

Emission and Air Quality Trends Review

Delaware

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_x, SO₂, and PM_{2.5}
- 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

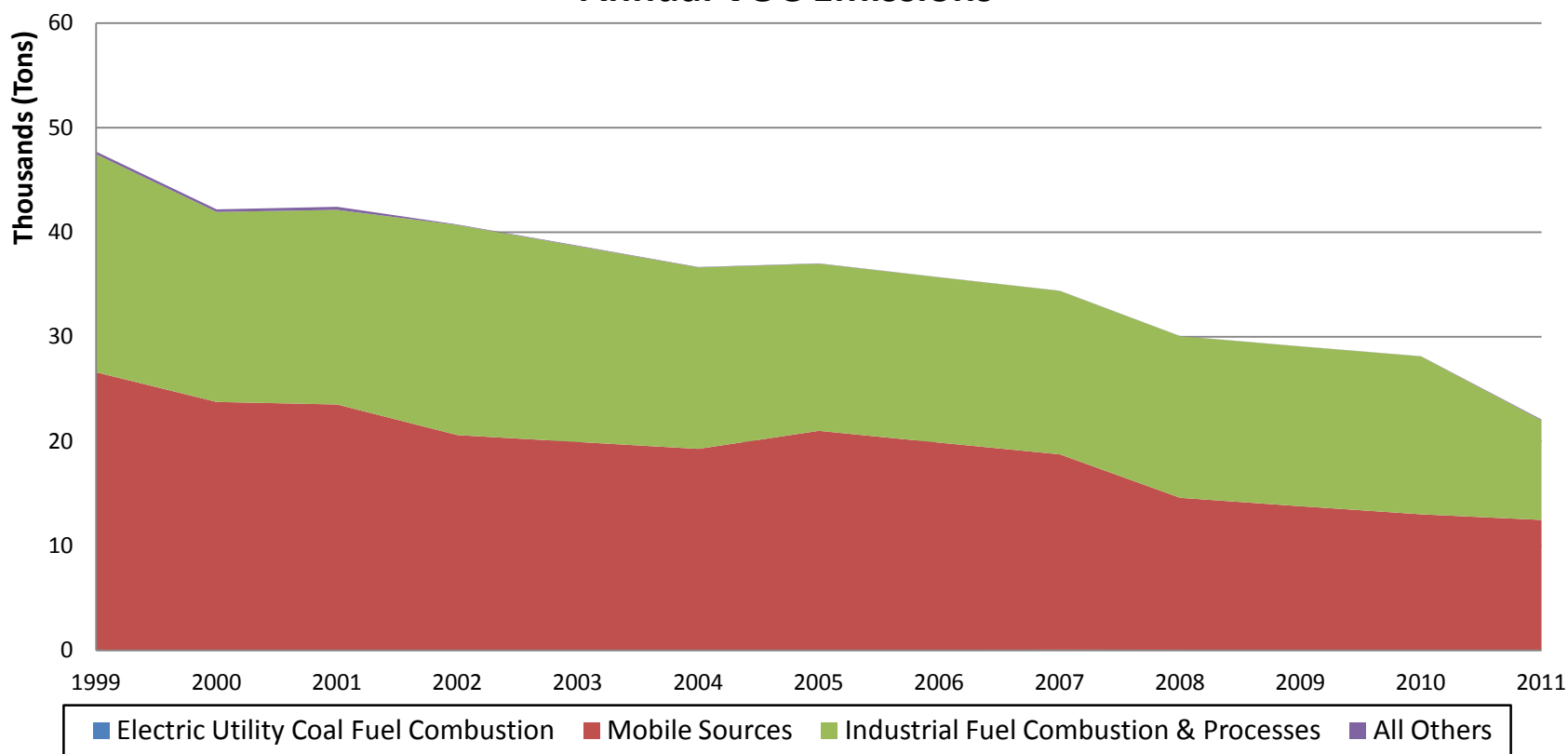
Delaware Emission Trends (VOC)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	37	41	58	64	62	72	66	36	38	17
Mobile Sources	26,565	23,482	19,877	20,939	19,811	18,684	14,530	13,756	12,982	12,464
Industrial Fuel Combustion & Processes	20,852	18,614	18,726	15,987	15,810	15,633	15,457	15,280	15,103	9,531
All Others	251	296	53	30	16	16	16	13	16	75
Total	47,705	42,433	38,714	37,020	35,699	34,406	30,069	29,084	28,138	22,087

