PENNSYLVANIA:
Johnstown, Delaware County, Allegheny County, Allentown, and Lebanon County Nonattainment Areas

Area Designations for the
2012 Primary Annual PM$_{2.5}$ National Ambient Air Quality Standard
Technical Support Document

1.0   Summary

In accordance with Section 107(d) of the Clean Air Act (CAA), EPA must promulgate designations for all areas of the country. In particular, EPA must identify those areas that are violating a National Ambient Air Quality Standard (NAAQS) or contributing to a violation of the NAAQS in a nearby area. EPA must complete this process within 2 years of promulgating a new of revised NAAQS, or may do so within 3 years under circumstances not relevant to these designations.[1] This technical support document (TSD) describes EPA's decision to designate areas in Pennsylvania as nonattainment for the 2012 primary annual fine particle NAAQS (2012 annual PM$_{2.5}$ NAAQS).[2]

Under section 107(d), states are required to submit area designation recommendations to EPA for the 2012 annual PM$_{2.5}$ NAAQS no later than 1 year following promulgation of the standard, or by December 13, 2013. On December 10, 2013, the Commonwealth of Pennsylvania made designation recommendations for the 2012 annual PM$_{2.5}$ NAAQS based on air quality data from 2010-2012. On July 30, 2014, Pennsylvania updated its recommendations to reflect the latest air quality data. Pennsylvania recommended that the counties and portions of counties identified in Table 1 be designated as nonattainment for the 2012 annual PM$_{2.5}$ NAAQS, based on air quality data from 2011-2013.

On August 19, 2014, EPA sent Pennsylvania a letter conveying our preliminary designations and informing the Commonwealth of the opportunity to provide additional information for EPA for consideration in our final decision on designations. The Pennsylvania Department of Environmental Protection (PA DEP) and the Allegheny County Health Department (ACHD) each responded (on October 28, 2014 and September 29, 2014, respectively) providing both comments on our intended designations and additional supporting information and analysis related to EPA's intended boundaries for the Allegheny County and Allentown Areas.

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[1] Section 107(d) of the CAA requires EPA to complete the initial designation process within 2 years of promulgation of a new or revised NAAQS, unless the Administrator has insufficient information to make initial designation decisions in the 2-year time frame. In such circumstances, EPA may take up to 1 additional year to make initial area designation decisions (i.e., no later than 3 years after promulgation of the standard).

[2] On December 14, 2012, EPA promulgated a revised primary annual PM$_{2.5}$ NAAQS (78 FR 3086, January 15, 2013). In that action, EPA revised the primary annual PM$_{2.5}$ standard, strengthening it from 15.0 micrograms per cubic meter ($\mu g/m^3$) to 12.0 $\mu g/m^3$.

After considering these recommendations and based on EPA's technical analysis as described in this TSD, EPA is designating the areas listed in Table 1 as nonattainment for the 2012 annual $PM_{2.5}$ standard. EPA must designate an area nonattainment if it has an air quality monitoring site[3] that is violating the standard or if it has sources of emissions that are contributing to a violation of the NAAQS in a nearby area. Legal descriptions (e.g., county boundaries, townships and ranges) of these areas are found below in the supporting technical analysis for each area. As provided in CAA section 188(a), EPA will initially classify all nonattainment areas as "Moderate" nonattainment areas.

Table 1. Pennsylvania Recommended Nonattainment Areas and EPA's Final Designated Nonattainment Areas for the 2012 annual $PM_{2.5}$ NAAQS

Pennsylvania's Recommended		EPA's Final Designated Nonattainment Counties	
Nonattainment Area	**Nonattainment Counties**	**Nonattainment Area**	**Nonattainment Counties**
Cambria County	Cambria	Johnstown	Cambria and Indiana – partial (townships of West Wheatfield, Center, East Wheatfield and Armagh Borough and Homer City Borough)
Greater Philadelphia	Delaware	Delaware County	Delaware
Liberty-Clairton	Allegheny – partial (City of Clairton, and boroughs of Glassport, Liberty, Lincoln and Port View)	Allegheny County	Allegheny
Northampton County	Northampton	Allentown	Northampton and Lehigh
Lebanon County	Lebanon	Lebanon County	Lebanon

In its recommendation letters, Pennsylvania recommended that EPA designate Adams, Allegheny (except for the Liberty-Clairton area), Armstrong, Beaver, Berks, Blair, Bucks, Centre, Chester, Cumberland, Dauphin, Erie, Lackawanna, Lancaster, Mercer, Monroe, Montgomery, Philadelphia, Washington Westmoreland, and York Counties as "attainment" and all other counties not identified in the Pennsylvania's Recommended Nonattainment Counties column of Table 1 as "unclassifiable/attainment."

EPA agrees with Pennsylvania's nonattainment recommendations for the Delaware County and Lebanon County Areas. As shown in Table 1, EPA's final nonattainment designations differ from Pennsylvania's recommendations for the Cambria County (Johnstown), Liberty-Clairton (Allegheny

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[3] In accordance with 40 CFR 50 Appendix N, $PM_{2.5}$ measurements from the primary monitor and suitable collocated $PM_{2.5}$ FRM, FEM or ARMs may be used in a "combined site data record" to establish a $PM_{2.5}$ design value to determine whether the NAAQS is met or not met at a particular $PM_{2.5}$ monitoring site.

County), and Northampton County (Allentown) Areas. EPA will designate the remainder of Pennsylvania as unclassifiable/attainment based on Pennsylvania's recommendations, ambient monitoring data collected during the 2011-2013 period showing compliance with the 2012 annual $PM_{2.5}$ NAAQS, and EPA's determination that areas within the Commonwealth are not likely contributing to nearby violations.[4,5]

2.0   Nonattainment Area Analyses and Final Boundary Determination

EPA evaluated and determined the final boundaries for each nonattainment area on a case-by-case basis considering the specific facts and circumstances unique to each area. In accordance with the CAA section 107(d), EPA is designating as nonattainment not only the area with the monitoring sites that violate the 2012 annual $PM_{2.5}$ NAAQS, but also those nearby areas with emissions sources that contribute to the violation in the violating area. As described in EPA guidance[6], after identifying each monitoring site indicating a violation of the standard in an area, EPA analyzed those areas with emissions contributing to that violating area by considering those counties in the entire metropolitan area (e.g., Core Based Statistical Area (CBSA) or Combined Statistical Area (CSA)) in which the violating monitoring sites are located. EPA also evaluated counties adjacent to the CBSA or CSA that have emissions sources with the potential to contribute to the violations. EPA uses the CBSA or CSA as a starting point for the contribution analysis because those areas are nearby for purposes of the $PM_{2.5}$ NAAQS. Based upon relevant facts and circumstances in each area, the designated nonattainment area could be larger or smaller that the CBSA or CSA. EPA's analytical approach is described in section 3 of this TSD.

3.0   Technical Analysis

In this technical analysis, EPA used the latest data and information available to EPA (and to the states and tribes through the $PM_{2.5}$ Designations Mapping Tool[7] and EPA PM Designations Guidance and

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[4] Unless a state or tribe has specifically identified jurisdictional boundaries in their area recommendations, when determining "remainder of the state," EPA will use Federal Information Processing Standard (FIPS) codes maintained by the National Institute of Standards and Technology (NIST), which are used to identify counties and county equivalents (e.g., parishes, boroughs) of the United States and its unincorporated territories (e.g., American Samoa, Guam, Northern Mariana Islands, Puerto Rico, and the US Virgin Islands). Available on EPA's Envirofacts website at *http://www.epa.gov/envirofw/html/codes/state.html*.

[5] EPA uses a designation category of "unclassifiable/ attainment" for areas that are monitoring attainment and for areas that do not have monitoring sites but which EPA believes are likely attainment and does not contain emissions sources that are contributing to nearby violations based on the five factor analysis and other available information.

[6] EPA issued guidance on April 16, 2013, that identified important factors that EPA intended to evaluate, in making a recommendation for area designations and nonattainment boundaries for the 2012 annual $PM_{2.5}$ NAAQS. Available at *http://www.epa.gov/pmdesignations/2012standards/docs/april2013guidance.pdf.*

[7] EPA's $PM_{2.5}$ Designations Mapping Tool can be found at *http://geoplatform2.epa.gov/PM_MAP/index.html*.

Data web page[8]) and/or data provided to EPA by states. This technical analysis identifies the areas with monitoring sites that violate the 2012 annual $PM_{2.5}$ standard. EPA evaluated these areas and other nearby areas with emissions sources or activities that potentially contribute to ambient fine particle concentrations at the violating monitors in the area based on the weight of evidence of the five factors recommended in EPA guidance and any other relevant information.

These five factors are:

Factor 1: Air Quality Data. The air quality data analysis involves examining available ambient $PM_{2.5}$ air quality monitoring data at, and in the proximity of, the violating monitoring locations. This includes reviewing the design values (DVs) calculated for each monitoring location in the area based on air quality data for the most recent complete 3 consecutive calendar years of quality-assured, certified air quality data in EPA's Air Quality System (AQS). In general, EPA identifies violations using data from suitable Federal Reference Method (FRM), Federal Equivalent Method (FEM), and/or Approved Regional Method (ARM) monitors sited and operated in accordance with 40 CFR Part 58.[9] Procedures for using the air quality data to determine whether a violation has occurred are given in 40 CFR part 50 Appendix N, as revised by a final action published in the Federal Register on January 15, 2013 (78 FR 3086).[10] In addition to reviewing data from violating monitor sites, EPA also assesses the air quality data from other monitoring locations to help ascertain the potential contribution of sources in areas nearby to the violating monitoring sites. Examples include using chemical speciation data to help characterize contributing emissions sources and the determination of nearby contributions through analyses that differentiate local and regional source contributions.

Factor 2: Emissions and emissions-related data. The emissions analysis examines identified sources of direct $PM_{2.5}$, the major components of direct $PM_{2.5}$, e.g., primary organic carbon (POC) and $PM_{2.5}$ organic mass (POM), elemental carbon (EC), crustal material (and/or individual trace metal compounds)), primary nitrate and primary sulfate, and precursor gaseous pollutants (e.g., sulfur dioxide (SO_2), nitrogen oxides (NO_x), total volatile organic compounds (VOC), and ammonia (NH_3). Emissions data are generally derived from the most recent National Emissions Inventory (NEI) (i.e., 2011 NEI version 1), and are given in tons per year. The emission estimates are based on the "2011ed" air quality modeling platform.[11] Although many emissions inventory components of the "2011ed"

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[8] EPA's PM Designations Guidance and Data web page can be found at
http://www.epa.gov/pmdesignations/2012standards/techinfo.htm.

[9] Suitable monitors include all FEM and/or ARMs except those specific continuous FEMs/ARMs used in the monitoring agency's network where the data are not of sufficient quality such that data are not to be compared to the NAAQS in accordance with 40 CFR part 58.10(b)(13) and approved by EPA Regional Administrator per 40 CFR part 58.11(e).

[10] As indicated in Appendix N to 40 CFR part 50, Interpretation of the National Ambient Air Quality Standards for $PM_{2.5}$, section 3(a) indicates "Except as otherwise provided in this appendix, all valid FRM/FEM/ARM $PM_{2.5}$ mass concentration data produced by suitable monitors that are required to be submitted to AQS, or otherwise available to EPA, meeting the requirements of part 58 of this chapter including appendices A, C, and E shall be used in the DV (design value) calculations. Generally, EPA will only use such data if they have been certified by the reporting organization (as prescribed by § 58.15 of this chapter); however, data not certified by the reporting organization can nevertheless be used, if the deadline for certification has passed and EPA judges the data to be complete and accurate."

[11] http://www.epa.gov/ttn/chief/emch/2011v6/outreach/2011v6_2018base_EmisMod_TSD_26feb2014.pdf

modeling platform derive from the 2011 NEIv1, there are some differences between the platform inventories and the 2011 NEIv1 emissions. There are also some differences in PM emissions between the 2011 NEI v1 and "2011ed" due to the meteorological adjustments made for certain sectors. In some cases, EPA may also evaluate emissions information from states, tribes, or other relevant sources that may not be reflected in the NEI. One example of "other information" could include an inventory or assessment of local/regional area sources that individually does not meet the current threshold for reporting to the NEI but collectively contributes to area $PM_{2.5}$ concentrations. Emissions data indicate the potential for a source to contribute to observed violations, making it useful in assessing boundaries of nonattainment areas.

Factor 3: Meteorology. Evaluating meteorological data helps to determine the effect on the fate and transport of emissions contributing to $PM_{2.5}$ concentrations and to identify areas potentially contributing to the violations at monitoring sites. The Factor 3 analysis includes assessing potential source-receptor relationships in the area identified for evaluation using summaries of air trajectories, wind speed, wind direction, and other meteorological data, as available.

Factor 4: Geography/topography. The geography/topography analysis includes examining the physical features of the land that might define the airshed and, therefore, affect the formation and distribution of $PM_{2.5}$ over an area. Mountains or other physical features may influence the fate and transport of emissions and $PM_{2.5}$ concentrations. Additional analyses may consider topographical features that cause local stagnation episodes via inversions, such as valley-type features that effectively "trap" air pollution, leading to periods of elevated $PM_{2.5}$ concentrations.

Factor 5: Jurisdictional boundaries. The analysis of jurisdictional boundaries identifies the governmental planning and organizational structure of an area that may be relevant for designations purposes. These jurisdictional boundaries provide insight into how the governing air agencies conduct or might conduct air quality planning and enforcement in a potential nonattainment area. Examples of jurisdictional boundaries include counties, air districts, areas of Indian country, CBSA or CSA, metropolitan planning organizations (MPOs), and existing nonattainment areas.

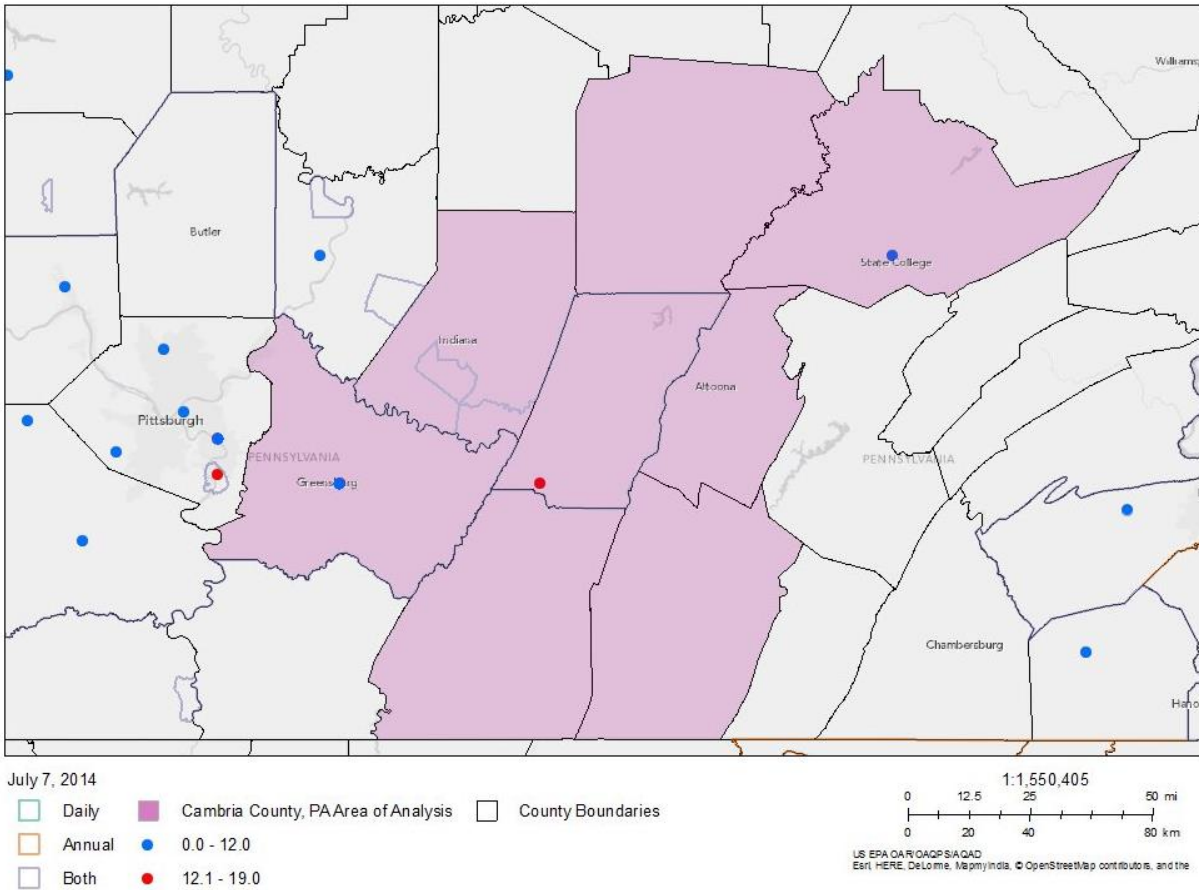## 3.1   Area Background and Overview - Johnstown Area

Figure 1a is a map of EPA's final nonattainment boundary for the Johnstown Area. The map shows the location and DVs of ambient air quality monitoring locations, county and other jurisdictional boundaries including the Johnstown, Pennsylvania Metropolitan Statistical Area (MSA). For purposes of the 1997 annual $PM_{2.5}$ NAAQS, this area was designated nonattainment. The boundary for the nonattainment area for the 1997 annual $PM_{2.5}$ NAAQS included the entire county of Cambria and part of Indiana County in Pennsylvania. For purposes of the 2006 24-hour $PM_{2.5}$ NAAQS, this area was designated nonattainment. The same boundary represents the nonattainment area for the 2006 24-hour $PM_{2.5}$ NAAQS. The final nonattainment boundary for the Johnstown Area for the 2012 annual $PM_{2.5}$ NAAQS is the same as the designated nonattainment area boundary for the Johnstown Area for the 1997 annual and the 2006 24-hour $PM_{2.5}$ NAAQS.

Figure 1a. EPA's Final Nonattainment Boundaries for the Johnstown Area
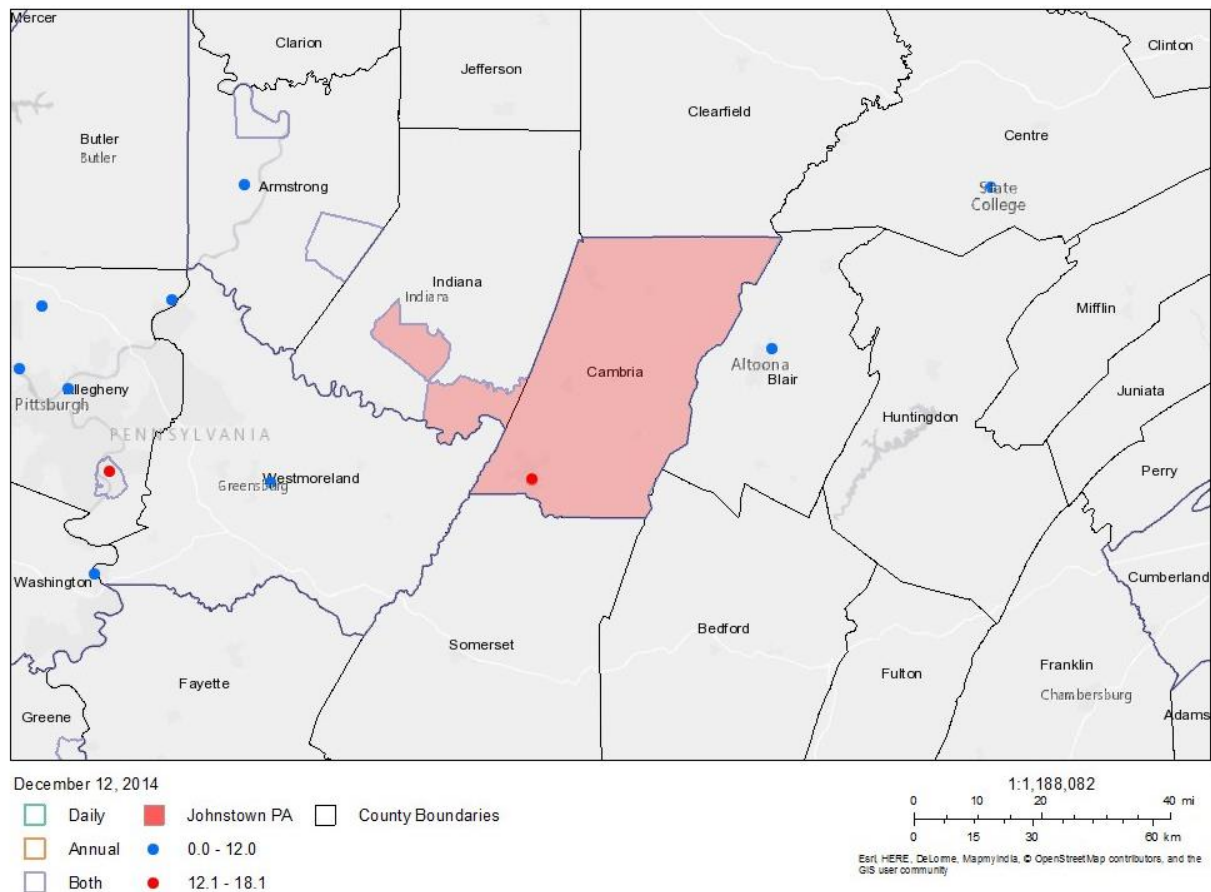
EPA must designate as nonattainment areas that violate the NAAQS and nearby areas that contribute to the violation in the violating area. Cambria County shows a violation of the 2012 $PM_{2.5}$ NAAQS, therefore this county is included in the nonattainment area. The Johnstown, Pennsylvania MSA is a single county MSA which consists of Cambria County, Pennsylvania. As shown in Figure 1b, EPA evaluated the Johnstown, Pennsylvania MSA and a ring of counties adjacent to the Johnstown, Pennsylvania MSA which includes Bedford, Blair, Centre, Clearfield, Indiana, Somerset and Westmorland counties in Pennsylvania. EPA's evaluation was based on the five factors and other relevant information and, as discussed below, supports a finding that the townships of West Wheatfield, Center, East Wheatfield and Armagh Borough and Homer City Borough in Indiana County contribute to the nearby violation in Cambria County. The following sections describe this five factor analysis process. While the factors are presented individually, they are not independent. The five factor analysis process carefully considers their interconnections and the dependence of each factor on one or more of the others.

Figure 1b. Area of Analysis for the Final Johnstown Nonattainment Area

July 7, 2014

Daily	Cambria County, PA Area of Analysis	County Boundaries
Annual	0.0 - 12.0	
Both	12.1 - 19.0	

1:1,550,405

US EPA OAR/OAQPS/AQAD
Esri, HERE, DeLorme, Mapmyindia, © OpenStreetMap contributors, and the

Factor 1: Air Quality Data

All data collected during the year are important when determining contributions to an annual standard such as the 2012 annual PM$_{2.5}$ NAAQS. Compliance with an annual NAAQS is dependent upon monitor readings throughout the year, including days with monitored ambient concentrations below the level of the NAAQS. For the 2012 annual PM$_{2.5}$ NAAQS, the annual mean is calculated as the mean of quarterly means. A high quarter can drive the mean for an entire year, which, in turn, can drive an elevated 3-year DV. Although all data are important, seasonal or episodic emissions can provide insight as to relative contributors to measured PM$_{2.5}$ concentrations. For these reasons, for the Factor 1 air quality analysis, EPA assessed and characterized air quality at, and in the proximity of, the violating monitoring site locations first, by evaluating trends and the spatial extent of measured concentrations at monitors in the area of analysis, and then, by identifying the conditions most associated with high average concentration levels of PM$_{2.5}$ mass in the area of analysis.

In most cases, EPA assessed air quality data on a seasonal, or quarterly, basis.[12] EPA also identified the spatial extent of these high $PM_{2.5}$ concentrations. The mass and composition at the DV location represents contributions from various emission sources including local, area-wide (which may comprise nearby urban and rural areas) and regional sources. To determine the source mix (by mass) at the DV monitoring site, EPA examined the chemical composition of the monitored $PM_{2.5}$ concentrations by pairing each violating FRM/FEM/ARM monitoring site with a collocated or nearby Chemical Speciation Network (CSN) monitoring site or sites. Then, EPA contrasted the approximated mass composition at the DV monitoring site with data collected at IMPROVE[13] and other monitoring locations whose data are representative of regional background.[14,15] This comparison of local/area-wide chemical composition data to regional chemical composition data derives an "urban increment," which helps differentiate the influence of more distant emissions sources from the influence of closer emissions sources, thus representing the portion of the measured violation that is associated with nearby emission contributions.[16,17,18]

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[12] Although compliance with the annual NAAQS depends on contributions from all days of the year, examining data on a quarterly or seasonal basis can inform the relationship between the temporal variability of emissions and meteorology and the resulting $PM_{2.5}$ mass and composition. In some areas of the country where there may be noticeable month-to-month variations in average $PM_{2.5}$, the quarterly averages may not adequately represent seasonal variability. In these areas, air quality data may be aggregated and presented by those months that best correspond to the local "seasons" in these areas.

[13] IMPROVE stands for Interagency Monitoring for Protected Visual Environments and is an aerosol monitoring network in mostly rural and remote areas.

[14] The "urban increment" analysis assesses and characterizes the increase in seasonal and annual average $PM_{2.5}$ mass and chemical components observed at violating monitoring site(s) relative to monitoring sites outside the area of analysis (which represent background concentrations). Developing the urban increment involves pairing a violating FRM/FEM/ARM monitor with a collocated monitor or nearby monitor with speciation data. EPA made every effort to pair these data to represent the same temporal and spatial scales. However, in some cases, the paired violating and CSN "urban" monitoring locations were separated by some distance such that the included urban CSN site(s) reflect(s) a different mixture of emissions sources, which could lead to misinterpretations. To generally account for differences in $PM_{2.5}$ mass between the violating site and the nearby CSN site(s), EPA determined material balance of the $PM_{2.5}$ composition at the violating site by assigning the extra measured $PM_{2.5}$ mass to the carbon components of $PM_{2.5}$. Where the general urban increment approach may be misleading, or in situations where non-carbonaceous emissions are believed to be responsible for a local $PM_{2.5}$ concentration gradient, EPA used alternative analyses to reflect the mix of urban and rural sources contributing to the measured concentrations at violating monitoring sites.

[15] The urban monitors were paired with any rural sites within a 150 mile radius of an urban site to calculate spatial means of the quarterly averages of each species. If there were no rural sites within 150 miles, then the nearest rural site was used alone. That rural mean was then subtracted from the quarterly mean of the urban site to get the increment. Negative values were simply replaced with zeros.

[16] In most, but not all, cases, the violating design value monitoring site is located in an urban area. Where the violating monitor is not located in an urban area, the "urban increment" represents the difference between local and other nearby emission sources in the vicinity of the violating monitoring location and more regional sources.

[17] Hand, et. al. Spatial and Seasonal Patterns and Temporal Variability of Haze and its Constituents in the United States: Report V, June 2011. Chapter 7 – Urban Excess in $PM_{2.5}$ Speciated Aerosol Concentrations, *http://vista.cira.colostate.edu/improve/Publications/Reports/2011/PDF/Chapter7.pdf*

[18] US EPA, Office of Air Quality Planning and Standards, December 2004. (2004) Area Designations for 1997 Fine Particle ($PM_{2.5}$) Standards, Technical Support Document for State and Tribal Air Quality Fine Particle ($PM_{2.5}$)

PM$_{2.5}$ Design Values and Total Mass Measurements - EPA examined ambient PM$_{2.5}$ air quality monitoring data represented by the DVs at the violating monitoring site and at other monitors in the area of analysis. EPA calculated DVs based on air quality data for the most recent 3 consecutive calendar years of quality-assured, certified air quality data from suitable FEM/FRM/ARM monitoring sites in EPA's Air Quality System (AQS). For this designations analysis, EPA used data for the 2011-2013 period (i.e., the 2013 DV), which are the most recent years with fully-certified air quality data. A monitor's DV is the metric or statistic that indicates whether that monitor attains a specified air quality standard. The 2012 annual PM$_{2.5}$ NAAQS is met at a monitoring site when the 3-year average annual mean concentration is 12.0 micrograms per cubic meter (µg/m^3) or less (e.g., 12.1 µg/m^3 or greater is a violation). A DV is only valid if minimum data completeness criteria are met or when other regulatory data processing provisions are satisfied (See 40 CFR part 50 Appendix N). Table 2 identifies the current DVs (i.e., the 2013 DV) and the most recent two DVs based on all monitoring sites in the area of analysis for the Johnstown Area intended nonattainment area.[19]

Table 2. Air Quality Data collected at Regulatory Monitors (all DV levels in µg/m^3)[a,b,]

County, State	Monitor Site ID	State Rec NA?	09-11 DV	10-12 DV	11-13 DV
Bedford, PA	N/A	No	No monitor		
Blair, PA	N/A	No	No monitor		
Cambria, PA	420210011	Yes	**12.4**	**12.3**	**12.3**
Centre, PA	420270100	No	9.3	9.5	9.3
Clearfield, PA	N/A	No	No monitor		
Indiana, PA	N/A	No	No monitor		
Somerset, PA	N/A	No	No monitor		
Westmoreland, PA	421290008	No	13.7	12.6	11.1

[a]If a county has more than one monitoring location, the county DV is indicated in bold type.
[b]If a monitor is violating, the NAAQS, the violating DV is indicated in red type.

The Figure 1a map, shown previously, identifies the final boundaries for the Johnstown Area nonattainment area, the Johnstown, Pennsylvania MSA boundary and monitoring locations with 2011-2013 violating DVs. As indicated on the map, there is one violating monitoring located in Cambria County, Pennsylvania (Cambria County violating monitor).
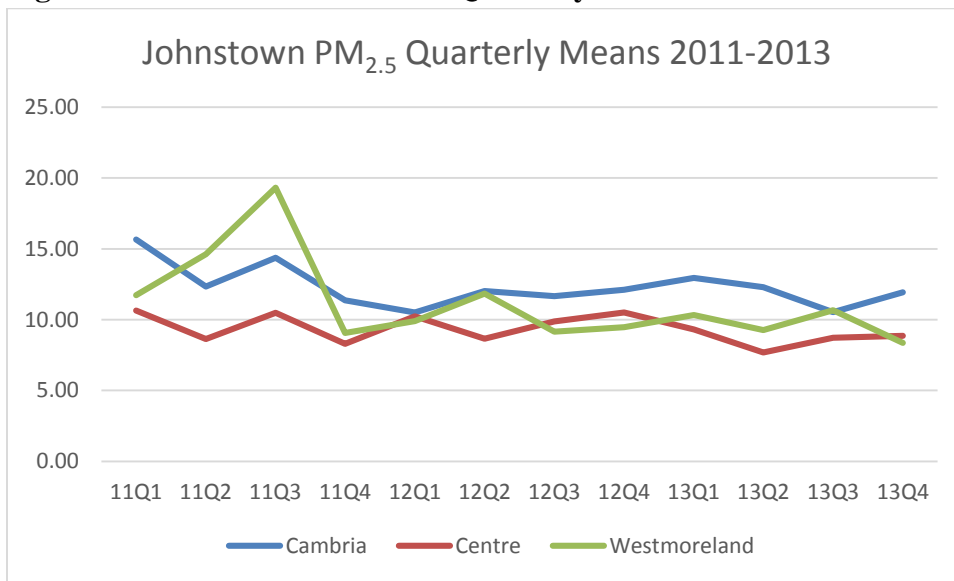
Seasonal variation can highlight those conditions most associated with high average concentration levels of PM$_{2.5}$. Figure 2 shows quarterly mean PM$_{2.5}$ concentrations for the most recent 3-year period

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Designations, Chapter 3, Urban Excess Methodology. Available at
www.epa.gov/pmdesignations/1997standards/documents/final/TSD/Ch3.pdf

[19] In certain circumstances, one or more monitoring locations within a monitoring network may not meet the network technical requirements set forth in 40 CFR 58.11(e), which states, "State and local governments must assess data from Class III PM$_{2.5}$ FEM and ARM monitors operated within their network using the performance criteria described in table C-4 to subpart C of part 53 of this chapter, for cases where the data are identified as not of sufficient comparability to a collocated FRM, and the monitoring agency requests that the FEM or ARM data should not be used in comparison to the NAAQS. These assessments are required in the monitoring agency's annual monitoring network plan described in §58.10(b) for cases where the FEM or ARM is identified as not of sufficient comparability to a collocated FRM…."

for the highest DV monitoring sites in each county within the area of analysis. This graphical representation is particularly relevant when assessing air quality data for an annual standard, such as the 2012 annual $PM_{2.5}$ NAAQS, because, as previously stated, the annual mean is calculated as the mean of quarterly means and a high quarter can drive the mean for an entire year, which, in turn, can drive an elevated 3-year DV.

Figure 2. Johnstown Area $PM_{2.5}$ Quarterly Means for 2011-2013

Johnstown $PM_{2.5}$ Quarterly Means 2011-2013

25.00
20.00
15.00
10.00
5.00
0.00

11Q1 11Q2 11Q3 11Q4 12Q1 12Q2 12Q3 12Q4 13Q1 13Q2 13Q3 13Q4

Cambria   Centre   Westmoreland

As shown, in Figure 2, the Cambria County monitor does not follow a seasonal pattern with consistent peaks in the first and third quarters. The Centre County monitor does follow a seasonal pattern. The peaks in the first quarter (January – March) may be due to higher electric generating units (EGUs) emissions from increased heating use in winter season and may include emissions from home heating oil and residential wood burning stoves. In addition, there is a greater tendency for NO_x to form in the atmosphere and for FRM monitors to retain particle nitrate during the cooler months. The peaks in the third quarter (July - September) likely correspond to higher emissions from EGUs from higher air conditioning use during summer season. The Westmoreland monitor in the area of analysis somewhat follows this peaking pattern except for the beginning of 2011. Starting in the fourth quarter of 2011 the Westmoreland monitor monitored lower $PM_{2.5}$ and Table 2 shows that it began meeting the 12.0 ug/m^3 standard.

PM$_{2.5}$ Composition Measurements - To assess potential emissions contributions for each violating monitoring location, EPA determined the various chemical species comprising total $PM_{2.5}$ to identify the chemical components over the analysis area, which can provide insight into the types of emission sources impacting the monitored concentration. To best describe the $PM_{2.5}$ at the violating monitoring location, EPA first adjusted the chemical speciation measurement data from a monitoring location at or near the violating FRM monitoring site using the SANDWICH approach to account for the amount

of PM$_{2.5}$ mass components retained in the FRM measurement.[20,21,22,23] In particular, this approach accounts for losses in fine particle nitrate and increases in sulfate mass associated with particle bound water. Figure 3a illustrates the fraction of each PM$_{2.5}$ chemical component at the Cambria County, Pennsylvania monitoring site based on annual averages for the years 2010-2012.

Figure 3a. Johnstown Area Annual Average PM$_{2.5}$ Chemical Components (2010-2012)
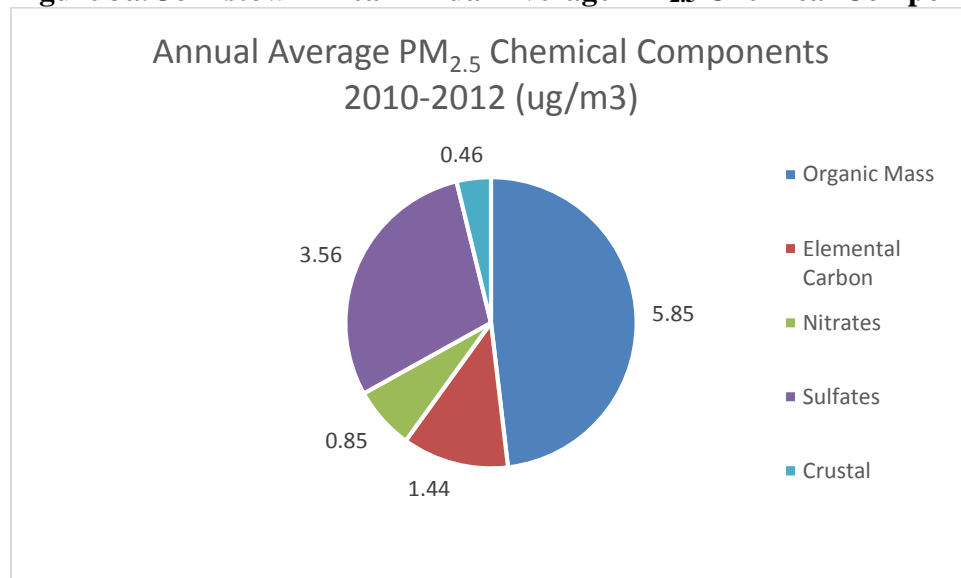

Figure 3b shows annual and quarterly chemical composition profiles and illustrates any seasonal or episodic contributors to PM$_{2.5}$ mass. This "increment analysis," combined with the other factor analyses, can provide additional insight as to which sources or factors may contribute at a greater level. Simply stated, this analysis can help identify nearby sources of emissions that contribute to the violation at the violating monitoring site.

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[20] SANDWICH stands for measured **S**ulfate, **A**djusted **N**itrate, **D**erived **W**ater, **I**nferred **C**arbonaceous mass **H**ybrid Material Balance Approach." The SANDWICH adjustment uses an FRM mass construction methodology that results in reduced nitrates (relative to the amount measured by routine speciation networks), higher mass associated with sulfates (reflecting water included in gravimetric FRM measurements) and a measure of organic carbonaceous mass derived from the difference between measured PM$_{2.5}$ and its non-carbon components. This characterization of PM$_{2.5}$ mass also reflects crustal material and other minor components. The resulting characterization provides a complete mass closure for the measured FRM PM$_{2.5}$ mass, which can be different than the data provided directly by the speciation measurements from the CSN network.

[21] Frank, N. H., SANDWICH Material Balance Approach for PM$_{2.5}$ Data Analysis, National Air Monitoring Conference, Las Vegas, Nevada, November 6-9, 2006. *http://www.epa.gov/ttn/amtic/files/2006conference/frank.pdf*.

[22] Frank, N. H., The Chemical Composition of PM$_{2.5}$ to support PM Implementation, EPA State /Local/Tribal Training Workshop: PM$_{2.5}$ Final Rule Implementation and 2006 PM$_{2.5}$ Designation Process, Chicago IL, June 20-21, 2007, *http://www.epa.gov/ttn/naaqs/pm/presents/pm2.5_chemical_composition.pdf*.

[23] Frank, N. H. *Retained Nitrate, Hydrated Sulfates, and Carbonaceous Mass in Federal Reference Method Fine Particulate Matter for Six Eastern U.S. Cities*. J. Air & Waste Manage. Assoc. 2006 56:500–511.

Figure 3b. Johnstown Area Annual and Quarterly Average PM$_{2.5}$ Species (2010-2012)[a]
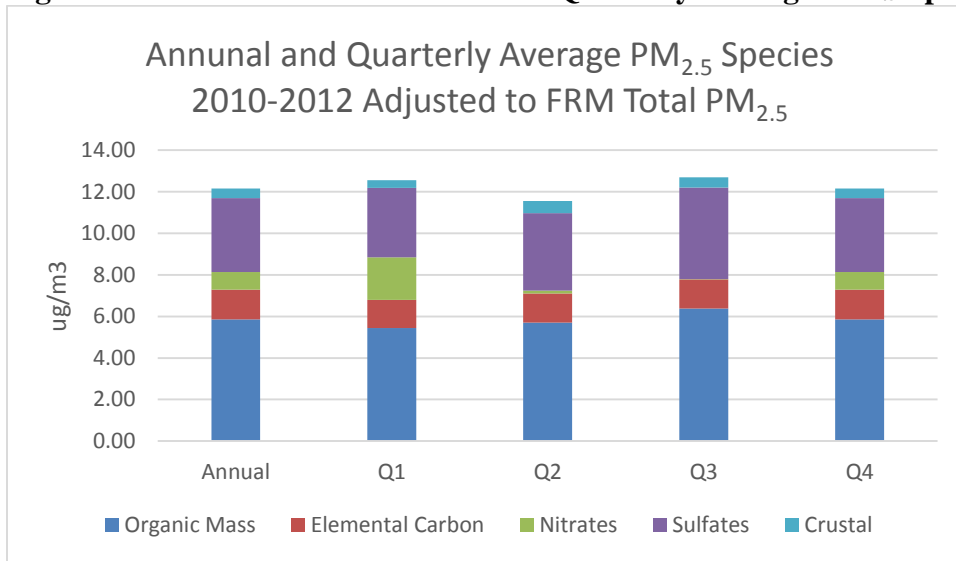
Annual and Quarterly Average PM$_{2.5}$ Species
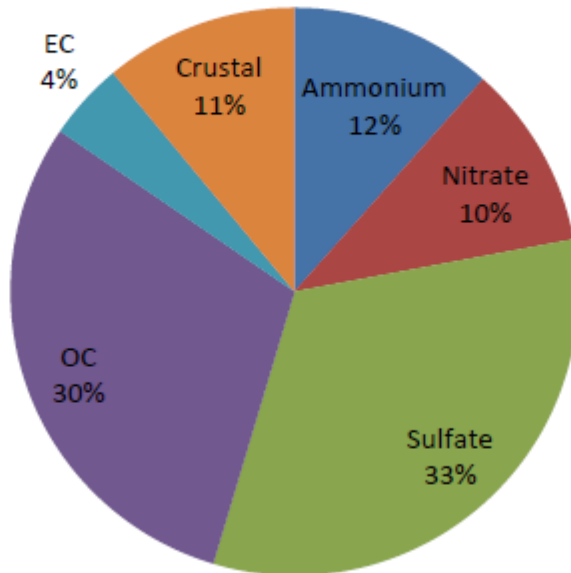2010-2012 Adjusted to FRM Total PM$_{2.5}$

[a]
Adjusted to FRM Total PM$_{2.5}$ indicates that the speciation profile and total mass depicted in this figure are the result of the urban increment calculation for the particular FRM monitor.

The speciation data in Figures 3a and 3b for the Cambria County violating monitoring site indicate that organic mass and sulfates are the predominant species overall. Figure 3b shows that in the first quarter, the nitrate component is higher than in the second through fourth quarters. This may be due to higher EGU emissions during the winter season as well as greater particle nitrate collection during the cooler months. In all four quarters, elemental carbon and crustal are smaller PM$_{2.5}$ components.

In addition, in Pennsylvania's December 2013 recommendation letter, Pennsylvania analyzed the speciation data from the Cambria County monitor for the 2010-2012 monitoring period (note that Pennsylvania's speciation presentation is based on measurement data which was not adjusted by the SANDWICH method.). Figure 3c displays the average distribution of measured speciated components of PM$_{2.5}$ during the entire 2010-2012 monitoring period, and similarly shows that organic carbon and sulfate are large components of PM$_{2.5}$ in the area.[24]

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[24] EPA notes that POM is much larger than measured OC and therefore represents a larger percentage of measured PM$_{2.5}$. Similarly, other PM$_{2.5}$ components like crustal material will represent a smaller portion of PM$_{2.5}$ when POM and other adjustments to measured components are made to represent the components of PM$_{2.5}$ using the SANDWICH approach. Crustal is a small PM$_{2.5}$ component whose average quarterly value is 0.4 to 0.6 ug/m3.
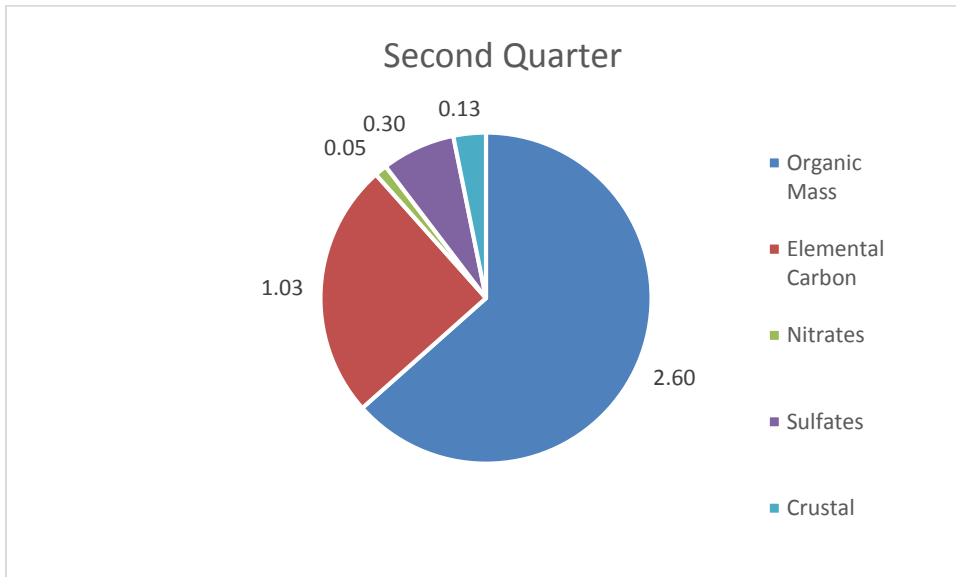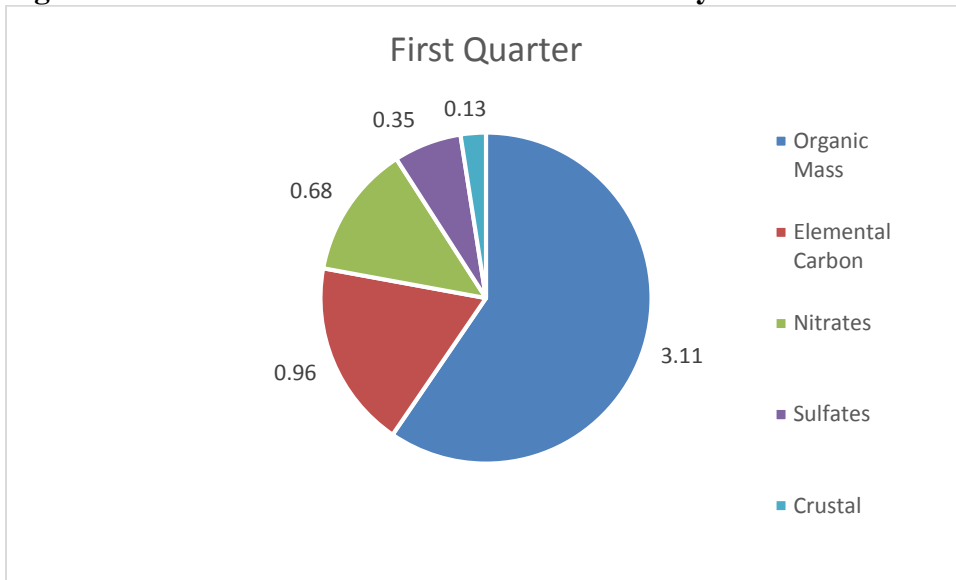
Figure 3c. Johnstown Area Speciated PM$_{2.5}$ Data (2010-2012)

Source: Pennsylvania's December 10, 2013 recommendation letter, Appendix C-4 - Cambria County Area

EPA assessed seasonal and annual average PM$_{2.5}$ components at monitoring sites within the area relative to monitoring sites outside of the analysis area to account for the difference between regional background concentrations of PM$_{2.5}$, and the concentrations of PM$_{2.5}$ in the area of analysis, also known as the "urban increment." This analysis differentiates between the influences of emissions from sources in nearby areas and in more distant areas on the violating monitor. Estimating the urban increment in the area helps to illuminate the amount and type of particles at the violating monitor that are most likely to be the result of sources of emissions in nearby areas, as opposed to impacts of more distant or regional sources of emissions. Figure 4a includes pie charts showing the annual and quarterly chemical mass components of the urban increment. Note that in these charts, sulfates and nitrates have been adjusted to represent their mass in measured PM$_{2.5}$.

Figure 4a. Johnstown Area Urban Increment Analysis for 2010-2012.

First Quarter

- Organic Mass
- Elemental Carbon
- Nitrates
- Sulfates
- Crustal

Second Quarter

- Organic Mass
- Elemental Carbon
- Nitrates
- Sulfates
- Crustal

Third Quarter

0.00 0.21 0.12

0.96

2.82

- Organic Mass
- Elemental Carbon
- Nitrates
- Sulfates
- Crustal

Fourth Quarter

0.24 0.16

0.38

1.11

3.11

- Organic Mass
- Elemental Carbon
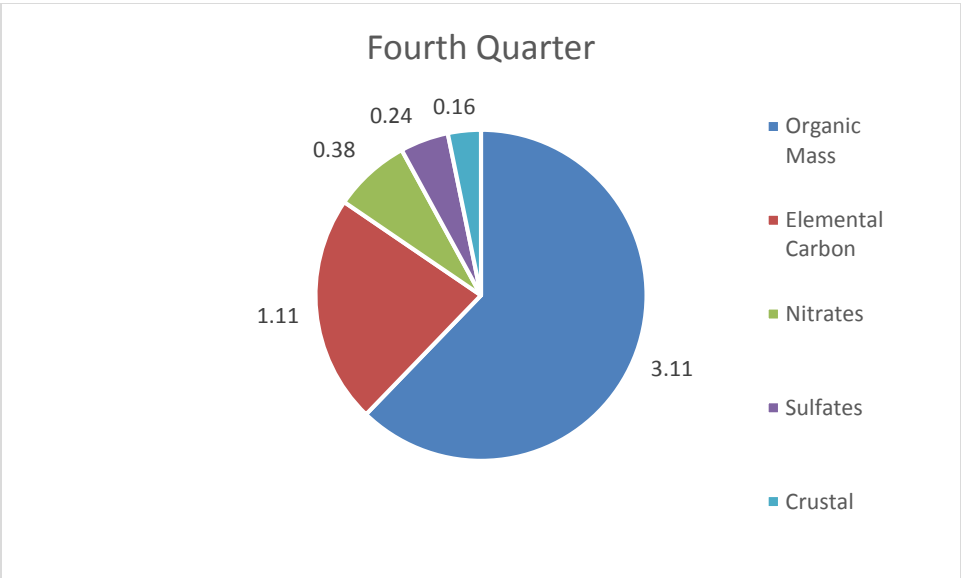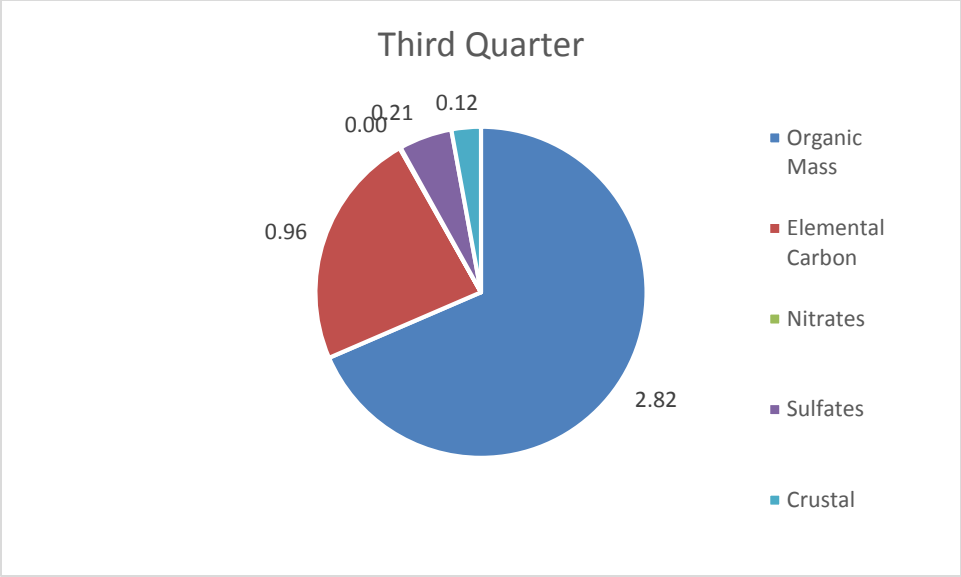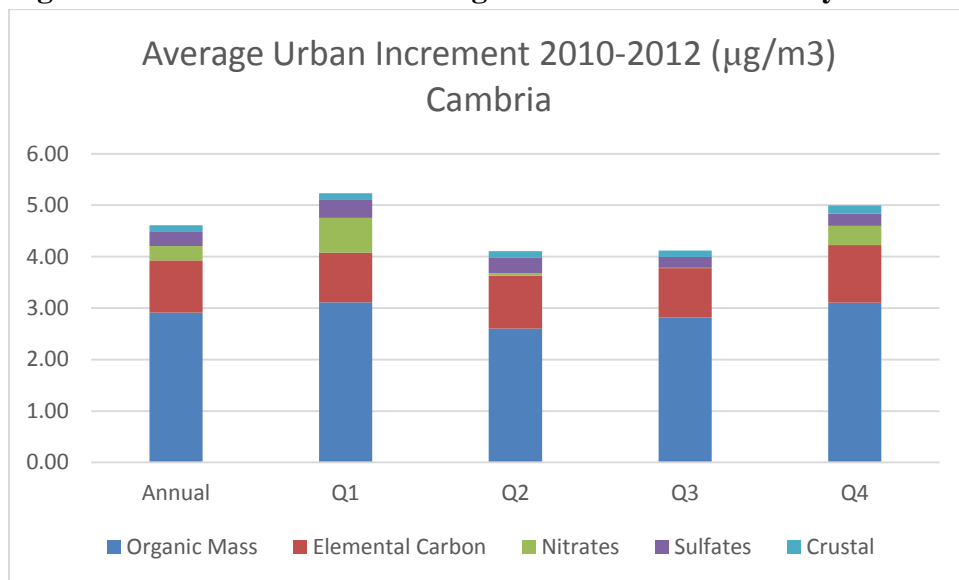- Nitrates
- Sulfates
- Crustal

Figure 4b. Johnstown Area Average Urban Increment Analysis for 2010-2012.

The urban increment data provides further insight to the chemical composition of PM$_{2.5}$ at the Cambria County violating monitoring site. As previously stated, Figures 3a-c show that organic mass and sulfates are the predominant species overall. When accounting for the urban increment in Figure 4a and Figure 4b, the sulfate component becomes less dominant, however, there is still some remaining sulfate detected at the monitor. Figure 4a and Figure 4b clearly indicate that organic mass and elemental carbon are the major components of PM$_{2.5}$ contributing to the violation at the Cambria County monitoring site.
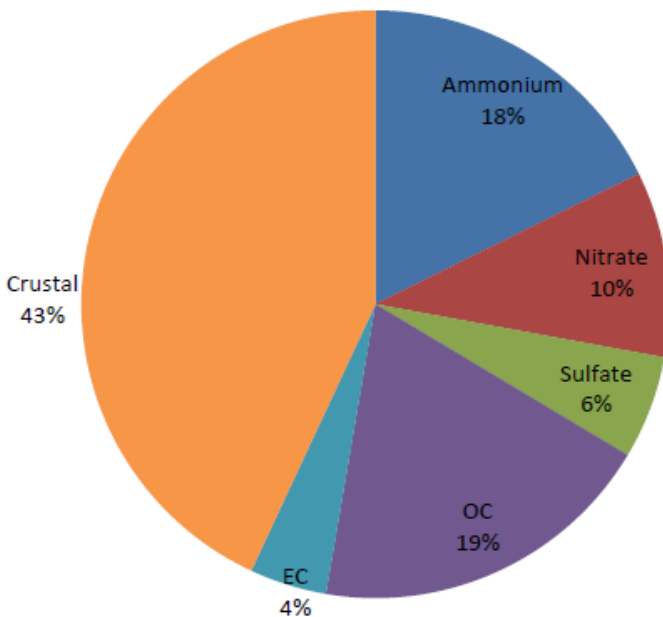
In Pennsylvania's December 2013 recommendation letter, Pennsylvania also included urban increment data (referred to as urban excess by Pennsylvania) for the Cambria County monitor during the 2010-2012 monitoring period. Pennsylvania compared measured PM$_{2.5}$ at the violating monitor (referred to as the Johnstown monitor by Pennsylvania) to the Florence monitor (AIRS #42-125-5001) which is situated in Hillman State Park in northern Washington County and reflects the transport coming into western Pennsylvania from areas to the west. Pennsylvania compared the 1st and 3rd quarters in the 2010-2012 monitoring period for these two monitors. Figures 4c and 4d show the urban excess at the Johnstown monitor (note that Pennsylvania's urban increment presentation is based on measurement data which was not adjusted by the SANDWICH method.).

Figure 4c. Urban Excess for Johnstown (Cambria) vs. Florence for 2010-2012 – 1st Quarter.
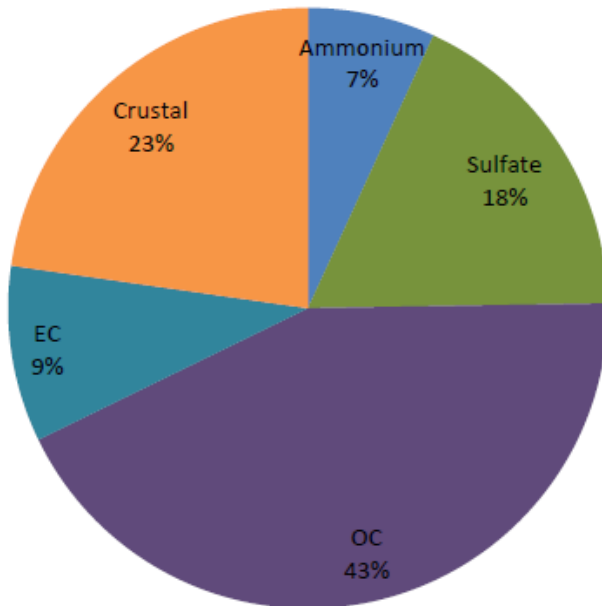
Source: Pennsylvania's December 10, 2013 recommendation letter, Appendix C-4 - Cambria County Area

Figure 4d. Urban Excess for Johnstown (Cambria) vs. Florence for 2010-2012 – 3rd Quarter.

Source: Pennsylvania's December 10, 2013 recommendation letter, Appendix C-2 - Cambria County Area

Pennsylvania's urban increment analysis shows a large amount of organic carbon in the first quarter with some crustal, sulfate and elemental carbon components. In the third quarter, the crustal component is the largest with some organic carbon and ammonium. As noted, Pennsylvania's data was not adjusted using the SANDWICH method and, as stated above, EPA's urban increment analysis shows that the crustal percent of the increment is only 5-7% and that carbonaceous mass is the predominant component.

Factor 2: Emissions and emissions-related data

In this designations process, for each area with a violating monitoring site, EPA evaluated the emissions data from nearby areas using emissions related data for the relevant counties to assess each county's potential contribution to $PM_{2.5}$ concentrations at the violating monitoring site or monitoring sites in the area under evaluation. Similar to the air quality analysis, these data were examined on a seasonal basis (see Figure 2b and Table 3c). EPA examined emissions of identified sources or source categories of direct $PM_{2.5}$, the major components of direct $PM_{2.5}$ (organic mass, elemental carbon, crustal material (and/or individual trace metal compounds)), primary nitrate and primary sulfate, and precursor gaseous pollutants (i.e., SO_2, NO_X, total VOC, and NH_3). EPA also considered the distance of those sources of emissions from the violating monitoring site. While direct $PM_{2.5}$ emissions and its major carbonaceous components are generally associated with sources near violating $PM_{2.5}$ monitoring sites, the gaseous precursors tend to have a more regional influence (although EPA is mindful of the potential local NO_X and VOC emissions contributions to $PM_{2.5}$ from mobile and stationary sources) and transport from neighboring areas can contribute to higher $PM_{2.5}$ levels at the violating monitoring sites.

Emissions Data

For this factor, EPA reviewed data from the 2011 National Emissions Inventory (NEI) version 1 (see *http://www.epa.gov/ttn/chief/net/2011inventory.html*). For each county in the area of analysis, EPA examined the magnitude of county-level emissions reported in the NEI. These county-level emissions represent the sum of emissions from the following general source categories: point sources, non-point (i.e., area) sources, nonroad mobile, on-road mobile, and fires. EPA also looked at the geographic distribution of major point sources of the relevant pollutants.[25] Significant emissions levels from sources in a nearby area indicate the potential for the area to contribute to monitored violations.

To further analyze area emissions data, EPA also developed a summary of direct $PM_{2.5}$, components of direct $PM_{2.5}$, and precursor pollutants, which is available at *http://www.epa.gov/pmdesignations/2012standards/docs/nei2011v1pointnei2008v3county.xlsx*.

When considered with the urban increment analysis in Factor 1, evaluating the components of direct $PM_{2.5}$ and precursor gases can help identify specific sources or source types contributing to elevated concentrations at violating monitoring sites and thus assist in identifying appropriate area boundaries. In general, directly emitted POC and VOCs[26] contribute to POM; directly emitted elemental carbon (EC) contributes to $PM_{2.5}$ EC; NO_X, NH_3 and directly emitted nitrate contribute to $PM_{2.5}$ nitrate mass (PNO3); SO_2, NH_3 and directly emitted sulfate contribute to $PM_{2.5}$ sulfate mass (PSO4); and directly

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[25] For purposes of this designations effort, "major" point sources are those whose sum of PM precursor emissions ($PM_{2.5}$ + NOx + SO_2 + VOC + NH_3) are greater than 500 tons per year based on NEI 2011v1.

[26] As previously mentioned, nearby VOCs are presumed to be a less important contributor to POM than POC.

emitted crustal material and metal oxides contribute to $PM_{2.5}$ crustal matter (Pcrustal). [27,28] EPA believes that the quantities of those nearby emissions as potential contributors to the $PM_{2.5}$ violating monitors are somewhat proportional to the $PM_{2.5}$ chemical components in the estimated urban increment. Thus, directly emitted POC is more important per ton than SO_2, partially because POC emissions are already $PM_{2.5}$ whereas SO_2 must convert to $PM_{2.5}$ and not all of the emitted SO_2 undergoes this conversion.

Table 3a provides a county-level emissions summary (i.e., the sum of emissions from the following general source categories: point sources, non-point (i.e., area) sources, nonroad mobile, on-road mobile, and fires) of directly emitted $PM_{2.5}$ and precursor species in tons per year (tpy) for the county with the violating monitoring site and nearby counties considered for inclusion in the Johnstown Area. Table 3b summarizes the directly emitted components of $PM_{2.5}$ for the same counties in the area of analysis for the Johnstown Area. Table 3c gives total emissions by quarter for the area of analysis. This information will be paired with the urban increment composition previously shown in Figures 4a and 4b.

Table 3a. County-Level Emissions of Directly Emitted $PM_{2.5}$ and Precursors (tpy)

County, State	Total NH₃	Total NOX	Total Direct PM₂.₅	Total SO₂	Total VOC	Total
Indiana, PA	832	35,818	3,172	98,344	5,005	143,171
Clearfield, PA	226	9,471	839	25,644	3,940	40,120
Westmoreland, PA	1,037	12,924	1,957	1,262	9,837	27,017
Cambria, PA	373	6,115	1,334	7,236	4,100	19,158
Blair, PA	1,131	4,849	1,156	4,091	3,961	15,189
Centre, PA	909	6,345	1,222	2,120	4,577	15,173
Somerset, PA	1,173	3,320	1,216	461	4,059	10,230
Bedford, PA	1,222	2,659	539	222	2,537	7,180

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[27] *See*, Seinfeld J. H. and Pandis S. N. (2006) *Atmospheric Chemistry and Physics: From Air Pollution to Climate Change*, 2nd edition, J. Wiley, New York. See also, Seinfeld J. H. and Pandis S. N. (1998) *Atmospheric Chemistry and Physics: From Air Pollution to Climate Change*, 1st edition, J. Wiley, New York.

[28] USEPA Report (2004), The Particle Pollution Report: Current Understanding of Air Quality and Emissions through 2003, found at: *http://www.epa.gov/airtrends/aqtrnd04/pm.html*.

Table 3b. County-Level Emissions for Components of Directly Emitted PM$_{2.5}$ (tpy) [29]

County, State	POM	EC	PSO4	PNO3	Pcrustal	Residual	Total Direct
Indiana, PA	547	172	247	4	870	1,333	3,172
Westmoreland, PA	962	277	101	6	206	405	1,957
Cambria, PA	678	148	48	3	158	300	1,334
Centre, PA	743	177	22	3	106	172	1,222
Somerset, PA	751	141	23	5	115	181	1,216
Blair, PA	668	141	48	2	118	180	1,156
Clearfield, PA	433	124	39	2	64	177	839
Bedford, PA	330	73	8	1	52	75	539

Table 3b breaks down the direct PM$_{2.5}$ emissions value from Table 3a into its components. These data will also be compared with the previously presented urban increment composition. As can be seen, Indiana County has the highest total emissions of directly emitted PM$_{2.5}$ and its precursors. In Table 3a, Indiana County's total emissions (143,171 tpy) are at least three times more than any other county's total emissions in the area of analysis. Indiana County's total direct PM$_{2.5}$ emissions (3,172 tpy) are also much higher than the other counties in the area of analysis. In the breakdown of direct PM$_{2.5}$ in Table 3b, a large portion of the Indiana County PM$_{2.5}$ is organic mass and crustal material. EPA's urban increment data in Figures 4a and 4b indicate that organic mass is the main component of PM$_{2.5}$ at the Cambria County violating monitor.

Using the previously described relationship between directly emitted and precursor gases and the measured mass to evaluate data presented in Tables 3a and 3b, EPA identified the following emissions warranting additional review: POM, EC, Pcrustal, SO$_2$ and VOC. EPA then looked at the contribution of these emissions from each of the counties included in the area of analysis as shown in Tables 4a-e.

Table 4a. County-Level POM Emissions

County, State	Emissions in average tpy		
	POM	Pct.	Cumulative %
Westmoreland, PA	962	19%	19%
Somerset, PA	751	15%	34%
Centre, PA	743	15%	48%
Cambria, PA	678	13%	61%
Blair, PA	668	13%	74%
Indiana, PA	547	11%	85%
Clearfield, PA	433	8%	94%
Bedford, PA	330	6%	100%

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[29] Data are based on the 2011 and 2018 Emissions Modeling Platform Data Files and Summaries (*ftp://ftp.epa.gov/EmisInventory/2011v6/v1platform*) available at: *http://www.epa.gov/ttn/chief/emch/index.html#2011* (accessed 02/26/14).

Table 4b. County-Level EC Emissions

County, State	Emissions in average tpy		
	EC	Pct.	Cumulative %
Westmoreland, PA	277	22%	22%
Centre, PA	177	14%	36%
Indiana, PA	172	14%	50%
Cambria, PA	148	12%	62%
Blair, PA	141	11%	73%
Somerset, PA	141	11%	84%
Clearfield, PA	124	10%	94%
Bedford, PA	73	6%	100%

Table 4c. County-Level Pcrustal Emissions

County, State	Emissions in average tpy		
	Pcrustal	Pct.	Cumulative %
Indiana, PA	870	52%	52%
Westmoreland, PA	206	12%	64%
Cambria, PA	158	9%	73%
Centre, PA	106	6%	79%
Somerset, PA	115	7%	86%
Blair, PA	118	7%	93%
Clearfield, PA	64	4%	97%
Bedford, PA	52	3%	100%

Table 4d. County-Level VOC Emissions

County, State	Emissions in average tpy		
	Total VOC	Pct.	Cumulative %
Westmoreland, PA	9,837	26%	26%
Indiana, PA	5,005	13%	39%
Centre, PA	4,577	12%	51%
Cambria, PA	4,100	11%	62%
Somerset, PA	4,059	11%	73%
Blair, PA	3,961	10%	83%
Clearfield, PA	3,940	10%	93%
Bedford, PA	2,537	7%	100%

Table 4e. County-Level SO₂ Emissions

County, State	Emissions in average tons/yr		
	SO₂	Pct.	Cumulative %
Indiana, PA	98,344	72%	72%
Clearfield, PA	25,644	19%	90%
Westmoreland, PA	1,262	1%	91%
Cambria, PA	7,236	5%	97%
Blair, PA	4,091	3%	100%
Somerset, PA	461	0%	100%
Bedford, PA	222	0%	100%

Tables 4a and 4b indicate that Westmoreland County produces the highest percentage of direct organic mass and elemental carbon emissions in the counties near the Cambria County violating monitor. In both of these Tables, the emissions of organic mass and elemental carbon appears somewhat evenly distributed between Westmoreland County and the next four highest contributing counties (totaling ~75%). Tables 4c and 4e indicate that Indiana County produces the highest percentage of crustal matter and directly emitted sulfate. In this case, Indiana County's emissions of crustal matter and sulfate both account for approximately 50% of the total crustal matter and sulfate in counties near the Cambria County violating monitor.

EPA notes that while total emissions of direct $PM_{2.5}$ and its precursors are very important, the distance of and spatial distribution of these emissions are also important. To further analyze the emissions in the area of analysis EPA evaluated the spatial distribution of $PM_{2.5}$ organic mass emissions presented in Figure 4f.

Figure 4f. Spatial Distribution of PM$_{2.5}$ Organic Mass Emissions in the Area of Analysis
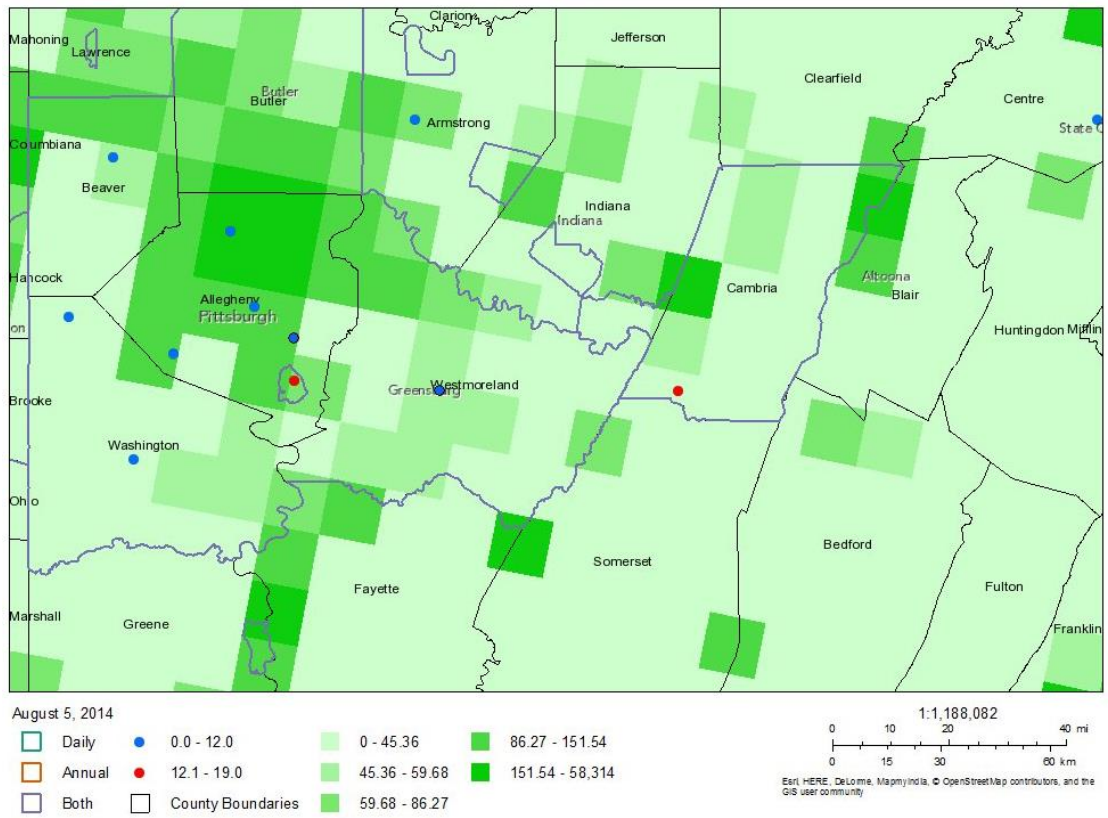
As mentioned above, Westmoreland County has the highest amount of PM$_{2.5}$ organic mass. However, the potential for transport to the violating monitor must also be considered. Figure 4f, shows that most emissions in Westmoreland are concentrated in the northwest corner near Allegheny County (darker green). Somerset County to the south of the Cambria monitor has very little PM$_{2.5}$ organic mass. This will be discussed further in the next section on meteorology. EPA notes, the combination of emission totals together with the other four factors will ultimately identify the areas which contribute to the violating monitor.

In addition to reviewing county-wide emissions of PM$_{2.5}$ and PM$_{2.5}$ precursors in the area of analysis, EPA also reviewed emissions from major point sources located in the area of analysis. The magnitude and location of these sources can help inform nonattainment boundaries. Table 5 provides facility-level emissions of direct PM$_{2.5}$, components of direct PM$_{2.5}$, and precursor pollutants (given in tons per year) from major point sources with total emissions of 500 tpy or more located in the area of analysis for the Johnstown Area. Table 5 also shows the distance from the facility to the Cambria County violating monitor.

