Emission and Air Quality Trends Review 1999-2011

Ohio

July 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 utility coal 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, NOx, SO_2, and $PM_{2.5}$
- Project Improvement
  - The Study Team augmented above data with year specific CEM emissions (2002 through 2011)

ALPINE GEOPHYSICS

ENVIRON

Emission Changes

- The following slides also include the tonnage-based emissions change from 1999 to 2011 for each pollutant

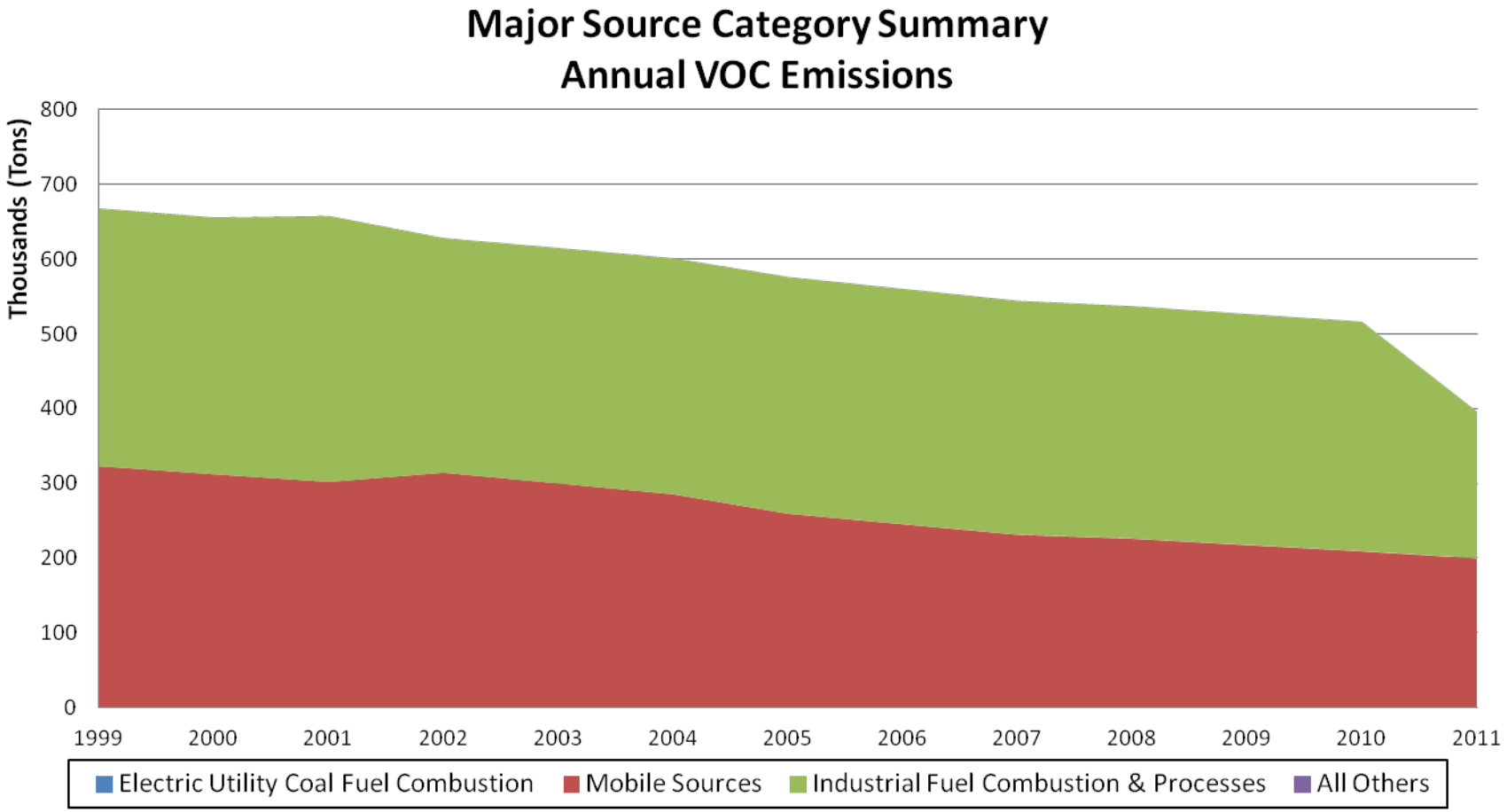
- Negative values indicate decrease in emissions, positive values indicate an increase

Ohio Emission Trends (VOC)

	Annual Emissions (Tons)									
Source Category	**1999**	**2001**	**2003**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Electric Utility Coal Fuel Combustion	1,584	1,625	1,775	1,598	1,578	1,601	1,543	1,374	1,407	1,419
Mobile Sources	321,023	300,081	297,844	257,591	243,528	229,465	224,233	215,878	207,523	198,029
Industrial Fuel Combustion & Processes	345,741	356,590	315,649	317,315	315,358	313,400	311,443	309,486	307,529	196,451
All Others	66	70	59	124	110	132	105	126	160	222
Total	**668,414**	**658,366**	**615,327**	**576,627**	**560,574**	**544,599**	**537,324**	**526,865**	**516,619**	**396,121**

	Annual Emissions Change (Percent since 1999)									
Source Category	**1999**	**2001**	**2003**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Electric Utility Coal Fuel Combustion	0%	3%	12%	1%	0%	1%	-3%	-13%	-11%	-10%
Mobile Sources	0%	-7%	-7%	-20%	-24%	-29%	-30%	-33%	-35%	-38%
Industrial Fuel Combustion & Processes	0%	3%	-9%	-8%	-9%	-9%	-10%	-10%	-11%	-43%
All Others	0%	6%	-11%	87%	66%	100%	59%	91%	142%	236%
Total	**0%**	**-2%**	**-8%**	**-14%**	**-16%**	**-19%**	**-20%**	**-21%**	**-23%**	**-41%**

