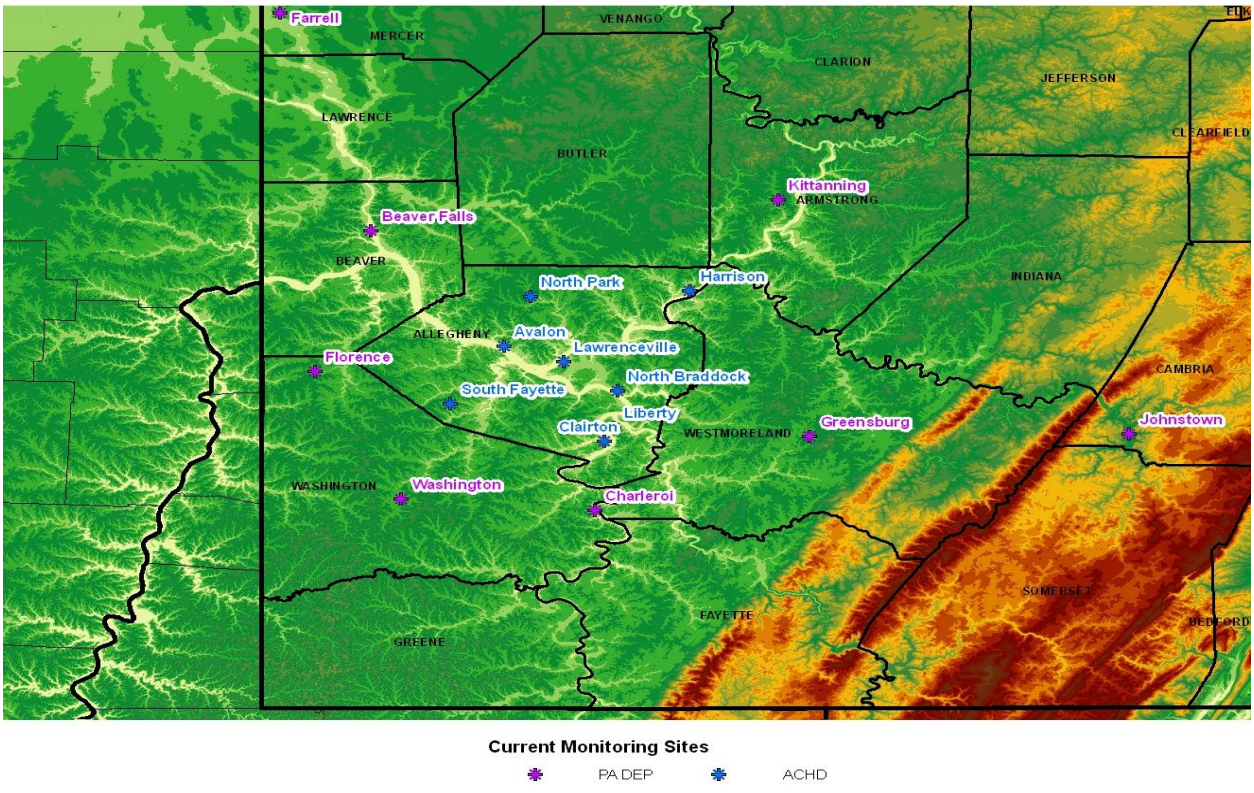
Appendix C-5
GREATER PITTSBURGH AREA

The Department is recommending a Greater Pittsburgh annual $PM_{2.5}$ NAAQS nonattainment area consisting of Westmoreland and Allegheny counties, with the exception of the Liberty-Clairton area of Allegheny County. The Department completed an analysis of the $PM_{2.5}$ ambient air quality data, which outlines the reason for recommending a smaller nonattainment area than the Pittsburgh-Beaver Valley nonattainment area for the 1997 and 2006 $PM_{2.5}$ standards. This analysis is provided below.

Analysis of the Ambient $PM_{2.5}$ Data – A Design Value Contribution Analysis

Based on EPA-certified 2012 $PM_{2.5}$ design values, three monitors in the Pittsburgh metropolitan statistical area (MSA) are violating the 2012 $PM_{2.5}$ annual standard of 12 µg/m^3. The monitors and their design values are: Avalon (AIRS # 42-003-0002) at 13.4 µg/m^3 (in Allegheny County), North Braddock (AIRS # 42-003-1301) at 12.5 µg/m^3 (in Allegheny County) and Greensburg (AIRS # 42-129-0008) at 12.6 µg/m^3 (in Westmoreland County). Figure C-5.1 is a map outlining the location of these monitors, along with monitors in attainment, in the Pittsburgh MSA.

Figure C-5.1: Pittsburgh MSA $PM_{2.5}$ Monitoring Map



The Department has completed a design value contribution analysis for all of the $PM_{2.5}$ monitors in the Pittsburgh MSA. The analysis attempts to determine the daily contribution of $PM_{2.5}$ concentrations to the annual $PM_{2.5}$ design value. Daily $PM_{2.5}$ measurements were grouped into different $PM_{2.5}$ concentration ranges. An analysis of each range's contribution was then conducted to determine which measurements are contributing to the monitor's design value. Dates of these measurements were then further analyzed to determine if there are specific meteorological conditions or sources that are adversely impacting the monitor's design value.

