

# Emission and Air Quality Trends Review

---

## Pennsylvania

May 2013

# Project Objective

---

- To develop and present publicly available information on trends in emissions and ambient air quality in the U.S. since 1999 in easy to understand visual and tabular formats

# Emission Trends

---

- Study Team collected and processed U.S. EPA emission inventories for years within the study period of interest (1999-2011)
  
- By pollutant and source category
  - electric generation fuel combustion
  - mobile sources
  - industrial fuel combustion & industrial processes
  - all other

# Emissions Data Summary

---

- Data Obtained from EPA National Emission Inventory (NEI) and Trends Websites
  - EPA's Trends reports and emission comparisons include interpolations of all categories between key years (1999, 2002, 2005, 2008, 2011) at county-pollutant level
  - Represented Pollutants: VOC, NO<sub>x</sub>, SO<sub>2</sub>, and PM<sub>2.5</sub>
- Project Improvement
  - The Study Team augmented above data with year specific CEM emissions (2002 through 2011)

# Emission Changes

---

- The following slides also include the tonnage-based emissions change from 1999 to 2011 for each pollutant
- Negative values indicate decrease in emissions, positive values indicate an increase

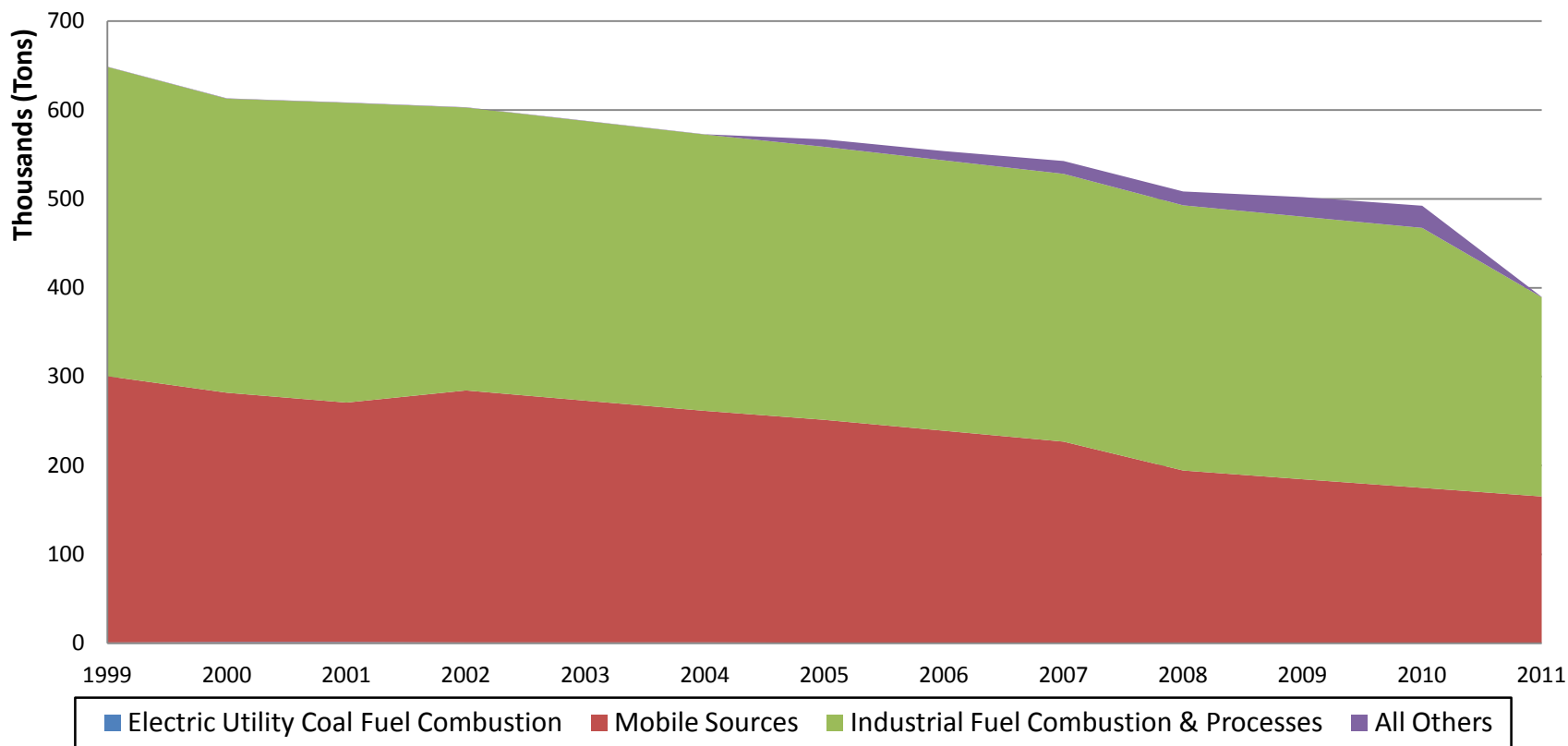
# Pennsylvania Emission Trends (VOC)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	904	1,370	941	656	662	706	799	686	745	373
Mobile Sources	299,582	269,419	271,990	250,693	238,409	226,125	193,572	183,833	174,094	164,795
Industrial Fuel Combustion & Processes	347,918	337,222	314,590	307,152	304,216	301,279	298,343	295,407	292,470	224,119
All Others	273	415	329	8,395	10,405	14,442	15,579	22,029	24,929	400
<b>Total</b>	<b>648,677</b>	<b>608,428</b>	<b>587,850</b>	<b>566,896</b>	<b>553,692</b>	<b>542,552</b>	<b>508,293</b>	<b>501,955</b>	<b>492,238</b>	<b>389,687</b>