Ohio Emission Trends (VOC)

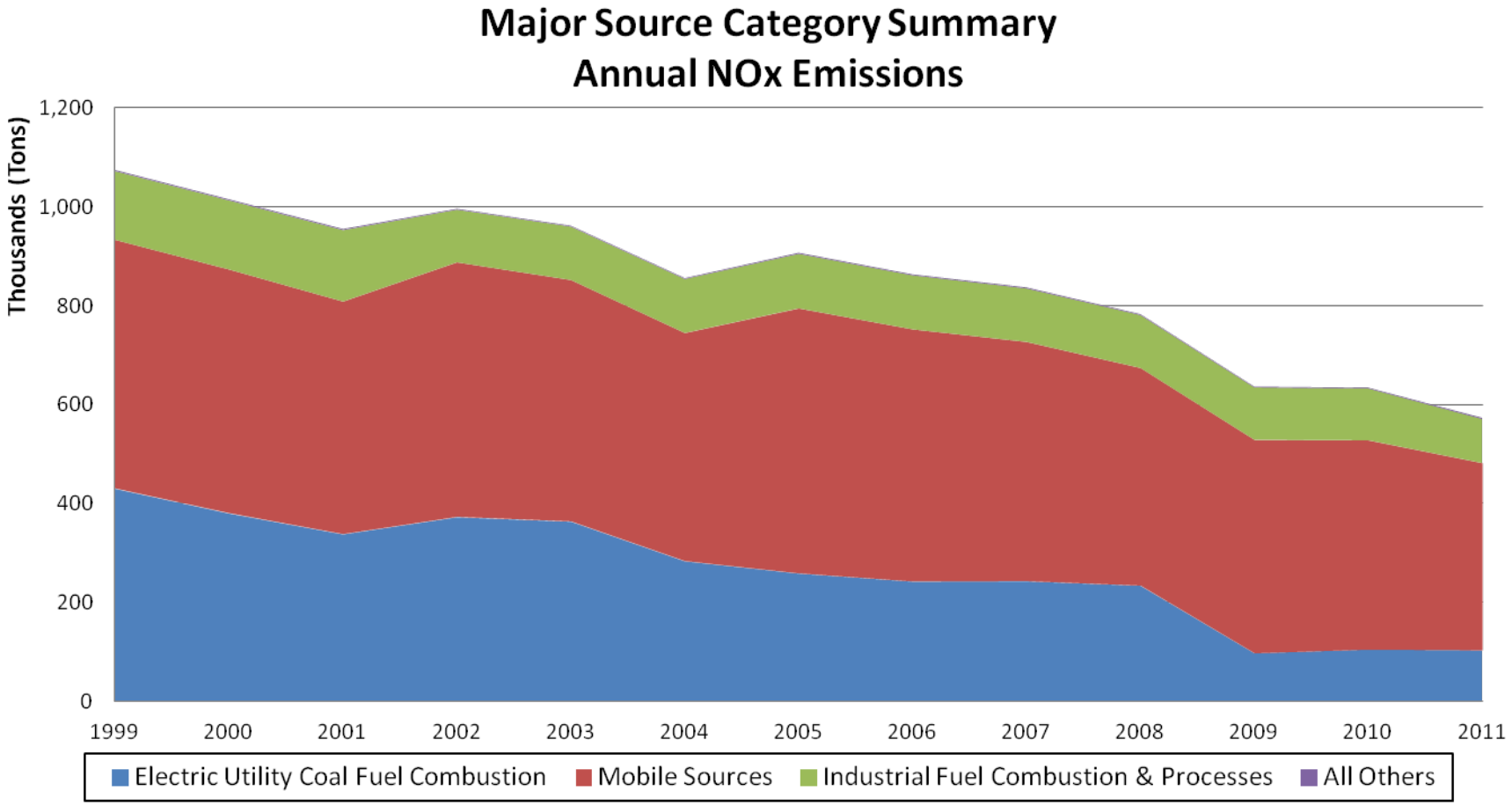


Ohio Emission Trends (NOx)

	Annual Emissions (Tons)									
Source Category	**1999**	**2001**	**2003**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Electric Utility Coal Fuel Combustion	430,140	337,708	363,518	258,198	241,839	242,447	233,469	96,453	103,733	102,335
Mobile Sources	502,645	470,334	488,119	535,959	509,892	483,826	440,083	431,738	423,394	378,733
Industrial Fuel Combustion & Processes	139,024	144,571	108,043	110,467	109,404	108,341	107,278	106,215	105,152	89,406
All Others	2,004	2,066	1,549	1,936	1,747	1,924	1,607	1,506	1,656	2,515
Total	**1,073,813**	**954,679**	**961,229**	**906,559**	**862,883**	**836,538**	**782,436**	**635,911**	**633,935**	**572,989**

	Annual Emissions Change (Percent since 1999)									
Source Category	**1999**	**2001**	**2003**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Electric Utility Coal Fuel Combustion	0%	-21%	-15%	-40%	-44%	-44%	-46%	-78%	-76%	-76%
Mobile Sources	0%	-6%	-3%	7%	1%	-4%	-12%	-14%	-16%	-25%
Industrial Fuel Combustion & Processes	0%	4%	-22%	-21%	-21%	-22%	-23%	-24%	-24%	-36%
All Others	0%	3%	-23%	-3%	-13%	-4%	-20%	-25%	-17%	25%
Total	**0%**	**-11%**	**-10%**	**-16%**	**-20%**	**-22%**	**-27%**	**-41%**	**-41%**	**-47%**

Ohio Emission Trends (NOx)