Table 5. NEI 2011 v1 Point Source Emissions (tpy)

County, State	Facility Name (Facility ID)	Distance from violating monitor (miles)	NEI 2011 v1 Emissions (tpy)					
			NH$_3$	NOx	PM$_{2.5}$	SO$_2$	VOC	Total
Indiana, PA	GenOn Wholesale Gen/Seward Gen Sta (420630002)	9	4	1,774	150	7,010	4	8,942
Indiana, PA	GenOn NE Mgmt Co/Conemaugh Plt (420630001)	9	3	17,562	335	7,190	19	25,109
Cambria, PA	Ebensburg Power Co/Ebensburg Cogeneration Plt (420210033)	13	0	308	50	1,937	4	2,299
Cambria, PA	Cambria Cogen Co/Ebensburg (420210046)	16	2	713	163	1,941	12	2,831
Cambria, PA	Inter Power Ahlcon L/Colver Power Proj (420210034)	18	2	713	20	2,883	4	3,622
Indiana, PA	Homer City Gen LP/ Center Twp (420630003)	20	90	9,026	1,355	83,596	17	94,083
Blair, PA	Appleton Papers/Spring Mill (420130010)	27	35	394	119	1,046	103	1,699
Blair, PA	Norfolk Southern Railway Co/Juniata Locomotive Shops (420130005)	32	0	114	11	484	33	642
Blair, PA	Team Ten/Tyrone Paper Mill (420130004)	44		286	2	2,181	13	2,482
Clearfield, PA	GenOn Rema LLC/Shawville Gen Sta (420330021)	60	2	3,531	77	25,198	6	28,815
Centre, PA	Pa State Univ/Univ Park Campus (420270017)	64		243	7	1,445	6	1,701
Centre, PA	Graymont Pa Inc/Pleasant Gap & Bellefonte Plts (420270003)	72	20	940	36	209	8	1,212

Table 5 shows the major point source emissions (from the 2011 NEI in tons per year) in the area of analysis for the Johnstown Area and the relative distances of these sources from the violating monitoring location, as depicted by red dots. The actual distance from the point sources to the violating monitoring location is presented in Table 5. The distance from the violating monitoring location is particularly important for directly emitted PM$_{2.5}$. The influence of directly emitted PM$_{2.5}$ on ambient PM$_{2.5}$ diminishes more than that of gaseous precursors as a function of distance.[30]

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[30] Baker, K. R. and K. M. Foley. *A nonlinear regression model estimating single source concentrations of primary and secondarily formed PM$_{2.5}$.* Atmospheric Environment. 45 (2011) 3758-3767.
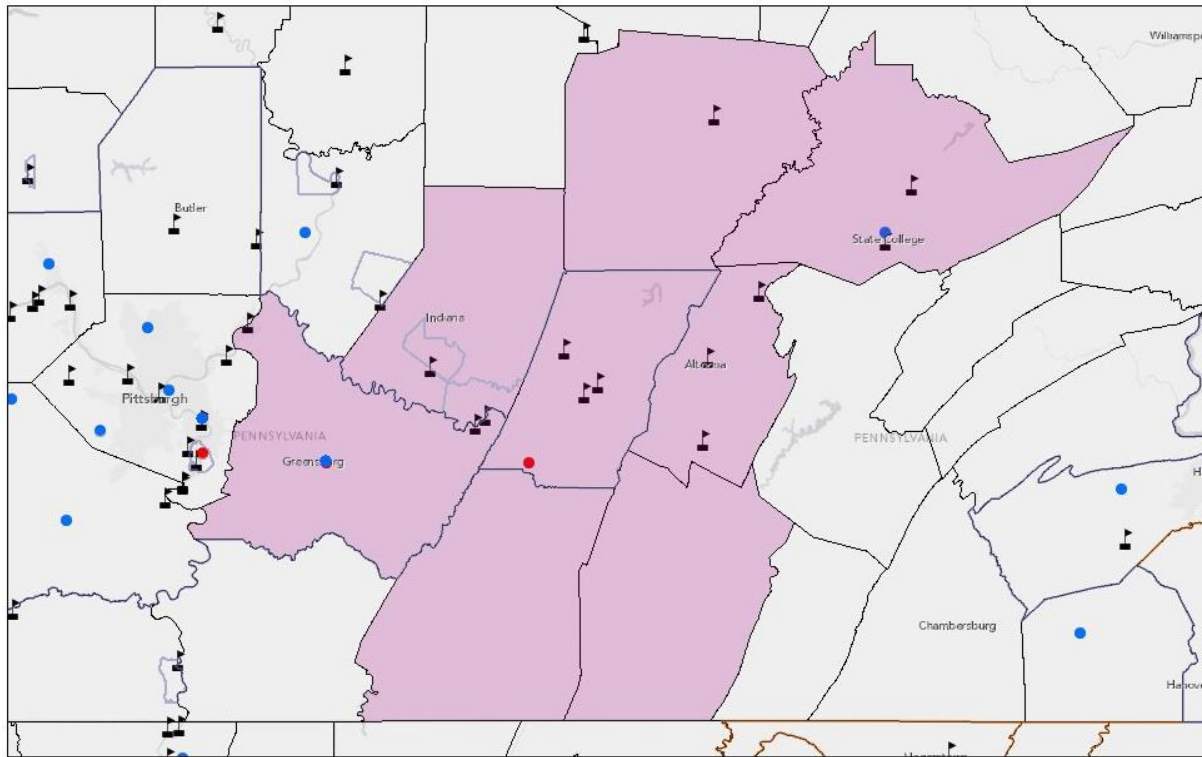
Figure 5a. Major Point Source Emissions in the Area of Analysis for the Johnstown Area
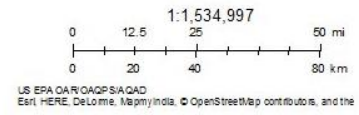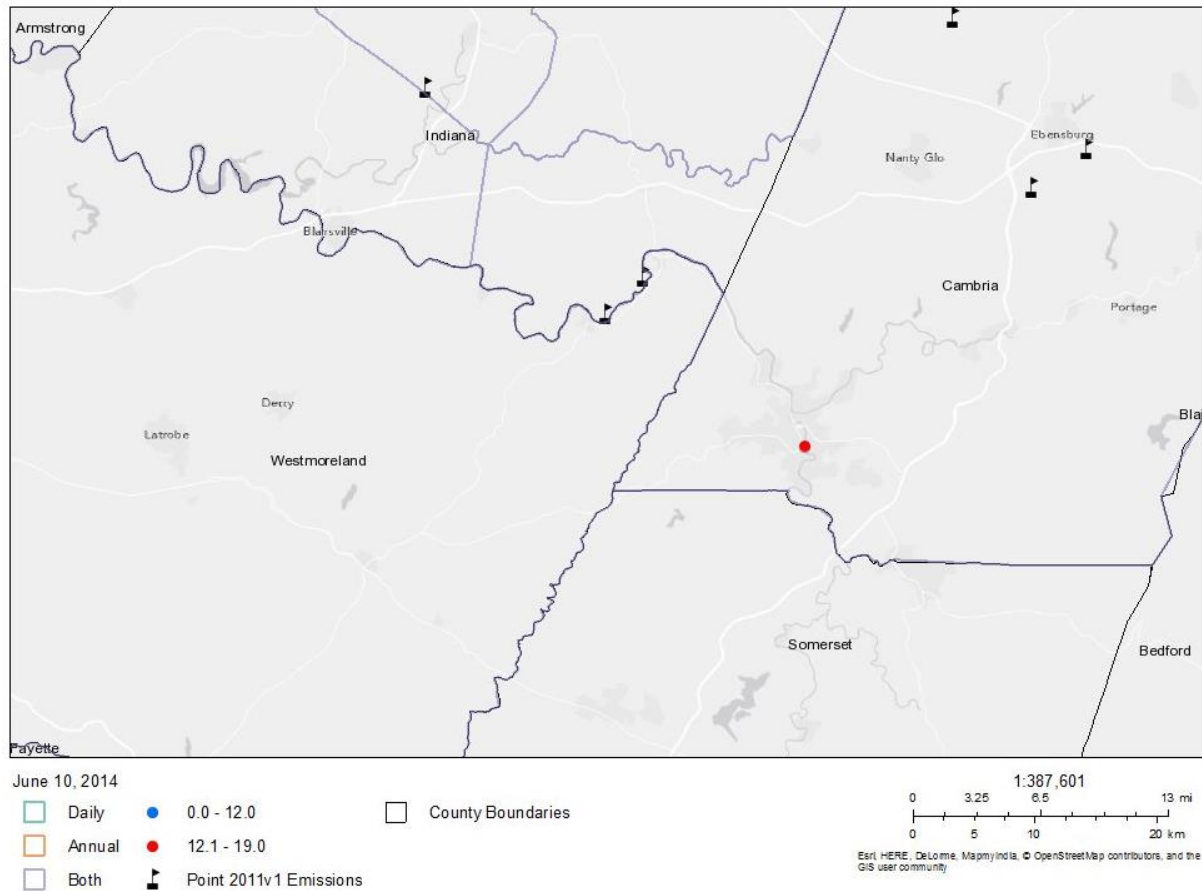
Figure 5b. Close-Up of Major Point Sources Near the Cambria County Monitor

As indicated in Figures 5a and 5b, there are twelve sources with emissions over 500 tpy within the area of analysis. Six of these large point sources are located northeast and northwest of the Cambria County violating monitor. The three point sources to the northwest of this monitor are located in Indiana County and are three large EGUs. These EGUs are Homer City, with emissions of over 94,000 tpy, and two GenOn facilities, Conemaugh and Seward Generating Station, with emissions of over 25,000 tpy and almost 9,000 tpy, respectively. These three EGUs are located in or adjacent to the townships of West Wheatfield, Center, East Wheatfield and Armagh Borough and Homer City Borough in Indiana County. As indicated in Table 5, these three facilities are three of the four largest sources of directly emitted $PM_{2.5}$ and its precursors in the area of analysis. In addition, the majority of the emissions in Indiana County are from these three facilities and, as indicated in Table 3b, the $PM_{2.5}$ emissions in Indiana County are mostly organic mass and crustal material which are components detected at the Cambria County violating monitor. Figure 5a shows that there are no point sources south of the monitor within the area of analysis.

As part of its December 2013 designation recommendation letter Pennsylvania provided additional information regarding local sources of $PM_{2.5}$. Pennsylvania believes that the proximity of a rail yard and a warehouse with unpaved roads near the Cambria County violating monitor may contribute to the local crustal mass collected at the monitor. EPA notes that rail yards can be large emitters of EC and POM and acknowledges that this source may be among the contributing emissions to the violation at

the Cambria County monitor. Figure 5c was provided by Pennsylvania in its December 2013 designation recommendation letter and shows the monitor and its proximity to the local sources described above.

Figure 5c. Cambria County Monitor (Johnstown) Location Proximity to Local Sources

Source: Pennsylvania's December 10, 2013 recommendation letter, Appendix C-4 - Cambria County Area

Population density and degree of urbanization

In this part of the factor analysis, EPA evaluated the population and vehicle use characteristics and trends of the area as indicators of the probable location and magnitude of non-point source emissions. Rapid population growth in a county on the urban perimeter signifies increasing integration with the core urban area, and indicates that it may be appropriate to include the county associated with area source and mobile source emissions as part of the nonattainment area. Table 6 shows the 2000 and 2010 population, population growth since 2000, and population density for each county in the area.

Table 6. Population Growth and Population Density.

County, State	Population 2000	Population 2010	% Change from 2000	Land Area (Sq. Miles)	Population Density (per Sq. Mile)	%	Cumulative %
Westmoreland, PA	369,993	365,086	-1.3%	1,025	356	34%	34%
Centre, PA	135,758	154,193	13.6%	1,108	139	14%	48%
Cambria, PA	152,598	143,484	-6.0%	688	209	13%	61%
Blair, PA	129,144	127,038	-1.6%	526	242	12%	73%
Indiana, PA	89,605	88,818	-0.9%	829	107	8%	81%
Clearfield, PA	83,382	81,579	-2.2%	1,147	71	8%	88%
Somerset, PA	80,023	77,706	-2.9%	1,075	72	7%	95%
Bedford, PA	49,984	49,737	-0.5%	1,015	49	5%	100%

Source: U.S. Census Bureau population estimates for 2000 and 2010

As the above table indicates, although Cambria County has the third highest population in the area of analysis, its population has decreased by 6% from 2000. Westmoreland County has the largest and most dense population in the area of analysis. Overall, all of the counties in the area of analysis are relatively low in population and low in population density and, except for Centre County, each county has seen a decrease in population from 2000 to 2010 with the exception of Centre County. The above data indicates that population and population density are not influential factors in determining nonattainment boundaries for the Johnstown Area.

Figure 6. 2010 County-Level Population in the Area of Analysis for the Johnstown Area.
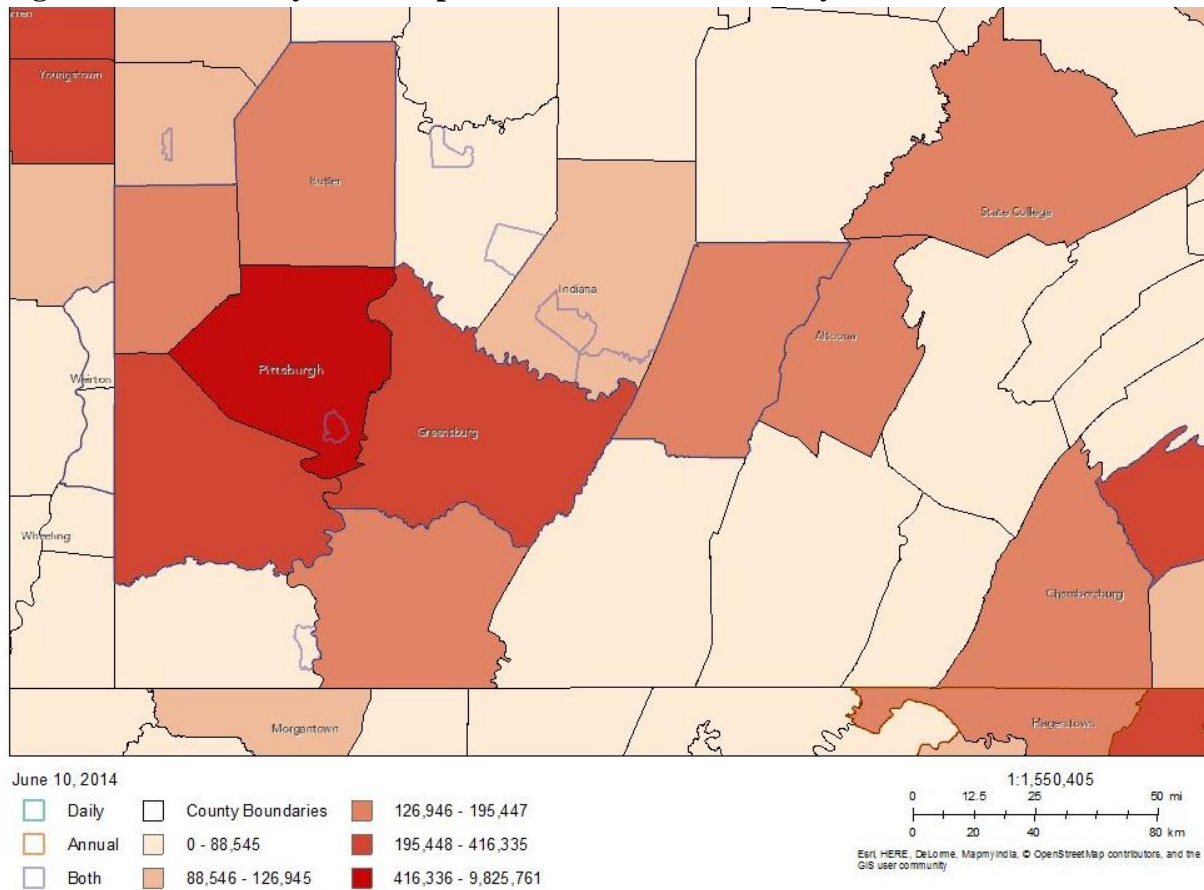

Traffic and Vehicle Miles Travelled

High vehicle miles travelled (VMT) and/or a high number of commuters associated with a county is generally an indicator that the county is an integral part of an urban area. Mobile source emissions of NO$_x$, VOC, and direct PM may contribute to ambient particulate matter that contributes to monitored violations of the NAAQS in the area. In combination with the population/population density data and the location of main transportation arteries, an assessment of VMT helps identify the probable location of nonpoint source emissions that contribute to violations in the area. Comparatively high VMT in a county outside of the CBSA or CSA signifies integration with the core urban area contained within the CSA or CBSA, and indicates that a county with the high VMT may be appropriate to include in the nonattainment area because emissions from mobile sources in that county contribute to violations in the area. Table 7 shows 2011 VMT while Figure 7 overlays 2011 county-level VMT with a map of the transportation arteries.

Table 7. 2011 VMT for the Johnstown Area

County, State	Total 2011 VMT	Percent	Cumulative %
Westmoreland, PA	3,087,660,497	31%	31%
Centre, PA	1,365,989,654	14%	44%
Cambria, PA	1,007,874,393	10%	54%
Clearfield, PA	1,003,982,533	10%	64%
Blair, PA	993,428,318	10%	74%
Bedford, PA	947,215,986	9%	83%
Somerset, PA	924,890,368	9%	92%
Indiana, PA	778,308,748	8%	100%

http://www.census.gov/hhes/commuting/data/commuting.html

Figure 7. Overlay of 2011 County-level VMT with Transportation Arteries.
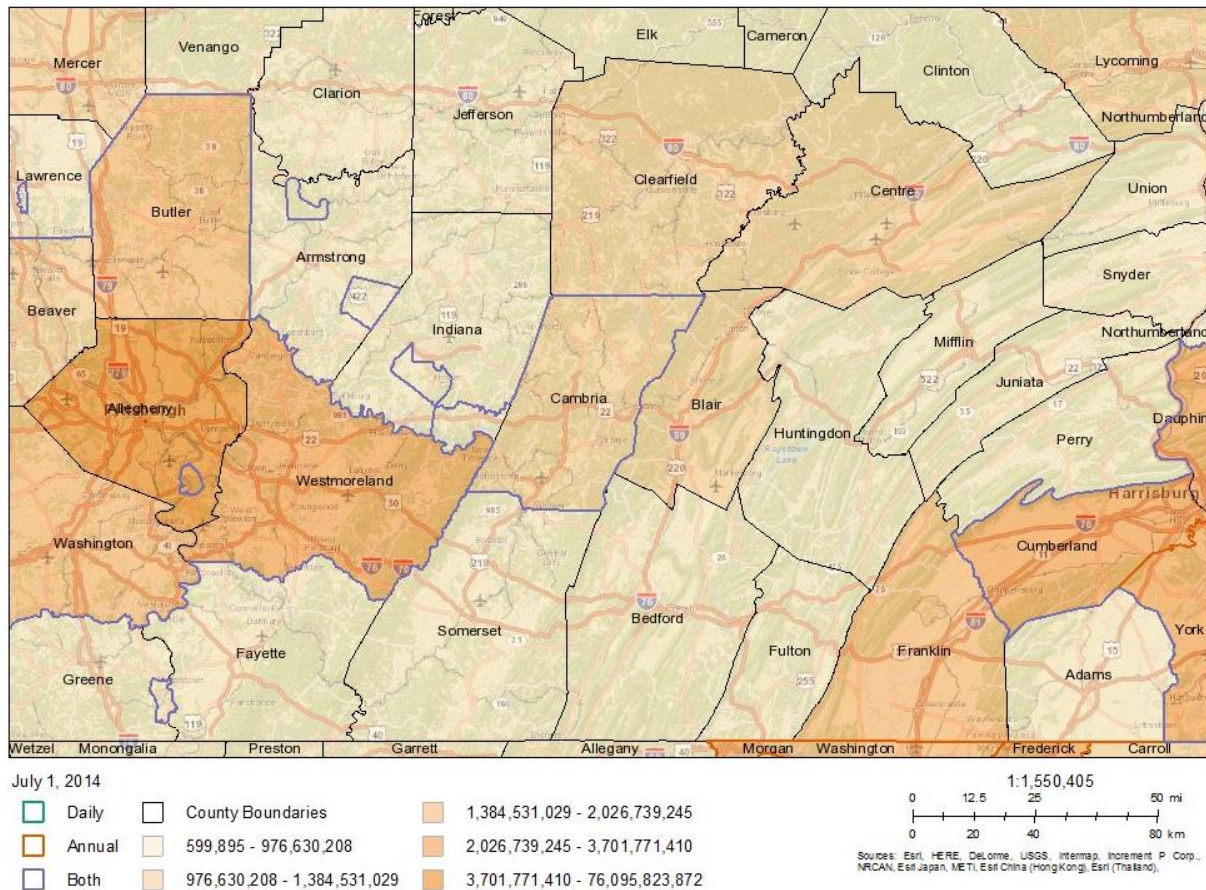
As the data in Table 7 illustrates, Westmoreland has the highest VMT which accounts for 31% of the total VMT in the area of analysis. Cambria County is the third highest in VMT, however, this county only accounts for 10% of the total VMT within the area of analysis. An airport to the east of the monitor in Cambria County and a few major roads near the monitor may contribute to the emissions at the Cambria County monitor. Overall, the above data indicates that VMT is not an influential factor in determining nonattainment boundaries for the Johnstown Area.

Factor 3: Meteorology

EPA evaluated available meteorological data to determine how meteorological conditions, including, but not limited to, weather, transport patterns, and stagnation conditions, could affect the fate and transport of directly emitted particulate matter and precursor emissions from sources in the area of analysis. EPA used two primary tools for this assessment: wind roses and kernel density estimation (KDE). When considered in combination with area $PM_{2.5}$ composition and county-level and facility emissions source location information, wind roses and KDE can help to identify nearby areas contributing to violations at violating monitoring sites.

Wind roses are graphic illustrations of the frequency of wind direction and wind speed. Wind direction can indicate the direction from which contributing emissions are transported; wind speed can indicate the force of the wind and thus the distance from which those emissions are transported. EPA constructed wind roses from hourly observations of wind direction and wind speed using 2009-2012 data from National Weather Service locations archived at the National Climate Data Center.[31] When developing these wind roses, EPA also used wind observations collected at meteorological sampling stations collocated at air quality monitoring sites, where these data were available. Figure 8a shows wind roses that EPA generated from data relevant in the Johnstown Area.

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[31] *ftp.ncdc.noaa.gov/pub/data/noaa* or
http://gis.ncdc.noaa.gov/map/viewer/#app=cdo&cfg=cdo&theme=hourly&layers=1&node=gis Quality assurance of the National Weather Service data is described here: *http://www1.ncdc.noaa.gov/pub/data/inventories/ish-qc.pdf*

**Figure 8a. Wind Roses in the Area of Analysis for Johnstown Area.**
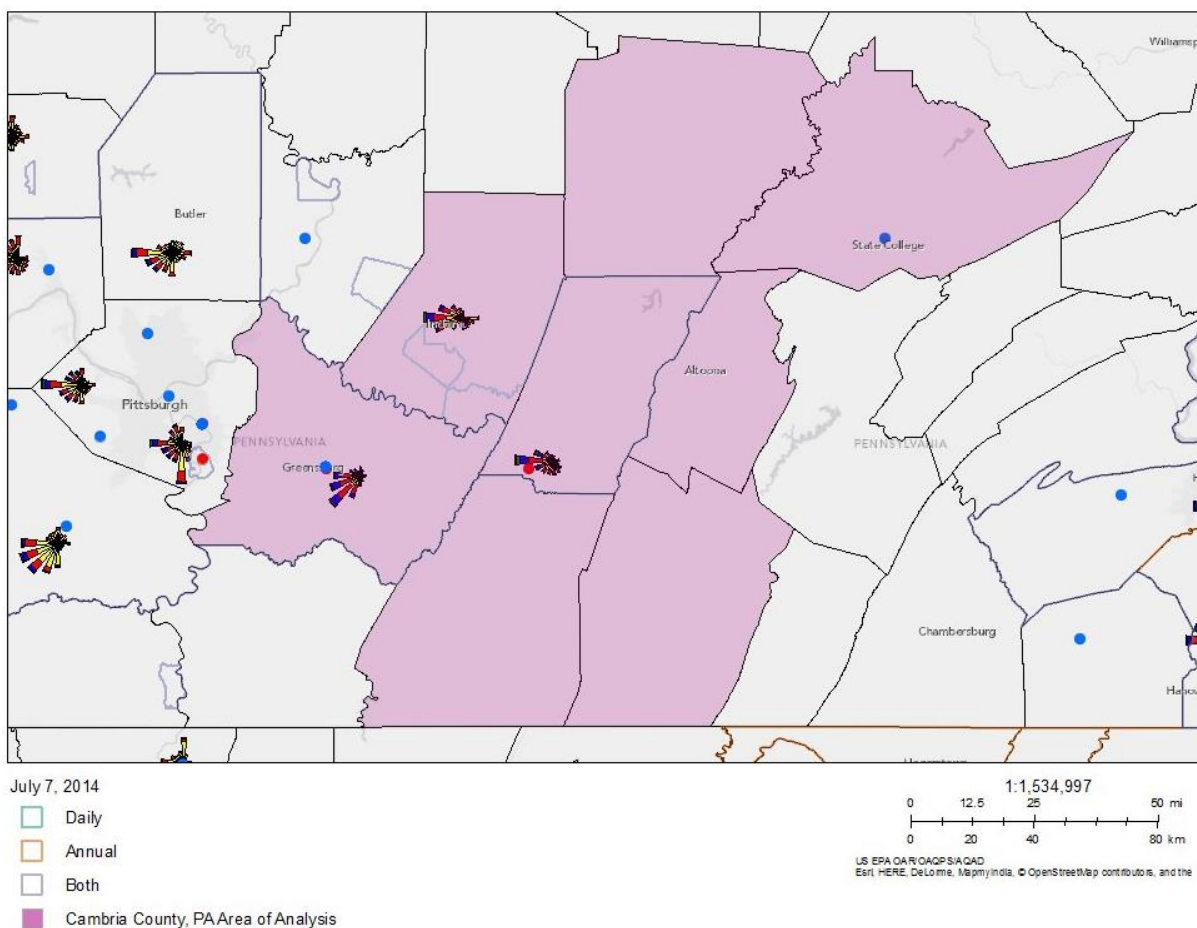
As shown in Figure 8a, the predominant winds near the violating monitor are from the west with some northwesterly and southwesterly components, suggesting that emission sources in the west upwind direction should be considered for analysis. These wind roses represent average wind directions throughout the year. Looking at point sources in the regional wind direction indicated in Figure 8a, there are three large EGUs in Indiana County which are northwest of the Cambria County monitor. These EGUs are Homer City, with emissions of over 94,000 tpy, and two GenOn facilities, Conemaugh and Seward Generating Station, with emissions of over 25,000 tpy and almost 9,000 tpy, respectively. As indicated in Table 5, these three facilities are three of the four largest sources of directly emitted $PM_{2.5}$ and its precursors in the area of analysis. The fourth source is in Clearfield County which is not in the regional wind direction with respect to the violating monitor. In addition, the majority of the emissions in Indiana County are from these three facilities and, as indicated in Table 3b, the $PM_{2.5}$ emissions in Indiana County are mostly organic mass and crustal material which are components detected at the Cambria County violating monitor.

In its December 2013 recommendation letter, Pennsylvania included wind direction analysis when the Cambria County monitor's $PM_{2.5}$ concentrations were relatively high but the regional monitoring concentrations were "clean," i.e. 0-12 $\mu g/m^3$. Between 2010 and 2012, Pennsylvania identified 173 days in which the Cambria County monitor was at least one standard deviation above the regional

average while the regional average was at or below 12 μg/m^3 (high days). The top 25% of these high days (most extreme events) were further analyzed to determine why the Cambria County violating monitor's concentrations were high. The Cambria County monitor is collocated with a meteorological tower which monitors wind direction and wind speed. For the top 25% of these high days (highest PM$_{2.5}$ days), Pennsylvania calculated the number of hours the wind was coming from a particular direction as well as the PM$_{2.5}$ concentrations from a particular direction. Figures 8b and 8c represent the wind direction frequency and PM$_{2.5}$ concentration distribution by wind direction, respectively, at the Cambria County monitor during its highest PM$_{2.5}$ days.

Figure 8b. Cambria County Monitor Wind Direction Frequency – Top 25% of Regionally "Clean" Days
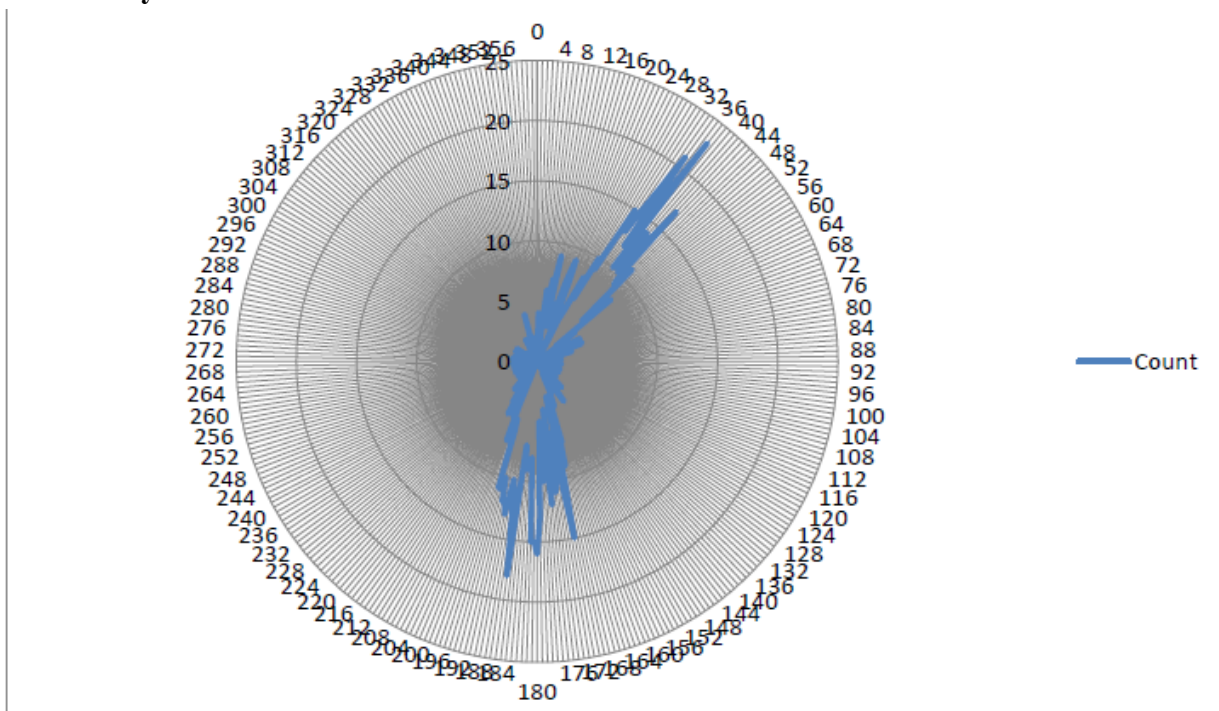
Source: Pennsylvania's December 10, 2013 recommendation letter, Appendix C-4 - Cambria County Area

Figure 8c. Cambria County Monitor PM2.5 Concentration Distribution by Wind Direction – Top 25% of Regionally "Clean" Days
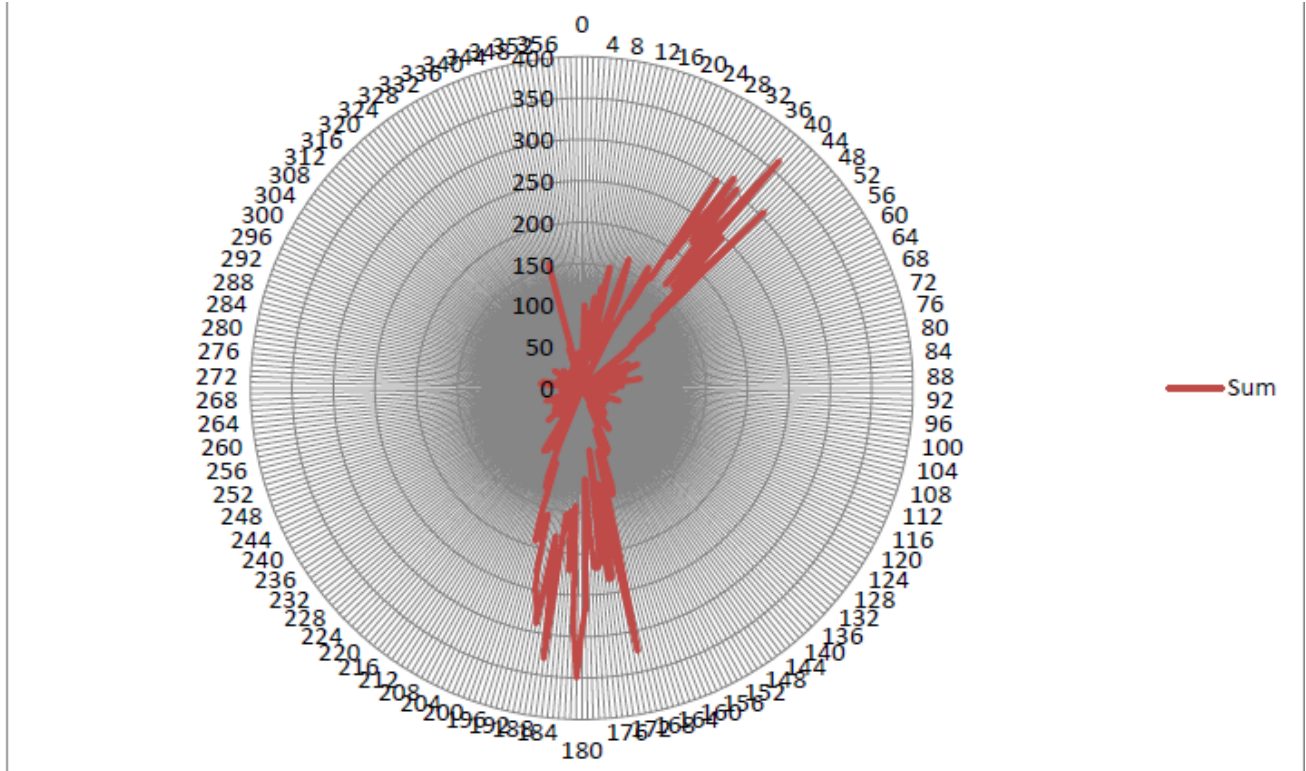
Source: Pennsylvania's December 10, 2013 recommendation letter, Appendix C-4 - Cambria County Area
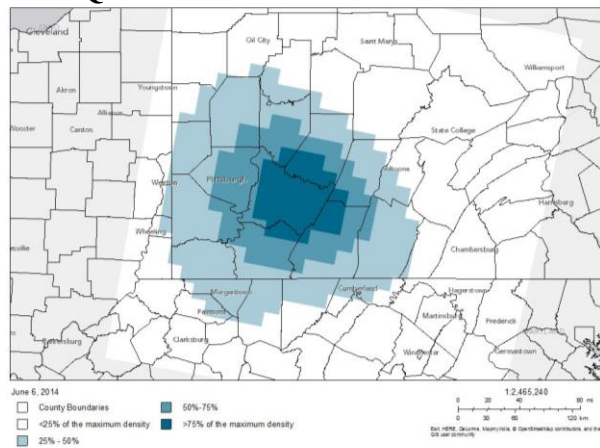
As indicated in Figure 8b, wind directions on high PM2.5 days at the Cambria County monitor are coming from due south and from the northeast. As indicated in Figure 8c, the high PM2.5 concentrations are also due south and from the northeast. The wind direction on high days identified by Pennsylvania in its December 2013 recommendation letter is slightly different from the regional wind directions identified by EPA shown in Figure 8a which is predominantly from the west and a small component from the northwest and southwest. As previously discussed, there are three large point sources to the west of the violating monitor in the regional wind direction. The wind direction on high PM2.5 days in Pennsylvania's analysis is to the northeast and due south. Figure 5a indicates that there are three point sources in Cambria County to the northeast of the monitor however, there are not any point sources to the south of the Cambria monitor within the area of analysis As previously stated from Pennsylvania's December 2013 recommendation letter, proximity to a rail yard and warehouse with unpaved roads near the Cambria County monitor likely contributes to the local PM2.5 concentrations and may account for this southerly component.

In addition to wind roses, EPA also generated kernel density estimation (KDE) plots to represent HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) backward trajectory frequency at
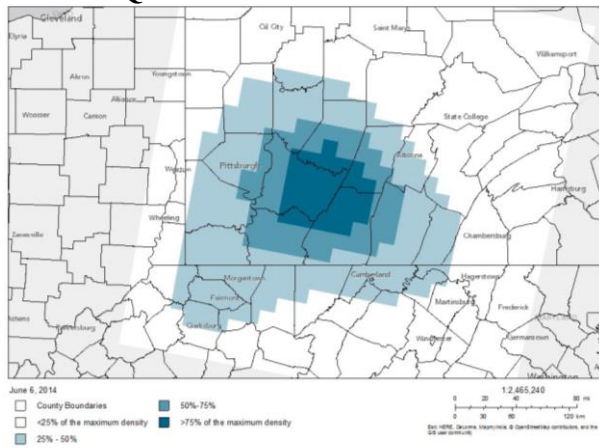
violating monitoring sites.[32,33] These KDEs are graphical statistical estimations to determine the density of trajectory endpoints at a particular location represented by a grid cell. EPA used KDEs to characterize and analyze the collection of individual HYSPLIT backward trajectories for days throughout a 3-year period.[34] Higher density values, indicated by darker blue colors, indicate a greater frequency of observed trajectory endpoints within a particular grid cell. Figure 9 shows a HYSPLIT KDE plot for the Johnstown Area summarized by calendar quarter for the 2010-2012 period. The HYSPLIT KDE is weighted in the westerly direction, indicating a greater frequency of trajectories passing over grid cells to the west.

Figure 9. HYSPLIT Kernel Density Estimation Plots for the Johnstown Area.
First Quarter   **Second Quarter**

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[32] In some past initial area designations efforts, EPA has used HYSPLIT backward trajectories to assist in determining nonattainment area boundaries. A HYSPLIT backward trajectory is usually depicted on a standard map as a single line, representing the centerline of an air parcel's motion, extending in two dimensional (x,y) space from a starting point and regressing backward in time to a point of origin. Backward trajectories may be an appropriate tool to assist in determining an air parcel's point of origin on a day in which a short-term standard, such as an 8-hour standard or a 24-hour standard, was exceeded. However, for an annual standard, such as the 2012 annual $PM_{2.5}$ NAAQS, every trajectory on every day is important. Plotting a mass of individual daily (e.g., 365 individual back trajectories), or more frequent, HYSPLIT trajectories may not be helpful as this process is likely to result in depicting air parcels originating in all directions from the violating monitoring site.

[33] HYSPLIT - Hybrid Single Particle Lagrangian Integrated Trajectory Model, *http://www.arl.noaa.gov/HYSPLIT_info.php*

[34] The KDEs graphically represent the aggregate of HYSPLIT backward trajectories for the years 2010-2012, run every third day (beginning on the first day of monitoring), four times each day, and ending at four endpoint heights.

Third Quarter
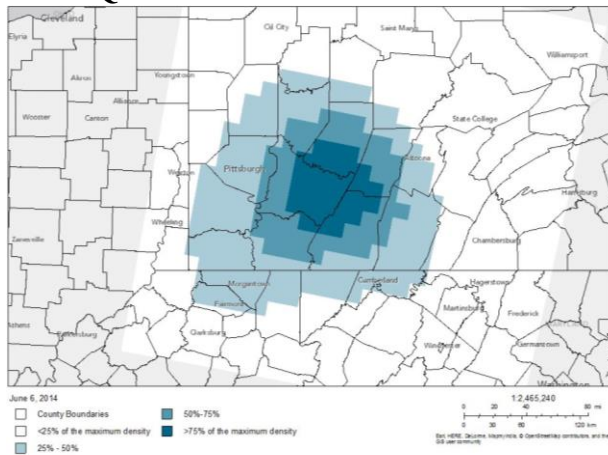
Fourth Quarter

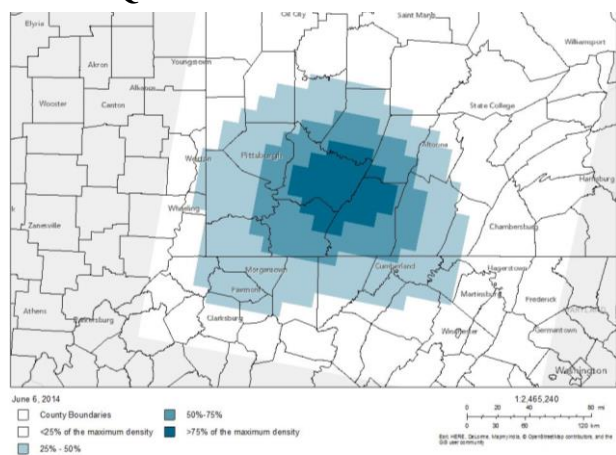The HYSPLIT KDE plots and regional wind roses suggest the greatest potential for contribution of emissions in the area of analysis is from the Westmoreland, Somerset and Indiana counties. As discussed in the emissions section and indicated in Figure 4f, the relatively high county total emissions for Westmoreland County are located in the northwest corner of the county. In Figure 9, the northwest corner of Westmoreland County is not in a grid square with very high potential for transport (darkest blue) to the violating monitor in Cambria County. Figure 4f and Table 3a also indicate that Somerset County has relatively low emissions, therefore, although Somerset County is within the grid cells with the higher potential to transport in Figure 9, there are relatively low emissions to actually transport to the violating monitor. Lastly, the higher density KDE values do include the three EGU's in Indiana County (Homer City and two GenOn facilities, Conemaugh and Seward Generating Stations) located in the south of Indiana County for all four quarters.

Factor 4: Geography/topography

To evaluate the geography/topography factor, EPA assessed physical features of the area of analysis that might define the airshed and thus affect the formation and distribution of PM$_{2.5}$ concentrations over the area.

For the Johnstown area, topography is an important factor, because the area is part of a river valley almost entirely surrounded by low mountains. These mountains limit transport of low-level emissions but do not limit transport of high-level emissions and PM$_{2.5}$ formation.

Some of the highest terrain in Pennsylvania brackets the Johnstown area with the Allegheny Mountains to the east and Laurel Hills to the west. The city of Johnstown itself lies in the approximately two-mile wide flood plain formed by the junction of the Stonycreek and Little Conemaugh Rivers, and the narrow Conemaugh River Gap where water flows out of the city. The basin within which the city lies is about 300 feet below the surrounding ridgelines. These topographical features diminish the transport of low level emissions such as mobile emissions from

surrounding areas but do not diminish transport of high-level emissions from sources such as the EGUs in Indiana County.

Figure 10. Topography of the Johnstown Area.
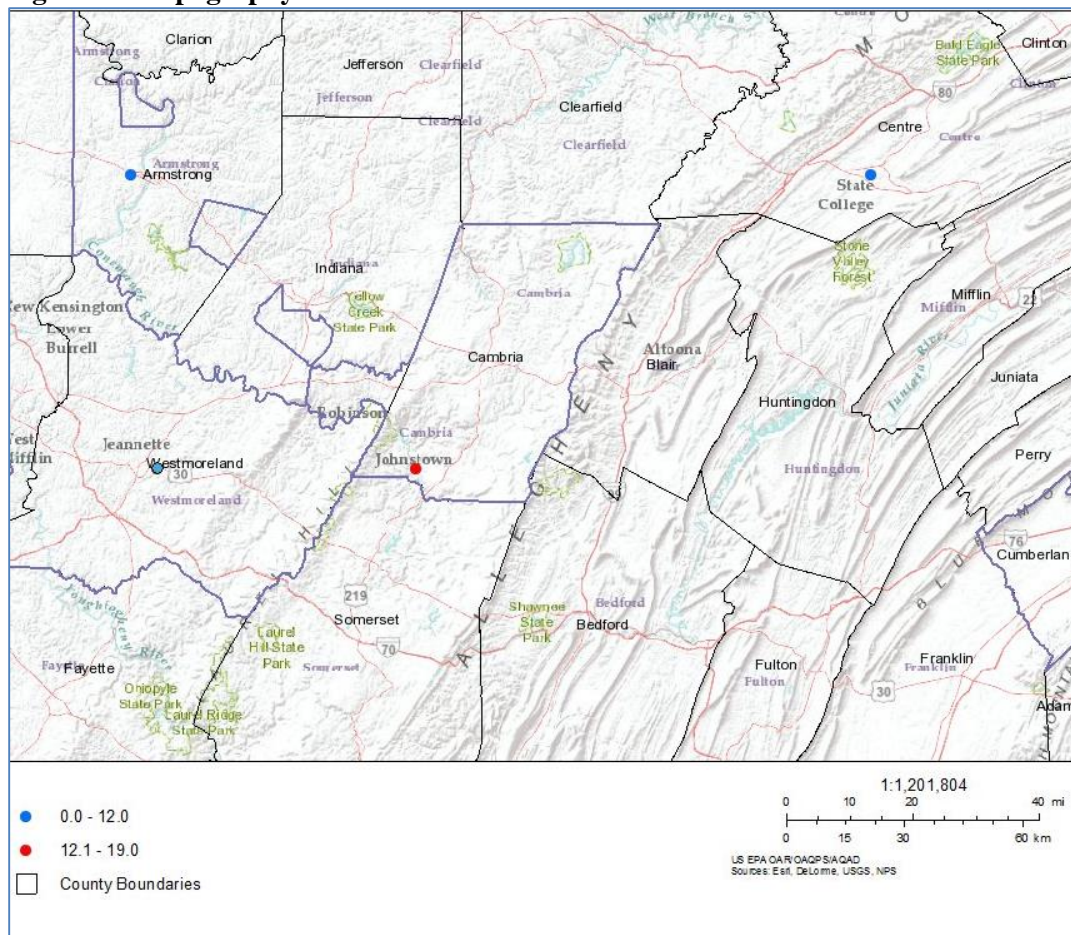
Factor 5: Jurisdictional boundaries

In defining the boundaries of the Johnstown Area final nonattainment area, EPA considered existing jurisdictional boundaries, which can provide easily identifiable and recognized boundaries for purposes of implementing the NAAQS. Existing jurisdictional boundaries often signify the state and local governmental organization with the necessary legal authority for carrying out air quality planning and enforcement functions for the area. Examples of such jurisdictional boundaries include existing/prior nonattainment area boundaries for particulate matter, county lines, air district boundaries, township boundaries, areas covered by a metropolitan planning organization, state lines, and Reservation boundaries, if applicable. Where existing jurisdictional boundaries were not adequate or appropriate to describe the nonattainment area, EPA considered other clearly defined and permanent landmarks or geographic coordinates for purposes of identifying the boundaries of the designated areas.

The violating monitor is located in the Johnstown, Pennsylvania MSA. This is a single county MSA which consists of Cambria County, Pennsylvania. Pennsylvania's regional transportation planning organizations fall along county lines. Cambria, Blair and Centre counties are all single-county MPOs named Johnstown MPO, Altoona MPO and Center MPO, respectively. Bedford, Huntingdon and Somerset Counties are part of the Southern Alleghenies Planning and Development Commission rural planning organization (RPO). Westmoreland and Indiana County are part of the larger Southwestern Pennsylvania Commission MPO.

The Johnstown Area has previously established nonattainment boundaries associated with the 1997 annual and the 2006 24-hour $PM_{2.5}$ NAAQS. The boundary for the nonattainment area for the 1997 annual and the 2006 24-hour $PM_{2.5}$ NAAQS included the entire county of Cambria and part of Indiana County in Pennsylvania.

The state has recommended a different boundary for the 2012 annual $PM_{2.5}$ NAAQS by recommending only the single county of Cambria, Pennsylvania. EPA's final boundary for the 2012 annual $PM_{2.5}$ NAAQS differs from the State's recommendation and is the same as the 1997 annual and the 2006 24-hour $PM_{2.5}$ nonattainment boundaries, and includes the entire county of Cambria, Pennsylvania, and partial county of Indiana, Pennsylvania. EPA used township boundaries to determine the partial area of Indiana County which includes the townships of West Wheatfield, Center, East Wheatfield and Armagh Borough and Homer City Borough. This portion of Indiana County contains three large sources of direct $PM_{2.5}$ and its precursors: Homer City, GenOn Conemaugh Plant, and GenOn Seward Generating Station. These three EGUs have combined emissions of over 128,000 tpy and are contributing to the violating Cambria County monitor.

Conclusion for the Johnstown Area

Based on the assessment of factors described above, both individually and in combination, EPA has concluded that the following counties should be included as part of the Johnstown Area nonattainment area because they are either violating the 2012 annual $PM_{2.5}$ NAAQS or contributing to a violation in a nearby area: Cambria County, Pennsylvania and a portion of Indiana County, Pennsylvania which includes the townships of West Wheatfield, Center, East Wheatfield and Armagh Borough and Homer City Borough.

These are the same counties that are included in the Johnstown nonattainment area for the 2006 24-hour and 1997 annual $PM_{2.5}$ NAAQS. The air quality monitoring site in Cambria County indicates violations of the 2012 annual $PM_{2.5}$ NAAQS based on the 2013 DVs; therefore this county is included in the nonattainment area. Indiana County is a nearby county that does not have a violating monitoring site, but EPA has concluded that partial areas of Indiana County contribute to the particulate matter concentrations in violation of the 2012 annual $PM_{2.5}$ NAAQS through emissions from point sources. Indiana County has among the highest emissions of directly emitted $PM_{2.5}$ and/or $PM_{2.5}$ precursors in the area and has three large point sources located in the regional westerly wind direction and near the violating monitor in Cambria County.

The speciation data for the Cambria County violating monitoring site indicate that organic mass and sulfates are the predominant species overall with an exception in the first quarter when nitrates are higher may be due to increased EGU emissions from winter heating needs and greater particle nitrate collection during the cooler months. When accounting for the urban increment, the sulfate component becomes less dominant, however, there is still some remaining sulfate detected at the monitor. The urban increment analysis indicates that organic mass and elemental carbon are the major components of $PM_{2.5}$ contributing to the violation at the Cambria County monitoring site

The wind roses representing average wind direction throughout the year indicate that the predominant winds near the violating monitor are from the west with some northwest and southwest components. Additional meteorological data provided by Pennsylvania indicate that wind directions on high $PM_{2.5}$ days at the Cambria County violating monitor are coming from due south and from the northeast.

Looking at point sources in the regional wind direction, westerly with components from the northwest and southwest, there are three large EGUs in Indiana County to the northwest of the Cambria County monitor. Considering the wind direction on high $PM_{2.5}$ days, northeast and south, there are point sources to the northeast of the monitor in Cambria County, however, there are not any point sources of $PM_{2.5}$ south of the monitor within the area of analysis. As previously stated in Pennsylvania's December 2013 recommendation letter, proximity to a rail yard and warehouse with unpaved roads near the Cambria County monitor likely contributes to the local $PM_{2.5}$ concentrations and may account for contributions from the south.

In addition, the HYSPLIT KDE is weighted in the westerly direction, indicating a greater frequency of trajectories passing over grid cells to the west. The three EGU's in Indiana County fall within the higher density grid cells indicated by darker blue color in Figure 9 for all four quarters. These high density values indicate a higher potential to transport from a particular grid cell.

The Johnstown area has low population density and low levels of VMT. Thus, population and VMT are generally not influential factors in this case contributing to the exceedances of the Cambria County violating monitor.

For the Johnstown area, topography is an important factor because the area is part of a river valley almost entirely surrounded by low mountains. These mountains limit transport of low-level emissions such as mobile emissions but do not limit transport of high-level emissions and $PM_{2.5}$ formation from sources such as EGUs.

In conclusion, for the Johnstown area the five factor analysis supports EPA's adoption of the same boundaries for the Johnstown 2012 annual $PM_{2.5}$ NAAQS nonattainment area as were designated for the 2006 24-hour and 1997 annual $PM_{2.5}$ NAAQS nonattainment area. The Johnstown Area therefore consists of Cambria County, Pennsylvania and the partial county of Indiana, Pennsylvania containing the townships of West Wheatfield, Center, East Wheatfield, and Armagh Borough and Homer City Borough.

3.2   Area Background and Overview - Delaware County Area

Figure 1a is a map of EPA's final nonattainment boundary for the Delaware County Area. The map shows the location and DVs of ambient air quality monitoring locations, county and other jurisdictional boundaries, including the Philadelphia-Camden-Wilmington, Pennsylvania-New Jersey-Delaware-Maryland MSA. For purposes of the 1997 annual and 2006 24-hour PM$_{2.5}$ NAAQS, Delaware County, PA was designated nonattainment as part of the Philadelphia-Wilmington, PA-NJ-DE nonattainment area. The boundary for the nonattainment area for the 1997 annual and 2006 24-hour PM$_{2.5}$ NAAQS included the entire counties of Bucks, Chester, Delaware, Montgomery, and Philadelphia in Pennsylvania; Burlington, Camden, and Gloucester in New Jersey; and New Castle in Delaware.

Figure 1a. EPA's Final Nonattainment Boundaries for the Delaware County Area
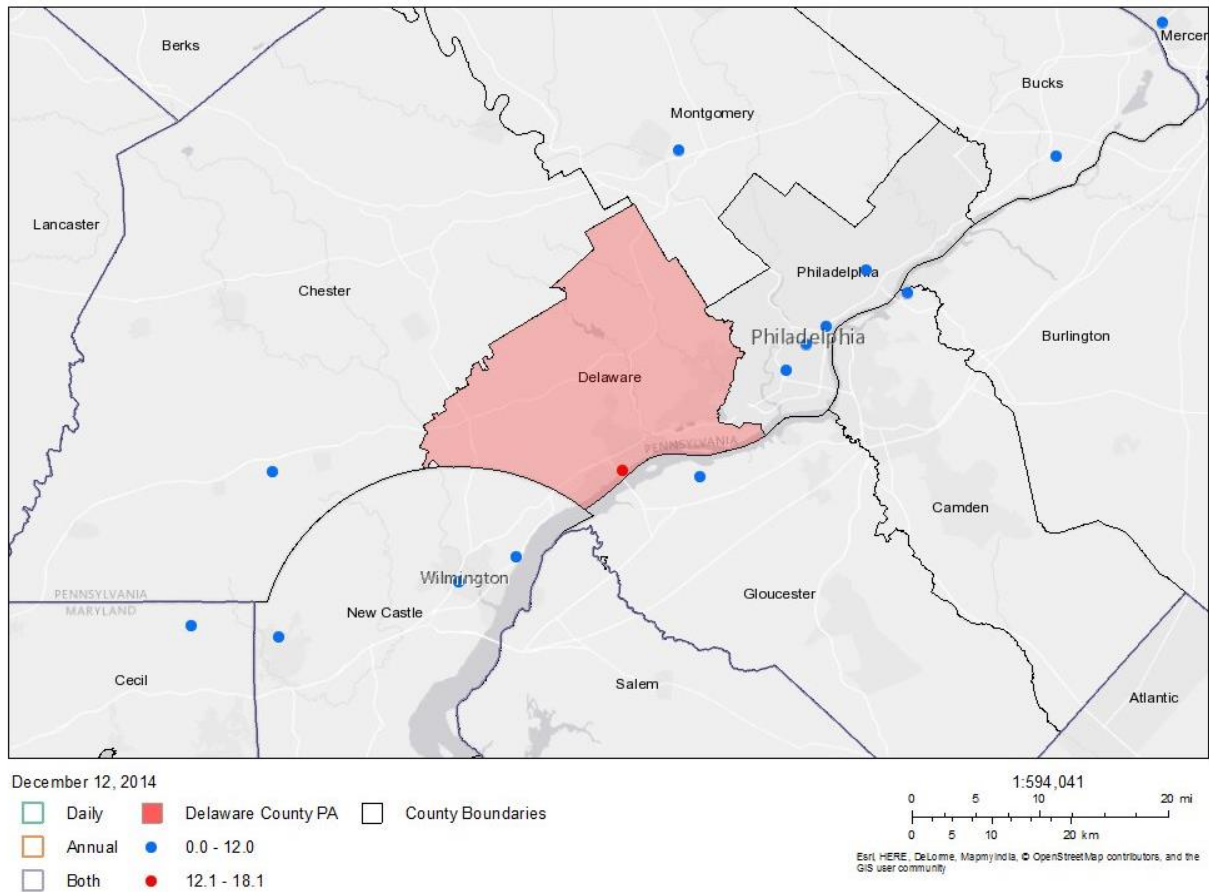
EPA must designate as nonattainment areas that violate the NAAQS and nearby areas that contribute to the violation in the violating area. As discussed below, a monitor in Delaware County, Pennsylvania shows a violation of the 2012 annual PM$_{2.5}$ NAAQS. Therefore, Delaware County is included in the nonattainment area. As shown in Figure 1b, EPA evaluated each county in the Philadelphia-Camden-Wilmington, Pennsylvania-New Jersey-Delaware-Maryland MSA, which includes Delaware County, Pennsylvania as well as New Castle County, Delaware; Cecil County,

Maryland; Burlington, Camden, Gloucester, and Salem Counties in New Jersey; and Bucks, Chester, Montgomery, and Philadelphia Counties in Pennsylvania, and a ring of counties adjacent to the Philadelphia-Camden-Wilmington, Pennsylvania-New Jersey-Delaware-Maryland MSA. EPA's evaluation was based on the five factors and other relevant information. Based upon the data discussed below, EPA determined that no counties in this area of analysis, other than Delaware County, contribute to the violation at the Delaware County monitor. Note that Northampton County, Pennsylvania, which shows a violation, is in the area of analysis. As discussed in section 3.4, EPA is designating Northampton County, along with Lehigh County, Pennsylvania, in a separate nonattainment area, i.e., the Allentown Area.

The following sections describe the five factor analysis process. While the factors are presented individually, they are not independent. The five factor analysis process carefully considers their interconnections and the dependence of each factor on one or more of the others.

Figure 1b. Area of Analysis for the Delaware County Final Nonattainment Area

Factor 1: Air Quality Data

All ambient air quality data collected during the year are important when determining contributions to an annual standard, such as the 2012 annual $PM_{2.5}$ NAAQS. Compliance with an annual NAAQS is dependent upon monitor readings throughout the year, including days with monitored ambient concentrations below the level of the NAAQS. For the 2012 annual $PM_{2.5}$ NAAQS, the annual mean

is calculated as the mean of quarterly means. A high quarter can drive the mean for an entire year, which, in turn, can drive an elevated 3-year DV. Although all data are important, seasonal or episodic emissions can provide insight as to relative contributors to measured $PM_{2.5}$ concentrations. For these reasons, for the Factor 1 air quality analysis, EPA assessed and characterized air quality at, and in the proximity of, the violating monitoring site locations first by evaluating trends and the spatial extent of measured concentrations at monitors in the area of analysis, and then by identifying the conditions most associated with high average concentration levels of $PM_{2.5}$ mass in the area of analysis.

In most cases, EPA assessed air quality data on a seasonal, or quarterly, basis.[35] EPA also identified the spatial extent of these high $PM_{2.5}$ concentrations. The mass and composition at the DV location represents contributions from various emission sources including local, area-wide (which may comprise nearby urban and rural areas) and regional sources. To determine the source mix (by mass) at the DV monitoring site, EPA examined the chemical composition of the monitored $PM_{2.5}$ concentrations by pairing each violating FRM/FEM/ARM monitoring site with a collocated or nearby Chemical Speciation Network (CSN) monitoring site or sites. Then, EPA contrasted the approximated mass composition at the DV monitoring site with data collected at IMPROVE[36] and other monitoring locations whose data are representative of regional background.[37,38] This comparison of local/area-wide chemical composition data to regional chemical composition data derives an "urban increment," which helps differentiate the influence of more distant emissions sources from the influence of closer

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[35] Although compliance with the annual NAAQS depends on contributions from all days of the year, examining data on a quarterly or seasonal basis can inform the relationship between the temporal variability of emissions and meteorology and the resulting $PM_{2.5}$ mass and composition. In some areas of the country where there may be noticeable month-to-month variations in average $PM_{2.5}$, the quarterly averages may not adequately represent seasonal variability. In these areas, air quality data may be aggregated and presented by those months that best correspond to the local "seasons" in these areas.

[36] IMPROVE stands for Interagency Monitoring for Protected Visual Environments and is an aerosol monitoring network in mostly rural and remote areas.

[37] The "urban increment" analysis assesses and characterizes the increase in seasonal and annual average $PM_{2.5}$ mass and chemical components observed at violating monitoring site(s) relative to monitoring sites outside the area of analysis (which represent background concentrations). Developing the urban increment involves pairing a violating FRM/FEM/ARM monitor with a collocated monitor or nearby monitor with speciation data. EPA made every effort to pair these data to represent the same temporal and spatial scales. However, in some cases, the paired violating and CSN "urban" monitoring locations were separated by some distance such that the included urban CSN site(s) reflect(s) a different mixture of emissions sources, which could lead to misinterpretations. To generally account for differences in $PM_{2.5}$ mass between the violating site and the nearby CSN site(s), EPA determined material balance of the $PM_{2.5}$ composition at the violating site by assigning the extra measured $PM_{2.5}$ mass to the carbon components of $PM_{2.5}$. Where the general urban increment approach may be misleading, or in situations where non-carbonaceous emissions are believed to be responsible for a local $PM_{2.5}$ concentration gradient, EPA used alternative analyses to reflect the mix of urban and rural sources contributing to the measured concentrations at violating monitoring sites.

[38] The urban monitors were paired with any rural sites within a 150 mile radius of an urban site to calculate spatial means of the quarterly averages of each species. If there were no rural sites within 150 miles, then the nearest rural site was used alone. That rural mean was then subtracted from the quarterly mean of the urban site to get the increment. Negative values were simply replaced with zeros.

emissions sources, thus representing the portion of the measured violation that is associated with nearby emission contributions.[39,40,41]

PM$_{2.5}$ Design Values and Total Mass Measurements - EPA examined ambient PM$_{2.5}$ air quality monitoring data represented by the DVs at each violating monitoring site and at other monitors in the area of analysis. EPA calculated DVs based on air quality data for the most recent 3 consecutive calendar years of quality-assured, certified air quality data from suitable FEM/FRM/ARM monitoring sites in EPA's Air Quality System (AQS). For this designations analysis, EPA used data for the 2011-2013 period (i.e., the 2013 DV), which are the most recent years with fully-certified air quality data. A monitor's DV is the metric or statistic that indicates whether that monitor attains a specified air quality standard. The 2012 annual PM$_{2.5}$ NAAQS is met at a monitoring site when the 3-year average annual mean concentration is 12.0 micrograms per cubic meter ($\mu g/m^3$) or less (e.g., 12.1 $\mu g/m^3$ or greater is a violation). A DV is only valid if minimum data completeness criteria are met or when other regulatory data processing provisions are satisfied (See 40 CFR part 50 Appendix N). Table 2 identifies the current DVs (i.e., the 2013 DV) and the most recent two DVs based on all monitoring sites in the area of analysis for the Delaware County Area intended nonattainment area.[42]

Table 2. Air Quality Data collected at Regulatory Monitors (all DV levels in $\mu g/m^3$)[a,b]

County, State	Monitor Site ID	State Rec NA?	09-11 DV	10-12 DV	11-13 DV
Kent, DE	100010002	No	9.1	8.7	8.2
Kent, DE	**100010003**	**No**	**9.4**	**9**	**8.4**
New Castle, DE	100031003	No	9.9	9.6	9.1
New Castle, DE	100031007	No	9.6	9.1	8.4
New Castle, DE	100031012	No	10.5	10.1	9.7

[39] In most, but not all, cases, the violating design value monitoring site is located in an urban area. Where the violating monitor is not located in an urban area, the "urban increment" represents the difference between local and other nearby emission sources in the vicinity of the violating monitoring location and more regional sources.

[40] Hand, et. al. Spatial and Seasonal Patterns and Temporal Variability of Haze and its Constituents in the United States: Report V, June 2011. Chapter 7 – Urban Excess in PM$_{2.5}$ Speciated Aerosol Concentrations, *http://vista.cira.colostate.edu/improve/Publications/Reports/2011/PDF/Chapter7.pdf*

[41] US EPA, Office of Air Quality Planning and Standards, December 2004. (2004) Area Designations for 1997 Fine Particle (PM$_{2.5}$) Standards, Technical Support Document for State and Tribal Air Quality Fine Particle (PM$_{2.5}$) Designations, Chapter 3, Urban Excess Methodology. Available at *www.epa.gov/pmdesignations/1997standards/documents/final/TSD/Ch3.pdf*

[42] In certain circumstances, one or more monitoring locations within a monitoring network may not meet the network technical requirements set forth in 40 CFR 58.11(e), which states, "State and local governments must assess data from Class III PM$_{2.5}$ FEM and ARM monitors operated within their network using the performance criteria described in table C-4 to subpart C of part 53 of this chapter, for cases where the data are identified as not of sufficient comparability to a collocated FRM, and the monitoring agency requests that the FEM or ARM data should not be used in comparison to the NAAQS. These assessments are required in the monitoring agency's annual monitoring network plan described in §58.10(b) for cases where the FEM or ARM is identified as not of sufficient comparability to a collocated FRM…."

County, State	Monitor Site ID	State Rec NA?	09-11 DV	10-12 DV	11-13 DV
New Castle, DE	100032004	No	**10.7**	**10.4**	**10**
Cecil, MD	240150003	No	10.4	10.4	10
Harford, MD	240251001	No	9.8	10.3	10.3
Kent, MD	N/A	No	No monitor		
Atlantic, NJ	340010006	No	8.4	8.2	7.8
Atlantic, NJ	340011006	No	**9.2**	**8.9**	**8.7**
Burlington, NJ	N/A	No	No monitor		
Camden, NJ	340071007	No	9.7	9.5	9.7
Cumberland, NJ	N/A	No	No monitor		
Gloucester, NJ	340150004	No	9.3	9.3	9
Hunterdon, NJ	N/A	No	No monitor		
Mercer, NJ	340210008	No	**9.7**	**9.5**	**9.4**
Mercer, NJ	340218001	No	8.2	8.2	8.2
Monmouth, NJ	N/A	No	No monitor		
Ocean, NJ	340292002	No	8.6	8.5	8.3
Salem, NJ	N/A	No	No monitor		
Warren, NJ	340410006	No	9.2	9.4	9.1
Berks, PA	420110011	No	10.7	10.9	11
Bucks, PA	420170012	No	10.9	10.9	10.8
Chester, PA	420290100	No	13.7	12.3	11.1
Cumberland, PA	N/A	No	No monitor		
Delaware, PA	420450002	Yes	12.9	13.1	12.4
Lancaster, PA	420710007	No	12	12.1	12
Lehigh, PA	N/A	No	No monitor		
Montgomery, PA	420910013	No	10.1	9.8	9.8
Northampton, PA	420950025	Yes (other area)	13.4	13.2	12.2
Northampton, PA	420950027	Yes (other area)		10.6	10.6
Philadelphia, PA	421010004	No	**11.5**	9.8	9.3

County, State	Monitor Site ID	State Rec NA?	09-11 DV	10-12 DV	11-13 DV
Philadelphia, PA	421010047	No	11.2	10.9	10.5
Philadelphia, PA	421010055	No	11.4	**11**	**11.1**
Philadelphia, PA	421010057	No	11.1	10.8	10.7

[a]If a county has more than one monitoring location, the county DV is indicated in bold type.
[b]If a monitor is violating, the NAAQS, the violating DV is indicated in red type.

The Figure 1 map, shown previously, identifies the Delaware County, Pennsylvania final nonattainment area, the Philadelphia-Camden-Wilmington, Pennsylvania-New Jersey-Delaware-Maryland MSA boundary, and monitoring locations with 2011-2013 violating DVs. As indicated on the map and in Table 2, there are two violating monitoring locations in the area of analysis. One violating monitor is located in Delaware County, Pennsylvania, monitor 420450002 (the "violating monitor" or the "Delaware County monitor"). The second violating monitor is located in Northampton County, Pennsylvania. As discussed in Section 3.4, below, EPA conducted a separate five factor analysis for the violating monitor in Northampton County, and has determined that Northampton County, Pennsylvania should be designated in a separate nonattainment area, i.e., the Allentown Area.

Seasonal variation can highlight those conditions most associated with high average concentration levels of $PM_{2.5}$. Figure 2a shows quarterly mean $PM_{2.5}$ concentrations for the most recent 3-year period for the highest DV monitoring sites in each county within the area of analysis. This graphical representation is particularly relevant when assessing air quality data for an annual standard, such as the 2012 annual $PM_{2.5}$ NAAQS, because, as previously stated, the annual mean is calculated as the mean of quarterly means and a high quarter can drive the mean for an entire year, which, in turn, can drive an elevated 3-year DV. Figure 2b shows quarterly mean $PM_{2.5}$ concentrations for the most recent 3-year period for the Delaware County, Pennsylvania monitoring site and for the highest DV monitor in each county in the area of analysis.

Figure 2a. Delaware County Area of Analysis PM$_{2.5}$ Quarterly Means for 2011-2013 (µg/m^3)
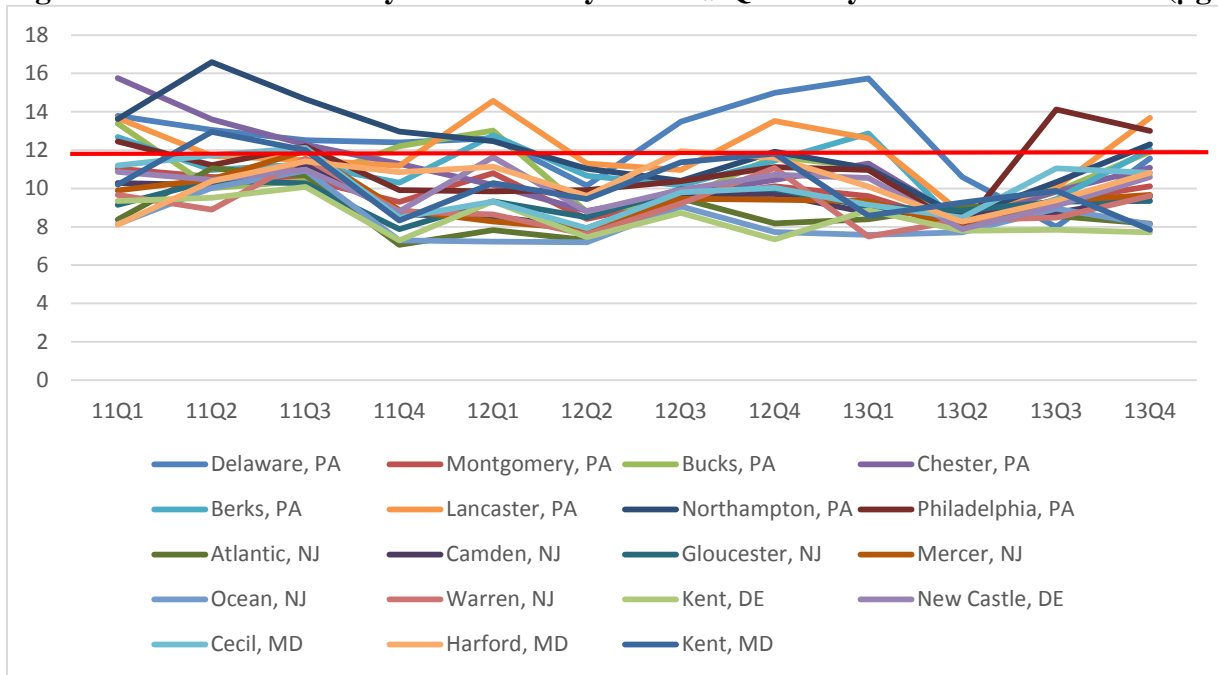
Figure 2b. Delaware County and Adjacent Counties PM$_{2.5}$ Quarterly Means for 2011-2013 (µg/m^3)
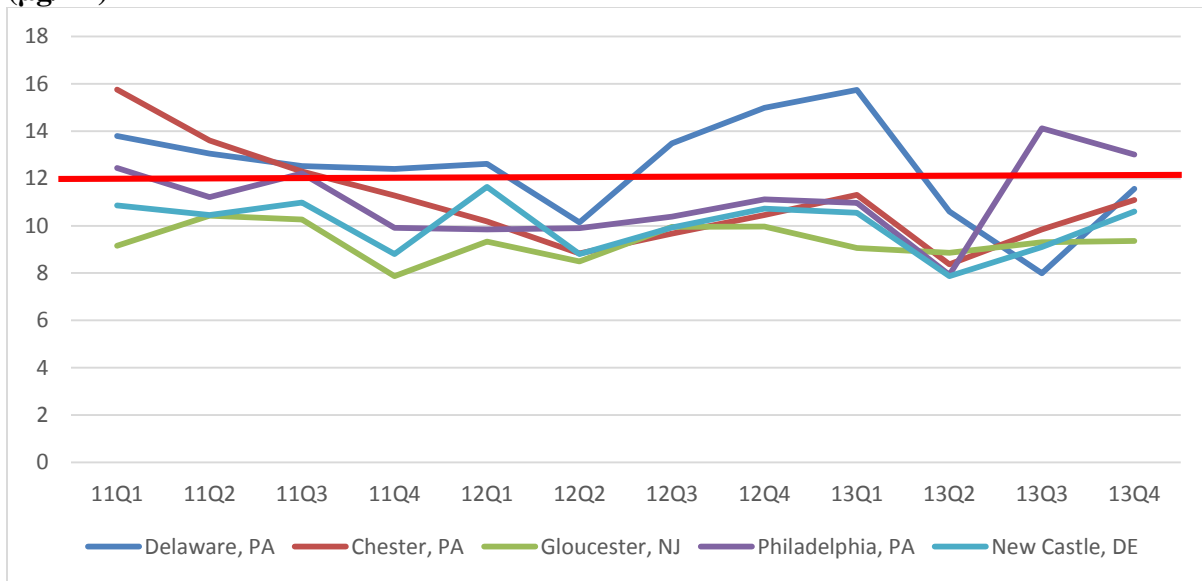
As shown, in Figure 2a, most monitors in the area of analysis show higher quarterly mean values in quarter 3 of each year, which likely corresponds to higher emissions from electric generating units (EGUs) from higher air conditioning use. These monitors also generally show higher quarterly mean values in the first quarter, which may be due to higher EGU emissions from higher heating use and possibly SO$_2$ emissions from home heating oil. In addition, there is a greater tendency for NO$_x$ to form in the atmosphere and for FRM monitors to retain particle nitrate during the cooler months. However, as shown in Figure 2b, the violating Delaware County monitor does not seem to experience highs and lows in the same quarters as its neighbors. Quarterly means were relatively consistent for the Delaware

County monitor starting in the first quarter in 2011 through the first quarter in 2012, with the low point in the second quarter of 2012. From the third quarter in 2012 to the second quarter in 2013, the Delaware County monitor was considerably higher than the other monitors in the area of analysis, while the surrounding monitors either drop off or remain low, suggesting an important local influence at the violating monitor relative to possible influences from elsewhere. In the third and fourth quarters of 2013, the $PM_{2.5}$ values at the Delaware County monitor appear to track with most other monitors in the area. This suggests that the influence of the local sources was less in those quarters. Furthermore, as can be seen in Figure 2b, the Delaware monitor's quarterly means the third and fourth quarters of 2013 are below the 12 µg/m^3 level of the 2012 annual $PM_{2.5}$ NAAQS.

$PM_{2.5}$ Composition Measurements - To assess potential emissions contributions for each violating monitoring location, EPA determined the various chemical species comprising total $PM_{2.5}$ to identify the chemical components over the analysis area, which can provide insight into the types of emission sources impacting the monitored concentration. To best describe the $PM_{2.5}$ at the violating monitoring location, EPA first adjusted the chemical speciation measurement data from a monitoring location at or near the violating FRM monitoring site using the SANDWICH approach to account for the amount of $PM_{2.5}$ mass components retained in the FRM measurement.[43,44,45,46] In particular, this approach accounts for losses in fine particle nitrate and increases in sulfate mass associated with particle bound water. The Delaware County monitoring site does not have the capability to provide speciation data. Therefore, EPA evaluated speciation data at two monitor locations near the Delaware County monitor, the monitoring site 100032004 located in New Castle County, Delaware and monitoring site 421010055 located in Philadelphia County, Pennsylvania. Figure 3a illustrates the average fraction of each $PM_{2.5}$ chemical component from these monitoring sites based on annual averages for the years 2010-2012. These monitoring sites were used because of their proximity to the violating monitor in Delaware County, Pennsylvania, to represent the speciation data in the region.