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	52%	4%	-27%	-27%	-22%	-12%	-24%	-18%	-59%
Mobile Sources	0%	-10%	-9%	-16%	-20%	-25%	-35%	-39%	-42%	-45%
Industrial Fuel Combustion & Processes	0%	-3%	-10%	-12%	-13%	-13%	-14%	-15%	-16%	-36%
All Others	0%	52%	21%	2973%	3709%	5187%	5603%	7964%	9025%	47%
<b>Total</b>	<b>0%</b>	<b>-6%</b>	<b>-9%</b>	<b>-13%</b>	<b>-15%</b>	<b>-16%</b>	<b>-22%</b>	<b>-23%</b>	<b>-24%</b>	<b>-40%</b>

# Pennsylvania Emission Trends (VOC)

**Major Source Category Summary  
Annual VOC Emissions**



# Pennsylvania Emission Trends (NO<sub>x</sub>)

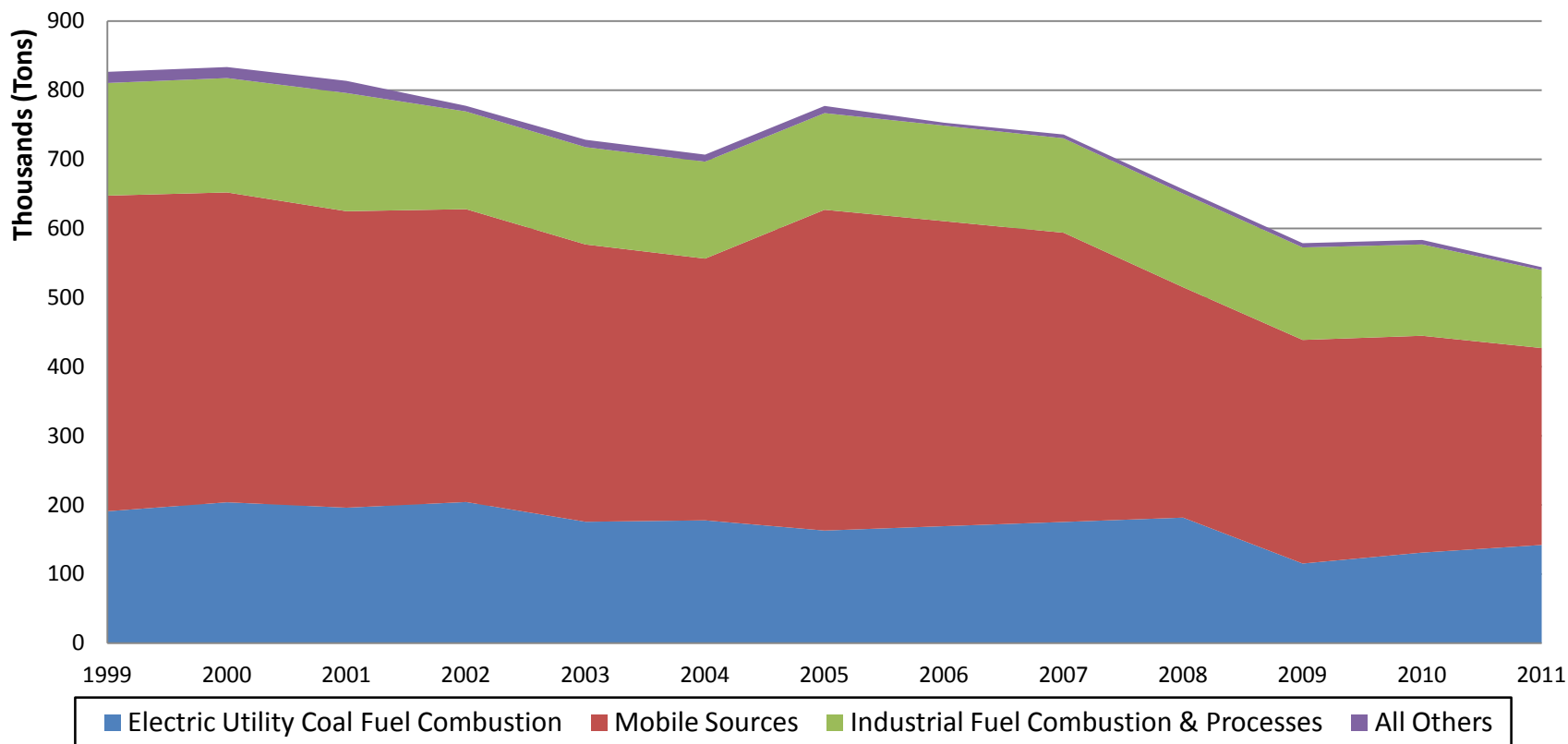
Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	190,793	195,955	175,582	162,886	169,215	175,307	181,587	115,170	130,994	142,014
Mobile Sources	456,670	428,935	401,208	464,112	441,282	418,451	333,323	323,511	313,699	284,905
Industrial Fuel Combustion & Processes	162,931	171,006	140,811	139,840	138,225	136,606	135,385	133,806	132,146	112,818
All Others	16,134	17,566	10,651	10,373	4,238	5,490	6,274	6,157	6,518	4,157
<b>Total</b>	<b>826,528</b>	<b>813,463</b>	<b>728,252</b>	<b>777,211</b>	<b>752,961</b>	<b>735,855</b>	<b>656,570</b>	<b>578,644</b>	<b>583,357</b>	<b>543,894</b>

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	3%	-8%	-15%	-11%	-8%	-5%	-40%	-31%	-26%
Mobile Sources	0%	-6%	-12%	2%	-3%	-8%	-27%	-29%	-31%	-38%
Industrial Fuel Combustion & Processes	0%	5%	-14%	-14%	-15%	-16%	-17%	-18%	-19%	-31%
All Others	0%	9%	-34%	-36%	-74%	-66%	-61%	-62%	-60%	-74%
<b>Total</b>	<b>0%</b>	<b>-2%</b>	<b>-12%</b>	<b>-6%</b>	<b>-9%</b>	<b>-11%</b>	<b>-21%</b>	<b>-30%</b>	<b>-29%</b>	<b>-34%</b>



