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Bureau of Air Quality

Fine Particulate Matter (PM2.5) National Ambient Air Quality Standard

Air Quality Technical Advisory Committee

April 4, 2024

Josh Shapiro, Governor

Jessica Shirley, Interim Acting Secretary

Agenda

- Overview of the National Ambient Air Quality Standards (NAAQS) and Particulate Matter (PM)
- PM2.5 Data Trends
- PM2.5 Designation Process
- PM2.5 Implementation Process
- 2024 PM2.5 Designation Timeline
- PM2.5 Monitoring Update
- PM2.5 Air Quality Index (AQI) Changes

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Overview of the National Ambient Air Quality Standards (NAAQS) and Particulate Matter (PM)

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National Ambient Air Quality Standards

- The Environmental Protection Agency (EPA) sets primary and secondary NAAQS for six common air pollutants, known as criteria pollutants:
  - Ground-level ozone
  - Carbon monoxide
  - Nitrogen Dioxide
  - Particulate matter
  - Lead
  - Sulfur Dioxide
- Primary standards provide protection to public health.
- Secondary standards provide protection to public welfare, including decreased visibility and damage to animals, crops, vegetation and buildings.

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Particulate Matter

- Primary particles are emitted directly from a source.
- Secondary particles are formed in atmospheric reactions that involve chemicals such as nitrogen oxides and sulfur dioxides.
- PM2.5 penetrates deeper into the lungs and poses a greater health risk than larger particles.

https://www.cdc.gov/air/particulate_matter.html

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Historical PM NAAQS Revisions

- Revisions to the NAAQS, including the PM NAAQS, are based solely on public health and welfare protection without consideration for implementation costs.
- Previously, in 2012, EPA revised the primary annual PM2.5 NAAQS from 15 micrograms per cubic meter ($\mu g/m^3$) to 12.0 $\mu g/m^3$.
- At that time, EPA retained:
  - the existing primary 24-hour standard;
  - the existing 24-hour PM10 standard; and
  - the secondary PM standards.

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2024 PM NAAQS Rule

- On January 27, 2023, EPA published its proposed rule, retaining the current primary 24-hour PM2.5 standard of 35 µg/m^3 without revision and revising the primary annual standard from 12.0 µg/m^3 to within the range of 9.0 to 10.0 µg/m^3.
- On February 7, 2024, EPA Administrator Regan signed the final rule, revising the primary annual standard to 9.0 µg/m^3. The primary 24-hour PM2.5 standard of 35 µg/m^3 was retained.
- The final rule was published in the *Federal Register* on March 6, 2024.

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PM2.5 Design Value Calculations

- The ***annual PM2.5 standard design value*** is calculated by averaging the annual value for the latest three years. The annual value is calculated by averaging each quarter.
  - Example: The 2022 design value is the annual average of 2020-2022 data.

- The ***24-hour PM2.5 standard design value*** is the three-year average of the annual 98th percentile.
  - Please note: With 365 valid days, the 98th percentile is the 8th high.
    With 61 valid days, the 98th percentile is the 2nd high.

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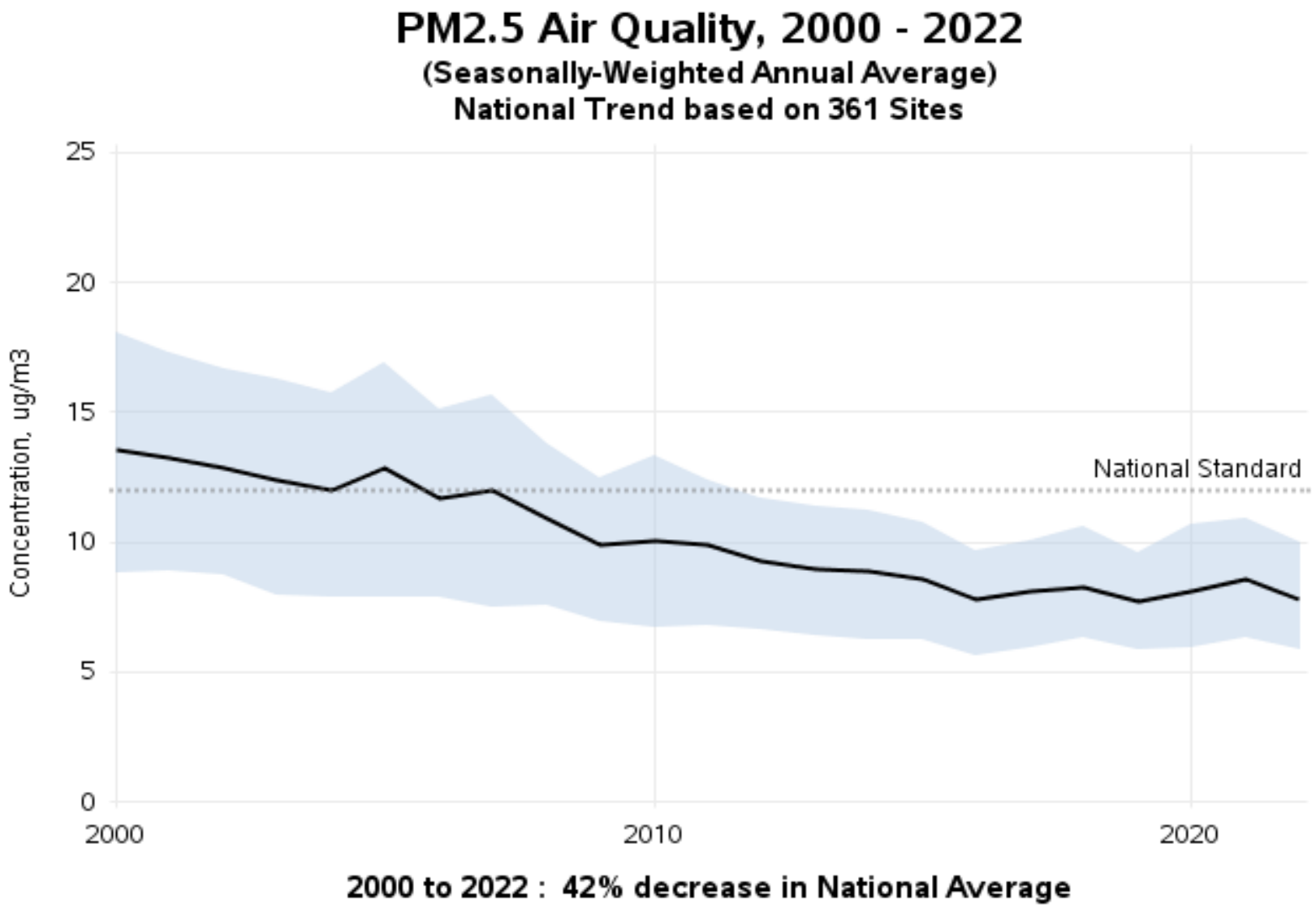
PM2.5 National Trends



Source: https://www.epa.gov/air-trends/particulate-matter-pm25-trends

PM2.5 Data Trends

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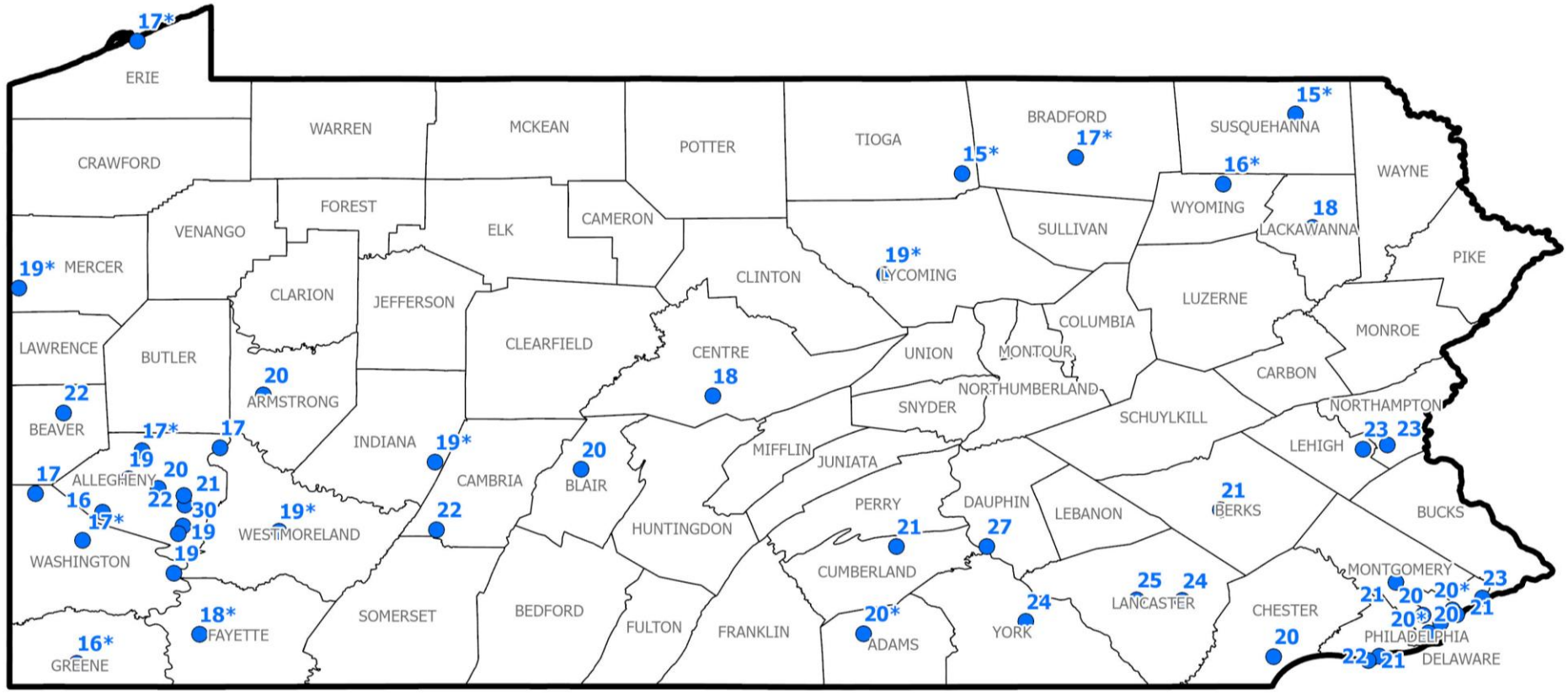
2022 24-Hour PM2.5 Design Values – 35 µg/m^3

