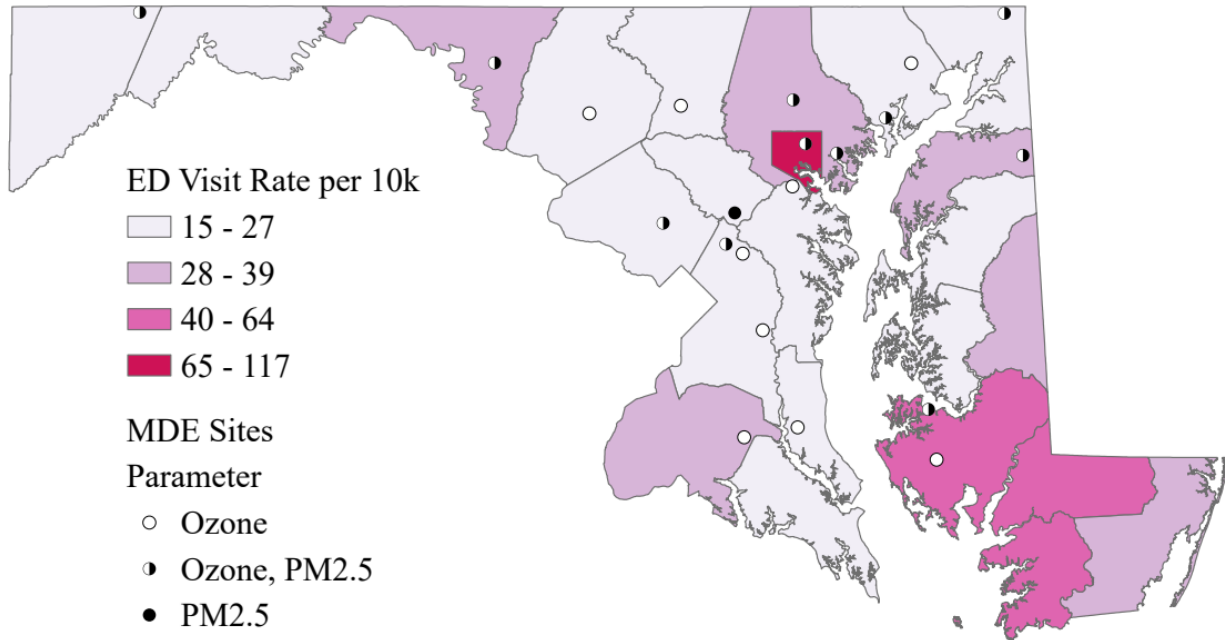


Figure 4-2 Maryland county, age-adjusted ED visits for asthma, per 10,000 population (2020). Ozone and PM_{2.5} monitor locations are also shown.

To determine how well the PM_{2.5} and ozone monitoring networks provide coverage to areas where sensitive populations are most prevalent, the scales of the networks are overlaid on the county level asthma hospital discharges in Figure 4-3 and Figure 4-4. The spatial coverage of many of these monitors overlap counties with asthma hospital ED visit rates of 28 – 39 per 10,000 population and higher (largely between the 50th and 75th percentiles of asthma hospital ED visits in the state). There is more spatial overlap of the monitoring scales in the ozone network than in the PM_{2.5} network. When examining how well the network serves sensitive populations, the spatial variability of the pollutants must be considered. PM_{2.5} concentrations are more homogeneous throughout the state than ozone concentrations and PM_{2.5} design values are below the NAAQS. Appendix D to Part 58 of the CFR states that “most PM_{2.5} monitoring in urban areas should be representative of the neighborhood scale.”; it also states that “location[s] carefully chosen to provide neighborhood scale data would represent the immediate neighborhood as well as neighborhoods of the same type in other parts of the city.” [EPA, 2025] The grouping of the three PM_{2.5} sites in the immediate Baltimore area, Lake Montebello, Padonia, and Essex, taken together are representative of PM_{2.5} in urban and suburban communities across greater Baltimore. This indicates that the network provides adequate coverage for sensitive populations throughout the state.