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	12%	57%	75%	68%	97%	80%	-2%	3%	-54%
Mobile Sources	0%	-12%	-25%	-21%	-25%	-30%	-45%	-48%	-51%	-53%
Industrial Fuel Combustion & Processes	0%	-11%	-10%	-23%	-24%	-25%	-26%	-27%	-28%	-54%
All Others	0%	18%	-79%	-88%	-94%	-93%	-94%	-95%	-94%	-70%
Total	0%	-11%	-19%	-22%	-25%	-28%	-37%	-39%	-41%	-54%

Delaware Emission Trends (VOC)

**Major Source Category Summary
Annual VOC Emissions**



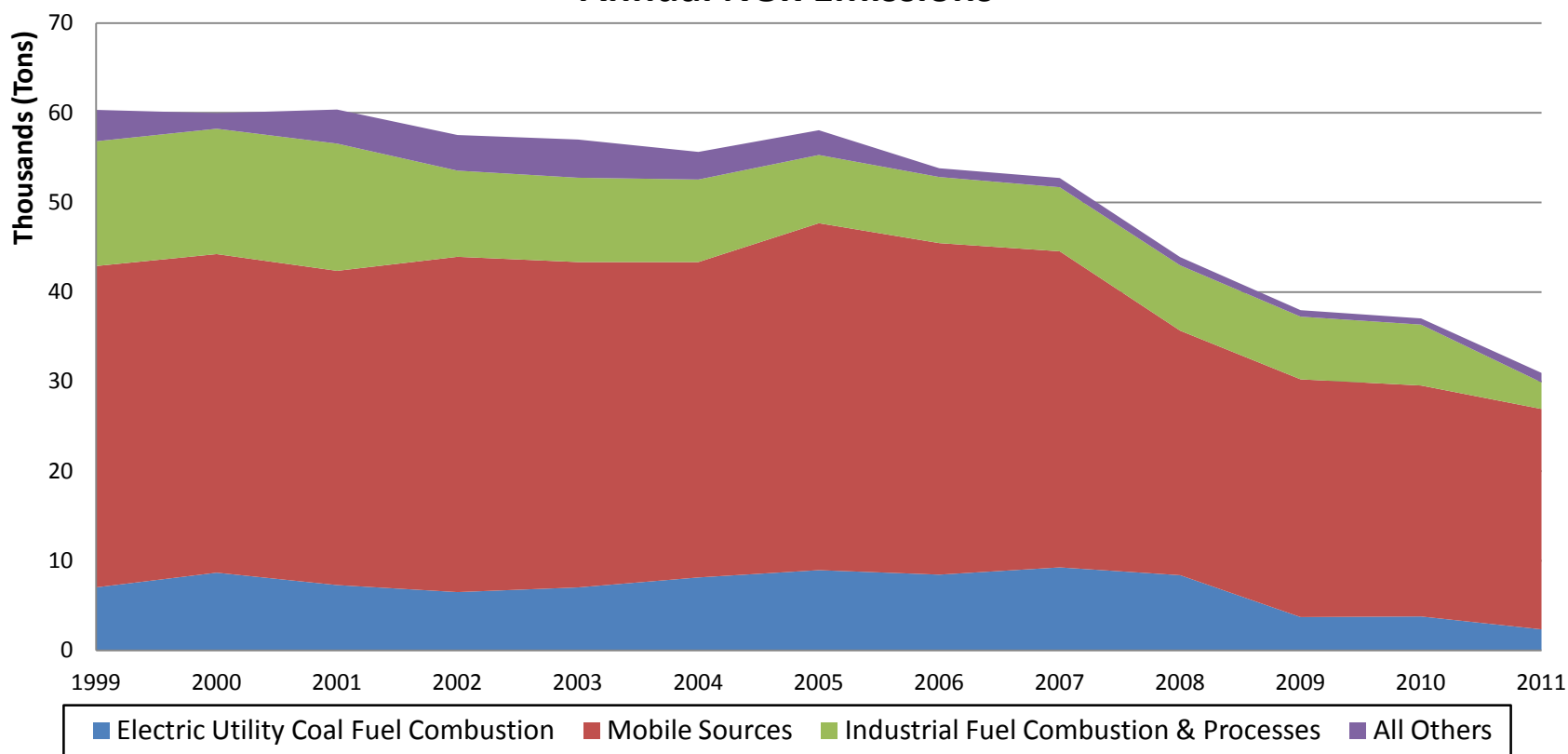
Delaware Emission Trends (NO_x)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	7,037	7,292	7,030	8,957	8,456	9,263	8,395	3,721	3,788	2,352
Mobile Sources	35,858	35,066	36,304	38,715	36,994	35,273	27,284	26,528	25,773	24,590
Industrial Fuel Combustion & Processes	13,920	14,197	9,412	7,613	7,375	7,150	7,287	6,995	6,796	2,965
All Others	3,501	3,799	4,261	2,763	976	1,029	922	723	691	1,061
Total	60,316	60,355	57,008	58,048	53,802	52,716	43,887	37,967	37,047	30,969