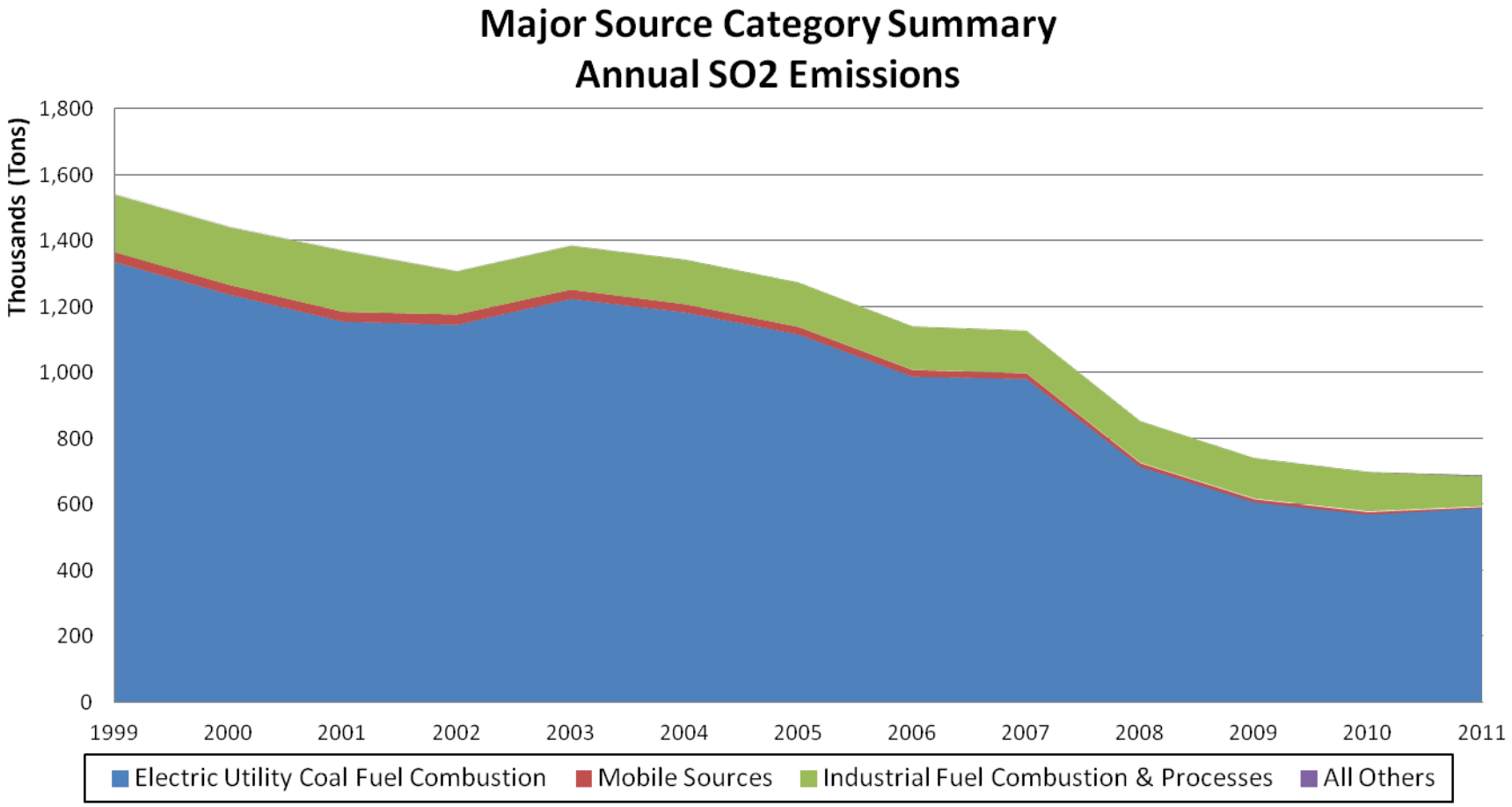


Ohio Emission Trends (SO_2)

	Annual Emissions (Tons)									
Source Category	**1999**	**2001**	**2003**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Electric Utility Coal Fuel Combustion	1,334,410	1,154,828	1,223,630	1,115,591	987,952	980,680	714,627	607,411	570,177	589,755
Mobile Sources	31,131	30,122	28,764	23,476	20,613	17,749	11,391	9,508	7,625	3,493
Industrial Fuel Combustion & Processes	176,113	186,159	133,637	134,999	131,926	128,853	125,781	122,708	119,635	93,098
All Others	348	354	133	110	94	92	78	75	85	2,702
Total	**1,542,002**	**1,371,463**	**1,386,165**	**1,274,175**	**1,140,584**	**1,127,375**	**851,877**	**739,702**	**697,522**	**689,048**

	Annual Emissions Change (Percent since 1999)									
Source Category	**1999**	**2001**	**2003**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Electric Utility Coal Fuel Combustion	0%	-13%	-8%	-16%	-26%	-27%	-46%	-54%	-57%	-56%
Mobile Sources	0%	-3%	-8%	-25%	-34%	-43%	-63%	-69%	-76%	-89%
Industrial Fuel Combustion & Processes	0%	6%	-24%	-23%	-25%	-27%	-29%	-30%	-32%	-47%
All Others	0%	2%	-62%	-68%	-73%	-74%	-78%	-78%	-76%	676%
Total	**0%**	**-11%**	**-10%**	**-17%**	**-26%**	**-27%**	**-45%**	**-52%**	**-55%**	**-55%**

Ohio Emission Trends (SO_2)