Results from the design value contribution analysis for the Pittsburgh MSA are summarized in Table C-5.1. Ultimately, the type of contribution a given monitor's daily value had on the 3-year design value (by comparing this value to 12 $\mu g/m^3$) was determined. The design value for each day a monitor measured $PM_{2.5}$ levels was placed in one of the ten categories. For example, on January 1, 2010, the Greensburg monitor's 24-hour $PM_{2.5}$ average was 12.8 $\mu g/m^3$. Since this value falls in the 12-18 $\mu g/m^3$ category in Table C-5.1, the calculated daily contribution to the design value was placed in this category. In the first quarter of 2010 (January 1 to March 31), the Greensburg monitor recorded 82 measurements. The Department determined that the January 1, 2010, contribution assessment to the 2012 design value was 0.000813 $\mu g/m^3$. The 0.000813 $\mu g/m^3$ was calculated by dividing the average daily value of 12.8 $\mu g/m^3$ by a factor of the number of measurements for the quarter (82) by 12 (there are a total of 12 quarters in a 3-year design value period). This type of analysis was completed for every day of measurements from January 1, 2010, through December 31, 2012. In Table C-5.1, the sum of the categorical breakdowns for the Greensburg monitor equals 0.57 $\mu g/m^3$, which demonstrates that the design value is 0.57 $\mu g/m^3$ above the annual standard of 12 $\mu g/m^3$.

Table C-5.1: Pittsburgh MSA
2012 $PM_{2.5}$ Annual Design Value Contribution Analysis

Site Name	Site ID	Owner	0 - 6.0	6.0 - 12.0	12.0 - 18.0	18.0 - 24.0	24.0 - 30.0	30.0 - 36.0	36.0 - 42.0	42.0 - 48.0	48.0 - 54.0	54.0 - 60.0	Sum
Monitors Attaining 2012 PM 2.5 Standard													
Florence	421255001	PA DEP	-3.7384	-1.4990	0.2361	0.1479	0.0553	0.0180	0.0000	0.0000	0.0000	0.0000	-4.7802
North Park	420030093	ACHD	-2.4093	-1.3915	0.4085	0.3873	0.3814	0.0000	0.0000	0.0000	0.0000	0.0000	-2.6236
South Fayette	420030067	ACHD	-1.5156	-1.6051	0.6252	0.4972	0.1753	0.2974	0.0000	0.0000	0.0000	0.0000	-1.5257
Lawrenceville	420030008	ACHD	-1.5307	-1.3301	0.6605	0.7516	0.3579	0.1419	0.0570	0.0000	0.0000	0.0000	-0.8918
Washington	421250200	PA DEP	-1.4587	-1.2800	0.7331	0.6447	0.3396	0.1206	0.0272	0.0000	0.0000	0.0000	-0.8733
Kittanning	420050001	PA DEP	-1.1986	-1.3255	0.6721	0.8285	0.3825	0.2133	0.0504	0.0301	0.0000	0.0000	-0.3472
Harrison	420031008	ACHD	-1.3211	-1.2859	0.7535	0.9858	0.2371	0.2225	0.0824	0.0000	0.0000	0.0000	-0.3256
Charleroi	421250005	PA DEP	-1.2256	-1.2403	0.7532	0.9015	0.4113	0.1218	0.1404	0.0000	0.0000	0.0000	-0.1376
Beaver Falls	420070014	PA DEP	-1.3739	-1.0749	0.8021	0.9574	0.4968	0.1791	0.0473	0.0000	0.0000	0.0000	0.0339
Monitors Not Attaining 2012 PM 2.5 Standard													
North Braddock	420031301	ACHD	-1.4699	-1.1114	0.7052	1.1313	0.7039	0.3106	0.2247	0.0000	0.0000	0.0000	0.4944
Greensburg	421290008	PA DEP	-1.0231	-1.2125	0.7203	1.0369	0.6247	0.1940	0.2290	0.0000	0.0000	0.0000	0.5693
Avalon	420030002	ACHD	-0.7746	-1.1588	0.7307	1.2707	0.7243	0.3252	0.2649	0.0300	0.0340	0.0000	1.4464
Greater Pittsburgh Regional Average			-1.5866	-1.2929	0.6500	0.7951	0.4075	0.1787	0.0936	0.0050	0.0028	0.0000	

Table C-5.1 illustrates the differences between the monitors that are attaining the 2012 $PM_{2.5}$ annual standard and the monitors that are not attaining the 2012 $PM_{2.5}$ annual standard. The monitors that are not attaining the standard have relatively fewer "clean" days (0-12 µg/m^3) than the monitors that are attaining the standard. For example, the Greensburg monitor's $PM_{2.5}$ contribution to the design value in the 0-12 µg/m^3 range was 0.7 µg/m^3 lower than the average in the Pittsburgh MSA.

The analysis described in the remainder of this Appendix focuses on the Greensburg monitor because it is the only monitor above the standard that also has a speciation monitor.
Figure C-5.2a illustrates the trend of annual averages while Figure C-5.2b illustrates the trend of annual design values for monitors in the Pittsburgh MSA. Of the three monitors measuring nonattainment, the Greensburg monitor is the monitor with the smallest level of decline in its annual design value from 2005 to 2012. Since 2003, annual $PM_{2.5}$ levels have been in a general decline in the Pittsburgh MSA. Over the last three years, annual averages at the Avalon monitor have fallen at a significant rate. If the trend continues, the Avalon monitor's 2013 design value is expected to reach attainment of the 12 µg/m^3 standard. A total of nine monitors in the Pittsburgh MSA are attaining the 2012 standard and continue to show a decline in annual average and annual design values: four monitors in Allegheny County (Lawrenceville, South Fayette, North Park and Harrison monitors), three monitors in Washington County (Charleroi, Washington and Florence monitors), one monitor in Beaver County (Beaver monitor) and one monitor in Armstrong County (Kittanning monitor).