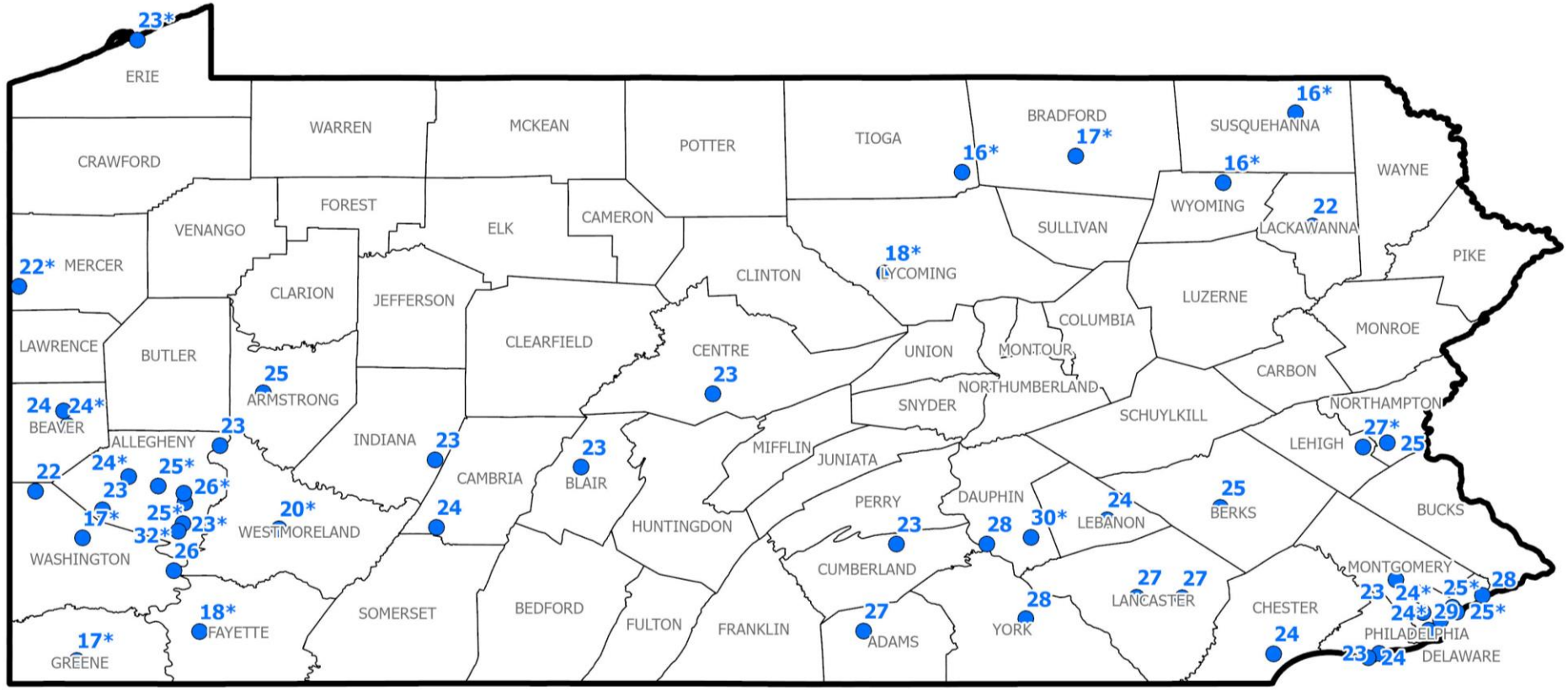


Appearing in Red – 2022 24-hour PM2.5 design value above 35 µg/m^3 (2006 PM2.5 Standard)

Appearing in Blue – 2022 24-hour PM2.5 design value at or below 35 µg/m^3 (2006 PM2.5 Standard)

Asterisk (*) appearing behind the design value means the data is incomplete during 3-year period.

2023 24-Hour PM2.5 Design Values – 35 µg/m^3

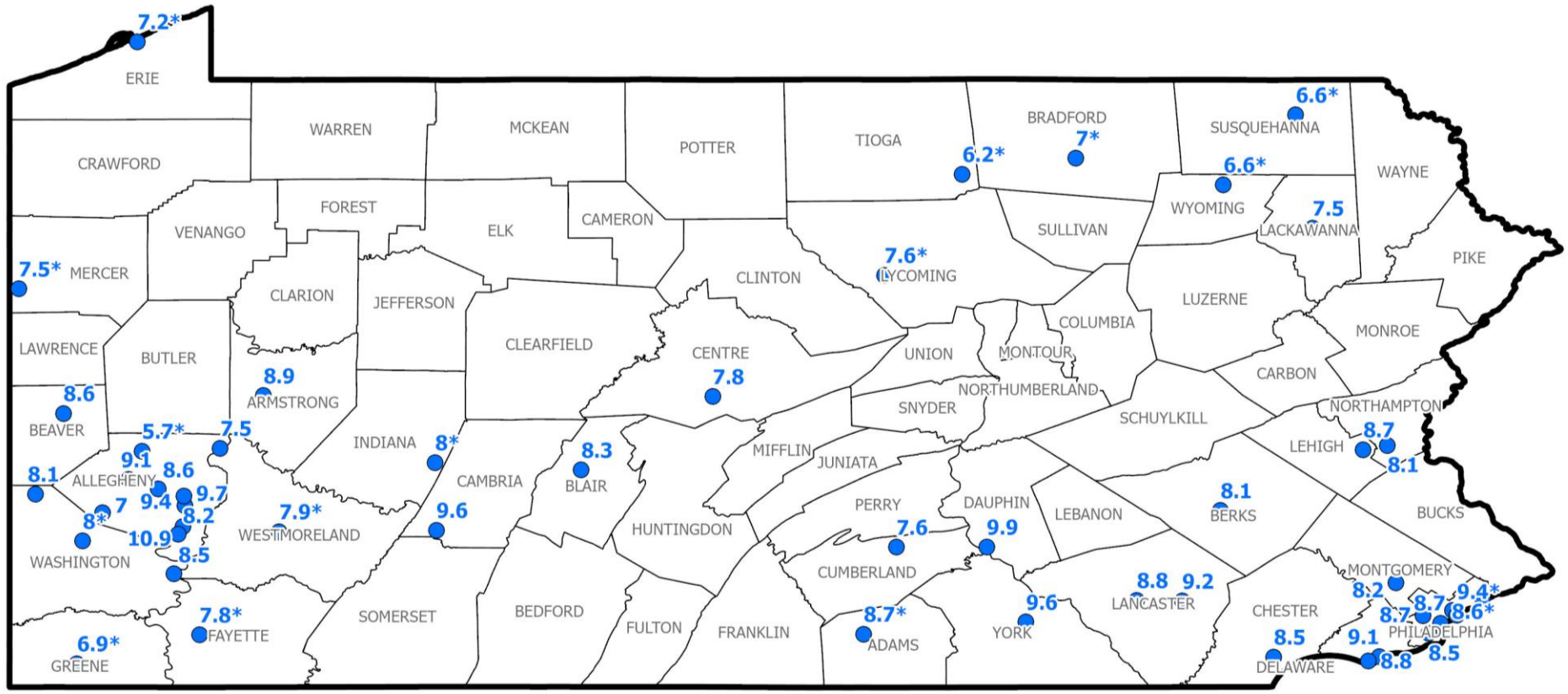


Appearing in Red – 2023 24-hour PM2.5 design value above 35 µg/m^3 (2006 PM2.5 Standard)

Appearing in Blue – 2023 24-hour PM2.5 design value at or below 35 µg/m^3 (2006 PM2.5 Standard)

Asterisk (*) appearing behind the design value means the data is incomplete during 3-year period.

2022 Annual PM2.5 Design Values – 12.0 µg/m^3

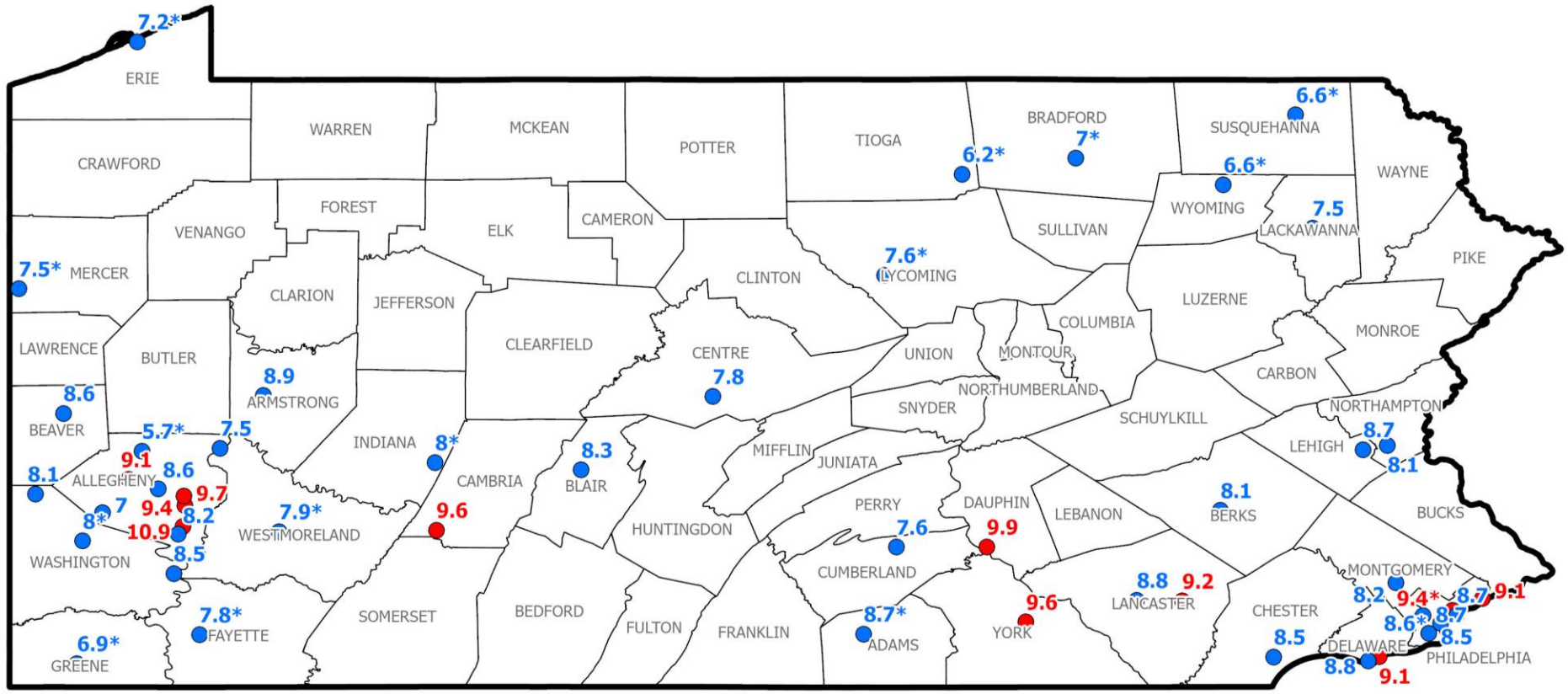


Appearing in Red – 2022 annual PM2.5 design value above 12.0 µg/m^3 (2012 PM2.5 Standard)

Appearing in Blue – 2022 annual PM2.5 design value at or below 12.0 µg/m^3 (2012 PM2.5 Standard)

Asterisk (*) appearing behind the design value means the data is incomplete during 3-year period.