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	4%	0%	27%	20%	32%	19%	-47%	-46%	-67%
Mobile Sources	0%	-2%	1%	8%	3%	-2%	-24%	-26%	-28%	-31%
Industrial Fuel Combustion & Processes	0%	2%	-32%	-45%	-47%	-49%	-48%	-50%	-51%	-79%
All Others	0%	9%	22%	-21%	-72%	-71%	-74%	-79%	-80%	-70%
Total	0%	0%	-5%	-4%	-11%	-13%	-27%	-37%	-39%	-49%

Delaware Emission Trends (NO_x)

**Major Source Category Summary
Annual NO_x Emissions**



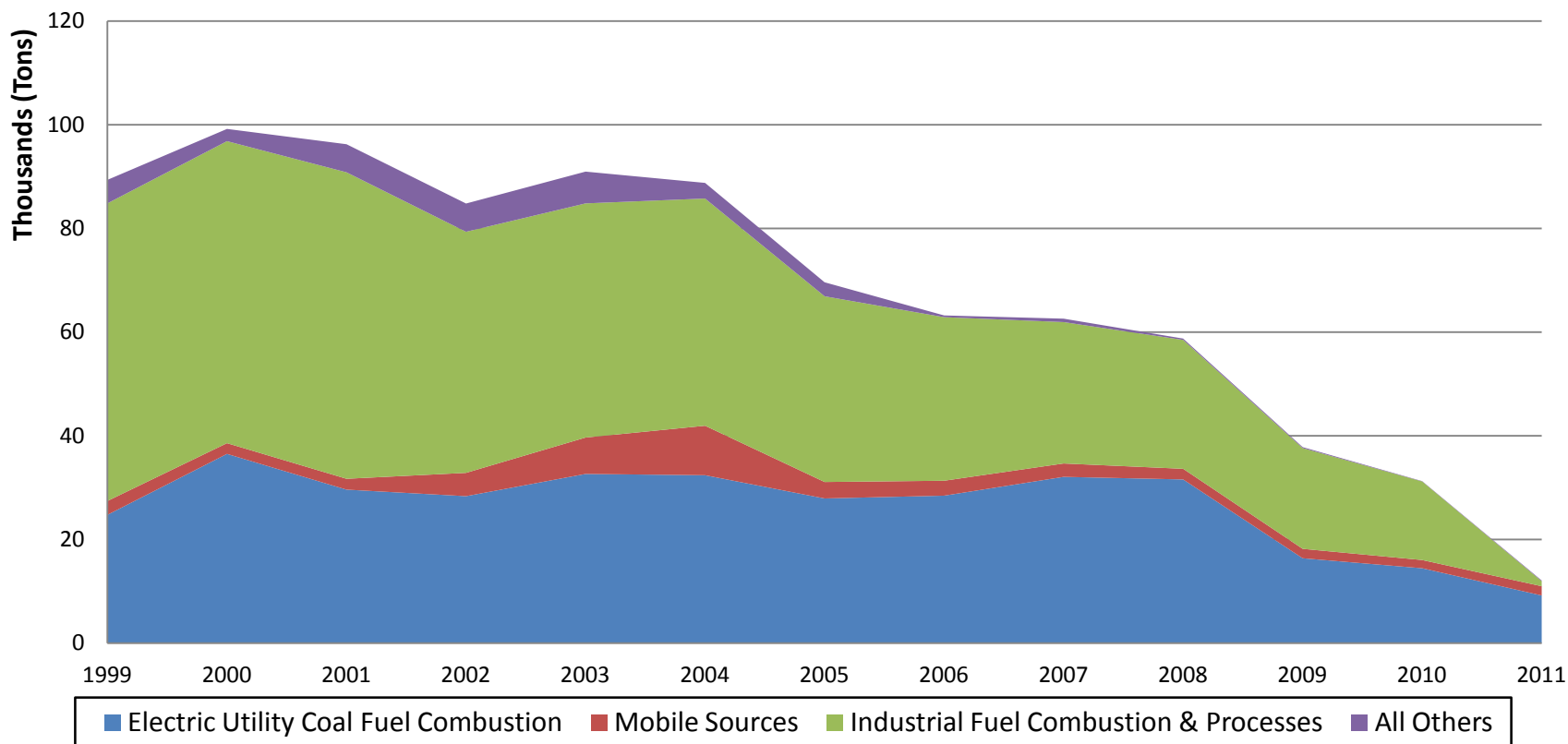
Delaware Emission Trends (SO₂)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	24,755	29,611	32,637	27,910	28,448	32,071	31,577	16,373	14,447	9,194
Mobile Sources	2,670	2,093	7,022	3,177	2,882	2,586	2,054	1,820	1,586	1,783
Industrial Fuel Combustion & Processes	57,418	59,122	45,169	35,826	31,548	27,271	24,864	19,436	15,158	975
All Others	4,529	5,415	6,131	2,697	337	662	252	182	60	134
Total	89,372	96,241	90,959	69,609	63,215	62,591	58,748	37,811	31,252	12,087