Figure C-5.2a: Pittsburgh MSA $PM_{2.5}$ Annual Averages

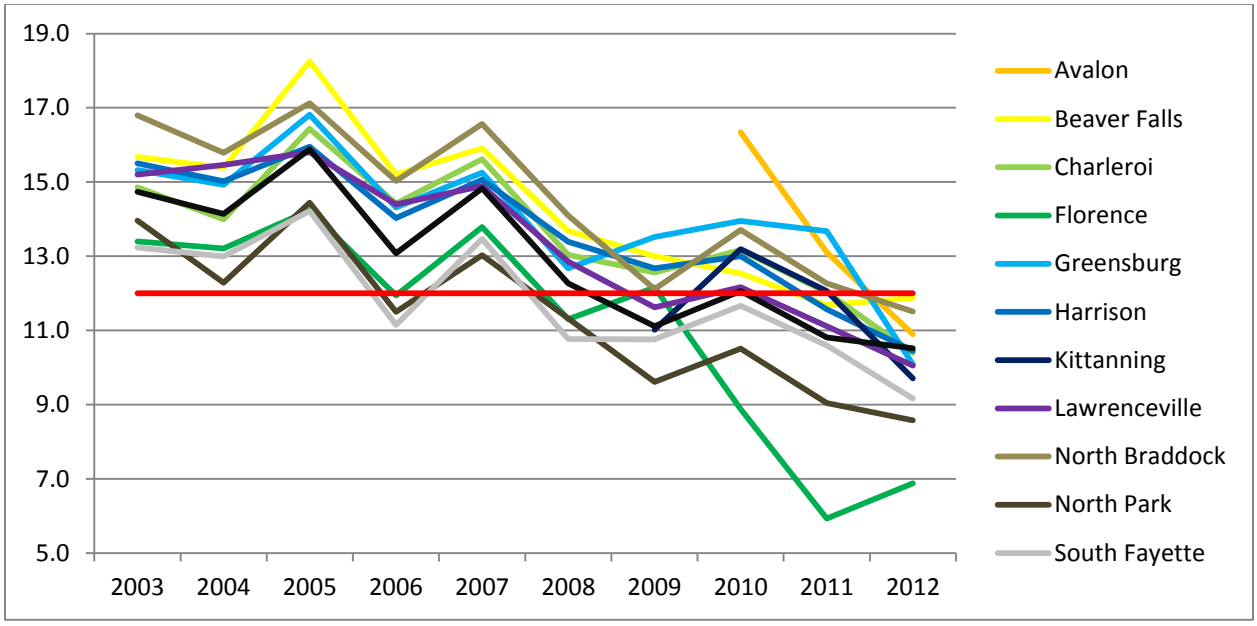
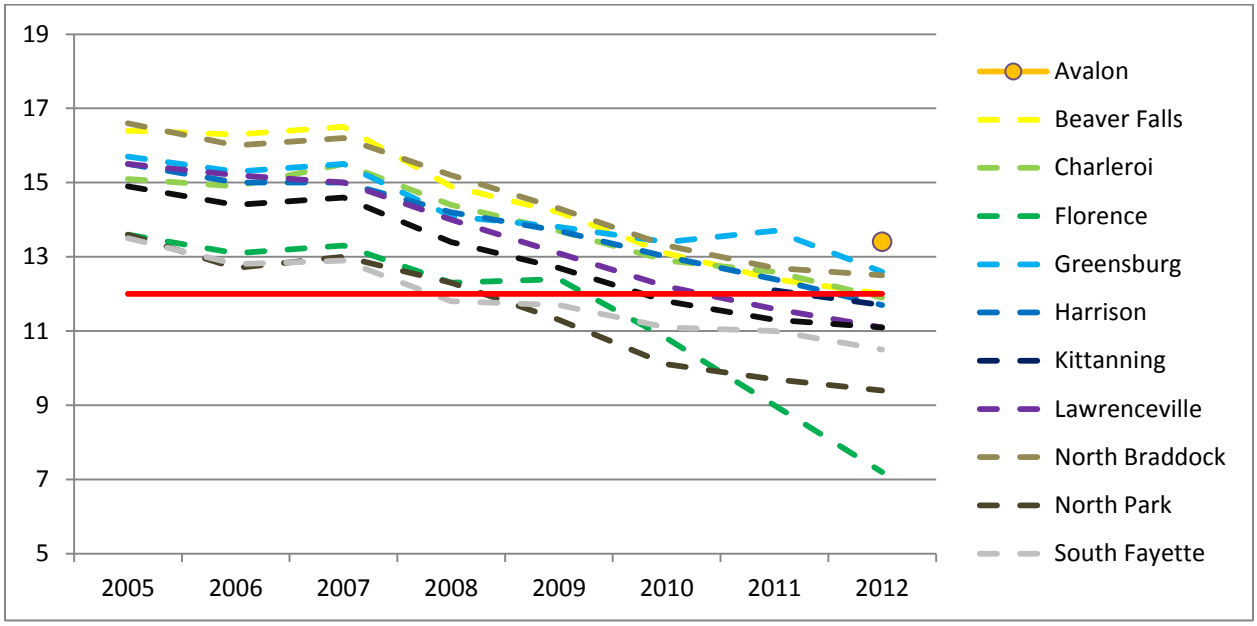