2022 Annual PM2.5 Design Values – 9.0 µg/m³

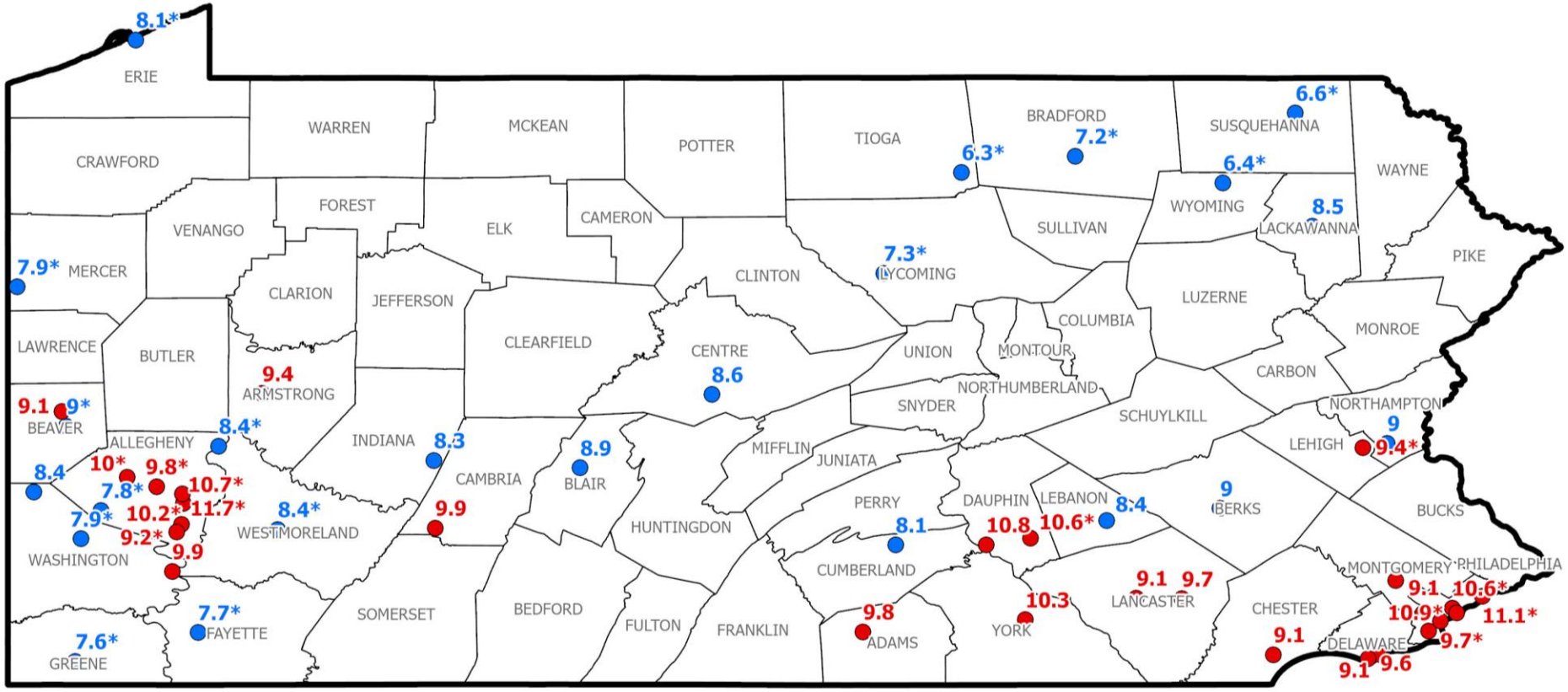


Appearing in Red – 2022 annual PM2.5 design value above 9.0 µg/m³ (New PM2.5 Standard)

Appearing in Blue – 2022 annual PM2.5 design value at or below 9.0 µg/m³ (New PM2.5 Standard)

Asterisk (*) appearing behind the design value means the data is incomplete during 3-year period.

2023 Annual PM2.5 Design Values – 9.0 µg/m³

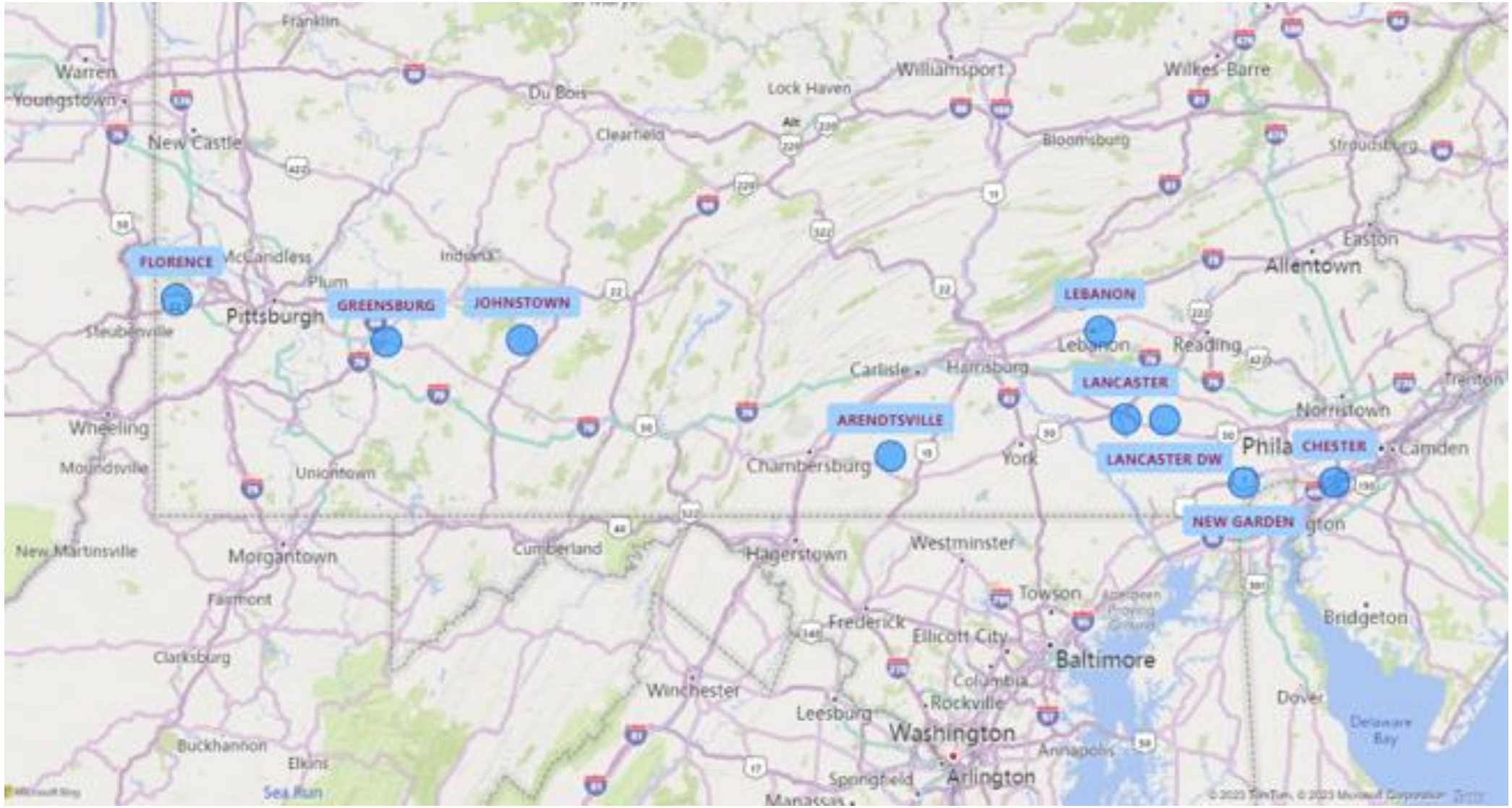


Appearing in Red – 2023 annual PM2.5 design value above 9.0 µg/m³ (New PM2.5 Standard)

Appearing in Blue – 2023 annual PM2.5 design value at or below 9.0 µg/m³ (New PM2.5 Standard)

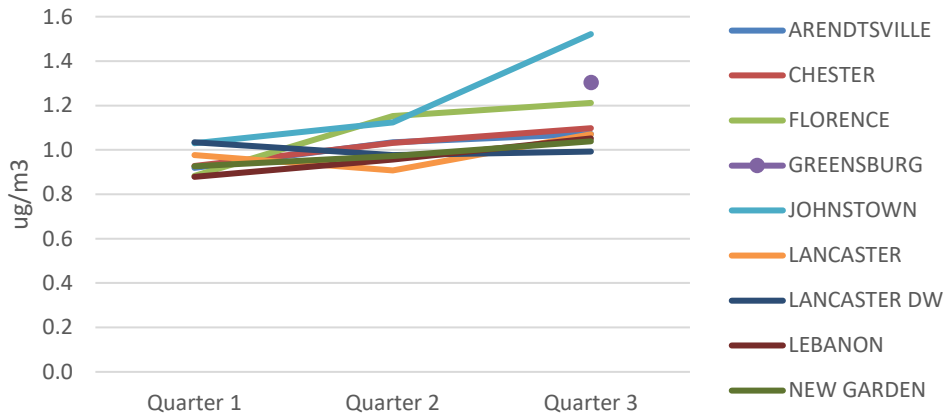
Asterisk (*) appearing behind the design value means the data is incomplete during 3-year period.