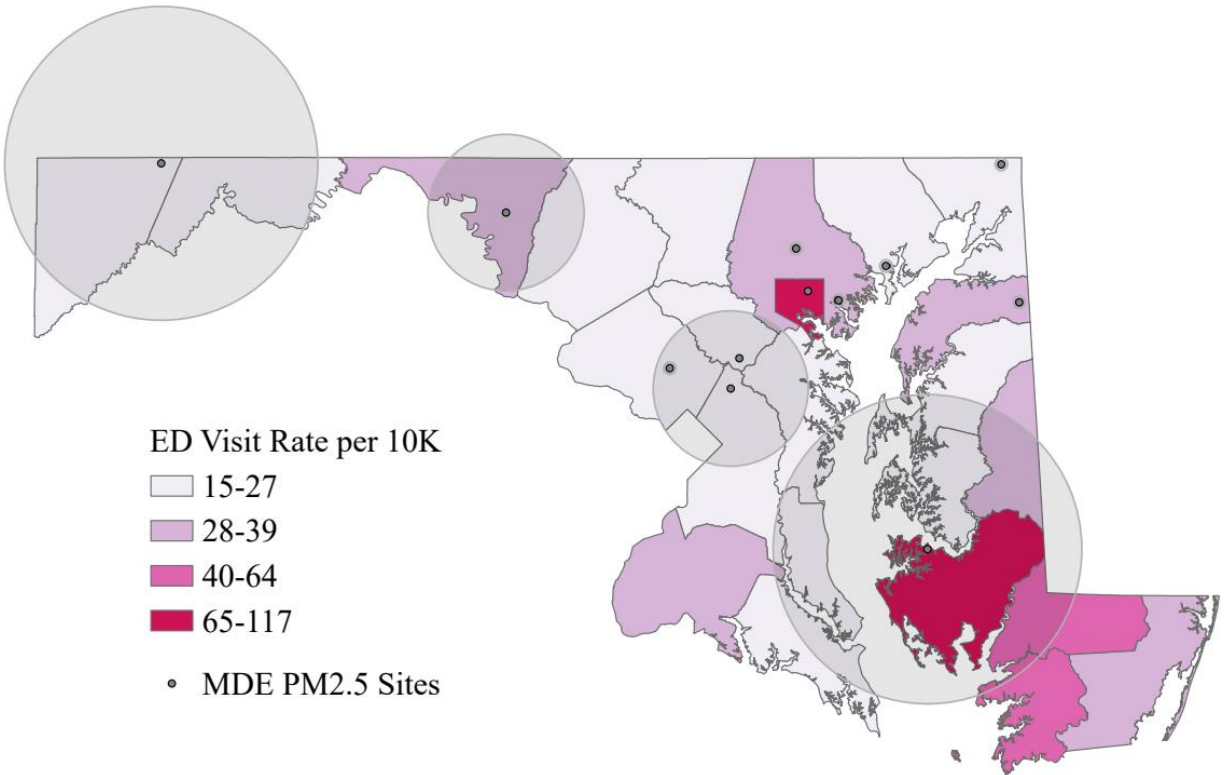


Figure 4-3 Maryland county level, age-adjusted rate of emergency department visits for asthma, with PM_{2.5} monitors, and spatial scales associated with those monitors. Only urban and regional scales are shown; the micro, middle, and neighborhood scales are too small for the map. The three PM_{2.5} monitors in the Baltimore area, Lake Montebello, Padonia, and Essex, represent neighborhoods of the same type throughout the greater Baltimore area.