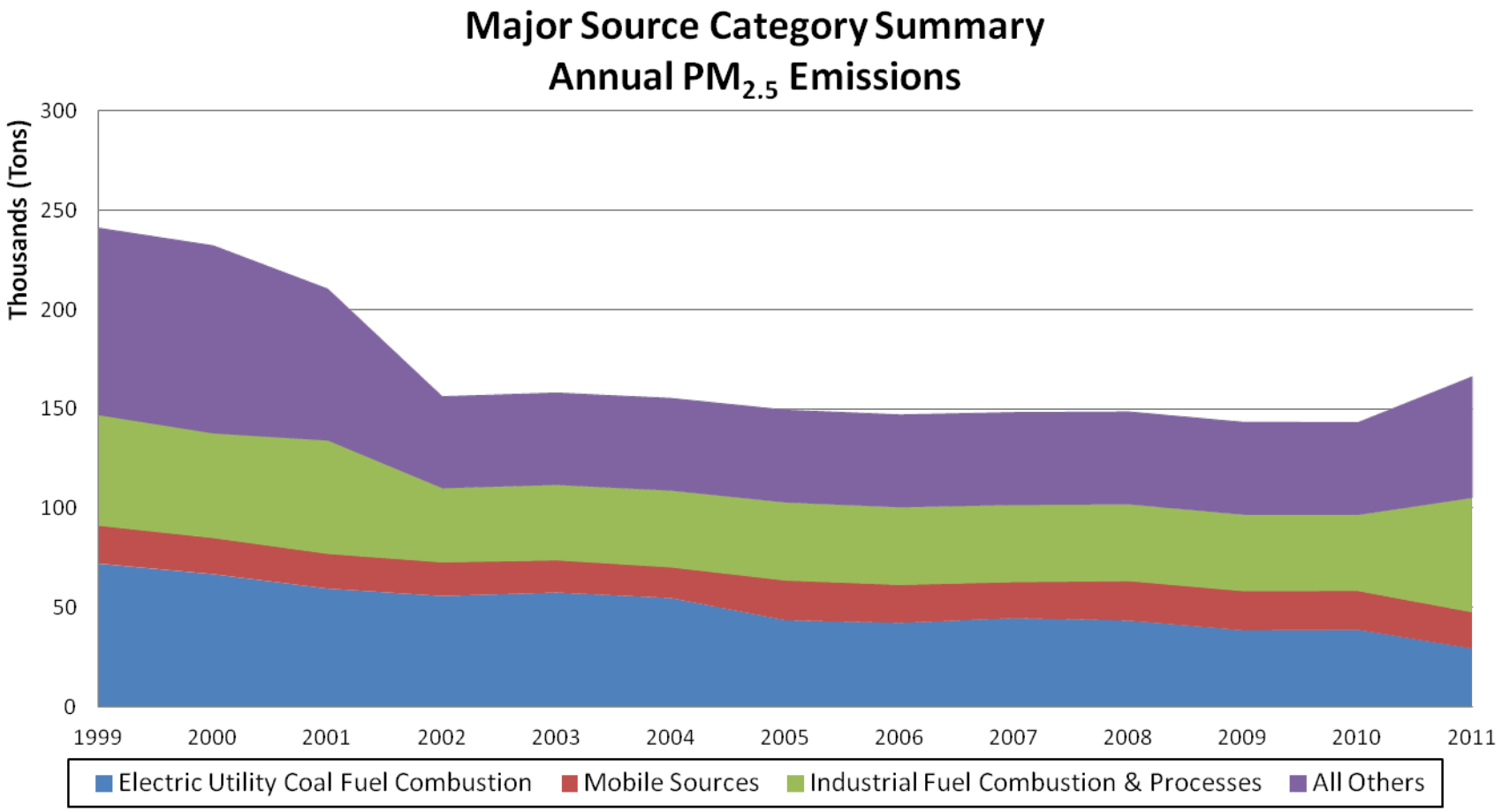


Ohio Emission Trends ($PM_{2.5}$)

	Annual Emissions (Tons)									
Source Category	**1999**	**2001**	**2003**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Electric Utility Coal Fuel Combustion	71,959	59,414	57,472	43,523	42,224	44,535	43,366	38,492	38,768	29,332
Mobile Sources	19,202	17,618	16,360	20,173	19,259	18,345	20,055	19,877	19,699	18,468
Industrial Fuel Combustion & Processes	55,848	57,207	38,073	39,318	39,108	38,899	38,689	38,480	38,270	57,558
All Others	94,428	76,560	46,506	46,816	46,809	46,805	46,797	46,794	46,792	61,314
Total	**241,436**	**210,798**	**158,410**	**149,830**	**147,400**	**148,584**	**148,907**	**143,643**	**143,529**	**166,672**

	Annual Emissions Change (Percent since 1999)									
Source Category	**1999**	**2001**	**2003**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Electric Utility Coal Fuel Combustion	0%	-17%	-20%	-40%	-41%	-38%	-40%	-47%	-46%	-59%
Mobile Sources	0%	-8%	-15%	5%	0%	-4%	4%	4%	3%	-4%
Industrial Fuel Combustion & Processes	0%	2%	-32%	-30%	-30%	-30%	-31%	-31%	-31%	3%
All Others	0%	-19%	-51%	-50%	-50%	-50%	-50%	-50%	-50%	-35%
Total	**0%**	**-13%**	**-34%**	**-38%**	**-39%**	**-38%**	**-38%**	**-41%**	**-41%**	**-31%**

Ohio Emission Trends ($PM_{2.5}$)



Emission Trends Summary

- All pollutants have decreased since 1999 in aggregate across Ohio
- NOx and SO2 from Electric Utility Fuel Combustion sources show significant decrease over time as a result of Acid Rain Program, NOx 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/m^3
- $PM_{2.5}$ 24-Hour
  - Annual 98th percentile of daily averages averaged over three consecutive years
  - Current standard = 35 ug/m^3