# Pennsylvania Emission Trends (NO<sub>x</sub>)

**Major Source Category Summary  
Annual NO<sub>x</sub> Emissions**



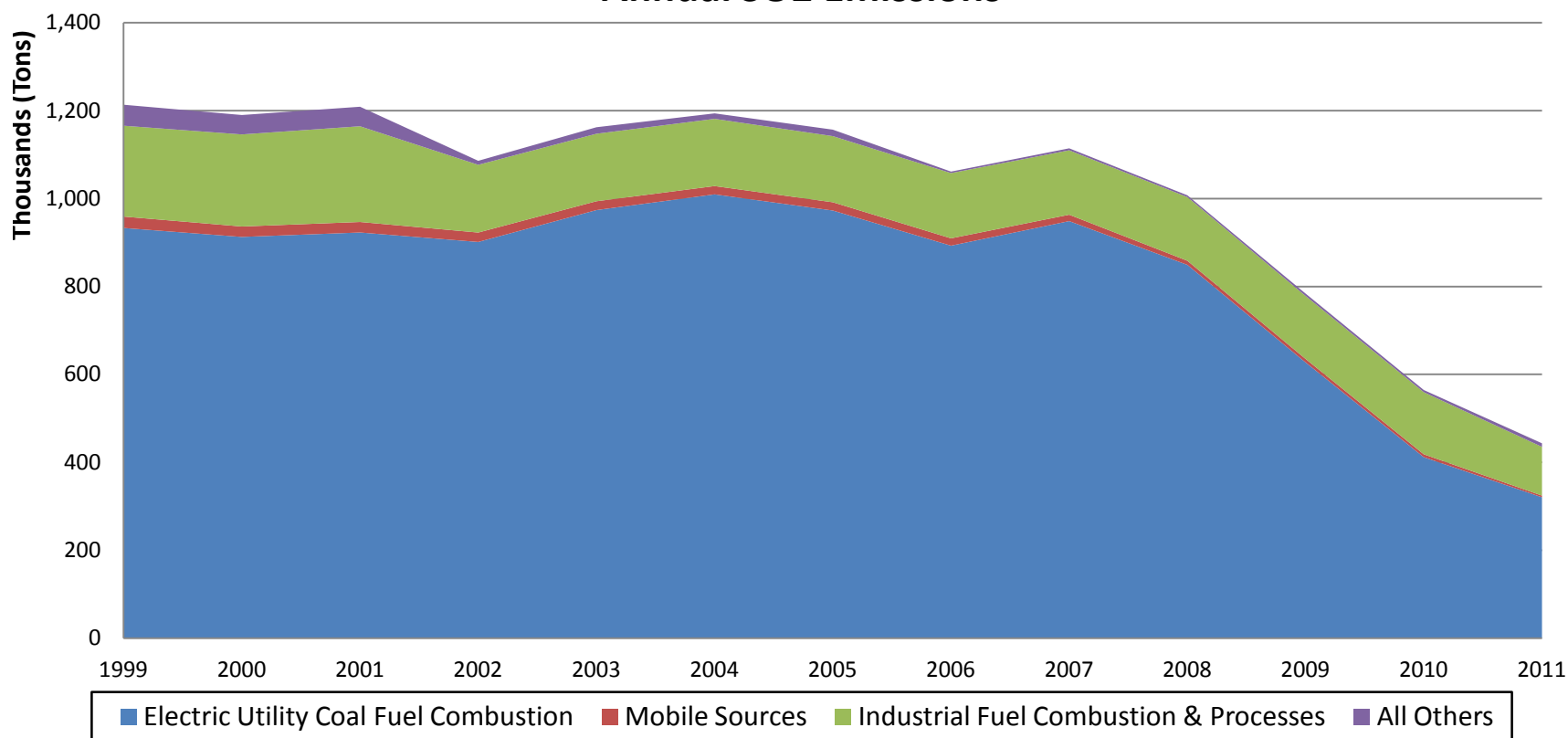
# Pennsylvania Emission Trends (SO<sub>2</sub>)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	933,049	922,783	973,729	972,744	892,783	948,671	849,119	627,265	411,715	320,504
Mobile Sources	25,937	23,906	20,150	18,819	16,679	14,539	9,306	7,934	6,562	3,822
Industrial Fuel Combustion & Processes	206,602	217,686	153,479	150,364	148,449	146,526	144,884	143,249	141,232	110,830
All Others	47,745	44,406	14,794	14,739	3,370	4,467	4,014	5,354	4,962	8,128
<b>Total</b>	<b>1,213,333</b>	<b>1,208,781</b>	<b>1,162,152</b>	<b>1,156,666</b>	<b>1,061,281</b>	<b>1,114,203</b>	<b>1,007,324</b>	<b>783,803</b>	<b>564,470</b>	<b>443,284</b>

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	-1%	4%	4%	-4%	2%	-9%	-33%	-56%	-66%
Mobile Sources	0%	-8%	-22%	-27%	-36%	-44%	-64%	-69%	-75%	-85%
Industrial Fuel Combustion & Processes	0%	5%	-26%	-27%	-28%	-29%	-30%	-31%	-32%	-46%
All Others	0%	-7%	-69%	-69%	-93%	-91%	-92%	-89%	-90%	-83%
<b>Total</b>	<b>0%</b>	<b>0%</b>	<b>-4%</b>	<b>-5%</b>	<b>-13%</b>	<b>-8%</b>	<b>-17%</b>	<b>-35%</b>	<b>-53%</b>	<b>-63%</b>