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	20%	32%	13%	15%	30%	28%	-34%	-42%	-63%
Mobile Sources	0%	-22%	163%	19%	8%	-3%	-23%	-32%	-41%	-33%
Industrial Fuel Combustion & Processes	0%	3%	-21%	-38%	-45%	-53%	-57%	-66%	-74%	-98%
All Others	0%	20%	35%	-40%	-93%	-85%	-94%	-96%	-99%	-97%
Total	0%	8%	2%	-22%	-29%	-30%	-34%	-58%	-65%	-86%

Delaware Emission Trends (SO₂)

**Major Source Category Summary
Annual SO₂ Emissions**



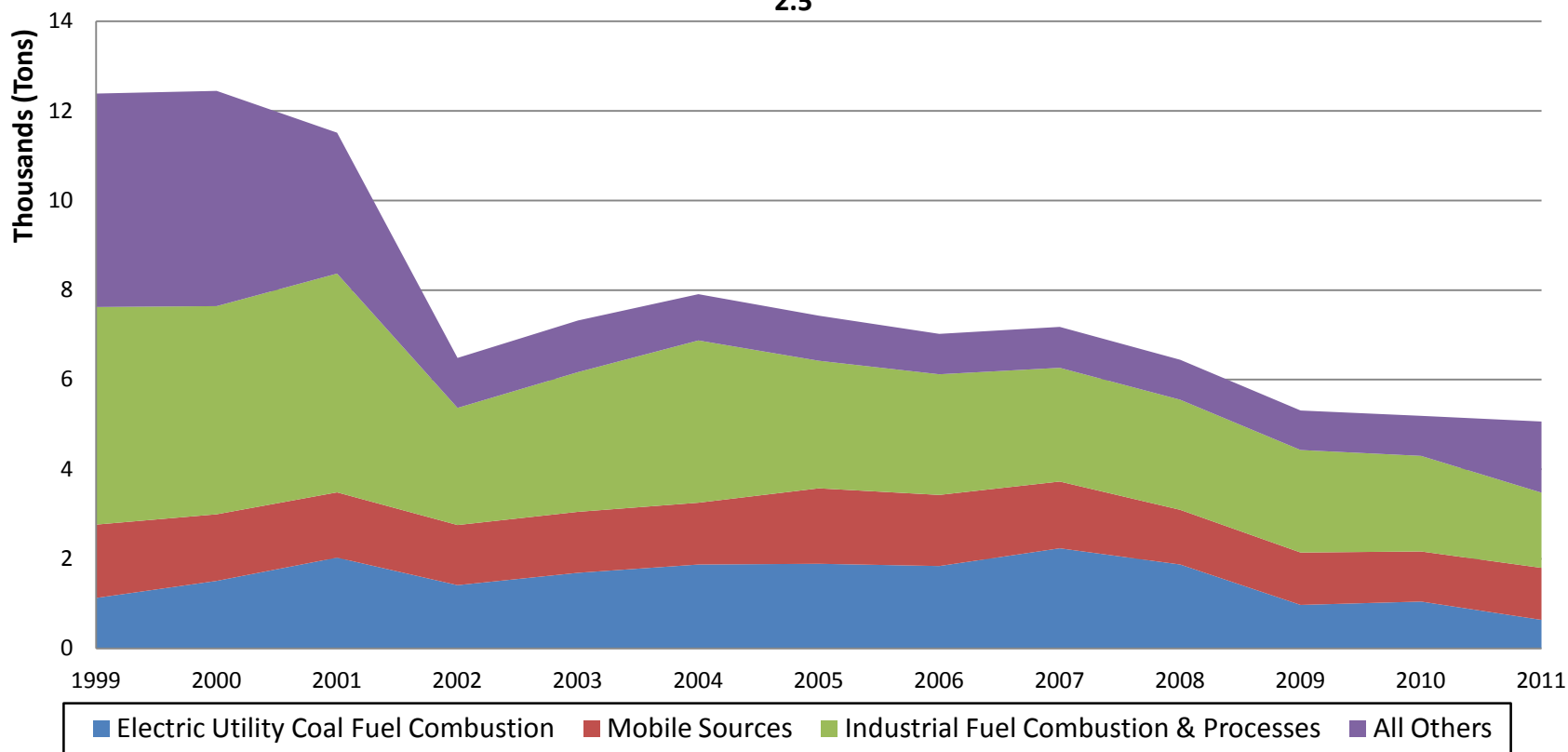
Delaware Emission Trends (PM_{2.5})