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

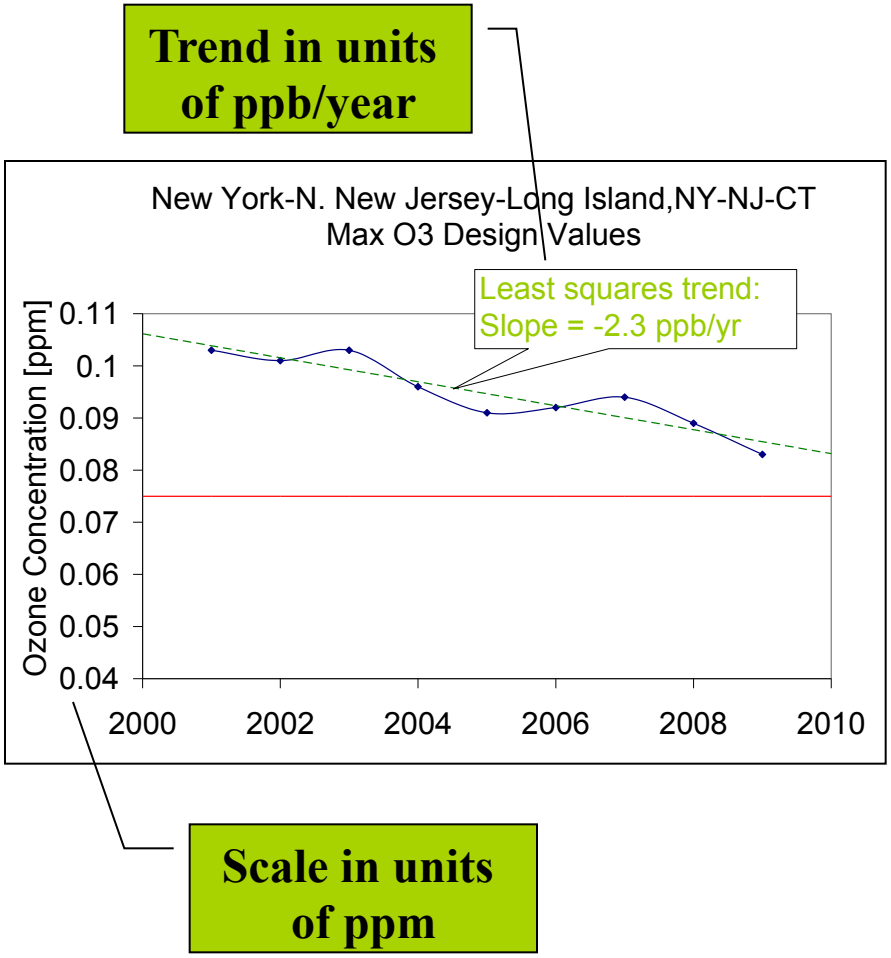
Data Handling Procedures

- O_3 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

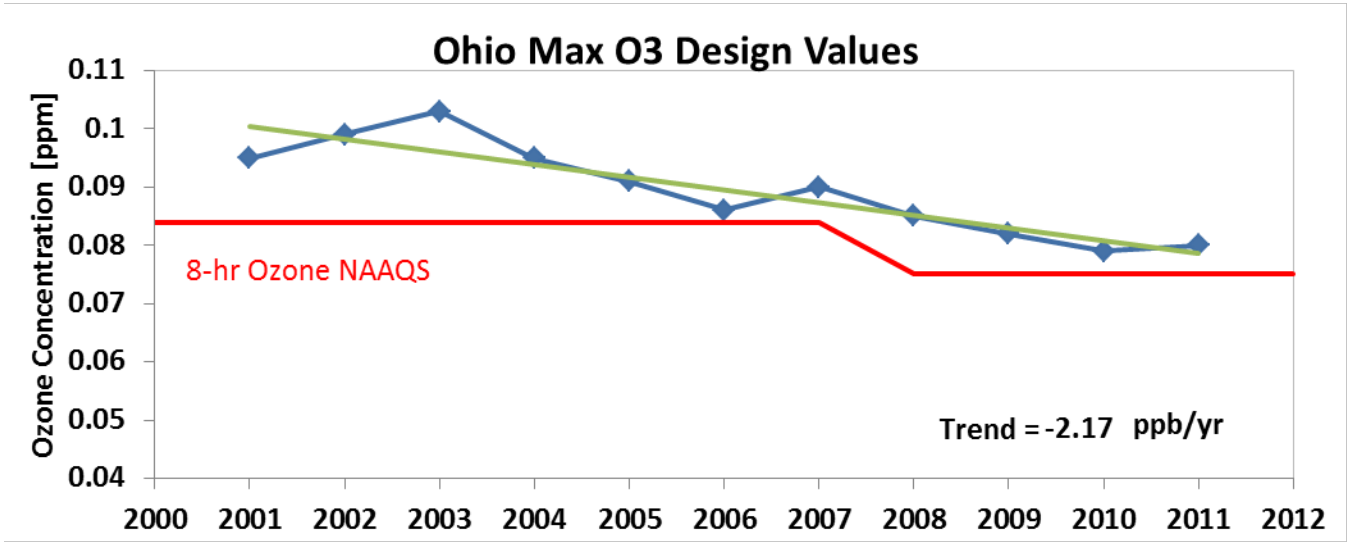
- Annual $PM_{2.5}$ DV and 24-hr $PM_{2.5}$ DV for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
  - DV calculations based on EPA data handling conventions
  - Data extracted from monitors that have a non-regulatory monitoring type are omitted
  - Selection of trend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