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[43] SANDWICH stands for measured **S**ulfate, **A**djusted **N**itrate, **D**erived **W**ater, **I**nferred **C**arbonaceous mass **H**ybrid Material Balance Approach." The SANDWICH adjustment uses an FRM mass construction methodology that results in reduced nitrates (relative to the amount measured by routine speciation networks), higher mass associated with sulfates (reflecting water included in gravimetric FRM measurements) and a measure of organic carbonaceous mass derived from the difference between measured $PM_{2.5}$ and its non-carbon components. This characterization of $PM_{2.5}$ mass also reflects crustal material and other minor components. The resulting characterization provides a complete mass closure for the measured FRM $PM_{2.5}$ mass, which can be different than the data provided directly by the speciation measurements from the CSN network.
[44] Frank, N. H., SANDWICH Material Balance Approach for $PM_{2.5}$ Data Analysis, National Air Monitoring Conference, Las Vegas, Nevada, November 6-9, 2006. *http://www.epa.gov/ttn/amtic/files/2006conference/frank.pdf*.
[45] Frank, N. H., The Chemical Composition of $PM_{2.5}$ to support PM Implementation, EPA State /Local/Tribal Training Workshop: $PM_{2.5}$ Final Rule Implementation and 2006 $PM_{2.5}$ Designation Process, Chicago IL, June 20-21, 2007, *http://www.epa.gov/ttn/naaqs/pm/presents/pm2.5_chemical_composition.pdf.*
[46] Frank, N. H. *Retained Nitrate, Hydrated Sulfates, and Carbonaceous Mass in Federal Reference Method Fine Particulate Matter for Six Eastern U.S. Cities*. J. Air & Waste Manage. Assoc. 2006 56:500–511.

Figure 3a. Greater Philadelphia Area 2010-2012 Annual Average PM$_{2.5}$ Chemical Components (µg/m^3)
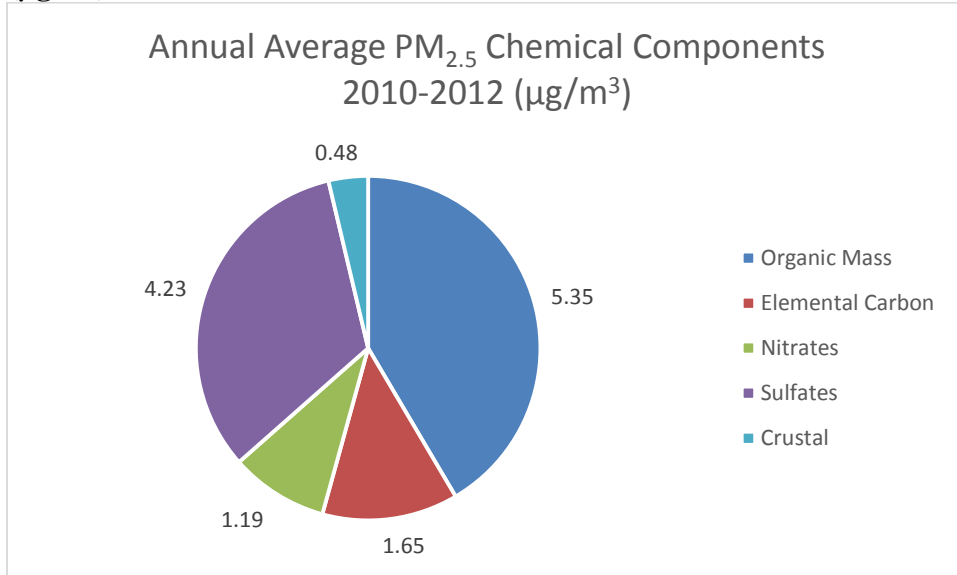
Figure 3b shows annual and quarterly chemical composition profiles and illustrates any seasonal or episodic contributors to PM$_{2.5}$ mass at the New Castle County, Delaware and Philadelphia County, Pennsylvania monitors, 100032004 and 421010055. This "increment analysis," combined with the other factor analyses, can provide additional insight as to which sources or factors may contribute at a greater level. Simply stated, this analysis can help identify nearby sources of emissions that contribute to the violation at the violating monitoring site. However, as stated above, because there is no speciation data available at the violating Delaware County monitor, the analysis shown in Figure 3b gives the annual and quarterly chemical composition profiles for monitoring site 100032004 in New Castle County, Delaware and monitoring site 421010055 in Philadelphia County, Pennsylvania.

Figure 3b. Greater Philadelphia Area 2010-2012 Annual and Quarterly Average PM$_{2.5}$ Species (µg/m^3) [a]

[a]*Adjusted to FRM Total PM$_{2.5}$* indicates that the speciation profile and total mass depicted in this figure are the result of the urban increment calculation for the particular FRM monitor.

EPA assessed seasonal and annual average PM$_{2.5}$ components at monitoring sites within the area relative to monitoring sites outside of the analysis area to account for the difference between regional background concentrations of PM$_{2.5}$, and the concentrations of PM$_{2.5}$ in the area of analysis, also known as the "urban increment." This analysis differentiates between the influences of emissions from sources in nearby areas and in more distant areas on the violating monitor. Estimating the urban increment in the area helps to illuminate the amount and type of particles at the violating monitor that are most likely to be the result of sources of emissions in nearby areas, as opposed to impacts of more distant or regional sources of emissions. Figure 4a includes bar charts showing the annual and quarterly chemical mass components of the urban increment at monitoring site 100032004 in New Castle County, DE and monitoring site 421010055 in Philadelphia County, Pennsylvania. The quarterly bar charts correspond to the high-concentration quarters identified in Figure 2. Evaluating these high concentration quarters can help identify composition of PM$_{2.5}$ during these times. Note that in these charts, sulfates and nitrates have been adjusted to represent their mass in measured PM$_{2.5}$.

Figure 4. Greater Philadelphia Area Average and Quarterly Urban Increment Analysis for 2010-2012 ($\mu g/m^3$).
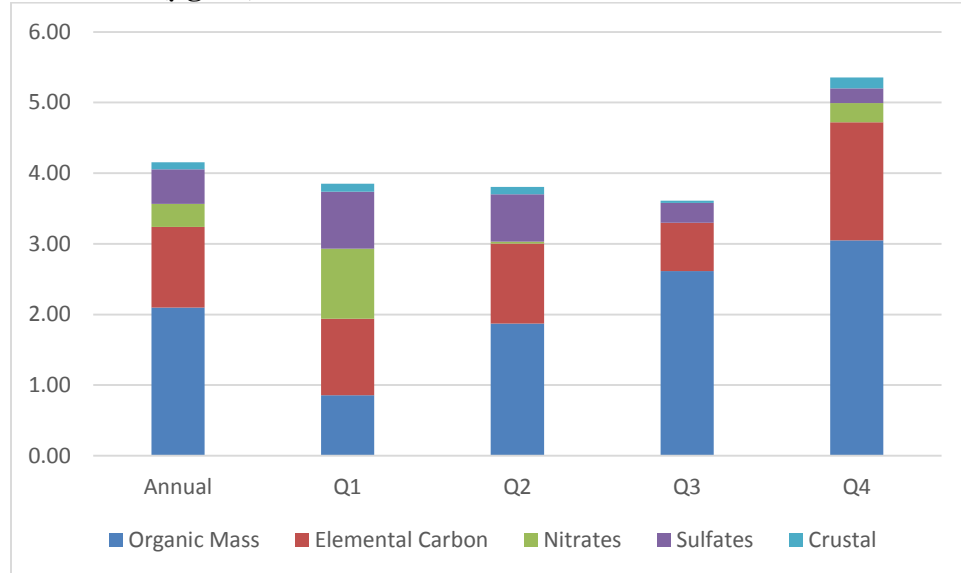
These speciation and urban increment data are illuminating with respect to the chemical composition of $PM_{2.5}$ at monitoring site 100032004 in New Castle County, Delaware and monitoring site 421010055 in Philadelphia County, Pennsylvania, and are relevant to the greater Philadelphia region. Figures 3a and 3b show large sulfate and organic mass at these monitors year round, with high nitrates in the first quarter, possibly due to EGU emissions from winter heating needs and greater particle nitrate collection during the cooler months. Figure 4a shows that organic mass and elemental carbon are a large part of the urban increment year round at these monitors, while nitrate appear in the first quarter and sulfates in both the first and second quarters. Since nitrate is limited to quarter one, mobile sources may not be a notable contributor to the urban increment.

However, EPA does not believe that the monitoring data from monitoring site 100032004 in New Castle County, Delaware and monitoring site 421010055 in Philadelphia County, Pennsylvania is sufficiently comparable to the Delaware County monitor to draw any conclusions about the sources that contribute to a violation of that monitor. As illustrated in Figures 2a and 2b and discussed above, $PM_{2.5}$ levels at the Delaware County monitor do not track well with the rest of the area of analysis, including monitors 100032004 and 421010055. The differences in seasonal peaks at the Delaware County monitor is an indication of local influences. There is a local influence at the Delaware County monitor that is not affecting the other monitors in the Philadelphia region, which are all meeting the 2012 annual $PM_{2.5}$ NAAQS.

As stated above, the Delaware County monitor does not appear to be influenced by the same seasonal factors as the other two monitors, or the rest of the greater Philadelphia area. This is supported by the assessment that Pennsylvania provided in its December 10, 2013 designation recommendations, which compared $PM_{2.5}$ levels at the Delaware County to other nearby monitors. Pennsylvania's analysis also supports EPA's finding that $PM_{2.5}$ concentrations at the Delaware County monitor were relatively high and not consistent with other monitors in the region. Here are two excerpts from Pennsylvania's

December 10, 2013 recommendation letter, Appendix C-1: Greater Philadelphia Area. Note that because the Delaware County monitor is located in the City of Chester, Pennsylvania refers to it as the "Chester monitor."

> "The Chester monitor is the only monitor in this region with an annual average and annual DV constantly above the 2012 standard. Since 2003, annual $PM_{2.5}$ levels have been in a general decline in the Greater Philadelphia area. The Bristol monitor in Bucks County has been below the 2012 standard on an annual average since 2009 and under the annual design value since 2010. In addition, the Norristown monitor in Montgomery County has been under the 2012 standard on an annual average since 2008 and the annual design value since 2009. Over the last three years, levels at the New Garden monitor have fallen at a significant rate. If the trend continues, the New Garden monitor's 2013 design value is expected to reach attainment of the 12 µg/m3 standard."

> and

> "Additional analyses were completed to determine what was contributing to the fewer number of "clean" days at the Chester monitor. The Department identified days when the Chester monitor's $PM_{2.5}$ concentrations were relatively high but regional monitoring concentrations in the five-county Philadelphia area were "clean." Between 2010 and 2012, the Department identified 212 days in which the Chester monitor was at least one standard deviation above the five-county regional average while the regional average was at or below 12 µg/m3."

Factor 2: Emissions and emissions-related data

In this designations process, for each area with a violating monitoring site, EPA evaluated the emissions data from nearby areas using emissions related data for the relevant counties to assess each county's potential contribution to $PM_{2.5}$ concentrations at the violating monitoring site or monitoring sites in the area under evaluation. Similar to the air quality analysis, these data were examined on a seasonal basis. However, as discussed above, there are no discernable seasonal trends at the Delaware County monitor. Therefore, EPA is not discussing seasonal emissions in this analysis, and is only discussing annual emissions. EPA examined emissions of identified sources or source categories of direct $PM_{2.5}$, the major components of direct $PM_{2.5}$ (organic mass, EC, crustal material (and/or individual trace metal compounds)), primary nitrate and primary sulfate, and precursor gaseous pollutants (i.e., SO_2, NO_X, total VOC, and NH_3). EPA also considered the distance of those sources of emissions from the violating monitoring site. While direct $PM_{2.5}$ emissions and its major carbonaceous components are generally associated with sources near violating $PM_{2.5}$ monitoring sites, the gaseous precursors tend to have a more regional influence (although EPA is mindful of the potential local NO_X and VOC emissions contributions to $PM_{2.5}$ from mobile and stationary sources) and transport from neighboring areas can contribute to higher $PM_{2.5}$ levels at the violating monitoring sites.

Emissions Data

For this factor, EPA reviewed data from the 2011 National Emissions Inventory (NEI) version 1 (see *http://www.epa.gov/ttn/chief/net/2011inventory.html*). For each county in the area of analysis, EPA examined the magnitude of county-level emissions reported in the NEI. These county-level emissions represent the sum of emissions from the following general source categories: point sources, non-point (i.e., area) sources, nonroad mobile, on-road mobile, and fires. EPA also looked at the geographic distribution of major point sources of the relevant pollutants.[47] Significant emissions levels from sources in a nearby area indicate the potential for the area to contribute to monitored violations. To further analyze area emissions data, EPA also developed a summary of direct $PM_{2.5}$, components of direct $PM_{2.5}$, and precursor pollutants, which is available at *http://www.epa.gov/pmdesignations/2012standards/docs/nei2011v1pointnei2008v3county.xlsx*.

When considered with the urban increment analysis in Factor 1, evaluating the components of direct $PM_{2.5}$ and precursor gases can help identify specific sources or source types contributing to elevated concentrations at violating monitoring sites and thus assist in identifying appropriate area boundaries. In general, directly emitted POC and VOCs[48] contribute to POM; directly emitted EC contributes to $PM_{2.5}$ EC; NO_X, NH_3 and directly emitted nitrate contribute to PNO3; SO_2, NH_3 and directly emitted sulfate contribute to PSO4; and directly emitted crustal material and metal oxides contribute to Pcrustal.[49,50] EPA believes that the quantities of those nearby emissions as potential contributors to the $PM_{2.5}$ violating monitors are somewhat proportional to the $PM_{2.5}$ chemical components in the estimated urban increment. Thus, directly emitted POC is more important per ton than SO_2, partially because POC emissions are already $PM_{2.5}$ whereas SO_2 must convert to $PM_{2.5}$ and not all of the emitted SO_2 undergoes this conversion.

Table 3a provides a county-level emissions summary (i.e., the sum of emissions from the following general source categories: point sources, non-point (i.e., area) sources, nonroad mobile, on-road mobile, and fires) of directly emitted $PM_{2.5}$ and precursor species in tons per year (tpy) for the county with the violating monitoring site and nearby counties considered for inclusion in the Delaware County Area. Table 3b summarizes the directly emitted components of $PM_{2.5}$ for the same counties in the area of analysis for the Delaware County Area. This information will be paired with the urban increment composition previously shown in Figures 4a and 4b.

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[47] For purposes of this designations effort, "major" point sources are those whose sum of PM precursor emissions ($PM_{2.5}$ + NOx + SO_2 + VOC + NH_3) are greater than 500 tons per year based on NEI 2011v1.

[48] As previously mentioned, nearby VOCs are presumed to be a less important contributor to POM than POC.

[49] *See*, Seinfeld J. H. and Pandis S. N. (2006) *Atmospheric Chemistry and Physics: From Air Pollution to Climate Change*, 2nd edition, J. Wiley, New York. See also, Seinfeld J. H. and Pandis S. N. (1998) *Atmospheric Chemistry and Physics: From Air Pollution to Climate Change*, 1st edition, J. Wiley, New York.

[50] USEPA Report (2004), The Particle Pollution Report: Current Understanding of Air Quality and Emissions through 2003, found at: *http://www.epa.gov/airtrends/aqtrnd04/pm.html*.

Table 3a. County-Level Emissions of Directly Emitted PM$_{2.5}$ and Precursors (tpy)

County, State	Total NH$_3$	Total NOx	Total Direct PM$_{2.5}$	Total SO$_2$	Total VOC	Total
Lancaster, PA	15,772	13,794	17,361	1,799	4,441	53,166
Philadelphia, PA	801	22,379	21,286	2,956	3,346	50,768
Northampton, PA	613	14,035	7,469	20,033	3,031	45,180
Montgomery, PA	779	17,147	18,975	2,518	3,338	42,757
Berks, PA	4,097	14,317	12,734	6,136	3,606	40,891
Delaware, PA	594	17,929	11,549	6,557	3,112	39,741
New Castle, DE	1,024	16,089	12,815	1,998	2,538	34,463
Bucks, PA	1,024	13,173	15,325	2,035	2,474	34,030
Chester, PA	1,908	12,094	11,581	2,176	2,220	29,979
Monmouth, NJ	741	9,903	12,111	522	1,408	24,685
Ocean, NJ	345	7,858	13,089	482	1,559	23,333
Lehigh, PA	620	8,861	9,649	1,321	2,081	22,532
Burlington, NJ	576	8,316	9,977	530	1,616	21,014
Camden, NJ	246	8,534	8,958	611	1,872	20,221
Gloucester, NJ	362	7,918	8,762	1,376	1,172	19,590
Mercer, NJ	254	7,397	7,327	946	1,324	17,248
Kent, DE	2,463	5,808	4,254	1,665	932	15,123
Atlantic, NJ	244	4,841	6,962	425	947	13,419
Harford, MD	495	6,050	5,096	490	879	13,010
Cumberland, NJ	463	3,914	4,883	1,349	1,028	11,638
Salem, NJ	708	3,269	2,083	1,757	486	8,303
Cecil, MD	651	3,587	2,776	300	517	7,831
Hunterdon, NJ	450	3,396	3,020	328	423	7,617
Warren, NJ	711	2,585	2,918	328	508	7,049
Kent, MD	744	942	1,218	157	409	3,470

Table 3b. County-Level Emissions for Components of Directly Emitted PM$_{2.5}$ (tpy) [51]

County, State	POM	EC	PSO4	PNO3	Pcrustal	Residual	Total Direct
Lancaster, PA	2,020	465	105.7	9	816	1024.802	4,441
Berks, PA	1,764	436	131.6	15	474	785.2966	3,606
Philadelphia, PA	1,423	568	254.2	19	448	633.553	3,346
Montgomery, PA	1,740	439	98.98	6	415	638.6036	3,338
Delaware, PA	1,131	497	325.8	21	479	658.8593	3,112
Northampton, PA	1,176	354	170	31	581	717.5565	3,031

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[51] Data are based on the 2011 and 2018 Emissions Modeling Platform Data Files and Summaries (*ftp://ftp.epa.gov/EmisInventory/2011v6/v1platform*) available at: *http://www.epa.gov/ttn/chief/emch/index.html#2011* (accessed 02/26/14).

County, State	POM	EC	PSO4	PNO3	Pcrustal	Residual	Total Direct
New Castle, DE	1,374	474	97.31	12	171	408.5423	2,538
Bucks, PA	1,253	403	77.96	8	315	416.3402	2,474
Chester, PA	1,030	433	78.68	10	284	384.1008	2,220
Lehigh, PA	1,208	247	57.17	5	196	367.6977	2,081
Camden, NJ	939	227	55.99	5	88	557.8196	1,872
Burlington, NJ	1,035	266	27.17	6	108	173.9813	1,616
Ocean, NJ	1,028	223	17.68	6	108	175.4669	1,559
Monmouth, NJ	846	226	20.05	3	119	193.3016	1,408
Mercer, NJ	842	223	24.2	3	81	149.5806	1,324
Gloucester, NJ	476	173	86.15	3	172	261.9218	1,172
Cumberland, NJ	614	137	62	5	39	170.5686	1,028
Atlantic, NJ	659	147	9.931	3	43	86.27427	947
Kent, DE	392	165	21.88	2	174	177.2305	932
Harford, MD	412	167	17.61	2	118	161.9914	879
Cecil, MD	227	106	12.54	1	78	92.79367	517
Warren, NJ	326	74	8.081	1	30	68.20153	508
Salem, NJ	155	52	47.08	1	56	175.4625	486
Hunterdon, NJ	229	97	7.36	1	33	55.55333	423
Kent, MD	143	42	5.118	1	122	95.91961	409

Table 3b breaks down the direct $PM_{2.5}$ emissions value from Table 3a into its components. These data will also be compared with the previously presented urban increment composition. As stated previously, the urban increment composition was derived from data obtained at monitoring site 100032004 in New Castle County, Delaware and monitoring site 421010055 in Philadelphia County, Pennsylvania, because speciation data is not available for the Delaware County monitor.

Using the previously described relationship between directly emitted and precursor gases and the measured mass to evaluate data presented in Tables 3a and 3b, EPA identified the following components warranting additional review: organic mass, VOCs, and elemental carbon. These components were shown to be the most common in the urban increment in the greater Philadelphia area, as shown in Figure 4a. Similar county level POM and VOC emissions are found in Delaware and the adjacent counties. Philadelphia and Delaware Counties had the highest EC. EPA then looked at the contribution of these components of interest from each of the counties included in the area of analysis as shown in Tables 4a-c.

Table 4a. County-Level POM Emission

County	Emissions in average tpy		
	POM	Percent (%)	Cumulative %
Lancaster, PA	2,020	9%	9%
Berks, PA	1,764	8%	17%
Montgomery, PA	1,740	8%	25%
Philadelphia, PA	1,423	6%	31%
New Castle, DE	1,374	6%	37%
Bucks, PA	1,253	6%	43%
Lehigh, PA	1,208	5%	48%
Northampton, PA	1,176	5%	53%
Delaware, PA	1,131	5%	58%
Burlington, NJ	1,035	5%	63%
Chester, PA	1,030	5%	68%
Ocean, NJ	1,028	5%	72%
Camden, NJ	939	4%	76%
Monmouth, NJ	846	4%	80%
Mercer, NJ	842	4%	84%
Atlantic, NJ	659	3%	87%
Cumberland, NJ	614	3%	89%
Gloucester, NJ	476	2%	92%
Harford, MD	412	2%	93%
Kent, DE	392	2%	95%
Warren, NJ	326	1%	97%
Hunterdon, NJ	229	1%	98%
Cecil, MD	227	1%	99%
Salem, NJ	155	1%	99%
Kent, MD	143	1%	100%
Total	22,444		

Table 4b. County-Level EC Emissions

County	Emissions in average tpy		
	EC	Percent (%)	Cumulative %
Philadelphia, PA	568	9%	9%
Delaware, PA	497	7%	16%
New Castle, DE	474	7%	23%
Lancaster, PA	465	7%	30%
Montgomery, PA	439	7%	37%
Berks, PA	436	7%	43%
Chester, PA	433	7%	50%
Bucks, PA	403	6%	56%
Northampton, PA	354	5%	61%
Burlington, NJ	266	4%	65%
Lehigh, PA	247	4%	69%
Camden, NJ	227	3%	72%
Monmouth, NJ	226	3%	76%
Mercer, NJ	223	3%	79%
Ocean, NJ	223	3%	83%
Gloucester, NJ	173	3%	85%
Harford, MD	167	3%	88%
Kent, DE	165	2%	90%
Atlantic, NJ	147	2%	92%
Cumberland, NJ	137	2%	94%
Cecil, MD	106	2%	96%
Hunterdon, NJ	97	1%	97%
Warren, NJ	74	1%	99%
Salem, NJ	52	1%	99%
Kent, MD	42	1%	100%
Total	6,643		

Table 4c. County-Level VOC Emissions

County	Emissions in average tpy		
	VOC	Percent (%)	Cumulative %
Lancaster, PA	4,441	9.81%	9.81%
Berks, PA	3,606	7.97%	18%
Philadelphia, PA	3,346	7.39%	25%
Montgomery, PA	3,338	7.37%	33%
Delaware, PA	3,112	6.88%	39%
Northampton, PA	3,031	6.69%	46%
New Castle, DE	2,538	5.61%	52%
Bucks, PA	2,474	5.46%	57%
Chester, PA	2,220	4.90%	62%
Lehigh, PA	2,081	4.60%	67%
Camden, NJ	1,872	4.14%	71%
Burlington, NJ	1,616	3.57%	74%
Ocean, NJ	1,559	3.44%	78%
Monmouth, NJ	1,408	3.11%	81%
Mercer, NJ	1,324	2.92%	84%
Gloucester, NJ	1,172	2.59%	86%
Cumberland, NJ	1,028	2.27%	89%
Atlantic, NJ	947	2.09%	91%
Kent, DE	932	2.06%	93%
Harford, MD	879	1.94%	95%
Cecil, MD	517	1.14%	96%
Warren, NJ	508	1.12%	97%
Salem, NJ	486	1.07%	98%
Hunterdon, NJ	423	0.94%	99%
Kent, MD	409	0.90%	100%
Total	45,267		

In addition to reviewing county-wide emissions of $PM_{2.5}$ and $PM_{2.5}$ precursors in the area of analysis, EPA also reviewed emissions from major point sources located in the area of analysis. The magnitude and location of these sources can help inform nonattainment boundaries. Table 5a provides facility-level emissions of direct $PM_{2.5}$, components of direct $PM_{2.5}$, and precursor pollutants (given in tons per year) from major point sources with total emissions of 500 tpy or more located in the area of analysis for the Delaware County area. Table 5a also shows the distance from the facility to the violating monitor in Delaware County.

Table 5a. NEI 2011 v1 Point Source Emissions (tpy)

County, State	Facility Name (Facility ID)	Distance from violating monitor (miles)	NEI 2011 v1 Emissions (tpy)					
			NH₃	NOₓ	PM₂.₅	SO₂	VOC	Total
Delaware, PA	Kimberly Clark Pa LLC/Chester Opr (420450016)	1	2	240	17	1,265	26	1,550
Delaware, PA	Covanta Delaware Valley LP/Delaware Valley Res Rec (420450059)	1		1,260	182	242	6	1,689
Delaware, PA	Monroe Energy LLC/Trainer (420450030)	2	6	656	228	142	241	1,273
Delaware, PA	Sunoco Inc (R&M)/Marcus Hook Refinery (420450025)	3	6	1,490	674	2,044	331	4,545
Gloucester, NJ	Logan Generating Plant, L.P. (55834)	4	2	656	17	600	6	1,280
Delaware, PA	Exelon Generation Co/Eddystone (420450014)	4	6	830	77	940	11	1,863
Gloucester, NJ	Paulsboro Refining Company LLC (55829)	6	5	655	238	77	308	1,283
Delaware, PA	Philadelphia Intl	7		2,246	53	254	318	2,871
New Castle, DE	Hay Road Energy Center (1000300388)	10	53	602	106	11	33	805
Philadelphia, PA	Sunoco Inc/ Phila Refinery R&M (4210101501)	11	4	1,315	722	297	749	3,088
Salem, NJ	Carneys Point Generating Plant (65498)	11	2	752	39	1,157	3	1,953
Camden, NJ	Camden County Municipal Utilities Authority (50163)	14	2	14	521	0	26	562
Montgomery, PA	Covanta Plymouth Renewable Energy/ Plymouth (420910295)	18	1	735	8	25	2	771
Chester, PA	Transcontinental Gas/Frazer Sta 200 (420290047)	18	0	595	248	1	49	893
Salem, NJ	Anchor Glass Container Corporation (65499)	19	1	509	67	90	9	676
New Castle, DE	Delaware City Refinery (1000300016)	22	7	1,072	281	333	139	1,832
Chester, PA	Exelon Gen Co/Cromby Gen Sta (420290023)	23	2	493	38	826	2	1,360
Chester, PA	Arcelormittal Plate LLC/Coatesville (420290024)	26	4	255	72	111	133	575
Bucks, PA	Wheelabrator Falls Inc/Falls Twp (420170469)	39	3	731	9	122	2	867
Bucks, PA	Fairless Energy LLC/Falls Twp (420170131)	40	170	201	196	18	25	609

County, State	Facility Name (Facility ID)	Distance from violating monitor (miles)	NEI 2011 v1 Emissions (tpy)					
			NH₃	NOx	PM₂.₅	SO₂	VOC	Total
Mercer, NJ	PSEG Fossil LLC Mercer Generating Station (61057)	41	1	430	56	573	18	1,078
Berks, PA	Genon Rema LLC/Titus Gen Sta (420110045)	43	0	683	43	4,087	5	4,818
Kent, DE	Nrg Energy Center Dover LLC (1000100127)	48	0	273	71	1,274	2	1,621
Berks, PA	Cryovac Inc/Cryovac Rigid Packaging (420110093)	50			0		556	556
Berks, PA	Lehigh Cement Co LLC/Evansville Cement Plt & Quarry (420110039)	52	41	1,225	134	200	12	1,611
Lehigh, PA	Lafarge Corp/Whitehall Plt (420770019)	59	14	368	36	331	7	754
Northampton, PA	Northampton Gen Co/Northampton (420950536)	59	2	441	44	546	2	1,034
Northampton, PA	Keystone Portland Cement/East Allen (420950012)	61	2	828	57	984	7	1,878
Northampton, PA	Essroc/Nazareth Lower Cement Plt 1 (420950045)	62	68	1,804	522	722	62	3,177
Northampton, PA	Hercules Cement Co LP/Stockertown (420950006)	63	3	989	29	1,420	20	2,462
Northampton, PA	PPL Martins Creek LLC/Martins Creek (420950010)	68	13	943	37	274	30	1,297
Lancaster, PA	Lancaster Cnty Rrf/ Lancaster (420710145)	69		577	4	12	4	597
Northampton, PA	GenOn Rema LLC/Portland Generating Sta (420950011)	76	0	1,977	67	15,148	14	17,206

Figure 5a shows the major point source emissions (from the 2011 NEI in tons per year) in the area of analysis for the Delaware County Area and the relative distances of these sources from the violating monitoring location, as depicted by red dots. The actual distance from the point sources to the violating monitoring location is presented in Table 5a. The distance from the violating monitoring location is particularly important for directly emitted PM₂.₅. The influence of directly emitted PM₂.₅ on ambient PM₂.₅ diminishes more than that of gaseous precursors as a function of distance.[52]

The Delaware County monitor is located in a heavily industrialized area. As indicated in Table 5a and Figure 5a, there are thirty-three sources with emissions of at least 500 tpy within the area of analysis. Six of these sources are in Delaware County and quite close to the violating monitor, as shown in Figure 5b.

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[52] Baker, K. R. and K. M. Foley. *A nonlinear regression model estimating single source concentrations of primary and secondarily formed PM₂.₅.* Atmospheric Environment. 45 (2011) 3758-3767.

Figure 5a. Major Point Sources in the Area of Analysis for the Delaware County Area
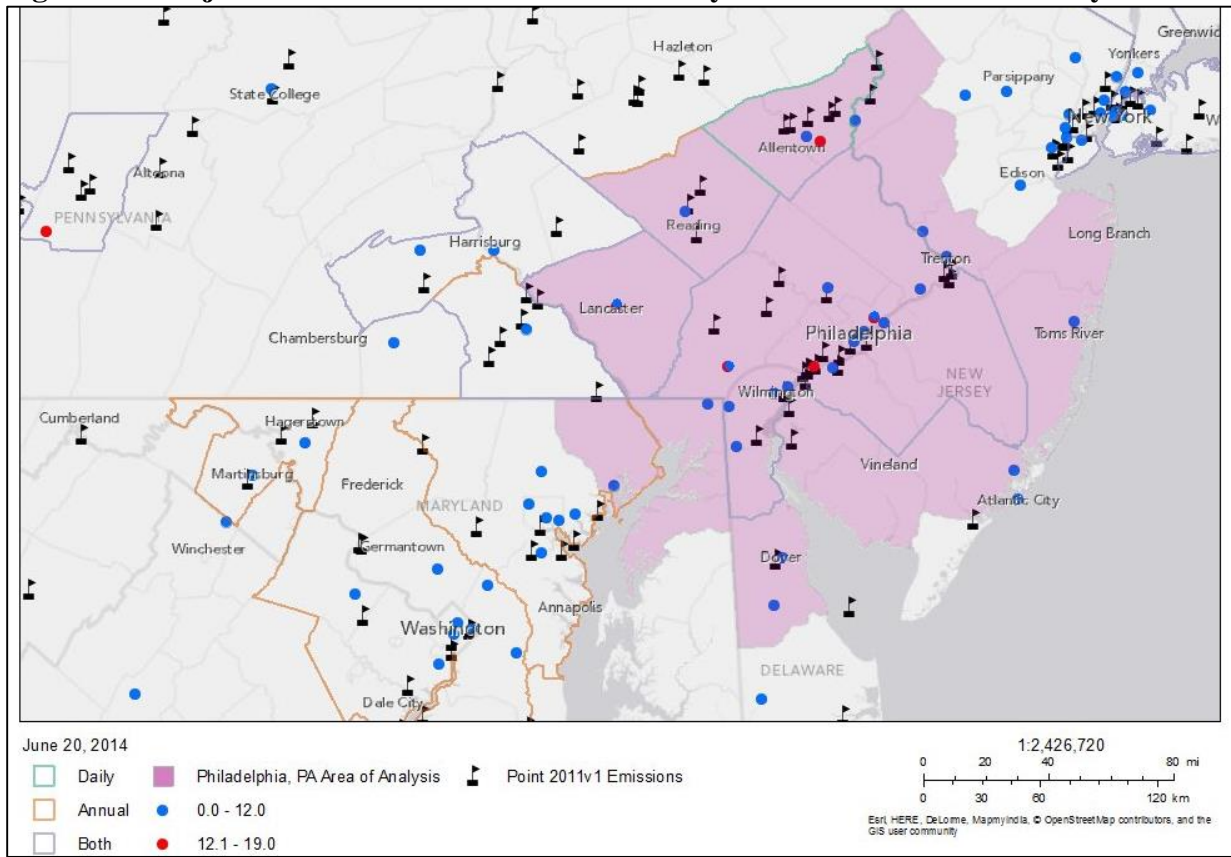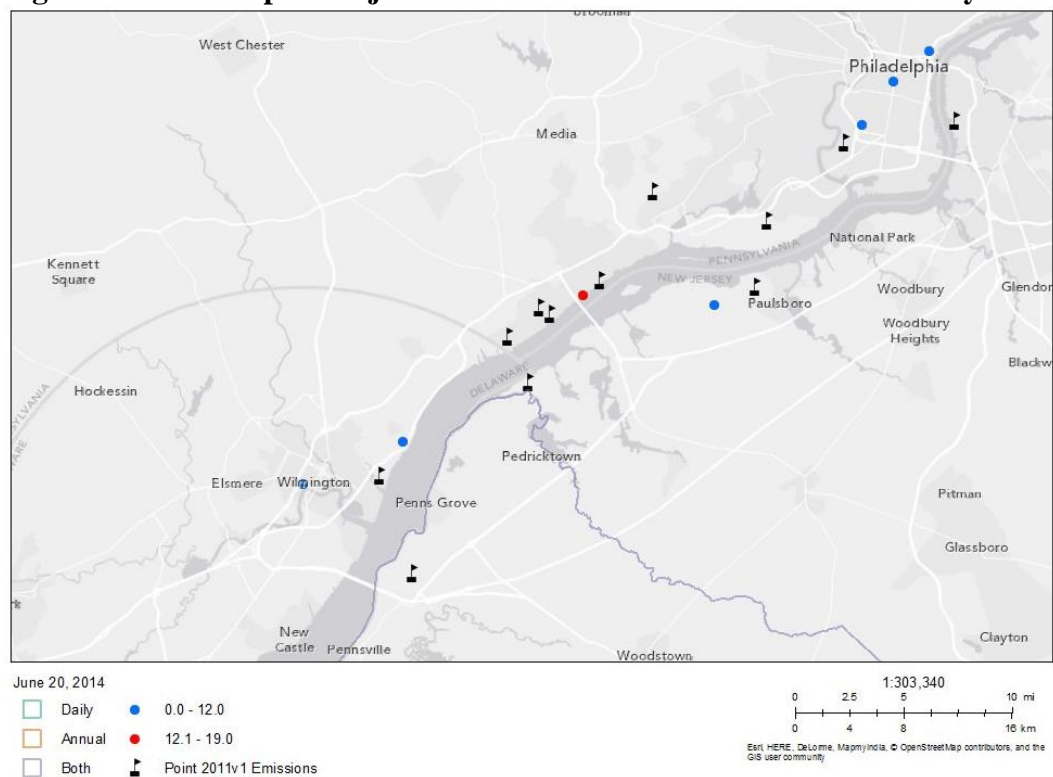

Figure 5b. Close-up of Major Point Sources Near the Delaware County Monitor.
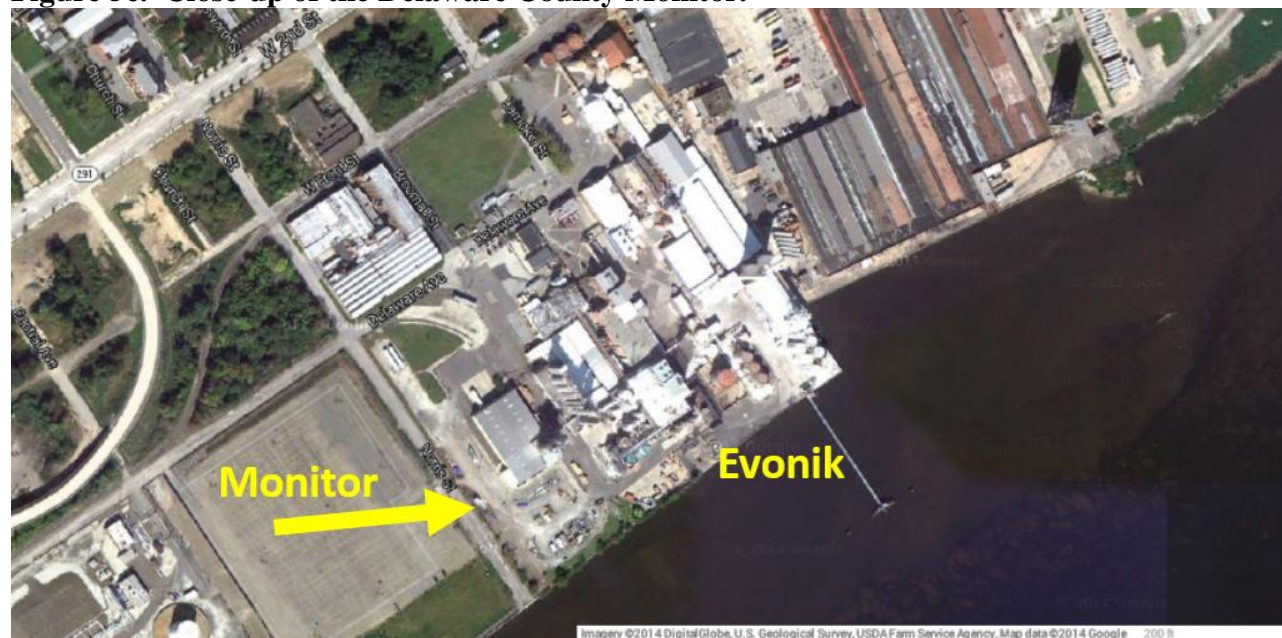
In addition, the Delaware County monitor is located adjacent, and actually within the fenceline of a small (less than 100 tpy) source, called Evonik. However, EPA has approved Pennsylvania's monitoring plan, which states that the Chester monitor (i.e. Delaware County monitor) is suitable to represent urban scale $PM_{2.5}$ population exposure.[53] Urban scale monitors are designed to represent air quality within an area of 4 to 50 kilometers.

Table 5b shows emissions from the Evonik facility. Figures 5c and 5d show the location of the monitor relative to this source. As discussed below in factor 3, regarding meteorology, the Evonik facility is upwind of the violating Delaware County monitor when its $PM_{2.5}$ levels are highest, indicating that this source is contributing to the violation.

Table 5b. Evonik Facility Emissions (tpy)

County, State	Facility Name (Facility ID)	Distance from monitor (miles)	NEI 2011 v1 Emissions (tpy)					
			NH_3	NO_X	$PM_{2.5}$	SO_2	VOC	Total
Delaware, PA	Evonik Corp/Chester (94723811)	0	0.4168	10.7063	2.9734	1.447	2.7619	18.3054

Figure 5c. Close-up of the Delaware County Monitor.

Source: Google Maps, at http://maps.google.com

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[53] Commonwealth of Pennsylvania Department of Environmental Protection 2013 Annual Ambient Air Monitoring Network Plan, dated July 2013.

Figure 5c. Close-up of the Delaware County Monitor and Evonik facility

Source: Google Maps, at http://maps.google.com

Monitors in the nearby vicinity to the east in Gloucester County, NJ, to the north in Philadelphia County, Pennsylvania, and to the south, New Castle County, Delaware, are not violating the NAAQS, indicating limited contribution from these areas relative to the contribution from local sources. The monitors to the east and south, are well below the NAAQS, despite their relative proximity to point sources listed in Table 5a. For example, the Gloucester County, NJ monitor is about 1.5 miles west of the Paulsboro Refining Company LLC facility, yet its 2011-2013 DV is 9.0 $\mu g/m^3$, indicating that the refinery may have limited contribution to the violation at the Delaware County monitoring site. The Hay Road Energy Center in New Castle County, DE is about 1.5 miles southwest of the New Castle County monitor, 100031003. The New Castle monitor has a 2011-2013 DV of 9.1 $\mu g/m^3$, again indicating that this major point source may have limited contribution to the violation at the Delaware County monitoring site compared with the contribution from local sources.

The sources in the nearby New Jersey counties are generally well controlled. For example, there are three New Jersey based coal fired generating stations: Logan Generating in Gloucester, PSEG Mercer in Mercer, and Carney's Point in Salem. PSEG Mercer is northeast of the monitor (not in a predominant wind direction). The other power plants are southwest of the monitor. All three power facilities are well-controlled with scrubbers, selective catalytic reduction (SCR), and baghouses. New Jersey's EGU rule (EGU-Coal, Oil, and Gas Fired Boilers: NJAC 7:27-4.2, 10.2, 19.4), has stringent NOx limits (1.5 pounds per megawatt hour) and SO_2 (0.150 pounds per Million British Thermal Units (MBTU) for a 30 day rolling average , and 0.0250 pounds per MBTU for a 24-hour average)for coal-fired units that required compliance by December 2012. New Jersey's sulfur in fuels regulation (Low Sulfur Distillate and Residual Fuel Strategies: NJAC 7:27-9, 7:27-27.9), covering residential, industrial, commercial, and electric power requires distillate to meet 500 parts per million (ppm) by 2014, and 15 ppm by 2016, as well as requiring residual fuel to meet 5,000 ppm by 2014, likely has

further reduced SO_2 emissions from New Jersey counties. New Jersey also has stringent RACT limits (NJAC 7:27-16,19). The Paulsboro Refining Company, which is east of the Delaware monitor, is under a Consent Decree and Administrative Consent Order with EPA and New Jersey[54], requiring reduction from major refinery processes including fluid catalytic cracking units (FCCU), boiler and process heaters, flare gas recovery, and leak detection and repair, to be completed by December 2011.

Sources in New Castle County, Delaware are also well controlled through measures in its federally approved State Implementation Plan (SIP). Here is an excerpt from Delaware's November 21, 2013 designation recommendation letter to EPA:

> "…total 2012 emissions of direct $PM_{2.5}$ and its precursors from New Castle County's largest point sources[55] decreased 87% between 2002 and 2012. This included a massive 99% reduction in SO_2, followed by a 65% reduction in direct $PM_{2.5}$, and a 52% decrease of NOx. VOC reductions of 54% have taken place since the early 1990s due to Delaware's ozone nonattainment issues over the years. NH_3 emissions have been reduced 52%, even though New Castle County emissions of ammonia in 2002 from these largest point sources were only 82 tons per year (tpy)."

Delaware's November 21, 2013 designation recommendation letter included a list of top point sources emitters in New Castle County, with their 2002 and 2012 emissions. That information is summarized in Table 5c.

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[54] United States of America, Plaintiff, and the States of Colorado, Louisiana, New Jersey, Oklahoma and Texas, Plaintiff-Interveners, v. Valero Refining Company, et al, and Tesoro Refining and Marketing Corporation, Defendants, Civil Action No. SA05CA0569, filed June 16, 2005.

[55] 2012 emissions $\geq$ 50 tpy for any $PM_{2.5}$-related pollutant

Table 5c. New Castle County - Top Point Source Emitters in 2002 and 2012

New Castle Top Emitting Facilities	NH$_3$		NOx		SO$_2$		PM$_{2.5}$		VOC		Sum of PM$_{2.5}$ related	
	2002	2012	2002	2012	2002	2012	2002	2012	2002	2012	2002	2012
Calpine Edge Moor	30	16	3,138	463	9,854	48	517	4	36	33	13,575	564
Calpine Hay Road	0	1	566	696	11	13	3	142	10	45	590	897
DE City Refinery	43	12	3,555	2,083	34,096	304	905	312	829	208	39,428	2,919
DuPont Edgemoor	1	1	35	29	92	21	27	1	83	98	239	150
DuPont Experimental	3	3	208	176	593	226	37	18	8	11	849	434
Evraz Steel	0	0	125	227	11	40	45	59	67	67	248	393
Formosa	4	6	31	31	0	1	35	15	124	69	194	122
TOTALS	**82**	**39**	**7,658**	**3,705**	**44,658**	**653**	**1,569**	**551**	**1,157**	**531**	**57,126**	**7,491**
2002-2012 % Reduction	**52%**		**52%**		**99%**		**65%**		**54%**		**87%**	

Source: Delaware's November 21, 2013 designation recommendation letter.

In summary, EPA's analysis of relevant county-level emissions and the geographic locations of the relevant pollutants shows that several of the counties within the area of analysis have relatively high emissions. Philadelphia County has the highest NO$_X$ and direct PM$_{2.5}$, while Northampton County has the highest SO$_2$ emissions, and Lancaster County has the highest NH$_3$ and VOC emissions. Delaware County ranks second in both NO$_X$ and SO$_2$ emissions. Furthermore, there are six facilities in Delaware County with emissions of 500 tpy or more that are quite close to the violating monitor, as can be seen in Figure 5b, including the Sunoco Marcus Hook Refinery which has total emissions of 4,545 tpy, and 674 tpy of direct PM$_{2.5}$. Large point sources in Philadelphia, Northampton, and Lancaster Counties are all farther away from the Delaware County monitor, as shown in Table 5a.

Population density and degree of urbanization

In this part of the factor analysis, EPA evaluated the population and vehicle use characteristics and trends of the area as indicators of the probable location and magnitude of non-point source emissions. Rapid population growth in a county on the urban perimeter signifies increasing integration with the core urban area, and indicates that it may be appropriate to include the county associated with area source and mobile source emissions as part of the nonattainment area. Table 6 shows the 2000 and 2010 population, population growth since 2000, and population density for each county in the area.
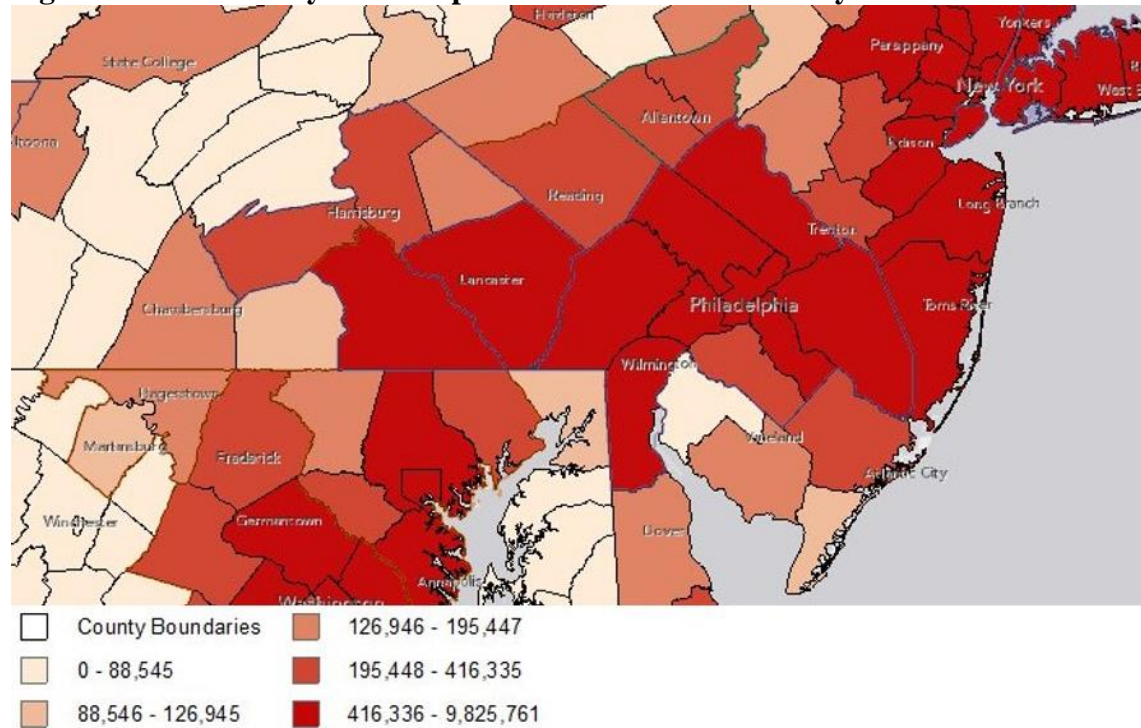
Table 6. Population Growth and Population Density.

County, State	Population 2000	Population 2010	% Change from 2000	Land Area (square miles)	Population Density (per square mile)	% of Area of Analysis	Cumulative %
Philadelphia, PA	1,517,550	1,528,458	0.7%	135	11,314	15%	15%
Montgomery, PA	750,097	801,134	6.8%	483	1,658	8%	23%
Monmouth, NJ	615,301	630,821	2.5%	472	1,337	6%	29%
Bucks, PA	597,635	625,505	4.7%	607	1,030	6%	35%
Ocean, NJ	510,916	577,697	13.1%	636	908	6%	41%
Delaware, PA	550,864	559,373	1.5%	184	3,037	5%	46%
New Castle, DE	500,265	538,951	7.7%	426	1,264	5%	51%
Lancaster, PA	470,658	520,344	10.6%	949	548	5%	57%
Camden, NJ	508,932	513,744	0.9%	222	2,311	5%	62%
Chester, PA	433,501	499,739	15.3%	756	661	5%	66%
Burlington, NJ	423,394	449,320	6.1%	805	558	4%	71%
Berks, PA	373,638	411,791	10.2%	859	479	4%	75%
Mercer, NJ	350,761	367,093	4.7%	226	1,625	4%	78%
Lehigh, PA	312,090	350,093	12.2%	347	1,010	3%	82%
Northampton, PA	267,066	298,065	11.6%	374	797	3%	85%
Gloucester, NJ	254,673	288,618	13.3%	325	889	3%	88%
Atlantic, NJ	252,552	274,715	8.8%	561	490	3%	90%
Harford, MD	218,590	245,243	12.2%	440	557	2%	93%
Kent, DE	126,697	162,973	28.6%	590	276	2%	94%
Cumberland, NJ	146,438	157,053	7.2%	489	321	2%	96%
Hunterdon, NJ	121,989	128,357	5.2%	430	299	1%	97%
Warren, NJ	102,437	108,693	6.1%	358	304	1%	98%
Cecil, MD	85,951	101,175	17.7%	348	291	1%	99%
Salem, NJ	64,285	66,008	2.7%	338	195	1%	100%
Kent, MD	19,197	20,184	5.1%	279	72	0%	100%
Total	9,575,477	10,225,147					

Source: U.S. Census Bureau population estimates for 2000 and 2010

The greater Philadelphia area is densely populated. Philadelphia County has both population and population density much larger than every other county in the area of analysis. Delaware County experienced 1.5 percent population growth between 2000 and 2010.   Delaware County has the second highest population density, and ranks sixth in population in the 25 county area of analysis.   Because EPA has determined the other factors indicate much less potential for contribution to the Delaware County monitor from emissions in other counties relative to local emissions from Delaware County, population and population density are not influential factors in determining nonattainment boundaries for the Delaware County Area.

Figure 6. 2010 County-Level Population in the Area of Analysis for the Delaware County Area.

☐ County Boundaries	▨ 126,946 - 195,447
☐ 0 - 88,545	▨ 195,448 - 416,335
▨ 88,546 - 126,945	▨ 416,336 - 9,825,761

Traffic and Vehicle Miles Travelled

High VMT and/or a high number of commuters associated with a county is generally an indicator that the county is an integral part of an urban area. Mobile source emissions of NO_x, VOC, and direct PM may contribute to ambient particulate matter that contributes to monitored violations of the NAAQS in the area. In combination with the population/population density data and the location of main transportation arteries, an assessment of VMT helps identify the probable location of nonpoint source emissions that contribute to violations in the area. Comparatively high VMT in a county outside of the CBSA or CSA signifies integration with the core urban area contained within the CSA or CBSA, and indicates that a county with the high VMT may be appropriate to include in the nonattainment area because emissions from mobile sources in that county contribute to violations in the area. Table 7 shows 2011 VMT while Figure 7 overlays 2011 county-level VMT with a map of the transportation arteries. This VMT data was obtained from the Federal Highway Administration.

Table 7. 2011 VMT for the Delaware County Area.

County, State	Total 2011 VMT	Percent	Cumulative %
Montgomery, PA	6,505,446,421	8%	8%
Monmouth, NJ	6,240,551,588	8%	16%
Philadelphia, PA	5,344,508,760	7%	22%
New Castle, DE	5,201,246,605	6%	29%
Bucks, PA	4,727,709,143	6%	35%
Ocean, NJ	4,617,759,793	6%	41%
Burlington, NJ	4,477,567,355	6%	46%
Chester, PA	4,277,236,066	5%	51%
Lancaster, PA	4,150,294,150	5%	57%
Camden, NJ	3,848,560,437	5%	61%
Berks, PA	3,381,679,887	4%	66%
Delaware, PA	3,336,446,326	4%	70%
Mercer, NJ	3,325,914,191	4%	74%
Lehigh, PA	2,988,094,564	4%	78%
Gloucester, NJ	2,713,227,986	3%	81%
Atlantic, NJ	2,676,389,714	3%	84%
Harford, MD	2,370,983,706	3%	87%
Northampton, PA	2,046,097,907	3%	90%
Hunterdon, NJ	1,828,353,779	2%	92%
Kent, DE	1,601,985,389	2%	94%
Warren, NJ	1,387,779,166	2%	96%
Cecil, MD	1,356,020,045	2%	97%
Cumberland, NJ	1,122,284,008	1%	99%
Salem, NJ	779,668,486	1%	100%
Kent, MD	205,005,588	0%	100%
Total	80,510,811,059		

http://www.census.gov/hhes/commuting/data/commuting.html

VMT varies greatly within the area of analysis, with Delaware County ranked twelfth out of twenty-six counties. Delaware County's VMT is about half that of the highest county, Montgomery County, Pennsylvania, and sixteen times higher than the lowest county, Kent County, Maryland. As seen in Figure 7, numerous large highways run through the area of analysis. Interstate 95 runs near the Delaware County monitor, as well as numerous non-violating monitors in the area.

EPA also considered "journey to work" data submitted by New Jersey and Delaware as part of their analysis in their February 24, 2014 and November 21, 2013 respective designation recommendation letters. New Jersey presented Journey to Work data from the US Census Bureau for the 2000 calendar year, since that was available at the time. The Census Bureau website also has a more recent five year average (2006 -2010 average) that differs slightly from the data presented by New Jersey. The tables below show that the commuters to Delaware County, Pennsylvania are mostly from Pennsylvania; relatively few are from New Jersey counties or New Castle County, Delaware.

Table 8a: Number of Commuters in Pennsylvania and New Jersey to Delaware County, Pennsylvania for the 2000 calendar year

Home County, State	#Commuters to Delaware County, PA
Philadelphia, PA	21,802
Delaware, PA	137,988
Montgomery, PA	11,758
Chester, PA	17,870
Bucks, PA	2,754
Berks, PA	505
Six county PA total commuting to Delaware County, PA	**192,677**
Gloucester, NJ	3,179
Camden, NJ	3,232
Burlington, NJ	1,771
Cumberland, NJ	105
Salem, NJ	486
Five county NJ commuting to Delaware County, PA	**8,773**

Source www.census.gov/population/www/cen2000/commuting/index.html

Table 8b. Number of Commuters to Delaware County, Pennsylvania for 2006-2010

Number	Margin of error	Residence State	Residence County, State	Workplace County
137,303	2,156	Pennsylvania	Delaware, PA	Delaware County
18,907	1,009	Pennsylvania	Chester, PA	Delaware County
17,732	1,234	Pennsylvania	Philadelphia, PA	Delaware County
12,113	791	Pennsylvania	Montgomery County, PA	Delaware County
9,097	838	Delaware	New Castle County, DE	Delaware County
3,303	408	New Jersey	Gloucester County	Delaware County
2,274	338	Pennsylvania	Bucks County, PA	Delaware County
2,208	248	New Jersey	Camden County, NJ	Delaware County
1,178	221	New Jersey	Burlington County, NJ	Delaware County
700	200	Pennsylvania	Berks County, PA	Delaware County
625	149	Pennsylvania	Lancaster County, PA	Delaware County
501	129	New Jersey	Salem County, NJ	Delaware County
316	110	Maryland	Cecil County, MD	Delaware County
237	88	Pennsylvania	Lehigh County, PA	Delaware County
181	93	New Jersey	Atlantic County, NJ	Delaware County
178	110	New Jersey	Mercer County, NJ	Delaware County
156	69	Delaware	Kent County, DE	Delaware County
127	56	New Jersey	Cumberland County, NJ	Delaware County
89	81	New Jersey	Middlesex County, NJ	Delaware County
67	44	New Jersey	Ocean County, NJ	Delaware County

Number	Margin of error	Residence State	Residence County, State	Workplace County
64	63	Maryland	Harford County, MD	Delaware County
45	34	Pennsylvania	York County, PA	Delaware County
42	34	Pennsylvania	Northampton County, PA	Delaware County
35	33	New Jersey	Monmouth County, NJ	Delaware County
20	17	Maryland	Kent County, MD	Delaware County
3	5	New Jersey	Hunterdon County, NJ	Delaware County

Source www.census.gov/population/www/cen2000/commuting/index.html

Figure 7. Overlay of 2011 County-level VMT with Transportation Arteries.

June 20, 2014

599,895 - 976,630,208	2,026,739,245 - 3,701,771,410
976,630,208 - 1,384,531,029	3,701,771,410 - 76,095,823,872
1,384,531,029 - 2,026,739,245	

1:2,426,720

Sources: Esri, HERE, DeLorme, USGS, Intermap, Increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

Factor 3: Meteorology

EPA evaluated available meteorological data to determine how meteorological conditions, including, but not limited to, weather, transport patterns, and stagnation conditions, could affect the fate and transport of directly emitted particulate matter and precursor emissions from sources in the area of analysis. EPA used two primary tools for this assessment: wind roses and kernel density estimation (KDE). When considered in combination with area $PM_{2.5}$ composition and county-level and facility emissions source location information, wind roses and KDE can help to identify nearby areas contributing to violations at violating monitoring sites.

Wind roses are graphic illustrations of the frequency of wind direction and wind speed. Wind direction can indicate the direction from which contributing emissions are transported; wind speed can indicate the force of the wind and thus the distance from which those emissions are transported. EPA constructed wind roses from hourly observations of wind direction and wind speed using 2009-2012 data from National Weather Service locations archived at the National Climate Data Center.[56] When developing these wind roses, EPA also used wind observations collected at meteorological sampling stations collocated at air quality monitoring sites, where these data were available. Figure 8 shows wind roses that EPA generated from data relevant in the Delaware County Area.

These wind roses represent average wind directions throughout the year. As can be seen in Figure 8a, the predominant wind direction in the area of analysis is westerly, with winds also coming from the southwest and northwest. There are also strong northerly and southerly components. These wind roses suggest potential emission sources in these directions should be considered for analysis. In its December 2013 recommendation letter, Pennsylvania included wind direction analysis at "high $PM_{2.5}$ days" at the Delaware County monitor. Specifically, Pennsylvania identified 212 days during the 2010 to 2012 monitoring period where $PM_{2.5}$ at the Delaware County monitor was at least one standard deviation above the five county Pennsylvania portion of the greater Philadelphia area. Pennsylvania analyzed the wind directions for the highest of those days, the top twenty-five percent. For these highest days, Pennsylvania calculated the number of hours the wind was coming from a particular direction as well as the concentrations coming from a particular direction, using data from a meteorological station collocated with the Delaware County monitor. Figures 8b and 8c represents the wind direction frequency and concentration distribution by wind direction, respectively, at the Delaware County monitor during the high $PM_{2.5}$ days.

As can be seen in Figures 8b and 8c, wind directions on high $PM_{2.5}$ days at the Delaware County monitor are predominantly from the east, with a northeast component and a lesser southwest component. This is contrary to the dominant wind direction in the region, which is westerly. This suggests local, rather than regional, sources are responsible for the high $PM_{2.5}$ days at the Delaware County monitor.

There are numerous sources in Delaware County, upwind of and very close to the violating monitor. The small Evonik facility is located directly east of the violating monitor, which, as illustrated above in Figure 5c, is within the fenceline of the facility. The Kimberly Clark Pa LLC facility is approximately one mile northeast of the monitor. The Covanta Delaware Valley facility is approximately one mile southwest of the monitor. Monroe Energy LLC/Trainer and Sunoco Inc (R&M)/Marcus Hook Refinery are both southwest of the monitor, two and three miles, away

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[56] *ftp.ncdc.noaa.gov/pub/data/noaa* or
http://gis.ncdc.noaa.gov/map/viewer/#app=cdo&cfg=cdo&theme=hourly&layers=1&node=gis Quality assurance of the National Weather Service data is described here: *http://www1.ncdc.noaa.gov/pub/data/inventories/ish-qc.pdf*

respectively. The Exelon Generation Co/Eddystone and the Philadelphia International Airport are northeast of the facility, four and seven miles away, respectively.

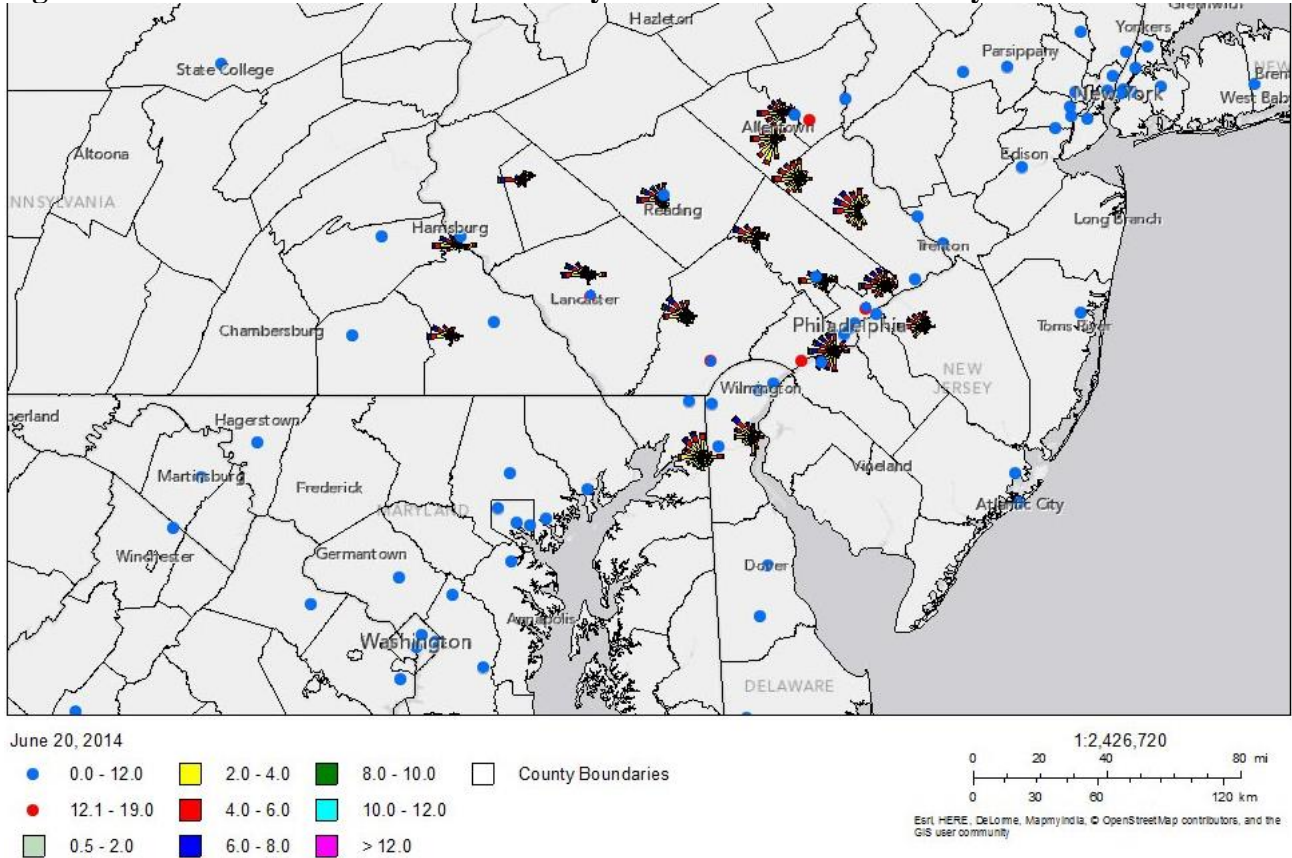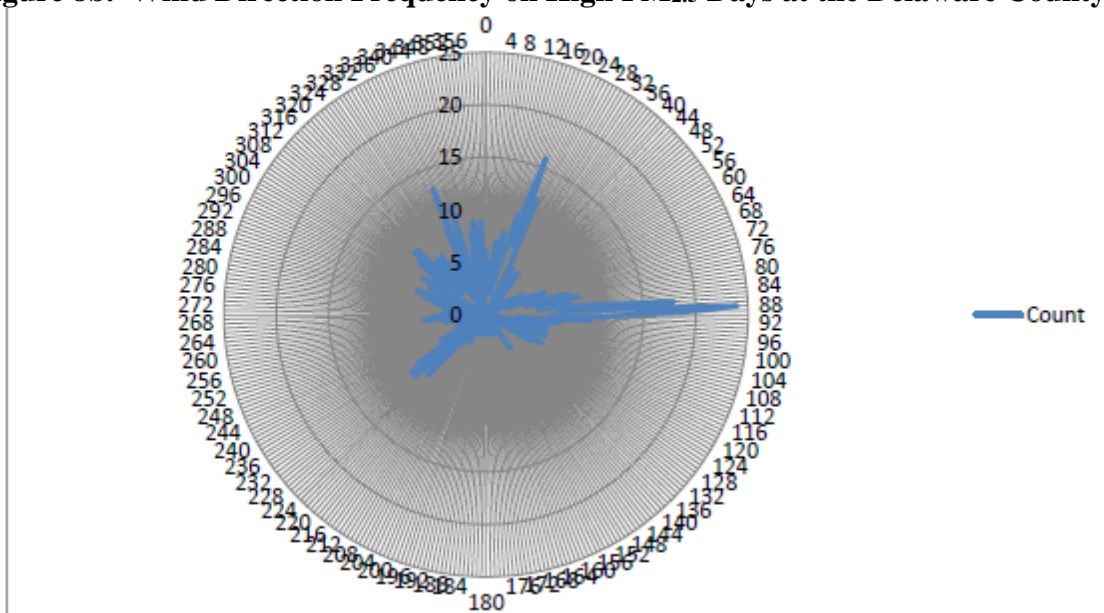**Figure 8a. Wind Roses in the Area of Analysis for the Delaware County Area.**

Figure 8b. Wind Direction Frequency on High PM$_{2.5}$ Days at the Delaware County Monitor

Source: Pennsylvania's December 10, 2013 recommendation letter, Appendix C-1- Greater Philadelphia Area

Figure 8c. Concentration Distribution by Wind Direction on High PM$_{2.5}$ Days at the Delaware County Monitor
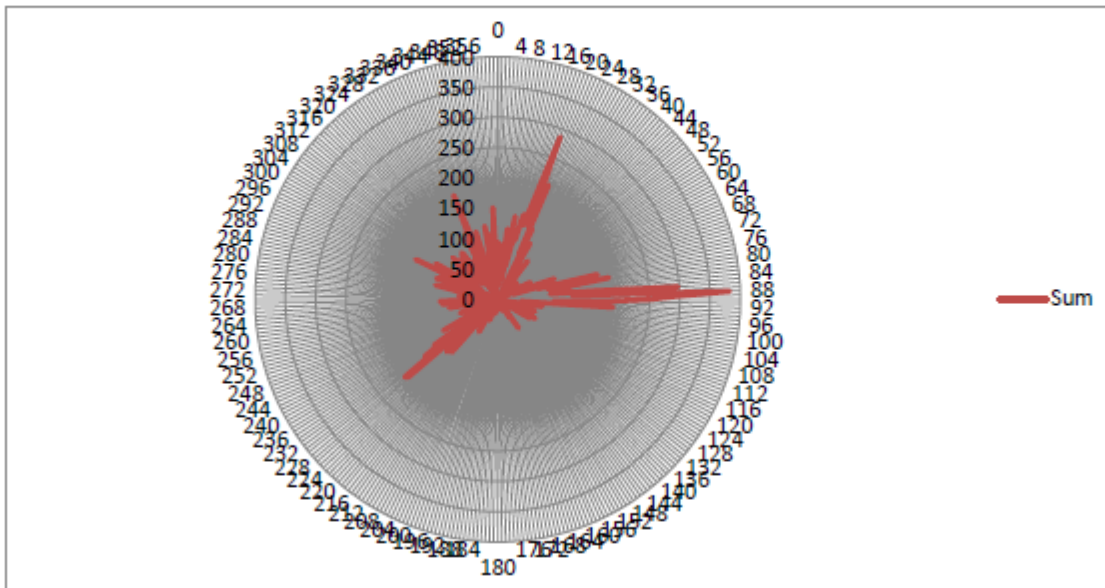
Source: Pennsylvania's December 10, 2013 recommendation letter, Appendix C-1- Greater Philadelphia Area

In addition to wind roses, EPA also generated kernel density estimation (KDE) plots to represent HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) backward trajectory frequency at violating monitoring sites.[57,58] These KDEs are graphical statistical estimations to determine the density of trajectory endpoints at a particular location represented by a grid cell. EPA used KDEs to characterize and analyze the collection of individual HYSPLIT backward trajectories.[59] Higher density values, indicated by darker blue colors, indicate a greater frequency of observed trajectory endpoints within a particular grid cell.

Figure 9 shows HYSPLIT KDE plots for the Delaware County Area summarized by calendar quarter for the 2010-2012 period. The HYSPLIT KDE plots are weighted in the westerly direction, indicating a greater frequency of trajectories passing over grid cells to the west of the Delaware County monitor. The first and third quarter plots show a strong northwesterly component, while the fourth quarter plot shows a southwesterly component.

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[57] In some past initial area designations efforts, EPA has used HYSPLIT backward trajectories to assist in determining nonattainment area boundaries. A HYSPLIT backward trajectory is usually depicted on a standard map as a single line, representing the centerline of an air parcel's motion, extending in two dimensional (x,y) space from a starting point and regressing backward in time to a point of origin. Backward trajectories may be an appropriate tool to assist in determining an air parcel's point of origin on a day in which a short-term standard, such as an 8-hour standard or a 24-hour standard, was exceeded. However, for an annual standard, such as the 2012 annual PM$_{2.5}$ NAAQS, every trajectory on every day is important. Plotting a mass of individual daily (e.g., 365 individual back trajectories), or more frequent, HYSPLIT trajectories may not be helpful as this process is likely to result in depicting air parcels originating in all directions from the violating monitoring site.

[58] HYSPLIT - Hybrid Single Particle Lagrangian Integrated Trajectory Model, *http://www.arl.noaa.gov/HYSPLIT_info.php*

[59] The KDEs graphically represent the aggregate of HYSPLIT backward trajectories for the years 2010-2012, run every third day (beginning on the first day of monitoring), four times each day, and ending at four endpoint heights.

The highest kernel density in the plots is found in Delaware County, indicating that Delaware County has the highest potential to contribute to the violating monitor. As seen in Figure 9, the kernel density in Lancaster County, which has the highest emissions in the area of analysis, is low, indicating less potential for contribution to the violating monitor in Delaware County. Similarly, the kernel density in most of Philadelphia County, which has the second highest emission in the area of analysis, is also relatively not high. High kernel density is found in portions of Chester, New Castle, Gloucester and Camden Counties. However, these counties have relatively low emissions, and therefore low potential for impacting the violating monitor.

Figure 9. HYSPLIT Kernel Density Estimation Plots for the Delaware County Area.
First Quarter   **Second Quarter**
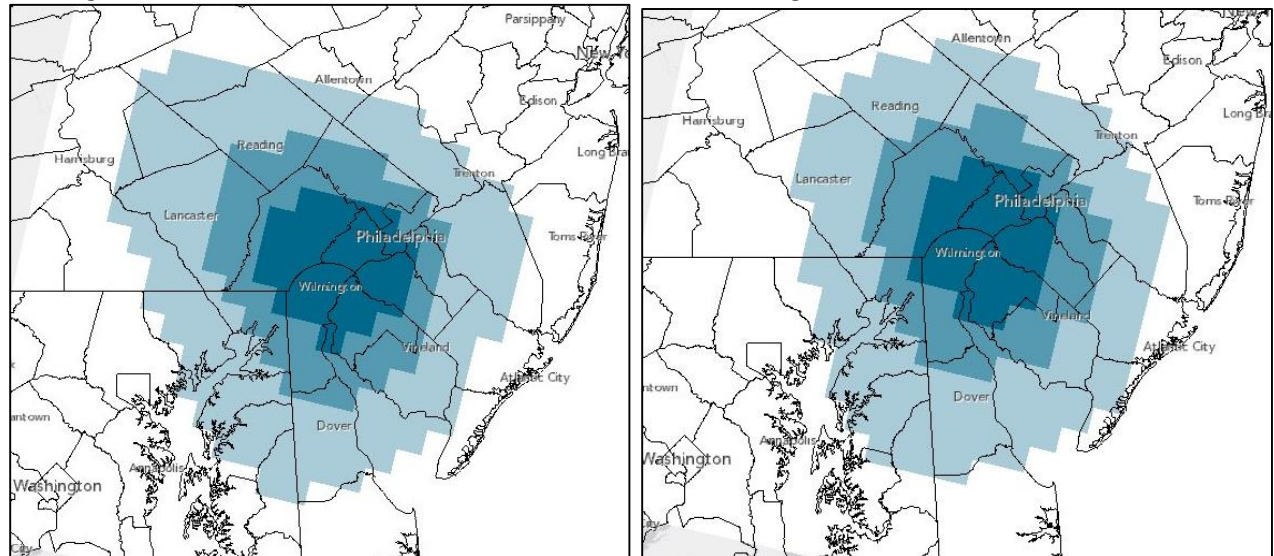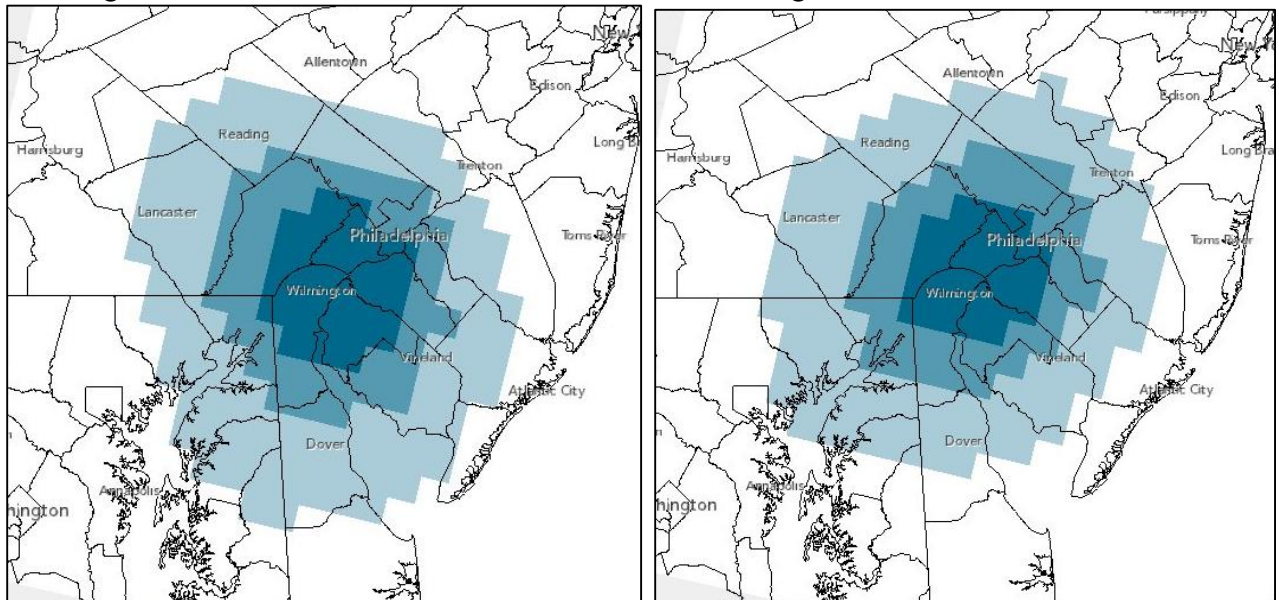
Third Quarter   **Fourth Quarter**

Factor 4: Geography/topography

To evaluate the geography/topography factor, EPA assessed physical features of the area of analysis that might define the airshed and thus affect the formation and distribution of PM$_{2.5}$ concentrations over the area. The Delaware County Area does not have any geographical or topographical barriers significantly limiting or directing air pollution transport within its air shed. Therefore, this factor did not play a significant role in this evaluation.