PADEP PM2.5 Speciation Monitors

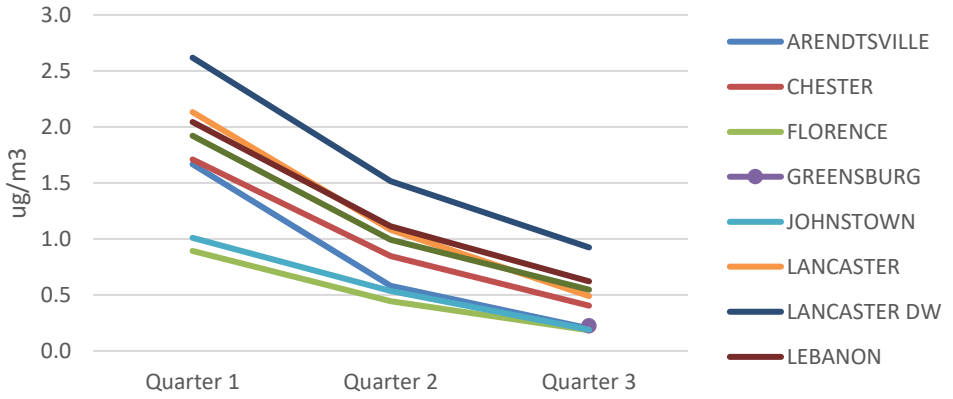


2023 PM2.5 Speciation Quarterly Data Trends

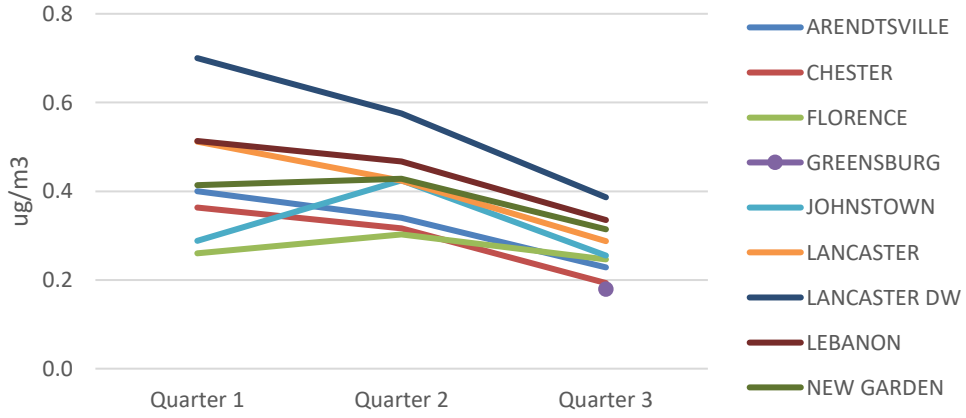
Sulfate



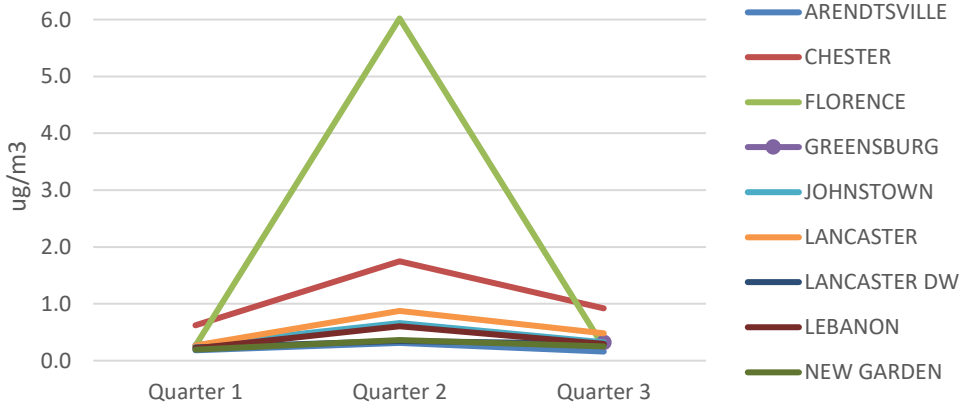
Total Nitrate



Ammonium Ion



Soil

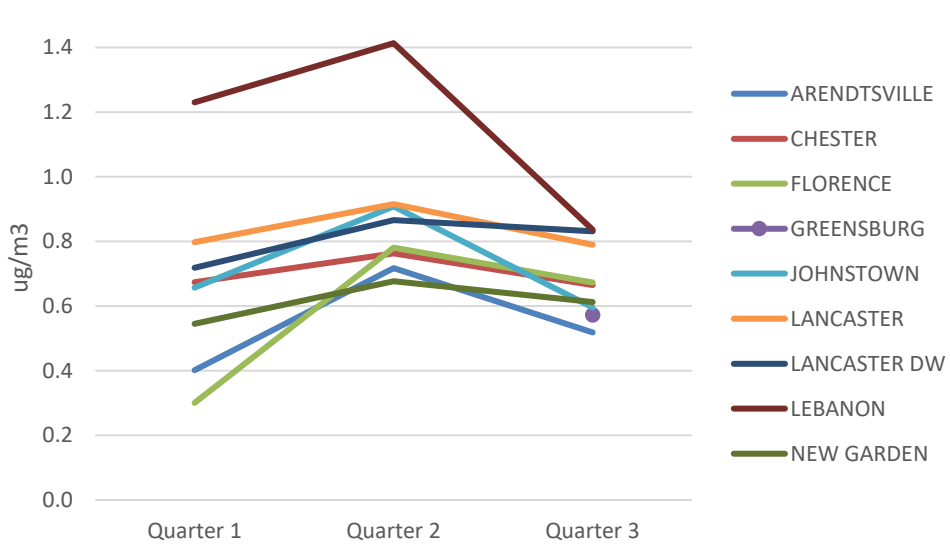


Soil = 2.2[Al] + 2.49[Si] + 1.94[Ti] + 1.63[Ca] + 2.42[Fe]

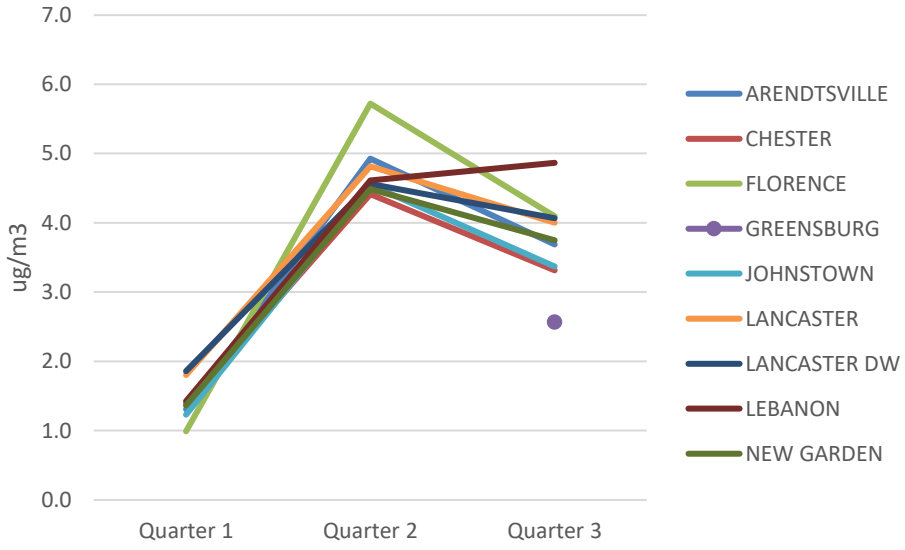
https://www.epa.gov/amtic/csn-and-improve-protocol-network-assessment

2023 PM2.5 Speciation Quarterly Data Trends

Elemental Carbon



Organic Carbon



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Where Do We Go From Here?

So, all that is great.

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PM2.5 Designation Process

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Understanding the Designation Process

- After EPA issues the final rule, the designation process begins.
  - The Clean Air Act (CAA) Section 107(d) – provides a mechanism for states to make recommendations to EPA on area designations (Does the area meet the new standard?)
  - EPA generally issues designation guidance through memorandum on the process and schedule
- Designations categories:
  - Nonattainment Area – Area that does not meet or contributes to a nearby area that does not meet the NAAQS; (The CAA classifies all initial areas in identified "boundaries" as "moderate" for PM2.5)
  - Attainment/Unclassifiable Area – Area meeting the NAAQS and does not contribute to a nearby area; or
  - Unclassifiable Area – Area that cannot be designated based on available information as meeting or not meeting the NAAQS
- To develop designations, EPA recommends the analysis of five factors, which represents a collective weight-of-evidence approach.

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Five Factors for Analysis for Designation Process

Air Quality Data	Examine monitoring data (design values, exceptional events)
Emissions and Emissions-Related Data	Examine source emissions, population, traffic, etc.
Meteorology Data	Examine transport (wind roses, HYSPLIT back trajectory model)
Geography/ Topography	Examine physical terrain (GIS)
Jurisdictional Boundaries	Assess a clearly defined legal boundary for air quality planning and enforcement

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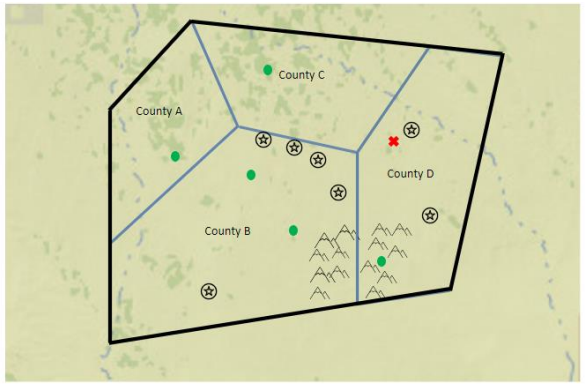
Weight-of-Evidence Approach



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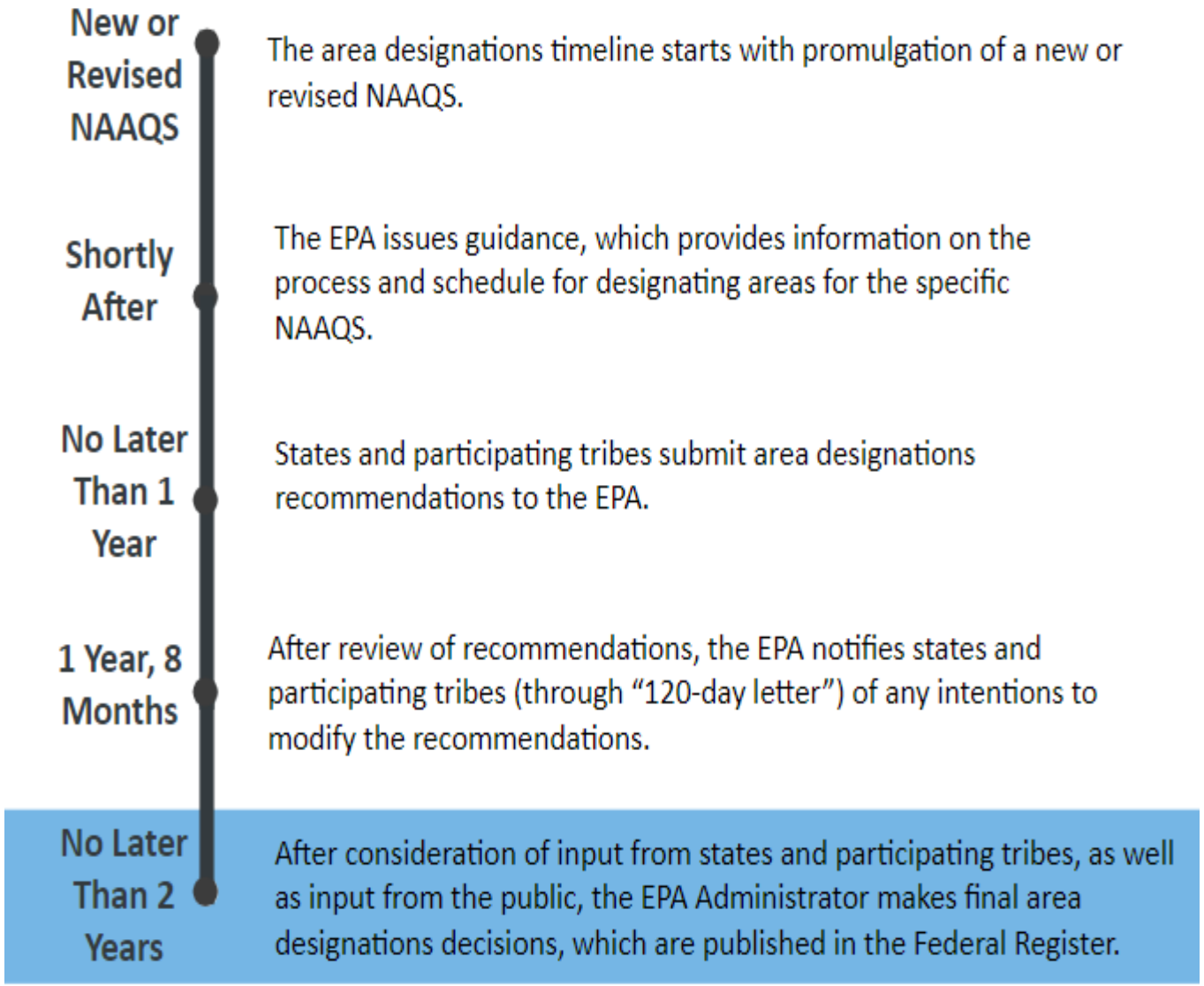
Pictures Source: EPA Course - PLAN201-SI: Applying Technical Factors for Area Designations

Summarized Key Steps in the Designation Process



Example - PM2.5 Designation Timeline

As an example, let's look at the 2012 PM NAAQS timeline:

- December 14, 2012 - EPA administrator signed final rule.
- January 15, 2013 - Final Rule was published in the *Federal Register.*
- April 16, 2013 - EPA released designation recommendation guidance.
- December 13, 2013 - PA sent initial designations to EPA.
- July 30, 2014 - PA sent letter to EPA with updated recommendations.
- August 19, 2014 - PA received EPA's 120-day letter.
- December 18, 2014 - PA received EPA's letter proposing designations in PA.
- February 18, 2015 - PA sent letter to EPA with the early certification of 2014 data.
- April 7, 2015 - EPA issues final designations, effective on April 15, 2015.