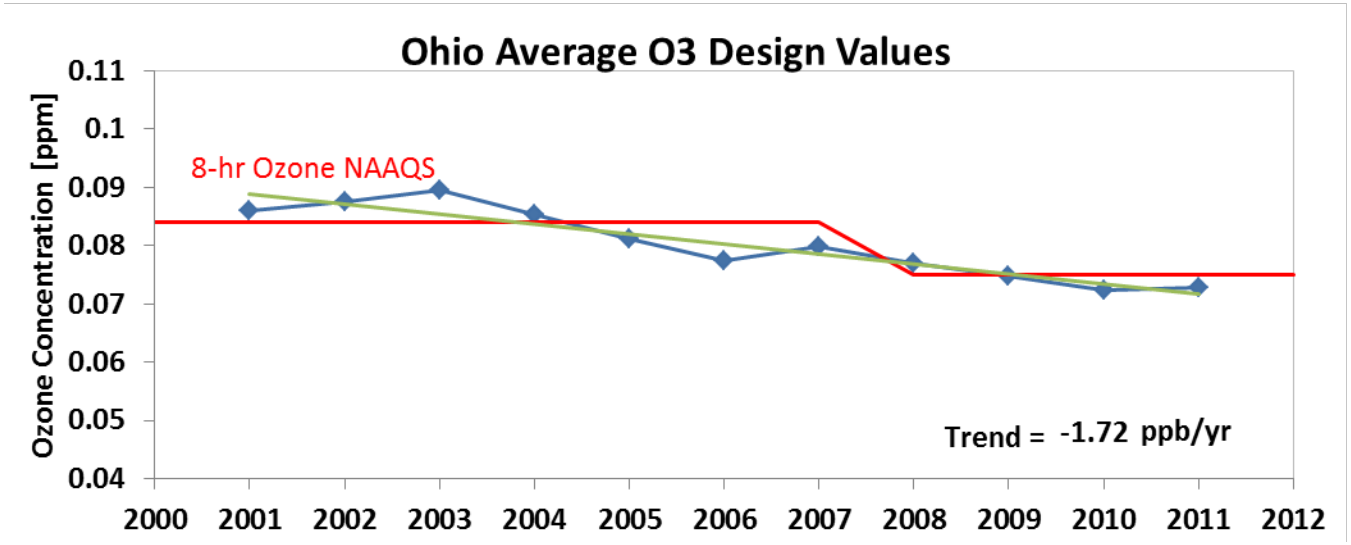
Trend Calculation



- 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 O_3 DVs and Trend





Ozone Trends by Site in Ohio

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/ yr]
390300024420101	Allen, OH	N/A	-2.35
390710014420101	Ashtabula, OH	0.078	-1.83
390170044420101	Butler, OH	0.076	-1.59
390171044420103	Butler, OH	0.079	-1.07
390230014420101	Clark, OH	0.074	-1.82
390230034420101	Clark, OH	0.074	-1.51
390250224420101	Clermont, OH	0.075	-2.12
390271024420101	Clinton, OH	0.076	-2.45
390350344420101	Cuyahoga, OH	0.075	-0.10
390350644420101	Cuyahoga, OH	0.066	-1.35

Note: Only monitoring sites meeting data completeness criteria listed

Ozone Trends by Site in Ohio

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/ yr]
390355002442010 1	Cuyahoga, OH	0.074	-1.31
390410002442010 1	Delaware, OH	0.072	-2.11
390490029442010 1	Franklin, OH	0.079	-2.00
390490037442010 1	Franklin, OH	0.073	-2.02
390490081442010 1	Franklin, OH	0.07	-1.73
390550004442010 1	Geauga, OH	0.073	-3.05
390570006442010 1	Greene, OH	0.072	-1.75
390610006442010 1	Hamilton, OH	0.08	-1.01
390610010442010 1	Hamilton, OH	0.074	-1.17
390610040442010 1	Hamilton, OH	0.078	-0.95

Note: Only monitoring sites meeting data completeness criteria listed

Ozone Trends by Site in Ohio

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/ yr]
390830002442010 1	Knox, OH	0.073	-1.98
390850003442010 1	Lake, OH	0.077	-2.07
390870006442010 1	Lawrence, OH	N/A	-1.82
390870011442010 1	Lawrence, OH	0.064	-1.54
390890005442010 1	Licking, OH	0.074	-1.96
390950024442010 1	Lucas, OH	0.064	-1.68
390950027442010 1	Lucas, OH	0.065	-1.59
390950034442010 1	Lucas, OH	0.072	-2.01
390970007442010 1	Madison, OH	0.073	-2.03
390990013442010 1	Mahoning, OH	0.069	-2.33