Factor 5: Jurisdictional boundaries

In defining the boundaries of the final Delaware County nonattainment area, EPA considered existing jurisdictional boundaries, which can provide easily identifiable and recognized boundaries for purposes of implementing the NAAQS. Existing jurisdictional boundaries often signify state and local governmental organization with the necessary legal authority for carrying out air quality planning and enforcement functions for the intended area. Examples of such jurisdictional boundaries include existing/prior nonattainment area boundaries for particulate matter, county lines, air district boundaries, township boundaries, areas covered by a metropolitan planning organization, state lines, and Reservation boundaries, if applicable. Where existing jurisdictional boundaries were not adequate or appropriate to describe the nonattainment area, EPA considered other clearly defined and permanent landmarks or geographic coordinates for purposes of identifying the boundaries of the designated areas.

The violating monitor is located in Delaware County, Pennsylvania, which is part of the Philadelphia-Camden-Wilmington, Pennsylvania-New Jersey-Delaware-Maryland MSA. This MSA includes New Castle County, Delaware; Cecil County, Maryland; Burlington, Camden, Gloucester, and Salem Counties in New Jersey; and Bucks, Chester, Delaware, Montgomery, and Philadelphia Counties in Pennsylvania. The major jurisdictional boundaries in the Philadelphia-Camden-Wilmington area are the state lines between Pennsylvania, Delaware, and New Jersey. Each state is responsible for its own air quality planning. In addition, the Philadelphia Air Management Services is responsible for certain air quality planning tasks in the City of Philadelphia.

The Delaware Valley Regional Planning Commission (DVRPC), the MPO in the Philadelphia area, serves Bucks, Chester, Delaware, Montgomery, and Philadelphia Counties in Pennsylvania, and Burlington, Camden, Gloucester, and Mercer Counties in New Jersey. New Castle County, DE is in a separate MPO, the Wilmington Area Planning Council (WILMAPCO). WILMAPCO is the Metropolitan Planning Organization for New Castle County, Delaware and Cecil County, Maryland.

Delaware County, Pennsylvania was designated as part of the Philadelphia-Wilmington, Pennsylvania-New Jersey-Delaware nonattainment area for the 1997 annual and 2006 24-hour PM$_{2.5}$ NAAQS. The boundary for the nonattainment area for the 1997 and 2006 PM$_{2.5}$ NAAQS included the entire counties of Bucks, Chester, Delaware, Montgomery, and Philadelphia in Pennsylvania; Burlington, Camden, and Gloucester in New Jersey; and New Castle in Delaware. EPA has redesignated to attainment the

New Jersey and Delaware portions of the Philadelphia-Wilmington, Pennsylvania-New Jersey-Delaware nonattainment area for the 1997 and 2006 $PM_{2.5}$ NAAQS (78 FR 54396) and (79 FR 45350), respectively. These redesignations to attainment indicate that air quality has improved in the Philadelphia region.

The states have recommended different boundaries for the 2012 annual $PM_{2.5}$ NAAQS. Both Delaware and New Jersey have recommended that no counties in their respective states should be part of a nonattainment area in the greater Philadelphia area. Pennsylvania recommended that Delaware County be designated as nonattainment, based on 2011-2013 ambient air quality monitoring data. EPA's intended nonattainment area boundary differs from the previously designated Philadelphia-Wilmington, Pennsylvania-New Jersey-Delaware nonattainment area for the 1997 annual and 2006 24-hour $PM_{2.5}$ NAAQS, because the data discussed above supports the finding that the violation in Delaware County is due to local, rather than regional emissions.

Conclusion for Delaware County Area

Based on the assessment of factors described above, both individually and in combination, EPA has concluded that, within the Philadelphia-Camden-Wilmington MSA, Delaware County, Pennsylvania should be the only county designated as nonattainment, because it is violating the 2012 annual $PM_{2.5}$ NAAQS and is contributing to the monitored violation. EPA's intended boundary is different from the Philadelphia-Wilmington, Pennsylvania-New Jersey-Delaware nonattainment area for the 1997 annual and 2006 24-hour $PM_{2.5}$ NAAQS. All other monitors in Philadelphia-Wilmington, Pennsylvania-New Jersey-Delaware area are meeting the 2012 annual $PM_{2.5}$ NAAQS based on the 2013 DVs. Furthermore, available data does not support a finding that the other counties in the Philadelphia-Wilmington, Pennsylvania-New Jersey-Delaware area are contributing to the monitored violation in Delaware County.

As stated above, starting in 2011, quarterly mean $PM_{2.5}$ levels at the Delaware County monitor are consistently high, while the surrounding monitors either drop off or remain low, suggesting notable local influence at the violating monitor. Most monitors in the area of analysis show higher quarterly mean $PM_{2.5}$ values in the third calendar quarter, which corresponds to higher EGU emissions from higher air conditioning use. These monitors also generally show higher quarterly mean values in the first calendar quarter, which may be due to higher EGU emissions from higher heating use, including home heating oil and from greater collection of particle nitrate during the cooler months. However, the violating Delaware County monitor does not seem to experience highs and lows in the same quarters as its neighbors.

Quarterly means were relatively consistent for the Delaware County monitor starting in the first quarter in 2011 through the first quarter in 2012, with the low point in the second quarter of 2012. From the third quarter in 2012 to the second quarter in 2013, the Delaware County monitor was considerably higher than the other monitors in the area of analysis, while the surrounding monitors either drop off or remain low, suggesting an important local influence at the violating monitor. In the

third and fourth quarters of 2013, the $PM_{2.5}$ values at the Delaware County monitor appear to track with most other monitors in the area, and are below the 12 $\mu g/m^3$ level of the 2012 annual $PM_{2.5}$ NAAQS. This suggests that the influence of the local sources was less important in those quarters.

The greater Philadelphia area is densely populated. Delaware County has the second highest population density, and ranks sixth in total population in the 25 county area of analysis. Delaware County's VMT is about half that of the highest county, Montgomery County, Pennsylvania, and sixteen times higher than the lowest county, Kent County, Maryland. Numerous large highways run through the area of analysis. Interstate 95 runs near the Delaware County monitor.
The Delaware County monitor is located in a heavily industrialized area, and is sited adjacent to a small industrial source. In the area of analysis, Delaware County ranks second in EC, NO_X and SO_2 emissions. Furthermore, there are six facilities in Delaware County with emissions of 500 tpy or more, located within seven miles of the violating monitor, including the Sunoco Marcus Hook Refinery with total emissions of 4,545 tpy, and 674 tpy of direct $PM_{2.5}$. In addition, the small Evonik site is located adjacent to and directly east of the violating monitor. EPA and the Commonwealth both believe that the high density of emission sources in close proximity to the monitor are the contributor to the $PM_{2.5}$ violation and further emphasize the impacts on the Delaware County monitor is a local contribution rather than a regional one from the surrounding counties.

The predominant wind direction in the area of analysis is westerly, with winds also coming from the southwest and northwest. Wind directions on high $PM_{2.5}$ days at the Delaware County monitor are predominantly from the east, with a northeast component and a lesser southwest component. This is contrary to the dominant wind direction in the region, which is westerly. This suggests local, rather than regional, sources are responsible for the high $PM_{2.5}$ days at the Delaware County monitor.

There are numerous sources in Delaware County, upwind of and very close to the violating monitor. The small Evonik facility is located directly east of, and therefore upwind of, the violating monitor, which, as illustrated above in Figure 5c, is within the fenceline of the facility. The Kimberly Clark Pa LLC facility is approximately one mile northeast of the monitor. The Covanta Delaware Valley facility is approximately one mile southwest of the monitor. Monroe Energy LLC/Trainer and Sunoco Inc (R&M)/Marcus Hook Refinery are both southwest of the monitor, two and three miles, away respectively. The Exelon Generation Co/Eddystone and the Philadelphia International Airport are northeast of the facility, four and seven miles away, respectively.

The HYSPLIT KDE plots for the Delaware County violating monitor are weighted in the westerly direction, indicating a greater frequency of trajectories passing over grid cells to the west of the Delaware County monitor. The first and third quarter plots show a strong northwesterly component, while the fourth quarter plot shows a southwesterly component. The highest kernel density in the plots is found in Delaware County, indicating that Delaware County has the highest potential to contribute to the violating monitor. As seen in Figure 9, the kernel density in Lancaster County, which has the highest emissions in the area of analysis, is low, indicating less potential for contribution to the violating monitor in Delaware County. Similarly, the kernel density in most of Philadelphia County,

which has the second highest emission in the area of analysis, is also not high. High kernel density is found in portions of Chester, New Castle, Gloucester and Camden Counties. However, these counties have relatively low emissions, and therefore low potential for impacting the violating monitor.

3.3   Area Background and Overview – Allegheny County Area

Figure A is a map of EPA's final nonattainment boundary for the Allegheny County Area. The map shows the location and DVs of ambient air quality monitoring locations, county and other jurisdictional boundaries, including the Pittsburgh, PA MSA and existing nonattainment area boundaries for the 1997 annual and/or 2006 24-hour $PM_{2.5}$ NAAQS.
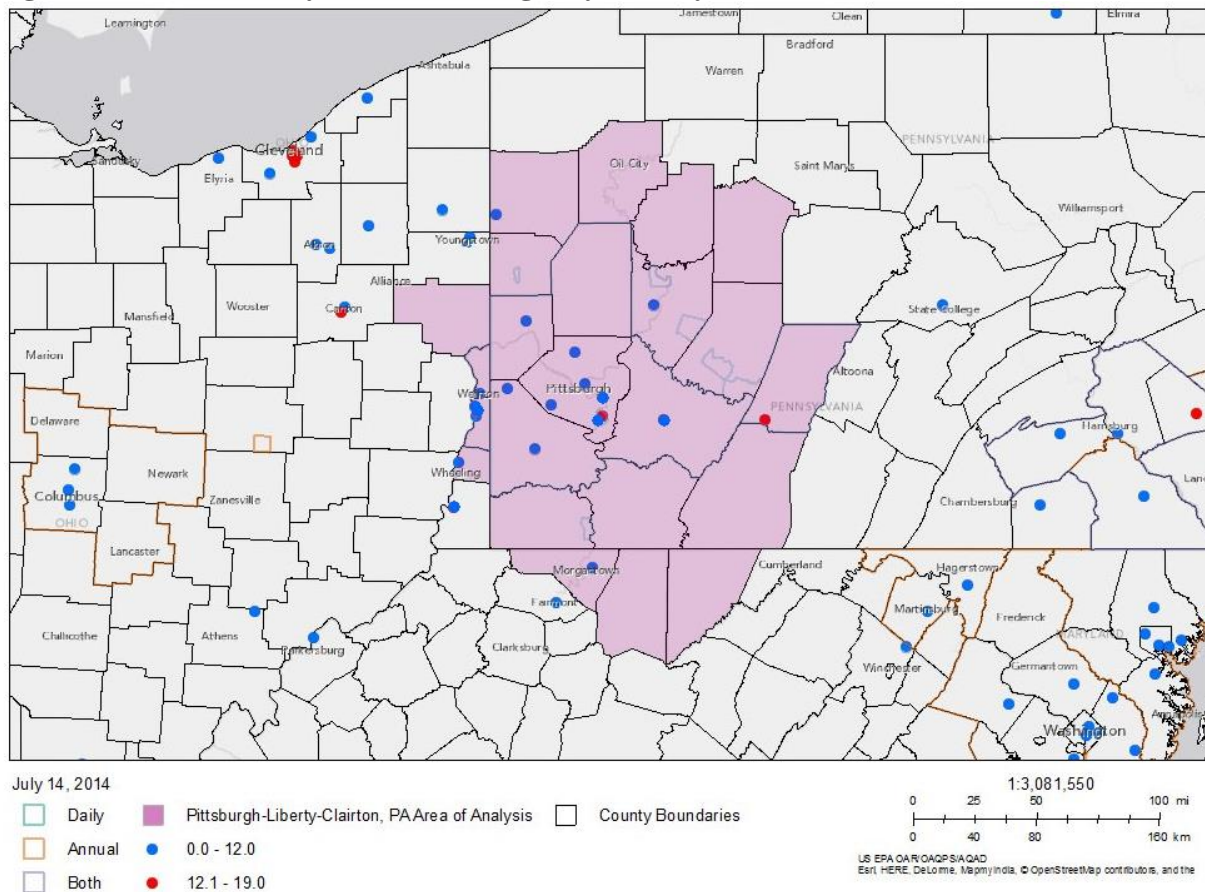
For purposes of the 1997 annual and 2006 24-hour $PM_{2.5}$ NAAQS, this area was designated nonattainment. Part of Allegheny County was designated nonattainment as the Liberty-Clairton Area for the 1997 annual and 2006 24-hour $PM_{2.5}$ NAAQS. The Liberty-Clairton Area includes the City of Clairton and the Boroughs of Glassport, Liberty, Lincoln, and Port Vue in Allegheny County, PA. For purposes of the 1997 annual and 2006 24-hour $PM_{2.5}$, the remainder of Allegheny County was designated in the Pittsburg-Beaver Valley nonattainment area, along with the, Beaver, Butler Washington, and Westmoreland Counties and portions of Armstrong Greene, and Lawrence Counties. Pennsylvania recommended that only the five municipalities in the Liberty-Clairton Area be designated as nonattainment for the 2012 annual $PM_{2.5}$ NAAQS. However, based on its five factor analysis, EPA is designating all of Allegheny County as the Allegheny County nonattainment area for the 2012 annual $PM_{2.5}$ NAAQS.

Figure A. EPA's Final Nonattainment Boundaries for the Allegheny County Area
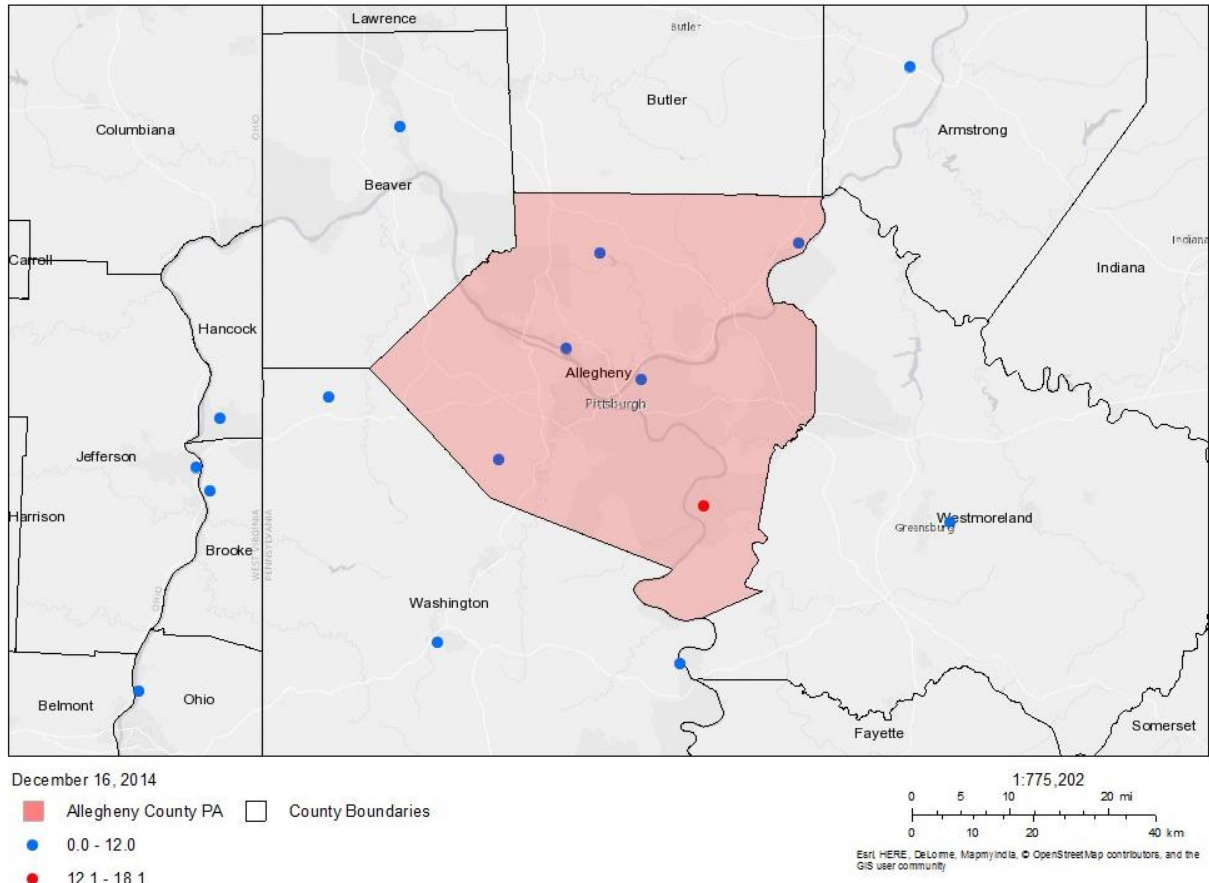
EPA must designate as nonattainment areas that violate the NAAQS and nearby areas that contribute to the violation in the violating area. A monitor in Liberty Borough in Allegheny County, PA shows a violation of the 2012 annual $PM_{2.5}$ NAAQS. Therefore, this county is included in the nonattainment area. As shown in Figure B, EPA evaluated each county in the Pittsburgh, MSA, which includes Allegheny, Armstrong, Beaver, Butler, Fayette, Washington, and Westmoreland Counties in Pennsylvania, and a ring of counties adjacent to the Pittsburgh, PA MSA. EPA's evaluation was based on the five factors and other relevant information. EPA has determined that only Allegheny County, PA contributes to the nearby violation. Note that Cambria County, PA, which is in the area of analysis, also shows a violation. As discussed in Section 3.1, EPA intends to designate Cambria County and a portion of Indiana County, PA as nonattainment in a separate nonattainment area, the Johnstown Area. The following sections describe this five factor analysis process. While the factors are presented individually, they are not independent. The five factor analysis process carefully considers their interconnections and the dependence of each factor on one or more of the others.

Figure B. Area of Analysis for the Allegheny County Intended Nonattainment Area

Factor 1: Air Quality Data

All ambient air quality data collected during the year are important when determining contributions to an annual standard such as the 2012 annual $PM_{2.5}$ NAAQS. Compliance with an annual NAAQS is dependent upon monitor readings throughout the year, including days with monitored ambient

concentrations below the level of the NAAQS. For the 2012 annual $PM_{2.5}$ NAAQS, the annual mean is calculated as the mean of quarterly means. A high quarter can drive the mean for an entire year, which, in turn, can drive an elevated 3-year DV. Although all data are important, seasonal or episodic emissions can provide insight as to relative contributors to measured $PM_{2.5}$ concentrations. For these reasons, for the Factor 1 air quality analysis, EPA assessed and characterized air quality at, and in the proximity of, the violating monitoring site locations first, by evaluating trends and the spatial extent of measured concentrations at monitors in the area of analysis, and then, by identifying the conditions most associated with high average concentration levels of $PM_{2.5}$ mass in the area of analysis.

In most cases, EPA assessed air quality data on a seasonal, or quarterly, basis.[60] EPA also identified the spatial extent of these high $PM_{2.5}$ concentrations. The mass and composition at the DV location represents contributions from various emission sources including local, area-wide (which may comprise nearby urban and rural areas) and regional sources. To determine the source mix (by mass) at the DV monitoring site, EPA examined the chemical composition of the monitored $PM_{2.5}$ concentrations by pairing each violating FRM/FEM/ARM monitoring site with a collocated or nearby Chemical Speciation Network (CSN) monitoring site or sites. Then, EPA contrasted the approximated mass composition at the DV monitoring site with data collected at IMPROVE[61] and other monitoring locations whose data are representative of regional background.[62,63] This comparison of local/area-wide chemical composition data to regional chemical composition data derives an "urban increment," which helps differentiate the influence of more distant emissions sources from the influence of closer

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[60] Although compliance with the annual NAAQS depends on contributions from all days of the year, examining data on a quarterly or seasonal basis can inform the relationship between the temporal variability of emissions and meteorology and the resulting $PM_{2.5}$ mass and composition. In some areas of the country where there may be noticeable month-to-month variations in average $PM_{2.5}$, the quarterly averages may not adequately represent seasonal variability. In these areas, air quality data may be aggregated and presented by those months that best correspond to the local "seasons" in these areas.

[61] IMPROVE stands for Interagency Monitoring for Protected Visual Environments and is an aerosol monitoring network in mostly rural and remote areas.

[62] The "urban increment" analysis assesses and characterizes the increase in seasonal and annual average $PM_{2.5}$ mass and chemical components observed at violating monitoring site(s) relative to monitoring sites outside the area of analysis (which represent background concentrations). Developing the urban increment involves pairing a violating FRM/FEM/ARM monitor with a collocated monitor or nearby monitor with speciation data. EPA made every effort to pair these data to represent the same temporal and spatial scales. However, in some cases, the paired violating and CSN "urban" monitoring locations were separated by some distance such that the included urban CSN site(s) reflect(s) a different mixture of emissions sources, which could lead to misinterpretations. To generally account for differences in $PM_{2.5}$ mass between the violating site and the nearby CSN site(s), EPA determined material balance of the $PM_{2.5}$ composition at the violating site by assigning the extra measured $PM_{2.5}$ mass to the carbon components of $PM_{2.5}$. Where the general urban increment approach may be misleading, or in situations where non-carbonaceous emissions are believed to be responsible for a local $PM_{2.5}$ concentration gradient, EPA used alternative analyses to reflect the mix of urban and rural sources contributing to the measured concentrations at violating monitoring sites.

[63] The urban monitors were paired with any rural sites within a 150 mile radius of an urban site to calculate spatial means of the quarterly averages of each species. If there were no rural sites within 150 miles, then the nearest rural site was used alone. That rural mean was then subtracted from the quarterly mean of the urban site to get the increment. Negative values were simply replaced with zeros.

emissions sources, thus representing the portion of the measured violation that is associated with nearby emission contributions.[64,65,66]

PM$_{2.5}$ Design Values and Total Mass Measurements - EPA examined ambient PM$_{2.5}$ air quality monitoring data represented by the DVs at each violating monitoring site and at other monitors in the area of analysis. EPA calculated DVs based on air quality data for the most recent 3 consecutive calendar years of quality-assured, certified air quality data from suitable FEM/FRM/ARM monitoring sites in EPA's Air Quality System (AQS). For this designations analysis, EPA used data for the 2011-2013 period (i.e., the 2013 DV), which are the most recent years with fully-certified air quality data. A monitor's DV is the metric or statistic that indicates whether that monitor attains a specified air quality standard. The 2012 annual PM$_{2.5}$ NAAQS is met at a monitoring site when the 3-year average annual mean concentration is 12.0 micrograms per cubic meter (µg/m^3) or less (e.g., 12.1 µg/m^3 or greater is a violation). A DV is only valid if minimum data completeness criteria are met or when other regulatory data processing provisions are satisfied. See 40 CFR part 50 Appendix N. Table 2 identifies the current DVs (i.e., the 2013 DV) and the most recent two DVs based on all monitoring sites in the area of analysis for the Allegheny County intended nonattainment area.[67]

Table 1. Air Quality Data collected at Regulatory Monitors (all DV levels in µg/m^3)^{a,b}

County, State	Monitor Site ID	State Rec NA?	09-11 DV	10-12 DV	11-13 DV
Garrett, MD	240230002	No	10.7 ^{c}	10.0 ^{c}	10.0 ^{c}
Columbiana, OH	N/A	No	No monitor		
Allegheny, PA	420030064	Yes (partial)	**15**	**14.8**	**13.4**
Allegheny, PA	420031301	Yes (partial)	12.7	12.5	11.7
Allegheny, PA	420030008	Yes (partial)	11.6	11.1	10.3
Allegheny, PA	420030067	Yes (partial)	11	10.5	9.6
Allegheny, PA	420030093	Yes (partial)	9.7	9.4	8.8

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[64] In most, but not all, cases, the violating design value monitoring site is located in an urban area. Where the violating monitor is not located in an urban area, the "urban increment" represents the difference between local and other nearby emission sources in the vicinity of the violating monitoring location and more regional sources.

[65] Hand, et. al. Spatial and Seasonal Patterns and Temporal Variability of Haze and its Constituents in the United States: Report V, June 2011. Chapter 7 – Urban Excess in PM$_{2.5}$ Speciated Aerosol Concentrations, *http://vista.cira.colostate.edu/improve/Publications/Reports/2011/PDF/Chapter7.pdf*

[66] US EPA, Office of Air Quality Planning and Standards, December 2004. (2004) Area Designations for 1997 Fine Particle (PM$_{2.5}$) Standards, Technical Support Document for State and Tribal Air Quality Fine Particle (PM$_{2.5}$) Designations, Chapter 3, Urban Excess Methodology. Available at *www.epa.gov/pmdesignations/1997standards/documents/final/TSD/Ch3.pdf*

[67] In certain circumstances, one or more monitoring locations within a monitoring network may not meet the network technical requirements set forth in 40 CFR 58.11(e), which states, "State and local governments must assess data from Class III PM$_{2.5}$ FEM and ARM monitors operated within their network using the performance criteria described in table C-4 to subpart C of part 53 of this chapter, for cases where the data are identified as not of sufficient comparability to a collocated FRM, and the monitoring agency requests that the FEM or ARM data should not be used in comparison to the NAAQS. These assessments are required in the monitoring agency's annual monitoring network plan described in §58.10(b) for cases where the FEM or ARM is identified as not of sufficient comparability to a collocated FRM…."

County, State	Monitor Site ID	State Rec NA?	09-11 DV	10-12 DV	11-13 DV
Allegheny, PA	420033007	Yes (partial)	11.5 [c]	10.9 [c]	9.8 [c]
Allegheny, PA	420030002	Yes (partial)	14.7[c]	13.4	11.4
Allegheny, PA	420031008	Yes (partial)	12.4[c]	11.7	10.6
Armstrong, PA	420050001	No	12.1[c]	11.7	10.8
Beaver, PA	420070014	No	12.4	12	11.6
Butler, PA	N/A	No	No monitor		
Cambria, PA	420210011	Yes (other area)	12.4	12.3	12.3
Clarion, PA	N/A	No	No monitor		
Fayette, PA	N/A	No	No monitor		
Greene, PA	N/A	No	No monitor		
Indiana, PA	N/A	No	No monitor		
Jefferson, PA	N/A	No	No monitor		
Lawrence, PA	N/A	No	No monitor		
Mercer, PA	420850100	No	10.5	10.6	10.3
Somerset, PA	N/A	No	No monitor		
Venango, PA	N/A	No	No monitor		
Washington, PA	421250200	No	**11.3**	**11.1**	**10.3**
Washington, PA	421255001	No	9	7.2	7.2
Westmoreland, PA	421290008	No	13.7	12.6	11.1
Brooke, WV	540090005	No	13	12.7	11.6
Hancock, WV	540291004	No	11.7	11.3	10.5
Monongalia, WV	540610003	No	10.9	10.3	9.5
Ohio, WV	540690010	No	11.9	11.6	10.6
Preston, WV	N/A	No	No monitor		

[a]If a county has more than one monitoring location, the county DV is indicated in bold type.
[b]If a monitor is violating, the NAAQS, the violating DV is indicated in red type.
[c]Incomplete data.

The Figure A map, shown previously, identifies the Allegheny County final nonattainment area, the Pittsburgh MSA boundary, and monitoring locations with 2011-2013 violating DVs in the area of analysis. Note that Figure A only shows monitors with valid DVs. Therefore, monitors in the area of analysis that did not meet the minimum data capture requirements as defined in 40 CFR 50, Appendix N, are not shown in Figure A. However, EPA has included these "incomplete data" monitors in Table 1.

As indicated on the map in Figures A and B and Table 1, there are 2 violating monitoring locations in the area of analysis. One violating monitor is located in Liberty Borough in Allegheny County, PA ("the Liberty monitor" or "the violating monitor"). The second violating monitor is located in Cambria County, PA. As discussed in Section 3.1, EPA conducted a five factor analysis for the violating monitor in Cambria County, and has determined that Cambria County, PA should be designated in a separate nonattainment area, the Johnstown nonattainment area.

As listed in Table 1, there are eight air quality monitors in Allegheny County. The PM$_{2.5}$ DVs at seven of the eight monitors correlate well. However, the PM$_{2.5}$ DV at the Liberty monitor is considerably higher. The large local sources plus the topographical features in this location result in substantially higher PM$_{2.5}$ monitored values at the Liberty monitor than the other monitors in Allegheny County, and indicate a higher potential for contribution from these local sources but do not discount potential from sources in the nearby area.

Seasonal variation can highlight those conditions most associated with high average concentration levels of PM$_{2.5}$. Figure 1a shows quarterly mean PM$_{2.5}$ concentrations for the most recent 3-year period for the highest DV monitoring sites in each county within the area of analysis. Figure 1b reflects the same information, for the eight monitors in Allegheny County. This graphical representation is particularly relevant when assessing air quality data for an annual standard, such as the 2012 annual PM$_{2.5}$ NAAQS, because, as previously stated, the annual mean is calculated as the mean of quarterly means and a high quarter can drive the mean for an entire year, which, in turn, can drive an elevated 3-year DV.

Figure 1a. Allegheny County Area of Analysis PM$_{2.5}$ Quarterly Means for 2011-2013
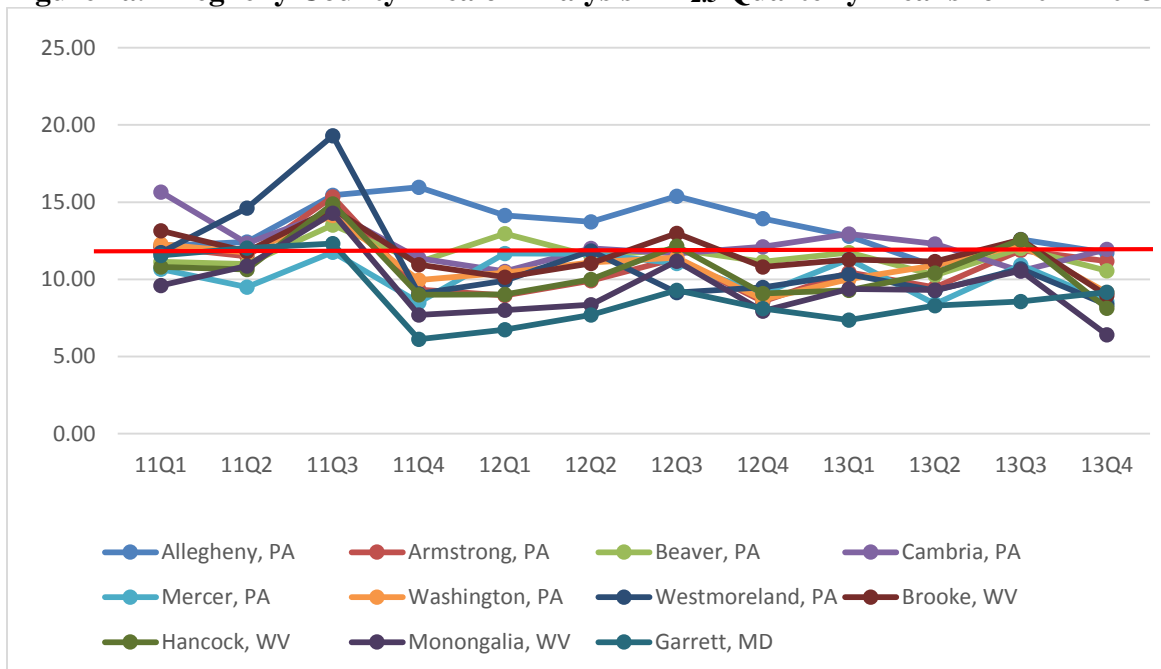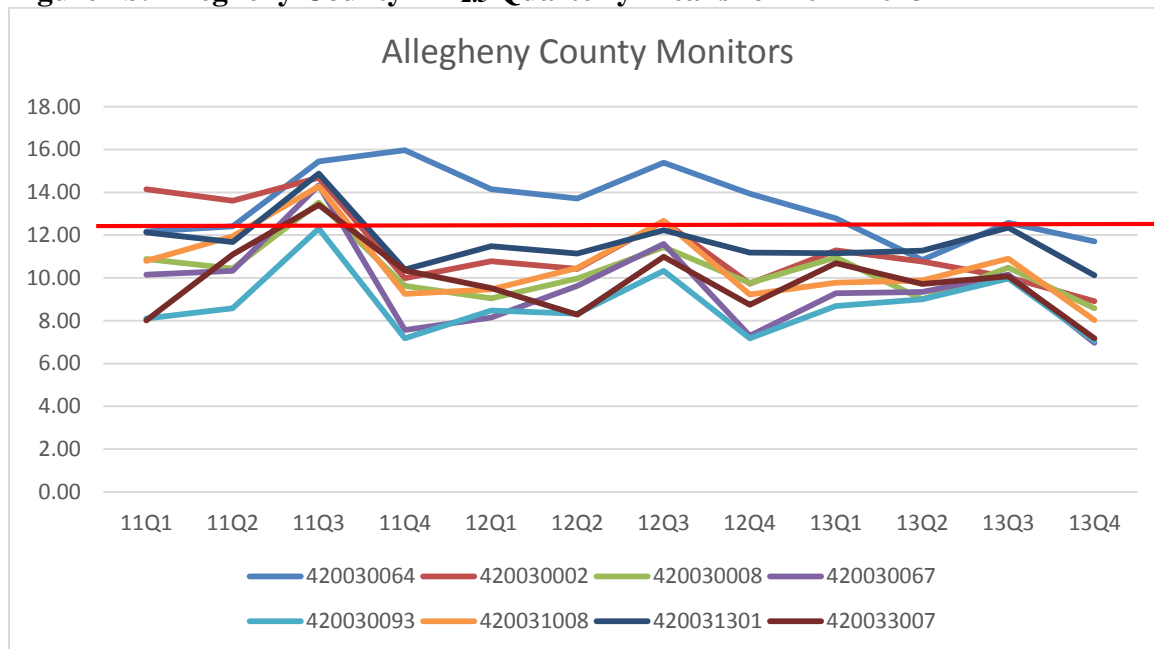
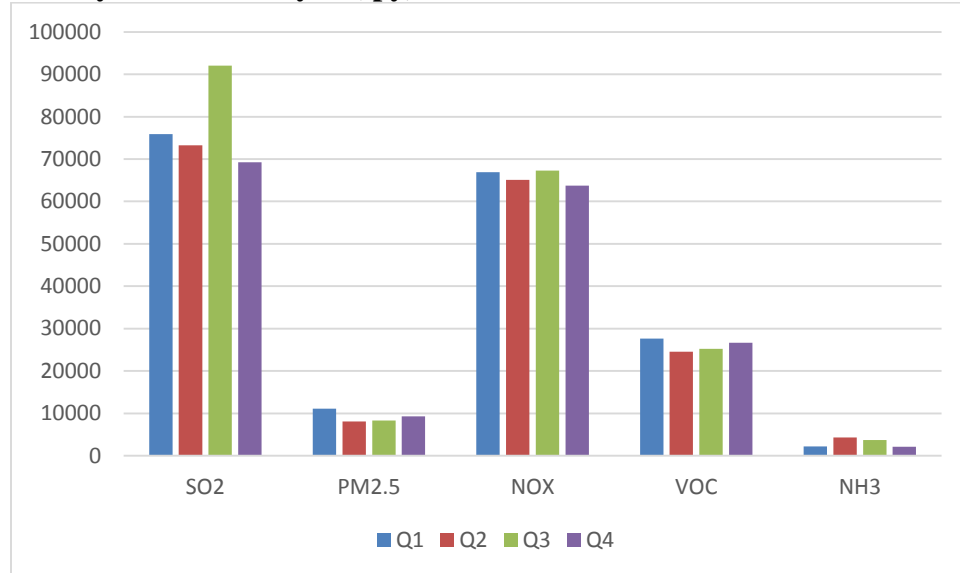**Figure 1b. Allegheny County PM$_{2.5}$ Quarterly Means for 2011-2013**

As shown, in Figures 1a and 1b, most monitors in the area of analysis show higher quarterly mean values in third quarter (July-September) of each year. This is typical in the eastern half of the United States, when sulfates are more readily formed from SO$_2$ emissions from EGUs due to higher air conditioning use. As shown in Figure 1c, below, SO$_2$ emissions in the area of analysis spike in the third quarter, as expected given this seasonal pattern. The violating Liberty monitor in Allegheny County follows this general pattern, but PM$_{2.5}$ levels there are consistently higher than levels at other area monitors, including the nearby Clairton monitor in the Borough. This indicates that the Liberty monitor is influenced by the same seasonal emissions patterns as the rest of the area, but there is an additional local component causing PM$_{2.5}$ levels to be higher than the rest of the area. Note that the recent improvement in air quality at the Liberty monitor coincide with control measures implemented at the Clairton Coke Works, as explained in factor 5, below. EPA notes this suggests that air quality at the Liberty monitor benefits from emission controls at the Clairton Coke Works, but does not resolve contribution from other sources in Allegheny County impacting the violating monitor.

Additionally, in the fourth quarter (October-December) of 2011, PM$_{2.5}$ levels at the Liberty monitor peaked, when the other monitors in the area of analysis monitored relatively low PM$_{2.5}$ levels, The high fourth quarter in 2011 was possibly caused by strong temperature inversions in the vicinity of the violating monitor in later months of the year.[68] The effects of temperature inversions are discussed in factor 4 regarding geography and topography, below.

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[68] "PM$_{2.5}$ Chemical Speciation Analysis for the Liberty-Clairton Area, 2005-2009," Allegheny County Health Department, December 2012.

Figure 1c. Quarterly Emissions of Directly Emitted PM$_{2.5}$ and Precursors in the Allegheny County Area of Analysis (tpy)

PM$_{2.5}$ Composition Measurements - To assess potential emissions contributions for each violating monitoring location, EPA determined the various chemical species comprising total PM$_{2.5}$ to identify the chemical components over the analysis area, which can provide insight into the types of emission sources impacting the monitored concentration. To best describe the PM$_{2.5}$ at the violating monitoring location, EPA first adjusted the chemical speciation measurement data from a monitoring location at or near the violating FRM monitoring site using the SANDWICH approach to account for the amount of PM$_{2.5}$ mass components retained in the FRM measurement.[69,70,71,72] In particular, this approach accounts for losses in fine particle nitrate and increases in sulfate mass associated with particle bound water. Figure 1d illustrates the fraction of each PM$_{2.5}$ chemical component at the violating Liberty monitoring site in Allegheny County based on annual averages for the years 2011-2013. Figure 1e gives speciation data as provided in Pennsylvania's December 2013 recommendation letter. Note that Pennsylvania's speciation data is the raw data from the speciation monitor at the Liberty monitoring

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[69] SANDWICH stands for measured **S**ulfate, **A**djusted **N**itrate, **D**erived **W**ater, **I**nferred **C**arbonaceous mass **H**ybrid Material Balance Approach." The SANDWICH adjustment uses an FRM mass construction methodology that results in reduced nitrates (relative to the amount measured by routine speciation networks), higher mass associated with sulfates (reflecting water included in gravimetric FRM measurements) and a measure of organic carbonaceous mass derived from the difference between measured PM$_{2.5}$ and its non-carbon components. This characterization of PM$_{2.5}$ mass also reflects crustal material and other minor components. The resulting characterization provides a complete mass closure for the measured FRM PM$_{2.5}$ mass, which can be different than the data provided directly by the speciation measurements from the CSN network.

[70] Frank, N. H., SANDWICH Material Balance Approach for PM$_{2.5}$ Data Analysis, National Air Monitoring Conference, Las Vegas, Nevada, November 6-9, 2006. *http://www.epa.gov/ttn/amtic/files/2006conference/frank.pdf*.

[71] Frank, N. H., The Chemical Composition of PM$_{2.5}$ to support PM Implementation, EPA State /Local/Tribal Training Workshop: PM$_{2.5}$ Final Rule Implementation and 2006 PM$_{2.5}$ Designation Process, Chicago IL, June 20-21, 2007, *http://www.epa.gov/ttn/naaqs/pm/presents/pm2.5_chemical_composition.pdf.*

[72] Frank, N. H. *Retained Nitrate, Hydrated Sulfates, and Carbonaceous Mass in Federal Reference Method Fine Particulate Matter for Six Eastern U.S. Cities*. J. Air & Waste Manage. Assoc. 2006 56:500–511.

site. Pennsylvania did not adjust this data using the SANDWICH approach. In particular, the organic component is not presented as organic mass and thus significantly understates its contribution to $PM_{2.5}$ mass. Because the Liberty monitor speciation data was not complete for the entire 3-year period, EPA constructed the speciation profile using other speciation monitors and adjusted the final profile to match the $PM_{2.5}$ mass at violating monitor DV. Therefore, EPA and PA composition profiles are different.

In its December 2013 letter, Pennsylvania identified 252 days in the 2010 to 2012 monitoring period, when the Liberty monitor's $PM_{2.5}$ concentrations were at least one standard deviation above the regional concentrations in the Pittsburgh MSA, and regional average was at or below 12 μg/m^3, i.e., "clean." Pennsylvania further analyzed the most extreme events during the 252 days, the top 25% high $PM_{2.5}$ days. Figure 1f shows the average chemical component at the violating Liberty monitoring during the top 25% days high $PM_{2.5}$ days.

Figure 1d. Liberty Monitor Annual Average $PM_{2.5}$ Chemical Components (2010-2012)
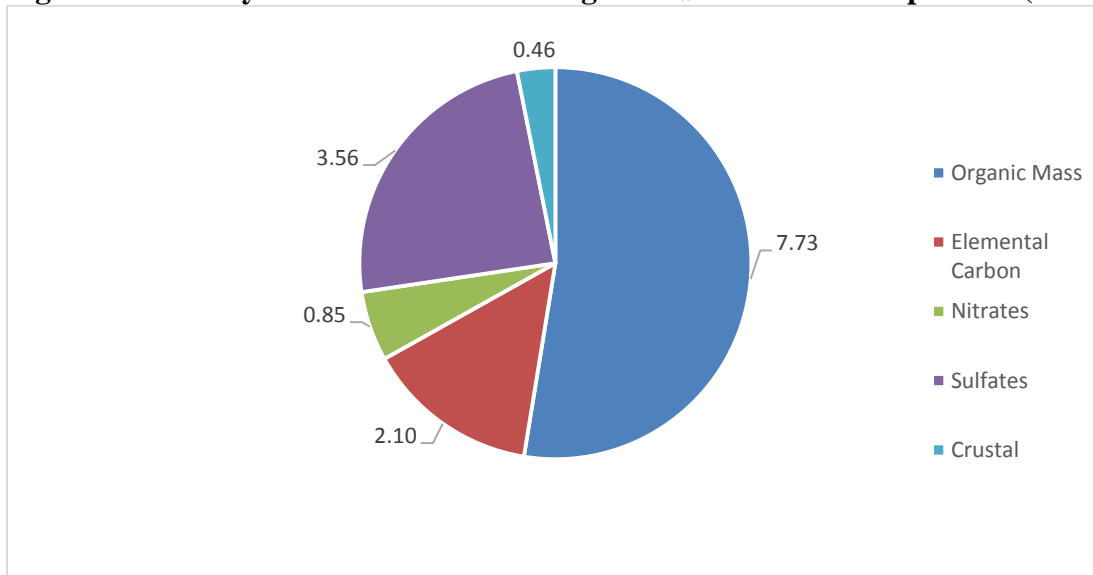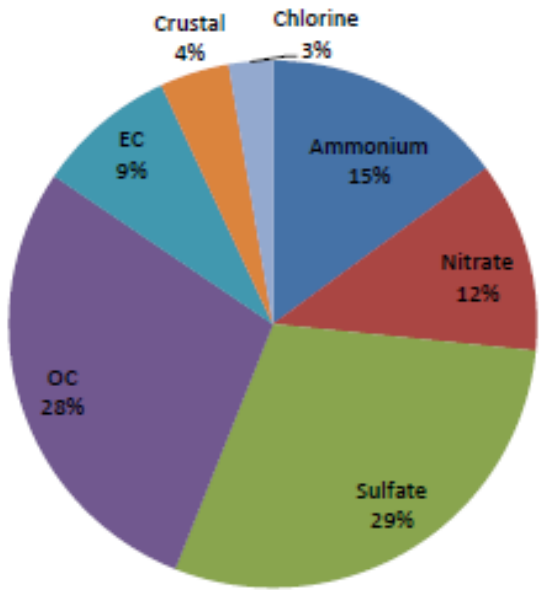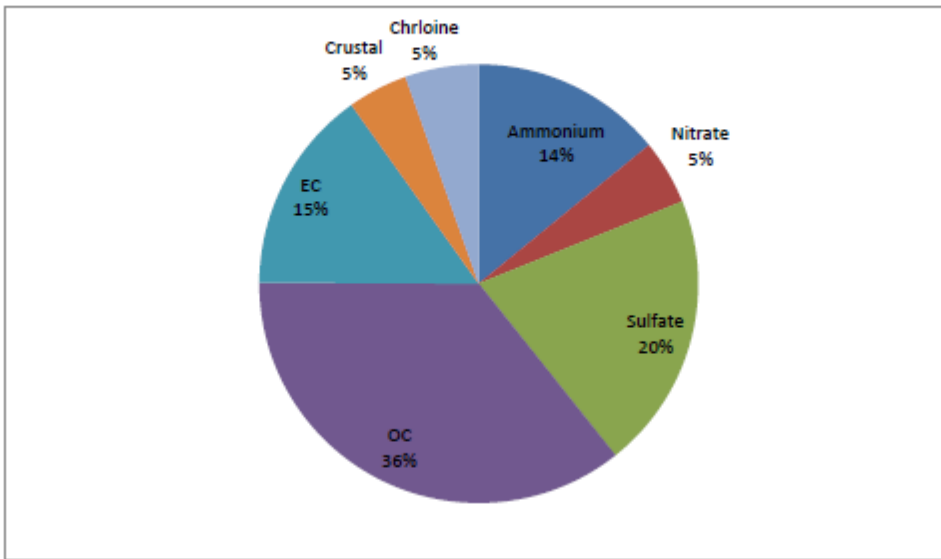
Figure 1e. Liberty Monitor Annual Average PM$_{2.5}$ Chemical Components (2010-2012)

Source: Pennsylvania's December 10, 2013 recommendation letter, Appendix C-6 - Liberty-Clairton Area

Figure 1f. Liberty Monitor Average PM$_{2.5}$ Chemical Components on the top 25% High PM$_{2,5}$ Days (2010-2012)

Source: Pennsylvania's December 10, 2013 recommendation lettr, Appendix C-6 - Liberty-Clairton Area

Figure 1g shows annual and quarterly chemical composition profiles and illustrates any seasonal or episodic contributors to PM$_{2.5}$ mass. This "increment analysis," combined with the other factor analyses, can provide additional insight as to which sources or factors may contribute at a greater level. Simply stated, this analysis can help identify nearby sources of emissions that contribute to the violation at the violating monitoring site.

Figure 1g. Liberty Monitor Annual and Quarterly Average PM$_{2.5}$ Species (2010-2012)[a]
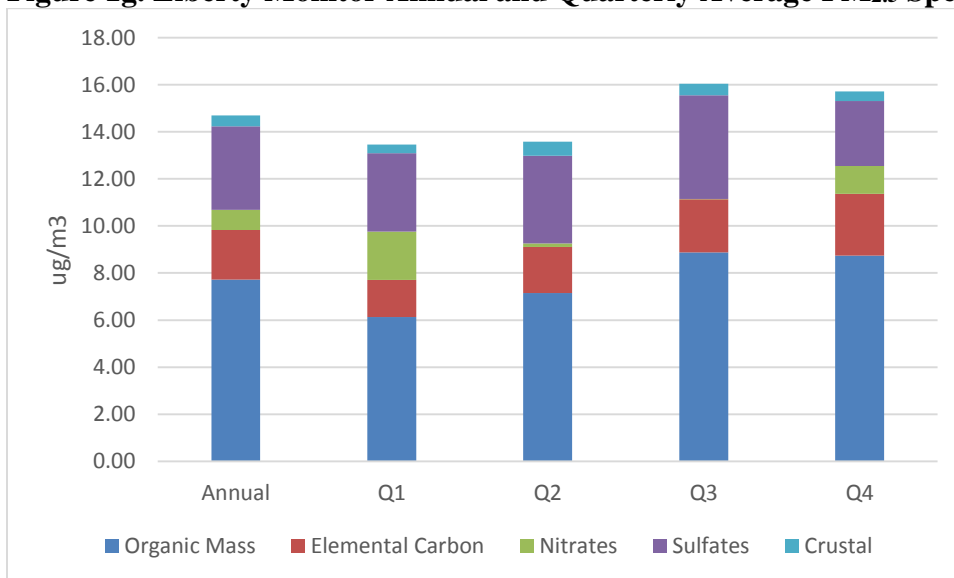
[a]*Adjusted to FRM Total PM$_{2.5}$* indicates that the speciation profile and total mass depicted in this figure are the result of the urban increment calculation for the particular FRM monitor.

EPA assessed seasonal and annual average PM$_{2.5}$ components at monitoring sites within the area of analysis relative to monitoring sites outside of the analysis area to account for the difference between regional background concentrations of PM$_{2.5}$, and the concentrations of PM$_{2.5}$ in the area of analysis, also known as the "urban increment." This analysis differentiates between the influences of emissions from sources in nearby areas and in more distant areas on the violating monitor. Estimating the urban increment in the area helps to illuminate the amount and type of particles at the violating monitor that are most likely to be the result of sources of emissions in nearby areas, as opposed to impacts of more distant or regional sources of emissions. Figures 1h and 1j includes pie charts showing the annual and quarterly chemical mass components of the urban increment. The quarterly pie charts correspond to the high-concentration quarters identified in Figures 1a and 1b. Figure 1i presents first and third quarter urban increment data provide by Pennsylvania in its December 2011 designation recommendation letter. Evaluating these high concentration quarters can help identify composition of PM$_{2.5}$ during these times. Note that in these charts, sulfates and nitrates have been adjusted to represent their mass in measured PM$_{2.5}$.

Figure 1h. Liberty Monitor Urban Increment Analysis for 2010-2012.

Figure 1i. Allegheny County Area Quarterly Average Urban Increment Analysis for 2010-2012.

Source: Pennsylvania's December 10, 2013 recommendation letter, Appendix C-6 - Liberty-Clairton Area
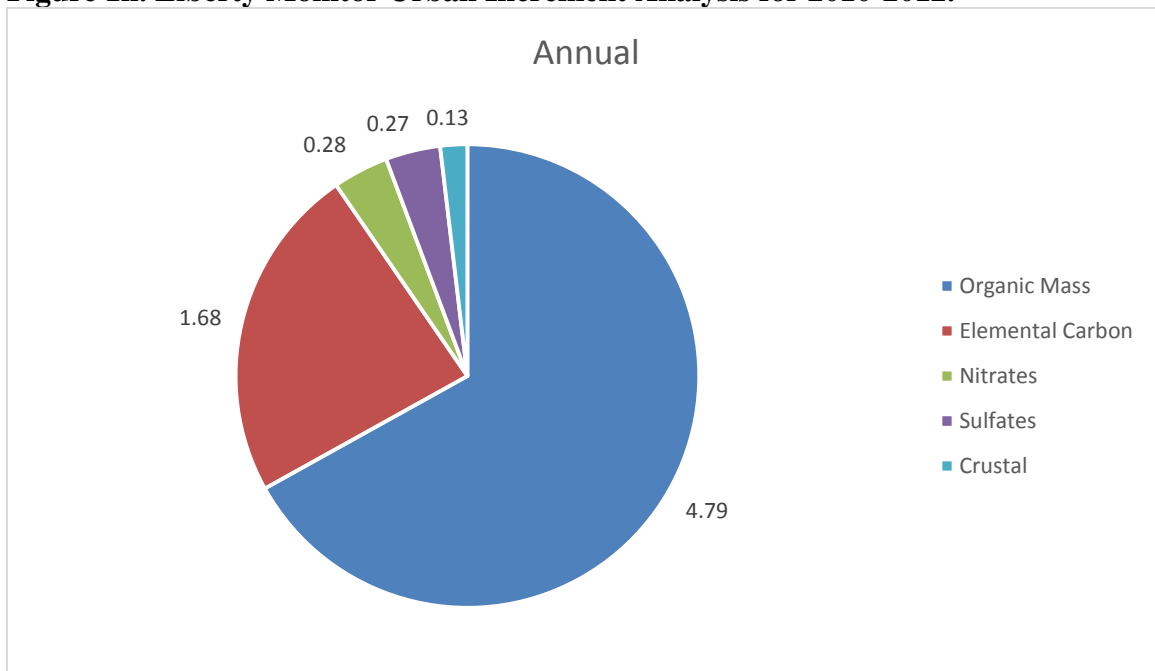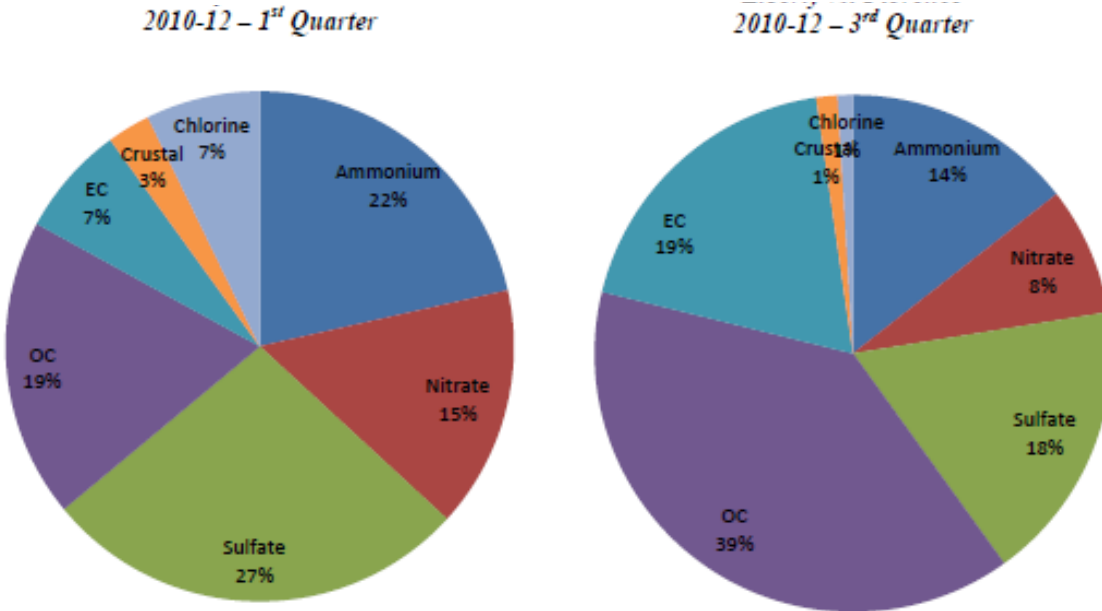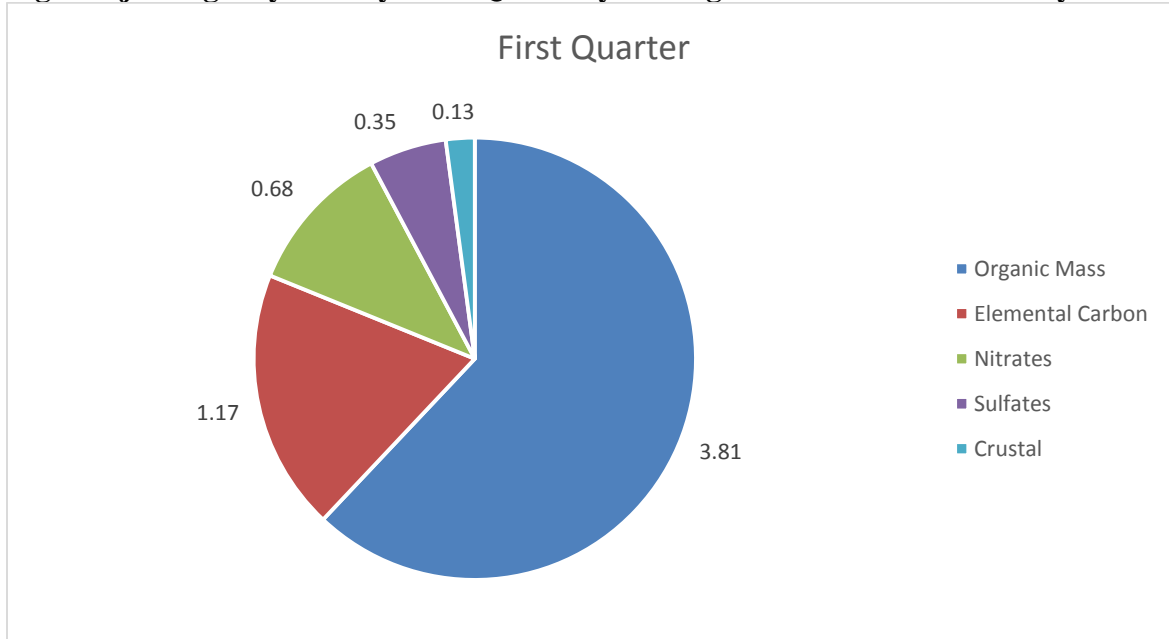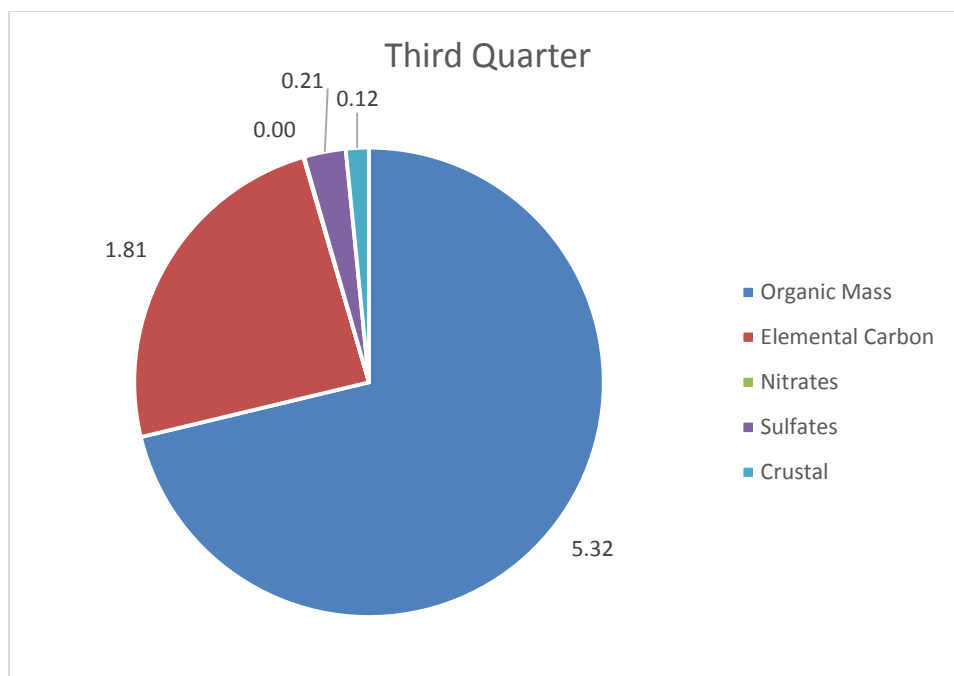
Figure 1j. Allegheny County Area Quarterly Average Urban Increment Analysis for 2010-2012.

Third Quarter

0.21
0.12
0.00
1.81
5.32

- Organic Mass
- Elemental Carbon
- Nitrates
- Sulfates
- Crustal

Both EPA's and PADEP's urban increment data shows high organic mass and elemental carbon. EPA's data shows high first quarter nitrates, while PADEP's shows high first quarter nitrates and sulfates. High first quarter nitrate concentrations are likely due to the greater tendency for NO_x to form in the atmosphere and for FRM monitors to retain particle nitrate during the cooler months. PADEP's data also shows chlorine at 7% in the first quarter. The organic and elemental carbon and chlorine signify contributions from local industrial sources. The organic and elemental carbon can also be attributed to other industrial sources in the surrounding county. Note that Pennsylvania's speciation data is the raw data from the speciation monitor at the Liberty monitoring site. Pennsylvania did not adjust this data using the SANDWICH approach. In particular, the organic component is not presented as organic mass and thus significantly understates its contribution to $PM_{2.5}$ mass.

Factor 2: Emissions and emissions-related data

In this designations process, for each area with a violating monitoring site, EPA evaluated the emissions data from nearby areas using emissions related data for the relevant counties to assess each county's potential contribution to $PM_{2.5}$ concentrations at the violating monitoring site or monitoring sites in the area under evaluation. Similar to the air quality analysis, these data were examined on a seasonal basis. EPA examined emissions of identified sources or source categories of direct $PM_{2.5}$, the major components of direct $PM_{2.5}$ (organic mass, elemental carbon, crustal material (and/or individual trace metal compounds)), primary nitrate and primary sulfate, and precursor gaseous pollutants (i.e., SO_2, NO_X, total VOC, and NH_3). EPA also considered the distance of those sources of emissions from the violating monitoring site. While direct $PM_{2.5}$ emissions and its major carbonaceous components are generally associated with sources near violating $PM_{2.5}$ monitoring sites, the gaseous precursors tend to have a more regional influence (although EPA is mindful of the potential local NO_X and VOC

emissions contributions to $PM_{2.5}$ from mobile and stationary sources) and transport from neighboring areas can contribute to higher $PM_{2.5}$ levels at the violating monitoring sites.

Emissions Data

For this factor, EPA reviewed data from the 2011 National Emissions Inventory (NEI) version 1 (see *http://www.epa.gov/ttn/chief/net/2011inventory.html*). For each county in the area of analysis, EPA examined the magnitude of county-level emissions reported in the NEI. These county-level emissions represent the sum of emissions from the following general source categories: point sources, non-point (i.e., area) sources, nonroad mobile, on-road mobile, and fires. EPA also looked at the geographic distribution of major point sources of the relevant pollutants.[73] Significant emissions levels from sources in a nearby area indicate the potential for the area to contribute to monitored violations.

To further analyze area emissions data, EPA also developed a summary of direct $PM_{2.5}$, components of direct $PM_{2.5}$, and precursor pollutants, which is available at *http://www.epa.gov/pmdesignations/2012standards/docs/nei2011v1pointnei2008v3county.xlsx*.

When considered with the urban increment analysis discussed in Factor 1, evaluating the components of direct $PM_{2.5}$ and precursor gases can help identify specific sources or source types contributing to elevated concentrations at violating monitoring sites and, thus, assist in identifying appropriate area boundaries. In general, directly emitted POC and VOCs[74] contribute to POM; directly emitted EC contributes to $PM_{2.5}$ EC; NO_X, NH_3 and directly emitted nitrate contribute to PNO3; SO_2, NH_3 and directly emitted sulfate contribute to PSO4; and directly emitted crustal material and metal oxides contribute to Pcrustal.[75,76] EPA believes that the quantities of those nearby emissions as potential contributors to the $PM_{2.5}$ violating monitors are somewhat proportional to the $PM_{2.5}$ chemical components in the estimated urban increment. Thus, directly emitted POC is more important per ton than SO_2, partially because POC emissions are already $PM_{2.5}$ whereas SO_2 must convert to $PM_{2.5}$ and not all of the emitted SO_2 undergoes this conversion.

Table 2a provides a county-level emissions summary (i.e., the sum of emissions from the following general source categories: point sources, non-point (i.e., area) sources, nonroad mobile, on-road mobile, and fires) of directly emitted $PM_{2.5}$ and precursor species in tpy for each county in the area of analysis for the Allegheny County Area. Table 2b breaks down the direct $PM_{2.5}$ emissions value from Table 2a into its components, This information will be paired with the urban increment composition

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[73] For purposes of this designations effort, "major" point sources are those whose sum of PM precursor emissions ($PM_{2.5}$ + NOx + SO_2 + VOC + NH_3) are greater than 500 tpy based on NEI 2011v1.

[74] As previously mentioned, nearby VOCs are presumed to be a less important contributor to POM than POC.

[75] *See*, Seinfeld J. H. and Pandis S. N. (2006) *Atmospheric Chemistry and Physics: From Air Pollution to Climate Change*, 2nd edition, J. Wiley, New York. See also, Seinfeld J. H. and Pandis S. N. (1998) *Atmospheric Chemistry and Physics: From Air Pollution to Climate Change*, 1st edition, J. Wiley, New York.

[76] USEPA Report (2004), The Particle Pollution Report: Current Understanding of Air Quality and Emissions through 2003, found at: *http://www.epa.gov/airtrends/aqtrnd04/pm.html*.

previously shown in Figures 1g-1i. Table 2c gives total emissions of directly emitted PM$_{2.5}$ and precursor species by quarter for the area of analysis.

Table 2a. County-Level Emissions of Directly Emitted PM$_{2.5}$ and Precursors (tpy)

County	Total NH$_3$	Total NOX	Total Direct PM$_{2.5}$	Total SO$_2$	Total VOC	Total
Indiana, PA	832	35,818	3,172	98,344	5,005	143,171
Armstrong, PA	402	29,321	1,310	72,548	3,602	107,183
Allegheny, PA	1,255	36,427	6,417	15,085	24,456	83,640
Beaver, PA	566	21,266	2,396	26,986	4,110	55,324
Greene, PA	250	30,737	2,638	2,477	2,579	38,680
Monongalia, WV	154	16,941	1,738	8,101	3,716	30,650
Westmoreland, PA	1,037	12,924	1,957	1,262	9,837	27,017
Washington, PA	591	9,748	1,456	1,873	6,252	19,920
Cambria, PA	373	6,115	1,334	7,236	4,100	19,158
Lawrence, PA	575	4,328	736	7,757	2,769	16,165
Butler, PA	651	6,523	1,563	1,096	5,879	15,711
Mercer, PA	934	6,348	1,171	451	5,322	14,226
Fayette, PA	450	5,538	1,008	486	5,256	12,738
Preston, WV	249	2,451	510	6,578	1,321	11,108
Columbiana, OH	2,024	4,160	677	173	3,963	10,996
Somerset, PA	1,173	3,320	1,216	461	4,059	10,230
Jefferson, PA	248	5,273	770	691	2,821	9,804
Venango, PA	223	3,672	615	2,313	2,968	9,791
Clarion, PA	330	3,828	479	1,641	2,669	8,947
Garrett, MD	414	1,923	353	277	1,583	4,550
Brooke, WV	47	1,822	320	880	1,142	4,211
Ohio, WV	91	1,343	274	130	1,521	3,360
Hancock, WV	32	1,290	158	288	993	2,760

Table 2b. County-Level Emissions for Components of Directly Emitted PM$_{2.5}$ (tpy) [77]

County, State	POM	EC	PSO4	PNO3	Pcrustal	Residual	Total Direct
Allegheny, PA	2,501	929	408	23	1,014	1,540	6,417
Indiana, PA	547	172	247	4	870	1,333	3,172
Greene, PA	290	163	200	3	850	1,132	2,638
Beaver, PA	478	178	192	3	493	1,052	2,396
Westmoreland, PA	962	277	101	6	206	405	1,957
Monongalia, WV	359	134	106	2	476	661	1,738
Butler, PA	707	190	74	5	236	351	1,563

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[77] Data are based on the 2011 and 2018 Emissions Modeling Platform Data Files and Summaries (*ftp://ftp.epa.gov/EmisInventory/2011v6/v1platform*) available at: *http://www.epa.gov/ttn/chief/emch/index.html#2011* (accessed 02/26/14).

County, State	POM	EC	PSO4	PNO3	Pcrustal	Residual	Total Direct
Washington, PA	691	183	72	31	154	325	1,456
Cambria, PA	678	148	48	3	158	300	1,334
Armstrong, PA	303	99	113	3	293	499	1,310
Somerset, PA	751	141	23	5	115	181	1,216
Mercer, PA	602	156	57	3	107	246	1,171
Fayette, PA	559	185	41	6	46	172	1,008
Jefferson, PA	300	102	120	2	35	211	770
Lawrence, PA	424	93	21	2	81	114	736
Columbiana, OH	328	124	12	2	88	123	677
Venango, PA	327	73	24	1	63	126	615
Preston, WV	169	55	25	1	105	155	510
Clarion, PA	265	73	20	1	26	94	479
Garrett, MD	184	66	11	1	16	75	353
Brooke, WV	90	35	19	1	58	116	320
Ohio, WV	163	47	5	1	18	40	274
Hancock, WV	84	31	6	1	11	26	158

Table 2c. Quarterly Emissions of Directly Emitted PM$_{2.5}$ and Precursors in the Allegheny County Area of Analysis (tpy)

Pollutant	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
SO_2	75854.16	73232.87	92059.14	69266.51
$PM_{2.5}$	11082.82	8112.798	8299.623	9274.499
NO_X	66934.62	65104.02	67248.11	63715.25
VOC	27627.55	24528.25	25252.56	26630.03
NH_3	2218.393	4343.374	3672.554	2151.167

Using the previously described relationship between directly emitted and precursor gases and the measured mass to evaluate data presented in Tables 2a and 2b, EPA identified the following components warranting additional review: organic mass, VOC, SO_2, PSO4, elemental carbon, NH_3, NOx and PNO3. These components were shown to be the most common in the urban increment in the Allegheny County Area, as shown in Figures 1g-1i. EPA then looked at the contribution of these components of interest from each of the counties included in the area of analysis as shown in Tables 2d-g.