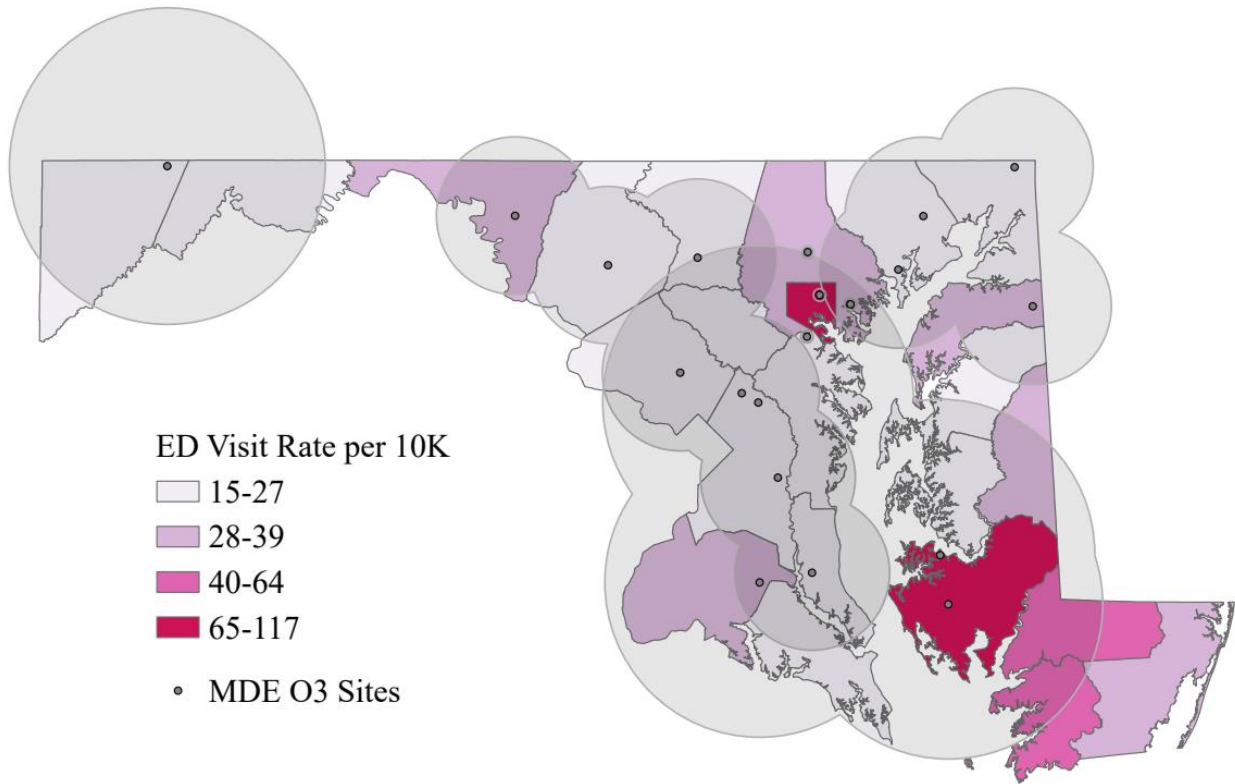


Figure 4-4 Maryland county level asthma hospital ED visits per 10,000 population with ozone monitors and spatial scales associated with those monitors. Only urban and regional scales are shown; the micro, middle, and neighborhood scales are too small for the map.

5. TECHNOLOGY

MDE has made great strides in upgrading almost all its criteria monitoring instrumentation to incorporate trace level monitors, trace level multi-gas calibrators, trace level zero air source and semi- and continuous PM_{2.5} monitors. Significant upgrades have also been made to communications capabilities of the monitoring network. Cellular modems are now used to transmit monitoring data to the central office, greatly improving MDE's ability to report data to EPA's AirNow and other near real-time air quality data mapping websites. These modems also allow for remote access to site dataloggers for quick troubleshooting as instrument issues arise, helping to keep data capture percentages high. Internet access is available at all the monitoring shelters and virtual private network access to MDE's central servers has been provided to all field personnel, while providing adequate security to the sites.