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	1,127	2,027	1,688	1,890	1,839	2,235	1,874	971	1,046	637
Mobile Sources	1,637	1,457	1,361	1,684	1,587	1,490	1,220	1,169	1,119	1,161
Industrial Fuel Combustion & Processes	4,857	4,883	3,119	2,848	2,693	2,539	2,458	2,288	2,134	1,679
All Others	4,764	3,145	1,152	1,006	902	913	892	882	893	1,588
Total	12,386	11,512	7,320	7,427	7,021	7,177	6,444	5,311	5,192	5,065

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	80%	50%	68%	63%	98%	66%	-14%	-7%	-43%
Mobile Sources	0%	-11%	-17%	3%	-3%	-9%	-25%	-29%	-32%	-29%
Industrial Fuel Combustion & Processes	0%	1%	-36%	-41%	-45%	-48%	-49%	-53%	-56%	-65%
All Others	0%	-34%	-76%	-79%	-81%	-81%	-81%	-81%	-81%	-67%
Total	0%	-7%	-41%	-40%	-43%	-42%	-48%	-57%	-58%	-59%

Delaware Emission Trends (PM_{2.5})

**Major Source Category Summary
Annual PM_{2.5} Emissions**



Emission Trends Summary

- ❑ All pollutants have decreased since 1999 in aggregate across Delaware
- ❑ NO_x and SO₂ from Electric Utility Fuel Combustion sources show significant decrease over time as a result of Acid Rain Program, NO_x 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 4th highest daily maximum 8-hour average averaged over three consecutive years
 - Current standard = 0.075 ppm
- PM_{2.5} Annual
 - Annual arithmetic mean of quarterly means averaged over three consecutive years
 - Current standard = 12 ug/m³
- PM_{2.5} 24-Hour
 - Annual 98th percentile of daily averages averaged over three consecutive years
 - Current standard = 35 ug/m³

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

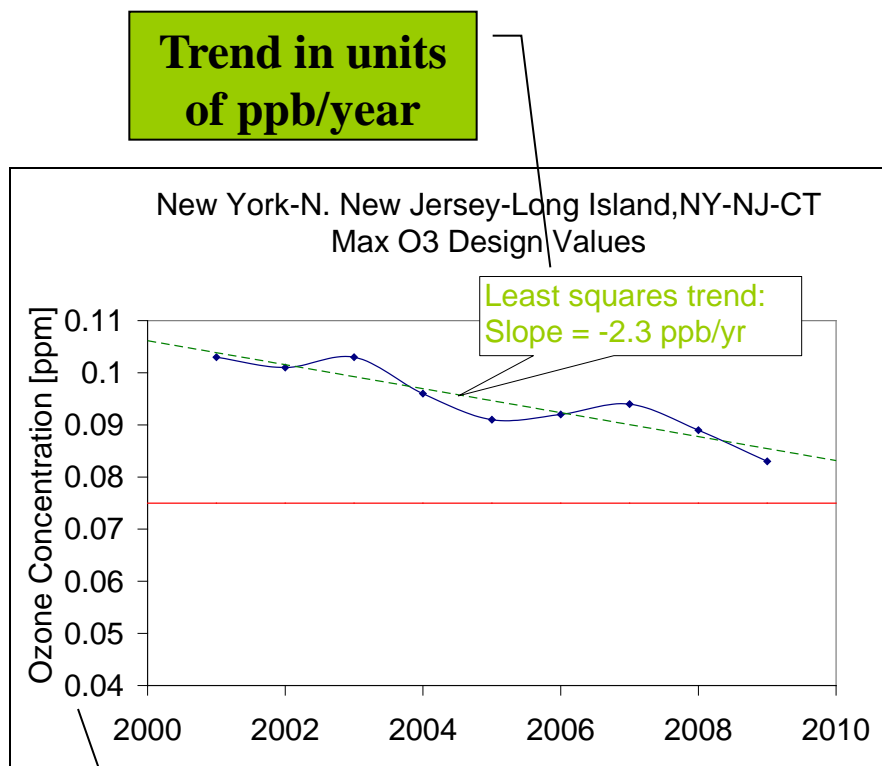
Data Handling Procedures

- O₃ design value (DV) for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
 - DV calculated using annual 4th 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