Table 2d. County-Level POM and VOC Emissions

County, State	Emissions in average tpy			County, State	Emissions in average tpy		
	POM	Pct.	Cumulative %		VOC	Pct.	Cumulative %
Allegheny, PA	2,501	21%	21%	Allegheny, PA	24,456	23%	23%
Westmoreland, PA	962	8%	29%	Westmoreland, PA	9,837	9%	32%
Somerset, PA	751	6%	36%	Washington, PA	6,252	6%	38%
Butler, PA	707	6%	42%	Butler, PA	5,879	6%	44%
Washington, PA	691	6%	48%	Mercer, PA	5,322	5%	49%
Cambria, PA	678	6%	53%	Fayette, PA	5,256	5%	54%
Mercer, PA	602	5%	59%	Indiana, PA	5,005	5%	59%
Fayette, PA	559	5%	63%	Beaver, PA	4,110	4%	62%
Indiana, PA	547	5%	68%	Cambria, PA	4,100	4%	66%
Beaver, PA	478	4%	72%	Somerset, PA	4,059	4%	70%
Lawrence, PA	424	4%	76%	Columbiana, OH	3,963	4%	74%
Monongalia, WV	359	3%	79%	Monongalia, WV	3,716	4%	77%
Columbiana, OH	328	3%	82%	Armstrong, PA	3,602	3%	81%
Venango, PA	327	3%	84%	Venango, PA	2,968	3%	84%
Armstrong, PA	303	3%	87%	Jefferson, PA	2,821	3%	86%
Jefferson, PA	300	3%	89%	Lawrence, PA	2,769	3%	89%
Greene, PA	290	2%	92%	Clarion, PA	2,669	3%	91%
Clarion, PA	265	2%	94%	Greene, PA	2,579	2%	94%
Garrett, MD	184	2%	96%	Garrett, MD	1,583	1.5%	95%
Preston, WV	169	1%	97%	Ohio, WV	1,521	1.4%	97%
Ohio, WV	163	1%	99%	Preston, WV	1,321	1.2%	98%
Brooke, WV	90	1%	99%	Brooke, WV	1,142	1.1%	99%
Hancock, WV	84	1%	100%	Hancock, WV	993	0.9%	100%
Total	11,763				105,925		

Table 2e. County-Level SO₂ and PSO4 Emissions

County, State	Emissions in average tpy			County, State	Emissions in average tpy		
	SO$_2$	Pct.	Cumulative %		PSO4	Pct.	Cumulative %
Indiana, PA	98,344	38%	38%	Allegheny, PA	408	21%	21%
Armstrong, PA	72,548	28%	66%	Indiana, PA	247	13%	34%
Beaver, PA	26,986	10%	77%	Greene, PA	200	10%	44%
Allegheny, PA	15,085	6%	83%	Beaver, PA	192	10%	54%
Monongalia, WV	8,101	3%	86%	Jefferson, PA	120	6%	60%
Lawrence, PA	7,757	3%	89%	Armstrong, PA	113	6%	66%
Cambria, PA	7,236	3%	92%	Monongalia, WV	106	5%	71%
Preston, WV	6,578	3%	94%	Westmoreland, PA	101	5%	76%
Greene, PA	2,477	1.0%	95%	Butler, PA	74	4%	80%
Venango, PA	2,313	0.9%	96%	Washington, PA	72	4%	84%
Washington, PA	1,873	0.7%	97%	Mercer, PA	57	3%	87%
Clarion, PA	1,641	0.6%	98%	Cambria, PA	48	2%	89%
Westmoreland, PA	1,262	0.5%	98%	Fayette, PA	41	2%	91%
Butler, PA	1,096	0.4%	99%	Preston, WV	25	1.3%	93%
Brooke, WV	880	0.3%	99%	Venango, PA	24	1.2%	94%
Jefferson, PA	691	0.3%	99%	Somerset, PA	23	1.2%	95%
Fayette, PA	486	0.2%	99%	Lawrence, PA	21	1.1%	96%
Somerset, PA	461	0.2%	99%	Clarion, PA	20	1.0%	97%
Mercer, PA	451	0.2%	100%	Brooke, WV	19	1.0%	98%
Hancock, WV	288	0.1%	100%	Columbiana, OH	12	0.6%	99%
Garrett, MD	277	0.1%	100%	Garrett, MD	11	0.5%	99%
Columbiana, OH	173	0.1%	100%	Hancock, WV	6	0.3%	100%
Ohio, WV	130	0.1%	100%	Ohio, WV	5	0.3%	100%
	257,134				1,945		

Table 2f. County-Level EC and NH₃ Emissions

County, State	Emissions in average tpy			County, State	Emissions in average tpy		
	EC	Pct.	Cumulative %		NH₃	Pct.	Cumulative %
Allegheny, PA	929	25%	25%	Columbiana, OH	2,024	16%	16%
Westmoreland, PA	277	8%	33%	Allegheny, PA	1,255	10%	25%
Butler, PA	190	5%	38%	Somerset, PA	1,173	9%	35%
Fayette, PA	185	5%	43%	Westmoreland, PA	1,037	8%	43%
Washington, PA	183	5%	48%	Mercer, PA	934	7%	50%
Beaver, PA	178	5%	53%	Indiana, PA	832	6%	56%
Indiana, PA	172	5%	58%	Butler, PA	651	5%	61%
Greene, PA	163	4%	62%	Washington, PA	591	5%	66%
Mercer, PA	156	4%	67%	Lawrence, PA	575	4%	70%
Cambria, PA	148	4%	71%	Beaver, PA	566	4%	75%
Somerset, PA	141	4%	75%	Fayette, PA	450	3%	78%
Monongalia, WV	134	4%	78%	Garrett, MD	414	3%	81%
Columbiana, OH	124	3%	82%	Armstrong, PA	402	3%	85%
Jefferson, PA	102	3%	84%	Cambria, PA	373	3%	87%
Armstrong, PA	99	3%	87%	Clarion, PA	330	3%	90%
Lawrence, PA	93	3%	90%	Greene, PA	250	2%	92%
Clarion, PA	73	2%	92%	Preston, WV	249	2%	94%
Venango, PA	73	2%	94%	Jefferson, PA	248	2%	96%
Garrett, MD	66	2%	95%	Venango, PA	223	2%	97%
Preston, WV	55	1%	97%	Monongalia, WV	154	1.2%	99%
Ohio, WV	47	1%	98%	Ohio, WV	91	0.7%	99%
Brooke, WV	35	1%	99%	Brooke, WV	47	0.4%	100%
Hancock, WV	31	1%	100%	Hancock, WV	32	0.2%	100%
Total	3,654				12,899		

Table 2g. County-Level NOx and PNO3 Emissions (tpy)

County, State	Emissions in average tpy			County, State	Emissions in average tpy		
	Total NOX	Pct.	Cumulative %		PNO3	Pct.	Cumulative %
Allegheny, PA	36,427	15%	15%	Washington, PA	31	28%	28%
Indiana, PA	35,818	14%	29%	Allegheny, PA	23	21%	50%
Greene, PA	30,737	12%	41%	Westmoreland, PA	6	5%	55%
Armstrong, PA	29,321	12%	53%	Fayette, PA	6	5%	60%
Beaver, PA	21,266	8%	61%	Butler, PA	5	5%	65%
Monongalia, WV	16,941	7%	68%	Somerset, PA	5	5%	69%
Westmoreland, PA	12,924	5%	73%	Indiana, PA	4	3%	73%
Washington, PA	9,748	4%	77%	Mercer, PA	3	3%	76%
Butler, PA	6,523	3%	80%	Beaver, PA	3	3%	78%
Mercer, PA	6,348	3%	82%	Cambria, PA	3	3%	81%
Cambria, PA	6,115	2%	84%	Armstrong, PA	3	2%	83%
Fayette, PA	5,538	2%	87%	Greene, PA	3	2%	86%
Jefferson, PA	5,273	2%	89%	Jefferson, PA	2	2%	88%
Lawrence, PA	4,328	2%	91%	Lawrence, PA	2	2%	90%
Columbiana, OH	4,160	2%	92%	Monongalia, WV	2	2%	92%
Clarion, PA	3,828	2%	94%	Columbiana, OH	2	1%	93%
Venango, PA	3,672	1%	95%	Venango, PA	1	1%	94%
Somerset, PA	3,320	1%	96%	Preston, WV	1	1%	96%
Preston, WV	2,451	1%	97%	Clarion, PA	1	1%	97%
Garrett, MD	1,923	1%	98%	Garrett, MD	1	1%	98%
Brooke, WV	1,822	1%	99%	Brooke, WV	1	1%	99%
Ohio, WV	1,343	1%	99%	Ohio, WV	1	1%	99%
Hancock, WV	1,290	1%	100%	Hancock, WV	1	1%	100%
Total	251,115			Total	110		

As can be seen in Tables 2a-g, Indiana County has the highest emissions in the area of analysis, due to several large sources of SO_2. As further discussed in Section 3.1, EPA has determined that the portions of Indiana County that contain the large SO_2 sources should be designated as part of the Johnstown, PA nonattainment area. Furthermore, as discussed in factor 3 regarding meteorology, because the dominant wind direction in the area of analysis is southwest, Indiana County is not upwind of the violating Liberty monitor, and therefore not likely to be contributing to the violation there.

Allegheny County, which includes the City of Pittsburgh, has the highest NOx, EC, direct $PM_{2.5}$, PSO_4, POM, and VOC emissions in the area of analysis. It also has the second highest PNO3 and NH_3 emissions, and the fourth highest SO_2 emissions in the area of analysis.

In addition to reviewing county-wide emissions of $PM_{2.5}$ and $PM_{2.5}$ precursors in the area of analysis, EPA also reviewed emissions from major point sources located in the area of analysis. The magnitude and location of these sources can help inform nonattainment boundaries. Table 2h provides facility-

level emissions of direct PM$_{2.5}$, components of direct PM$_{2.5}$, and precursor pollutants (given in tpy) from major point sources with total emissions of 500 tpy or more located in the area of analysis for the Allegheny County Area. Table 2h also shows the distance from the facility to the violating Liberty monitor.

Table 2h. NEI 2011 v1 Point Source Emissions (tpy)

County, State	Facility Name (Facility ID)	Distance from violating monitor (miles)	NEI 2011 v1 Emissions (tpy)					
			NH$_3$	NO$_X$	PM$_{2.5}$	SO$_2$	VOC	Total
Allegheny, PA	USS/Clairton Coke Works (4200300032)	1	123	3,075	500	1,468	336	5,502
Allegheny, PA	Us Steel Corp/Irvin Plt (4200300203)	2	4	762	72	419	61	1,318
Allegheny, PA	USS Corp/Edgar Thomson Works (4200300202)	5	22	275	633	1,279	41	2,251
Allegheny, PA	Guardian Ind Corp/Jefferson Hills (4200300342)	5	0	978	22	73	19	1,093
Washington, PA	Genon Power Midwest LP/Elrama Power Plt (421250024)	6	0	561	24	428	4	1,017
Washington, PA	Allegheny Energy Supply Co/Mitchell Power Sta (421250014)	9	0	1,305	85	863	11	2,264
Allegheny, PA	Bay Valley Foods LLC/Pgh (4200300024)	11		212	20	313	1	546
Allegheny, PA	Genon Energy Inc/Cheswick Sta (4200300157)	15	3	3,294	498	9,290	10	13,096
Allegheny, PA	Shenango Inc/Shenango Coke Plt (4200300022)	16	3	427	97	372	100	999
Allegheny, PA	Allegheny Ludlum LLC/Brackenridge (4200300093)	21	4	255	223	33	62	576
Allegheny, PA	Pittsburgh International	23		550	17	68	94	729
Beaver, PA	Conway	31	0	545	16	5	41	608
Greene, PA	Allegheny Energy Supply Co/Hatfields Ferry Power Sta (420590006)	32	66	26,032	1,707	1,931	66	29,802
Beaver, PA	AES Beaver Valley LLC/Beaver Valley LLC (420070042)	34	0	2,705	156	3,170	17	6,050
Beaver, PA	Horsehead Corp/Monaca Smelter (420070032)	34	3	908	804	2,015	77	3,808
Butler, PA	Armstrong Cement & Supply/Winfield (420190024)	34		260	13	289	2	564
Butler, PA	AK Steel Corp/Butler Works (420190007)	35	7	310	156	54	63	589
Armstrong, PA	Genon Ne Mgmt Co/Keystone Sta (420050012)	36	2	20,797	438	46,467	29	67,732

County, State	Facility Name (Facility ID)	Distance from violating monitor (miles)	NEI 2011 v1 Emissions (tpy)					
			NH$_3$	NOx	PM$_{2.5}$	SO$_2$	VOC	Total
Beaver, PA	Firstenergy Gen LLC/Bruce Mansfield Plt (420070005)	36	14	11,550	270	21,196	2	33,032
Beaver, PA	Jewel Acquisition/Midland Fac (420070043)	38	1	300	57	162	41	561
Greene, PA	Consol Pa Coal Co LLC/Bailey Prep Plt (420590008)	38		299	56	434	239	1,028
Indiana, PA	Homer City Gen LP/ Center Twp (420630003)	38	90	9,026	1,355	83,596	17	94,083
Brooke, WV	Mountain State Carbon, LLC (0002)	39	13	965	127	697	222	2,024
Monongalia, WV	Monongahela Power Co.- Fort Martin Power (0001)	42	43	11,144	752	3,964	93	15,995
Indiana, PA	Genon Ne Mgmt Co/Conemaugh Plt (420630001)	43	3	17,562	335	7,190	19	25,109
Monongalia, WV	Longview Power (0134)	43		340	55	364	16	775
Indiana, PA	Genon Wholesale Gen/Seward Gen Sta (420630002)	44	4	1,774	150	7,010	4	8,942
Armstrong, PA	Allegheny Energy Supply Co/Armstrong Power Sta (420050001)	47	10	3,109	116	25,739	21	28,994
Monongalia, WV	Morgantown Energy Associates (0027)	48	0	819	106	1,024	4	1,953
Lawrence, PA	Genon Power Midwest LP/New Castle Power Plt (420730025)	50	0	1,310	8	7,510	8	8,837
Cambria, PA	Inter Power Ahlcon L/Colver Power Proj (420210034)	58	2	713	20	2,883	4	3,622
Preston, WV	Monongahela Power Co - Albright P.S. (0001)	59	3	920	206	6,454	7	7,590
Cambria, PA	Ebensburg Power Co/Ebensburg Cogeneration Plt (420210033)	60	0	308	50	1,937	4	2,299
Cambria, PA	Cambria Cogen Co/Ebensburg (420210046)	62	2	713	163	1,941	12	2,831
Clarion, PA	Piney Creek LP/Piney Creek Power Plt (420310406)	63	0	270	8	1,477	0	1,755
Venango, PA	Scrubgrass Generating Co LP/Kennerdell Plt (421210013)	65	2	693	46	1,862	6	2,608
Jefferson, PA	Owens Brockway Glass Container Inc/Crenshaw Plt 19 (420650007)	87	1	410	107	180	23	722

Figure 2a shows the major point sources with emissions of at least 500 tpy (from the 2011 NEI in tpy) in the area of analysis for the Allegheny County Area and the relative distances of these sources from the violating monitoring location, as depicted by red dots. The actual distance from the point sources

to the violating Liberty monitoring location is presented in Table 5. The distance from the violating Liberty monitoring location is particularly important for directly emitted PM$_{2.5}$. The influence of directly emitted PM$_{2.5}$ on ambient PM$_{2.5}$ diminishes more than that of gaseous precursors as a function of distance.[78]

As indicated in Table 2h and Figure 2a, there are 37 point sources with emissions of at least 500 tpy located in the area of analysis. Nine of those sources are in Allegheny County. Figure 2b shows the point sources closest to the violating Liberty monitor.

Figure 2a. Major Point Sources in the Area of Analysis for the Allegheny County Area.

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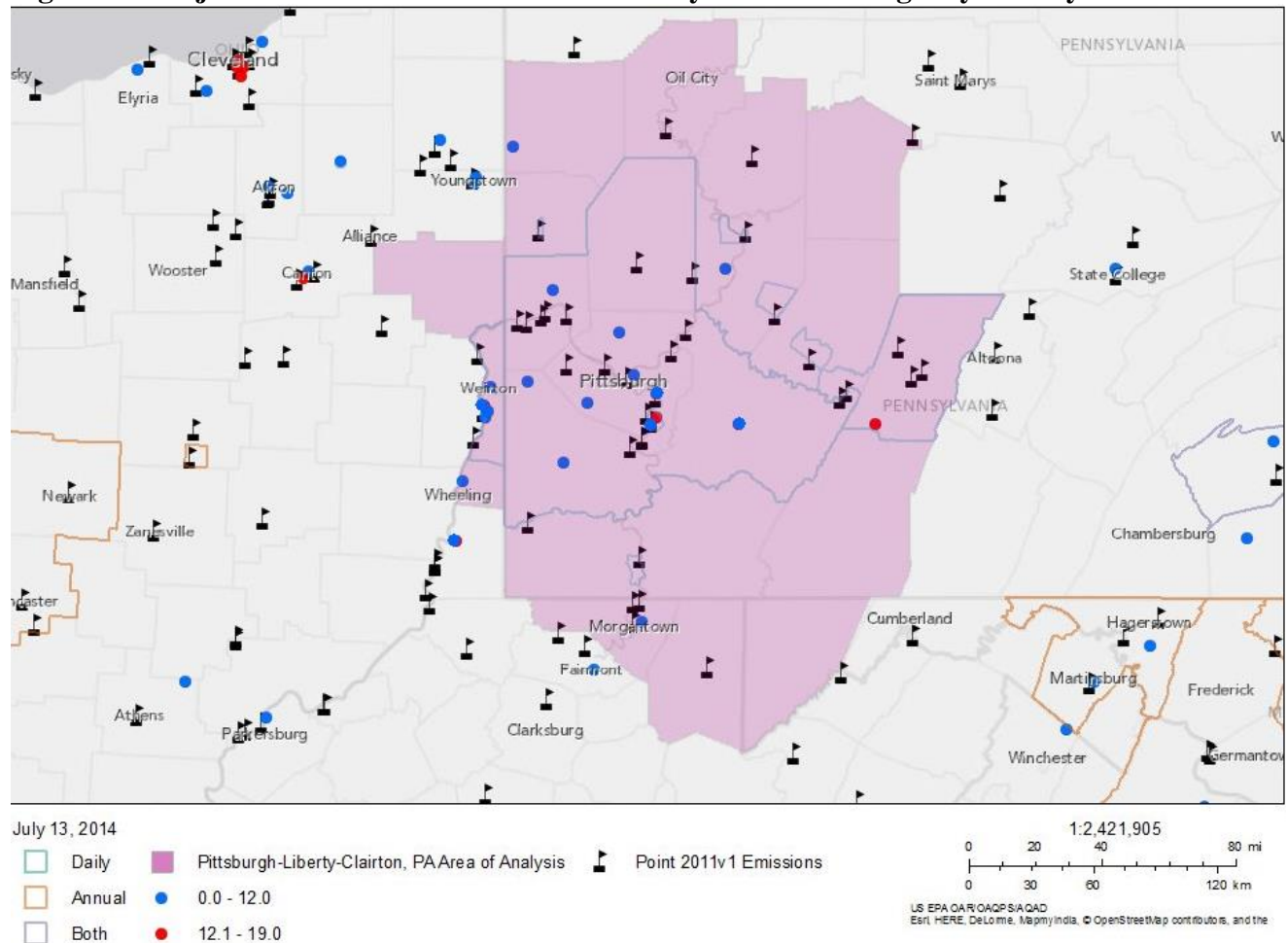
[78] Baker, K. R. and K. M. Foley. *A nonlinear regression model estimating single source concentrations of primary and secondarily formed PM$_{2.5}$.* Atmospheric Environment. 45 (2011) 3758-3767.

Figure 2b. Close Up of Major Point Sources in the Area of Analysis for the Allegheny County Area.
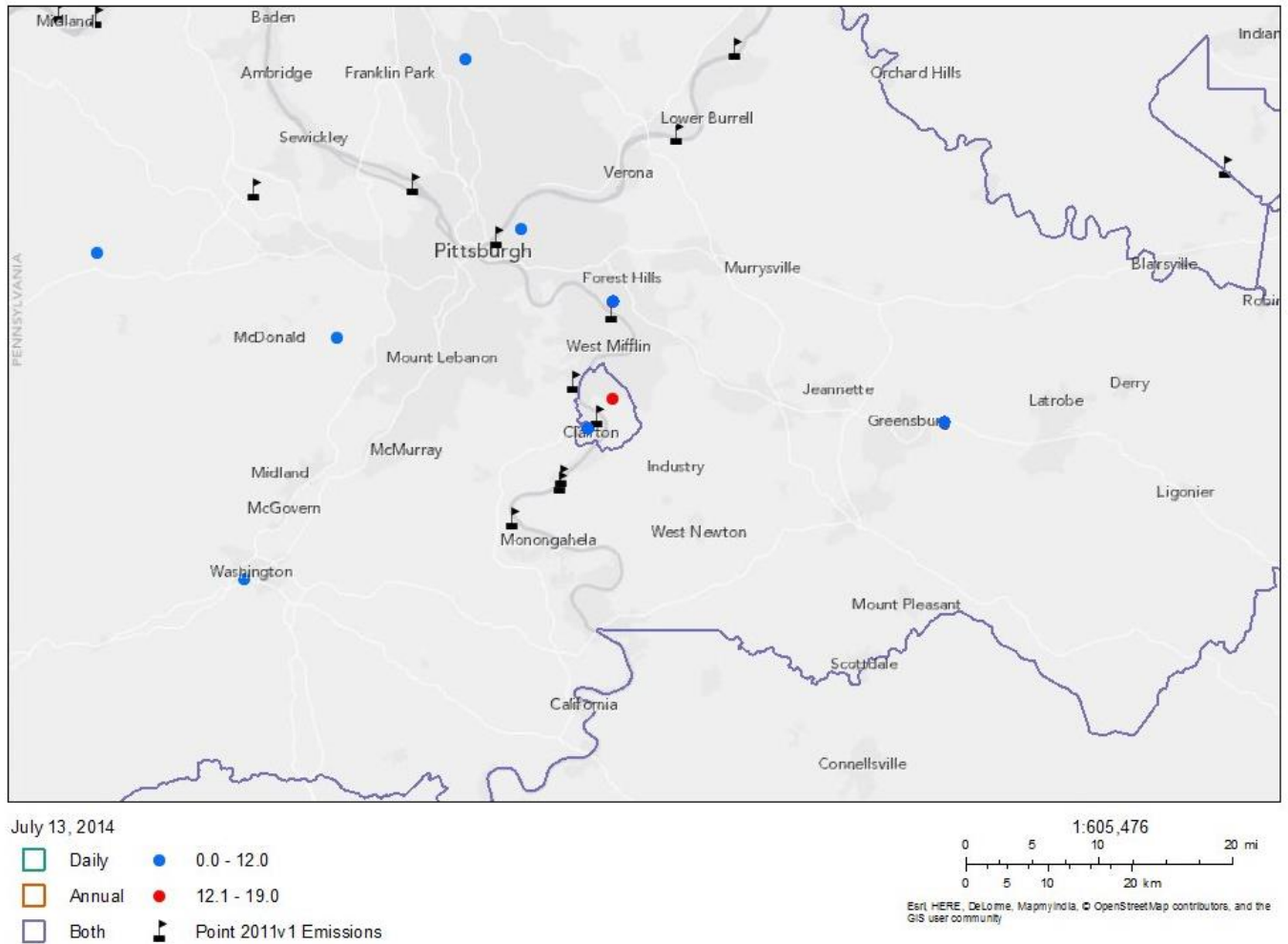
Figure 2b shows other local industrial sources near the Liberty monitor. As discussed in the next section on meteorology, emissions from these sources as well as other PM$_{2.5}$-related emissions, may be locally transported from other directions under certain conditions, and therefore from other parts of Allegheny County.

The spatial distribution of selected emissions throughout the area of analysis also provides useful information. POM and EC are the largest components of the urban increment at the Liberty monitor. Figures 2b1 and 2b2 shows that POM and EC are high throughout Allegheny County, including several 12 km grid squares immediately to the north and west of the Liberty monitor. POM and EC are lower in the surrounding counties. This suggests that POM and EC from the Pittsburgh urban area in Allegheny County, to the north and west of the Liberty monitor, have a relatively high potential to influence PM$_{2.5}$ values at the violating monitor.

Figure 2b1. Spatial distribution of POM in the Allegheny County Area of Analysis

August 7, 2014

☐ Daily	● 0.0 - 12.0	☐ 0 - 45.36	☐ 86.27 - 151.54	
☐ Annual	● 12.1 - 19.0	☐ 45.36 - 59.68	☐ 151.54 - 58,314	
☐ Both	☐ County Boundaries	☐ 59.68 - 86.27		

1:1,232,620

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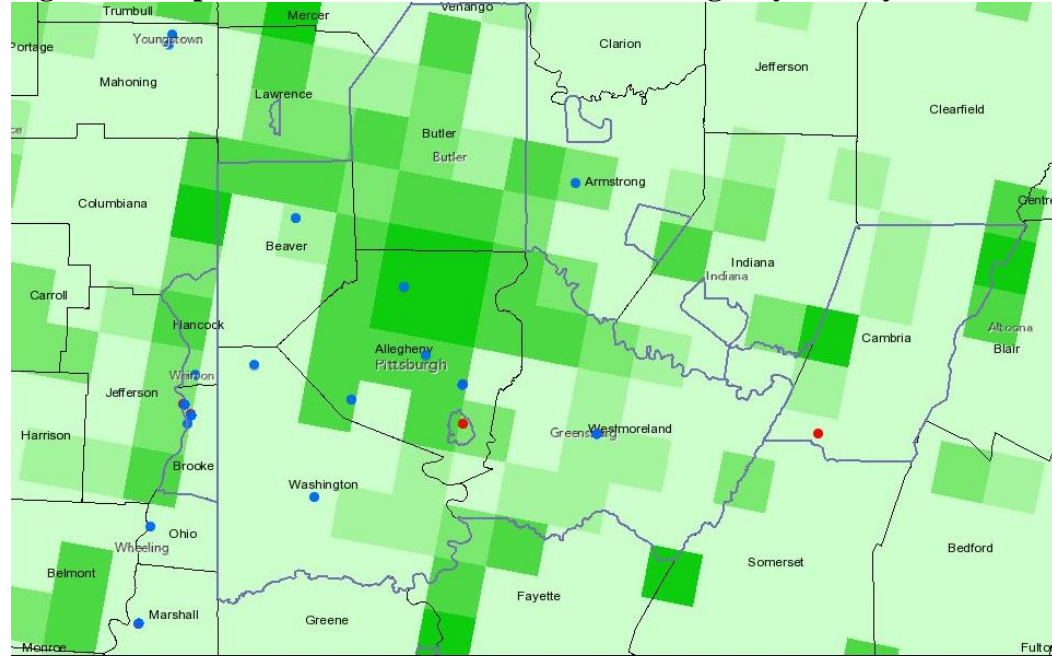
Figure 2b2. Spatial distribution of EC in the Allegheny County Area of Analysis
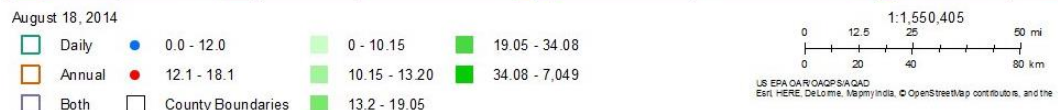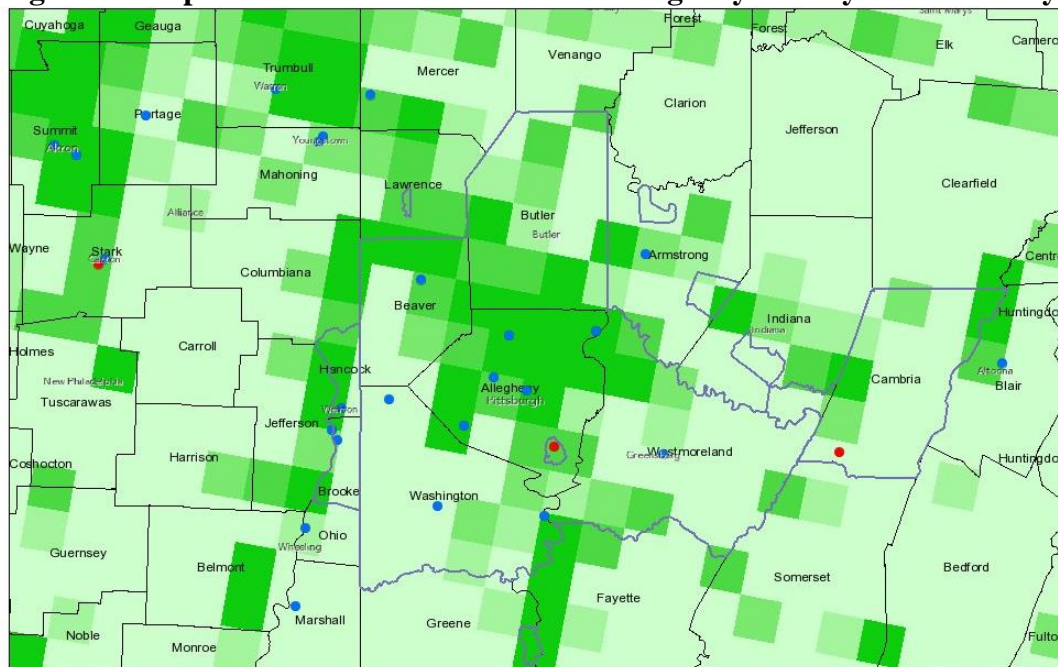
August 18, 2014

☐ Daily	● 0.0 - 12.0	☐ 0 - 10.15	☐ 19.05 - 34.08	
☐ Annual	● 12.1 - 18.1	☐ 10.15 - 13.20	☐ 34.08 - 7,049	
☐ Both	☐ County Boundaries	☐ 13.2 - 19.05		

1:1,550,405

US EPA OAR/OAQPS/AQAD
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Population density and degree of urbanization

In this part of the factor analysis, EPA evaluated the population and vehicle use characteristics and trends of the area as indicators of the probable location and magnitude of non-point source emissions. Rapid population growth in a county on the urban perimeter signifies increasing integration with the core urban area, and indicates that it may be appropriate to include the county associated with area source and mobile source emissions as part of the nonattainment area. Table 2i shows the 2000 and 2010 population, population growth since 2000, and population density for each county in the area of analysis.

Table 2i. Population Growth and Population Density.

County, State	Population 2000	Population 2010	% Change from 2000	Land Area (square miles)	Population Density (per square mile)	%	Cumulative %
Allegheny, PA	1,281,666	1,223,840	-4.5%	730	1,676	36%	36%
Westmoreland, PA	369,993	365,086	-1.3%	1,025	356	11%	46%
Washington, PA	202,897	207,882	2.5%	857	243	6%	53%
Butler, PA	174,083	184,053	5.7%	789	233	5%	58%
Beaver, PA	181,412	170,595	-6.0%	434	393	5%	63%
Cambria, PA	152,598	143,484	-6.0%	688	209	4%	67%
Fayette, PA	148,644	136,507	-8.2%	790	173	4%	71%
Mercer, PA	120,293	116,541	-3.1%	672	173	3%	74%
Columbiana, OH	112,075	107,820	-3.8%	532	202	3%	78%
Monongalia, WV	81,866	96,774	18.2%	361	268	3%	80%
Lawrence, PA	94,643	90,964	-3.9%	360	252	3%	83%
Indiana, PA	89,605	88,818	-0.9%	829	107	3%	86%
Somerset, PA	80,023	77,706	-2.9%	1,075	72	2%	88%
Armstrong, PA	72,392	68,864	-4.9%	654	105	2%	90%
Venango, PA	57,565	54,940	-4.6%	675	81	2%	92%
Jefferson, PA	45,932	45,224	-1.5%	655	69	1%	93%
Ohio, WV	47,427	44,447	-6.3%	106	419	1%	94%
Clarion, PA	41,765	39,934	-4.4%	602	66	1%	95%
Greene, PA	40,672	38,623	-5.0%	576	67	1%	97%
Preston, WV	29,334	33,534	14.3%	648	52	1%	98%
Hancock, WV	32,667	30,638	-6.2%	83	370	1%	98%
Garrett, MD	29,846	30,075	0.8%	648	46	1%	99%
Brooke, WV	25,447	24,000	-5.7%	89	270	1%	100%
Total	**3,512,845**	**3,420,349**					

Source: U.S. Census Bureau population estimates for 2000 and 2010

This data presented in Table 2i and Figure 2c clearly shows that Allegheny County has the highest population and population density in the area of analysis. Allegheny County accounts for 36 percent of the population in this 23 county area of analysis. Allegheny County's population density is four times higher than Ohio County, WV, which has the second highest population density in the area of

analysis. Allegheny County has the highest population and population density, this in conjunction with the other factors, indicate potential for contribution from sources in Allegheny County.

Figure 2c. 2010 County-Level Population in the Area of Analysis for the Allegheny County Area.

Traffic and Vehicle Miles Travelled

High VMT and/or a high number of commuters associated with a county is generally an indicator that the county is an integral part of an urban area. Mobile source emissions of NO_x, VOC, and direct PM may contribute to ambient particulate matter that contributes to monitored violations of the NAAQS in the area. In combination with the population/population density data and the location of main transportation arteries, an assessment of VMT helps identify the probable location of nonpoint source emissions that contribute to violations in the area. Comparatively high VMT in a county outside of the CBSA or CSA signifies integration with the core urban area contained within the CSA or CBSA, and indicates that a county with high VMT may be appropriate to include in the nonattainment area because emissions from mobile sources in that county contribute to violations in the area of analysis. Table 2j shows 2011 VMT, while Figure 2k overlays 2011 county-level VMT with a map of the transportation arteries.

Table 2j. 2011 VMT for the Allegheny County Area.

County, State	Total 2011 VMT	Percent	Cumulative %
Allegheny, PA	8,276,513,524	29%	29%
Westmoreland, PA	3,087,660,497	11%	40%
Butler, PA	1,765,361,166	6%	46%
Washington, PA	1,745,736,088	6%	53%
Mercer, PA	1,346,517,193	5%	57%
Beaver, PA	1,320,804,012	5%	62%
Columbiana, OH	1,092,970,892	4%	66%
Cambria, PA	1,007,874,393	4%	69%
Fayette, PA	948,403,446	3%	73%
Somerset, PA	924,890,368	3%	76%
Monongalia, WV	862,449,234	3%	79%
Indiana, PA	778,308,748	3%	82%
Lawrence, PA	700,366,617	2%	84%
Jefferson, PA	608,222,065	2%	86%
Clarion, PA	583,315,329	2%	89%
Armstrong, PA	582,533,913	2%	91%
Venango, PA	574,609,872	2%	93%
Garrett, MD	536,008,855	2%	95%
Ohio, WV	435,221,104	2%	96%
Greene, PA	421,356,837	1%	98%
Preston, WV	339,402,952	1%	99%
Brooke, WV	203,137,567	1%	99%
Hancock, WV	154,774,599	1%	100%
Total	**28,296,439,271**		

http://www.census.gov/hhes/commuting/data/commuting.html

As shown in Table 2j and Figure 2d, Allegheny County has by far the highest VMT in the area of analysis. Allegheny County accounts for 29 percent of the population in this 23 county area of analysis. Allegheny County's VMT is more than 2.5 times higher than Westmoreland County, which has the second highest VMT in the area of analysis. Allegheny County's high VMT compared with the rest of the area of analysis indicate it would be appropriate to include this county in the nonattainment area because of the potential for emissions from mobile sources in that county to contribute to the violating Liberty monitor.

Figure 2d. Overlay of 2011 County-level VMT with Transportation Arteries.
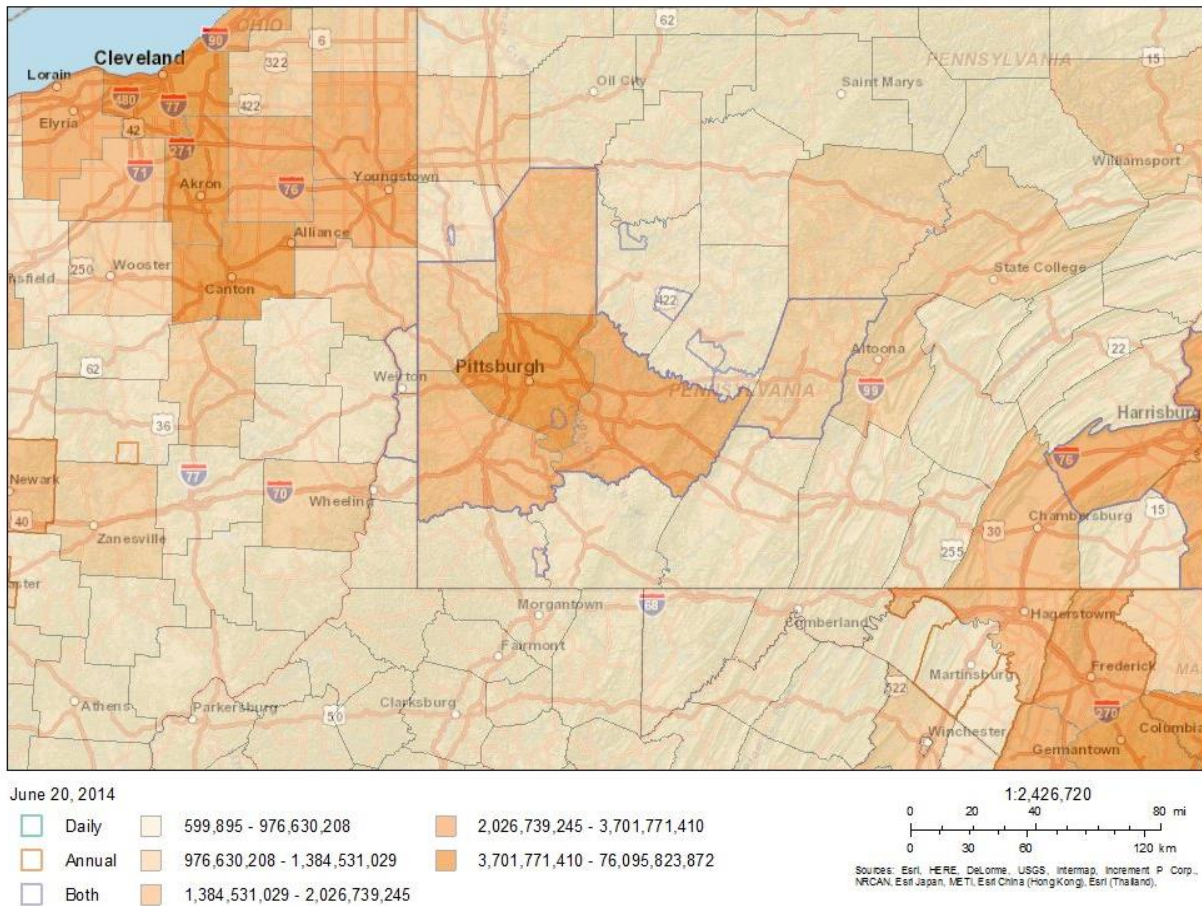
Pittsburgh is a densely populated city, with a population of 1.2 million and VMT of over 8 billion. As explained in factor 3, regarding meteorology, the wind rose closest to the Liberty monitor has a northwesterly component, indicating that at least some of the time, Pittsburgh is directly upwind of the violating Liberty monitor. Therefore, emissions from this highly urbanized area in Allegheny County, just northwest of the violating Liberty monitor, have a high potential to contribute to $PM_{2.5}$ levels at the Liberty monitor.

Factor 3: Meteorology

EPA evaluated available meteorological data to determine how meteorological conditions, including, but not limited to, weather, transport patterns, and stagnation conditions, could affect the fate and transport of directly emitted particulate matter and precursor emissions from sources in the area of analysis. EPA used two primary tools for this assessment: wind roses and kernel density estimation (KDE). When considered in combination with area $PM_{2.5}$ composition and county-level and facility emissions source location information, wind roses and KDE can help to identify nearby areas contributing to violations at violating monitoring sites.

Wind roses are graphic illustrations of the frequency of wind direction and wind speed. Wind direction can indicate the direction from which contributing emissions are transported; wind speed can indicate the force of the wind and, thus, the distance from which those emissions are transported. EPA constructed wind roses from hourly observations of wind direction and wind speed using 2009-2012 data from National Weather Service locations archived at the National Climate Data Center.[79] When developing these wind roses, EPA also used wind observations collected at meteorological sampling stations collocated at air quality monitoring sites, where these data were available. Figure 3a shows wind roses that EPA generated from data relevant in the Allegheny County area. Figure 3b gives a close up of wind roses near the violating Liberty monitor.

As can be seen in Figures 3a and 3b, the dominant wind direction in the area of analysis this southwest, with a large westerly component. The wind rose closest to the Liberty monitor, seen more clearly in Figure 3b, shows strong southerly and westerly components, with southwesterly and northwesterly components. The northwesterly component indicates that the highly urbanized Pittsburgh area is upwind of, and therefore contributing to, the Liberty monitor.

Indiana County, which has the highest emissions in the area of analysis due to several large sources of SO_2, is east of the Allegheny County and therefore east of the violating monitor. Armstrong County, which has the second highest emissions in the area of analysis is northeast of Allegheny County, and therefore northeast of the violating monitor. Because the dominant wind direction in the area of analysis is southwest, Indiana and Armstrong Counties are not upwind of the violating Liberty monitor, and therefore not contributing to the violation there.

Washington County is to the southwest of the violating monitor. However, emissions in Washington County are relatively low, less than a quarter of Allegheny County's emissions. Furthermore, POM and EC, the largest components of the urban increment at the violating monitor, are low in Washington County, as can be seen in Figures 2b2 and 2b3. Washington County also has relatively low population, population density, and VMT. There are two point sources with emissions of greater than 500 tpy in Washington County. However, as seen in Table 2h, these sources have very low direct $PM_{2.5}$ and VOC emissions, which indicates that any potential contribution to the POM and EC in the urban increment at the Liberty monitor is relatively low.

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[79] *ftp.ncdc.noaa.gov/pub/data/noaa* or
http://gis.ncdc.noaa.gov/map/viewer/#app=cdo&cfg=cdo&theme=hourly&layers=1&node=gis Quality assurance of the National Weather Service data is described here: *http://www1.ncdc.noaa.gov/pub/data/inventories/ish-qc.pdf*

Figure 3a. Wind Roses in the Area of Analysis for Allegheny County Area.
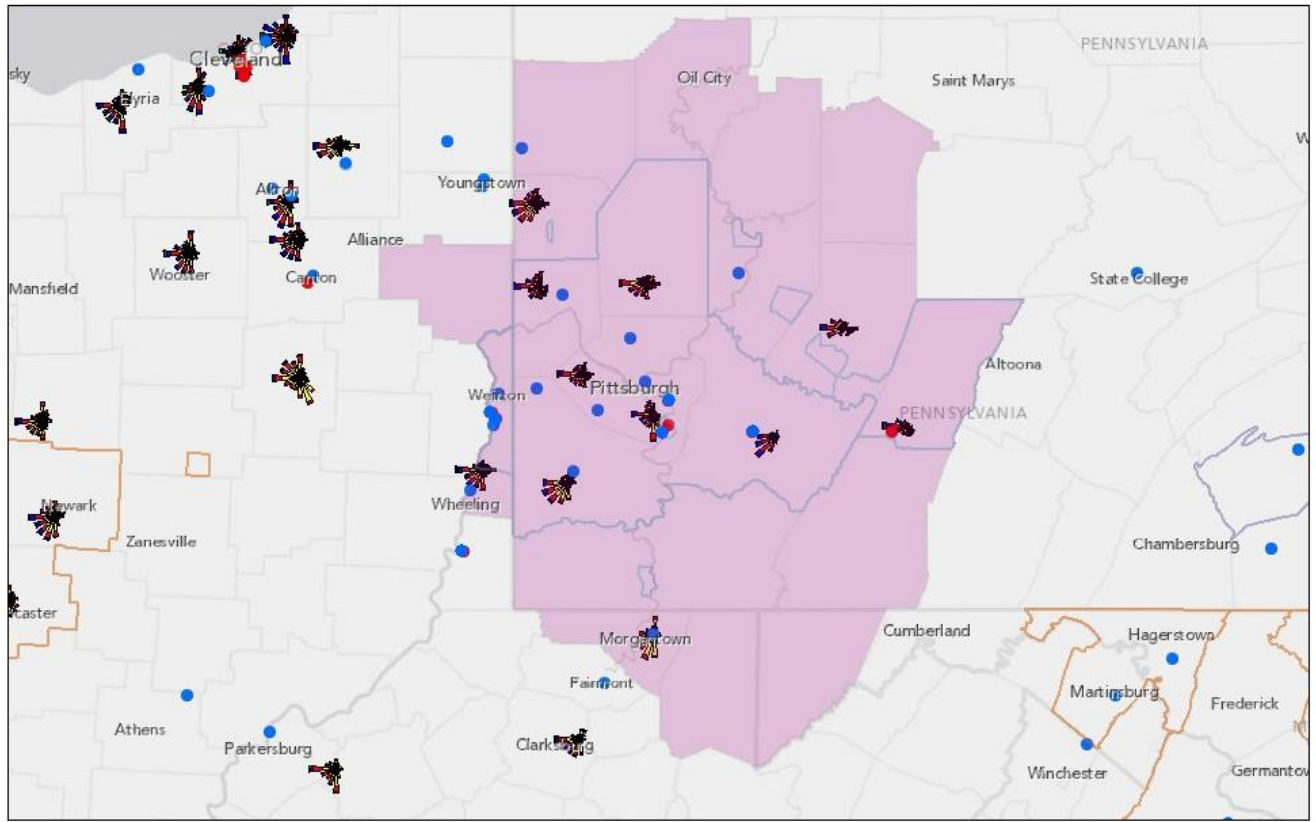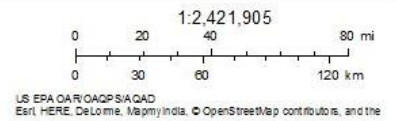
Figure 3b. Wind Roses Close to the Violating Liberty Monitor.
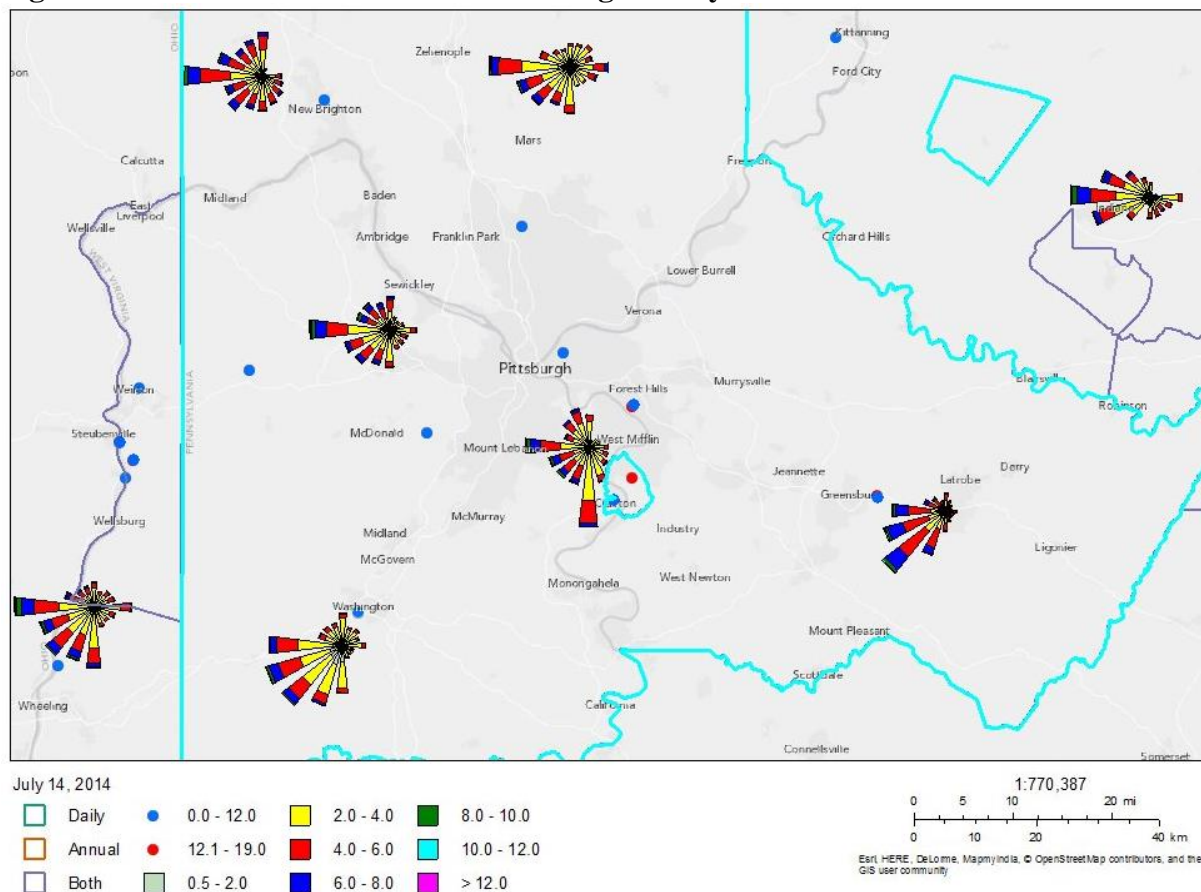
July 14, 2014

☐ Daily	● 0.0 - 12.0	☐ 2.0 - 4.0	☐ 8.0 - 10.0
☐ Annual	● 12.1 - 19.0	☐ 4.0 - 6.0	☐ 10.0 - 12.0
☐ Both	☐ 0.5 - 2.0	☐ 6.0 - 8.0	☐ > 12.0

1:770,387

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In its December 2013 recommendation letter, Pennsylvania included wind direction analysis at high PM$_{2.5}$ days at the Liberty monitor. As stated above, Pennsylvania identified 252 days in the 2010 to 2012 monitoring period where PM$_{2.5}$ at the Liberty monitor was at least one standard deviation above the Pittsburgh MSA. Pennsylvania analyzed the wind directions for the highest of those days, the top twenty-five percent (the "high PM$_{2.5}$ days"). For these high PM$_{2.5}$ days, Pennsylvania calculated the number of hours the wind was coming from a particular direction as well as the concentrations coming from a particular direction, using data from a meteorological station collocated with the Liberty monitor. Figures 3c and 3d represents the wind direction frequency and concentration distribution by wind direction, respectively, at the Liberty monitor during its high PM$_{2.5}$ days.

As can be seen in Figures 3c and 3d, wind direction on the high PM$_{2.5}$ days at the Liberty monitor is almost completely from the southwest. This wind direction shows that on high PM$_{2.5}$ days, the Clairton Coke Works is directly upwind of the Liberty monitor. EPA must evaluate wind direction on all days when determining nonattainment boundaries for an annual standard. As explained throughout the TSD, based on all five factors, EPA's analysis has determined that there is contribution from Allegheny County to the Liberty monitor on all days

Figure 3c. Wind Direction Frequency on High PM$_{2.5}$ Days at the Liberty Monitor
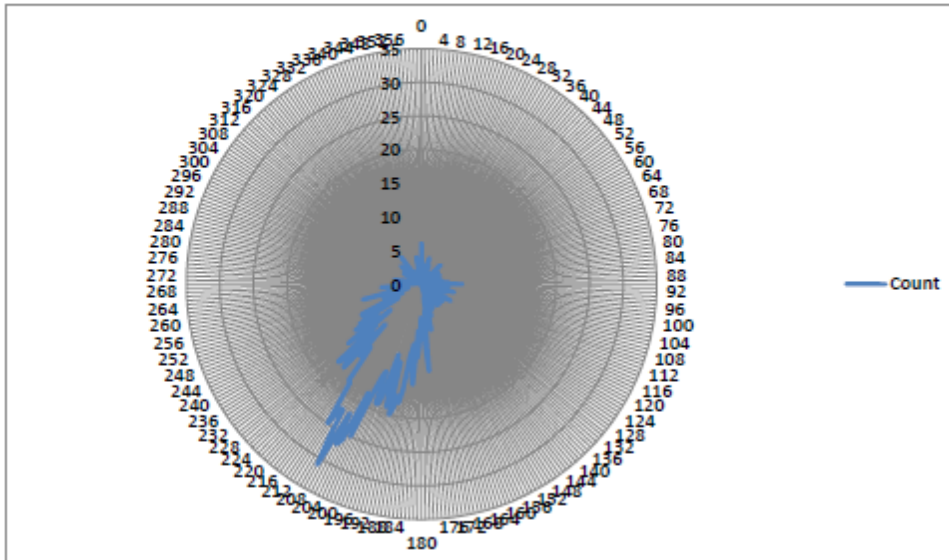
Source: Pennsylvania's December 10, 2013 recommendation letter, Appendix C-6 - Liberty-Clairton Area

Figure 3d. Concentration Distribution by Wind Direction on High PM$_{2.5}$ Days at the Liberty Monitor
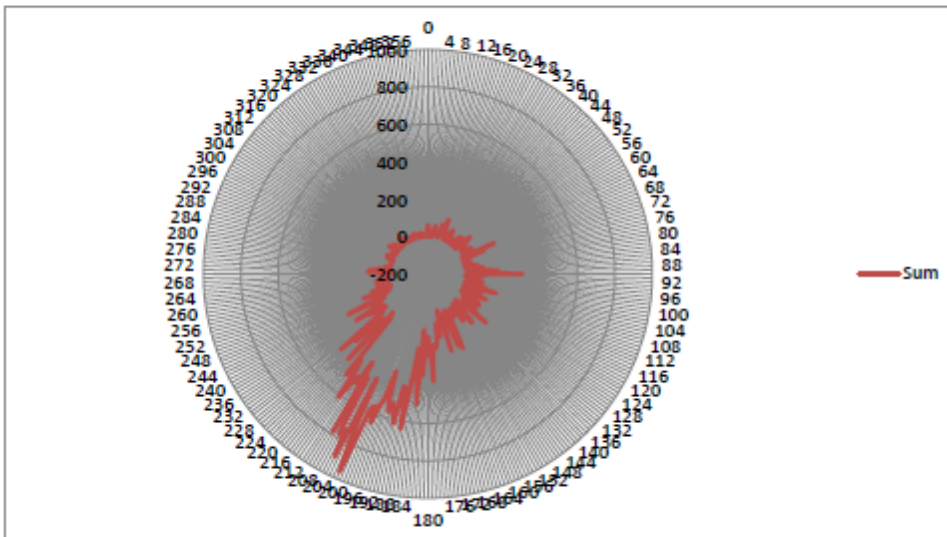
Source: Pennsylvania's December 10, 2013 recommendation letter, Appendix C-6 - Liberty-Clairton Area

In addition to wind roses, EPA also generated kernel density estimation (KDE) plots to represent HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) backward trajectory frequency at

violating monitoring sites.[80,81] These KDEs are graphical statistical estimations to determine the density of trajectory endpoints at a particular location represented by a grid cell. EPA used KDEs to characterize and analyze the collection of individual HYSPLIT backward trajectories.[82] Higher density values, indicated by darker blue colors, indicate a greater frequency of observed trajectory endpoints within a particular grid cell. Figure 3e shows a HYSPLIT KDE plot for the Allegheny County Area summarized by calendar quarter for the 2010-2012 period. The HYSPLIT KDE is weighted in the southwesterly direction, indicating a greater frequency of trajectories passing over grid cells to the southwest. However, the darker blue colors also cover most of Allegheny County, including the area to the north and northwest of the county, i.e., the highly urbanized Pittsburgh area, that contains high density of POM and EC emissions.

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[80] In some past initial area designations efforts, EPA has used HYSPLIT backward trajectories to assist in determining nonattainment area boundaries. A HYSPLIT backward trajectory is usually depicted on a standard map as a single line, representing the centerline of an air parcel's motion, extending in two dimensional (x,y) space from a starting point and regressing backward in time to a point of origin. Backward trajectories may be an appropriate tool to assist in determining an air parcel's point of origin on a day in which a short-term standard, such as an 8-hour standard or a 24-hour standard, was exceeded. However, for an annual standard, such as the 2012 annual $PM_{2.5}$ NAAQS, every trajectory on every day is important. Plotting a mass of individual daily (e.g., 365 individual back trajectories), or more frequent, HYSPLIT trajectories may not be helpful as this process is likely to result in depicting air parcels originating in all directions from the violating monitoring site.

[81] HYSPLIT - Hybrid Single Particle Lagrangian Integrated Trajectory Model, *http://www.arl.noaa.gov/HYSPLIT_info.php*

[82] The KDEs graphically represent the aggregate of HYSPLIT backward trajectories for the years 2010-2012, run every third day (beginning on the first day of monitoring), four times each day, and ending at four endpoint heights.
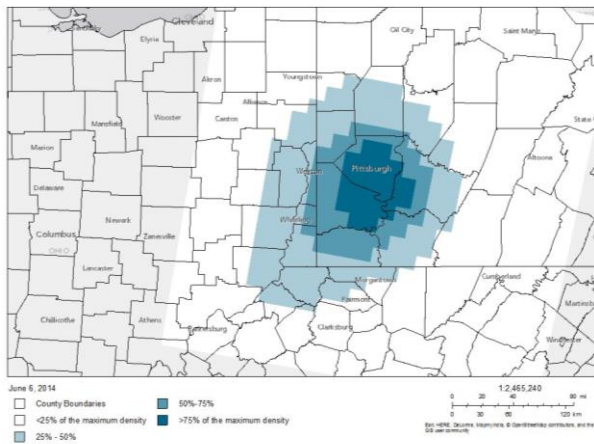
Figure 3e. HYSPLIT Kernel Density Estimation Plots for the Allegheny County Area.
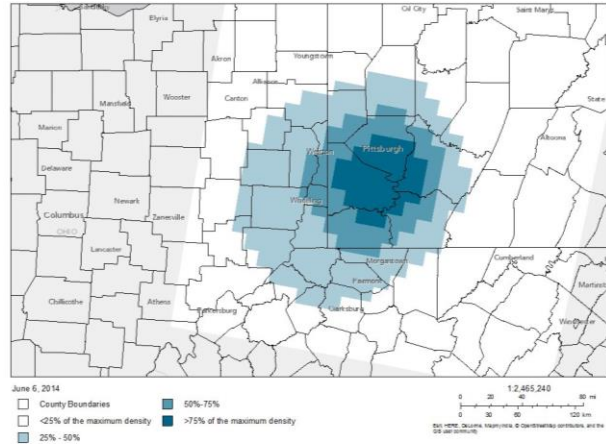
First Quarter   **Second Quarter**
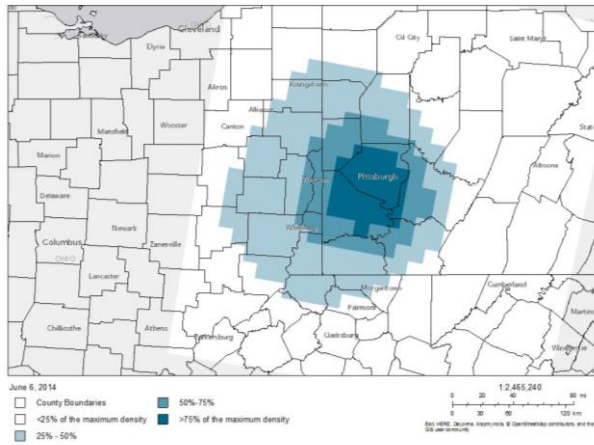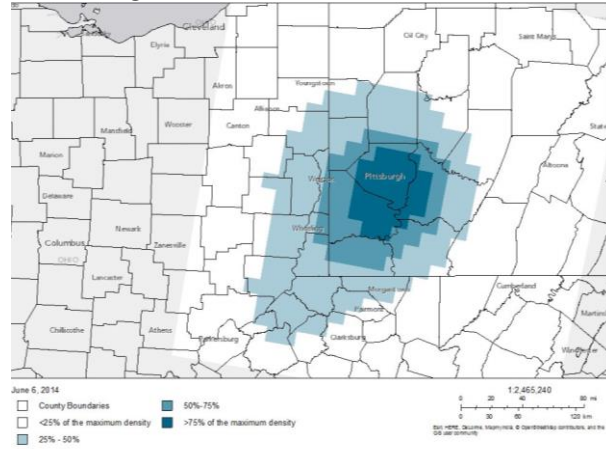
**Third Quarter**   **Fourth Quarter**

In an attempt to better understand the meteorological impact at the violating monitor EPA conducted its own additional analysis of conditions at this site. EPA compared the gradient between the Liberty monitor values on all days against the average of all seven other Allegheny County monitoring sites. EPA grouped these conditions into three categories based on days when the readings at the Liberty monitor was much higher than the average of the other monitors (greater than $2\mu g/m^3$); when the readings were similar ($+/-2\mu g/m^3$) and when the readings were lower than the average for the County (less than $2\mu g/m^3$). When analyzing the results for all days from 2010 – 2012, the comparison of Liberty monitor to the average of all seven other Allegheny County monitors is essentially the same as a comparison between Liberty and Lawrenceville monitors (depicted graphically in Figure3g). It appears that on approximately 37% of the days the Liberty monitor is greater than $2\mu g/m^3$ (depicted in red in Figure 3g), 55% of the days the gradient is similar in value ($+/- 2\mu g/m^3$ depicted in black), the remaining 8% of the days the Liberty monitor is lower than the Lawrenceville monitor ($-2\mu g/m^3$, depicted in blue).

Figure 3f. Comparison of the difference between daily PM$_{2.5}$ with the average of other sites in Allegheny County, 2010-2012
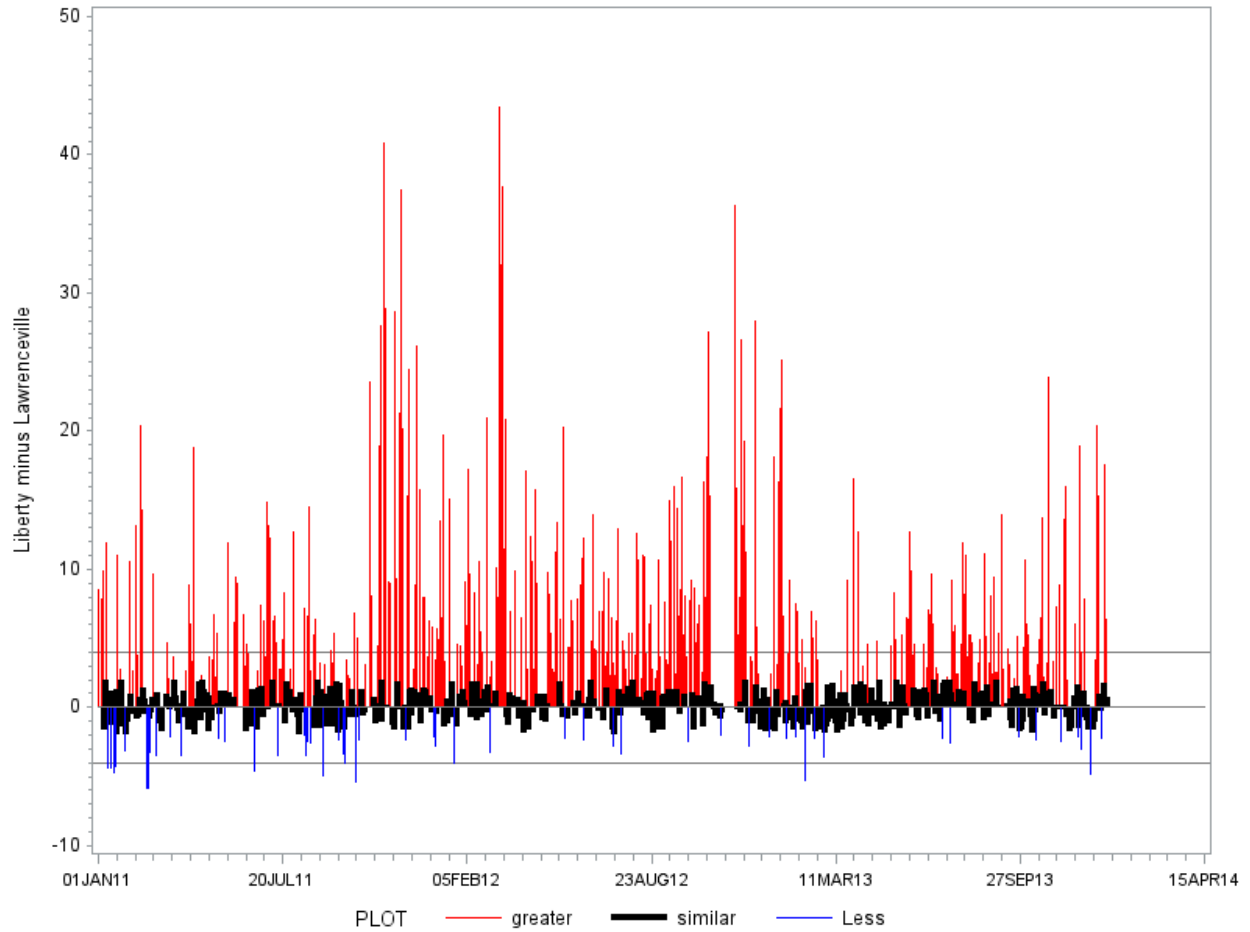
In an attempt to analyze wind impacts at the violating monitor, EPA analyzed wind directions during these differing conditions across the three-year period from the Allegheny County airport, approximately 5 miles from the Liberty monitoring site.

Figure 3g. EPA Analysis of Wind Roses For Days When The Liberty Monitor Concentrations Exceed the Lawrenceville Monitor by Greater Than 2µg/m³ (2011-2013)
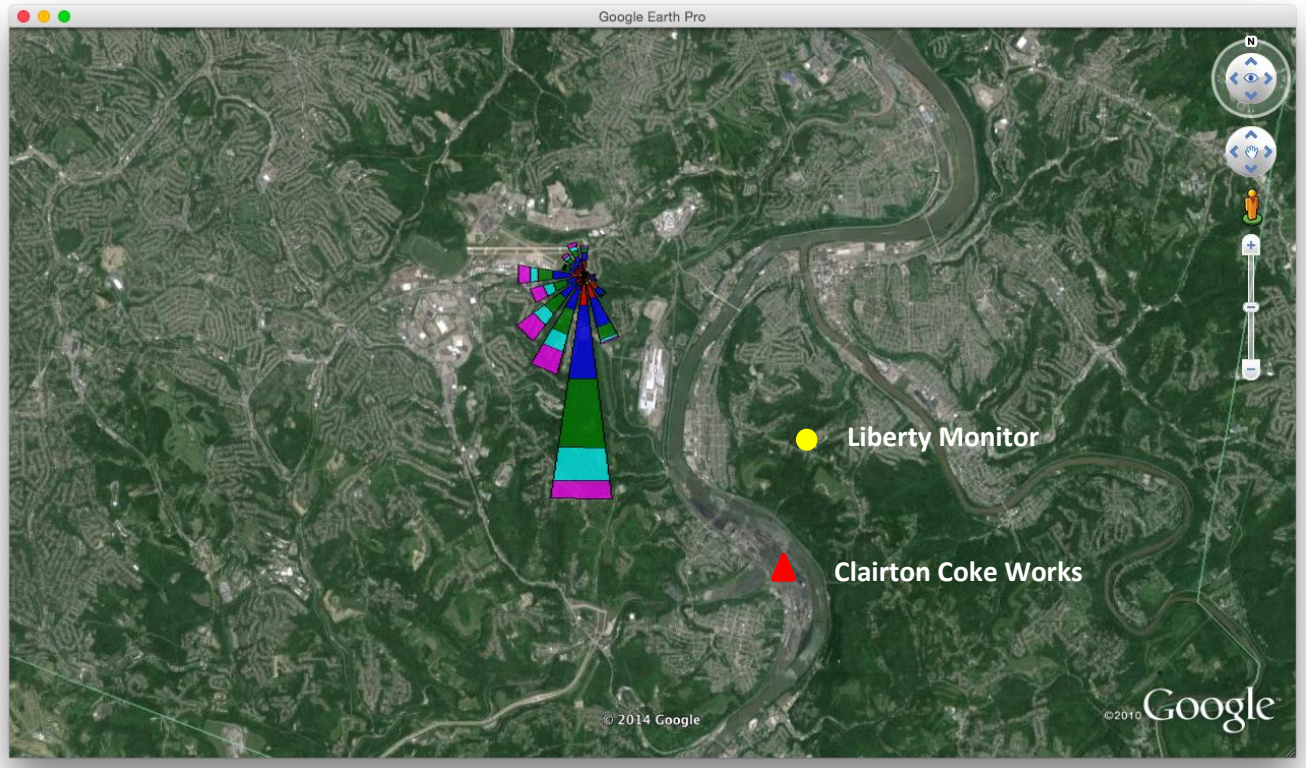
Figure 3h. EPA Analysis of Wind Roses For Days When Liberty Monitor Concentrations Are Similar To Lawrenceville Monitor Concentrations (within a 2µg/m^3 range) (2011-2013)
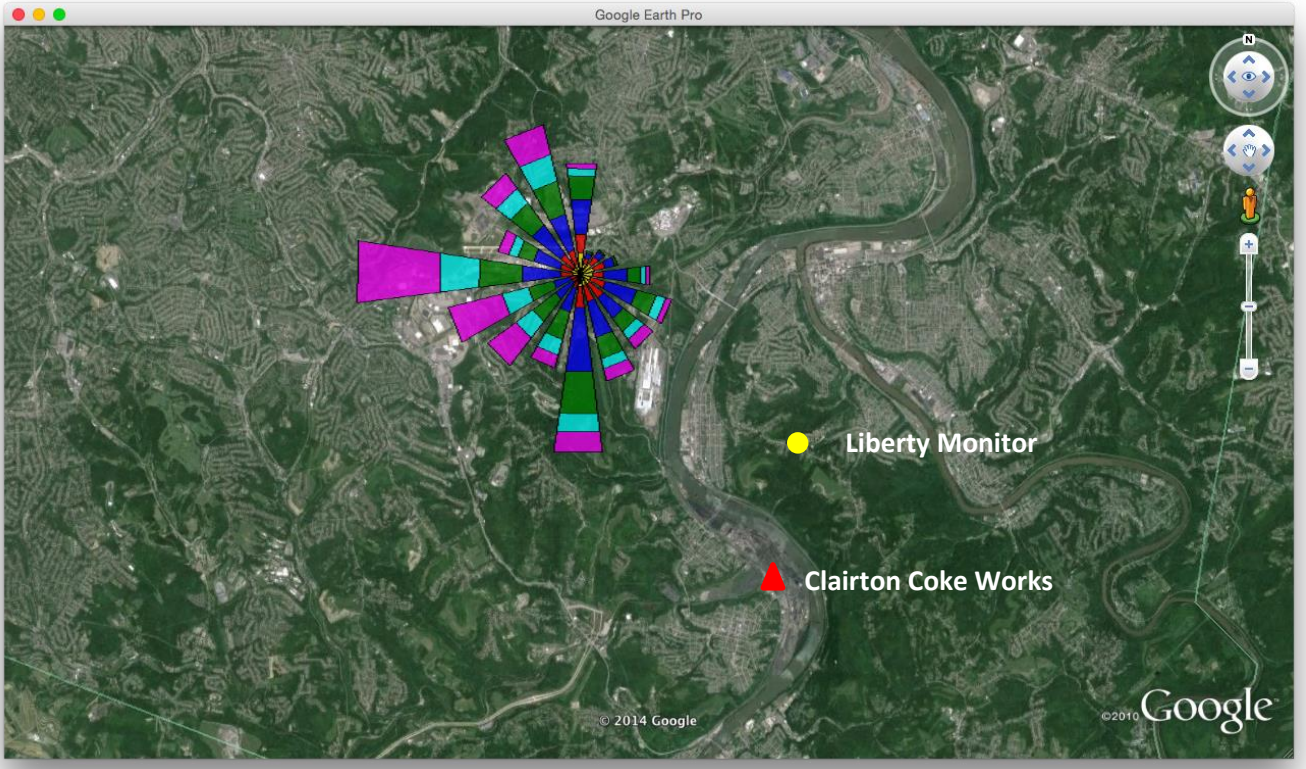
Figure 3i. EPA Analysis of Wind Roses For Those Days When Lawrenceville Monitor Concentrations Exceed the Liberty Monitor by Greater Than 2µg/m^3 (2011-2013)
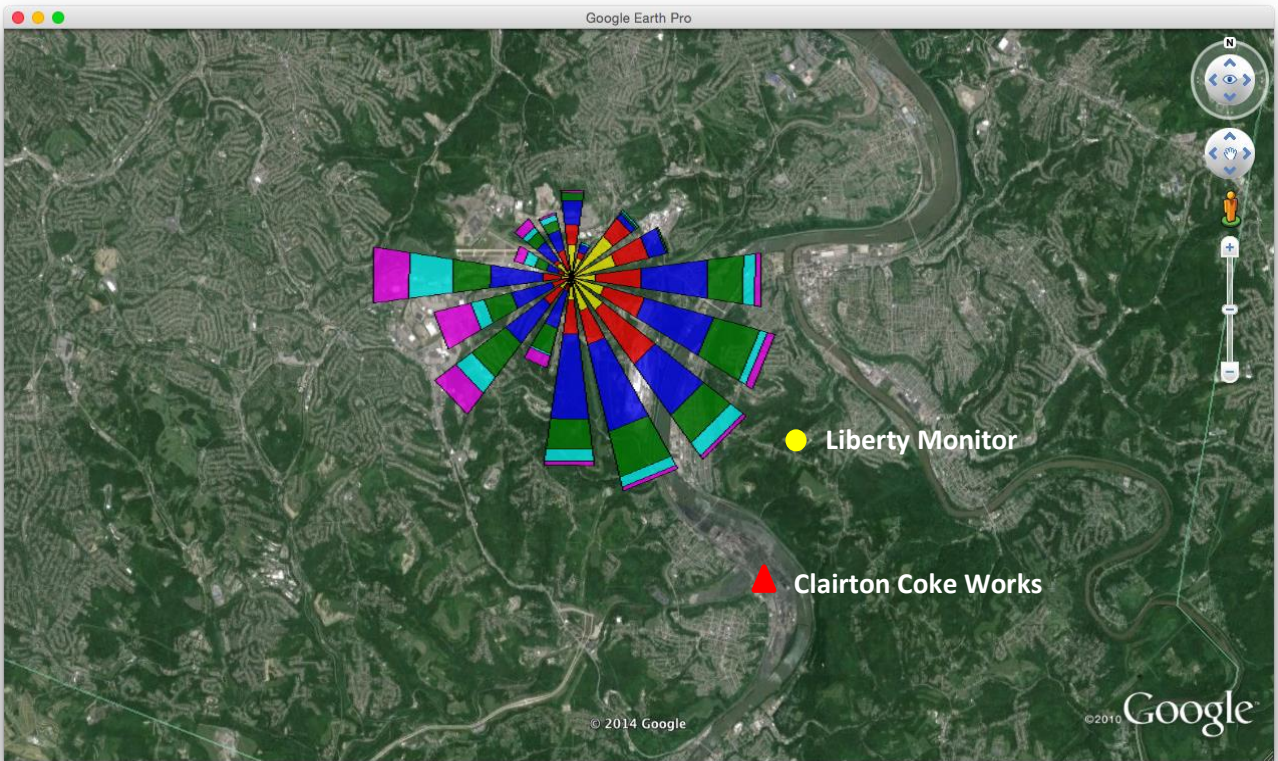
EPA's own supplemental analysis of wind directions on days of varying comparative concentrations at the Liberty Monitor relative to other Allegheny County monitors (depicted here by the Lawrenceville representative monitor) clearly supports the commenters' assertion that the Clairton Coke Works is the primary contributor to the violating monitor on days with the highest $PM_{2.5}$ concentration gradient between the Liberty and the Lawrenceville monitor (Figure 3g).

However, on days when the Liberty monitor concentrations are similar (+/- $2\mu g/m^3$) to Lawrenceville, the dominant wind direction comes from the west, with strong southern and northwestern components (Figure 3h). Winds from the north to northwest allow for contribution from the surrounding county, including the urbanized Pittsburgh area. This low gradient concentration days at the Liberty monitor account for over half of the days for the entire analyzed period. Although contribution is expected to be a small portion of the total during these days, their large number would have some impact on the annual average.

On days when concentrations measured at other monitors in the county (as depicted by Lawrenceville) exceed that of the Liberty monitor (by more than $2\mu g/m^3$), the dominant wind direction generally comes from the southeast direction, with some westerly components and much smaller northern components (Figure 3i). It is unclear if the lower values at the Liberty monitor are the result of lower emissions impact on these days from the immediately nearby Liberty-Clairton area industrial sources, or if emissions from the surrounding area have a greater impact on the other Allegheny monitors on those days. It is also possible that the coke works is impacting the other Allegheny County monitors on these days, but such a conclusion cannot be drawn solely from this type of monitor concentration averaging assessment.

In any event, it is evident that under certain conditions on low gradient concentration days, there is potential contribution from sources in the surrounding Allegheny County at the violating monitor.

Factor 4: Geography/topography

To evaluate the geography/topography factor, EPA assessed physical features of the area of analysis that might define the airshed and thus affect the formation and distribution of $PM_{2.5}$ concentrations over the area.

The Clairton Coke Works is at the base of the Mon Valley, approximately 750 feet above mean sea level (MSL). The facility sits on the west bank of the Monongahela River. On the east bank, the terrain rises sharply reaching elevations more than 300 feet above the coke works within a thousand feet of the plant. The Liberty monitor is about 1100 feet above MSL, to the northeast of the coke works.