Consistent with recommendations from the Government Accounting Office's (GAO) 2020 report 'Air Pollution: Opportunities to Better Sustain and Modernize the National Air Quality Monitoring System', MDE carefully tracks the age of the inventory of air monitoring instrumentation and equipment and maintains a formal replacement plan projecting five years into the future. Replacement goals are in broad groups, and the actual replacement schedule is ultimately dependent on the availability of sufficient resources. Monitoring shelters generally are targeted after 15 years of service, continuous instruments (O₃, CO, SO₂, NO_x, PM_{2.5}) have five-year targets and newer technologies are evaluated and incorporated when at all practicable. The PM_{2.5} semi-continuous FEMs are currently targeted for replacement at ten years. American Rescue Plan award money has been used to upgrade the current PM_{2.5} network with Teledyne API T640X instruments designed to collect PM data at a higher temporal resolution using scattered light spectrometry. The first T640x was installed at Essex in early 2025; MDE's 2023 Continuous Gas NAAQS QAPP has complete details. In addition, the 2022 Inflation Reduction Act (IRA) provided direct award funding for multipollutant monitoring site support. This funding allows for continued replacement of aging analyzers, calibration systems, and data loggers.

MDE air monitoring personnel stay abreast of new developments in monitoring technologies through building and maintaining relationships with vendors, acquiring loaner instruments to evaluate in the field alongside existing instrumentation, attendance at MARAMA Monitoring Committee meetings and participation in EPA/NACAA Monitoring Committee conference calls and training workshops. In addition, field and quality assurance staff participate in independent course work provided on EPA's Airknowledge website.

The number and variety of consumer grade sensors measuring PM_{2.5} has increased over the past few years. Recent technological advances in the development of these small, portable and lower-cost monitoring devices (generally referred to as sensors) have improved the quality of the data. Sensors have the potential to expand MDE's monitoring capabilities and supplement traditional ambient air quality monitoring. American Rescue Plan and Inflation Reduction Act

award money has been used to purchase lower-cost sensors (QuantAQ Modulairs and Sensit SPODS) to observe air quality in several communities in the Baltimore-Washington area, to better understand local air quality concerns. Modulairs measure PM₁, PM_{2.5}, PM₁₀, Total Suspended Particles (TSP), CO, NO, NO₂, and O₃, in addition to collecting wind speed, wind direction, temperature, and relative humidity. SPODs measure total volatile organic compounds. All sensors purchased under the American Rescue Plan and Inflation Reduction Act Competitive Grant have been deployed in communities in the Baltimore and Washington metropolitan areas.

6. SUMMARY AND CONCLUSIONS

Recommendations from the assessment of each pollutant network are summarized by individual monitoring site in Table 6-1. It should be noted that these recommendations require approval of the EPA Regional Administrator and the availability of adequate resources prior to implementation.

Table 6-1 Summary of site-specific network assessment recommendations.

SITE NAME	POLLUTANT	RECOMMENDED CHANGES	QUALIFIER
Frederick Airport	PM _{2.5}	Commence measurement with Population Exposure objective at the Urban scale, in response to population increase in area	Dependent on availability of monitoring equipment.
Lake Montebello	PM _{2.5}	Change measurement scale from Middle to Neighborhood	Implement now.
Millington	PM _{2.5}	Change measurement scale from Neighborhood to Urban	Implement now.

The annual ambient air monitoring network plan, which this assessment is a part of, is posted on the web and made available for public comment as the primary means of disseminating information about network modifications to the public and to stakeholders. MDE also works closely with local universities and disseminates news of site changes to the surrounding state and local air monitoring agencies at regional meetings and conference calls (i.e. MARAMA Annual Air Monitoring Committee Meeting).

In general, this network assessment found Maryland’s air monitoring networks in compliance with EPA regulations and fulfilling intended monitoring objectives. In some cases, the assigned monitoring scale was found to be in need of change, and a site was identified as a good candidate for additional data collection.

7. REFERENCES

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