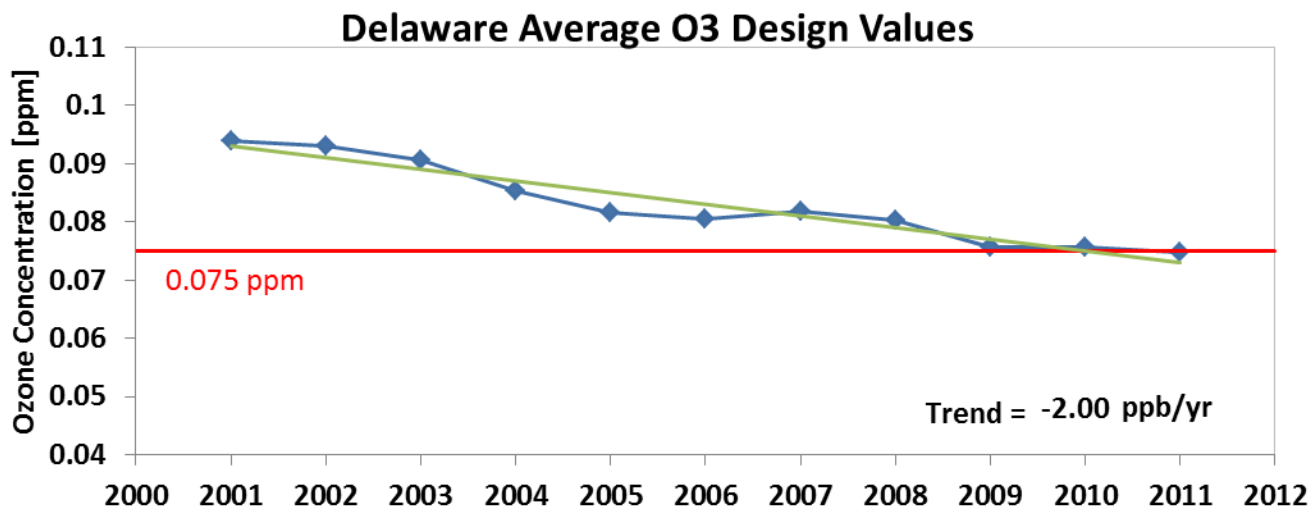
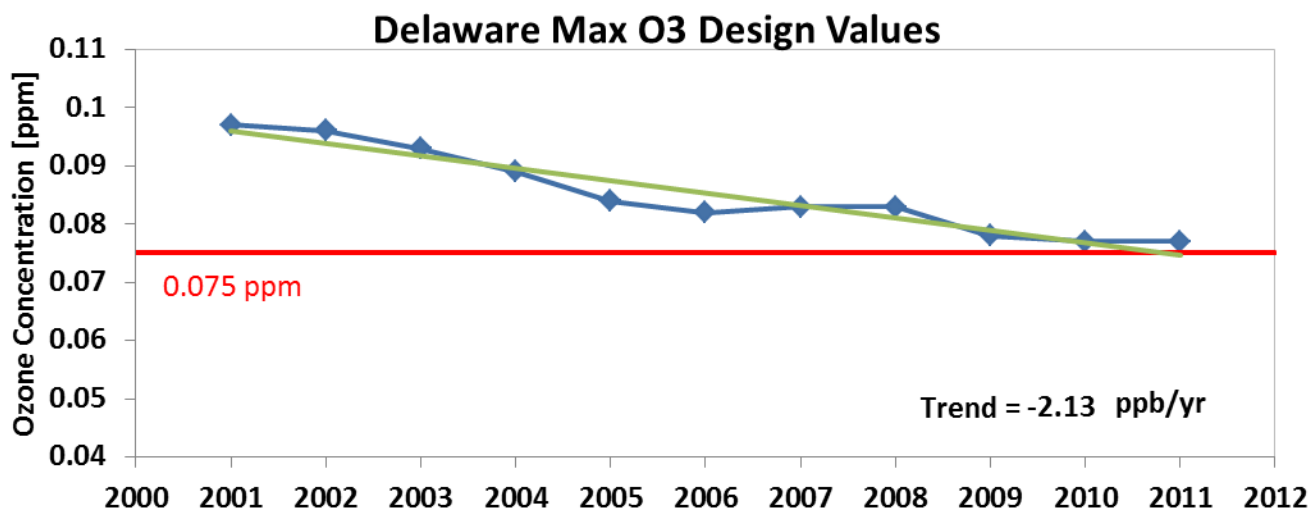
- Annual $PM_{2.5}$ DV and 24-hr $PM_{2.5}$ DV for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
 - DV calculations based on EPA data handling conventions
 - Data extracted from monitors that have a non-regulatory monitoring type are omitted
 - Selection of trend 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 O₃ DVs and Trend