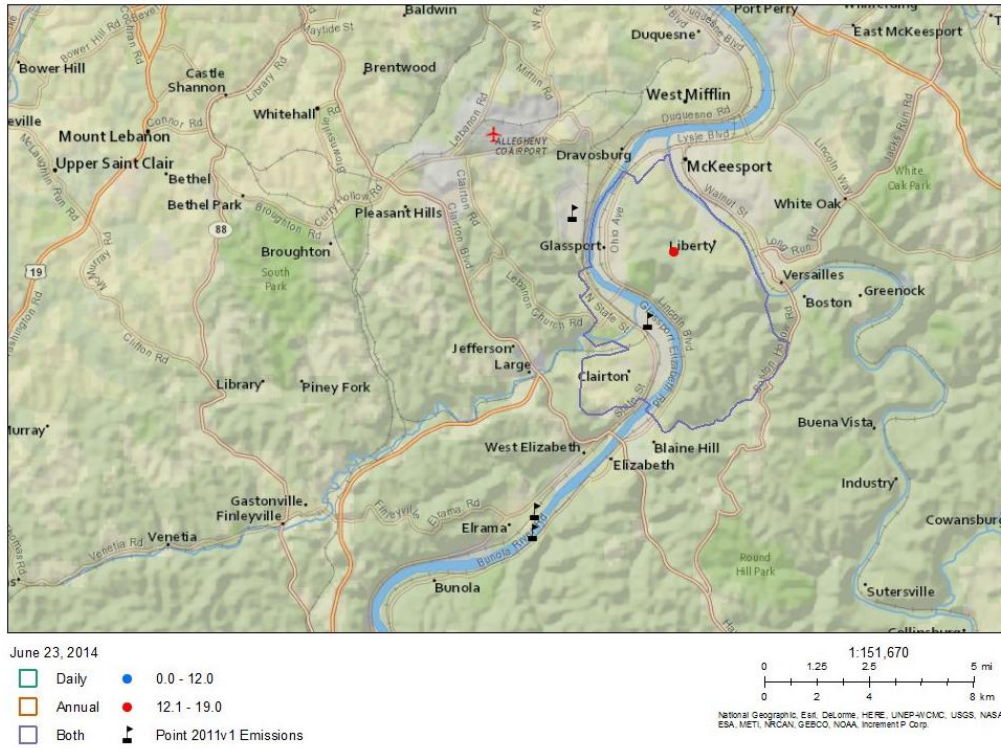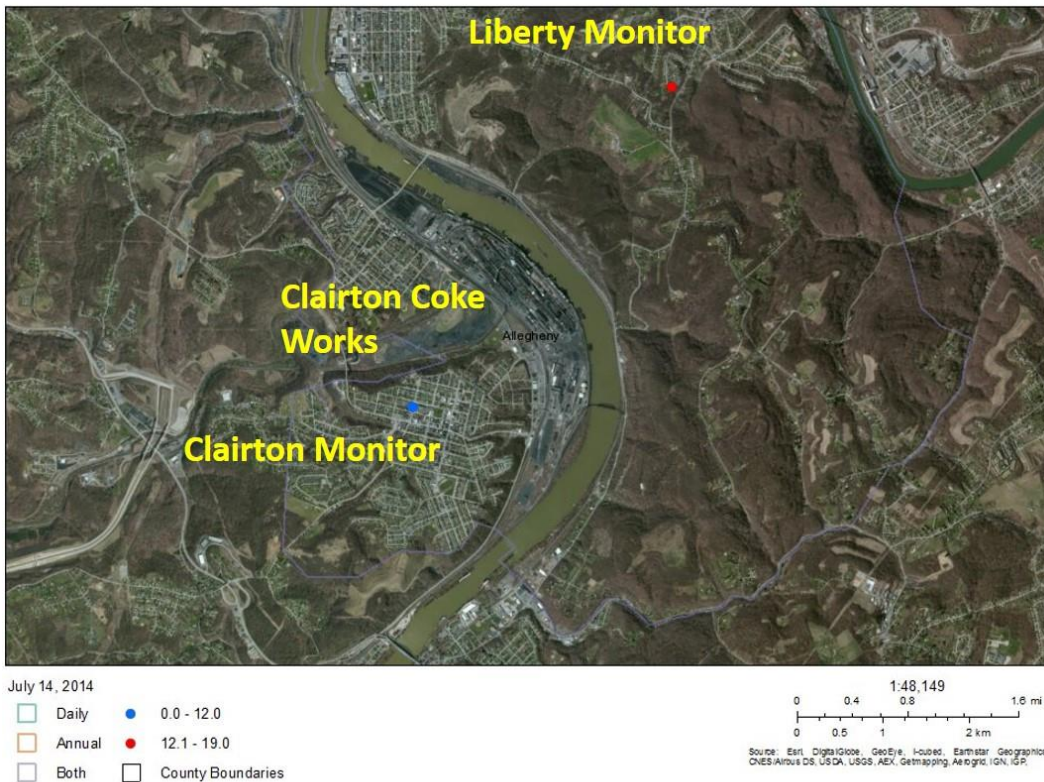**Figure 4a. Topography of Liberty Monitor and Surrounding Area.**

June 23, 2014

☐ Daily	●	0.0 - 12.0
☐ Annual	●	12.1 - 19.0
☐ Both	⚑	Point 2011v1 Emissions

1:151,670

National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA,
ESA, METI, NRCAN, GEBCO, NOAA, Increment P Corp.

Figure 4b. Satellite Imagery of the Clairton Coke Works and Surroundings

July 14, 2014

☐ Daily	●	0.0 - 12.0
☐ Annual	●	12.1 - 19.0
☐ Both	☐	County Boundaries

1:48,149

Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics,
CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP,

Southwestern Pennsylvania has relatively high terrain cut by numerous river valleys, which tend to trap local emissions. This tendency to trap local emissions, combined with large local emissions, would explain why the monitored values at the Liberty monitor on some days are so much higher than at the other monitors in the Pittsburgh area, which are all attaining the 2012 annual PM$_{2.5}$ NAAQS.

Furthermore, in its October 20, 2008 letter to EPA regarding boundary recommendations for the 2006 24-hr PM$_{2.5}$ NAAQS, PADEP stated that the Clairton Coke Works facility has stack heights that are lower than normal power plant stacks. This means that the effects of a source like the coke works would impact the ground at a much closer location locally than a power plant. PADEP's October 20, 2008 letter also explained that the highest PM$_{2.5}$ concentrations occur at the Liberty monitor when there are south-southwesterly winds along with a morning inversion. A morning inversion occurs when air at the ground is cooler than the air above it; normally at night, the area is under the control of high pressure and clear skies. With the warmer air being above the cooler air, vertical mixing is at a minimum. Therefore, with an inversion in place, PM$_{2.5}$ and precursor emissions in the boundary layer will remain trapped in that layer. For example, as the Clairton Coke Works' low level stacks emit emissions, the plume of emissions will only rise to the top of the inversion layer. At that point, the pollution is spread out horizontally. These inversions usually set up only a few hundred feet above the surface. Therefore, fine particulate levels can become very high near the surface. This low lying topography and inversions is significant in explaining the high PM$_{2.5}$ concentrations detected at the Liberty monitor on some days (relative to other Allegheny County monitors), however, it does not restrict air movement from other parts of the county or disprove contribution from nearby Allegheny County emissions sources to the Liberty monitor when conditions are more favorable for transport of emissions from nearby locations to the west and northwest of the Liberty monitor.

Factor 5: Jurisdictional boundaries

In defining the boundaries of the intended Allegheny County nonattainment area, EPA considered existing jurisdictional boundaries, which can provide easily identifiable and recognized boundaries for purposes of implementing the NAAQS. Existing jurisdictional boundaries often signify the state, local, or tribal governmental organization with the necessary legal authority for carrying out air quality planning and enforcement functions for the intended area. Examples of such jurisdictional boundaries include existing/prior nonattainment area boundaries for particulate matter, county lines, air district boundaries, township boundaries, areas covered by a metropolitan planning organization, state lines, and Reservation boundaries, if applicable. Where existing jurisdictional boundaries were not adequate or appropriate to describe the nonattainment area, EPA considered other clearly defined and permanent landmarks or geographic coordinates for purposes of identifying the boundaries of the intended designated areas.

There are no jurisdiction issues in the Allegheny County Area. The PM$_{2.5}$ planning for Allegheny County is under the purview of the Allegheny County Health Department. The Pennsylvania Department of Environmental Protection does the planning for the Pittsburgh-Beaver Valley

nonattainment areas for the 1997 annual and 2006 24-hour $PM_{2.5}$ NAAQS. However, these two agencies have a long history of cooperation.

ACHD has a long history of air quality planning for the area surrounding the Liberty monitor. The City of Clairton and the Boroughs of Glassport, Liberty, Lincoln, and Port Vue Clairton Area were designated as the Liberty-Clairton nonattainment area for the 1997 annual and 2006 24-hour $PM_{2.5}$ NAAQS. The same five municipalities were designated nonattainment for the 1987 PM_{10} NAAQS by operation of law on November 15, 1990. The nonattainment designation and classification as a moderate PM_{10} area was codified in 40 CFR part 81 on November 6, 1991 (56 FR 56694). The area attained the PM_{10} NAAQS through ACHD's state implementation plan (SIP) approved measures, and was redesignated to attainment in 2003 (68 FR 53515).

As a result of cooperation and planning efforts between ACHD, PADEP and local industrial sources, air quality in the area has improved markedly over time, as seen below in Table 5.

Table 5. Annual $PM_{2.5}$ DVs at the Liberty Monitor ($\mu g/m^3$)

2001-2003	2002-2004	2003-2005	2004-2006	2005-2007	2006-2008	2007-2009	2008-2010	2009-2011	2010-2012	Preliminary 2011-2013
21.2	20.4	20.8	20.4	19.8	18.3	17.0	16.0	15.0	14.8	13.4

In addition, on October 25, 2013 (78 FR 63881), effective November 25, 2013, EPA determined that the Liberty-Clairton area has air quality data that meets the 1997 annual $PM_{2.5}$ NAAQS, and that the area attained that NAAQS by its attainment date. EPA believes that the same locally focused planning will bring the area into attainment for the 2012 annual $PM_{2.5}$ NAAQS.

Conclusion for the Allegheny County Area

Based on the assessment of factors described above, both individually and in combination, EPA has concluded that entirety of Allegheny County should be designated as nonattainment for the 2012 annual $PM_{2.5}$ NAAQS. EPA has determined that there although there is an extremely large local industrial influence at the violating Liberty monitor, there is also a degree of contribution from mobile, area, and point emission sources throughout Allegheny County that contribute to its nonattainment. The detailed technical analysis, set forth in Factors 1-4, including consideration of supplemental information provided by PADEP and ACHD in response to EPA's 120-day letter, supports a finding that this area presents local air quality issues that differentiate this county from the surrounding counties. Therefore, EPA has determined that it is appropriate to designate Allegheny County, and no other counties in the Pittsburgh MSA, as nonattainment.

The Liberty monitor is located in the industrialized Mon Valley, which is dominated by emissions from the largest coke manufacturing facility in the United States – the U.S. Steel Clairton Cokes

Works. The Clairton Coke Works is a large and complex facility that emits a combination of $PM_{2.5}$ emissions and emissions precursors, including: direct particulate matter, sulfur dioxide, ammonia, and hundreds of volatile organic chemicals. Although the coke plant has numerous existing emission controls, the combination of a large amount of low-level emissions in a narrow river valley creates a local air quality problem which is uniquely different from the remainder of the area. DVs for 2011-2013 at seven monitors in Allegheny County are below the 12 µg/m^3 standard. However, the 2011-2013 DV at the Liberty monitor is 13.4 µg/m^3. In its December 2013 letter, Pennsylvania identified 252 days in the 2010 to 2012 monitoring period when the violating Liberty monitor's $PM_{2.5}$ concentrations were at least one standard deviation above the regional concentrations in the Pittsburgh MSA, and regional average was at or below 12 µg/m^3. EPA's own analysis of the Liberty monitor during all days for the three-year period 2011 to 2013 corroborates this fact, as our own analysis shows that the Liberty monitor measured concentrations more than 2 µg/m^3 higher than the average of other Allegheny County sites on more than 37% of all days. However, for the remaining days EPA analyzed during that same period, prevailing wind direction allowed for some contribution from the surrounding county to the violating Liberty monitor.

As discussed in factor 3 of this TSD regarding meteorology, while Indiana and Armstrong Counties have the highest and second highest emissions in EPA's area of analysis, the dominant wind directions in the area indicate that Indiana and Armstrong Counties do not contribute to the violation at the Liberty monitor. Furthermore, as discussed in Section 3.1, EPA has determined that the portions of Indiana County that contain the large SO$_2$ sources should be designated as part of the Johnstown, PA nonattainment area.

Washington County is to the southwest of the violating monitor. However, total emissions, as well as emissions of POM and EC, the largest components of the urban increment at the violating monitor, are relatively low in Washington County. Washington County also has relatively low population, population density, and VMT. There are two point sources with emissions of greater than 500 tpy in Washington County. However, these sources have very low direct $PM_{2.5}$ and VOC emissions, which indicates that any potential contribution to the POM and EC in the urban increment at the Liberty monitor is relatively low.

Wind roses provided by PADEP, and by EPA as part of our own supplemental analysis, show that wind directions on high concentration $PM_{2.5}$ days at the Liberty monitor originate almost exclusively from the southwest. This wind direction shows that on high concentration $PM_{2.5}$ days, the Clairton Coke Works is directly upwind of the violating Liberty monitor. However, EPA's supplemental analysis of wind directions performed after the 120-day intended designations, shows that during all days for the period between 2011 and 2013 shows that under certain conditions on low gradient concentration days, there is potentially contribution from the surrounding Allegheny County area to the violating Liberty monitor.

As discussed in factor 4 regarding geography/topography, southwestern Pennsylvania is dominated by high terrain cut by numerous river valleys. The Clairton Coke Works is located in one of these river

valleys, the Mon Valley. The fact that this type of terrain tends to trap local emissions, combined with large local emissions, explains why the monitored values on some days at the Liberty Borough monitor are so much higher than at the other seven monitors in the Pittsburgh area on those same days, however, it does not restrict movement of emissions from other parts of the county or disprove emission contribution from Allegheny County to the Liberty monitor on other days when conditions are more favorable for transport of emissions from nearby Allegheny county locations to the west and northwest of the Liberty monitor.

As shown, in Figures 1a and 1b, most monitors in the area of analysis, including the violating Liberty monitor, show higher quarterly mean values in third quarter (July-September) of each year. However, $PM_{2.5}$ levels at the violating Liberty monitor are consistently higher than the rest of the monitors in the area. This indicates that the Liberty monitor is influenced by the same seasonal emissions patterns as the rest of the area, but there is an additional local component causing $PM_{2.5}$ levels to be higher than the rest of the area. PADEP and ACHD submitted additional monitoring trends and correlation information for monitors in the area of analysis compared to the Liberty monitor in response to EPA's 120-day intended designations affirming the unique nature of the Liberty monitor, both in its higher recorded concentrations relative to other area monitors, and its unique $PM_{2.5}$ speciation composition. However, EPA continues to believe that the data presented for the violating Liberty monitor do not rule out the possibility of some contribution to the violation from the surrounding Allegheny County area.

Pennsylvania has recommended that only the five municipalities in the Liberty-Clairton nonattainment area for the 1997 annual and 2006 24-hour $PM_{2.5}$ NAAQS be designated as nonattainment for the 2012 annual $PM_{2.5}$ NAAQS. While there is a very strong local contribution to the violation at the Liberty monitor from the Clairton Coke Works, EPA has concluded that other sources in the remainder of Allegheny County also contribute to the violation at the Liberty monitor. Allegheny County, which includes the City of Pittsburgh, has the highest NOx, EC, direct $PM_{2.5}$, PSO4, POM, and VOC emissions in the area of analysis. It also has the second highest PNO3 and NH_3 emissions, and the fourth highest SO_2 emissions in the area of analysis. There are nine major sources with emissions of 500 tpy or more in Allegheny County, four of which are within five miles of the violating monitor.

The spatial distribution of selected emissions throughout the area of analysis also provides useful information. POM and EC, the largest components of the urban increment at the Liberty monitor, are high throughout Allegheny County, including several 12 km grid squares immediately to the north and west of the Liberty monitor. POM and EC are lower in the surrounding counties. This suggests that POM and EC from the Pittsburgh urban area in Allegheny County, to the north and west of the Liberty monitor, have at least some potential to influence $PM_{2.5}$ values at the violating monitor, particularly when on days of lower concentration gradients between the Liberty monitor and other county monitors and when wind directions have some components from the direction of the urban Pittsburgh area.

Pittsburgh is a densely populated city, with a population of 1.2 million and VMT of over 8 billion. As explained in factor 3, regarding meteorology, the wind rose closest to the Liberty monitor has a

northwesterly component, indicating that at least some of the time, Pittsburgh is directly upwind of the violating Liberty monitor. Therefore, emissions from this highly urbanized area in Allegheny County, approximately 20 miles northwest of the violating Liberty monitor, have a high potential to contribute to $PM_{2.5}$ levels at the Liberty monitor under at least some emissions and meteorological conditions. Therefore, EPA has concluded that all of Allegheny County should be designated as nonattainment for the 2012 annual $PM_{2.5}$ area, as the Allegheny County Area.

Attachments

ACDH's December 13, 2011 report, "Allegheny County $PM_{2.5}$ Source Apportionment Results using the Positive Matrix Factorization Model (PMF Version 3.0) and Conditional Probability Function (CPF), Model Timeframe: January 2005 through December 2010"

ACHD Air Quality Program "2013 Air Monitoring Network Review," dated July 1, 2013

Letter dated October 20, 2008 from the PADEP to EPA regarding boundary recommendations for the 2006 $PM_{2.5}$ NAAQS

"Proposed Revision to the Allegheny County Portion of the Pennsylvania State Implementation Plan, Attainment Demonstration for the Liberty-Clairton $PM_{2.5}$ Nonattainment Area 2006 Standards," by ACHD Air Quality Program, dated May 10, 2013

3.4   Area Background and Overview - Allentown Area

Figure 1a is a map of EPA's final nonattainment boundary for the Allentown Area. The map shows the location and DVs of ambient air quality monitoring locations, county and other jurisdictional boundaries including the Allentown-Bethlehem-Easton, Pennsylvania-New Jersey MSA. For purposes of the 2006 24-hour PM$_{2.5}$ NAAQS, a portion of this area was designated nonattainment. The boundary for the Allentown nonattainment area for the 2006 24-hour PM$_{2.5}$ NAAQS included the entire counties of Lehigh and Northampton counties in Pennsylvania. The boundary for the intended 2012 annual PM$_{2.5}$ NAAQS is the same as the boundary for the 2006 24-hour PM$_{2.5}$ NAAQS.

Figure 1a. EPA's Final Nonattainment Boundaries for the Allentown Area
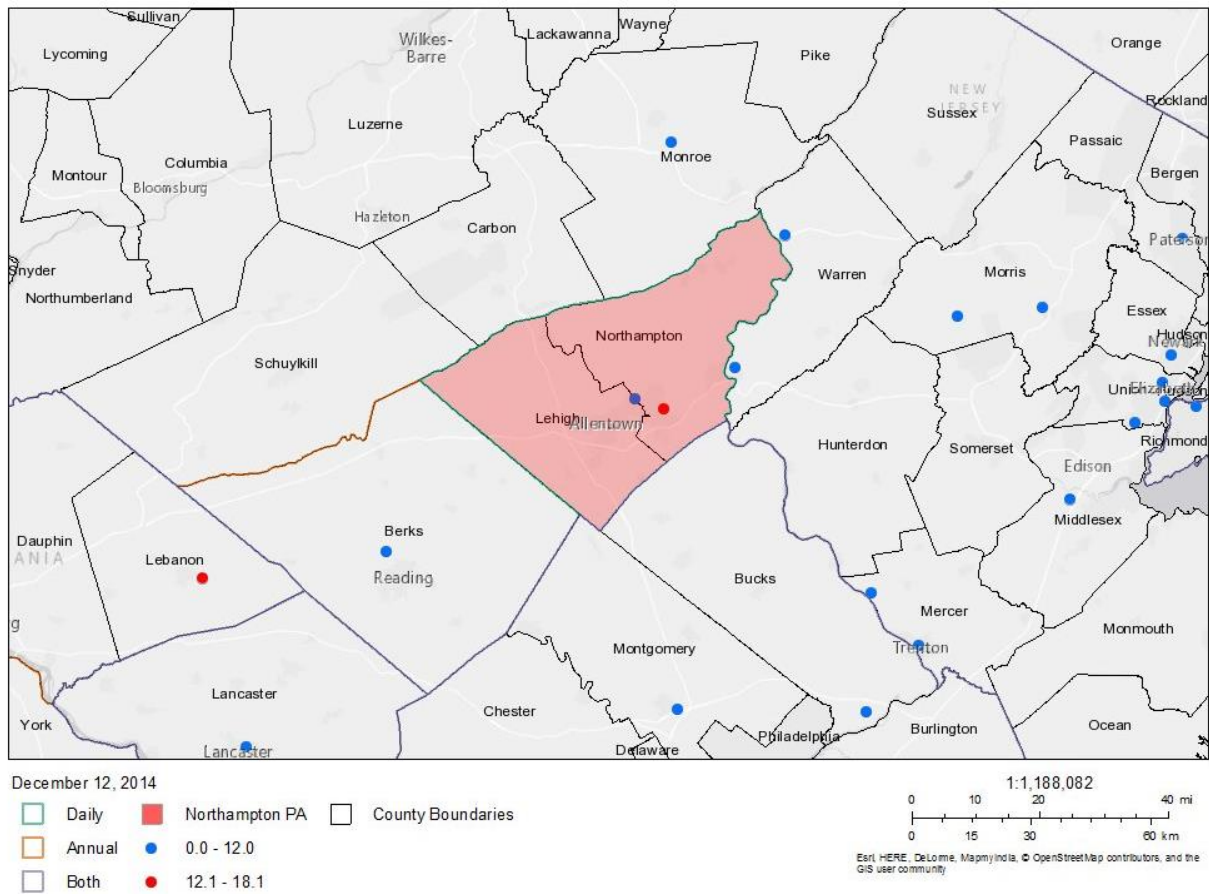
EPA must designate, as nonattainment, areas that violate the NAAQS and nearby areas that contribute to the violation in the violating area. A monitor in Northampton County, Pennsylvania shows a violation of the 2012 annual PM$_{2.5}$ NAAQS, therefore this county is included in the nonattainment area. As shown in Figure 1b, EPA evaluated each county in the Allentown-Bethlehem-Easton MSA, which includes Northampton County, Pennsylvania as well as Carbon County and Lehigh County in Pennsylvania; Warren County, New Jersey, and a ring of counties adjacent to the Allentown-Bethlehem-Easton, Pennsylvania-New Jersey MSA. EPA's evaluation was based on the five factors and other relevant information. In addition to Northampton County, EPA has determined that Lehigh

County also contributes to the nearby violation at the Northampton County violating monitor. The following sections describe this five factor analysis process. While the factors are presented individually, they are not independent. The five factor analysis process carefully considers their interconnections and the dependence of each factor on one or more of the others.

Figure 1b. Area of Analysis for the Allentown Final Nonattainment Area

Factor 1: Air Quality Data

All data collected during the year are important when determining contributions to an annual standard such as the 2012 annual $PM_{2.5}$ NAAQS. Compliance with an annual NAAQS is dependent upon monitor readings throughout the year, including days with monitored ambient concentrations below the level of the NAAQS. For the 2012 annual $PM_{2.5}$ NAAQS, the annual mean is calculated as the mean of quarterly means. A high quarter can drive the mean for an entire year, which, in turn, can drive an elevated 3-year DV. Although all data are important, seasonal or episodic emissions can provide insight as to relative contributors to measured $PM_{2.5}$ concentrations. For these reasons, for the Factor 1 air quality analysis, EPA assessed and characterized air quality at, and in the proximity of, the violating monitoring site locations first, by evaluating trends and the spatial extent of measured concentrations at monitors in the area of analysis, and then, by identifying the conditions most associated with high average concentration levels of $PM_{2.5}$ mass in the area of analysis.

In most cases, EPA assessed air quality data on a seasonal, or quarterly, basis.[83] EPA also identified the spatial extent of these high $PM_{2.5}$ concentrations. The mass and composition at the DV location represents contributions from various emission sources including local, area-wide (which may comprise nearby urban and rural areas) and regional sources. To determine the source mix (by mass) at the DV monitoring site, EPA examined the chemical composition of the monitored $PM_{2.5}$ concentrations by pairing each violating FRM/FEM/ARM monitoring site with a collocated or nearby Chemical Speciation Network (CSN) monitoring site or sites. Then, EPA contrasted the approximated mass composition at the DV monitoring site with data collected at IMPROVE[84] and other monitoring locations whose data are representative of regional background.[85,86] This comparison of local/area-wide chemical composition data to regional chemical composition data derives an "urban increment," which helps differentiate the influence of more distant emissions sources from the influence of closer emissions sources, thus representing the portion of the measured violation that is associated with nearby emission contributions.[87,88,89]

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[83] Although compliance with the annual NAAQS depends on contributions from all days of the year, examining data on a quarterly or seasonal basis can inform the relationship between the temporal variability of emissions and meteorology and the resulting $PM_{2.5}$ mass and composition. In some areas of the country where there may be noticeable month-to-month variations in average $PM_{2.5}$, the quarterly averages may not adequately represent seasonal variability. In these areas, air quality data may be aggregated and presented by those months that best correspond to the local "seasons" in these areas.

[84] IMPROVE stands for Interagency Monitoring for Protected Visual Environments and is an aerosol monitoring network in mostly rural and remote areas.

[85] The "urban increment" analysis assesses and characterizes the increase in seasonal and annual average $PM_{2.5}$ mass and chemical components observed at violating monitoring site(s) relative to monitoring sites outside the area of analysis (which represent background concentrations). Developing the urban increment involves pairing a violating FRM/FEM/ARM monitor with a collocated monitor or nearby monitor with speciation data. EPA made every effort to pair these data to represent the same temporal and spatial scales. However, in some cases, the paired violating and CSN "urban" monitoring locations were separated by some distance such that the included urban CSN site(s) reflect(s) a different mixture of emissions sources, which could lead to misinterpretations. To generally account for differences in $PM_{2.5}$ mass between the violating site and the nearby CSN site(s), EPA determined material balance of the $PM_{2.5}$ composition at the violating site by assigning the extra measured $PM_{2.5}$ mass to the carbon components of $PM_{2.5}$. Where the general urban increment approach may be misleading, or in situations where non-carbonaceous emissions are believed to be responsible for a local $PM_{2.5}$ concentration gradient, EPA used alternative analyses to reflect the mix of urban and rural sources contributing to the measured concentrations at violating monitoring sites.

[86] The urban monitors were paired with any rural sites within a 150 mile radius of an urban site to calculate spatial means of the quarterly averages of each species. If there were no rural sites within 150 miles, then the nearest rural site was used alone. That rural mean was then subtracted from the quarterly mean of the urban site to get the increment. Negative values were simply replaced with zeros.

[87] In most, but not all, cases, the violating design value monitoring site is located in an urban area. Where the violating monitor is not located in an urban area, the "urban increment" represents the difference between local and other nearby emission sources in the vicinity of the violating monitoring location and more regional sources.

[88] Hand, et. al. Spatial and Seasonal Patterns and Temporal Variability of Haze and its Constituents in the United States: Report V, June 2011. Chapter 7 – Urban Excess in $PM_{2.5}$ Speciated Aerosol Concentrations, *http://vista.cira.colostate.edu/improve/Publications/Reports/2011/PDF/Chapter7.pdf*

[89] US EPA, Office of Air Quality Planning and Standards, December 2004. (2004) Area Designations for 1997 Fine Particle ($PM_{2.5}$) Standards, Technical Support Document for State and Tribal Air Quality Fine Particle ($PM_{2.5}$)

PM$_{2.5}$ Design Values and Total Mass Measurements - EPA examined ambient PM$_{2.5}$ air quality monitoring data represented by the DVs at the violating monitoring site and at other monitors in the area of analysis. EPA calculated DVs based on air quality data for the most recent 3 consecutive calendar years of quality-assured, certified air quality data from suitable FEM/FRM/ARM monitoring sites in EPA's Air Quality System (AQS). For this designations analysis, EPA used data for the 2011-2013 period (i.e., the 2013 DV), which are the most recent years with fully-certified air quality data. A monitor's DV is the metric or statistic that indicates whether that monitor attains a specified air quality standard. The 2012 annual PM$_{2.5}$ NAAQS is met at a monitoring site when the 3-year average annual mean concentration is 12.0 micrograms per cubic meter (μg/m^3) or less (e.g., 12.1 μg/m^3 or greater is a violation). A DV is only valid if minimum data completeness criteria are met or when other regulatory data processing provisions are satisfied (See 40 CFR part 50 Appendix N). Table 2 identifies the current DVs (i.e., the 2013 DV) and the most recent two DVs based on all monitoring sites in the area of analysis for the Allentown final nonattainment area.[90]

Table 2. Air Quality Data collected at Regulatory Monitors (all DV levels in μg/m^3)[a,b]

County, State	Monitor Site ID	State Rec NA?	09-11 DV	10-12 DV	11-13 DV
Berks, PA	420110011	No	10.7	10.9	11
Bucks, PA	420170012	No	10.9	10.9	10.8
Lehigh, PA	N/A	No	No monitor		
Luzerne, PA	N/A	No	No monitor		
Monroe, PA	N/A	No	8	8	7.9
Montgomery, PA	420910013	No	10.1	9.8	9.8
Northampton, PA	420950025	Yes	**13.4**	**13.2**	**12.2**
Northampton, PA	420950027	Yes		10.6	10.6
Schuylkill, PA	N/A	No	No monitor		
Hunterdon, NJ	N/A	No	No monitor		
Morris, NJ	340270004	No	**8.5**	**8.4**	**8.4**
Morris, NJ	340273001	No	7.6	7.6	7.5
Sussex, NJ	N/A	No	No monitor		
Warren, NJ	340410006	No	9.2	9.4	9.1

[a]If a county has more than one monitoring location, the county DV is indicated in bold type.
[b]If a monitor is violating, the NAAQS, the violating DV is indicated in red type.

Designations, Chapter 3, Urban Excess Methodology. Available at
www.epa.gov/pmdesignations/1997standards/documents/final/TSD/Ch3.pdf

[90] In certain circumstances, one or more monitoring locations within a monitoring network may not meet the network technical requirements set forth in 40 CFR 58.11(e), which states, "State and local governments must assess data from Class III PM$_{2.5}$ FEM and ARM monitors operated within their network using the performance criteria described in table C-4 to subpart C of part 53 of this chapter, for cases where the data are identified as not of sufficient comparability to a collocated FRM, and te monitoring agency requests that the FEM or ARM data should not be used in comparison to the NAAQS. These assessments are required in the monitoring agency's annual monitoring network plan described in §58.10(b) for cases where the FEM or ARM is identified as not of sufficient comparability to a collocated FRM…."

The Figure 1a map, shown previously, identifies the Northampton County, Pennsylvania final nonattainment area, the Allentown-Bethlehem-Easton, Pennsylvania-New Jersey MSA boundary and monitoring locations with 2011-2013 violating DVs. As indicated on the map, there is one violating monitoring located in Northampton County, Pennsylvania (Northampton County violating monitor). Northwest of the violating monitor there is a non-violating monitor also located in Northampton County (Northampton County non-violating monitor).

Seasonal variation can highlight those conditions most associated with high average concentration levels of $PM_{2.5}$. Figure 2 shows quarterly mean $PM_{2.5}$ concentrations for the most recent 3-year period for the highest DV monitoring sites in each county within the area of analysis. This graphical representation is particularly relevant when assessing air quality data for an annual standard, such as the 2012 annual $PM_{2.5}$ NAAQS, because, as previously stated, the annual mean is calculated as the mean of quarterly means and a high quarter can drive the mean for an entire year, which, in turn, can drive an elevated 3-year DV.

Figure 2. Allentown Area $PM_{2.5}$ Quarterly Means for 2011-2013
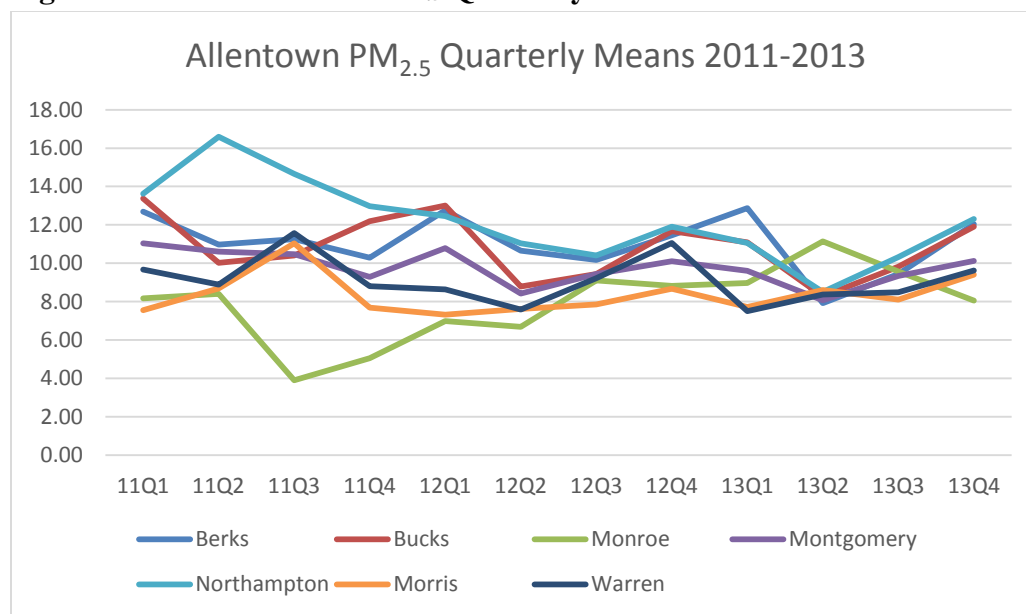
As shown, in Figure 2, most monitors in the area of analysis show higher quarterly mean values in quarter 1 and quarter 3. Higher quarterly mean values in quarter 3 correspond to higher emissions from electric generating units (EGUs) from higher air conditioning use. Higher quarterly mean values in quarter 1 may be due to higher EGU emissions from increased heating use, and may include emissions from home heating oil and residential wood burning stoves. In addition, there is a greater tendency for NO_x to form in the atmosphere and for FRM monitors to retain particle nitrate during the cooler months. However, the Northampton County violating monitor does not have a clear seasonal pattern similar to other monitors in the area of analysis, indicating local influences at the monitor.

PM$_{2.5}$ Composition Measurements - To assess potential emissions contributions for each violating monitoring location, EPA determined the various chemical species comprising total $PM_{2.5}$ to identify

the chemical components over the analysis area, which can provide insight into the types of emission sources impacting the monitored concentration. To best describe the PM$_{2.5}$ at the violating monitoring location, EPA first adjusted the chemical speciation measurement data from a monitoring location at or near the violating FRM monitoring site using the SANDWICH approach to account for the amount of PM$_{2.5}$ mass components retained in the FRM measurement.[91,92,93,94] In particular, this approach accounts for losses in fine particle nitrate and increases in sulfate mass associated with particle bound water. Figure 3a illustrates the fraction of each PM$_{2.5}$ chemical component at the violating monitoring site (420950025) located in Northampton County, PA based on annual averages for the years 2010-2012.

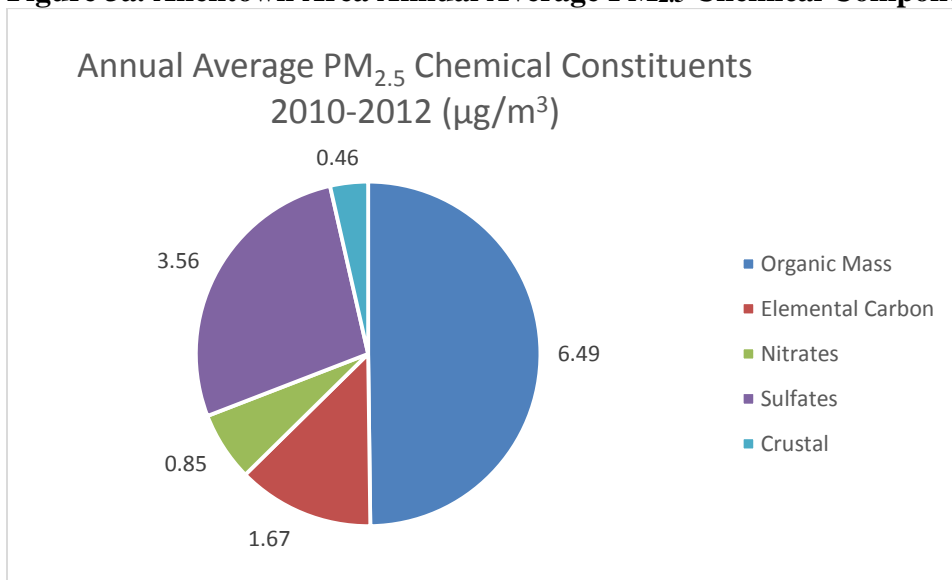**Figure 3a. Allentown Area Annual Average PM$_{2.5}$ Chemical Components (2010-2012)**

Figure 3b shows annual and quarterly chemical composition profiles and illustrates any seasonal or episodic contributors to PM$_{2.5}$ mass. This "increment analysis," combined with the other factor analyses, can provide additional insight as to which sources or factors may contribute at a greater

[91] SANDWICH stands for measured **S**ulfate, **A**djusted **N**itrate, **D**erived **W**ater, **I**nferred **C**arbonaceous mass **H**ybrid Material Balance Approach." The SANDWICH adjustment uses an FRM mass construction methodology that results in reduced nitrates (relative to the amount measured by routine speciation networks), higher mass associated with sulfates (reflecting water included in gravimetric FRM measurements) and a measure of organic carbonaceous mass derived from the difference between measured PM$_{2.5}$ and its non-carbon components. This characterization of PM$_{2.5}$ mass also reflects crustal material and other minor components. The resulting characterization provides a complete mass closure for the measured FRM PM$_{2.5}$ mass, which can be different than the data provided directly by the speciation measurements from the CSN network.

[92] Frank, N. H., SANDWICH Material Balance Approach for PM$_{2.5}$ Data Analysis, National Air Monitoring Conference, Las Vegas, Nevada, November 6-9, 2006. *http://www.epa.gov/ttn/amtic/files/2006conference/frank.pdf*.

[93] Frank, N. H., The Chemical Composition of PM$_{2.5}$ to support PM Implementation, EPA State /Local/Tribal Training Workshop: PM$_{2.5}$ Final Rule Implementation and 2006 PM$_{2.5}$ Designation Process, Chicago IL, June 20-21, 2007, *http://www.epa.gov/ttn/naaqs/pm/presents/pm2.5_chemical_composition.pdf*.

[94] Frank, N. H. *Retained Nitrate, Hydrated Sulfates, and Carbonaceous Mass in Federal Reference Method Fine Particulate Matter for Six Eastern U.S. Cities*. J. Air & Waste Manage. Assoc. 2006 56:500–511.

level. Simply stated, this analysis can help identify nearby sources of emissions that contribute to the violation at the violating monitoring site.

Figure 3b. Allentown Area Annual and Quarterly Average PM$_{2.5}$ Species (2010-2012)[a]
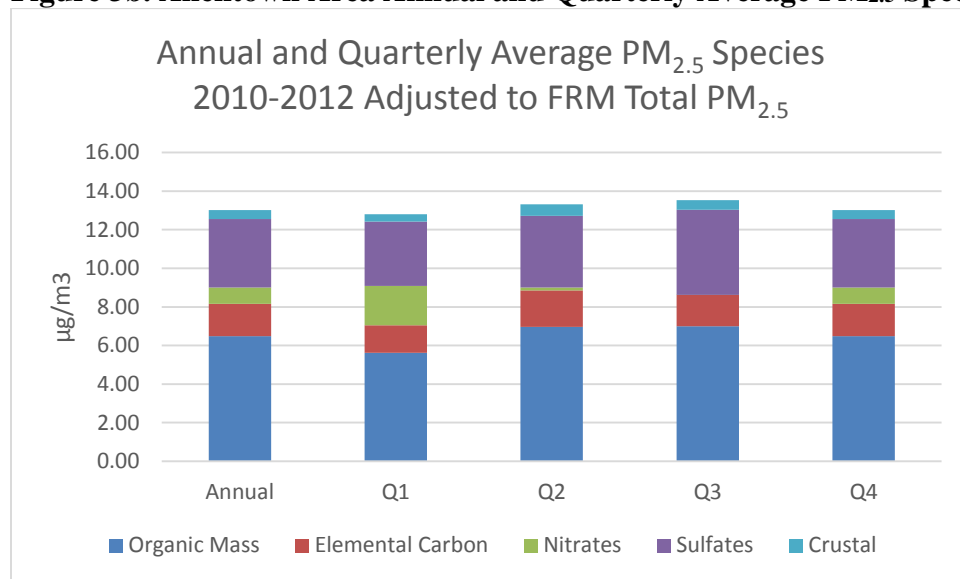

[a]*Adjusted to FRM Total PM$_{2.5}$* indicates that the speciation profile and total mass depicted in this figure are the result of the urban increment calculation for the particular FRM monitor.

The speciation data in Figures 3a and 3b for the Northampton County violating monitoring site indicate that organic mass and sulfates are the predominant species overall. Figure 3b also illustrates that during the first quarter the percentage of nitrates is higher than the other quarters, which may be due to increased EGU emissions from winter heating needs and greater particle nitrate collection during the cooler months. In all four quarters, elemental carbon and crustal are smaller PM$_{2.5}$ components.

In Pennsylvania's December 2013 recommendation letter, Pennsylvania also included speciation data for the 2010-2012 monitoring period (note that Pennsylvania's speciation presentation is based on measurement data which was not adjusted by the SANDWICH method. One consequence is that their POC portion of PM$_{2.5}$ is less than EPA's POM portion). Pennsylvania also included speciation data for days when the Northampton monitor's PM$_{2.5}$ concentrations were relatively high but the regional monitoring concentrations were "clean," i.e. 0-12 $\mu g/m^3$. Pennsylvania considered regional monitoring concentrations to be those from the following monitoring sites: Swiftwater (Monroe County), Lehigh Valley (Northampton County) and Reading Airport (Berks County). Specifically, Pennsylvania identified 344 days in the 2010 to 2012 monitoring period where PM$_{2.5}$ at the Northampton County violating monitor was at least one standard deviation above the Allentown-Bethlehem-Easton MSA regional average (high days). The top 25% of these high days (highest PM$_{2.5}$ days) were further analyzed to determine why the Northampton County violating monitor's concentrations were high. During the highest PM$_{2.5}$ days, Pennsylvania analyzed the days when the Northampton County monitor collected speciation data. Of the 86 days which were in the top 25% (highest PM$_{2.5}$ days), speciated data was collected on nine days. Figure 3c displays the distribution of

the speciated components of PM$_{2.5}$ during the entire 2010-2012 monitoring period and, similar to EPA's speciation analysis, shows that organic carbon and sulfate are large components of PM$_{2.5}$. Figure 3d displays the distribution of the speciated components of PM$_{2.5}$ during the nine days in the top 25% of high days. On these highest PM$_{2.5}$ days, organic carbon, sulfate and crustal material are large components of the PM$_{2.5}$. [95]
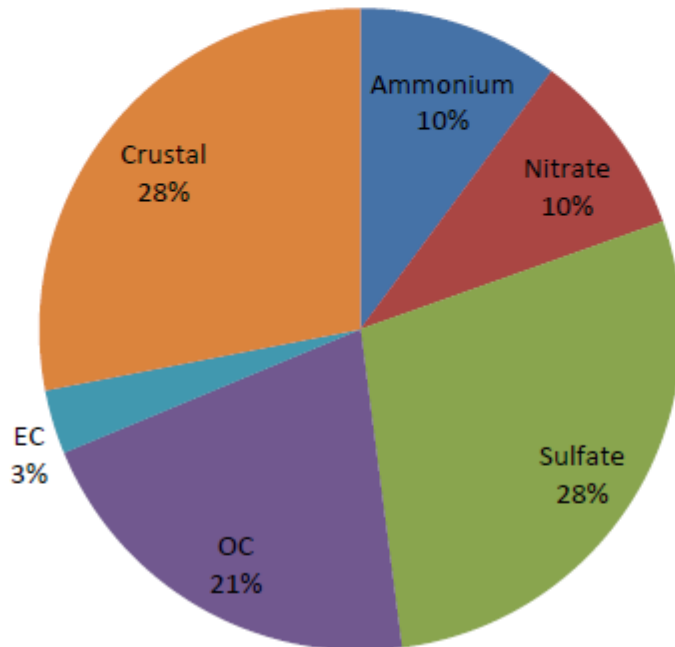
Figure 3c. Northampton County Monitor PM$_{2.5}$ Speciation Data 2010-2012
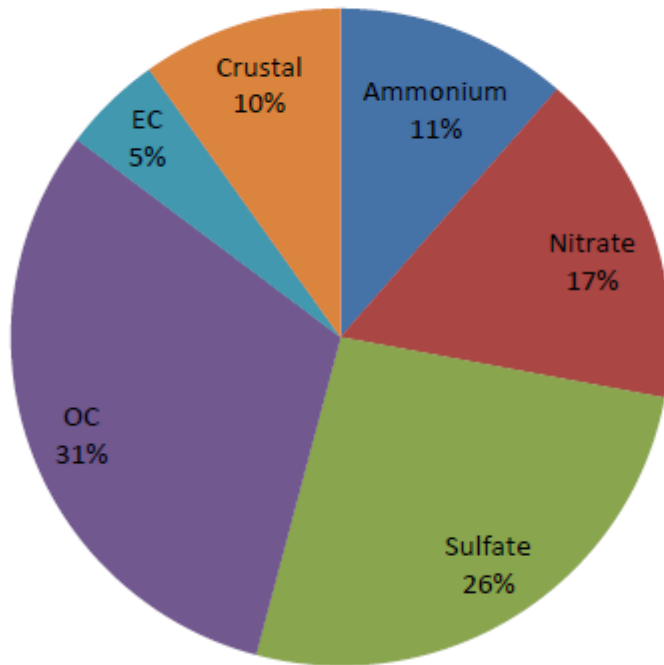
Source: Pennsylvania's December 10, 2013 recommendation letter, Appendix C-2 - Northampton County Area

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[95] EPA notes that POM is much larger than measured OC and therefore represents a larger percentage of measured PM$_{2.5}$. Similarly, other PM$_{2.5}$ components like crustal material will represent a smaller portion of PM$_{2.5}$ when POM and other adjustments to measured components are made to represent the components of PM$_{2.5}$ using the SANDWICH approach.

Figure 3d. Northampton County Monitor PM$_{2.5}$ Speciation Data 2010-2012 for Top 25% of Regionally "Clean" Days

Source: Pennsylvania's December 10, 2013 recommendation letter, Appendix C-2 - Northampton County Area

EPA assessed seasonal and annual average PM$_{2.5}$ components at monitoring sites within the area relative to monitoring sites outside of the analysis area to account for the difference between regional background concentrations of PM$_{2.5}$, and the concentrations of PM$_{2.5}$ in the area of analysis, also known as the "urban increment." This analysis differentiates between the influences of emissions from sources in nearby areas and in more distant areas on the violating monitor. Estimating the urban increment in the area helps to illuminate the amount and type of particles at the violating monitor that are most likely to be the result of sources of emissions in nearby areas, as opposed to impacts of more distant or regional sources of emissions. Figure 4a includes pie charts showing the annual and quarterly chemical mass components of the urban increment. Note that in these charts, sulfates and nitrates have been adjusted to represent their mass in measured PM$_{2.5}$.

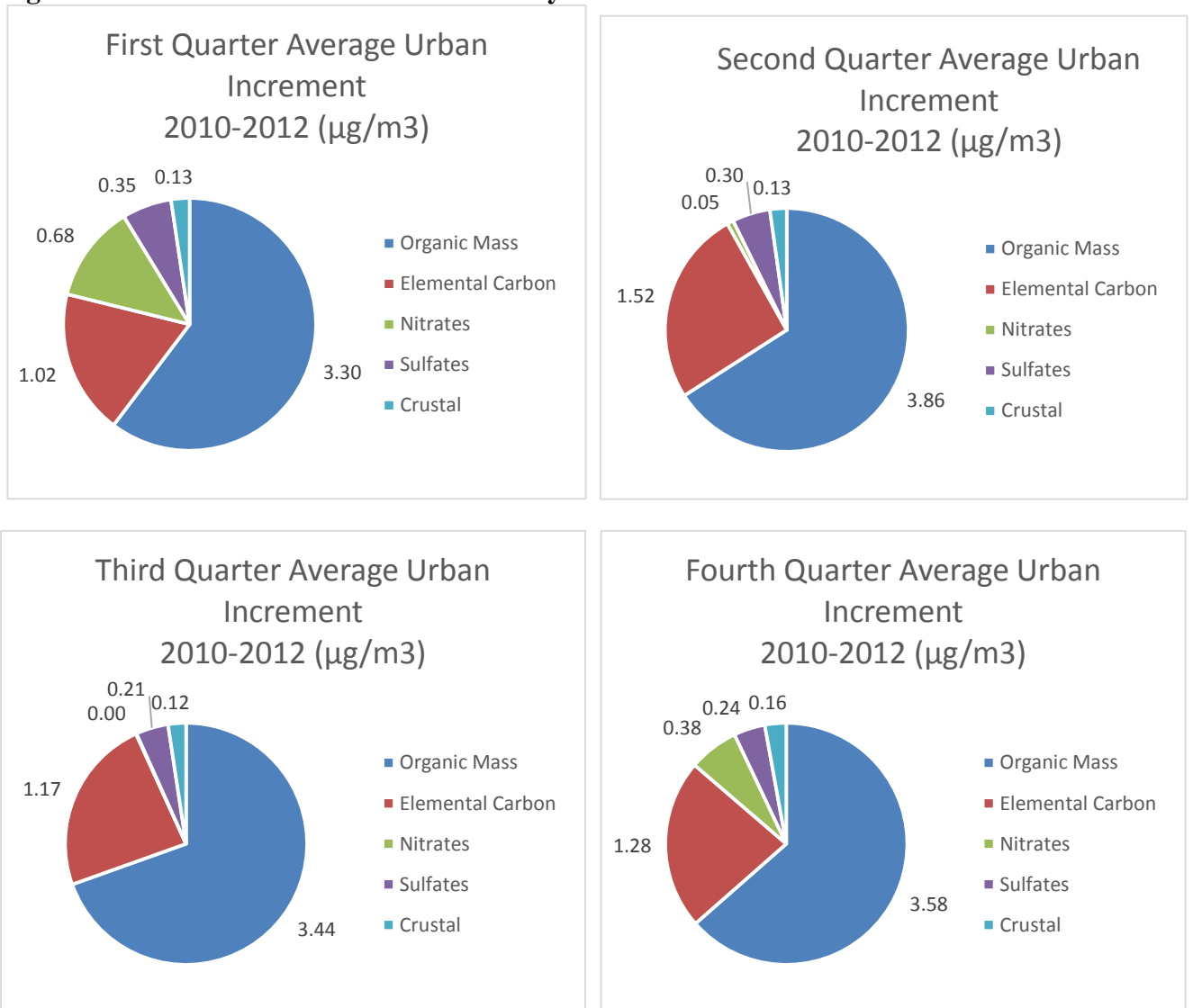**Figure 4a. Allentown Urban Increment Analysis for 2010-2012.**

First Quarter Average Urban Increment 2010-2012 (µg/m3)

- Organic Mass: 3.30
- Elemental Carbon: 1.02
- Nitrates: 0.68
- Sulfates: 0.35
- Crustal: 0.13

Second Quarter Average Urban Increment 2010-2012 (µg/m3)

- Organic Mass: 3.86
- Elemental Carbon: 1.52
- Nitrates: 0.05
- Sulfates: 0.30
- Crustal: 0.13

Third Quarter Average Urban Increment 2010-2012 (µg/m3)

- Organic Mass: 3.44
- Elemental Carbon: 1.17
- Nitrates: 0.00
- Sulfates: 0.21
- Crustal: 0.12

Fourth Quarter Average Urban Increment 2010-2012 (µg/m3)

- Organic Mass: 3.58
- Elemental Carbon: 1.28
- Nitrates: 0.38
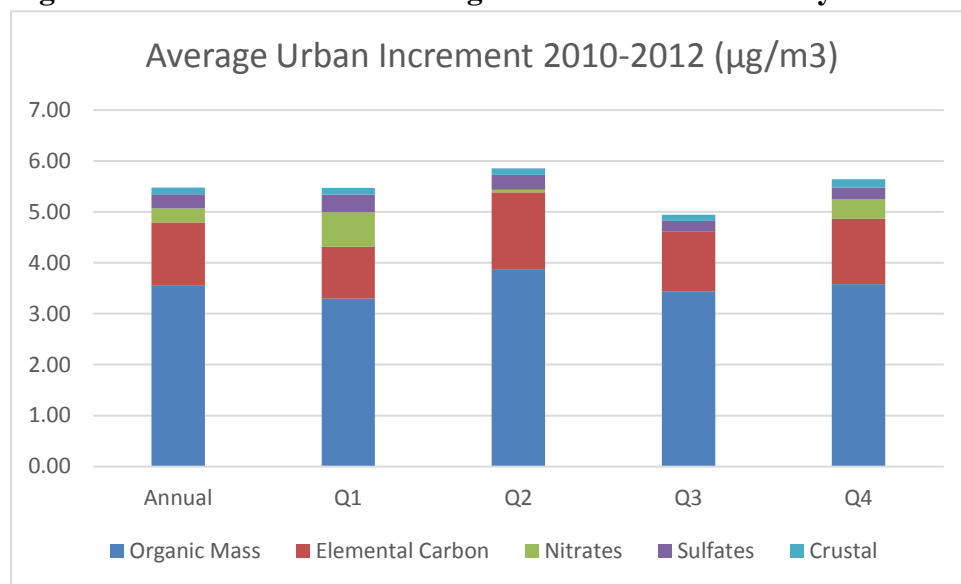- Sulfates: 0.24
- Crustal: 0.16

Figure 4b. Allentown Area Average Urban Increment Analysis for 2010-2012.


The urban increment data provides further insight to the chemical composition of PM$_{2.5}$ at the Northampton County monitoring site. As previously stated, Figures 3a-d show that organic mass and sulfates are the predominant species overall. When accounting for the urban increment illustrated in Figure 4a and Figure 4b, the sulfate component becomes less dominant, however, there is still some remaining sulfate detected at the monitor. Figure 4a and Figure 4b clearly indicate that organic mass and elemental carbon are the main components of the average urban increment of PM$_{2.5}$ at the Northampton County monitoring site. These components suggests that the sources of PM$_{2.5}$ are local in nature and could result from mobile, area or local industrial sources in the Allentown-Easton-Bethlehem urban area.

In Pennsylvania's December 2013 recommendation letter, Pennsylvania also included urban increment data (referred to as urban excess by Pennsylvania) for the 2010-2012 monitoring period. Pennsylvania compared the violating monitor (referred to as Freemansburg) to the Arendtsville monitor (AIRS # 42-001-0001, Adams County) which is located in a rural area for the 1st and 3rd quarters in the 2010-2012 monitoring period. Figures 4c and 4d show the urban excess at the Freemansburg monitor and, similar to EPA's analysis, indicate that organic carbon, elemental carbon and crustal material are the main components at the violating monitor. (Note that Pennsylvania's urban excess presentation is based on measurement data which was not adjusted by the SANDWICH method.) Below is an excerpt from Pennsylvania's 2013 recommendation letter further explaining the analysis.

> "In the case of Freemansburg and Arendtsville, the sulfates and ammonium portion of the speciated PM$_{2.5}$ were higher in Arendtsville than Freemansburg. This strengthens the argument that the PM$_{2.5}$ problem at Freemansburg is a local issue. The excess organic carbon, elemental carbon and crustal material (and to some extent nitrate) at the Freemansburg monitor links closely with sources of dust and secondary nitrate formation, such as traffic, suggesting that Freemansburg's emissions are local in nature."

Figure 4c. Urban Excess for Freemansburg (Northampton) vs. Arendtsville for 2010-2012 – 1st Quarter
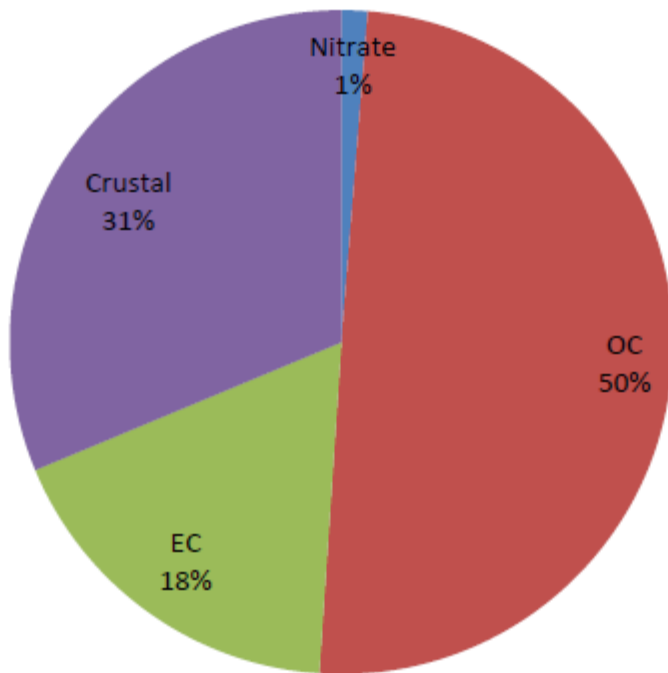
Source: Pennsylvania's December 10, 2013 recommendation letter, Appendix C-2 - Northampton County Area

Figure 4d. Urban Excess for Freemansburg (Northampton) vs. Arendtsville for 2010-2012 – 3rd Quarter
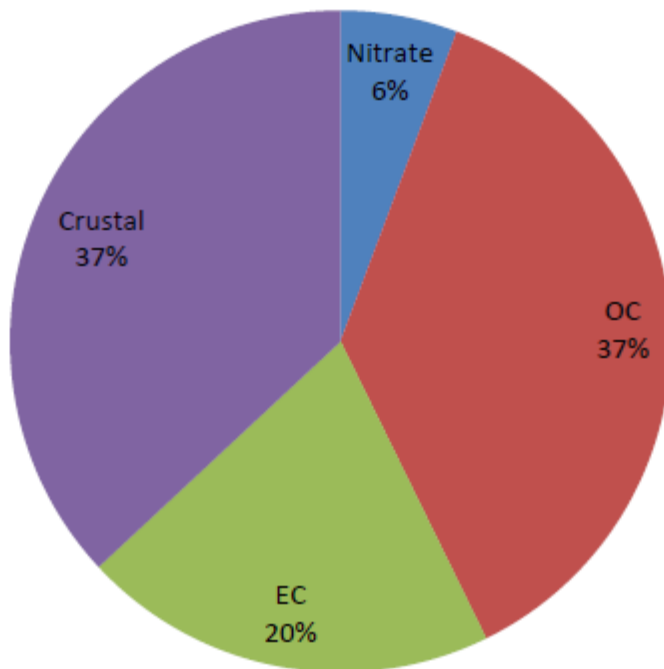
Source: Pennsylvania's December 10, 2013 recommendation letter, Appendix C-2 - Northampton County Area

Through its October 28, 2014 comment letter, PADEP submitted additional data related to trends in annual means and design values for the Freemansburg (Northampton County violating monitor) and Lehigh Valley monitors. PADEP uses this data to draw comparisons between $PM_{2.5}$ concentrations monitored at the Freemansburg and Lehigh Valley monitors and asserts that concentrations monitored at the Freemansburg monitor have been influenced by significant, yet temporary, construction activity at the former Bethlehem Steel site, which is just south of the monitor during 2010 through the present. PADEP provided additional aerial photographs during the construction period at the former Bethlehem Steel site to supplement its argument.

As part of its comments, PADEP submitted several charts, including Figures 4e and 4f shown below. PADEP asserts that Figure 4e illustrates a local problem at the Freemansburg monitor in 2010 and 2011 with values at that monitor at least $3\mu g/m^3$ higher than the nearby Lehigh Valley monitor. From 2001 to 2013, the monitored values between the Freemansburg monitor and Allentown and Lehigh Valley monitors never varied by more than $1.08\ \mu g/m^3$, except during the construction time period of 2010 and 2011. Figure 4e shows that monitored values for the Allentown area are trending downward with the exception of the upward tick in Freemansburg beginning in 2010. Figure 4f shows a similar downward trend in the design values for the Freemansburg monitor with the exception of 2011 and 2012.

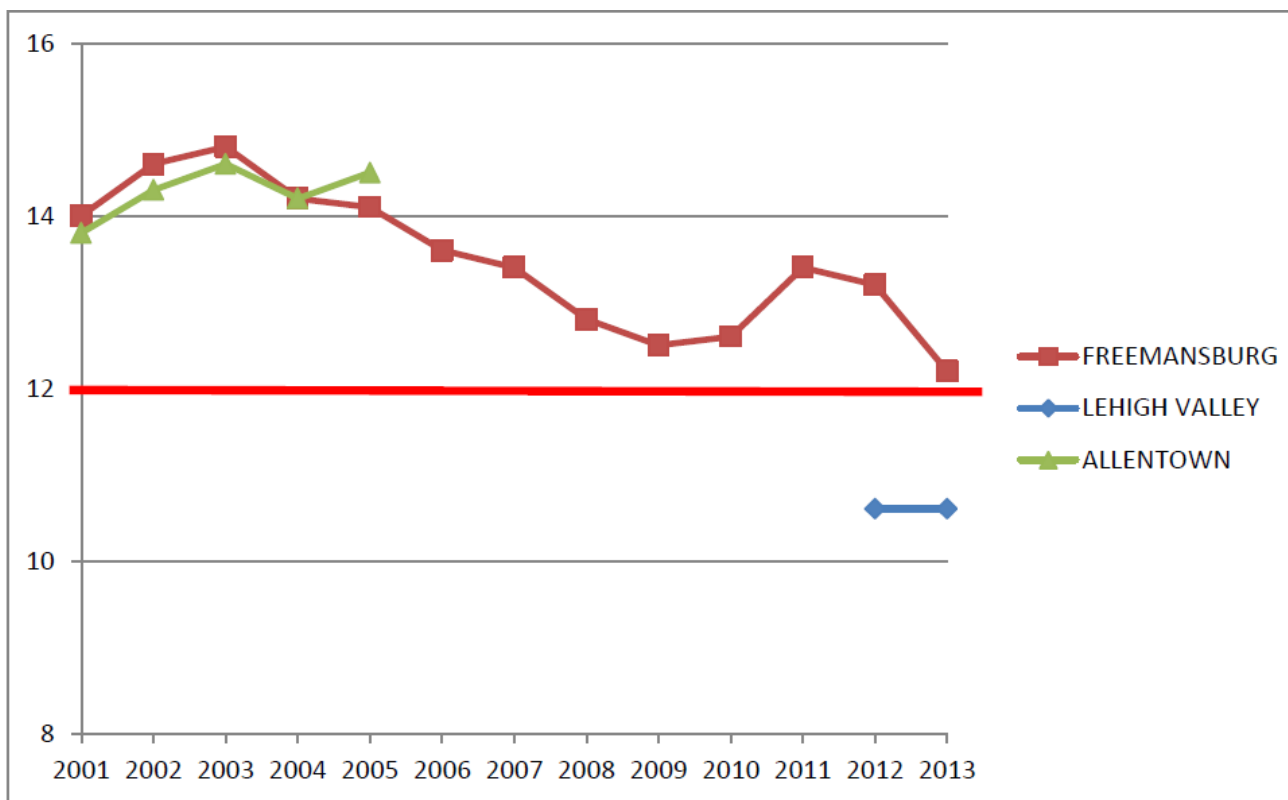**Figure 4e. Allentown Area PM$_{2.5}$ Annual Mean (in µg/m3) by Station – Since 2001**

*The Allentown monitor ceased operation on 12/31/2005.
**The Lehigh Valley monitor commenced operation in 2010.

Source: Pennsylvania's October 28, 2014 letter

Figure 4f. Allentown Area PM2.5 Annual Design Value (in µg/m3) by Station – Since 2001

*The Allentown monitor ceased operation on 12/31/2005.
**The Lehigh Valley monitor began operation in 2010, so the first design value was valid in 2012.

Source: Pennsylvania's October 28, 2014 letter

In its October 28, 2014 comments, the Commonwealth asserts that the large disparity of monitored PM2.5 concentrations of more than 3µg/m^3 between the Lehigh Valley and Freemansburg monitors has been, and continues to be, influenced by emissions from construction-related at the former Bethlehem Steel site to the south of the Freemansburg monitor.

EPA has reviewed the additional data provided by PADEP. Although EPA agrees that the data provided demonstrates that there is clearly a spike in annual means during the period of 2009-2011 at Freemansburg and from 2010-2011 at Lehigh, EPA does not clearly see the link between the nearby construction-related activity to the spike in monitored annual means during those same periods. Given the proximity of the construction site to the Freemansburg monitor, if the monitored emissions were directly caused by the elevated emissions resulting from major and widespread construction activity, the emissions speciation data should reveal a higher proportion of crustal material as a result of the soil disturbance, construction vehicle emissions and other related construction activity.

PADEP asserts that the nearby monitors had annual means that trended similarly to Freemansburg monitor except for the spikes in 2010 and 2011. Since the Allentown monitor ceased operation in 2005, the only data available is significantly outdated and therefore not reliable for purposes of

making such comparison. Since the Lehigh Valley monitor began operation during 2009, this monitor has not operated long enough to draw any trend characterization between the emissions monitored at this monitor and the Freemansburg monitor. Furthermore, since there was no nearby monitor with which to compare data between 2006 and 2009 with the Freemansburg monitor, there is insufficient data necessary to draw trends in direction or magnitude of these annual means given the incomplete data from 2006 to 2009. Based upon the above, there is insufficient information to compare $PM_{2.5}$ monitoring trends between these monitors.

PADEP asserts that the Freemansburg monitor data for 2009-2011 period was anomalous compared to other Allentown area monitors and resulted from emissions from temporary construction at Bethlehem Steel site. The speciation data and urban increment data clearly indicates that organic mass and elemental carbon are the main components of $PM_{2.5}$ at the Northampton County violating monitoring site (Freemansburg). PADEP did not provide new data to directly link the construction activity to the spike in the Freemansburg monitor. EPA stands by its contention that the speciation data and urban increment data at this monitor show high organic mass and elemental carbon which suggests that the sources of $PM_{2.5}$ at the monitor are local in nature and could result from mobile, area or local industrial sources. Given the proximity of the construction site to the Freemansburg monitor, if the monitored emissions were directly caused by the elevated emissions resulting from major and widespread construction activity, the emissions speciation data should reveal a higher proportion of crustal material as a result of the soil disturbance, construction vehicle emissions and other related construction activity.

PADEP further argues that if emissions from Lehigh County were contributing to the Freemansburg monitor violation, then the Lehigh Valley monitor annual means would also have increased significantly. EPA contends that the lack of more than one violating monitor in an area is not dispositive evidence of whether a nearby area or county contributes to the violation of another monitor, as the violation may be the result of cumulative or aggregate impacts from the surrounding area.

In a further attempt to show the uniqueness of the emissions at the Freemansburg monitor, as part of its October 2014 comment letter, PADEP provided design value correlation data comparing the Freemansburg monitor to five other monitors in the area of analysis (Figure 4g). PADEP contends that the Freemansburg monitor and the Lehigh Valley monitor correlate to a stronger degree in 2013 than in 2011 and also contends that the next best correlation is between the emissions monitored at the Freemansburg and Reading monitors.

Figure 4g. Correlations for Five Nearby Monitoring Locations Compared to the Freemansburg Monitor (Based on 2013 Design Values)

Calculation of r (Correlation Coefficient)

	Lehigh Valley	Reading	Swiftwater	Bristol	Norristown
2011-13	0.828930077	0.787194606	0.613021262	0.735520741	0.742178037
2011	0.767578003	0.764991712	0.755702134	0.667923623	0.721879358
2012	0.827356044	0.747365310	0.617786461	0.727071440	0.704021058
2013	0.953881874	0.909063001	0.689684057	0.857663778	0.828215254

Calculation of r2 (Coefficient of Determination)

	Lehigh Valley	Reading	Swiftwater	Bristol	Norristown
2011-13	0.687125073	0.619675348	0.375795068	0.540990760	0.550828239
2011	0.589175990	0.585212320	0.571085715	0.446121966	0.521109808
2012	0.684518024	0.558554907	0.381660112	0.528632878	0.495645650
2013	0.909890630	0.826395540	0.475664099	0.735587156	0.685940507

Source: Pennsylvania's October 28, 2014 letter

PADEP's supposition linking Freemansburg and Lehigh Valley correlations on the basis of local, construction-related emissions is not supported by the similar correlation that exists for the same period between the Reading and Freemansburg monitors.

The provided PADEP data shows the strongest correlation between the Freemansburg and Lehigh Valley monitors, which PADEP attributes to local construction emissions, and the next strongest correlation between Freemansburg and Reading monitors, which PADEP attributes to a topographic relationship between Reading and Freemansburg. If PADEP contends that the change in correlation relationship between Freemansburg and Lehigh Valley monitors for 2011 (0.589) versus that of 2013 (0.910) is the result of short-term construction emissions, then we would not expect to see a similar correlation relationship between Freemansburg and the Reading monitors, given the 37 mile distance separating these monitors and the nature of construction-related crustal $PM_{2.5}$ components that would be expected to disperse or settle over such long distances. Although, PADEP asserts that there is a link to local emissions at Freemansburg versus Lehigh Valley based upon a stronger correlation in 2013 data versus that in 2011, the provided information does not clearly link the spike in monitor means values to construction. The correlation relationship between these pairs of monitors during and after construction at the Bethlehem Steel site instead supports the notion of a regional emissions influence as opposed to PADEP's contention that the correlation between Lehigh Valley and Freemansburg is a result of local emissions.

Factor 2: Emissions and emissions-related data

In this designations process, for each area with a violating monitoring site, EPA evaluated the emissions data from nearby areas using emissions related data for the relevant counties to assess each county's potential contribution to $PM_{2.5}$ concentrations at the violating monitoring site or monitoring sites in the area under evaluation. Similar to the air quality analysis, these data were examined on a seasonal basis. However, as discussed in Factor 1, there are no discernable seasonal trends at the Northampton County violating monitor. Therefore, seasonal emissions will not be further discussed in this analysis. EPA examined emissions of identified sources or source categories of direct $PM_{2.5}$, the major components of direct $PM_{2.5}$ (organic mass, elemental carbon, crustal material (and/or individual trace metal compounds)), primary nitrate and primary sulfate, and precursor gaseous pollutants (i.e., SO_2, NO_X, total VOC, and NH_3). EPA also considered the distance of those sources of emissions from the violating monitoring site. While direct $PM_{2.5}$ emissions and its major carbonaceous components are generally associated with sources near violating $PM_{2.5}$ monitoring sites, the gaseous precursors tend to have a more regional influence (although EPA is mindful of the potential local NO_X and VOC emissions contributions to $PM_{2.5}$ from mobile and stationary sources) and transport from neighboring areas can contribute to higher $PM_{2.5}$ levels at the violating monitoring sites.

<u>Emissions Data</u>

For this factor, EPA reviewed data from the 2011 National Emissions Inventory (NEI) version 1 (see *http://www.epa.gov/ttn/chief/net/2011inventory.html*). For each county in the area of analysis, EPA examined the magnitude of county-level emissions reported in the NEI. These county-level emissions represent the sum of emissions from the following general source categories: point sources, non-point (i.e., area) sources, nonroad mobile, on-road mobile, and fires. EPA also looked at the geographic distribution of major point sources of the relevant pollutants.[96] Significant emissions levels from sources in a nearby area indicate the potential for the area to contribute to monitored violations.

To further analyze area emissions data, EPA also developed a summary of direct $PM_{2.5}$, components of direct $PM_{2.5}$, and precursor pollutants, which is available at *http://www.epa.gov/pmdesignations/2012standards/docs/nei2011v1pointnei2008v3county.xlsx*.

When considered with the urban increment analysis discussed in Factor 1, evaluating the components of direct $PM_{2.5}$ and precursor gases can help identify specific sources or source types contributing to elevated concentrations at violating monitoring sites and thus assist in identifying appropriate area boundaries. In general, directly emitted POC and VOCs[97] contribute to POM; directly emitted EC contributes to $PM_{2.5}$ EC; NO_X, NH_3 and directly emitted nitrate contribute to PNO3; SO_2, NH_3 and

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[96] For purposes of this designations effort, "major" point sources are those whose sum of PM precursor emissions ($PM_{2.5}$ + NOx + SO_2 + VOC + NH_3) are greater than 500 tons per year based on NEI 2011v1.

[97] As previously mentioned, nearby VOCs are presumed to be a less important contributor to POM than POC.

directly emitted sulfate contribute to PSO4; and directly emitted crustal material and metal oxides contribute to Pcrustal. [98],[99] EPA believes that the quantities of those nearby emissions as potential contributors to the $PM_{2.5}$ violating monitors are somewhat proportional to the $PM_{2.5}$ chemical components in the estimated urban increment. Thus, directly emitted POC is more important per ton than SO_2, partially because POC emissions are already $PM_{2.5}$ whereas SO_2 must convert to $PM_{2.5}$ and not all of the emitted SO_2 undergoes this conversion.

Table 3a provides a county-level emissions summary (i.e., the sum of emissions from the following general source categories: point sources, non-point (i.e., area) sources, nonroad mobile, on-road mobile, and fires) of directly emitted $PM_{2.5}$ and precursor species for the county with the violating monitoring site and nearby counties considered for inclusion in the Allentown Area. Table 3b summarizes the directly emitted components of $PM_{2.5}$ for the same counties in the area of analysis for the Allentown Area. This information will be paired with the urban increment composition previously shown in Figures 4a and 4b.

Table 3a. County-Level Emissions of Directly Emitted PM₂.₅ and Precursors (tpy)

County, State	Total NH₃	Total NOx	Total Direct PM₂.₅	Total SO₂	Total VOC	Total
Northampton, PA	613	14,035	3,031	20,033	7,469	45,180
Montgomery, PA	779	17,147	3,338	2,518	18,975	42,757
Berks, PA	4,097	14,317	3,606	6,136	12,734	40,891
Bucks, PA	1,024	13,173	2,474	2,035	15,325	34,030
Lehigh, PA	620	8,861	2,081	1,321	9,649	22,532
Luzerne, PA	391	9,001	1,804	1,113	9,350	21,659
Morris, NJ	313	8,468	1,164	649	10,466	21,060
Schuylkill, PA	1,655	6,016	1,409	5,481	5,935	20,496
Monroe, PA	212	5,253	1,164	428	6,003	13,060
Hunterdon, NJ	450	3,396	423	328	3,020	7,617
Warren, NJ	711	2,585	508	328	2,918	7,049
Carbon, PA	97	2,819	553	1,042	2,490	7,000
Sussex, NJ	333	2,097	385	499	3,448	6,761

Table 3a indicates that Northampton County has the highest total emissions of directly emitted $PM_{2.5}$ and precursors. The SO_2 emissions in Northampton County are significantly higher than in any other county in the area of analysis. In Table 5 and Figures 5a and 5b, the GenOn Rema Portland Generating Station is the largest source of SO_2 (15,148 tpy) in the area of analysis. This facility is located in Northampton County and to the northeast of the Northampton County violating monitor. Northampton County has high levels of NO_x and VOC emissions as well. As mentioned above,

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[98] *See*, Seinfeld J. H. and Pandis S. N. (2006) *Atmospheric Chemistry and Physics: From Air Pollution to Climate Change*, 2nd edition, J. Wiley, New York. See also, Seinfeld J. H. and Pandis S. N. (1998) *Atmospheric Chemistry and Physics: From Air Pollution to Climate Change*, 1st edition, J. Wiley, New York.
[99] USEPA Report (2004), The Particle Pollution Report: Current Understanding of Air Quality and Emissions through 2003, found at: *http://www.epa.gov/airtrends/aqtrnd04/pm.html*.

directly emitted VOC contributes to POM. Montgomery, Berks and Bucks counties have the next highest emissions. As discussed in Factors 3 and 4 below, topography and wind direction indicate that Montgomery, Berks and Bucks counties are less likely to contribute to the Northampton County violating monitor. Among the five counties bordering Northampton, Bucks and Lehigh counties have the highest emissions of most of the listed pollutants. Lehigh County has high levels of NO_x and VOC. It is also worth noting that the violating monitor is near the border with Lehigh County.