# Pennsylvania Emission Trends (SO<sub>2</sub>)

**Major Source Category Summary  
Annual SO<sub>2</sub> Emissions**



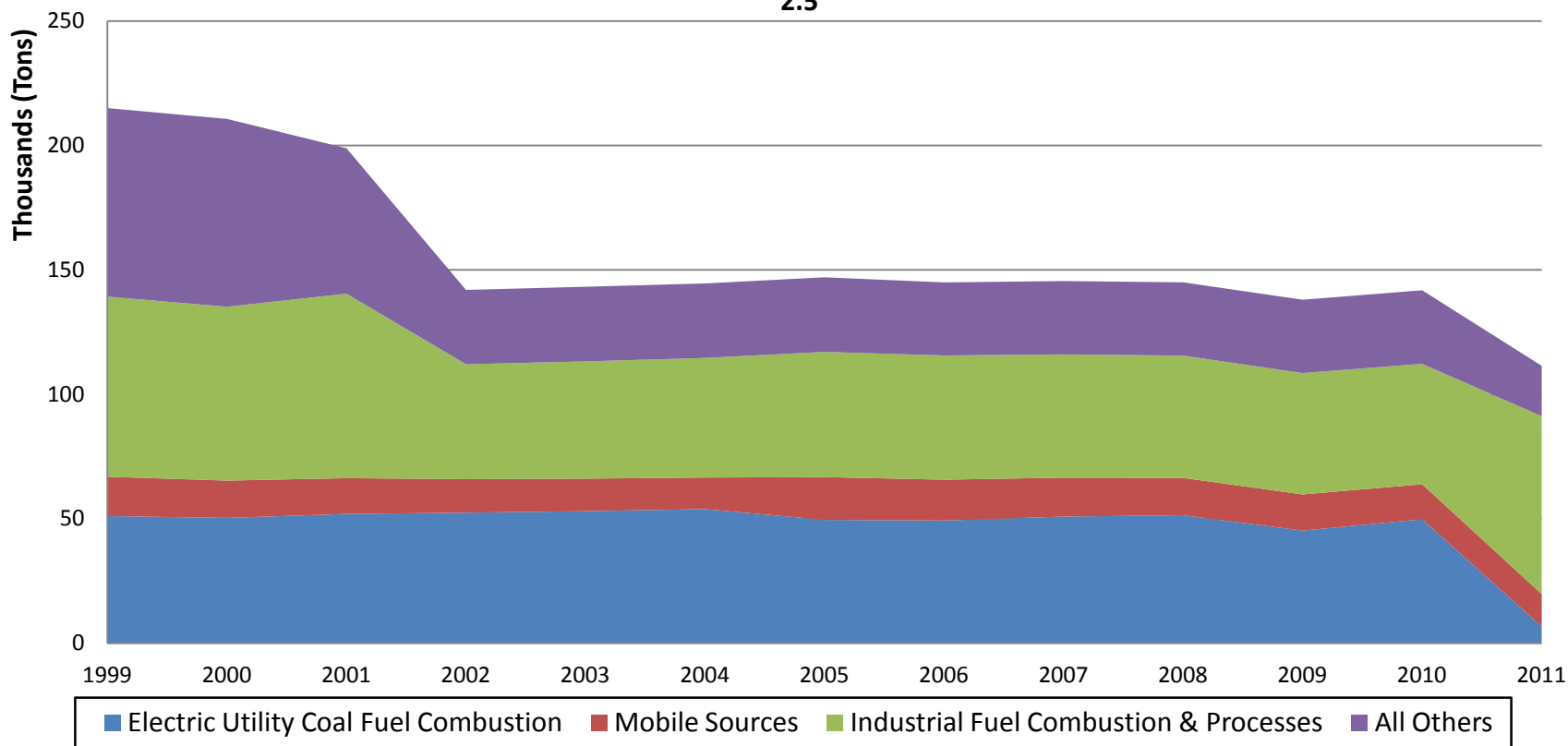
# Pennsylvania Emission Trends (PM<sub>2.5</sub>)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	51,111	51,976	53,078	49,585	49,320	50,906	51,447	45,275	49,825	6,753
Mobile Sources	15,810	14,359	13,071	17,184	16,408	15,631	14,993	14,535	14,076	12,998
Industrial Fuel Combustion & Processes	72,359	74,126	47,110	50,303	49,918	49,532	49,147	48,761	48,375	71,495
All Others	75,741	58,417	29,993	29,976	29,347	29,464	29,433	29,458	29,557	20,236
<b>Total</b>	<b>215,021</b>	<b>198,879</b>	<b>143,252</b>	<b>147,048</b>	<b>144,992</b>	<b>145,533</b>	<b>145,020</b>	<b>138,028</b>	<b>141,832</b>	<b>111,482</b>

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	2%	4%	-3%	-4%	0%	1%	-11%	-3%	-87%
Mobile Sources	0%	-9%	-17%	9%	4%	-1%	-5%	-8%	-11%	-18%
Industrial Fuel Combustion & Processes	0%	2%	-35%	-30%	-31%	-32%	-32%	-33%	-33%	-1%
All Others	0%	-23%	-60%	-60%	-61%	-61%	-61%	-61%	-61%	-73%
<b>Total</b>	<b>0%</b>	<b>-8%</b>	<b>-33%</b>	<b>-32%</b>	<b>-33%</b>	<b>-32%</b>	<b>-33%</b>	<b>-36%</b>	<b>-34%</b>	<b>-48%</b>

# Pennsylvania Emission Trends (PM<sub>2.5</sub>)

**Major Source Category Summary  
Annual PM<sub>2.5</sub> Emissions**



# Emission Trends Summary

---

- ❑ All pollutants have decreased since 1999 in aggregate across Pennsylvania
- ❑ NO<sub>x</sub> and SO<sub>2</sub> from Electric Utility Fuel Combustion sources show significant decrease over time as a result of Acid Rain Program, NO<sub>x</sub> Budget Trading Program and CAIR control implementation
- ❑ Onroad emission step increase seen between 2004 and 2005 is the result of EPA's method change and MOVES model integration for estimating onroad mobile source emissions