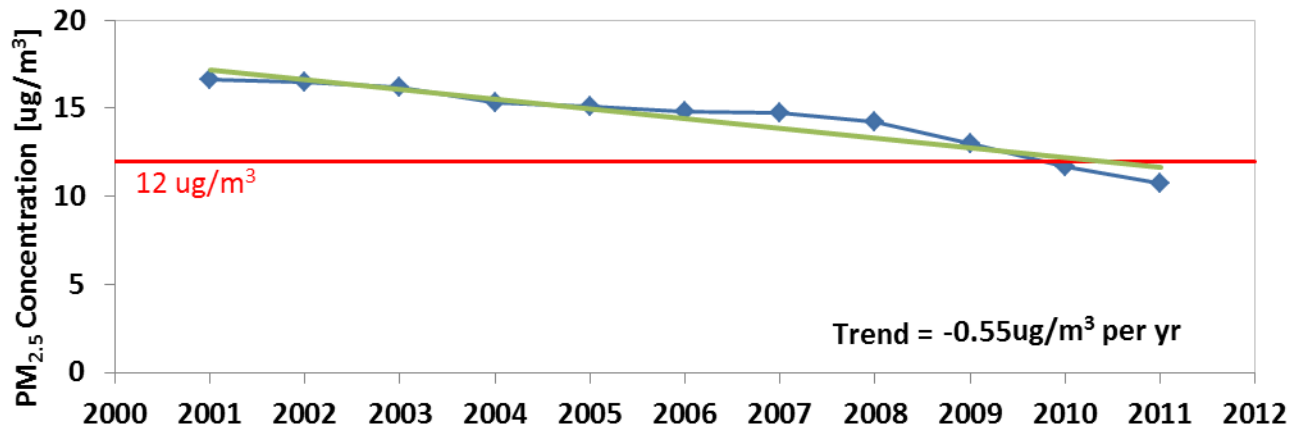
Ozone Trends by Site in Delaware

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
1000100024420101	Kent, DE	0.071	-2.08
1000310074420101	New Castle, DE	0.075	-2.31
1000310104420101	New Castle, DE	N/A	-2.21
1000310134420101	New Castle, DE	0.077	-1.68
1000510024420101	Sussex, DE	0.076	-1.96
1000510034420101	Sussex, DE	0.075	-1.50

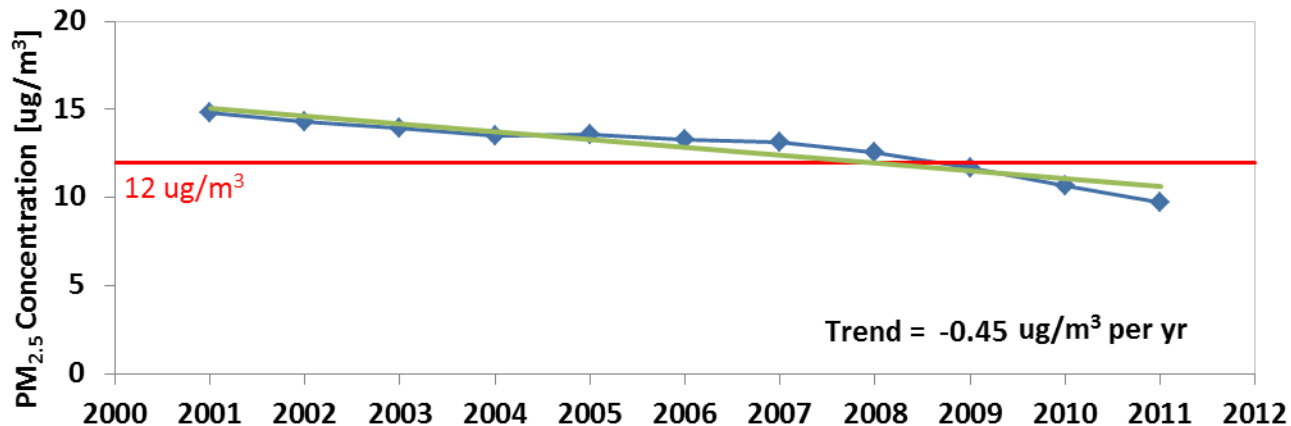
Note: Only monitoring sites meeting data completeness criteria listed