Table 3b. County-Level Emissions for Components of Directly Emitted PM$_{2.5}$ (tpy) [100]

County, State	POM	EC	PSO4	PNO3	Pcrustal	Residual	Total Direct
Berks, PA	1,764	436	132	15	474	785	3,606
Montgomery, PA	1,740	439	99	6	415	639	3,338
Northampton, PA	1,176	354	170	31	581	718	3,031
Bucks, PA	1,253	403	78	8	315	416	2,474
Lehigh, PA	1,208	247	57	5	196	368	2,081
Luzerne, PA	1,161	252	39	4	149	200	1,804
Schuylkill, PA	750	170	44	4	159	284	1,409
Monroe, PA	785	176	20	3	49	131	1,164
Morris, NJ	733	208	19	4	66	134	1,164
Carbon, PA	352	64	14	1	30	92	553
Warren, NJ	326	74	8	1	30	68	508
Hunterdon, NJ	229	97	7	1	33	56	423
Sussex, NJ	235	61	8	1	26	54	385

Table 3b breaks down the direct PM$_{2.5}$ emissions value from Table 3a into its components. These data will also be compared with the previously presented Urban Increment composition. Table 3b shows that organic mass is the largest component of direct PM$_{2.5}$ emissions in the area of analysis and organic mass is a significant component of the urban increment. Northampton and Lehigh counties both have high amounts of organic mass. As previously mentioned, and further discussed in Factors 3 and 4, Montgomery, Berks and Bucks counties are less likely to contribute to the Northampton County violating monitor due to wind direction and topography. Luzerne County is also less likely to contribute to the Northampton County violating monitor as a result of the topography.

Using the previously described relationship between directly emitted and precursor gases and the measured mass to evaluate data presented in Tables 3a and 3b, EPA identified the following components warranting additional review: organic mass, elemental carbon, crustal material and VOC. EPA then looked at the contribution of these components of interest from each of the counties included in the area of analysis as shown in Tables 4a-d.

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[100] Data are based on the 2011 and 2018 Emissions Modeling Platform Data Files and Summaries (*ftp://ftp.epa.gov/EmisInventory/2011v6/v1platform*) available at: *http://www.epa.gov/ttn/chief/emch/index.html#2011* (accessed 02/26/14).

Table 4a. County-Level POM Emissions

County, State	Emissions in average tons/yr		
	POM	Pct.	Cumulative %
Berks, PA	1,764	15%	15%
Montgomery, PA	1,740	15%	30%
Bucks, PA	1,253	11%	51%
Lehigh, PA	1,208	10%	61%
Northampton, PA	1,176	10%	40%
Luzerne, PA	1,161	10%	71%
Monroe, PA	785	7%	84%
Schuylkill, PA	750	6%	77%
Morris, NJ	733	6%	90%
Carbon, PA	352	3%	93%
Warren, NJ	326	3%	96%
Hunterdon, NJ	229	2%	98%
Sussex, NJ	235	2%	100%

Table 4b. County-Level EC Emissions

County, State	Emissions in average tons/yr		
	EC	Pct.	Cumulative %
Montgomery, PA	439	15%	15%
Berks, PA	436	15%	29%
Bucks, PA	403	14%	43%
Northampton, PA	354	12%	55%
Luzerne, PA	252	8%	63%
Lehigh, PA	247	8%	72%
Morris, NJ	208	7%	84%
Monroe, PA	176	6%	77%
Schuylkill, PA	170	6%	90%
Hunterdon, NJ	97	3%	93%
Warren, NJ	74	2%	96%
Carbon, PA	64	2%	98%
Sussex, NJ	61	2%	100%

Table 4c. County-Level Pcrustal Emissions

County	Emissions in average tons/yr		
County	Pcrustal	Pct.	Cumulative %
Northampton, PA	581	23%	23%
Berks, PA	474	19%	42%
Montgomery, PA	415	16%	58%
Bucks, PA	315	12%	71%
Lehigh, PA	196	8%	79%
Schuylkill, PA	159	6%	85%
Luzerne, PA	149	6%	91%
Morris, NJ	66	3%	93%
Monroe, PA	49	2%	95%
Hunterdon, NJ	33	1%	97%
Carbon, PA	30	1%	98%
Warren, NJ	30	1%	99%
Sussex, NJ	26	1%	100%

Table 4d. County-Level VOC Emissions

County	Emissions in average tons/yr		
County	VOC	Pct.	Cumulative %
Montgomery, PA	18,975	18%	18%
Bucks, PA	15,325	14%	32%
Berks, PA	12,734	12%	44%
Morris, NJ	10,466	10%	53%
Lehigh, PA	9,649	9%	62%
Luzerne, PA	9,350	9%	71%
Northampton, PA	7,469	7%	78%
Monroe, PA	6,003	6%	83%
Schuylkill, PA	5,935	6%	89%
Sussex, NJ	3,448	3%	92%
Hunterdon, NJ	3,020	3%	95%
Warren, NJ	2,918	3%	98%
Carbon, PA	2,490	2%	100%

In Figure 4a, the emissions of organic mass appear somewhat evenly distributed between the top six contributing counties (totaling ~71%). Lehigh County and Northampton County are among the top six counties and contribute similar amounts of the total organic mass component of direct $PM_{2.5}$. As discussed in Factors 3 and 4 below, topography and wind direction indicate that Montgomery, Berks and Bucks counties are less likely to contribute to the Northampton County violating monitor. As seen in Figure 4c, Northampton County contributes the largest amount of the crustal matter component of direct $PM_{2.5}$. In Figure 4d, Lehigh County contributes more VOC than Northampton County. As discussed above, VOCs contribute to $PM_{2.5}$ organic mass and organic mass is a main component of the urban increment at the Northampton County violating monitor. As mentioned, Montgomery, Berks

and Bucks, PA are less likely to contribute to the Northampton County monitor due to wind direction and topography. Morris, NJ is also not in the regional wind direction thus less likely to contribute to the Northampton County violating monitor.

In addition to reviewing county-wide emissions of $PM_{2.5}$ and $PM_{2.5}$ precursors in the area of analysis, EPA also reviewed emissions from major point sources located in the area of analysis. The magnitude and location of these sources can help inform nonattainment boundaries. Table 5 provides facility-level emissions of direct $PM_{2.5}$, components of direct $PM_{2.5}$, and precursor pollutants (given in tons per year) from major point sources located in the area of analysis for the Allentown Area. Table 5 also shows the distance from the facility to the Northampton County violating monitor.

Table 5. NEI 2011 v1 Point Source Emissions (tpy)

County, State	Facility Name (Facility ID)	Distance from violating monitor (miles)	NEI 2011 v1 Emissions (tpy)					
			NH_3	NOx	$PM_{2.5}$	SO_2	VOC	Total
Northampton, PA	Keystone Portland Cement/East Allen (420950012)	7	2	828	57	984	7	1,878
Northampton, PA	Essroc/Nazareth Lower Cement Plt 1 (420950045)	7	68	1,804	522	722	62	3,177
Northampton, PA	Northampton Gen Co/Northampton (420950536)	9	2	441	44	546	2	1,034
Northampton, PA	Hercules Cement Co Lp/Stockertown (420950006)	9	3	989	29	1,420	20	2,462
Lehigh, PA	Lafarge Corp/Whitehall Plt (420770019)	10	14	368	36	331	7	754
Northampton, PA	Ppl Martins Creek Llc/Martins Creek (420950010)	17	13	943	37	274	30	1,297
Northampton, PA	Genon Rema Llc/Portland Generating Sta (420950011)	24	0	1,977	67	15,148	14	17,206
Berks, PA	Lehigh Cement Co Llc/Evansville Cement Plt & Quarry (420110039)	31	41	1,225	134	200	12	1,611
Carbon, PA	Panther Creek Partners/Nesquehoning Plt (420250023)	32	1	551	16	571	4	1,143
Berks, PA	Cryovac Inc/Cryovac Rigid Packaging (420110093)	35			0		556	556
Montgomery, PA	Covanta Plymouth Renewable Energy/ Plymouth (420910295)	37	1	735	8	25	2	771
Berks, PA	Genon Rema Llc/Titus Gen Sta (420110045)	37	0	683	43	4,087	5	4,818
Schuylkill, PA	Northeastern Power Co/Mcadoo Cogen (421070054)	38	0	104	16	706	20	846
Bucks, PA	Wheelabrator Falls Inc/Falls Twp (420170469)	44	3	731	9	122	2	867
Schuylkill, PA	Wheelabrator Frackville/Morea Plt (421070022)	45	0	443	19	468	9	938
Schuylkill, PA	Schuylkill Energy Res/St Nicholas Cogen (421070024)	46	1	273	27	1,883	25	2,208
Bucks, PA	Fairless Energy Llc/Falls Twp (420170131)	46	170	201	196	18	25	609
Schuylkill, PA	Gilberton Power Co/John B Rich Mem Power Sta (421070025)	46	0	211	39	1,314	28	1,591
Schuylkill, PA	Wps Westwood Gen Llc/Gen Sta (421070023)	58	0	220	5	268	13	506

Figure 5a shows the major point source emissions (from the 2011 NEI in tons per year) in the area of analysis for the Allentown Area and the relative distances of these sources from the violating

monitoring location, as depicted by a red dot. The actual distance from the point sources to the DV monitoring location is presented in Table 5. The distance from the violating monitoring location is particularly important for directly emitted PM$_{2.5}$. The influence of directly emitted PM$_{2.5}$ on ambient PM$_{2.5}$ diminishes more than that of gaseous precursors as a function of distance.[101] Figure 5b illustrates the location of major point sources listed in Table 5 which are near the Northampton County violating monitor.

Figure 5a. Major Point Source Emissions in the Area of Analysis for the Allentown Area

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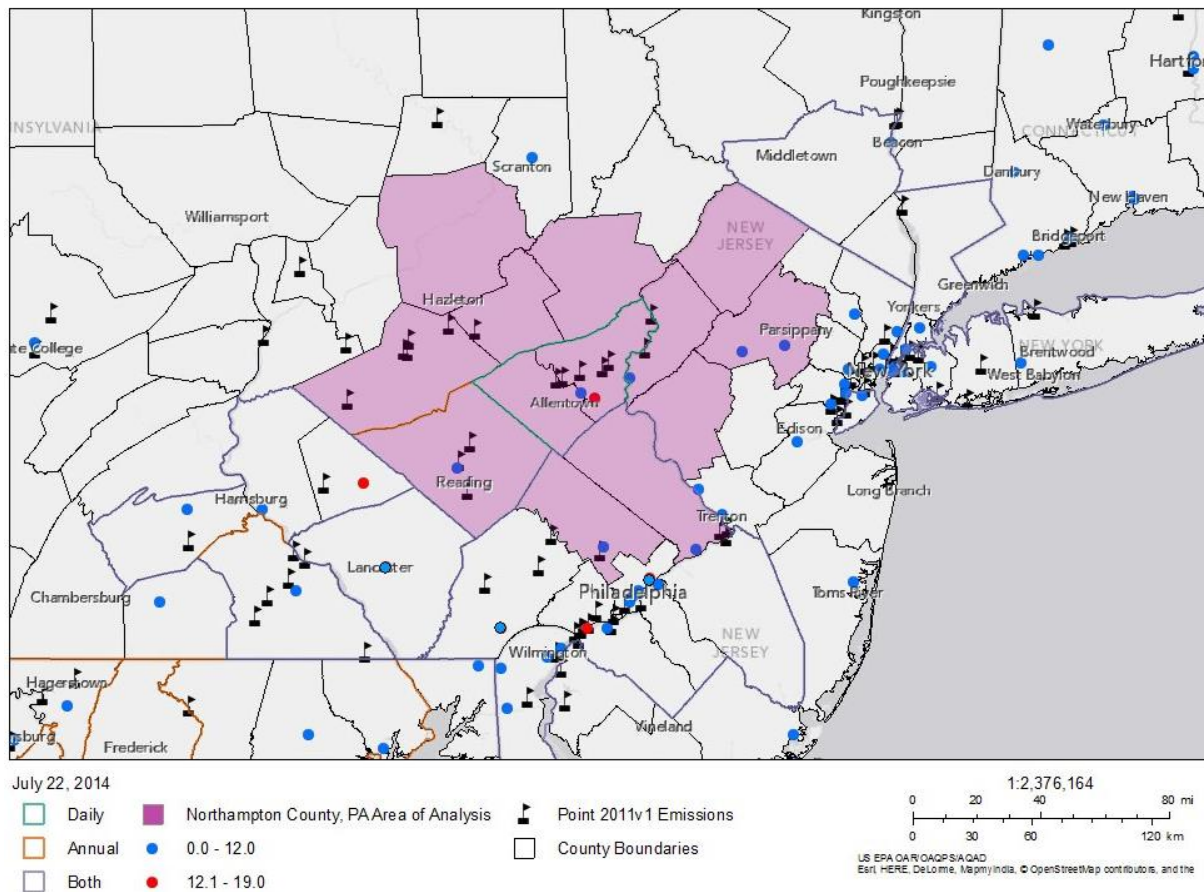
[101] Baker, K. R. and K. M. Foley. *A nonlinear regression model estimating single source concentrations of primary and secondarily formed PM$_{2.5}$.* Atmospheric Environment. 45 (2011) 3758-3767.

Figure 5b. Close up of Major Point Sources Near the Northampton County violating monitor
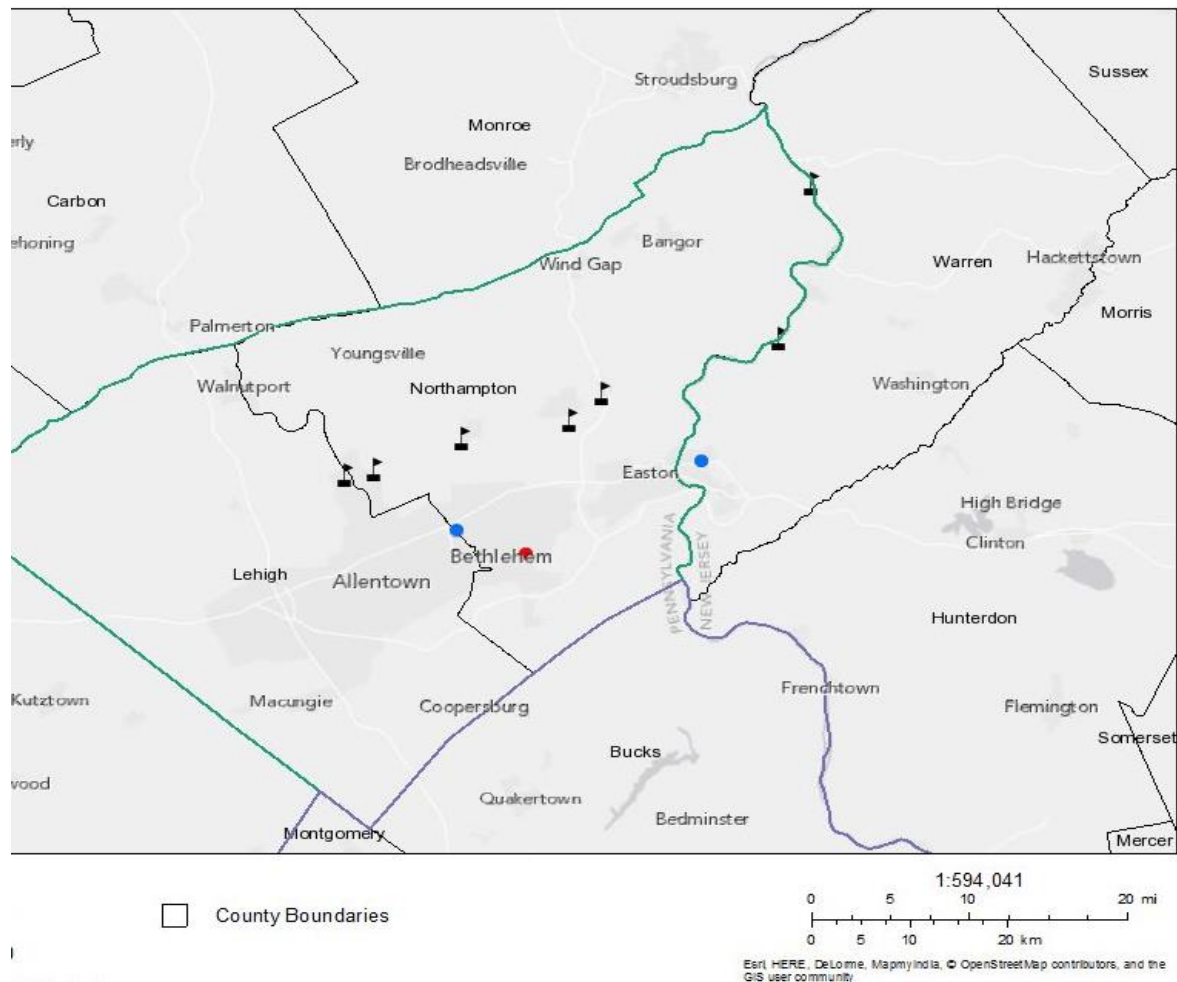
As indicated in Figures 5a and 5b, there are nineteen sources with emissions over 500 tpy within the area of analysis. Seven of these large point sources are located north and northeast of the Northampton County violating monitor. Eight point sources are further west and southwest of the Northampton County violating monitor. Mountains run between the sources which are further west in Schuylkill County and the violating monitor. No major point sources exist south of the monitor in the area of analysis except the Covanta facility in southern Montgomery County. The Covanta facility is relatively low in emissions and, as discussed in Factors 3 and 4, emissions from Montgomery County are not in the regional wind direction and are limited by hills to the south of the monitor.

Pennsylvania provided additional information in its December 2013 designation recommendation regarding local influences of PM$_{2.5}$ Below is an excerpt from Pennsylvania's December 2013 recommendation letter, Appendix C-2 Northampton County Area. Figure 5c below was provided in support of the following excerpt. In this excerpt the Northampton County violating monitor is referred to as the Freemansburg monitor.

> "The additional crustal material illustrates the local nature of the problem at the Freemansburg monitor. Iron, which is a factor of the crustal calculation along with aluminum, calcium, silicon, and titanium, is abnormally high on several of the nine days. The iron, which can be

found in dust associated with construction activities, often reached levels 10 to 20% of the total mass measured from the daily speciated sample. The high iron contribution to the PM$_{2.5}$, coupled with the strong southerly signal outlined in Figure C-2.3 and Figure C-2.4, could be attributed to the recent disturbing of soil at the former Bethlehem Steel Corporation industrial site (which lies just to the south of Freemansburg). The Bethlehem Steel site produced 2,500 to 3,000 tons of iron a day to manufacture steel. The Bethlehem Steel plant at the site closed down in 2003. The western portion of the Bethlehem Steel site, which is south-southwest of the Freemansburg monitor, has transformed into the Sands Casino, with a casino, hotel, and outlet shopping center. Also, the area just east of the Sands Casino, an area downwind of the Freemansburg monitor, appears to have been developed over the last three to four years, according to time lapse photos on Google Maps. Construction, disturbance of ground, and truck traffic on unpaved roads in this area are likely to cause dust particles to leave the premises. With a southerly wind, this explains some of the crustal portion of the speciated data recorded at the Freemansburg monitor."

Figure 5c. Northampton County Monitor (Freemansburg) Location and Former Bethlehem Steel Site Map
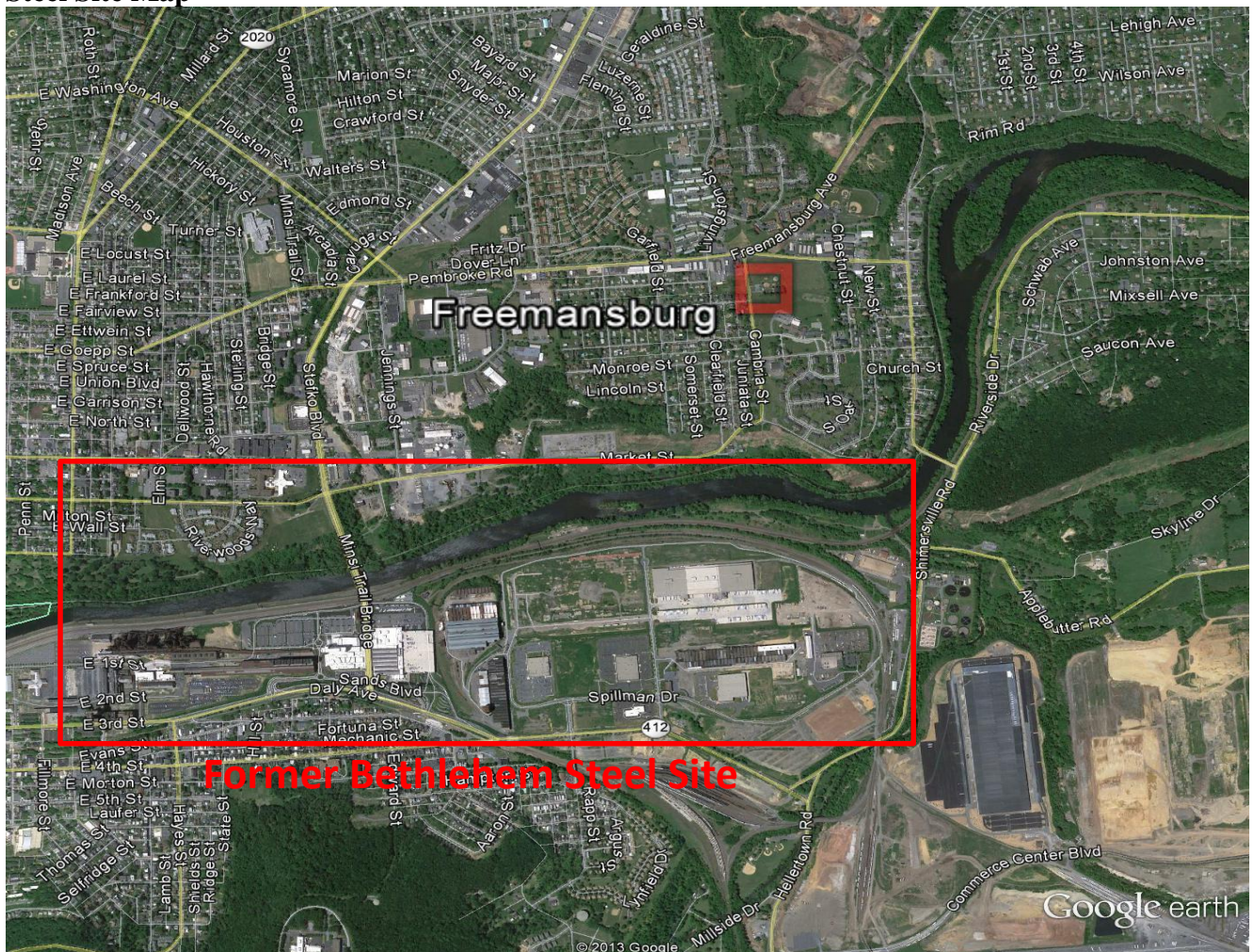
Source: Pennsylvania's December 10, 2013 recommendation letter, Appendix C-2 - Northampton County Area

In response to EPA's 120 day letter, PADEP provided updated emissions data for 2013 from Air Information Management System (AIMS) for 6 major facilities in Northampton and 1 in Lehigh County (greater than 500 tpy). PA DEP data shows a 56.8% reduction in emissions for these select point sources in Northampton and Lehigh counties.

Figure 5d. Allentown Area Facility Emissions Difference Between 2011 and 2013

County	Facility Name (Facility ID)	2011 Totals	2013 Totals	Difference	Percent Change
Northampton	Keystone Portland Cement/East Allen (420950012)	1,878	1,524	-354	-18.8%
Northampton	Essroc/Nazareth Lower Cement Plant 1 (420950045)	3,177	2,648	-529	-16.7%
Northampton	Northampton Gen Co/Northampton (420950536)	1,034	844	-190	-18.4%
Northampton	Hercules Cement Co LP/Stockertown (420950006)	2,462	2,883	421	17.1%
Lehigh	Lafarge Corp/Whitehall Plant (420770019)	754	583	-171	-22.7%
Northampton	PPL Martins Creek LLC/Martins Creek (420950010)	1,297	995	-302	-23.3%
Northampton	Genon Rema LLC/Portland Generating Sta (420950011)	17,206	2,532	-14,674	-85.3%
	GRAND TOTAL	**27,808**	**12,009**	**-15,799**	**-56.8%**

Source: Pennsylvania's October 28, 2014 letter

Figure 5d indicates that the emissions reductions from major point sources in the area of analysis are in Northampton County with only a small portion of the reduction attributable to the single source in Lehigh County. The reduction of emissions in Northampton County does not negate the contribution of area and mobile sources not shown in Figure 5d. As explained earlier, emissions from Lehigh County impacting the violating Northampton County monitor can be attributed to mobile and area sources.

PADEP believes that the PM$_{2.5}$ concentrations at the Freemansburg monitor were being influenced by emissions from construction activity at the former Bethlehem Steel site south of the Freemansburg monitor. PADEP provided descriptions and additional photographs of the former Bethlehem Steel site in response to EPA's 120-day letter. PADEP's supplemental information and photographs show that this construction activity at the Bethlehem Steel redevelopment site is nearby and in the prevalent upwind direction from the violating monitor, and that this construction likely impacts the monitor to some degree. However, the commenters' supplemental information does not rule out EPA's contention that there appears to be contribution from other sources in both Northampton and Lehigh Counties. Monitor annual means, design value and correlation relationship data provided by the commenters seems open to interpretation, and does not dismiss the possibility of contribution from metropolitan Allentown area mobile and non-point sources, nor from point sources in Northampton County.

## Population density and degree of urbanization

In this part of the five factor analysis, EPA evaluated the population and vehicle use characteristics and trends of the area as indicators of the probable location and magnitude of non-point source emissions. Rapid population growth in a county on the urban perimeter signifies increasing integration with the core urban area, and indicates that it may be appropriate to include the county associated with area source and mobile source emissions as part of the nonattainment area. Table 6 shows the 2000 and 2010 population, population growth since 2000, and population density for each county in the area of analysis.

Table 6. Population Growth and Population Density.

County, State	Population 2000	Population 2010	% Change from 2000	Land Area (square miles)	Population Density (per square mile)	% of Area of Analysis	Cumulative %
Montgomery, PA	750,097	801,134	6.8%	483	1,658	20%	20%
Bucks, PA	597,635	625,505	4.7%	607	1,030	15%	35%
Morris, NJ	470,212	492,899	4.8%	469	1,051	12%	47%
Berks, PA	373,638	411,791	10.2%	859	479	10%	57%
Lehigh, PA	312,090	350,093	12.2%	347	1,010	9%	66%
Luzerne, PA	319,250	320,925	0.5%	891	360	8%	74%
Northampton, PA	267,066	298,065	11.6%	374	797	7%	81%
Monroe, PA	138,687	169,981	22.6%	609	279	4%	85%
Sussex, NJ	144,166	149,221	3.5%	521	286	4%	89%
Schuylkill, PA	150,336	148,199	-1.4%	778	190	4%	93%
Hunterdon, NJ	121,989	128,357	5.2%	430	299	3%	96%
Warren, NJ	102,437	108,693	6.1%	358	304	3%	98%
Carbon, PA	58,802	65,204	10.9%	381	171	2%	100%
Total	**3,806,405**	**4,070,067**					

Source: U.S. Census Bureau population estimates for 2000 and 2010

Figure 6. 2010 County-Level Population in the Area of Analysis for the Allentown Area.
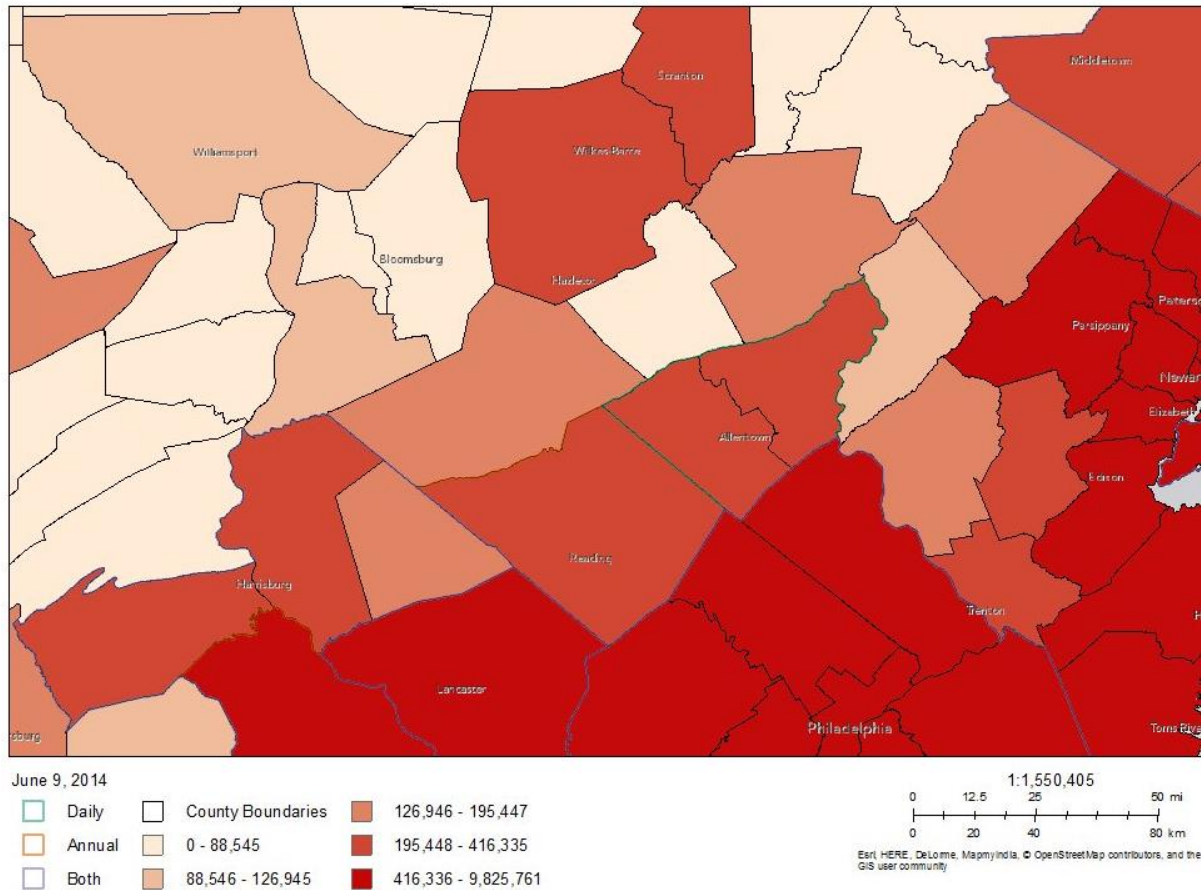
As Table 6 illustrates, Montgomery County has the largest and most dense population than the other counties in the area of analysis.   As previously mentioned, Montgomery County emissions are less likely to contribute to the Northampton County violating monitor due to topography and regional wind direction. Northampton County has a moderately sized population, which has increased by 11.6% during 2000 to 2010. Northampton County ranks seventh in population and fifth in population density in the thirteen county area of analysis. Lehigh County has a similar sized population and population density as Northampton County. Lehigh County ranks fifth in population and fourth in population density in the thirteen county area of analysis. A majority of the population in Northampton and Lehigh counties are in the cities of Allentown, Bethlehem and Easton which span the county borders and are located in the Lehigh River Valley.

Traffic and Vehicle Miles Travelled

High VMT and/or a high number of commuters associated with a county is generally an indicator that the county is an integral part of an urban area. Mobile source emissions of NO_x, VOC, and direct PM may contribute to ambient particulate matter that contributes to monitored violations of the NAAQS in the area. In combination with the population/population density data and the location of main transportation arteries, an assessment of VMT helps identify the probable location of nonpoint source
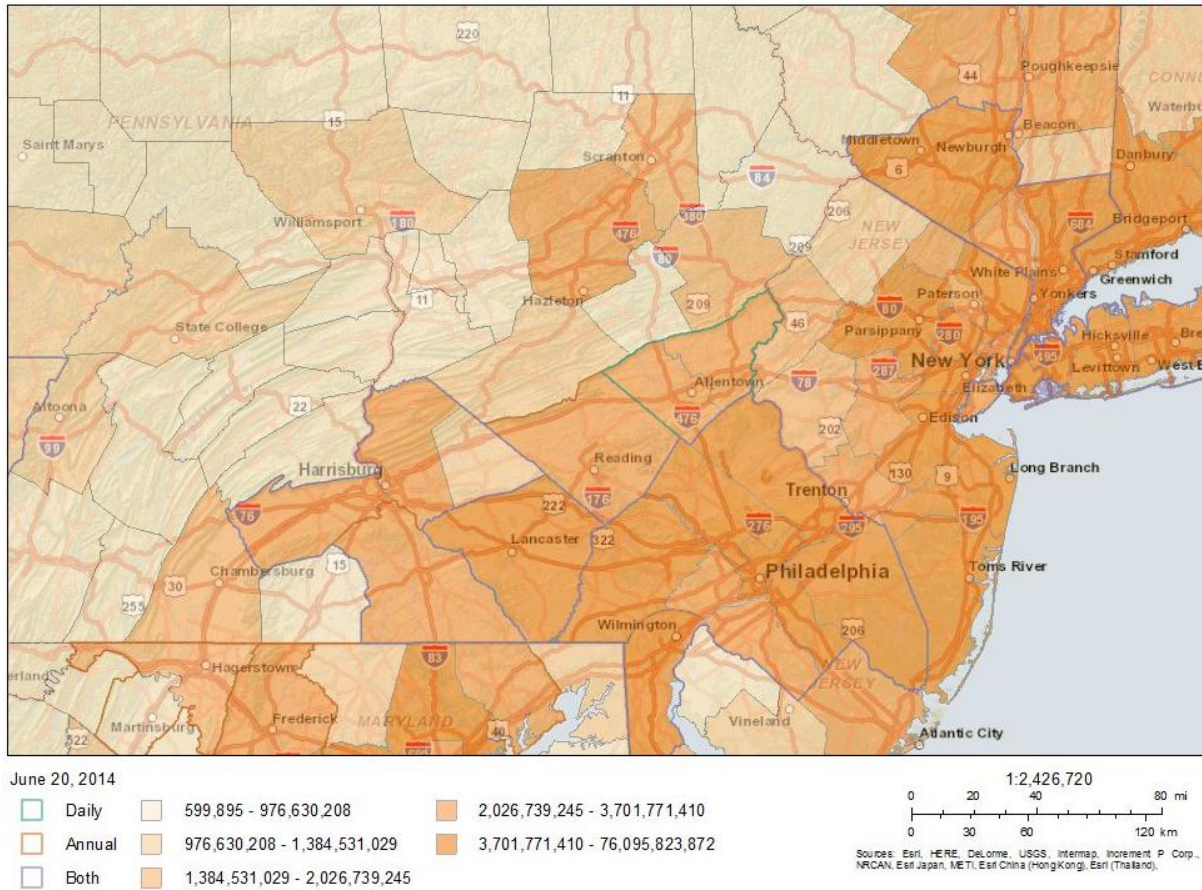
emissions that contribute to violations in the area. Comparatively high VMT in a county outside of the CBSA or CSA signifies integration with the core urban area contained within the CSA or CBSA, and indicates that a county with the high VMT may be appropriate to include in the nonattainment area because emissions from mobile sources in that county contribute to violations in the area. Table 7 shows 2011 VMT while Figure 7 overlays 2011 county-level VMT with a map of the transportation arteries. This VMT data was obtained from the Federal Highway Administration.

Table 7. 2011 VMT for the Allentown Area.

County, State	Total 2011 VMT	Percent	Cumulative %
Montgomery, PA	6,505,446,421	18%	18%
Morris, NJ	5,419,112,025	15%	33%
Bucks, PA	4,727,709,143	13%	46%
Berks, PA	3,381,679,887	9%	56%
Lehigh, PA	2,988,094,564	8%	64%
Luzerne, PA	2,769,808,578	8%	72%
Northampton, PA	2,046,097,907	6%	77%
Hunterdon, NJ	1,828,353,779	5%	82%
Monroe, PA	1,664,133,702	5%	87%
Warren, NJ	1,387,779,166	4%	91%
Schuylkill, PA	1,373,853,518	4%	95%
Sussex, NJ	1,182,572,750	3%	98%
Carbon, PA	772,100,374	2%	100%
Total	36,046,741,815		

http://www.census.gov/hhes/commuting/data/commuting.html

Figure 7. Overlay of 2011 County-level VMT with Transportation Arteries.

June 20, 2014

☐ Daily	☐ 599,895 - 976,630,208
☐ Annual	☐ 976,630,208 - 1,384,531,029
☐ Both	☐ 1,384,531,029 - 2,026,739,245
	☐ 2,026,739,245 - 3,701,771,410
	☐ 3,701,771,410 - 76,095,823,872

1:2,426,720

Sources: Esri, HERE, DeLorme, USGS, Intermap, Increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

As Table 7 and Figure 7 illustrate, VMT varies within the area of analysis. For vehicle miles traveled, Lehigh County ranks fifth and Northampton County ranks seventh out of the thirteen counties in the area of analysis. The population in Allentown, Bethlehem and Easton and the two interstates that run east to west across these two counties most likely contribute to the emissions impacting the violating monitors. Montgomery County has the most VMT, which is approximately three times higher than the VMT in Northampton County. As previously mentioned, Montgomery County emissions most likely do not contribute to the Northampton County violating monitor due to topography and regional wind direction.

Factor 3: Meteorology

EPA evaluated available meteorological data to determine how meteorological conditions, including, but not limited to, weather, transport patterns, and stagnation conditions, could affect the fate and transport of directly emitted particulate matter and precursor emissions from sources in the area of analysis. EPA used two primary tools for this assessment: wind roses and kernel density estimation (KDE). When considered in combination with area $PM_{2.5}$ composition and county-level and facility emissions source location information, wind roses and KDE can help to identify nearby areas contributing to violations at violating monitoring sites.
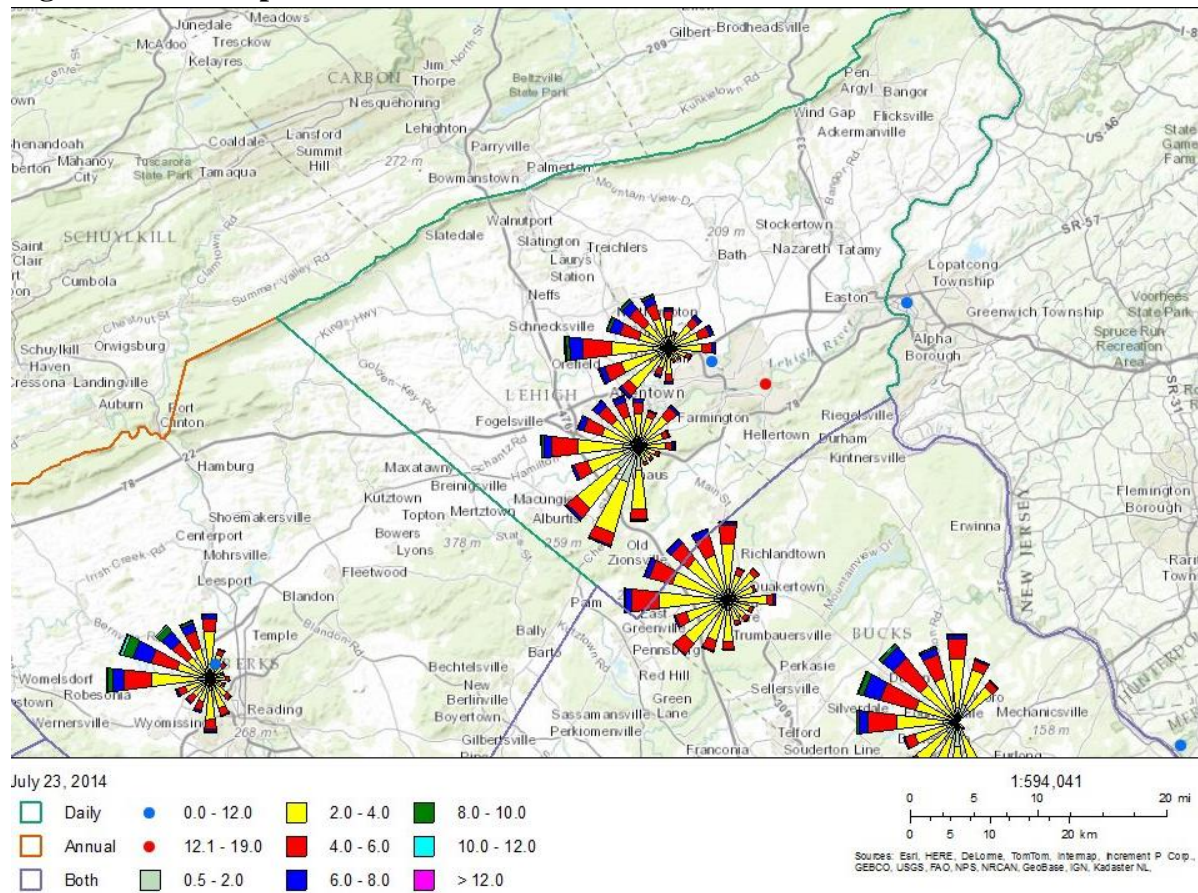
Wind roses are graphic illustrations of the frequency of wind direction and wind speed. Wind direction can indicate the direction from which contributing emissions are transported; wind speed can indicate the force of the wind and thus the distance from which those emissions are transported. EPA constructed wind roses from hourly observations of wind direction and wind speed using 2009-2012 data from National Weather Service locations archived at the National Climate Data Center.[102] When developing these wind roses, EPA also used wind observations collected at meteorological sampling stations collocated at air quality monitoring sites, where these data were available. Figure 8 shows wind roses that EPA generated from data relevant in the Northampton County Area.

Figure 8a. Wind Roses in the Area of Analysis for Allentown Area.
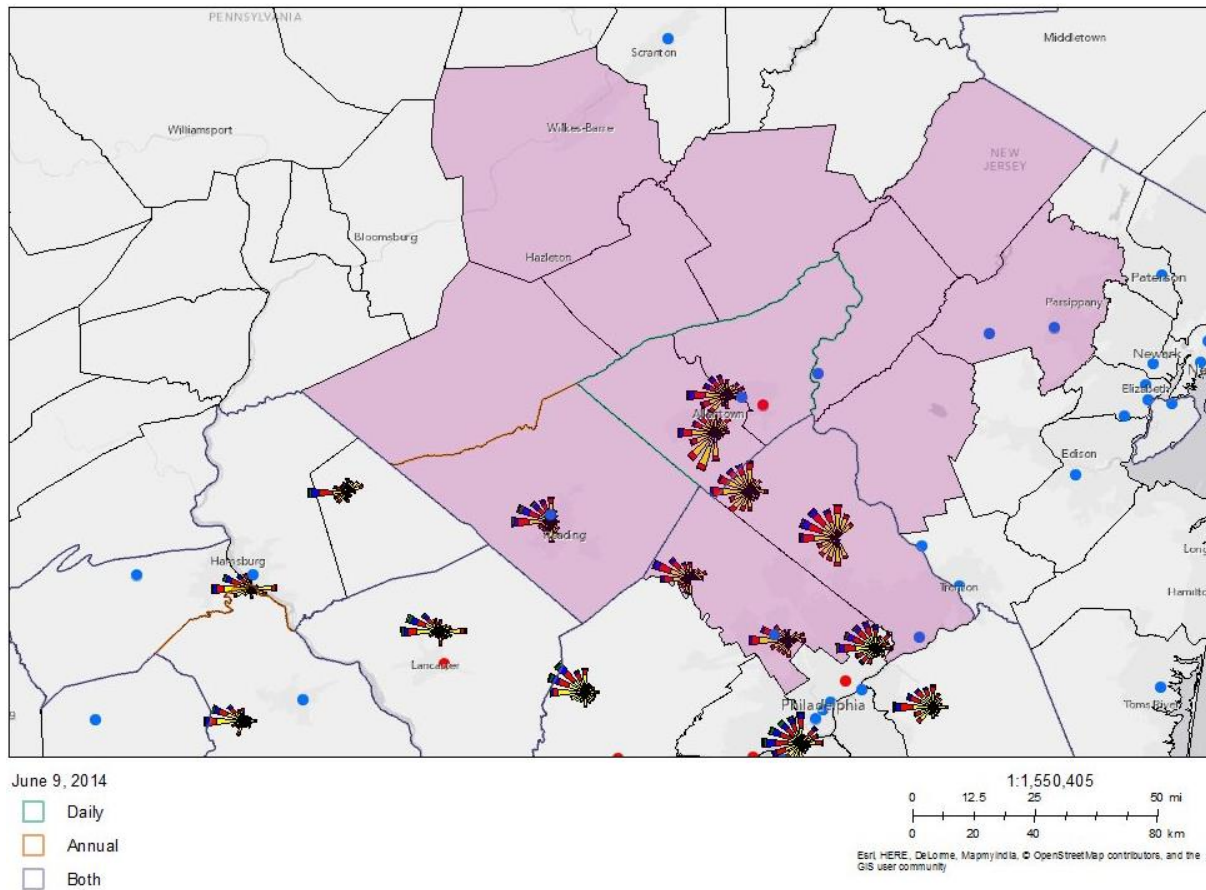
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[102] *ftp.ncdc.noaa.gov/pub/data/noaa* or
http://gis.ncdc.noaa.gov/map/viewer/#app=cdo&cfg=cdo&theme=hourly&layers=1&node=gis Quality assurance of the National Weather Service data is described here: *http://www1.ncdc.noaa.gov/pub/data/inventories/ish-qc.pdf*

Figure 8b. Close up of Wind Roses for Allentown Area

July 23, 2014

▢ Daily	● 0.0 - 12.0	▨ 2.0 - 4.0 ▨ 8.0 - 10.0
▢ Annual	● 12.1 - 19.0	▨ 4.0 - 6.0 ▨ 10.0 - 12.0
▢ Both	▨ 0.5 - 2.0	▨ 6.0 - 8.0 ▨ > 12.0

1:594,041

Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp.,
GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL,

As shown in Figures 8a and 8b, the predominant winds near the Northampton County violating monitor are from the west and the southwest, with some northwesterly, and northeasterly components. These wind roses represent average wind directions throughout the year. Lehigh County is to the west and southwest of the violating monitor and is situated in the Lehigh River Valley with Northampton County. Lehigh County emissions are high in POM which is a main component of the urban increment at the Northampton County violating monitor. As seen in Figures 5a and 5b, there are major point sources in Northampton County to the northwest and northeast of the Northampton County violating monitor. Montgomery and Bucks counties are to the south and southeast of the Northampton County violating monitor which is not in the regional wind direction. Berks County is further southwest of the monitor and emissions are less likely to contribute to the Northampton violating monitor due to hills running between the emission sources and the monitor (see Factor 4).

In its December 2013 recommendation letter, Pennsylvania included wind direction analysis at high PM$_{2.5}$ days at the Northampton County violating monitor. As stated previously, Pennsylvania identified 344 days in the 2010 to 2012 monitoring period where PM$_{2.5}$ at the Northampton County violating monitor was at least one standard deviation above the Allentown-Bethlehem-Easton MSA regional average (high days). The top 25% (highest PM$_{2.5}$ days) were further analyzed to determine why the Northampton County violating monitor's concentrations were high. The Northampton County violating monitor is collocated with a meteorological tower which monitors wind direction and

wind speed. For the highest PM$_{2.5}$ days, Pennsylvania calculated the number of hours the wind was coming from a particular direction as well as the concentrations from a particular direction. Figures 8c and 8d represent the wind direction frequency and concentration distribution by wind direction, respectively, at the Northampton County violating monitor during its highest PM$_{2.5}$ days.

Figure 8c. Northampton County Monitor Wind Direction Frequency – Top 25% of Regionally "Clean" Days
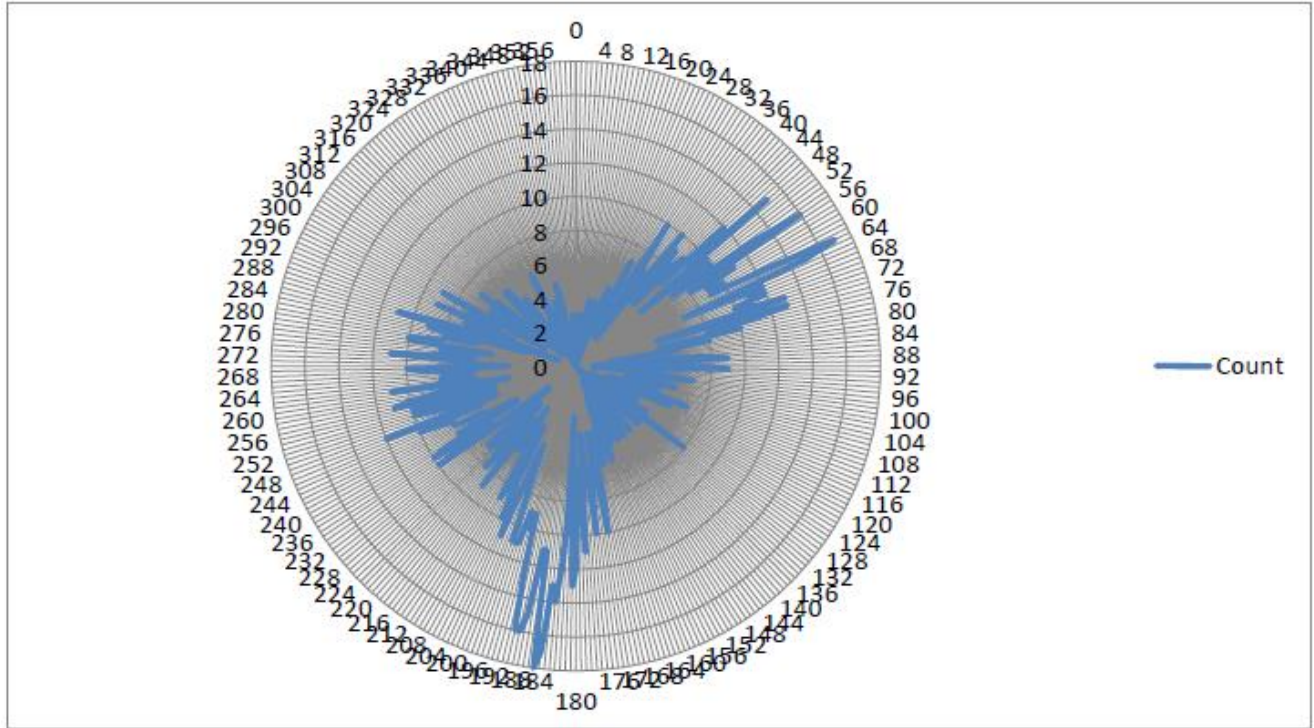
Source: Pennsylvania's December 10, 2013 recommendation letter, Appendix C-2 - Northampton County Area

Figure 8d. Northampton County Monitor PM$_{2.5}$ Concentration Distribution by Wind Direction – Top 25% of Regionally "Clean" Days
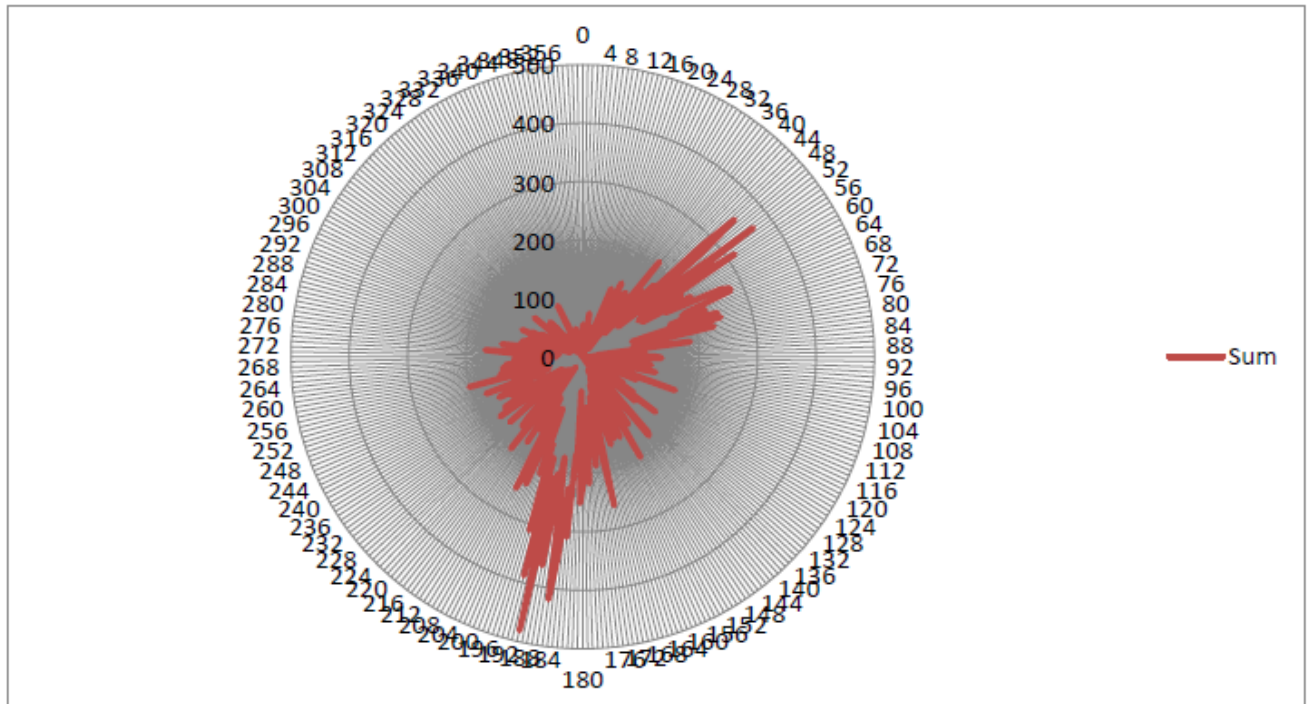
Source: Pennsylvania's December 10, 2013 recommendation letter, Appendix C-2 - Northampton County Area

As can be seen in Figure 8c, wind directions on highest PM$_{2.5}$ days at the Northampton County violating monitor are coming predominantly from due south and the northeast. The high PM$_{2.5}$ concentrations in Figure 8d follow the same pattern. This is slightly different from the regional wind directions shown in Figures 8a and 8b which are predominantly from the west and from the southwest with northwesterly and northeasterly components. As discussed above, Table 5 and Figures 5a and 5b list and illustrate the major point sources located in the area of analysis. There are several point sources to the northeast of the violating monitor in Lehigh River Valley corresponding to the wind direction on highest PM$_{2.5}$ days, however, there are not any major point sources of PM$_{2.5}$ to the south likely to contribute to the Northampton County violating monitor. Figure 5c illustrates that the former Bethlehem Steel site is located south and southwest of the Northampton County violating monitor. As Pennsylvania suggested in its December 2013 recommendation letter, heavy construction just south of the monitor at the former Bethlehem Steel Site likely contributed to the high concentration of PM$_{2.5}$ at this monitor.

In addition to wind roses, EPA also generated kernel density estimation (KDE) plots to represent HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) backward trajectory frequency at

violating monitoring sites.[103,104] These KDEs are graphical statistical estimations to determine the density of trajectory endpoints at a particular location represented by a grid cell. EPA used KDEs to characterize and analyze the collection of individual HYSPLIT backward trajectories.[105] Higher density values, indicated by darker blue colors, indicate a greater frequency of observed trajectory endpoints within a particular grid cell. Figure 9 shows a HYSPLIT KDE plot for the Northampton County Area summarized by calendar quarter for the 2010-2012 period. The HYSPLIT KDE is weighted in the southwesterly direction, indicating a greater frequency of trajectories passing over grid cells to the southwest. Lehigh County is southwest of the violating monitor. Lehigh County and Northampton County fall within the higher density values indicated by darker blue color in all four quarters. The higher density values indicate a greater frequency of observed trajectory endpoints within a particular grid cell. The higher density grid cells do cover the edges of Montgomery, Bucks and Berks counties at times, however as discussed below in Factor 4, hills between the monitor and the emissions in these counties most likely prevent contribution to the Northampton County violating monitor.

Figure 9. HYSPLIT Kernel Density Estimation Plots for the Allentown Area.
**First Quarter**   **Second Quarter**

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[103] In some past initial area designations efforts, EPA has used HYSPLIT backward trajectories to assist in determining nonattainment area boundaries. A HYSPLIT backward trajectory is usually depicted on a standard map as a single line, representing the centerline of an air parcel's motion, extending in two dimensional (x,y) space from a starting point and regressing backward in time to a point of origin. Backward trajectories may be an appropriate tool to assist in determining an air parcel's point of origin on a day in which a short-term standard, such as an 8-hour standard or a 24-hour standard, was exceeded. However, for an annual standard, such as the 2012 annual PM$_{2.5}$ NAAQS, every trajectory on every day is important. Plotting a mass of individual daily (e.g., 365 individual back trajectories), or more frequent, HYSPLIT trajectories may not be helpful as this process is likely to result in depicting air parcels originating in all directions from the violating monitoring site.

[104] HYSPLIT - Hybrid Single Particle Lagrangian Integrated Trajectory Model,
http://www.arl.noaa.gov/HYSPLIT_info.php

[105] The KDEs graphically represent the aggregate of HYSPLIT backward trajectories for the years 2010-2012, run every third day (beginning on the first day of monitoring), four times each day, and ending at four endpoint heights.
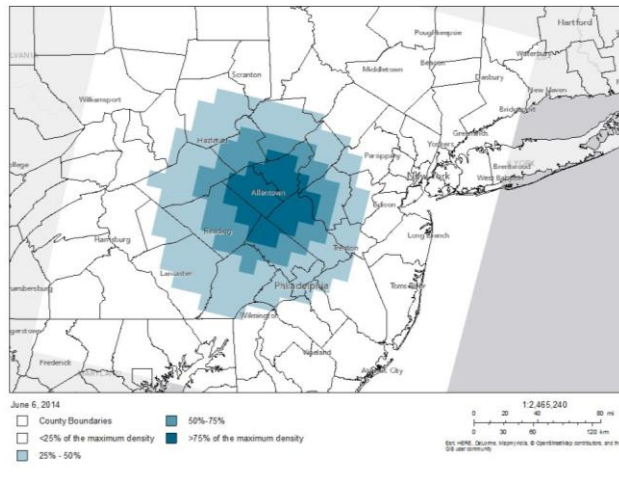
Third Quarter   **Fourth Quarter**
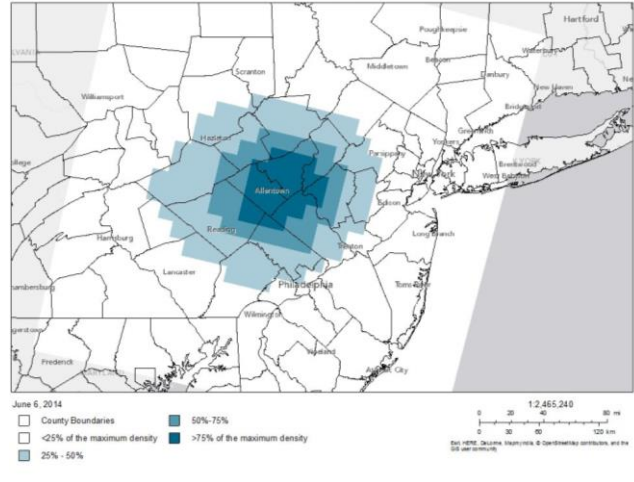
Factor 4: Geography/topography

To evaluate the geography/topography factor, EPA assessed physical features of the area of analysis
that might define the airshed and thus affect the formation and distribution of $PM_{2.5}$ concentrations
over the area.   As seen in Figure 10, the mountain range north of the Northampton County violating
monitor runs southwest to northeast and lower hills to the south of the violating monitor also run
southwest to northeast. This mountain range provides a physical barrier between Monroe, Carbon and
Schuylkill counties and the Northampton County violating monitor. The hills to the south of the
violating monitor provide a barrier between this monitor and emissions in Berks, Montgomery, and
Bucks counties. The Lehigh River Valley runs between these mountains and hills and connects Lehigh
and Northampton counties. A majority of the population and VMT in Northampton and Lehigh
counties are in the cities of Allentown, Bethlehem and Easton which are located in the Lehigh River
Valley. EPA believes that these topographical barriers significantly affect the formation and
distribution of $PM_{2.5}$ concentrations in the area of analysis.

Figure 10. Topography for the Allentown Area
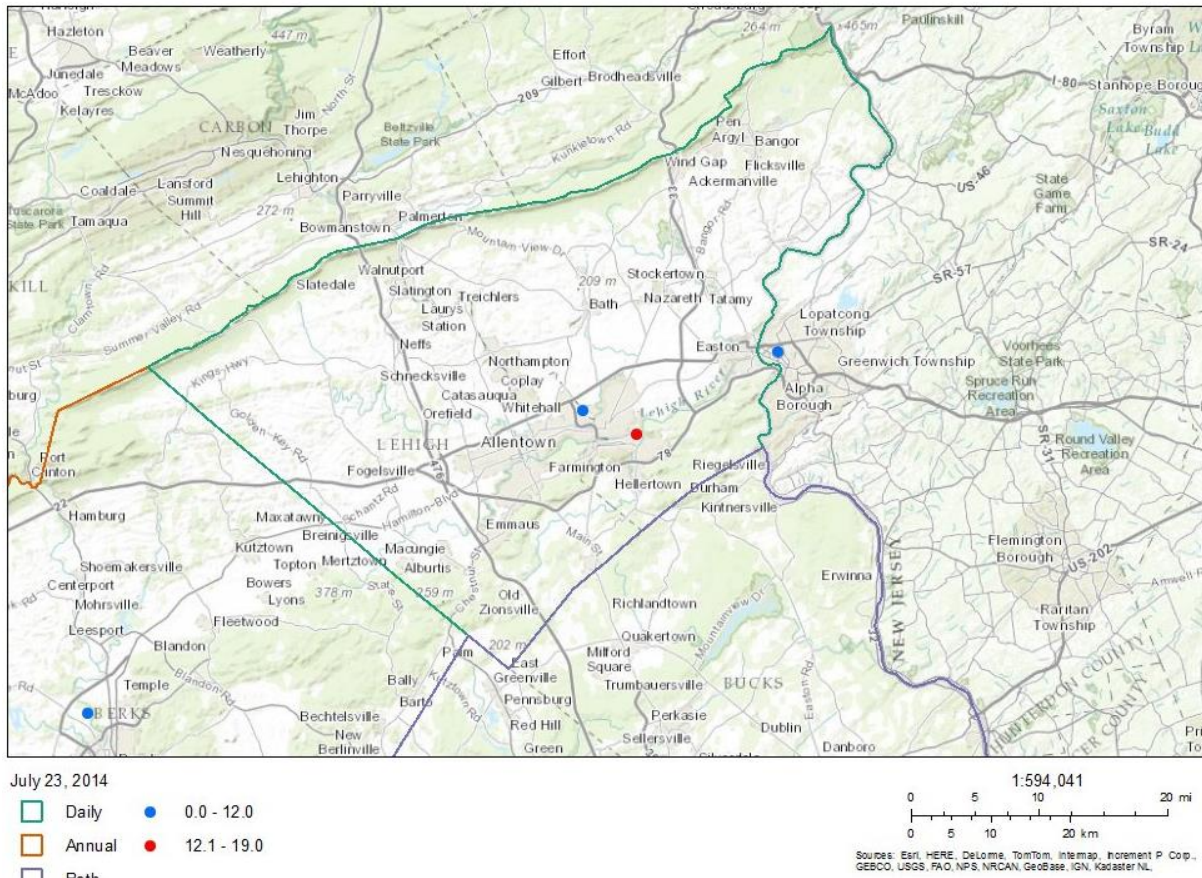
Factor 5: Jurisdictional boundaries

In defining the boundaries of the Allentown final nonattainment area, EPA considered existing jurisdictional boundaries, which can provide easily identifiable and recognized boundaries for purposes of implementing the NAAQS. Existing jurisdictional boundaries often signify state and local governmental organization with the necessary legal authority for carrying out air quality planning and enforcement functions for the intended area. Examples of such jurisdictional boundaries include existing/prior nonattainment area boundaries for particulate matter, county lines, air district boundaries, township boundaries, areas covered by a metropolitan planning organization, state lines, and Reservation boundaries, if applicable. Where existing jurisdictional boundaries were not adequate or appropriate to describe the nonattainment area, EPA considered other clearly defined and permanent landmarks or geographic coordinates for purposes of identifying the boundaries of the designated areas.

The violating monitor is located in Northampton County, PA, which is located in the Allentown-Bethlehem-Easton MSA. The Allentown-Bethlehem-Easton MSA includes Northampton County, Pennsylvania as well as Carbon County and Lehigh County in Pennsylvania, and Warren County, New Jersey.

The Lehigh Valley Planning Commission is the MPO for Lehigh and Northampton Counties. Carbon County is part of the Northeastern Pennsylvania Alliance Rural Planning Organization. The MPO for Warren County, New Jersey is the North Jersey Transportation Planning Authority.

The Allentown, Pennsylvania area has previously established nonattainment boundaries associated with the 2006 24-hour $PM_{2.5}$ NAAQS. The boundary for the Allentown, Pennsylvania nonattainment area for the 2006 24-hour $PM_{2.5}$ NAAQS included the entire counties of Lehigh and Northampton in Pennsylvania. The state has recommended a different boundary for the 2012 annual $PM_{2.5}$ NAAQS. Pennsylvania has recommended only the single county of Northampton, Pennsylvania as the intended nonattainment area for 2012 annual $PM_{2.5}$ NAAQS. EPA's analysis of the five factors supports a finding that Lehigh and Northampton counties contribute to the Northampton County violating monitor. Therefore, EPA's final nonattainment boundaries for the 2012 annual $PM_{2.5}$ NAAQS are the same as the 2006 24-hour $PM_{2.5}$ NAAQS and include the entire counties of Lehigh County and Northampton County in Pennsylvania.

Conclusion for the Allentown Area

Based on the assessment of factors described above, both individually and in combination, EPA has concluded that the following counties should be included as part of the Allentown nonattainment area because they are either violating the 2012 annual $PM_{2.5}$ NAAQS or contributing to a violation in a nearby area: Northampton County, Pennsylvania and Lehigh County, Pennsylvania. These are the same counties that are included in the Allentown, PA nonattainment area for the 2006 24-hour $PM_{2.5}$ NAAQS. The air quality monitoring site in Northampton County, Pennsylvania indicates a violation of the 2012 annual $PM_{2.5}$ NAAQS based on the 2013 DVs; therefore this county is included in the nonattainment area. Lehigh County, Pennsylvania is a nearby county that does not have a monitoring site, but EPA has concluded that this area contributes to the particulate matter concentrations in violation of the 2012 annual $PM_{2.5}$ NAAQS through emissions from non-point sources (e.g., area sources), and from mobile source emissions.

Seasonal variation can highlight those conditions most associated with high average concentration levels of $PM_{2.5}$. The Northampton County violating monitor does not follow the seasonal pattern seen at the other monitors in the area of analysis.

The speciation data for the Northampton County violating monitoring site indicate that organic mass and sulfates are the predominant species overall with small amount of nitrates in the first and 4th calendar quarters, which may be due to EGU emissions from winter heating needs and greater particle nitrate collection during the cooler months. When accounting for the urban increment, the sulfate component becomes less dominant, however, there is still some remaining sulfate detected at the monitor. The urban increment data clearly indicates that organic mass and elemental carbon are the main components of $PM_{2.5}$ at the Northampton County violating monitoring site. Additional speciation data provided by Pennsylvania for the top 25% of high $PM_{2.5}$ days also indicate that crustal material is

a major component of $PM_{2.5}$ along with organic mass and elemental carbon. These components (organic mass, elemental carbon and crustal material) suggest that the sources of $PM_{2.5}$ at the Northampton County violating monitor are local in nature and could result from mobile, area or local industrial sources.

Montgomery, Bucks, Berks, Northampton and Lehigh counties have the highest emissions of directly emitted $PM_{2.5}$ and precursors in the thirteen county area of analysis. These same five counties also have high amounts of organic mass, crustal matter and elemental carbon components of directly emitted $PM_{2.5.}$

Northampton County and Lehigh County have similar, moderately sized population and population density. A majority of the population in Northampton and Lehigh counties are in the cities of Allentown, Bethlehem and Easton which span the county borders and are located in the Lehigh River Valley. The population in these three cities and the two interstates that run east to west across these counties most likely contribute to the emissions at the Northampton County violating monitor.

Topography is an important factor when evaluating the formation and distribution of $PM_{2.5}$ in the area of analysis. The mountain range north of the Northampton County violating monitor runs southwest to northeast and lower hills to the south of the violating monitor also run southwest to northeast. The mountain range provides a physical barrier between Monroe, Carbon and Schuylkill counties and the Northampton County violating monitor. The hills to the south of the violating monitor provide a barrier between this monitor and Berks, Montgomery and Bucks counties. The Lehigh River Valley runs between these mountains and hills and connects Lehigh and Northampton counties. These topographical barriers suggest that emissions from Lehigh County and Northampton County are most likely impacting the Northampton County violating monitor.

The wind roses representing average wind direction throughout the year indicate that the predominant winds near the violating monitor are from the west and the southwest with northwesterly and northeasterly components. Emissions from Northampton and Lehigh counties are upwind and closest to the violating monitor; therefore they are most likely to impact the violating site. The HYSPLIT KDEs also indicate that Lehigh County and Northampton County fall within the higher density values indicated by darker blue color for all four quarters. The higher density values indicate a greater frequency of observed trajectory endpoints within a particular grid cell.

Additional meteorological data provided by Pennsylvania indicate that wind directions on highest $PM_{2.5}$ days at the Northampton County violating monitor are coming from due south and from the northeast. There are point sources in Northampton County to the northeast and upwind of the violating monitor. There are not any point sources of $PM_{2.5}$ south of the Northampton monitor which most likely contribute to the violation. As Pennsylvania suggested in their December 2013 recommendation letter, heavy construction just south of the monitor at the former Bethlehem Steel Site corresponds to the wind direction on the top 25% of high days.

EPA reevaluated the five factor analysis in consideration of PADEP's supplemental information provided in response to EPA's 120 day letter. With respect to the air quality factor, PADEP submitted historical annual means and design value data for the Allentown area monitors back to 2001. PADEP also submitted correlation relationship data comparing the Freemansburg monitor to other regional monitors. PADEP, however, does not establish the relationship between the local construction and the peak in annual means and design value in 2009-2011 at the Freemansburg monitor. Speciation data at the Freemansburg monitor continues to show high amounts of organic mass and elemental carbon and low amounts of crustal material, which should be higher as a result of construction-related activity. Northampton and Lehigh counties have comparable amounts of organic mass and elemental carbon emissions. The correlation relationship between Freemansburg, Lehigh Valley and Reading monitors indicates a regional relationship. The regional contribution is also supported by the wind roses representing average wind direction near the violating monitor which indicate that winds are from the west and southwest with northwesterly and northeasterly components.

PADEP provided updated emissions data for 2013 from Air Information Management System (AIMS) for six major facilities in Northampton County and one in Lehigh County (greater than 500 tpy). The updated emissions data focuses on the contribution in the county with the violating monitor and does not negate the contribution from mobile and area sources in Lehigh County.

PADEP submitted additional aerial photography of the construction at the Bethlehem Steel site. However, PADEP has not refuted EPA's contention that topographical barriers in the Allentown area limit the impact at the violating monitor to emissions from Lehigh and Northampton counties.
In conclusion, EPA continues to find that the five factor analysis supports EPA's finding that Lehigh and Northampton counties contribute to the violation at the Northampton County violating monitor. Therefore, EPA's final nonattainment boundaries for the 2012 annual $PM_{2.5}$ NAAQS include the entire counties of Lehigh County and Northampton County, Pennsylvania.