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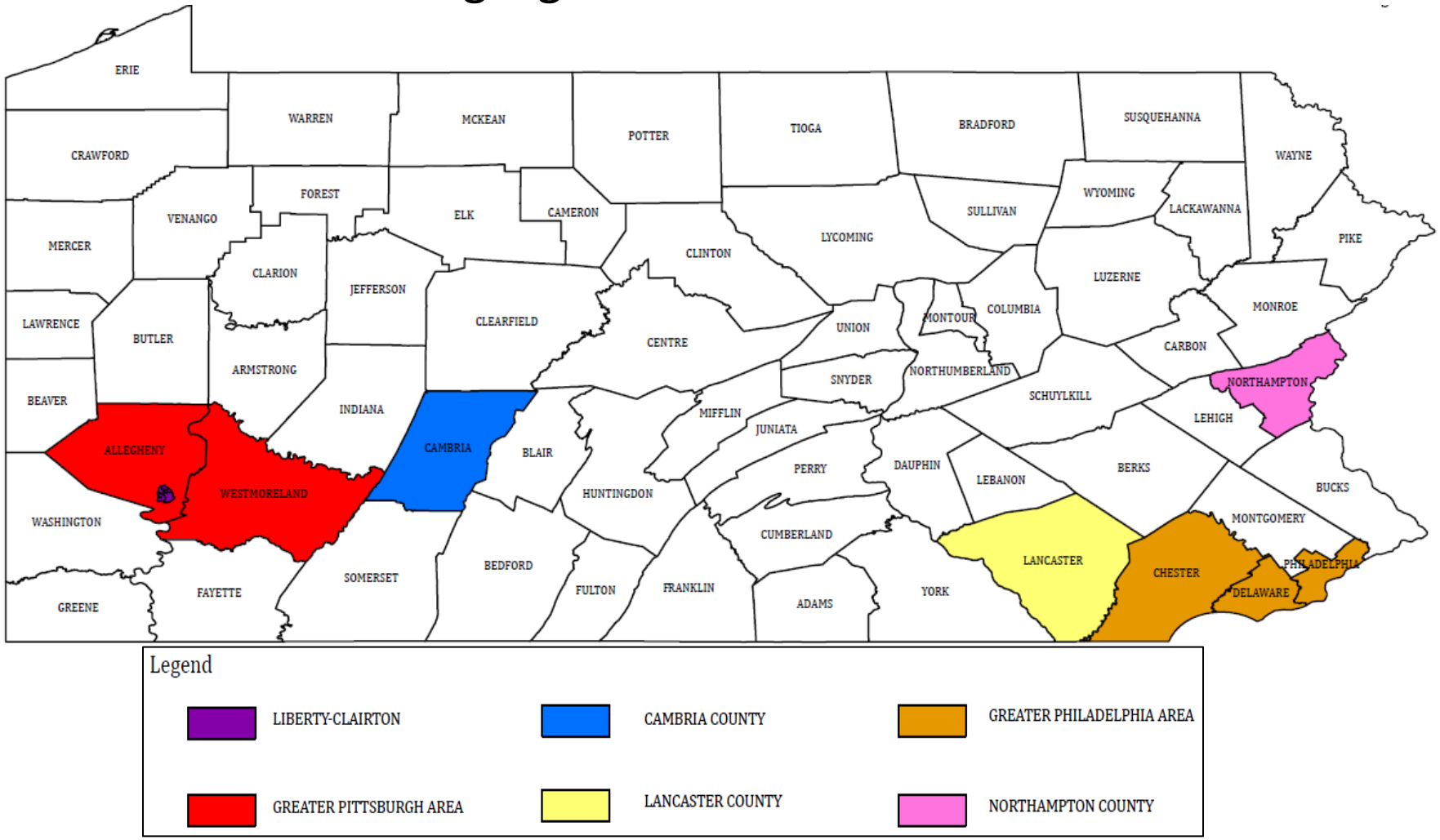
Pennsylvania's Initial Designation Recommendations

- Based on 2012 Design Value: 10 monitors above 12 µg/m^3. PA recommended six nonattainment areas covering eight counties.



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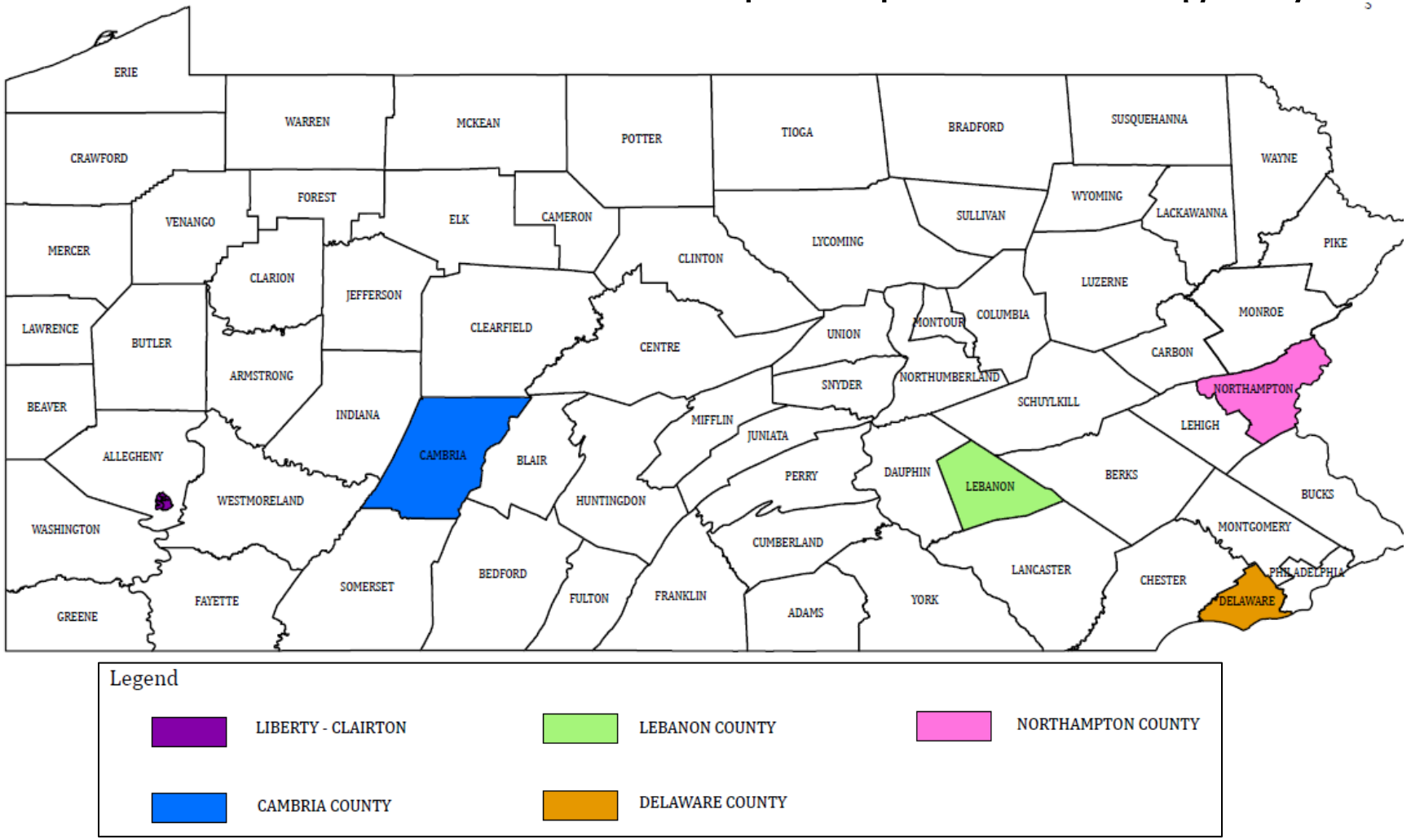
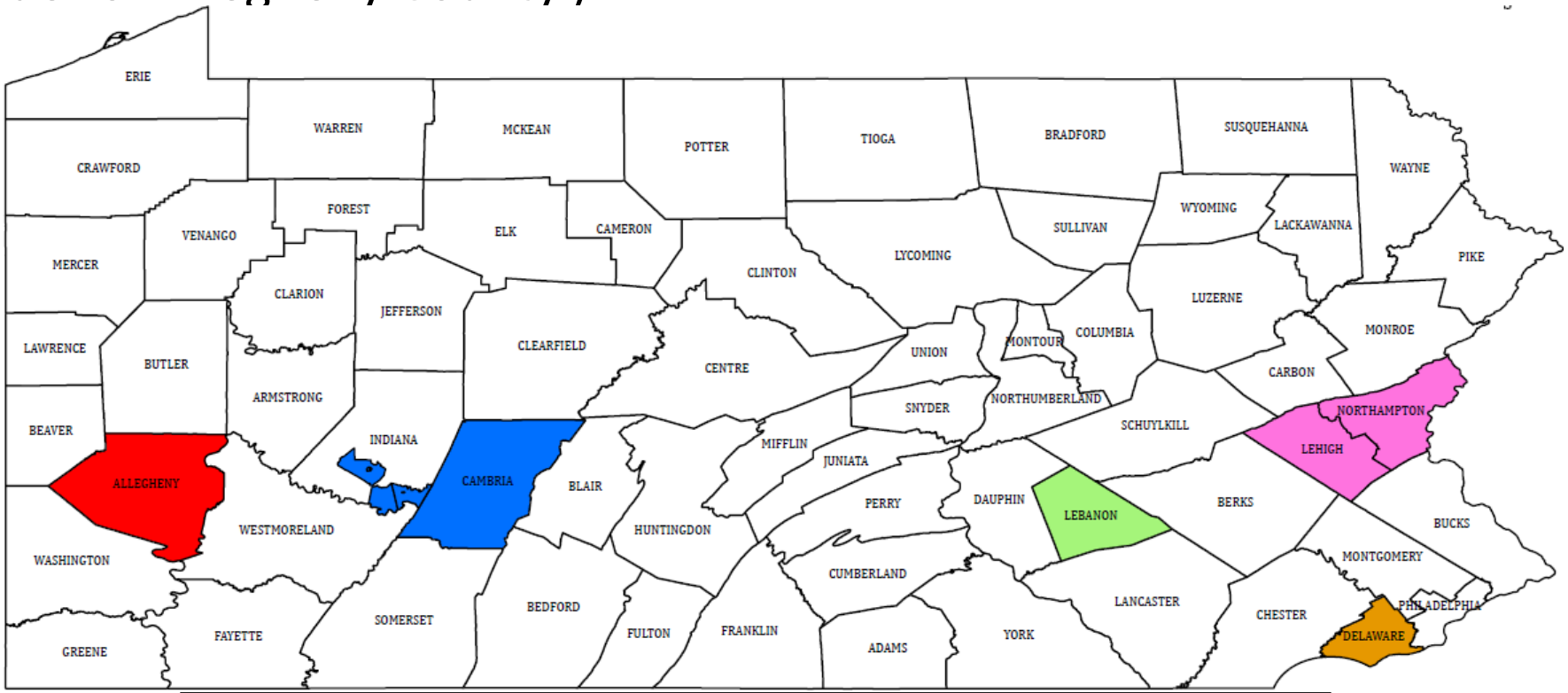
Pennsylvania's Updated Designation Recommendations

- Based on 2013 Design Values: 5 monitors above 12 µg/m^3. PA updated recommendations included four counties plus a portion of Allegheny County.