Figure C-5.2b: Pittsburgh MSA $PM_{2.5}$ Annual Design Values



Additional analyses were completed to determine what was contributing to the fewer number of "clean" days at the Greensburg monitor. The Department identified days when the Greensburg monitor's $PM_{2.5}$ concentrations were relatively high but regional monitoring concentrations in the Pittsburgh MSA were "clean." Between 2010 and 2012, the Department identified 189 days in which the Greensburg monitor was at least one standard deviation above the Pittsburgh MSA regional average while the regional average was at or below 12 µg/m^3. The most extreme events (top 25%) were further analyzed to determine why the Greensburg monitor's concentrations were high when regional concentrations were low.

Meteorological Conditions Impacting High $PM_{2.5}$ Days at the Greensburg Monitor

The top 25% days were examined to determine the reason the Greensburg monitor's concentrations were high. The Greensburg monitor has a collocated meteorological tower that monitors wind direction and wind speed. Figure C-5.3 illustrates the number of hours the wind is coming from a particular direction, while Figure C-5.4 illustrates the total $PM_{2.5}$ concentration coming from a particular direction.

Figure C-5.3: Greensburg Wind Direction Frequency
Top 25% of Regionally "Clean" Days

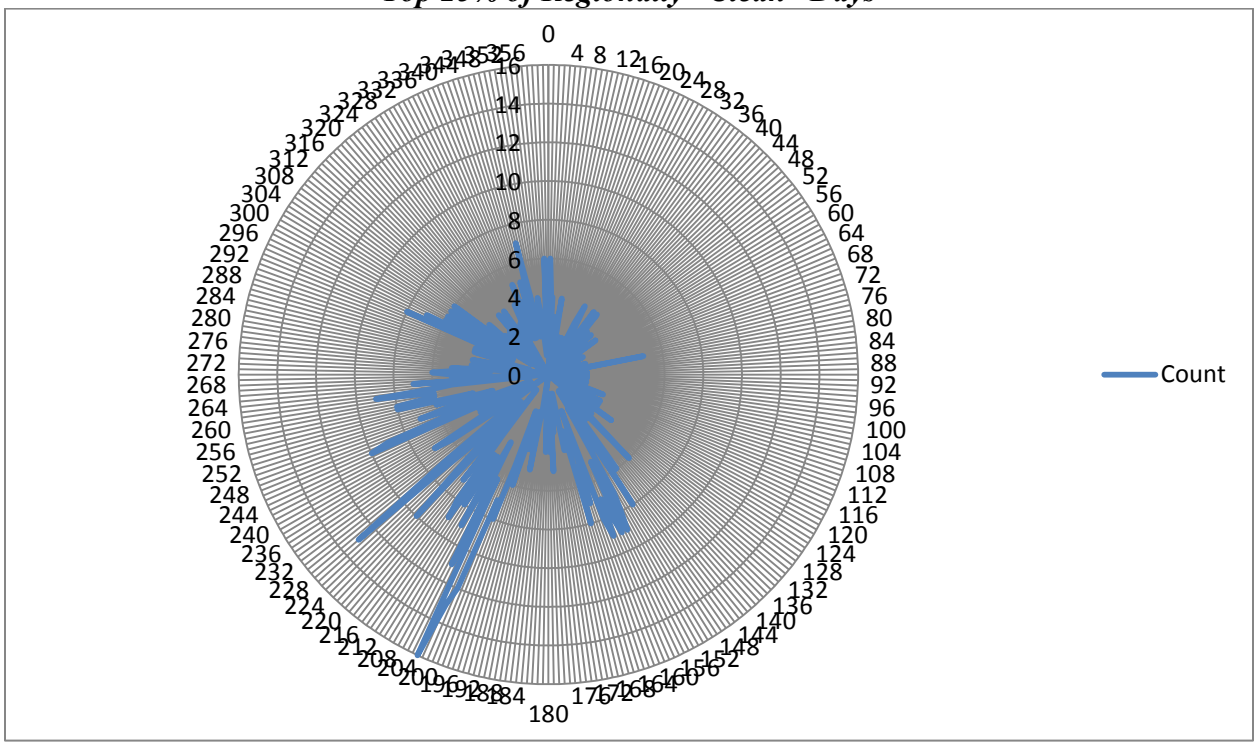


Figure C-5.4: Greensburg $PM_{2.5}$ Concentration Distribution by Wind Direction
Top 25% of Regionally "Clean" Days