# Air Quality Design Values

---

- Ozone
  - Annual 4<sup>th</sup> highest daily maximum 8-hour average averaged over three consecutive years
  - Current standard = 0.075 ppm
- PM<sub>2.5</sub> Annual
  - Annual arithmetic mean of quarterly means averaged over three consecutive years
  - Current standard = 12 ug/m<sup>3</sup>
- PM<sub>2.5</sub> 24-Hour
  - Annual 98<sup>th</sup> percentile of daily averages averaged over three consecutive years
  - Current standard = 35 ug/m<sup>3</sup>

# State-Wide Design Value (DV) Trends

---

- Trends in state-wide maximum DV and average DV
  - Max DV: Maximum DVs over all valid trend monitoring sites in the state in each overlapping three year period
  - Average DV: Average of DVs over all valid trend monitoring sites in the state in each overlapping three year period
- Compute linear trend via least-squares regression



# Data Handling Procedures

---

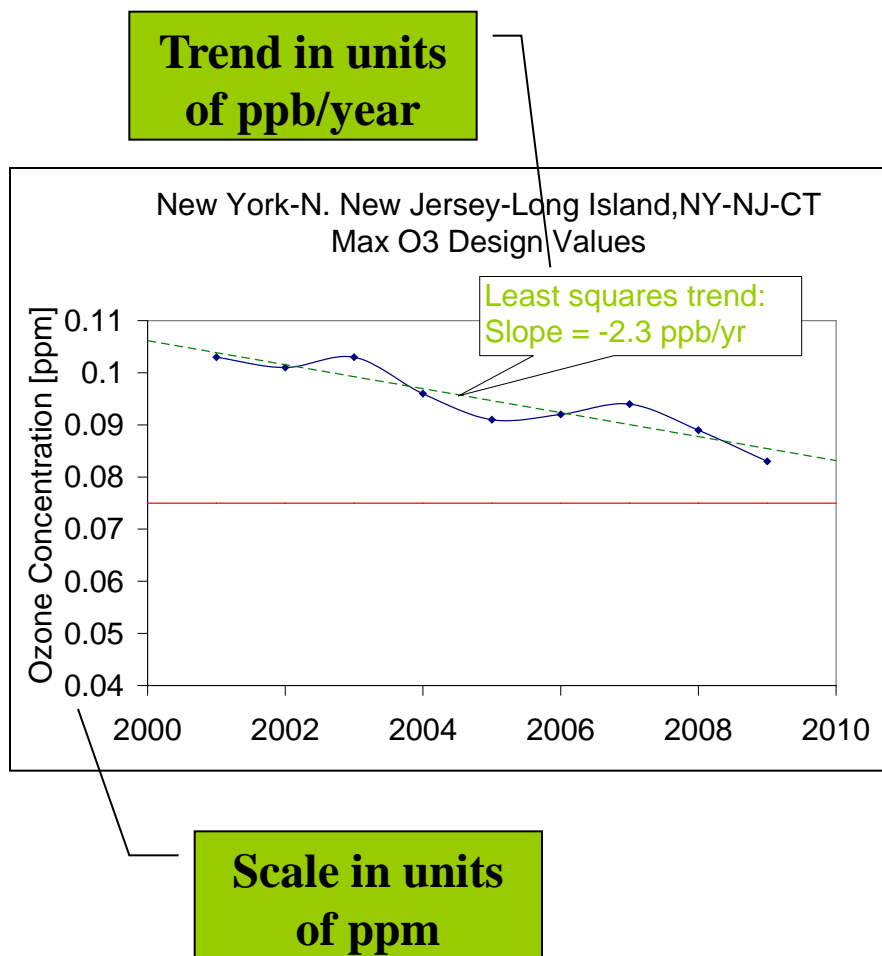
- O<sub>3</sub> design value (DV) for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
  - DV calculated using annual 4<sup>th</sup> highest daily max 8-hr averages and percent of valid observations, based on EPA data handling conventions
  - Data associated with exceptional events that have received EPA concurrence are omitted
  - Selection of trend sites require valid DV in 9 out of 11 three-year periods between 1999 and 2011
  - Identification of nonattainment areas is with respect to the 2008 8-hour standard only