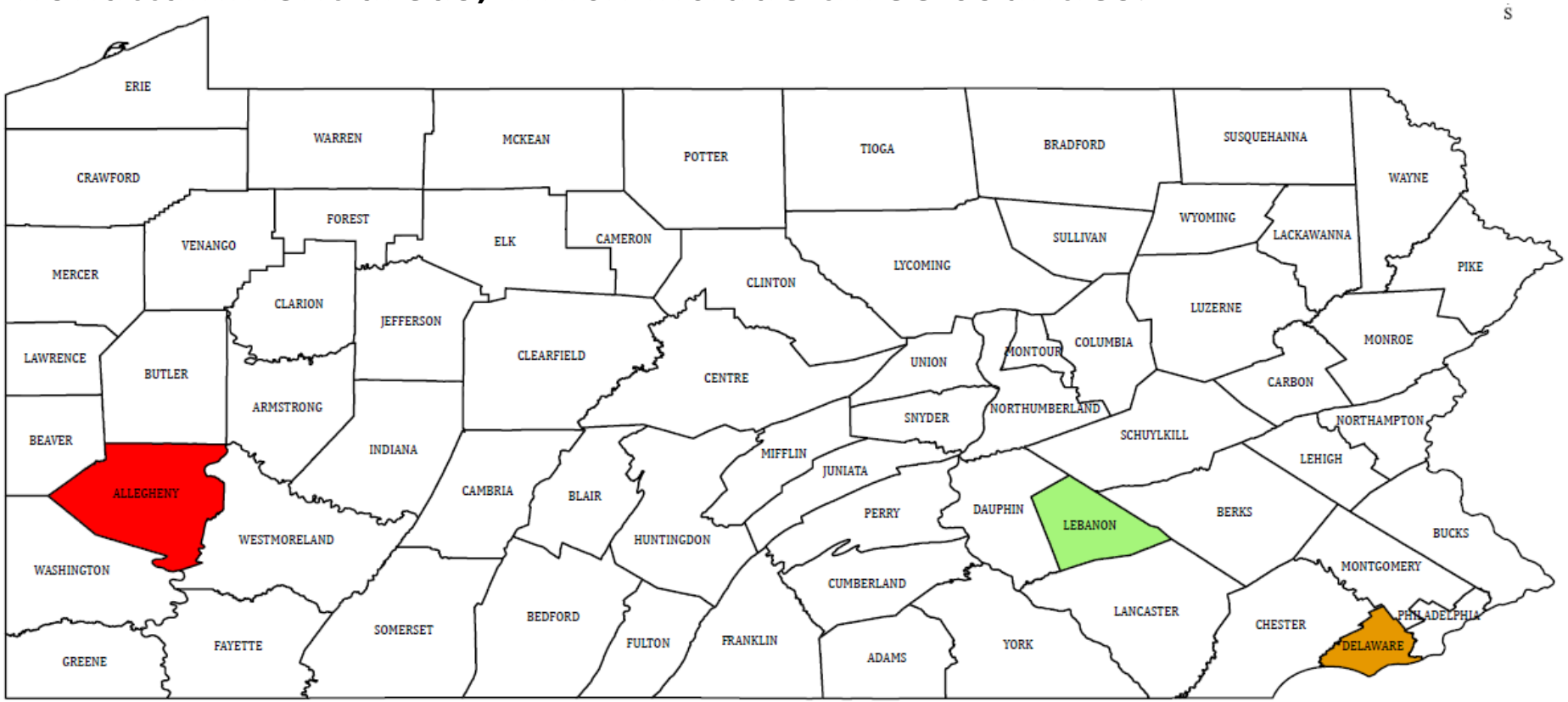
EPA's Initial PM2.5 Designations in Pennsylvania

- Five nonattainment areas using 2013 design values, which included all or parts of 7 counties (added Lehigh County and portions of Indiana County, as well as the remainder of Allegheny County.)



EPA's Final PM2.5 Designations for Pennsylvania

- Based on 2014 Design Values: 3 monitors above 12 µg/m^3. In the end, EPA designated three nonattainment areas, which include three counties.



PM2.5 Implementation Process

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Pennsylvania's Implementation Process

- July 29, 2016 – EPA issued a PM2.5 SIP Requirements Rule finalizing requirements for states to implement the SIP.
- December 13, 2016 – EPA issued a Clean Data Determination for Delaware County attaining the standard, based on 2013-2015 data.
- March 6, 2018 – EPA issued a Clean Data Determination for Lebanon County for attaining the standard, based on 2014-2016 data.
- January 23 and February 11, 2019 – PA submitted requests to EPA to approve Delaware and Lebanon County Maintenance Plans and Redesignation Requests, respectively.

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Pennsylvania's Implementation Process

- July 16 and September 30, 2019 – EPA proposed and finalized, the Delaware and Lebanon County Maintenance Plans and Redesignation Requests, respectively.
- September 12, 2019 – PA submitted Allegheny County's attainment demonstration SIP on behalf of ACHD, which demonstrated attainment by December 31, 2021.
- March 16, 2022 – EPA issued a Clean Data Determination for Allegheny County for attaining the standard, based on 2018-2020 data.
- November 29, 2022 – PA submitted request to EPA to approve Allegheny County Maintenance Plan and Redesignation Request, respectively. (No EPA action yet.)

Identifying Nonattainment Areas and Boundary Determinations

- The analytical starting point for the 2024 PM2.5 designations is the entire metropolitan area where the violating monitor is located (Core Based Statistical Area and Combined Statistical Area).
- States will likely use 2021-2023 data for developing recommendations.
- States are not required to develop complete exceptional events demonstrations for their recommendations but should address any data they believe were affected by exceptional events.
- EPA will likely use 2022-2024 for making final designations.
- Boundaries for each nonattainment area will be evaluated on a case-by-case basis.
- EPA strives for national consistency in decisions.

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2024 PM2.5 Designation Timeline

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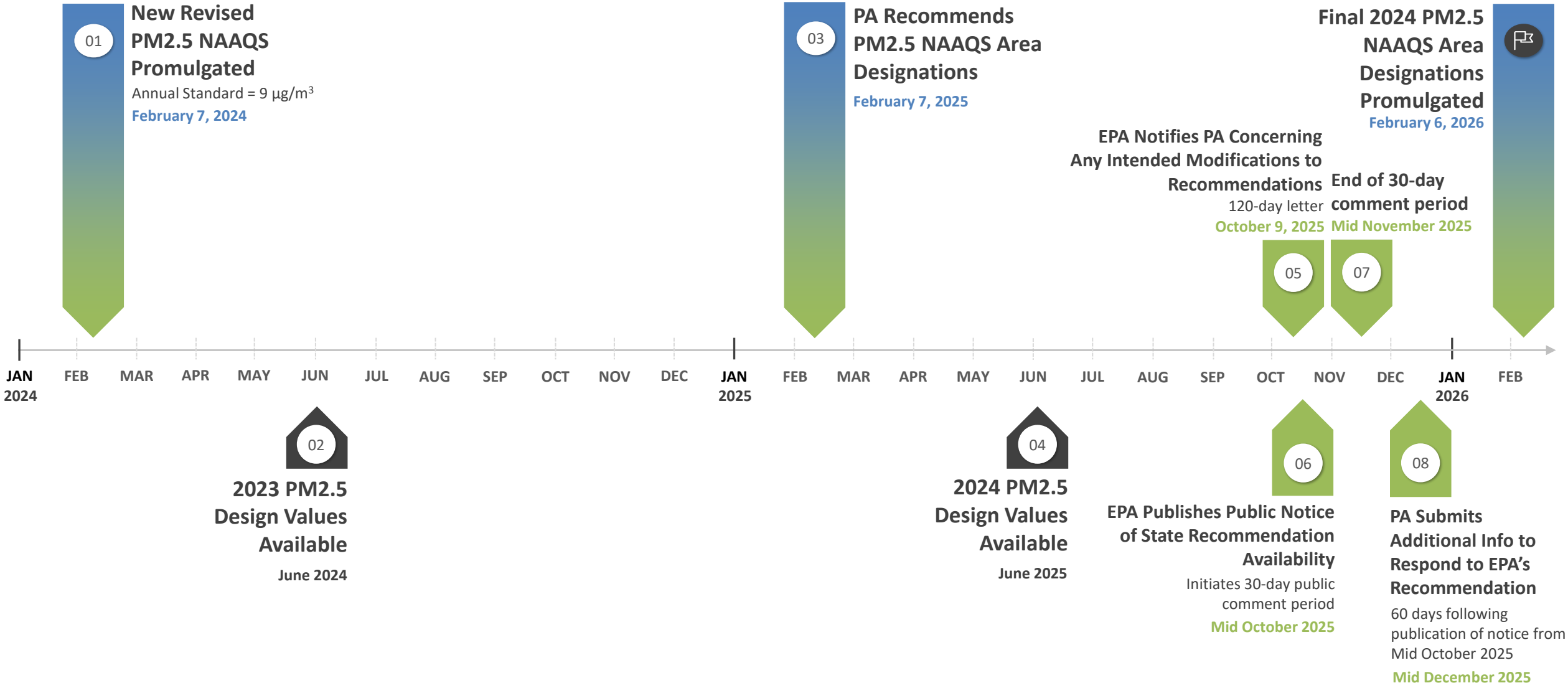
2024 PM2.5 NAAQS - Anticipated Timeline for Designation Process



Exceptional Events Related To Initial Area Designations

- Air quality monitoring data affected by exceptional events may be excluded from use in area designations if the data meet the criteria for exclusion, as specified in the Exceptional Events Rule.
- Submittal is discretionary.
- Events should have regulatory significance for the 2024 revised primary annual PM2.5 NAAQS initial area designations.
- DEP is currently reviewing its 2021-23 PM2.5 data. It is possible that DEP completes exceptional event analyses for two distinctive time periods in June-July 2023.

Source: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-50#p-50.14(c)(2)(vi)

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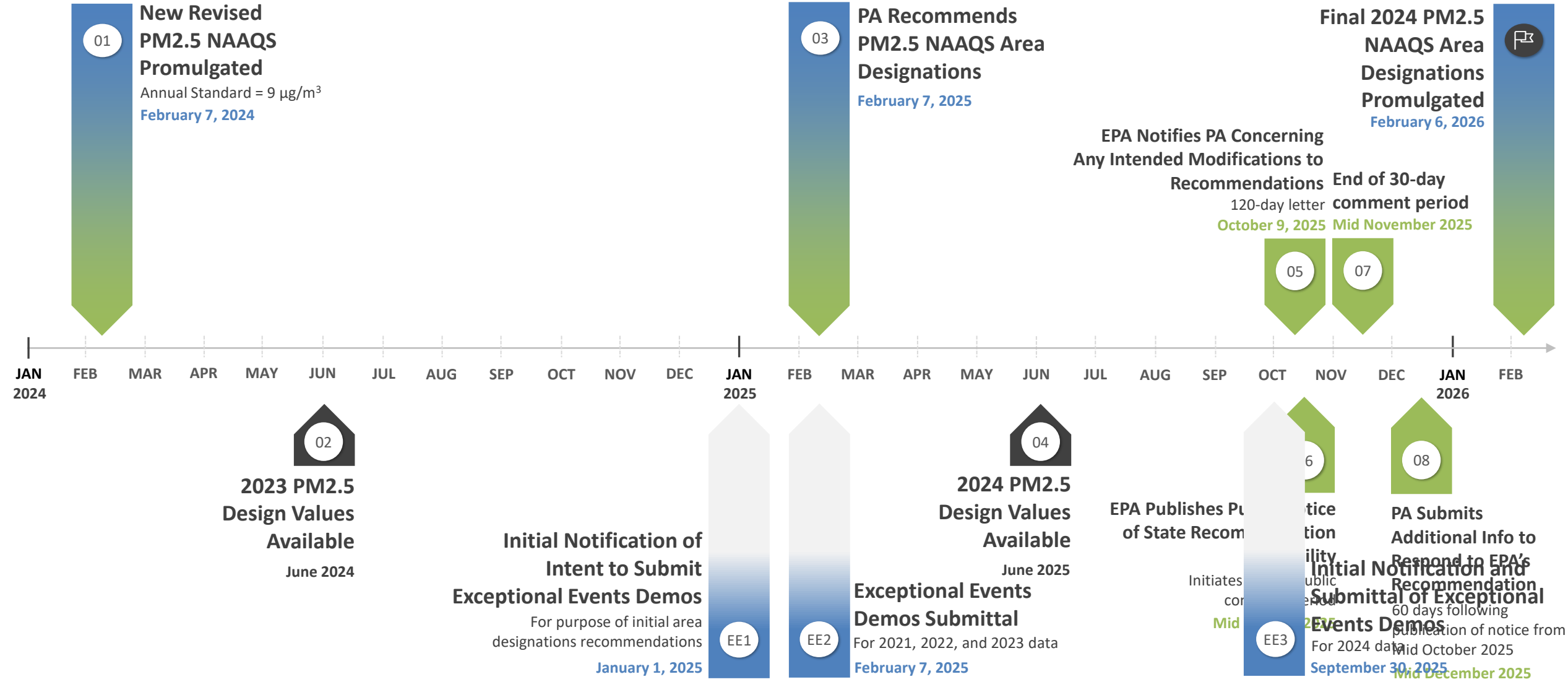
2024 PM2.5 NAAQS - Anticipated Timeline for Designation Process



Environmental Justice Factor in Designation Process

- Nonattainment areas may disproportionately impact vulnerable populations. It is important to provide meaningful engagement opportunities for public input into the area designations process.
- Does not add a requirement for new monitors; rather it utilizes existing sites and ensures at risk communities are considered if sites need to move.
- Any new or relocated monitors would not be in effect for the upcoming PM2.5 designations.