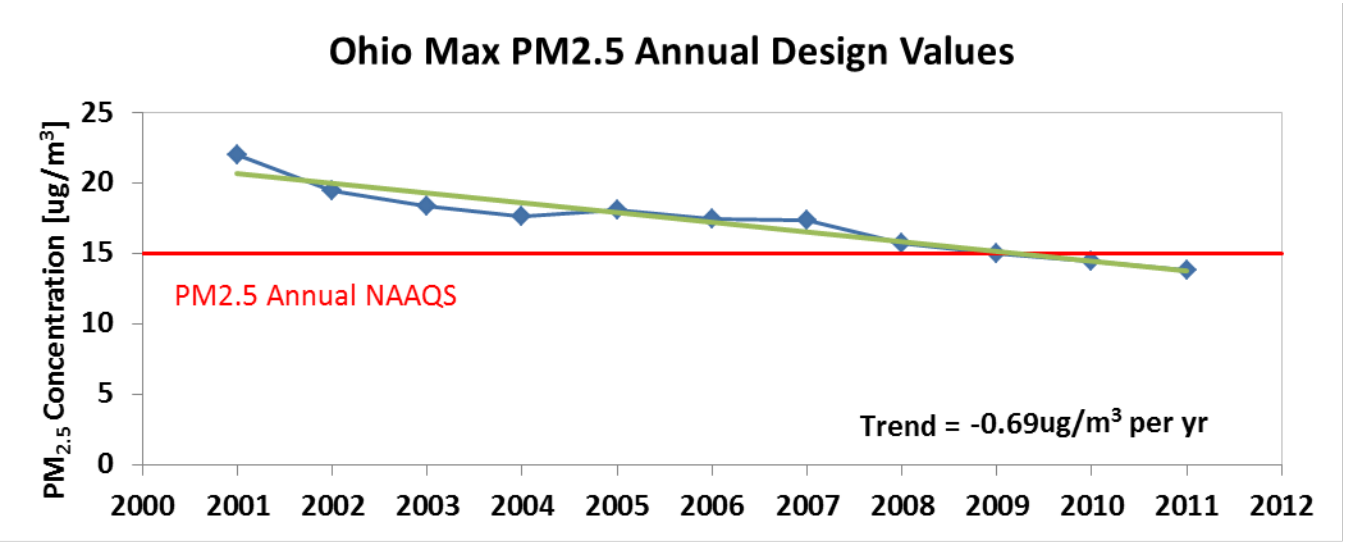
Note: Only monitoring sites meeting data completeness criteria listed

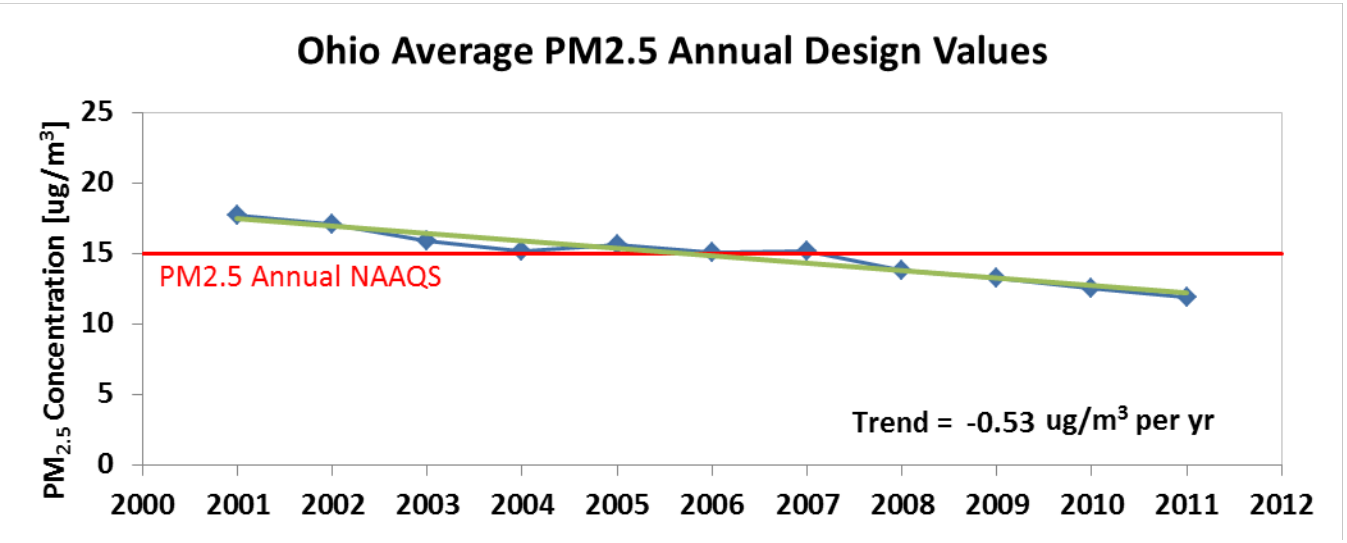
Ozone Trends by Site in Ohio

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/ yr]
3910300034420101	Medina, OH	N/A	-2.29
3910900054420101	Miami, OH	0.072	-1.93
3913310014420101	Portage, OH	0.067	-2.91
3913510014420101	Preble, OH	0.071	-1.17
3915100164420101	Stark, OH	0.075	-1.61
3915140054420101	Stark, OH	0.071	-1.88
3915300204420101	Summit, OH	0.074	-2.11
3915500094420101	Trumbull, OH	0.071	-1.92
3916700044420101	Washington, OH	0.071	-1.55
3917300034420101	Wood, OH	0.07	-1.98

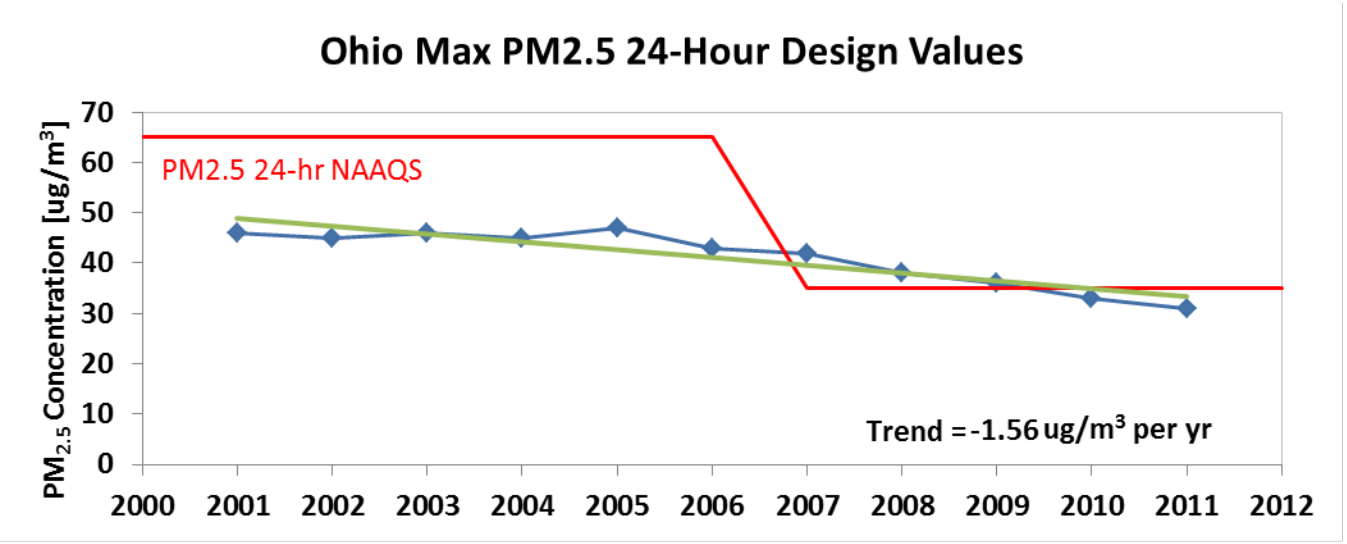
Note: Only monitoring sites meeting data completeness criteria listed