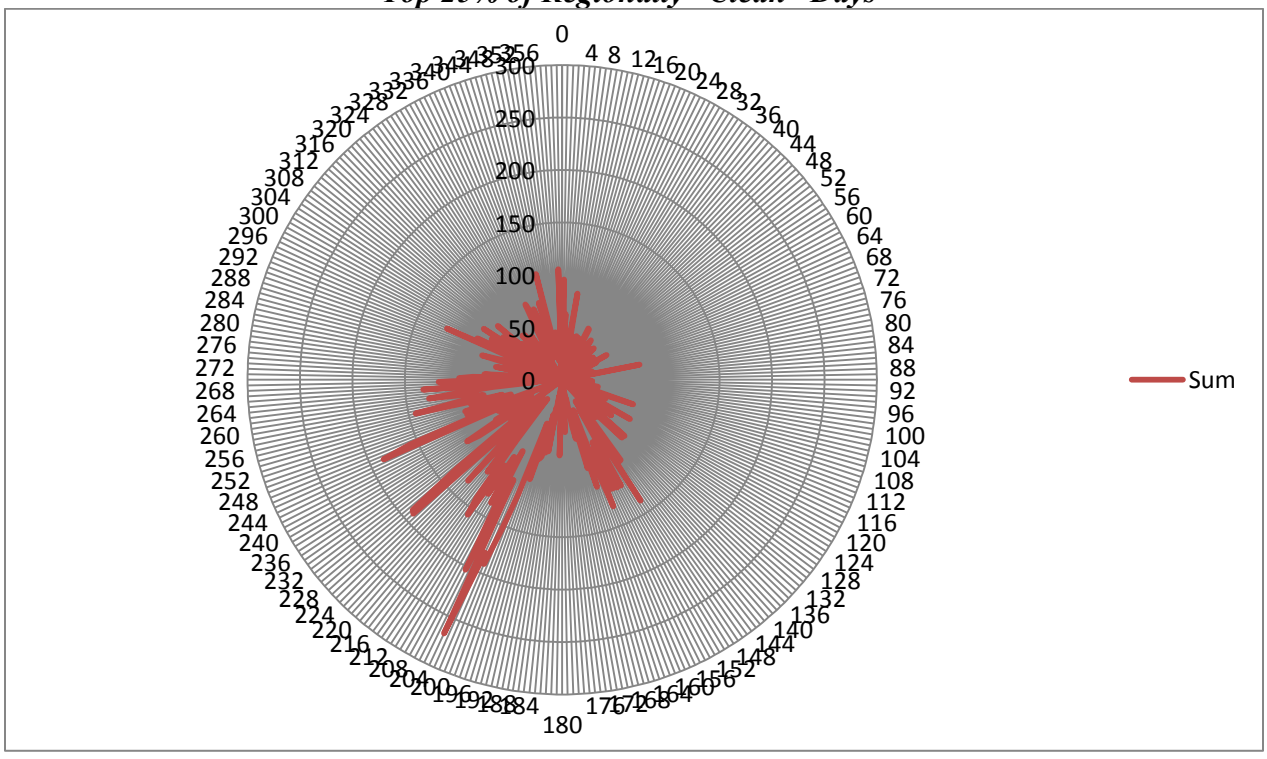
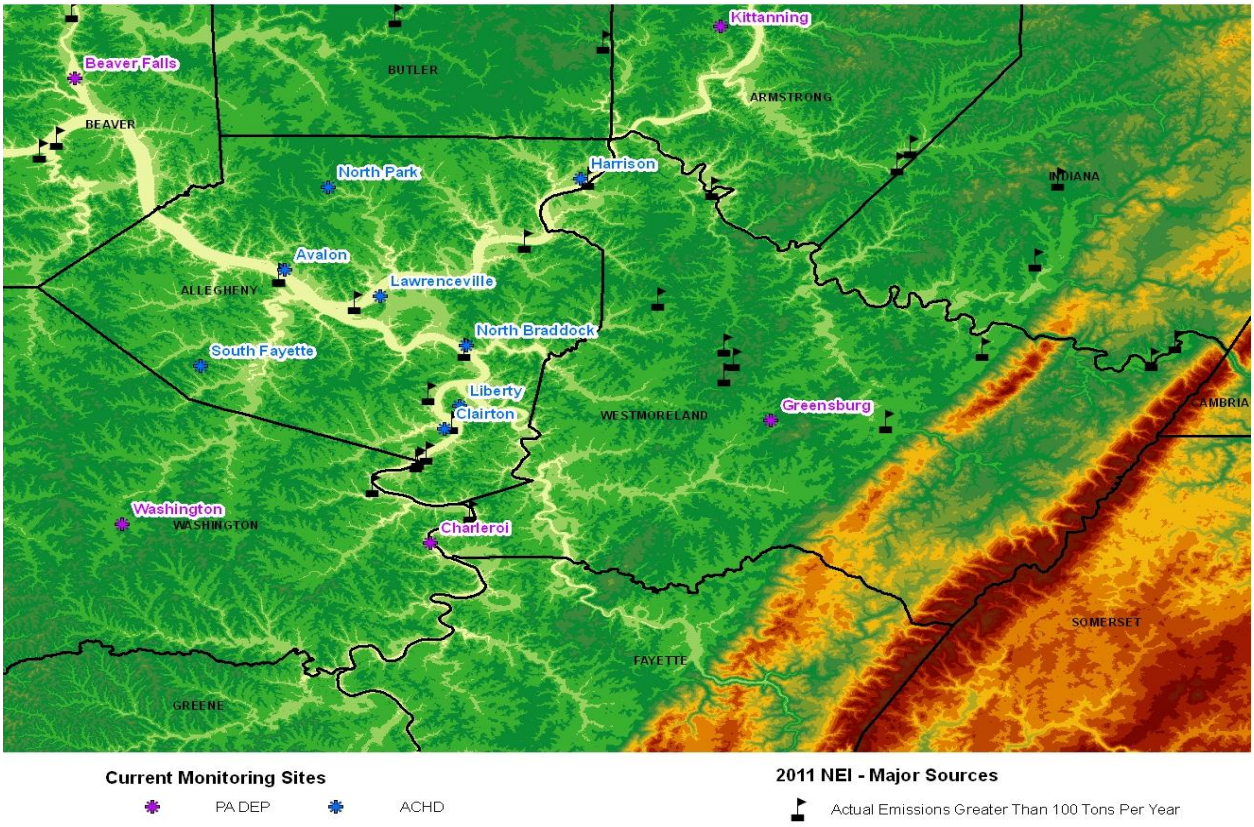