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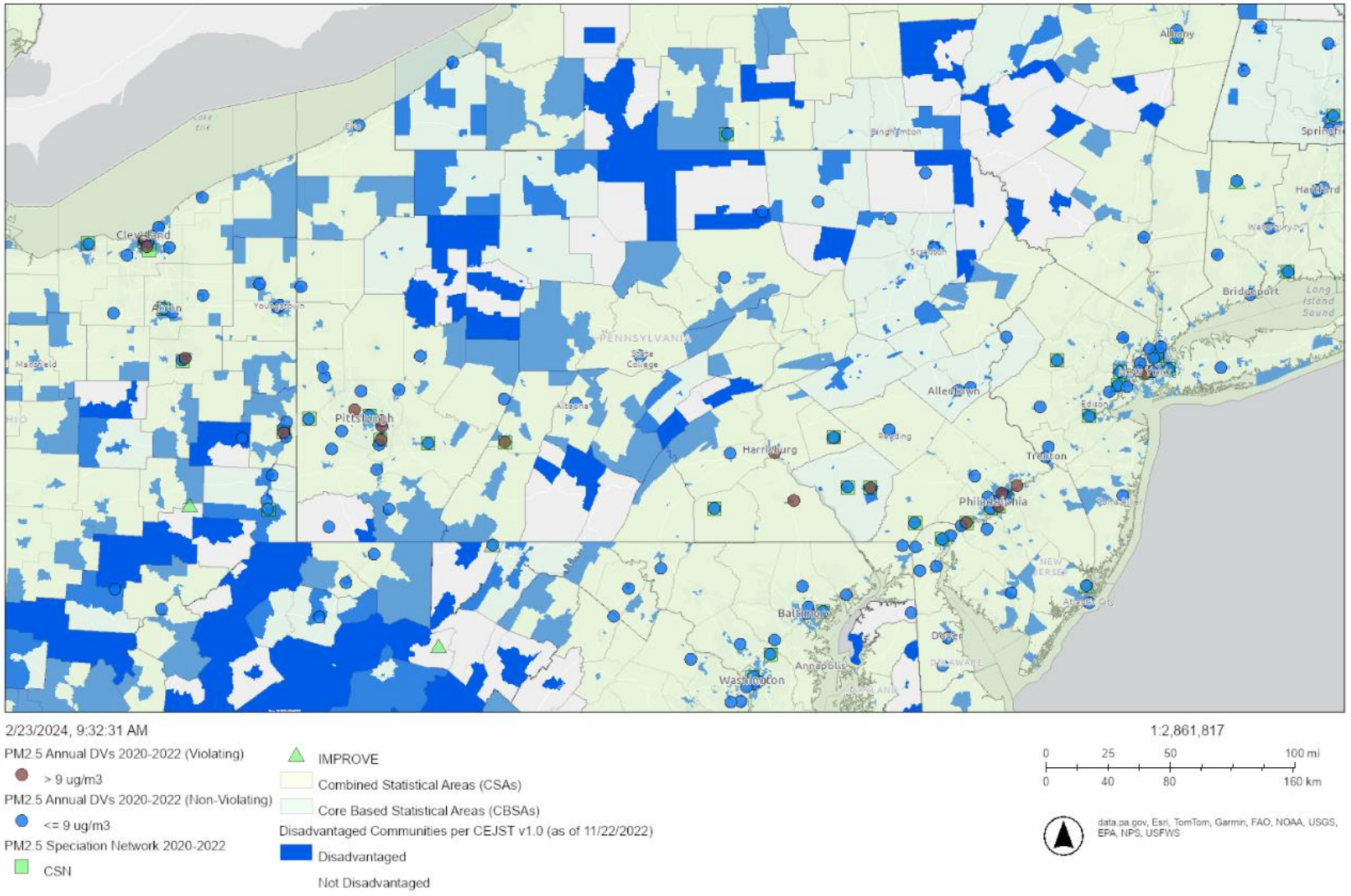
Environmental Justice Factor



Source: https://experience.arcgis.com/experience/a2ca272ce9fc4019a88ce35b863e2cab

PM2.5 Monitoring Update

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PM2.5 Monitoring Equipment

Federal Reference Methods (FRM) and Federal Equivalent Methods (FEM) are standardized methods to ensure air quality monitoring is conducted accurately across the United States.

Thermo 2025i (FRM)
Filter Based (24-hour Sampling) PM2.5 Mass Monitor

Source: https://www.thermofisher.com/order/catalog/product/2025I

Teledyne API Model T640/T640x (FEM)
Real-Time Continuous PM2.5 Mass Monitor

Source: https://www.teledyne-api.com/prod/Downloads/08354D%20T640%20USER%20MANUAL.pdf

Proposal to Update PM2.5 Data from T640/T640X Monitors

- T640 approved as FEM on July 13, 2016
  - 30 reported in AQS in 2017
  - 400 reported in AQS in 2023
  - Advantages – Less maintenance, fewer consumables, high time resolution data
  - Disadvantages – Positive bias (20% higher than collocated FRMs)
- Clean Air Scientific Advisory Committee (CASAC) 3/18/2022 letter
  - "The FEM bias needs to be addressed to make the FRMs and FEMs more comparable."
- Teledyne API Network Data Alignment Equation Modification
  - EPA approval – April 2023
  - Firmware change available – June 2023
  - Updated method working – January 2024

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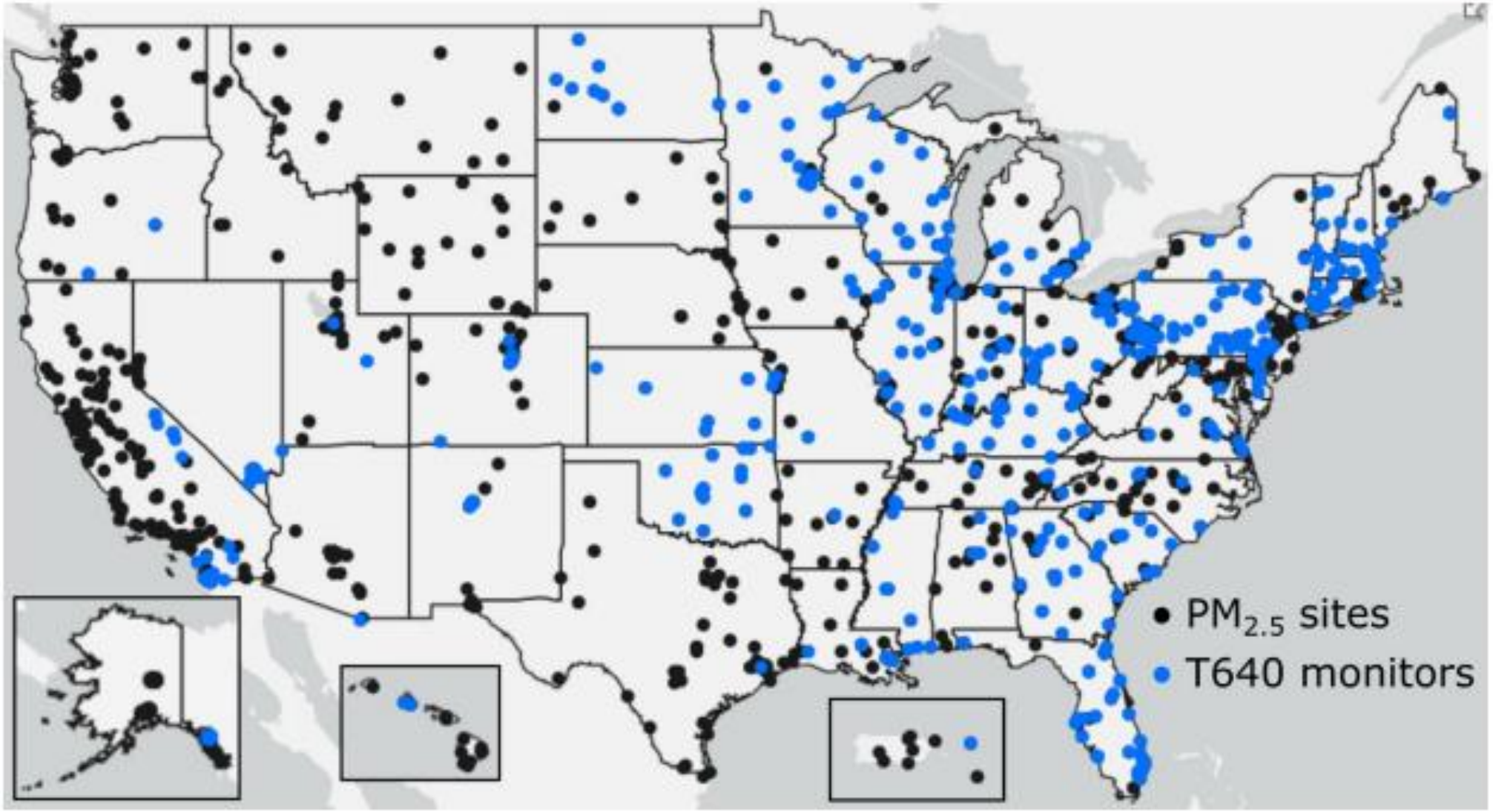
T640 PM Mass Monitors Widespread Use