Max/Ave PM_{2.5} Annual DVs and Trend

Delaware Max PM2.5 Annual Design Values

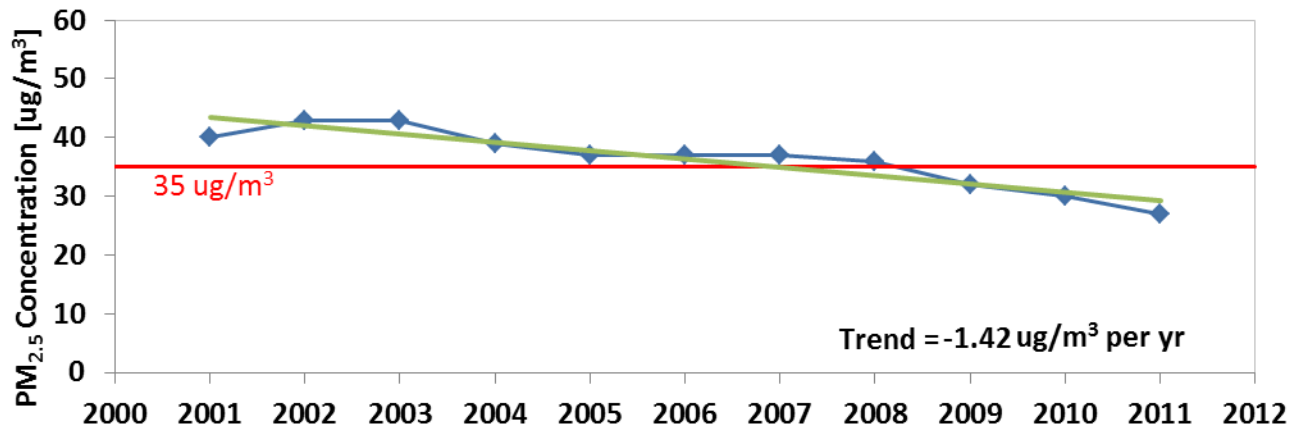


Delaware Average PM2.5 Annual Design Values

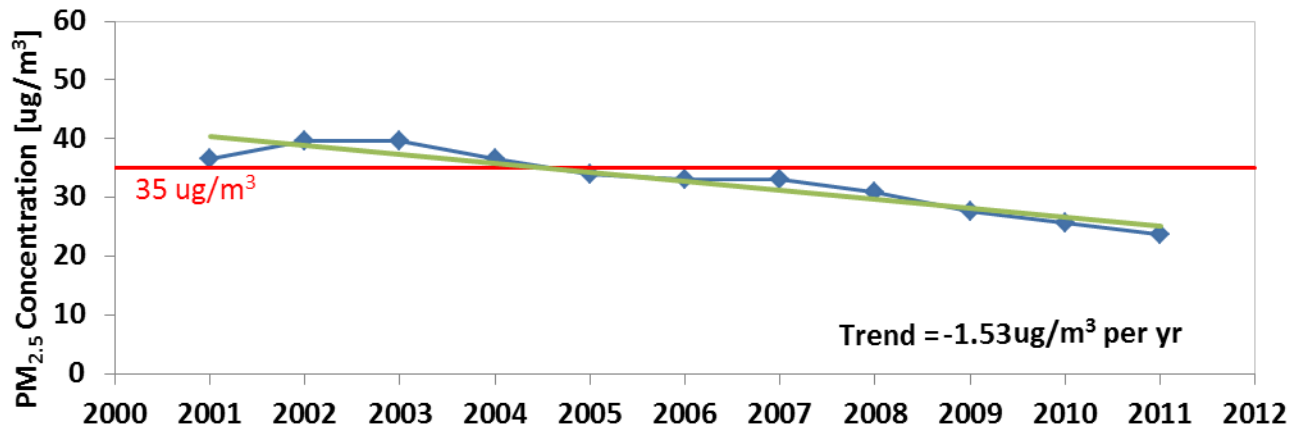


Max/Ave PM_{2.5} 24-Hour DVs and Trend

Delaware Max PM_{2.5} 24-Hour Design Values



Delaware Average PM_{2.5} 24-Hour Design Values



PM_{2.5} Trends by Site in Delaware

Monitoring Site	County	2009-2011 DV [ug/m ³]		Trend [ug/m ³ per year]	
		Annual	24-Hr	Annual DV	24-Hr DV
100010002	Kent	9.1	22	-0.34	-1.47
100010003	Kent	9.4	23	-0.38	-1.47
100031003	New Castle	9.9	23	-0.48	-1.51
100031007	New Castle	9.6	23	-0.45	-1.78
100031012	New Castle	N/A	24	N/A	-1.64
100032004	New Castle	10.7	27	-0.55	-1.42
100051002	Sussex	9.4	24	-0.42	-1.65

Note: Only monitoring sites meeting data completeness criteria listed

Air Quality Trends Summary

- Average O₃ and PM_{2.5} design values have decreased since 1999 in Delaware
- O₃ design values have decreased since 1999 in Seaford, DE, the only currently designated O₃ non-attainment area in Delaware. PM_{2.5} design values have also decreased since 1999 in Philadelphia-Wilmington, PA-NJ-DE, the only currently designated PM_{2.5} non-attainment area in Delaware