Figure C-5.3 illustrates that the highest frequency of wind distribution on the top 25% days is coming from the southwest. Figure C-5.4 illustrates that the highest $PM_{2.5}$ concentrations are coming from the same direction. These graphs also illustrate the local nature of the problem. Developed from the EPA PM online tool (http://geoplatform2.epa.gov/PM_Map/), Figure C-5.5 illustrates the sources within the immediate proximity of the Greensburg monitor.

Figure C-5.5: Greater Pittsburgh Area
Major Sources (Over 100 Tons Per Year) Based on 2011 NEI



There are multiple major sources of $PM_{2.5}$, SO_2, and NO_X that are in close proximity of the Greensburg monitor. The wind direction analysis above shows that the predominant winds on the top 25% days travel directly over these sources. This analysis indicates the local nature of the problem near the Greensburg monitor.

The Change in the Composition of the $PM_{2.5}$

The Greensburg monitor has been recording speciated data since 2002. The composition of $PM_{2.5}$ has changed at the Greensburg monitor since the height of $PM_{2.5}$ concentrations in the 2005 to 2007 time period. Table C-5.2 outlines the main speciated components of $PM_{2.5}$ during the cold season (1st quarter). Table C-5.3 outlines the main speciated components of $PM_{2.5}$

during the warm season (3rd quarter). Overall, Table C-5.2 and Table C-5.3 illustrate the decline in the main speciated components of $PM_{2.5}$ from the 2005 to 2007 period to the 2010 to 2012 period.

Table C-5.2: Greensburg Speciated $PM_{2.5}$ Data*
Cold Season (1st Quarter) Comparison – 2005-07 Versus 2010-12

Year	Ammonium	Nitrate	Sulfate	OC	EC	Crustal
2005 – 07	1.69197627	2.09586219	3.32282328	3.34094542	0.72165949	0.40138048
2010 – 12	1.30488858	1.97861036	2.47803878	2.26913328	0.36529170	0.43543027
Difference (2005 – 07 minus 2010 – 12)	0.38708768	0.11725183	0.84478451	1.07181214	0.35636779	-0.03404979

*All concentrations are averages and have units of $\mu g/m^3$

Table C-5.3: Greensburg Speciated $PM_{2.5}$ Data*
Warm Season (3rd Quarter) Comparison – 2005-07 Versus 2010-12

Year	Ammonium	Nitrate	Sulfate	OC	EC	Crustal
2005 – 07	2.91335067	0.61523158	9.05785547	4.16522571	0.63412385	0.81919754
2010 – 12	1.19283974	0.46790007	4.04125965	2.92687463	0.39794990	0.42905305
Difference (2005 – 07 minus 2010 – 12)	1.72051093	0.14733151	5.01659582	1.23835108	0.23617395	0.39014449

*All concentrations are averages and have units of $\mu g/m^3$

During the cold season, there has been an equal amount of reduction in ammonium, nitrate, sulfate, and organic carbon concentrations. During the warm season, the largest reductions have occurred in ammonium, sulfate and organic carbon concentrations.

To analyze this further, we chose to compare these seasonal values with what has occurred in Florence (AIRS # 42-001-0001), located in Washington County. Florence is in a rural location of Pennsylvania and does not have a major nitrogen oxide (NO_X) or sulfur dioxide (SO_2) source within 50 kilometers of the monitor. For that reason, the Florence monitor reflects the transport that is coming into western Pennsylvania from areas to the west (prevailing wind flow is from west to east across Pennsylvania).

Table C-5.4: Florence Speciated $PM_{2.5}$ Data*
Cold Season (1st Quarter) Comparison – 2005-07 Versus 2010-12

Year	Ammonium	Nitrate	Sulfate	OC	EC	Crustal
2005 – 07	1.31827402	1.45532736	3.20309281	2.88969583	0.59347306	0.32894438
2010 – 12	1.15058471	1.85637720	2.43243089	1.73627967	0.17623659	0.25624708
Difference (2005 – 07 minus 2010 – 12)	0.16768931	-0.40104984	0.77066192	1.15341616	0.41723647	0.07269730

*All concentrations are averages and have units of $\mu g/m^3$

Table C-5.5: Florence Speciated $PM_{2.5}$ Data*
Warm Season (3rd Quarter) Comparison – 2005-07 Versus 2010-12