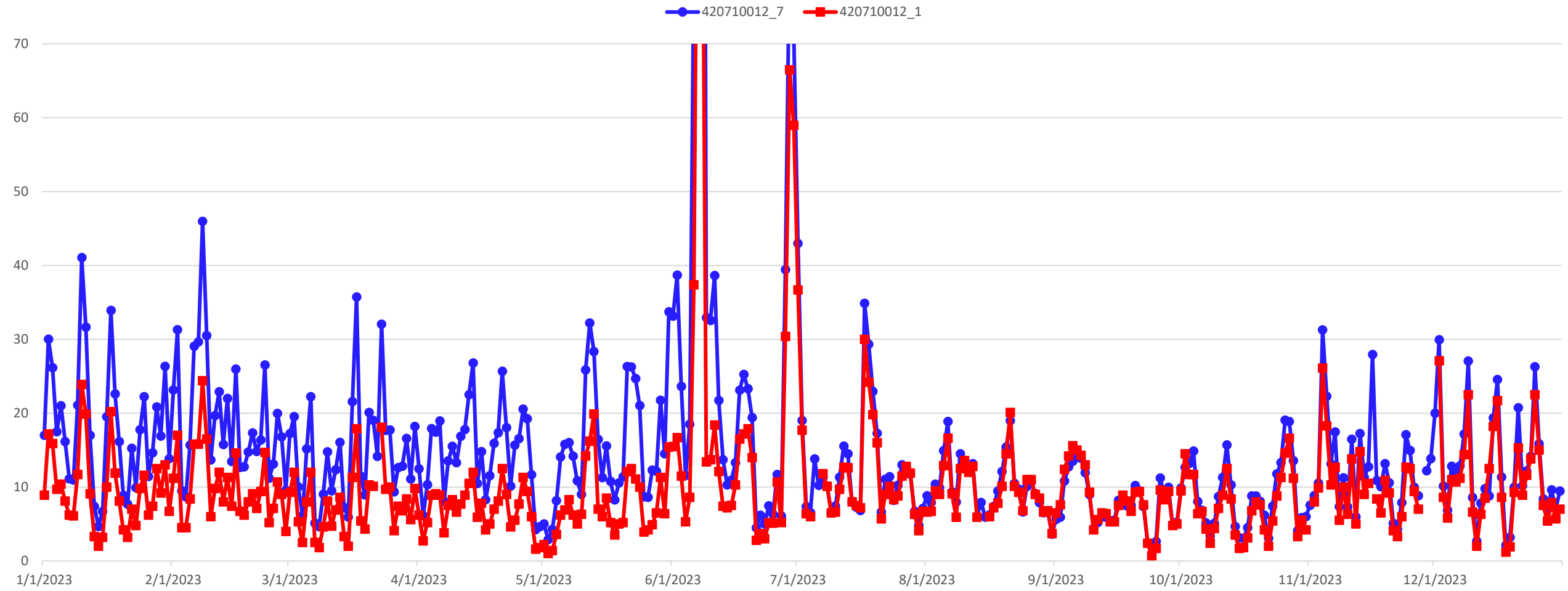
Source: https://www.epa.gov/system/files/documents/2024-02/teledyne-data-update-noa-supporting-documentation-2024.pdf

Wilkes-Barre T640 vs. T640x with Algorithm On and Off Example

T640 – Algorithm On T640x – Algorithm On T640x – Algorithm Off

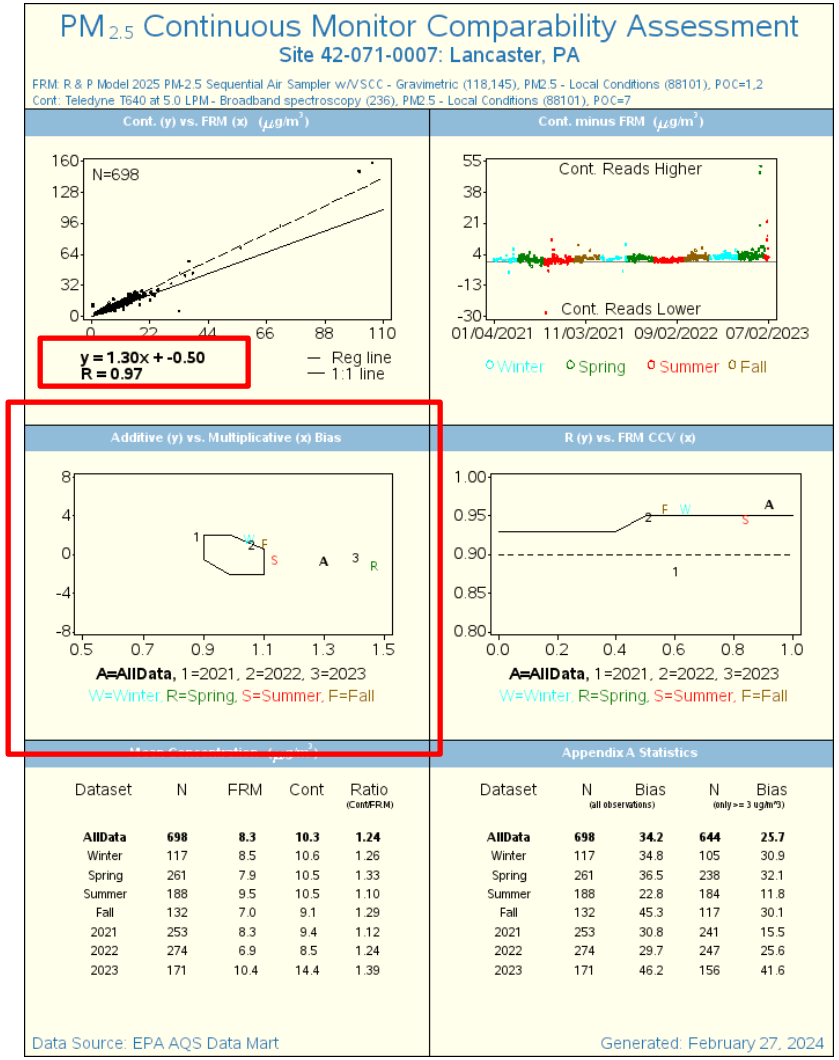
2023 Lancaster DW T640 vs. FRM Example

FEM (T640) FRM (Thermo 2025i)



2023 Lancaster DW T640 vs. FRM Example

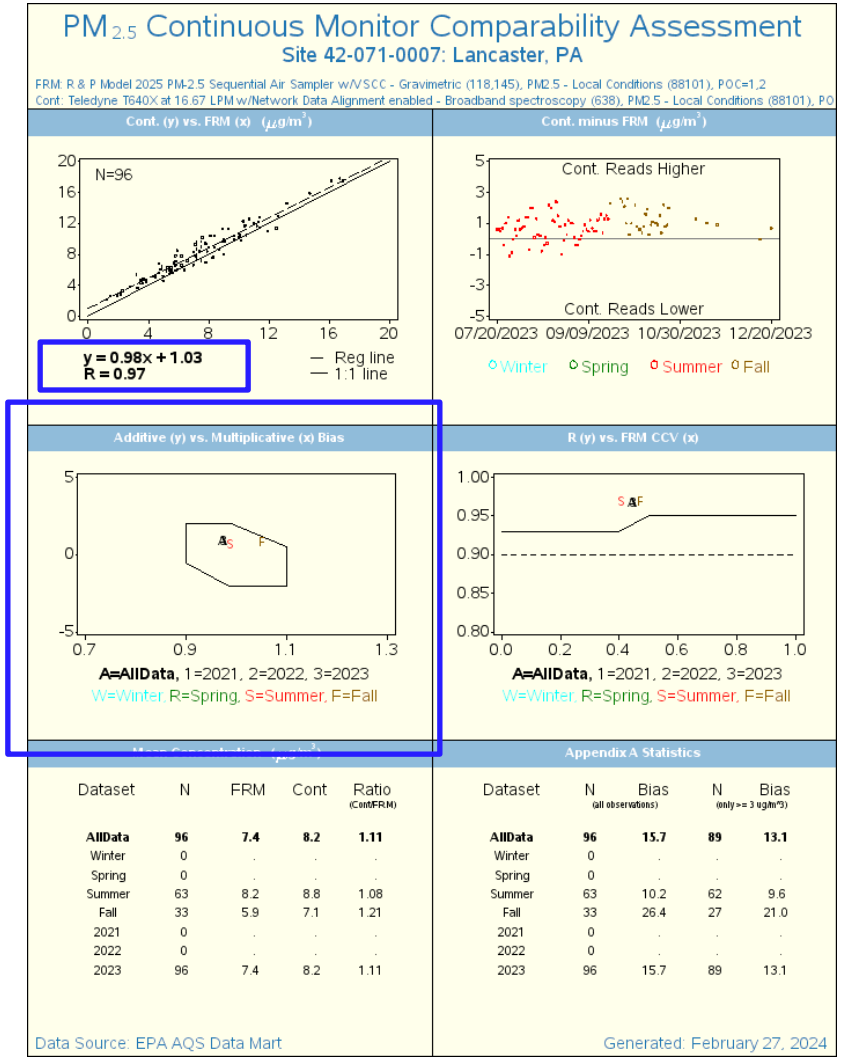
Before Algorithm



Dataset	N	FRM	Cont	Ratio (Cont/FRM)
AllData	**698**	**8.3**	**10.3**	**1.24**
Winter	117	8.5	10.6	1.26
Spring	261	7.9	10.5	1.33
Summer	188	9.5	10.5	1.10
Fall	132	7.0	9.1	1.29
2021	253	8.3	9.4	1.12
2022	274	6.9	8.5	1.24
2023	171	10.4	14.4	1.39

Dataset	N (all observations)	Bias	N (only >= 3 ug/m^3)	Bias
AllData	**698**	**34.2**	**644**	**25.7**
Winter	117	34.8	105	30.9
Spring	261	36.5	238	32.1
Summer	188	22.8	184	11.8
Fall	132	45.3	117	30.1
2021	253	30.8	241	15.5
2022	274	29.7	247	25.6
2023	171	46.2	156	41.6

After Algorithm



Dataset	N	FRM	Cont	Ratio (Cont/FRM)
AllData	**96**	**7.4**	**8.2**	**1.11**
Winter	0	.	.	.
Spring	0	.	.	.
Summer	63	8.2	8.8	1.08
Fall	33	5.9	7.1	1.21
2021	0	.	.	.
2022	0	.	.	.
2023	96	7.4	8.2	1.11

Dataset	N (all observations)	Bias	N (only >= 3 ug/m^3)	Bias
AllData	**96**	**15.7**	**89**	**13.1**
Winter	0	.	.	.
Spring	0	.	.	.
Summer	63	10.2	62	9.6
Fall	33	26.4	27	21.0
2021	0	.	.	.
2022	0	.	.	.
2023	96	15.7	89	13.1

Proposal to Update PM2.5 Data from T640/T640X Monitors

- 2/15/2024 - EPA published in the *Federal Register* (89 Fed. Reg. 11,831) a "Notice of Opportunity to Comment" on the proposed plan to retroactively update the PM2.5 data in EPA's AQS from Teledyne T640 and T640X mass monitors.
  - Ensure data accurately represents ambient air concentrations
    - Regulatory decisions, PSD permitting, designations, exceptional events, attainment
    - Human health and ecosystem peer-reviewed research that support the NAAQS review process
  - Data update to all hourly T640/T640X PM2.5 in AQS from 2017 – present
  - Both the original and updated data will be publicly available
- 3/15/2024 - Comments received by (Docket ID No. EPA-HQ-OAR-2023-0642).
- April 2024 - Anticipate finalization of data update (if proposal finalized).
- May/June 2024 - Anticipate utilization of updated data in design values (if proposal finalized).

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PM2.5 AQI Changes

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AQI Breakpoint Change

- As part of a revision of the NAAQS, EPA adjusts the AQI accordingly.
- With regards to PM2.5…
  - Changes to the annual standard = change to the threshold level between good and moderate.
  - Changes to the 24-hour standard = change to the threshold level between moderate and USG.

Final Revision to AQI for $PM_{2.5}$

AQI Value	Current [µg/m³]	Revisions [µg/m³]
0, Good	0	0
50, Moderate	12	9
100, USG	35	35
150, Unhealthy	55	55
200, Very Unhealthy	150	125
300, Hazardous	250	225
500, Hazardous*	500	325

*The 500 breakpoint is used in conjunction with the 300 breakpoint to calculate AQI values within the hazardous category. The approach does not use the 500 breakpoint to determine other breakpoints values.

Source: https://www.4cleanair.org/wp-content/uploads/EPA-PM-NAAQS-Informational-Presentation-Feb-13-2024.pdf


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