# Data Handling Procedures

---

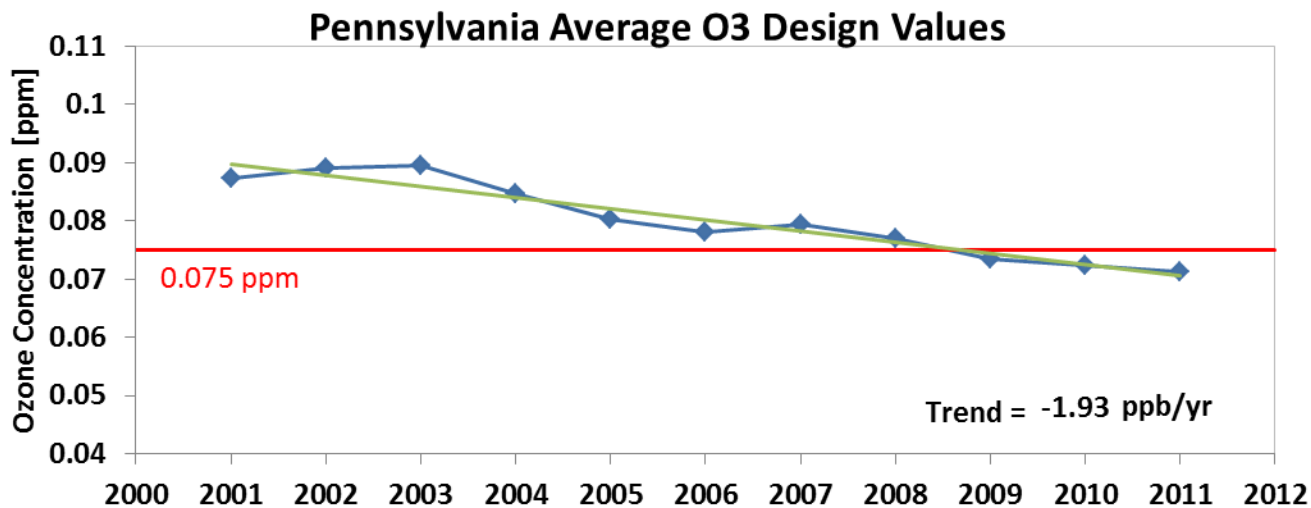
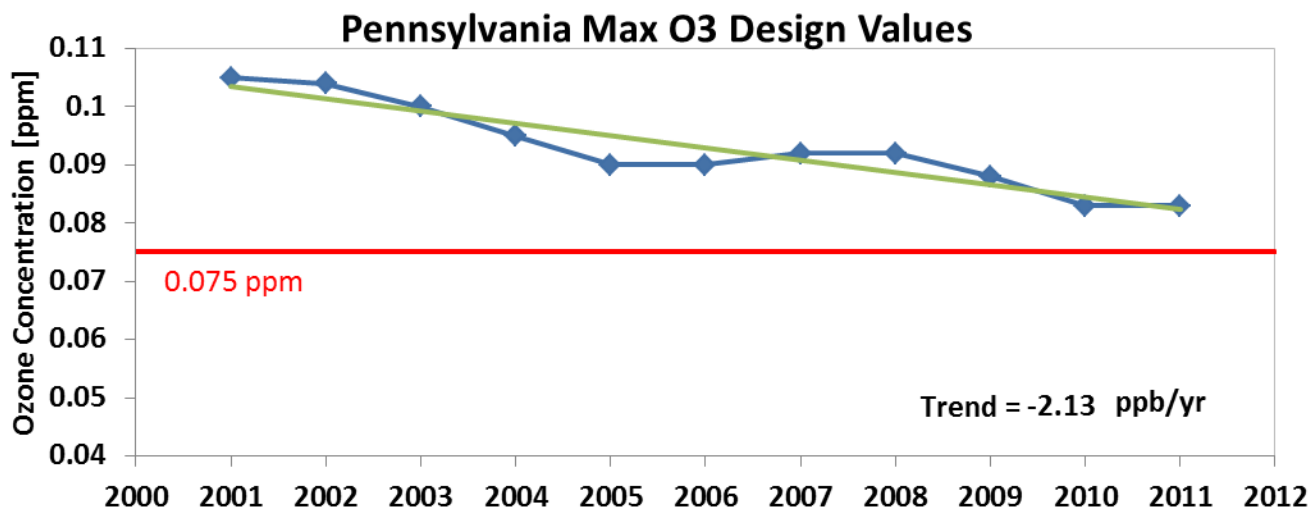
- Annual  $PM_{2.5}$  DV and 24-hr  $PM_{2.5}$  DV for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
  - DV calculations based on EPA data handling conventions
  - Data extracted from monitors that have a non-regulatory monitoring type are omitted
  - Selection of trend sites require valid DV in 9 out of 11 three-year periods between 1999 and 2011

# Trend Calculation



- Trends based on linear least squares fit to rolling three year design values (DVs)
- Negative trend indicates improving air quality
- DVs based on each 3-year period: 1999-2001, 2000-2002, ... 2009-2011
- Notes
  - On plots, DVs are for three year period ending in year shown (i.e., 2009-2011 DV plotted as 2011 value)
  - Ozone trend values expressed as ppb/year (1,000 ppb = 1 ppm); DVs are plotted as ppm

# Max/Ave O<sub>3</sub> DVs and Trend



# Ozone Trends by Site in Pennsylvania

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
4200300084420101	Allegheny, PA	0.074	-1.52
4200300104420101	Allegheny, PA	0.071	-2.45
4200300674420101	Allegheny, PA	0.075	-1.95
4200310054420101	Allegheny, PA	0.08	-1.29
4200500014420101	Armstrong, PA	0.073	-2.00
4200700024420101	Beaver, PA	0.069	-2.36
4200700054420101	Beaver, PA	0.072	-2.23
4200700144420101	Beaver, PA	0.071	-1.75
4201308014420101	Blair, PA	0.07	-1.75
4201700124420101	Bucks, PA	0.08	-2.19
4202100114420101	Cambria, PA	0.069	-2.38

Note: Only monitoring sites meeting data completeness criteria listed

# Ozone Trends by Site in Pennsylvania

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
4202701004420101	Centre, PA	0.07	-1.93
4202901004420101	Chester, PA	0.074	-2.94
4203340004420101	Clearfield, PA	0.072	-1.80
4204304014420101	Dauphin, PA	0.069	-1.67
4204311004420101	Dauphin, PA	0.073	-2.00
4204500024420101	Delaware, PA	0.073	-2.27
4204900034420101	Erie, PA	0.072	-1.90
4205500014420101	Franklin, PA	0.065	-3.13
4205900024420101	Greene, PA	0.069	-2.32
4206901014420101	Lackawanna, PA	0.071	-1.69

Note: Only monitoring sites meeting data completeness criteria listed

# Ozone Trends by Site in Pennsylvania

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
4206920064420101	Lackawanna, PA	0.066	-1.77
4207100074420101	Lancaster, PA	0.076	-2.02
4207300154420101	Lawrence, PA	0.067	-1.35
4207700044420101	Lehigh, PA	0.076	-2.19
4207911004420101	Luzerne, PA	0.065	-2.03
4207911014420101	Luzerne, PA	0.062	-2.26
4208501004420101	Mercer, PA	0.073	-1.95
4209100134420101	Montgomery, PA	0.077	-2.31
4209500254420101	Northampton, PA	0.075	-2.30
4209580004420101	Northampton, PA	0.069	-1.15