Year	Ammonium	Nitrate	Sulfate	OC	EC	Crustal
2005 – 07	2.15507812	0.34361657	8.17978175	3.32471443	0.35976005	0.83256858
2010 - 12	0.90089860	0.21878832	3.84856214	2.40295511	0.19830720	0.51222953
Difference (2005 – 07 minus 2010 – 12)	1.25417952	0.12482826	4.33121961	0.92175932	0.16145285	0.32033904

*All concentrations are averages and have units of $\mu g/m^3$

The reductions at Florence reflected in the "difference" row of Table C-5.5 are more representative of the reductions observed in western Pennsylvania due to emission control strategies of various sources (for example, the installation of flue gas desulfurization units on electric generation units across western Pennsylvania into the Ohio Valley). The data indicates that the greatest level of reduction at the Greensburg and Florence monitors occurs during the summer months (when sulfate is the primary constituent of $PM_{2.5}$). During the 2005 – 07 time frame, the Florence monitor had a 3rd quarter total mass average of 19.97 $\mu g/m^3$, and during the 2010 – 12 time frame it had a 3rd quarter total mass average of 12.94 $\mu g/m^3$, a 7 $\mu g/m^3$ reduction.

An analysis of the 2010 – 12 differences between the Greensburg and Florence monitors indicates the nature of the problem at Greensburg.

Figure C-5.6: Urban Excess
Greensburg vs. Florence
2010 – 12 - 1st Quarter

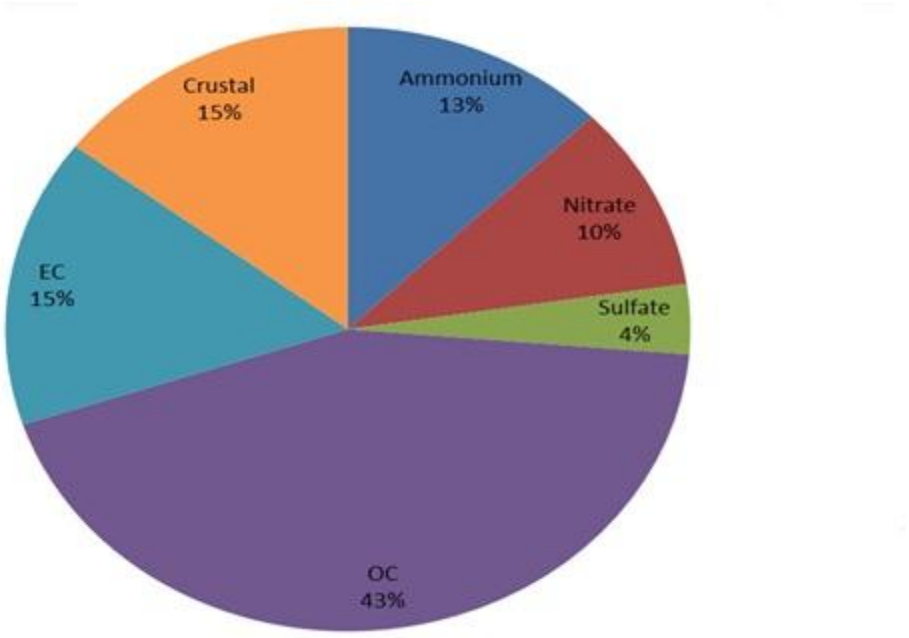


Figure C-5.7: Urban Excess
Greensburg vs. Florence
2010 – 12 – 3rd Quarter

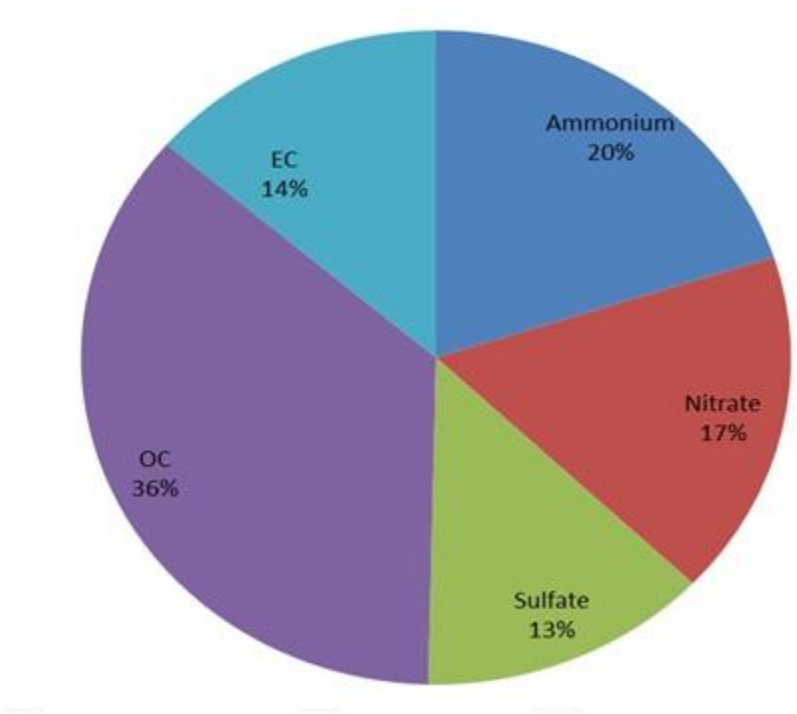


Figure C-5.6 and Figure C-5.7 display the same problem; every major constituent of $PM_{2.5}$ at the Greensburg monitor is in excess when compared to Florence. Overall, the region has seen a drastic reduction in emissions from the 2002 through 2011. Table C-5.6 displays a comparison in the nitrogen oxide (NO_X) emissions from each county in southwestern Pennsylvania (an area including the Pittsburgh MSA plus Greene, Indiana, and Lawrence counties) from the 2002 National Emission Inventory (NEI) to 2011 NEI. The 2002 NEI inventory was used because it was the last national inventory prior to the initiation of a major federal NO_X reduction program (NO_X SIP call) and voluntary SO_2 reduction program (from individual facilities installing scrubbers).