3.5   Area Background and Overview - Lebanon County

Figure 1a is a map of EPA's final nonattainment boundary for the Lebanon County area. The map shows the location and DVs of ambient air quality monitoring locations, county and other jurisdictional boundaries including the Lebanon, Pennsylvania MSA. For purposes of the 1997 annual $PM_{2.5}$ NAAQS, this area was designated nonattainment. The boundary for the nonattainment area for the 1997 annual $PM_{2.5}$ NAAQS included the entire counties of Cumberland, Dauphin and Lebanon in Pennsylvania. For purposes of the 2006 24-hour $PM_{2.5}$ NAAQS, this area was designated nonattainment. The boundary for the nonattainment area for the 2006 24-hour $PM_{2.5}$ NAAQS included the entire counties of Cumberland, Dauphin, Lebanon and York in Pennsylvania. The boundary for the 2012 annual $PM_{2.5}$ NAAQS is different than the boundary for the 1997 annual and the 2006 24-hour $PM_{2.5}$ NAAQS. EPA is recommending the single county of Lebanon, Pennsylvania as the boundary for the nonattainment area for the 2012 annual $PM_{2.5}$ NAAQS.
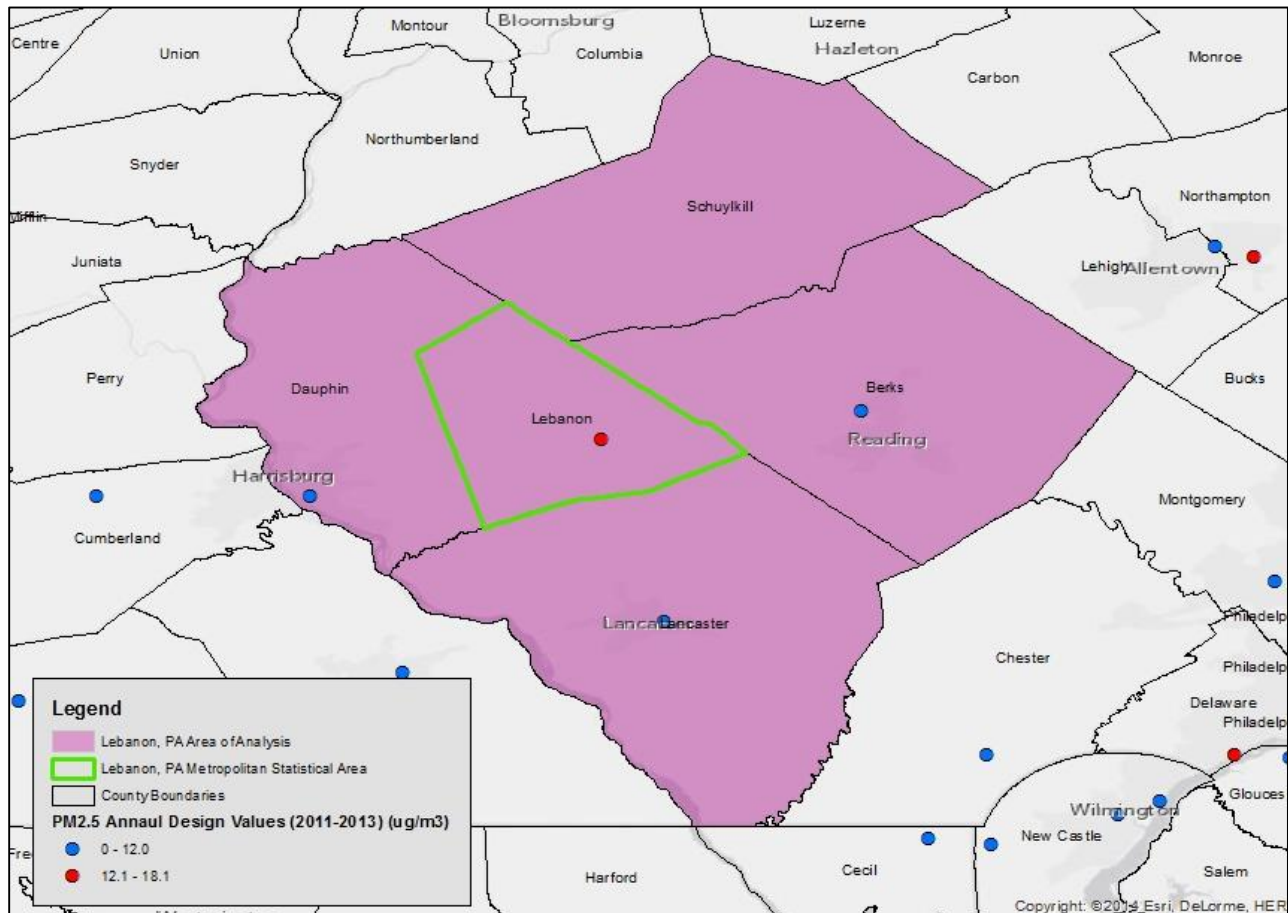
Figure 1a. EPA's Final Nonattainment Boundaries for the Lebanon County Area
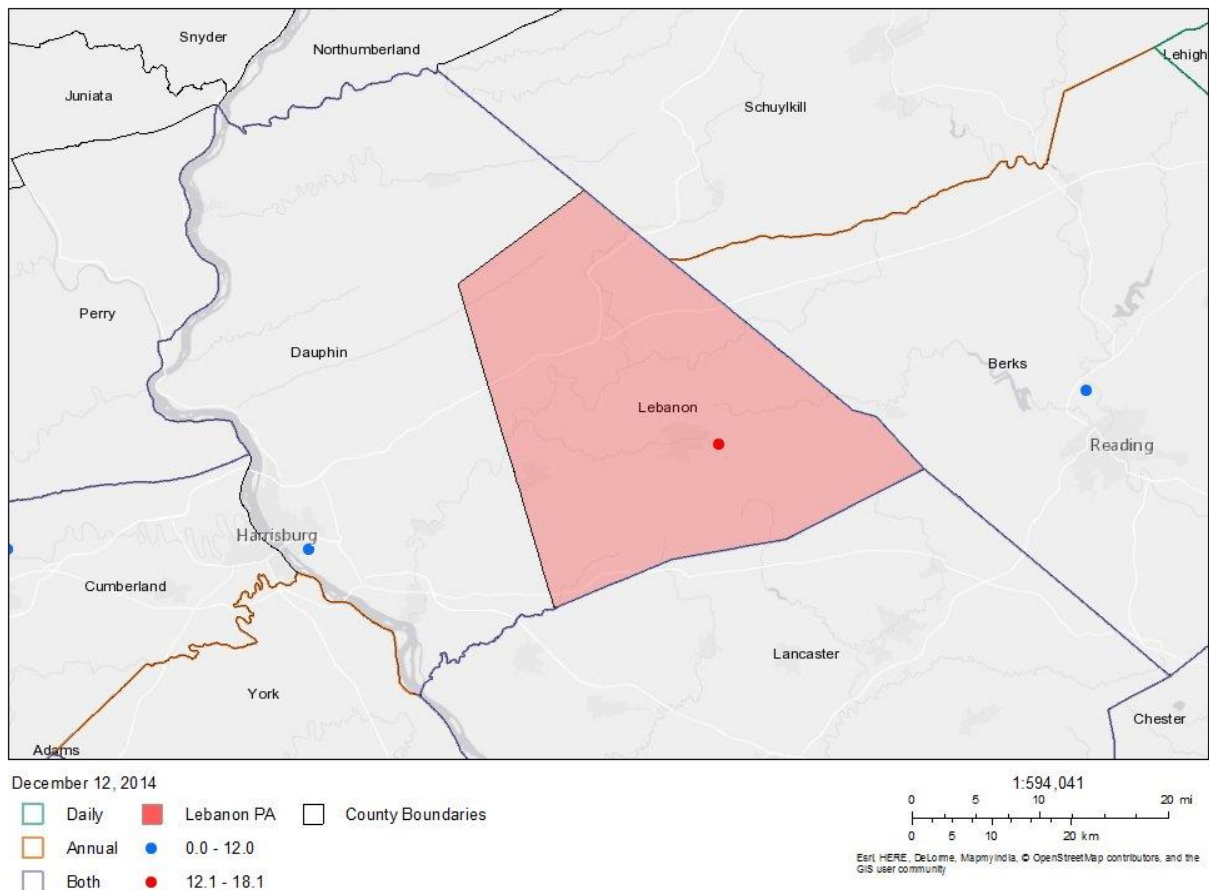
EPA must designate as nonattainment areas that violate the NAAQS and nearby areas that contribute to the violation in the violating area. Lebanon County shows a violation of the 2012 $PM_{2.5}$ NAAQS, therefore this county is included in the nonattainment area. The Lebanon, Pennsylvania MSA is a single county MSA which consists of Lebanon County, Pennsylvania. As shown in Figure 1b, EPA evaluated the Lebanon, PA MSA and a ring of counties adjacent to the Lebanon, Pennsylvania MSA,

including Berks, Dauphin, Lancaster and Schuylkill Counties in Pennsylvania. EPA's evaluation was based on the five factors and other relevant information. The following sections describe this five factor analysis process. While the factors are presented individually, they are not independent. The five factor analysis process carefully considers their interconnections and the dependence of each factor on one or more of the others.

Figure 1b. Area of Analysis for the Lebanon County Nonattainment Area

Factor 1: Air Quality Data

All data collected during the year are important when determining contributions to an annual standard such as the 2012 annual $PM_{2.5}$ NAAQS. Compliance with an annual NAAQS is dependent upon monitor readings throughout the year, including days with monitored ambient concentrations below the level of the NAAQS. For the 2012 annual $PM_{2.5}$ NAAQS, the annual mean is calculated as the mean of quarterly means. A high quarter can drive the mean for an entire year, which, in turn, can drive an elevated 3-year DV. Although all data are important, seasonal or episodic emissions can provide insight as to relative contributors to measured $PM_{2.5}$ concentrations. For these reasons, for the Factor 1 air quality analysis, EPA assessed and characterized air quality at, and in the proximity of, the violating monitoring site locations first, by evaluating trends and the spatial extent of measured

concentrations at monitors in the area of analysis, and then, by identifying the conditions most associated with high average concentration levels of PM$_{2.5}$ mass in the area of analysis.

In most cases, EPA assessed air quality data on a seasonal, or quarterly, basis.[106] EPA also identified the spatial extent of these high PM$_{2.5}$ concentrations. The mass and composition at the DV location represents contributions from various emission sources including local, area-wide (which may comprise nearby urban and rural areas) and regional sources. To determine the source mix (by mass) at the DV monitoring site, EPA examined the chemical composition of the monitored PM$_{2.5}$ concentrations by pairing each violating FRM/FEM/ARM monitoring site with a collocated or nearby Chemical Speciation Network (CSN) monitoring site or sites. Then, EPA contrasted the approximated mass composition at the DV monitoring site with data collected at IMPROVE[107] and other monitoring locations whose data are representative of regional background.[108,109] This comparison of local/area-wide chemical composition data to regional chemical composition data derives an "urban increment," which helps differentiate the influence of more distant emissions sources from the influence of closer

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[106] Although compliance with the annual NAAQS depends on contributions from all days of the year, examining data on a quarterly or seasonal basis can inform the relationship between the temporal variability of emissions and meteorology and the resulting PM$_{2.5}$ mass and composition. In some areas of the country where there may be noticeable month-to-month variations in average PM$_{2.5}$, the quarterly averages may not adequately represent seasonal variability. In these areas, air quality data may be aggregated and presented by those months that best correspond to the local "seasons" in these areas.

[107] IMPROVE stands for Interagency Monitoring for Protected Visual Environments and is an aerosol monitoring network in mostly rural and remote areas.

[108] The "urban increment" analysis assesses and characterizes the increase in seasonal and annual average PM$_{2.5}$ mass and chemical components observed at violating monitoring site(s) relative to monitoring sites outside the area of analysis (which represent background concentrations). Developing the urban increment involves pairing a violating FRM/FEM/ARM monitor with a collocated monitor or nearby monitor with speciation data. EPA made every effort to pair these data to represent the same temporal and spatial scales. However, in some cases, the paired violating and CSN "urban" monitoring locations were separated by some distance such that the included urban CSN site(s) reflect(s) a different mixture of emissions sources, which could lead to misinterpretations. To generally account for differences in PM$_{2.5}$ mass between the violating site and the nearby CSN site(s), EPA determined material balance of the PM$_{2.5}$ composition at the violating site by assigning the extra measured PM$_{2.5}$ mass to the carbon components of PM$_{2.5}$. Where the general urban increment approach may be misleading, or in situations where non-carbonaceous emissions are believed to be responsible for a local PM$_{2.5}$ concentration gradient, EPA used alternative analyses to reflect the mix of urban and rural sources contributing to the measured concentrations at violating monitoring sites.

[109] The urban monitors were paired with any rural sites within a 150 mile radius of an urban site to calculate spatial means of the quarterly averages of each species. If there were no rural sites within 150 miles, then the nearest rural site was used alone. That rural mean was then subtracted from the quarterly mean of the urban site to get the increment. Negative values were simply replaced with zeros.

emissions sources, thus representing the portion of the measured violation that is associated with nearby emission contributions.[110,111,112]

PM$_{2.5}$ Design Values and Total Mass Measurements - EPA examined ambient PM$_{2.5}$ air quality monitoring data represented by the DVs at the violating monitoring site and at other monitors in the area of analysis. EPA calculated DVs based on air quality data for the most recent 3 consecutive calendar years of quality-assured, certified air quality data from suitable FEM/FRM/ARM monitoring sites in EPA's Air Quality System (AQS). For this designations analysis, EPA used data for the 2011-2013 period (i.e., the 2013 DV), which are the most recent years with fully-certified air quality data. A monitor's DV is the metric or statistic that indicates whether that monitor attains a specified air quality standard. The 2012 annual PM$_{2.5}$ NAAQS is met at a monitoring site when the 3-year average annual mean concentration is 12.0 micrograms per cubic meter ($\mu g/m^3$) or less (e.g., 12.1 $\mu g/m^3$ or greater is a violation). A DV is only valid if minimum data completeness criteria are met or when other regulatory data processing provisions are satisfied (See 40 CFR part 50 Appendix N). Table 2 identifies the current DVs (i.e., the 2013 DV) and the most recent two DVs based on all monitoring sites in the area of analysis for the Lebanon County final nonattainment area.[113]

Table 2. Air Quality Data collected at Regulatory Monitors (all DV levels in $\mu g/m^3$)[a,b,]

County, State	Monitor Site ID	State Rec NA?	09-11 DV	10-12 DV	11-13 DV
Berks, PA	420110011	No	10.7	10.9	11
Dauphin, PA	420430401	No	12.1	11.9	11.9
Lancaster, PA	420710007	No	12	12.1	12
Lebanon, PA	420750100	Yes	11.4	12.8	12.3
Schuylkill, PA	N/A	No	No monitor		

[a]If a county has more than one monitoring location, the county DV is indicated in bold type.
[b]If a monitor is violating, the NAAQS, the violating DV is indicated in red type.

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[110] In most, but not all, cases, the violating design value monitoring site is located in an urban area. Where the violating monitor is not located in an urban area, the "urban increment" represents the difference between local and other nearby emission sources in the vicinity of the violating monitoring location and more regional sources.

[111] Hand, et. al. Spatial and Seasonal Patterns and Temporal Variability of Haze and its Constituents in the United States: Report V, June 2011. Chapter 7 – Urban Excess in PM$_{2.5}$ Speciated Aerosol Concentrations, *http://vista.cira.colostate.edu/improve/Publications/Reports/2011/PDF/Chapter7.pdf*

[112] US EPA, Office of Air Quality Planning and Standards, December 2004. (2004) Area Designations for 1997 Fine Particle (PM$_{2.5}$) Standards, Technical Support Document for State and Tribal Air Quality Fine Particle (PM$_{2.5}$) Designations, Chapter 3, Urban Excess Methodology. Available at *www.epa.gov/pmdesignations/1997standards/documents/final/TSD/Ch3.pdf*

[113] In certain circumstances, one or more monitoring locations within a monitoring network may not meet the network technical requirements set forth in 40 CFR 58.11(e), which states, "State and local governments must assess data from Class III PM$_{2.5}$ FEM and ARM monitors operated within their network using the performance criteria described in table C-4 to subpart C of part 53 of this chapter, for cases where the data are identified as not of sufficient comparability to a collocated FRM, and the monitoring agency requests that the FEM or ARM data should not be used in comparison to the NAAQS. These assessments are required in the monitoring agency's annual monitoring network plan described in §58.10(b) for cases where the FEM or ARM is identified as not of sufficient comparability to a collocated FRM…."

The Figure 1a map, shown previously, identifies the Lebanon County final nonattainment area, the Lebanon, Pennsylvania MSA boundary and monitoring locations with 2011-2013 violating DVs. As indicated on the map, there is one violating monitoring, monitor 420750100, located in Lebanon County, Pennsylvania (the "Lebanon County monitor" or the "violating monitor").

Seasonal variation can highlight those conditions most associated with high average concentration levels of PM$_{2.5}$. Figure 2 shows quarterly mean PM$_{2.5}$ concentrations for the most recent 3-year period for the highest DV monitoring sites in each county within the area of analysis. This graphical representation is particularly relevant when assessing air quality data for an annual standard, such as the 2012 annual PM$_{2.5}$ NAAQS, because, as previously stated, the annual mean is calculated as the mean of quarterly means and a high quarter can drive the mean for an entire year, which, in turn, can drive an elevated 3-year DV.

Figure 2. Lebanon County PM$_{2.5}$ Quarterly Means for 2011-2013
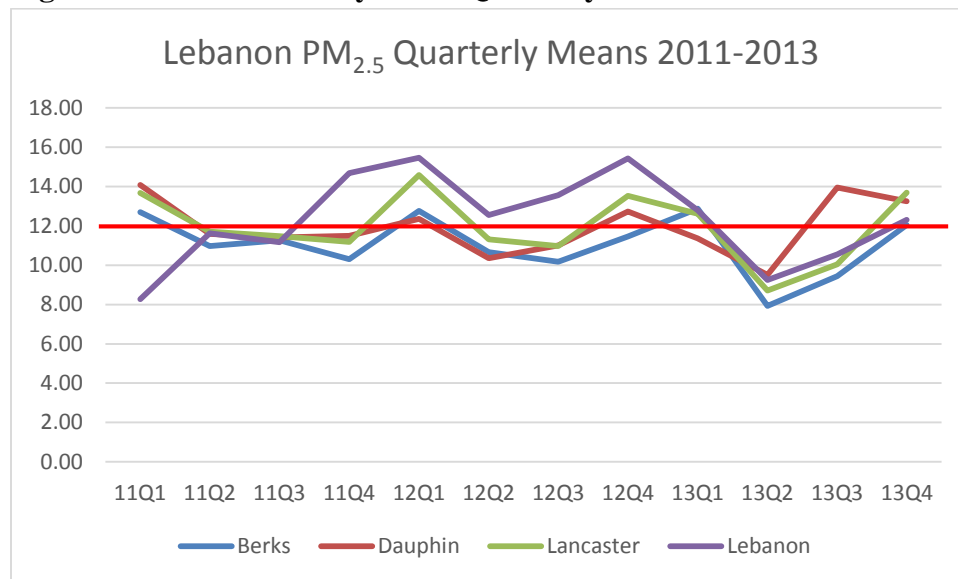
As shown, in Figure 2, the Lebanon County monitor does not follow a similar pattern to any of the other monitors in the area of analysis. The other three monitors in Berks, Dauphin and Lancaster counties tend to track together, with higher third quarters. All the monitors in the area, including the Lebanon County monitor had a high fourth quarter in 2012. The Lebanon County monitor does not have a clear seasonal pattern, indicating local influences at the violating monitor. However, staring in the second quarter of 2013, the PM$_{2.5}$ values at the Lebanon County monitor appear to track with most other monitors in the area. This suggests that the influence of the local sources was less in those quarters. Furthermore, as can be seen in Figure 2, the Lebanon monitor's quarterly means the second and third quarters of 2013 are below the 12 µg/m^3 level of the 2012 annual PM$_{2.5}$ NAAQS.

PM$_{2.5}$ Composition Measurements - To assess potential emissions contributions for each violating monitoring location, EPA determined the various chemical species comprising total PM$_{2.5}$ to identify the chemical components over the analysis area, which can provide insight into the types of emission sources impacting the monitored concentration. To best describe the PM$_{2.5}$ at the violating monitoring

location, EPA first adjusted the chemical speciation measurement data from a monitoring location at or near the violating FRM monitoring site using the SANDWICH approach to account for the amount of PM$_{2.5}$ mass components retained in the FRM measurement.[114,115,116,117] In particular, this approach accounts for losses in fine particle nitrate and increases in sulfate mass associated with particle bound water. Figure 3a illustrates the fraction of each PM$_{2.5}$ chemical component at the Lebanon County, PA monitoring site based on annual averages for the years 2010-2012. Please note that speciation data is not available at the Lebanon County monitor. Therefore, EPA used speciation data representative of the northeastern United States and adjusted it to match the PM$_{2.5}$ mass recorded at the Lebanon monitoring site.

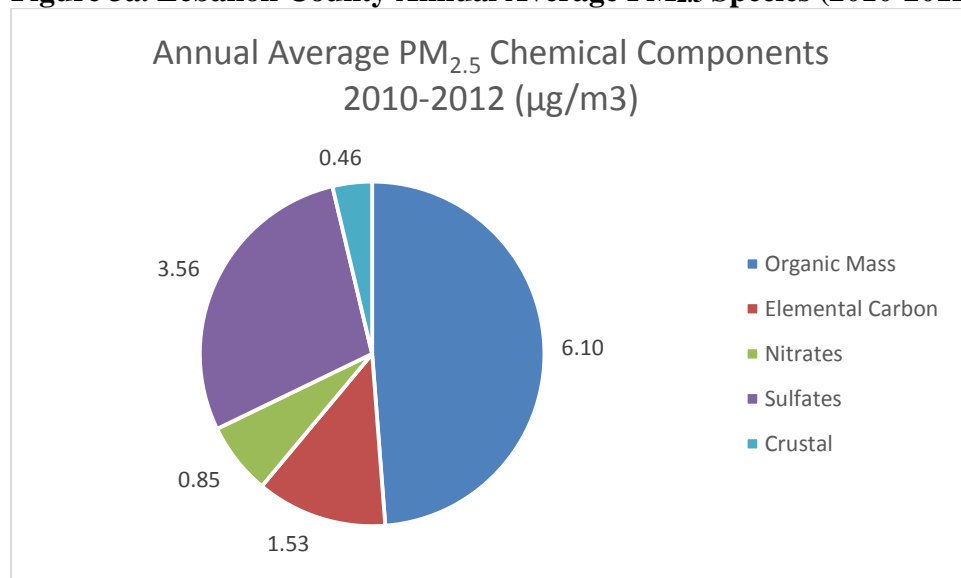**Figure 3a. Lebanon County Annual Average PM$_{2.5}$ Species (2010-2012)[a]**

Figure 3b shows annual and quarterly chemical composition profiles and illustrates any seasonal or episodic contributors to PM$_{2.5}$ mass. This "increment analysis," combined with the other factor analyses, can provide additional insight as to which sources or factors may contribute at a greater

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[114] SANDWICH stands for measured **S**ulfate, **A**djusted **N**itrate, **D**erived **W**ater, **I**nferred **C**arbonaceous mass **H**ybrid Material Balance Approach." The SANDWICH adjustment uses an FRM mass construction methodology that results in reduced nitrates (relative to the amount measured by routine speciation networks), higher mass associated with sulfates (reflecting water included in gravimetric FRM measurements) and a measure of organic carbonaceous mass derived from the difference between measured PM$_{2.5}$ and its non-carbon components. This characterization of PM$_{2.5}$ mass also reflects crustal material and other minor components. The resulting characterization provides a complete mass closure for the measured FRM PM$_{2.5}$ mass, which can be different than the data provided directly by the speciation measurements from the CSN network.

[115] Frank, N. H., SANDWICH Material Balance Approach for PM$_{2.5}$ Data Analysis, National Air Monitoring Conference, Las Vegas, Nevada, November 6-9, 2006. *http://www.epa.gov/ttn/amtic/files/2006conference/frank.pdf*.

[116] Frank, N. H., The Chemical Composition of PM$_{2.5}$ to support PM Implementation, EPA State /Local/Tribal Training Workshop: PM$_{2.5}$ Final Rule Implementation and 2006 PM$_{2.5}$ Designation Process, Chicago IL, June 20-21, 2007, *http://www.epa.gov/ttn/naaqs/pm/presents/pm2.5_chemical_composition.pdf.*

[117] Frank, N. H. *Retained Nitrate, Hydrated Sulfates, and Carbonaceous Mass in Federal Reference Method Fine Particulate Matter for Six Eastern U.S. Cities*. J. Air & Waste Manage. Assoc. 2006 56:500–511.

level. Simply stated, this analysis can help identify nearby sources of emissions that contribute to the violation at the violating monitoring site.

Figure 3b. Lebanon County Annual and Quarterly Average PM2.5 Species (2010-2012)[a]
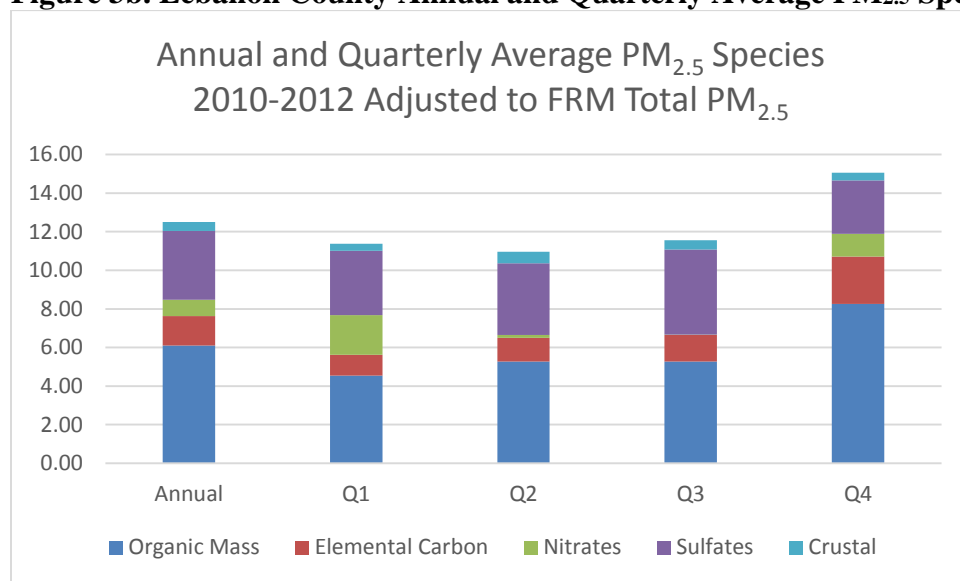
[a]*Adjusted to FRM Total PM2.5* indicates that the speciation profile and total mass depicted in this figure are the result of the urban increment calculation for the particular FRM monitor.

The speciation data in Figures 3a and 3b for the Lebanon County violating monitoring site indicate that organic mass and sulfates are the predominant species overall with a smaller component of elemental carbon and crustal matter in each quarter. Figure 3b shows that in the first quarter, nitrates are higher, which corresponds to higher EGU emissions from increased heating needs during the winter and greater particle nitrate collection during the cooler months.

EPA assessed seasonal and annual average PM2.5 components at monitoring sites within the area relative to monitoring sites outside of the analysis area to account for the difference between regional background concentrations of PM2.5, and the concentrations of PM2.5 in the area of analysis, also known as the "urban increment." This analysis differentiates between the influences of emissions from sources in nearby areas and in more distant areas on the violating monitor. Estimating the urban increment in the area helps to illuminate the amount and type of particles at the violating monitor that are most likely to be the result of sources of emissions in nearby areas, as opposed to impacts of more distant or regional sources of emissions. Figure 4a includes pie charts showing the annual and quarterly chemical mass components of the urban increment. The quarterly pie charts correspond to the high-concentration quarters identified in Figure 2. Evaluating these high concentration quarters can help identify composition of PM2.5 during these times. Note that in these charts, sulfates and nitrates have been adjusted to represent their mass in measured PM2.5.

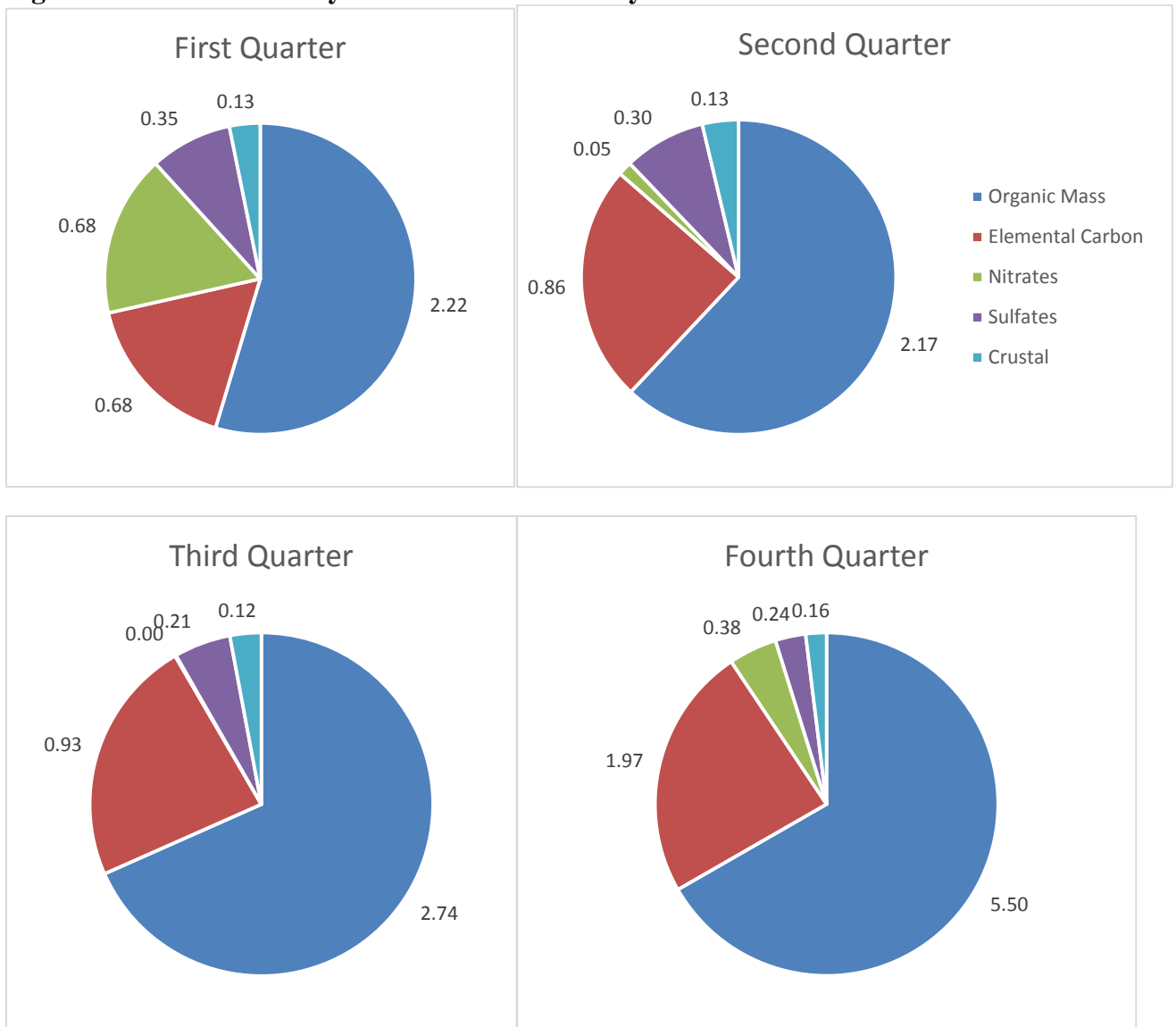**Figure 4a. Lebanon County Urban Increment Analysis for 2010-2012.**

First Quarter

- 2.22
- 0.68
- 0.68
- 0.35
- 0.13

Second Quarter

- 2.17
- 0.86
- 0.05
- 0.30
- 0.13

Legend:
- Organic Mass
- Elemental Carbon
- Nitrates
- Sulfates
- Crustal

Third Quarter

- 2.74
- 0.93
- 0.00
- 0.21
- 0.12

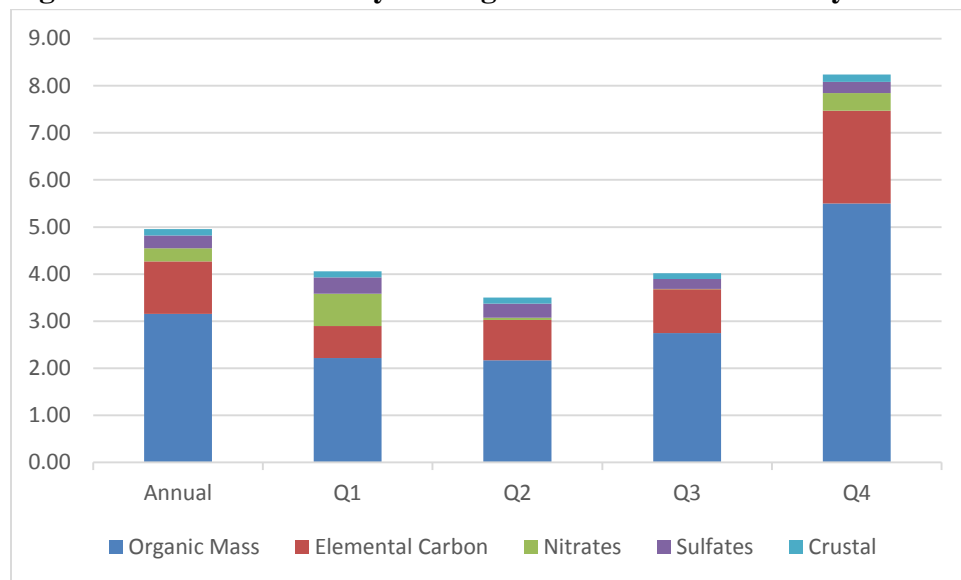**Fourth Quarter**

- 5.50
- 1.97
- 0.38
- 0.24
- 0.16

Figure 4b. Lebanon County Average Urban Increment Analysis for 2010-2012.

The urban increment data provides further insight to the chemical composition of PM$_{2.5}$ at the Lebanon County violating monitoring site. As previously stated, Figures 3a and 3b show that organic mass and sulfates are the predominant species overall. When accounting for the urban increment in Figure 4a and Figure 4b, the sulfate component becomes less dominant. However, there is still some remaining sulfate detected at the monitor. Figure 4a and Figure 4b clearly indicate that organic mass and elemental carbon are the major components of PM$_{2.5}$ contributing to the Lebanon County monitor. These components suggests that the sources of PM$_{2.5}$ are local in nature and could result from mobile, area or local industrial sources.

Factor 2: Emissions and emissions-related data
In this designations process, for each area with a violating monitoring site, EPA evaluated the emissions data from nearby areas using emissions related data for the relevant counties to assess each county's potential contribution to PM$_{2.5}$ concentrations at the violating monitoring site or monitoring sites in the area under evaluation. Similar to the air quality analysis, these data were examined on a seasonal basis. Similar to the air quality analysis, these data were examined on a seasonal basis. However, as discussed above, there are no discernable seasonal trends at the Lebanon County monitor. Therefore, EPA is not discussing seasonal emissions in this analysis. EPA examined emissions of identified sources or source categories of direct PM$_{2.5}$, the major components of direct PM$_{2.5}$ (organic mass, elemental carbon, crustal material (and/or individual trace metal compounds)), primary nitrate and primary sulfate, and precursor gaseous pollutants (i.e., SO$_2$, NO$_X$, total VOC, and NH$_3$). EPA also considered the distance of those sources of emissions from the violating monitoring site. While direct PM$_{2.5}$ emissions and its major carbonaceous components are generally associated with sources near violating PM$_{2.5}$ monitoring sites, the gaseous precursors tend to have a more regional influence (although EPA is mindful of the potential local NO$_X$ and VOC emissions contributions to PM$_{2.5}$ from mobile and stationary sources) and transport from neighboring areas can contribute to higher PM$_{2.5}$ levels at the violating monitoring sites.

Emissions Data

For this factor, EPA reviewed data from the 2011 National Emissions Inventory (NEI) version 1 (see *http://www.epa.gov/ttn/chief/net/2011inventory.html*). For each county in the area of analysis, EPA examined the magnitude of county-level emissions reported in the NEI. These county-level emissions represent the sum of emissions from the following general source categories: point sources, non-point (i.e., area) sources, nonroad mobile, on-road mobile, and fires. EPA also looked at the geographic distribution of major point sources of the relevant pollutants.[118] Significant emissions levels from sources in a nearby area indicate the potential for the area to contribute to monitored violations.

To further analyze area emissions data, EPA also developed a summary of direct $PM_{2.5}$, components of direct $PM_{2.5}$, and precursor pollutants, which is available at *http://www.epa.gov/pmdesignations/2012standards/docs/nei2011v1pointnei2008v3county.xlsx*.

When considered with the urban increment analysis in Factor 1, evaluating the components of direct $PM_{2.5}$ and precursor gases can help identify specific sources or source types contributing to elevated concentrations at violating monitoring sites and thus assist in identifying appropriate area boundaries. In general, directly emitted POC and VOCs[119] contribute to POM; directly emitted EC contributes to $PM_{2.5}$ EC; NO_X, NH_3 and directly emitted nitrate contribute to PNO3; SO_2, NH_3 and directly emitted sulfate contribute to PSO4; and directly emitted crustal material and metal oxides contribute to Pcrustal. [120,121] EPA believes that the quantities of those nearby emissions as potential contributors to the $PM_{2.5}$ violating monitors are somewhat proportional to the $PM_{2.5}$ chemical components in the estimated urban increment. Thus, directly emitted POC is more important per ton than SO_2, partially because POC emissions are already $PM_{2.5}$ whereas SO_2 must convert to $PM_{2.5}$ and not all of the emitted SO_2 undergoes this conversion.

Table 3a provides a county-level emissions summary (i.e., the sum of emissions from the following general source categories: point sources, non-point (i.e., area) sources, nonroad mobile, on-road mobile, and fires) of directly emitted $PM_{2.5}$ and precursor species in tons per year (tpy) for the county with the violating monitoring site and nearby counties considered for inclusion in the Lebanon County. Table 3b summarizes the directly emitted components of $PM_{2.5}$ for the same counties in the area of analysis for the Lebanon County. This information will be paired with the urban increment composition previously shown in Figures 4a and 4b.

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[118] For purposes of this designations effort, "major" point sources are those whose sum of PM precursor emissions ($PM_{2.5}$ + NOx + SO_2 + VOC + NH_3) are greater than 500 tons per year based on NEI 2011v1.

[119] As previously mentioned, nearby VOCs are presumed to be a less important contributor to POM than OC.

[120] *See*, Seinfeld J. H. and Pandis S. N. (2006) *Atmospheric Chemistry and Physics: From Air Pollution to Climate Change*, 2nd edition, J. Wiley, New York. See also, Seinfeld J. H. and Pandis S. N. (1998) *Atmospheric Chemistry and Physics: From Air Pollution to Climate Change*, 1st edition, J. Wiley, New York.

[121] USEPA Report (2004), The Particle Pollution Report: Current Understanding of Air Quality and Emissions through 2003, found at: *http://www.epa.gov/airtrends/aqtrnd04/pm.html*.

Table 3a. County-Level Emissions of Directly Emitted PM$_{2.5}$ and Precursors (tpy)

County, State	Total NH$_3$	Total NOX	Total Direct PM$_{2.5}$	Total SO$_2$	Total VOC	Total
Lancaster, PA	15,772	13,794	4,441	1,799	17,361	53,166
Berks, PA	4,097	14,317	3,606	6,136	12,734	40,891
Dauphin, PA	1,576	9,595	1,923	810	9,378	23,283
Schuylkill, PA	1,655	6,016	1,409	5,481	5,935	20,496
Lebanon, PA	3,917	5,024	1,151	814	4,252	15,158

Table 3b. County-Level Emissions for Components of Directly Emitted PM$_{2.5}$ (tpy) [122]

County, State	POM	EC	PSO4	PNO3	Pcrustal	Residual	Total Direct
Lancaster, PA	2,020	465	106	9	816	1,025	4,441
Berks, PA	1,764	436	132	15	474	785	3,606
Dauphin, PA	1,241	279	32	7	147	216	1,923
Schuylkill, PA	750	170	44	4	159	284	1,409
Lebanon, PA	582	165	27	3	182	193	1,151

As can be seen in Table 3a, Lancaster County has the highest total emissions of directly emitted PM$_{2.5}$ and its precursors, however, as discussed in Factor 3, emissions from Lancaster County are less likely to contribute to the Lebanon County monitor due to the regional wind direction being from the west. Berks and Schuylkill Counties are also not in the regional wind direction.   The PM$_{2.5}$ emissions in Lebanon and Dauphin Counties are mainly NO$_X$ and VOC. Lebanon County also has a high level of NH$_3$ emissions. Table 3b breaks down the direct PM$_{2.5}$ emissions value from Table 3a into its components. These data will also be compared with the previously presented urban increment composition Table 3b shows that throughout the area of analysis organic matter is the largest component of directly emitted PM$_{2.5}$.

Using the previously described relationship between directly emitted and precursor gases and the measured mass to evaluate data presented in Tables 3a and 3b, EPA identified the following components warranting additional review: organic mass, elemental carbon and VOC. EPA then looked at the contribution of these components of interest from each of the counties included in the area of analysis as shown in Tables 4a-e.

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[122] Data are based on the 2011 and 2018 Emissions Modeling Platform Data Files and Summaries (*ftp://ftp.epa.gov/EmisInventory/2011v6/v1platform*) available at: *http://www.epa.gov/ttn/chief/emch/index.html#2011* (accessed 02/26/14).

Table 4a. County-Level POM Emissions

County, State	Emissions in average tons/yr		
	POM	Pct.	Cumulative %
Lancaster, PA	2,020	32%	32%
Berks, PA	1,764	28%	60%
Dauphin, PA	1,241	20%	79%
Schuylkill, PA	750	12%	91%
Lebanon, PA	582	9%	100%

Table 4b. County-Level EC Emissions

County, State	Emissions in average tons/yr		
	EC	Pct.	Cumulative %
Lancaster, PA	465	31%	31%
Berks, PA	436	29%	59%
Dauphin, PA	279	18%	78%
Schuylkill, PA	170	11%	89%
Lebanon, PA	165	11%	100%

Table 4c. County-Level VOC Emissions

County, State	Emissions in average tons/yr		
	Total VOC	Pct.	Cumulative %
Lancaster, PA	17,361	35%	35%
Berks, PA	12,734	26%	61%
Dauphin, PA	9,378	19%	79%
Schuylkill, PA	5,935	12%	91%
Lebanon, PA	4,252	9%	100%

In Tables 4a – 4c, Lancaster and Berks counties have high POM, EC and VOC emissions. As previously mentioned, Lancaster and Berks counties are less likely to contribute to the Lebanon County violating monitor due to wind direction. Dauphin, Schuylkill and Lebanon counties have similar levels of POM, EC and VOC emissions.

In addition to reviewing county-wide emissions of $PM_{2.5}$ and $PM_{2.5}$ precursors in the area of analysis, EPA also reviewed emissions from major point sources located in the area of analysis. The magnitude and location of these sources can help inform nonattainment boundaries. Table 5 provides facility-level emissions of direct $PM_{2.5}$, components of direct $PM_{2.5}$, and precursor pollutants (given in tons per year) from major point sources with total emissions of 500 tpy or more located in the area of analysis for the Lebanon County. Table 5 also shows the distance from the facility to the Lebanon County.

Table 5. NEI 2011 v1 Point Source Emissions (tpy)

County, State	Facility Name (Facility ID)	Distance from violating monitor (miles)	NEI 2011 v1 Emissions (tpy)					
			NH_3	NOx	$PM_{2.5}$	SO_2	VOC	Total
Lebanon, PA	Carmeuse Lime Inc/Millard Lime Plt (420750016)	9	0	444	14	262	4	724
Schuylkill, PA	WPS Westwood Gen LLC/Gen Sta (421070023)	20	0	220	5	268	13	506
Lancaster, PA	Lancaster Cnty RRF/ Lancaster (420710145)	23		577	4	12	4	597
Berks, PA	Cryovac Inc/Cryovac Rigid Packaging (420110093)	23			0		556	556
Berks, PA	Genon Rema LLC/Titus Gen Sta (420110045)	25	0	683	43	4087	5	4818
Berks, PA	Lehigh Cement Co LLC/Evansville Cement Plt & Quarry (420110039)	27	41	1225	134	200	12	1611
Schuylkill, PA	Wheelabrator Frackville/Morea Plt (421070022)	33	0	443	19	468	9	938
Schuylkill, PA	Gilberton Power Co/John B Rich Mem Power Sta (421070025)	33	0	211	39	1314	28	1591
Schuylkill, PA	Schuylkill Energy Res/St Nicholas Cogen (421070024)	35	1	273	27	1883	25	2208
Schuylkill, PA	Northeastern Power Co/Mcadoo Cogen (421070054)	42	0	104	16	706	20	846

Table 5 shows the major point source emissions (from the 2011 NEI in tons per year) in the area of analysis for the Lebanon County and the relative distances of these sources from the violating monitoring location, as depicted by red dots. The actual distance from the point sources to the Lebanon County monitoring location is presented in Table 5. The distance from the violating monitoring location is particularly important for directly emitted $PM_{2.5}$. The influence of directly emitted $PM_{2.5}$ on ambient $PM_{2.5}$ diminishes more than that of gaseous precursors as a function of distance.[123]

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[123] Baker, K. R. and K. M. Foley. *A nonlinear regression model estimating single source concentrations of primary and secondarily formed $PM_{2.5}$.* Atmospheric Environment. 45 (2011) 3758-3767.

Figure 5. Major Point Source Emissions in the Area of Analysis for the Lebanon County
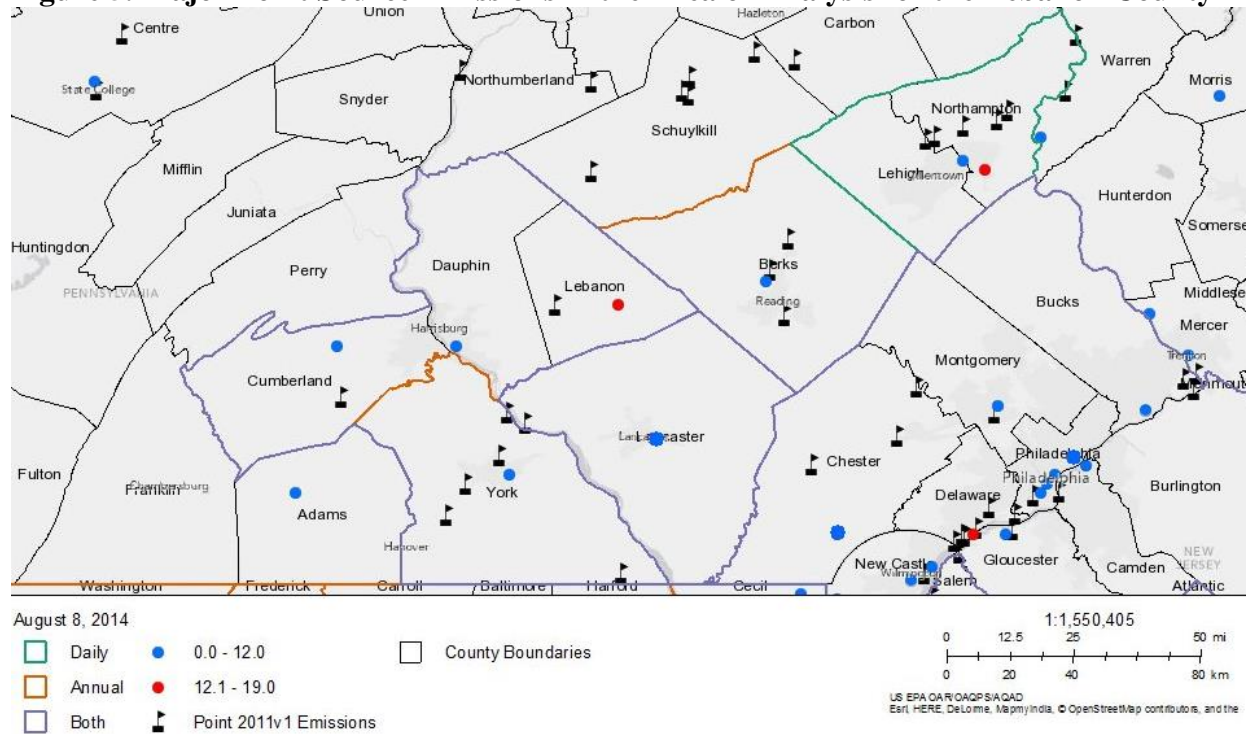
As indicated in Table 5 and Figure 5, there are ten sources with emissions over 500 tpy within the area of analysis. One source (Carmeuse Lime) is 9 miles west of the Lebanon County monitor. The largest point sources in the area of analysis are located in Schuylkill and Berks counties. Five point sources are located in Schuylkill County, to the northeast of the Lebanon County monitor. Three point sources are to the east of the Lebanon County monitor in Berks County. As previously mentioned, Schuylkill and Berks counties are not in the regional wind direction (see Factor 3).   There are no major point sources with emissions of 500 tpy or more in Dauphin County.

Population density and degree of urbanization

In this part of the factor analysis, EPA evaluated the population and vehicle use characteristics and trends of the area as indicators of the probable location and magnitude of non-point source emissions. Rapid population growth in a county on the urban perimeter signifies increasing integration with the core urban area, and indicates that it may be appropriate to include the county associated with area source and mobile source emissions as part of the nonattainment area. Table 6 shows the 2000 and 2010 population, population growth since 2000, and population density for each county in the area.

Table 6. Population Growth and Population Density.

County, State	Population 2000	Population 2010	% Change from 2000	Land Area (Sq. Miles)	Population Density (per Sq. Mile)	%	Cumulative %
Lancaster, PA	470,658	520,344	10.6%	949	548	35%	35%
Berks, PA	373,638	411,791	10.2%	859	479	28%	63%
Dauphin, PA	251,798	268,281	6.5%	525	511	18%	81%
Schuylkill, PA	150,336	148,199	-1.4%	778	190	10%	91%
Lebanon, PA	120,327	133,717	11.1%	362	370	9%	100%
Total	**1,246,430**	**1,482,332**					

Source: U.S. Census Bureau population estimates for 2000 and 2010

Figure 6. 2010 County-Level Population in the Area of Analysis for the Lebanon County Area.
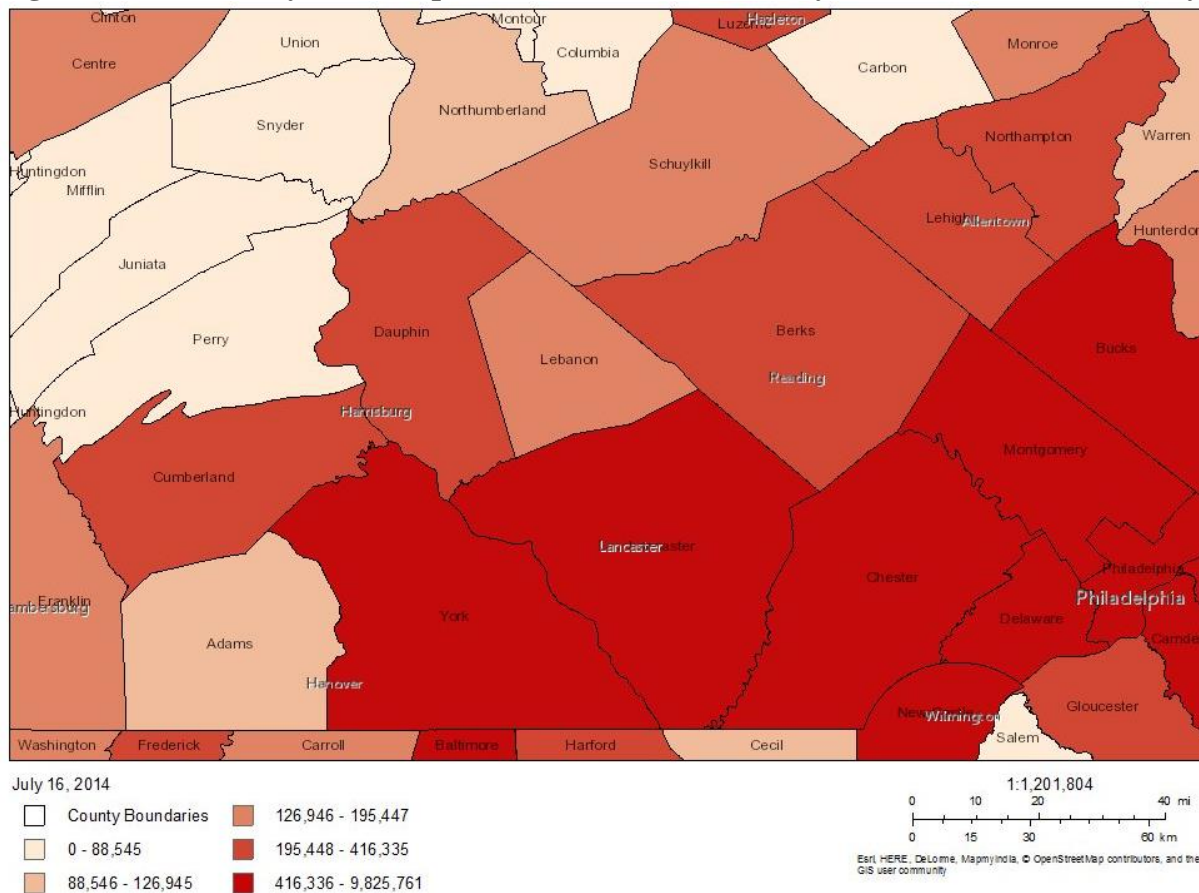
As indicated in Table 6, Lebanon County has low population but has increased in population by 11.1% from 2000. Lancaster County has the largest and most dense population in the area of analysis. Overall, all of the counties in the area of analysis have seen an increase in population from 2000 to 2010 with the exception of Schuylkill County. The above data indicates that population and population density are not influential factors in determining nonattainment boundaries for the Lebanon County.

**Traffic and Vehicle Miles Travelled**

High VMT and/or a high number of commuters associated with a county is generally an indicator that the county is an integral part of an urban area. Mobile source emissions of NO_x, VOC, and direct PM may contribute to ambient particulate matter that contributes to monitored violations of the NAAQS in the area. In combination with the population/population density data and the location of main transportation arteries, an assessment of VMT helps identify the probable location of nonpoint source emissions that contribute to violations in the area. Comparatively high VMT in a county outside of the CBSA or CSA signifies integration with the core urban area contained within the CSA or CBSA, and indicates that a county with the high VMT may be appropriate to include in the nonattainment area because emissions from mobile sources in that county contribute to violations in the area. Table 7 shows 2011 VMT while Figure 7 overlays 2011 county-level VMT with a map of the transportation arteries.

Table 7. 2011 VMT for the Lebanon County

County, State	Total 2011 VMT	Percent	Cumulative %
Lancaster, PA	4,150,294,150	32%	32%
Berks, PA	3,381,679,887	26%	58%
Dauphin, PA	2,800,543,986	22%	80%
Schuylkill, PA	1,373,853,518	11%	91%
Lebanon, PA	1,179,030,237	9%	100%
Total	**12,885,401,778**		

http://www.census.gov/hhes/commuting/data/commuting.html

Figure 7. Overlay of 2011 County-level VMT with Transportation Arteries.
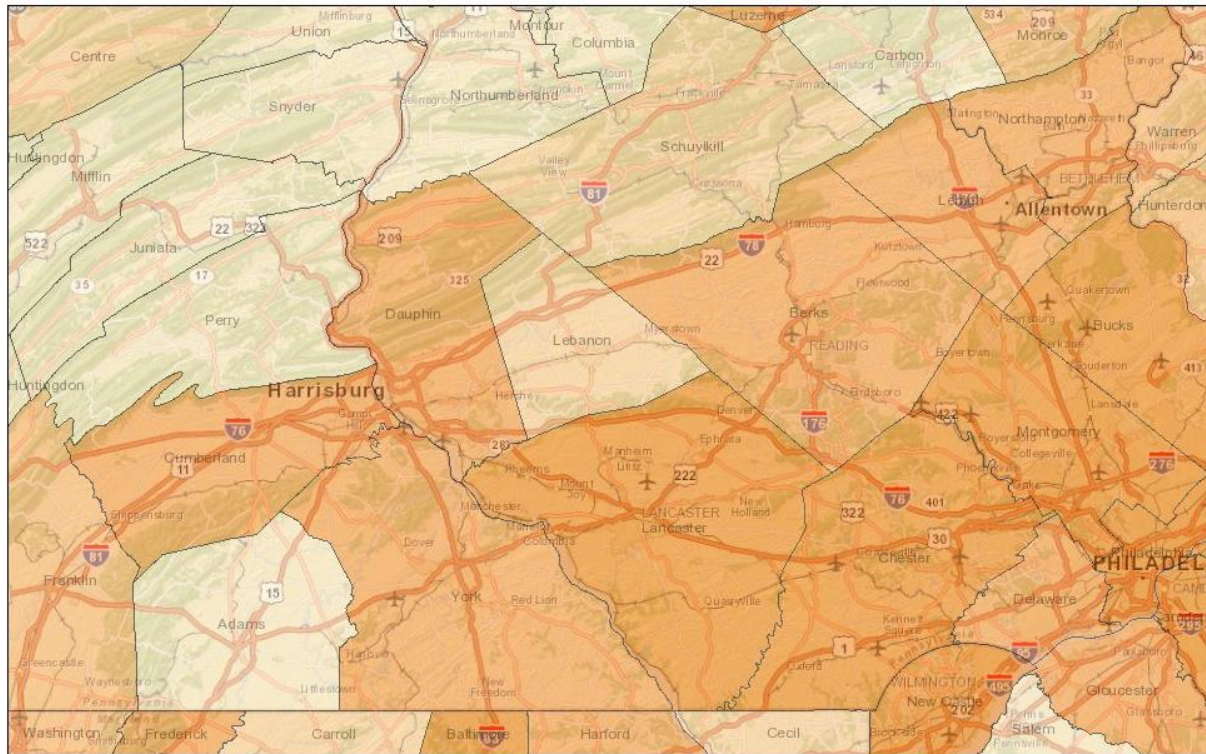
July 16, 2014

County Boundaries

599,895 - 976,630,208

976,630,208 - 1,384,531,029

1,384,531,029 - 2,026,739,245

2,026,739,245 - 3,701,771,410

3,701,771,410 - 76,095,823,872

1:1,201,804

0   10   20   40 mi

0   15   30   60 km

Sources: Esri, HERE, DeLorme, USGS, Intermap, Increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand).

As the data in Table 7 illustrates, Lebanon County has the lowest VMT in the area of analysis. Lancaster and Berks counties together account for 58% of the total VMT in the area of analysis. As previously mentioned, Lancaster and Berks counties are not in the regional wind direction. Dauphin County has the next highest VMT, but as further discussed in Factor 4, transport of emissions from mobile sources is limited by topography.

Factor 3: Meteorology

EPA evaluated available meteorological data to determine how meteorological conditions, including, but not limited to, weather, transport patterns, and stagnation conditions, could affect the fate and transport of directly emitted particulate matter and precursor emissions from sources in the area of analysis. EPA used two primary tools for this assessment: wind roses and kernel density estimation (KDE). When considered in combination with area $PM_{2.5}$ composition and county-level and facility emissions source location information, wind roses and KDE can help to identify nearby areas contributing to violations at violating monitoring sites.

Wind roses are graphic illustrations of the frequency of wind direction and wind speed. Wind direction can indicate the direction from which contributing emissions are transported; wind speed can indicate the force of the wind and thus the distance from which those emissions are transported. EPA

constructed wind roses from hourly observations of wind direction and wind speed using 2009-2012 data from National Weather Service locations archived at the National Climate Data Center.[124] When developing these wind roses, EPA also used wind observations collected at meteorological sampling stations collocated at air quality monitoring sites, where these data were available. Figure 8 shows wind roses that EPA generated from data relevant in the Lebanon County.

Figure 8. Wind Roses in the Area of Analysis for Lebanon County.
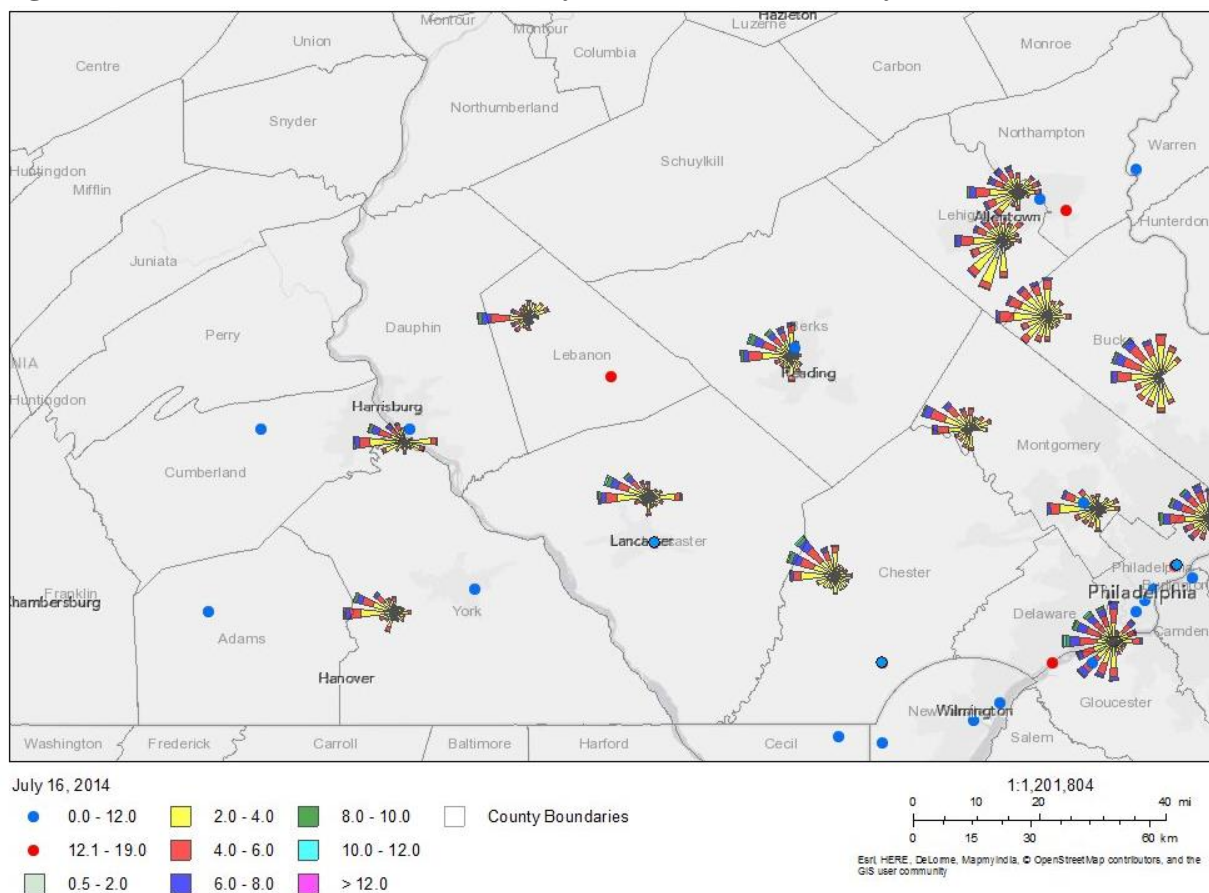
As shown in Figure 8, the predominant winds near the violating monitor are from the west with some northwesterly components. These wind roses represent average wind directions throughout the year. According to Table 3a, Lancaster and Berks counties have high PM$_{2.5}$ emissions, however, they are south and east, respectively, of the Lebanon County monitor. Dauphin County is to the west of the Lebanon monitor. Dauphin County does not have any major point sources with emissions of 500 tpy or more, but does have some population and VMT. However, as discussed in Factor 4 below, topography limits transport of low level emissions, such as mobile emissions, from Dauphin County.

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[124] *ftp.ncdc.noaa.gov/pub/data/noaa* or
http://gis.ncdc.noaa.gov/map/viewer/#app=cdo&cfg=cdo&theme=hourly&layers=1&node=gis Quality assurance of the National Weather Service data is described here: *http://www1.ncdc.noaa.gov/pub/data/inventories/ish-qc.pdf*

In addition to wind roses, EPA also generated kernel density estimation (KDE) plots to represent HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) backward trajectory frequency at violating monitoring sites.[125,126] These KDEs are graphical statistical estimations to determine the density of trajectory endpoints at a particular location represented by a grid cell. EPA used KDEs to characterize and analyze the collection of individual HYSPLIT backward trajectories.[127] Higher density values, indicated by darker blue colors, indicate a greater frequency of observed trajectory endpoints within a particular grid cell. Figure 9 shows HYSPLIT KDE plots for the Lebanon County summarized by calendar quarter for the 2010-2012 period. The HYSPLIT KDE plots are weighted in the northwesterly and westerly directions, indicating a greater frequency of trajectories passing over grid cells to the west and northwest.

Figure 9. HYSPLIT Kernel Density Estimation Plots for the Lebanon County.
**First Quarter**   **Second Quarter**

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[125] In some past initial area designations efforts, EPA has used HYSPLIT backward trajectories to assist in determining nonattainment area boundaries. A HYSPLIT backward trajectory is usually depicted on a standard map as a single line, representing the centerline of an air parcel's motion, extending in two dimensional (x,y) space from a starting point and regressing backward in time to a point of origin. Backward trajectories may be an appropriate tool to assist in determining an air parcel's point of origin on a day in which a short-term standard, such as an 8-hour standard or a 24-hour standard, was exceeded. However, for an annual standard, such as the 2012 annual $PM_{2.5}$ NAAQS, every trajectory on every day is important. Plotting a mass of individual daily (e.g., 365 individual back trajectories), or more frequent, HYSPLIT trajectories may not be helpful as this process is likely to result in depicting air parcels originating in all directions from the violating monitoring site.

[126] HYSPLIT - Hybrid Single Particle Lagrangian Integrated Trajectory Model, *http://www.arl.noaa.gov/HYSPLIT_info.php*

[127] The KDEs graphically represent the aggregate of HYSPLIT backward trajectories for the years 2010-2012, run every third day (beginning on the first day of monitoring), four times each day, and ending at four endpoint heights.
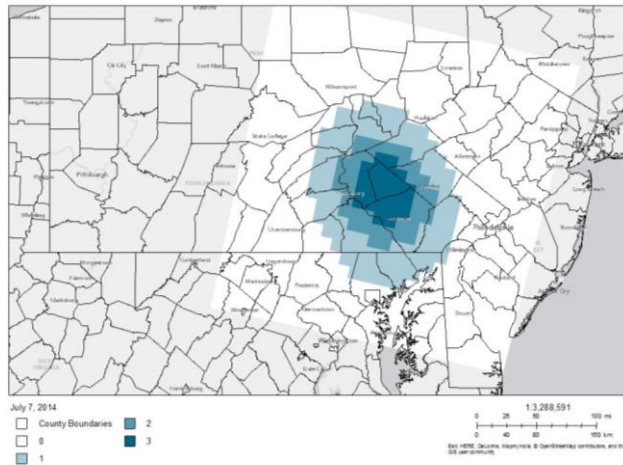
**Third Quarter**   **Fourth Quarter**
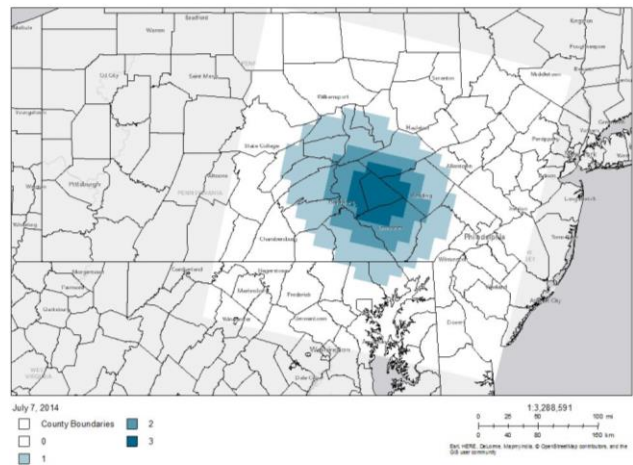
Both the wind roses and HYSPLIT KDE plots indicate that prevailing winds in the Lebanon County area are westerly. The counties with the highest emissions in the area of analysis, Lancaster and Berks, therefore are not upwind of the violating monitor. Lancaster County is south of the violating monitor, and Berks County is to the east. Lebanon County falls in the higher density grid cells which indicate a very high potential for transport (darkest blue) in all four quarters. The Carmeuse Lime facility in Lebanon County is 9 miles west of the Lebanon County monitor. Parts of Dauphin County also fall in the higher density grid cells. There are no major sources in Dauphin County and, as discussed in Factor 4 below, mountains to the north and west of the monitor may limit transport of low level emissions, such as mobile emissions, from Dauphin County.

Factor 4: Geography/topography

To evaluate the geography/topography factor, EPA assessed physical features of the area of analysis that might define the airshed and thus affect the formation and distribution of $PM_{2.5}$ concentrations over the area.

Topography is an important factor, as Lebanon County is in a river valley almost entirely surrounded by low mountains. The mountains to the north of the Lebanon County monitor run from the southwest to the northeast and provide a physical barrier between Schuylkill and Dauphin counties and the violating monitor. These mountains limit transport of low-level emissions, such as mobile emissions, and impact meteorology and $PM_{2.5}$ formation.

Figure 10. Topography of the Lebanon County and Surrounding Area
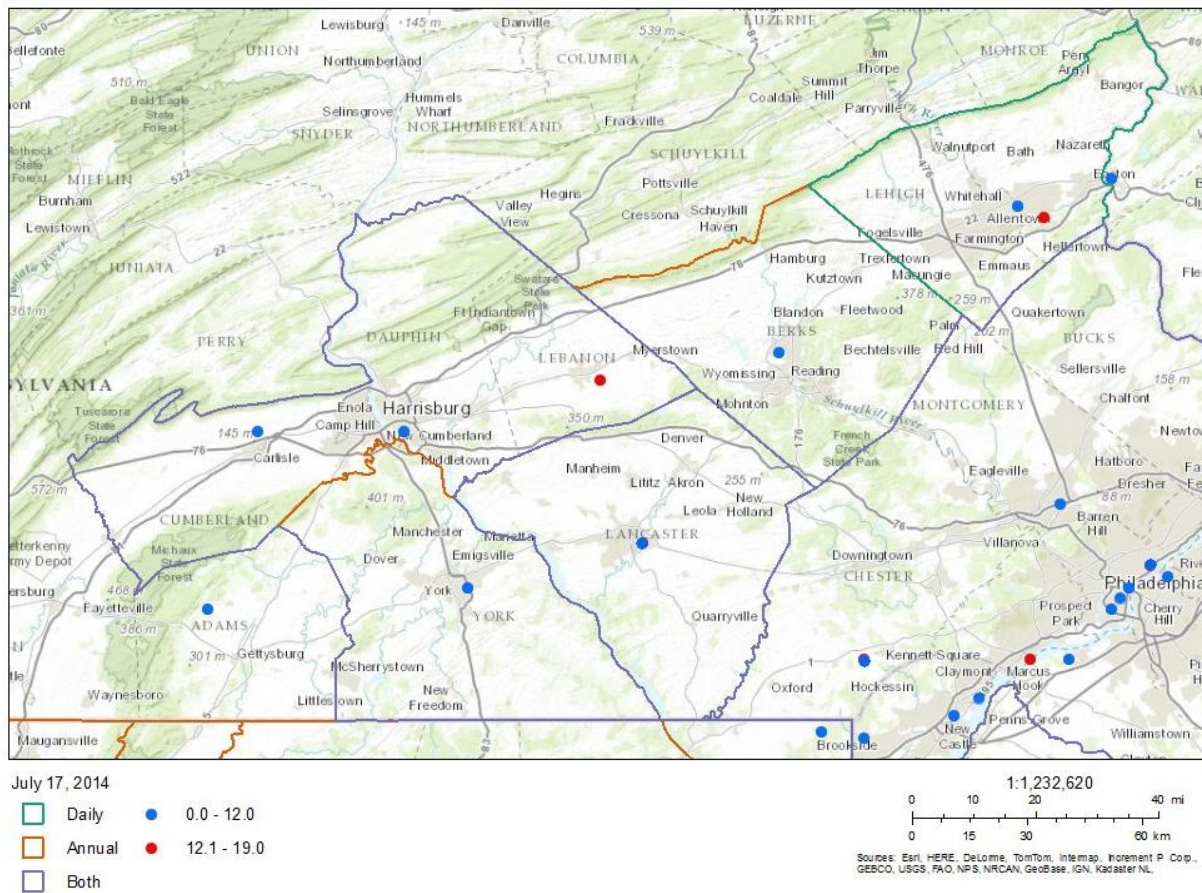
Factor 5: Jurisdictional boundaries

In defining the boundaries of the final Lebanon County nonattainment area, EPA considered existing jurisdictional boundaries, which can provide easily identifiable and recognized boundaries for purposes of implementing the NAAQS. Existing jurisdictional boundaries often signify the state and local governmental organization with the necessary legal authority for carrying out air quality planning and enforcement functions for the area. Examples of such jurisdictional boundaries include existing/prior nonattainment area boundaries for particulate matter, county lines, air district boundaries, township boundaries, areas covered by a metropolitan planning organization, state lines, and Reservation boundaries, if applicable. Where existing jurisdictional boundaries were not adequate or appropriate to describe the nonattainment area, EPA considered other clearly defined and permanent landmarks or geographic coordinates for purposes of identifying the boundaries of the designated areas.

The violating monitor is located in the Lebanon, Pennsylvania MSA. This is a single county MSA which consists of Lebanon County, Pennsylvania. The Lebanon, Pennsylvania MSA is served by the Lebanon County Metropolitan Planning organization.

The Lebanon County has previously established nonattainment boundaries associated with the 1997 annual and the 2006 24-hour $PM_{2.5}$ NAAQS. Lebanon County is part of the Harrisburg-Lebanon-Carlisle nonattainment area for the 1997 annual $PM_{2.5}$ NAAQS. That area consists of Cumberland, Dauphin, Lebanon Counties. For the 2006 24-hour $PM_{2.5}$ NAAQS, Lebanon County is part of the Harrisburg-Lebanon-Carlisle-York nonattainment area, which also includes Cumberland, Dauphin, and York Counties. EPA does not believe that the counties included in those nonattainment areas, Cumberland, Dauphin, and York Counties, contribute to the violation at the Lebanon County monitor.

Conclusion for the Lebanon County

Based on the assessment of factors described above, both individually and in combination, EPA has concluded that only Lebanon County should be included in the Lebanon County nonattainment area because it is violating the 2012 annual $PM_{2.5}$ NAAQS. EPA does not believe that the other counties in the area of analysis contribute to the violation in Lebanon County.

Seasonal variation can highlight those conditions most associated with high average concentration levels of $PM_{2.5}$. The Lebanon County monitor does not follow the seasonal pattern seen at the other monitors in the area of analysis. The other three monitors in Berks, Dauphin and Lancaster counties tend to track together, with higher first and third quarters, but the Lebanon County monitor does not have a clear seasonal pattern, indicating local influences at the violating monitor.

Organic mass and elemental carbon are the major components of the urban increment at the Lebanon County monitor. These components suggests that the sources of $PM_{2.5}$ are local in nature and could result from mobile, area or local industrial sources.

Lancaster County has the highest total emissions of directly emitted $PM_{2.5}$ and its precursors in the area of analysis. The $PM_{2.5}$ emissions in Lebanon and Dauphin counties are mainly NO_X and VOC emissions. Lebanon County also has a high level of NH_3 emissions. Looking at the components of $PM_{2.5}$, Lancaster and Berks counties have high POM, EC and VOC emissions, however, Lancaster and Berks counties are less likely to contribute to the Lebanon County violating monitor due to wind direction. Dauphin, Schuylkill and Lebanon counties have similar levels of POM, EC and VOC emissions.

There are large point sources (over 500 tpy) to the northeast and east of the violating Lebanon monitor in Schuylkill County and Berks County, respectively. There is one point source in Lebanon County and there are no point sources in Dauphin County. Dauphin County does have a moderate size population and amount of VMT which likely indicate mobile or area sources of emissions.

Both the wind roses and HYSPLIT KDE plots indicate that prevailing winds in the Lebanon County area are westerly. The counties with the highest emissions in the area of analysis, Lancaster and Berks, therefore are not upwind of the violating monitor. Lancaster County is south of the violating

monitor, and Berks County is to the east. Sources to the north in Schuylkill County are also not in the regional wind direction and therefore less likely to contribute to the Lebanon County monitor.

Topography is an important factor, as Lebanon County is in a river valley almost entirely surrounded by low mountains. The mountains to the north of the Lebanon County monitor run from the southwest to the northeast and provide a physical barrier between Schuylkill and Dauphin Counties and the violating monitor. These mountains limit transport of low-level emissions from these counties, such as mobile emissions, and impact meteorology and $PM_{2.5}$ formation.

Lebanon County is in a single county MSA, served by a single county MPO. Lebanon County is in a river valley almost entirely surrounded by low mountains. These mountains limit transport of low-level emissions and impact meteorology and $PM_{2.5}$ formation.

The Lebanon County has previously established nonattainment boundaries associated with the 1997 annual and the 2006 24-hour $PM_{2.5}$ NAAQS. However, EPA does not believe that the counties included in those nonattainment areas, Cumberland, Dauphin, and York Counties, contribute to the violation at the Lebanon County monitor.