Note: Only monitoring sites meeting data completeness criteria listed

# Ozone Trends by Site in Pennsylvania

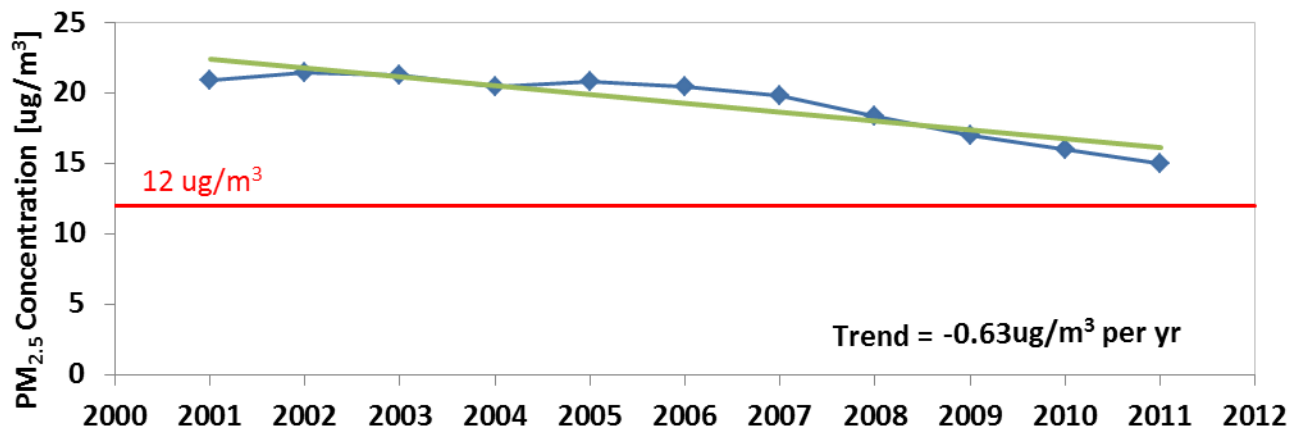
Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
4209903014420101	Perry, PA	0.067	-1.65
4210100044420101	Philadelphia, PA	0.068	-0.70
4210100244420101	Philadelphia, PA	0.083	-0.99
4211740004420101	Tioga, PA	0.069	-1.76
4212500054420101	Washington, PA	0.069	-2.05
4212502004420101	Washington, PA	0.068	-2.28
4212550014420101	Washington, PA	0.069	-2.00
4212900064420101	Westmoreland, PA	0.068	-1.51
4212900084420101	Westmoreland, PA	0.069	-2.04
4213300084420101	York, PA	0.071	-1.95