Table C-5.6: NO_X Point Source Emission Comparison 2002 Versus 2011

County	NO_X in 2011 (tons per year)	NO_X in 2002 (tons per year)	% Difference*
Allegheny	10594.2	16225.0	-34.70%
Armstrong	24398.8	23341.7	4.53%
Beaver	15998.7	35426.6	-54.84%
Butler	974.8	1960.3	-50.27%
Fayette	184.3	539.9	-65.87%
Greene	26677.6	23809.1	12.05%
Indiana	28691.7	46948.8	-38.89%
Lawrence	1503.3	7027.4	-78.61%
Washington	2437.5	10938.3	-77.72%
Westmoreland	1506.0	2873.9	-47.60%
TOTAL	112966.9	169091.0	-33.19%

*The percent difference was calculated as 2002 emissions minus 2011 emissions.

In southwestern Pennsylvania, NO_X emissions from 2002 to 2011 have been reduced by one-third (33%). The NO_X SIP call, which was fully implemented in the 2003 – 04 time frame, reduced NO_X emissions from the electric generation unit sector. These reductions can be seen in Table C-5.6. Table C-5.7 displays a comparison in the SO_2 emissions from each county in southwestern Pennsylvania from the 2002 NEI to 2011 NEI.

Table C-5.7: SO_2 Point Source Emission Comparison 2002 Versus 2011

County	SO_2 in 2011 (tons per year)	SO_2 in 2002 (tons per year)	% Difference*
Allegheny	13392.7	47196.8	-71.62%
Armstrong	72216.9	183156.1	-60.57%
Beaver	26703.2	40840.2	-34.62%
Butler	597.6	2265.0	-73.61%
Fayette	10.9	260.6	-95.81%
Greene	2373.2	159506.4	-98.51%
Indiana	97799.1	122465.5	-20.14%
Lawrence	7534.9	28808.6	-73.84%
Washington	1420.3	6611.8	-78.52%
Westmoreland	177.1	541.5	-67.29%
TOTAL	222226.0	591652.7	-62.44%

*The percent difference was calculated as 2002 emissions minus 2011 emissions.

Overall, county wide point source emissions for SO_2 have been reduced by approximately two-thirds (62%) since 2002. As a result of the installation of scrubbers from several of Pennsylvania's coal fired electric generation units, we have seen SO_2 reductions exceeding 95% in some counties.

The emission reductions in NO_X and SO_2 in southwestern Pennsylvania correlate well with the results we are seeing in the speciation data network. The differences in speciation profiles between the Greensburg monitor, at which the 2012 annual $PM_{2.5}$ design value is not attaining the standard, and the Florence monitor, at which the 2012 annual $PM_{2.5}$ design value is attaining the standard, signify the local nature of the problem. The Florence monitor is situated in a location that captures the transport of pollutants from areas to the west (the industrialized Ohio Valley region). The excess amount of sulfate, nitrate, carbon and ammonium at the Greensburg monitor can be contributed to sources within southwestern Pennsylvania.

Summary

The Department's analysis illustrates the need for one small two-county nonattainment area (containing one partial county) in southwestern Pennsylvania. An analysis of the $PM_{2.5}$ data monitored at the Greensburg monitor in Westmoreland County illustrates that the monitor sees concentrations in the 12-30 $\mu g/m^3$ range while the regional concentrations are in the 0-12 $\mu g/m^3$ range. A further examination into the monitoring data demonstrates that the high concentrations are coming out of the southwest. An analysis of the speciated data at the Greensburg and Florence monitors illustrates the excess sulfate, nitrate, ammonium, and carbon at the Greensburg monitor. The Greensburg monitor has a 2012 annual design value that exceeds the 2012 annual $PM_{2.5}$ NAAQS. The Avalon and North Braddock monitors in Allegheny County also have 2012 annual design values that exceed the 2012 annual $PM_{2.5}$ NAAQS. The other monitors in the Pittsburgh MSA (namely the Lawrenceville, South Fayette, North Park and Harrison monitor in Allegheny County, Charleroi, Washington and Florence monitors in Washington County, Beaver monitor in Beaver County and Kittanning monitor in Armstrong County) are monitoring attainment of the 2012 standard, are continuing to have a general decline in the annual average, and are not contributing to excess emissions elsewhere. Therefore, the Department is recommending a Greater Pittsburgh nonattainment area encompassing Westmoreland and Allegheny counties (with the exception of the Liberty-Clairton area in Allegheny County; see Appendix C-6 for details) in Pennsylvania be designated nonattainment for the 2012 annual $PM_{2.5}$ NAAQS. A map of the proposed nonattainment area is provided below as Figure C-5.8.

Figure C-5.8: Recommended Greater Pittsburgh $PM_{2.5}$ Nonattainment Area