Note: Only monitoring sites meeting data completeness criteria listed

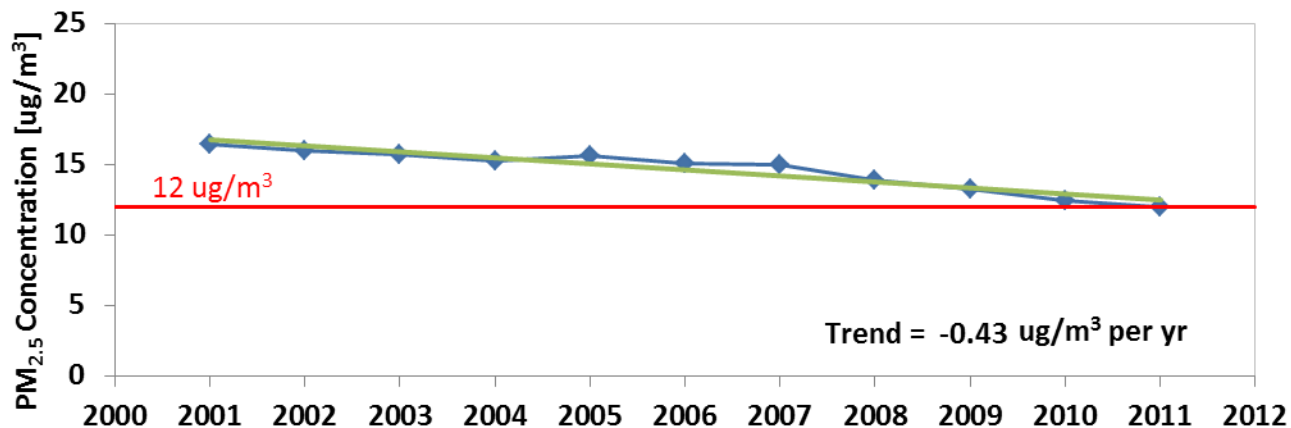


# Max/Ave PM<sub>2.5</sub> Annual DVs and Trend

**Pennsylvania Max PM<sub>2.5</sub> Annual Design Values**

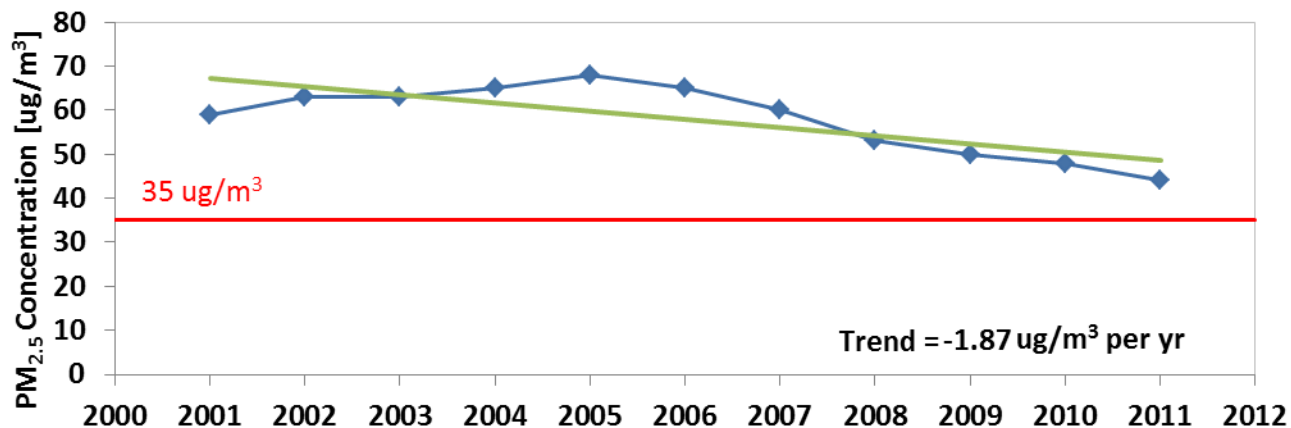


**Pennsylvania Average PM<sub>2.5</sub> Annual Design Values**

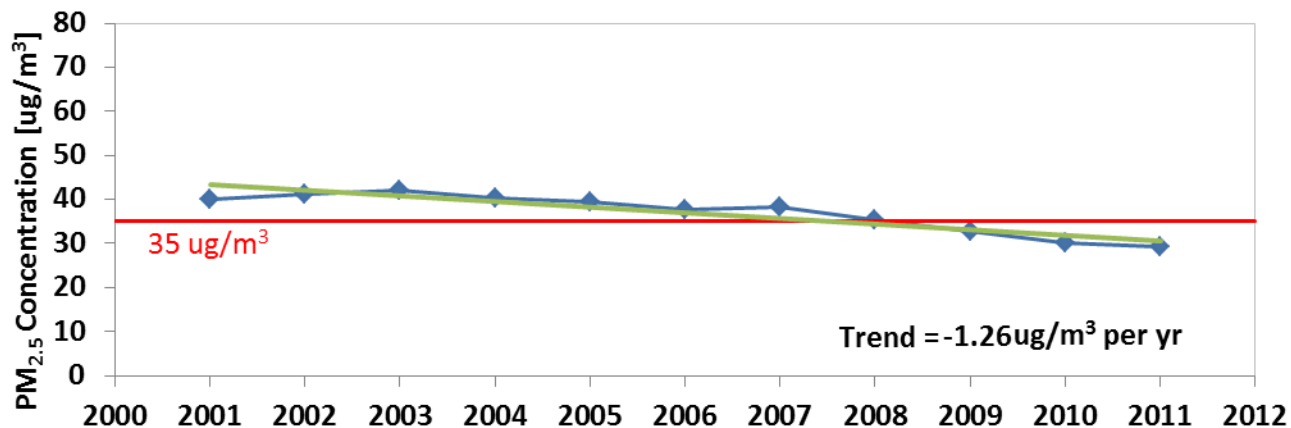


# Max/Ave PM<sub>2.5</sub> 24-Hour DVs and Trend

**Pennsylvania Max PM<sub>2.5</sub> 24-Hour Design Values**



**Pennsylvania Average PM<sub>2.5</sub> 24-Hour Design Values**



# PM<sub>2.5</sub> Trends by Site in Pennsylvania

Monitoring Site	County	2009-2011 DV [ug/m <sup>3</sup> ]		Trend [ug/m <sup>3</sup> per year]	
		Annual	24-Hr	Annual DV	24-Hr DV
420010001	Adams	11.7	29	-0.25	-1.03
420030008	Allegheny	11.6	27	-0.47	-1.07
420030064	Allegheny	15.0	44	-0.63	-1.87
420030067	Allegheny	N/A	27	N/A	-1.88
420031008	Allegheny	12.4	N/A	-0.39	N/A
420031301	Allegheny	12.7	34	-0.43	-1.19
420070014	Beaver	12.4	29	-0.38	-1.37
420110011	Berks	10.7	27	-0.60	-1.65
420170012	Bucks	10.9	28	-0.42	-1.13
420210011	Cambria	12.4	30	-0.33	-1.34
420270100	Centre	N/A	26	N/A	-1.50
420410101	Cumberland	N/A	31	N/A	-1.47
420430401	Dauphin	12.1	32	-0.38	-1.37

Note: Only monitoring sites meeting data completeness criteria listed 27

# PM<sub>2.5</sub> Trends by Site in Pennsylvania

Monitoring Site	County	2009-2011 DV [ug/m <sup>3</sup> ]		Trend [ug/m <sup>3</sup> per year]	
		Annual	24-Hr	Annual DV	24-Hr DV
420450002	Delaware	12.7	30	-0.32	-0.94
420692006	Lackawanna	9.4	25	-0.37	-1.61
420710007	Lancaster	12.0	31	-0.53	-1.26
420850100	Mercer	10.5	N/A	-0.47	N/A
420950025	Northampton	13.4	33	-0.22	-0.81
421010004	Philadelphia	N/A	28	N/A	-1.24
421010047	Philadelphia	N/A	27	N/A	-1.07
421250005	Washington	12.6	28	-0.29	-1.35
421250200	Washington	11.3	27	-0.40	-1.17
421255001	Washington	N/A	20	N/A	-1.18
421290008	Westmoreland	N/A	N/A	-0.23	-0.90
421330008	York	11.5	28	-0.53	-1.67

Note: Only monitoring sites meeting data completeness criteria listed

# Air Quality Trends Summary

---

- Average O<sub>3</sub> and PM<sub>2.5</sub> design values have decreased since 1999 in Pennsylvania
  
- O<sub>3</sub> and PM<sub>2.5</sub> design values have decreased since 1999 in all currently designated O<sub>3</sub> and PM<sub>2.5</sub> non-attainment areas in Pennsylvania in which monitoring data met the 1999–2011 trends completeness criteria. Additional O<sub>3</sub> or PM<sub>2.5</sub> nonattainment areas in Pennsylvania in which monitoring data did not meet the 1999–2011 trends completeness criteria include:
  - Reading, PA (Ozone)