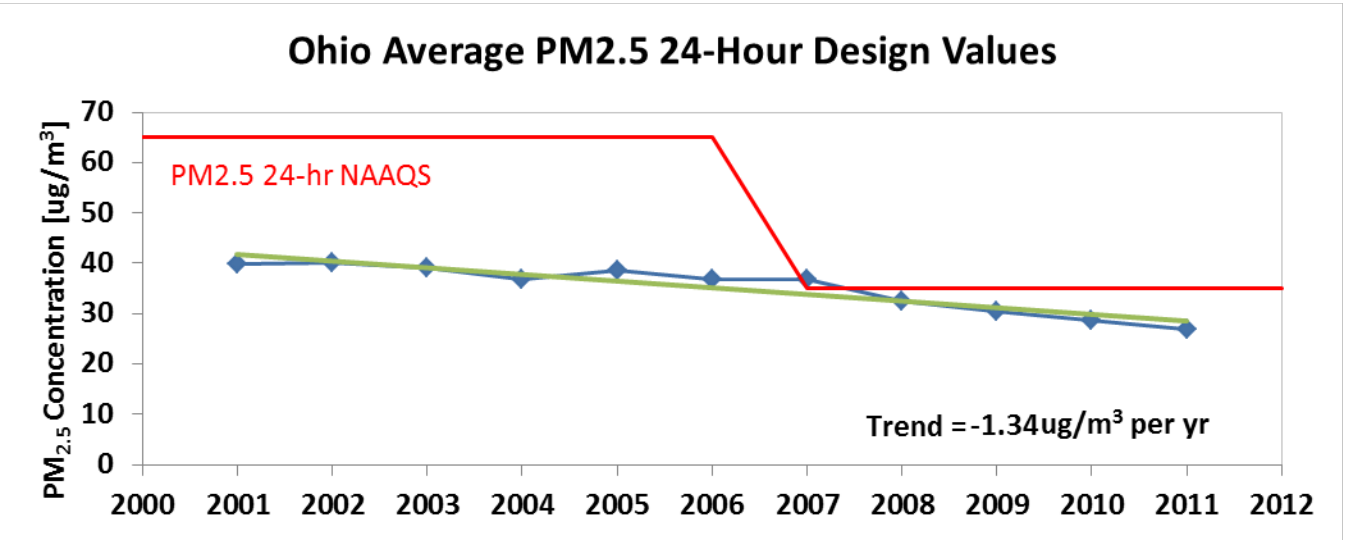
Max/Ave $PM_{2.5}$ Annual DVs and Trend





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





$PM_{2.5}$ Trends by Site in Ohio

		2009-2011 DV [ug/m³]		Trend [ug/m³ per year]	
Monitoring Site	**County**	**Annual**	**24-Hr**	**Annual DV**	**24-Hr DV**
390090003	Athens	9.0	18	-0.41	-1.55
390170003	Butler	N/A	29	N/A	-1.30
390170016	Butler	13.0	29	-0.37	-1.04
390230005	Clark	12.6	28	-0.27	-0.82
390350034	Cuyahoga	10.4	25	-0.50	-1.38
390350038	Cuyahoga	13.1	30	-0.69	-1.61
390350045	Cuyahoga	12.3	27	-0.57	-1.24
390350065	Cuyahoga	12.7	28	-0.42	-1.35
390351002	Cuyahoga	10.9	24	-0.43	-1.01
390490024	Franklin	12.2	26	-0.58	-1.56
390490025	Franklin	11.9	28	-0.52	-1.31
390610014	Hamilton	13.8	29	-0.50	-1.51
390610040	Hamilton	12.8	28	-0.35	-1.11

Note: Only monitoring sites meeting data completeness criteria listed

$PM_{2.5}$ Trends by Site in Ohio

		2009-2011 DV [ug/m³]		Trend [ug/m³ per year]	
Monitoring Site	**County**	**Annual**	**24-Hr**	**Annual DV**	**24-Hr DV**
390610042	Hamilton	13.8	31	-0.45	-1.35
390617001	Hamilton	N/A	N/A	-0.37	-1.21
390618001	Hamilton	N/A	N/A	-0.39	-0.57
390811001	Jefferson	11.8	24	-0.64	-1.85
390950024	Lucas	11.1	27	-0.50	-1.10
390950026	Lucas	11.0	26	-0.46	-1.25
390990005	Mahoning	11.4	28	-0.43	-1.10
391130032	Montgomery	N/A	29	N/A	-1.57
391330002	Portage	10.9	26	-0.40	-1.24
391450013	Scioto	10.9	22	-0.94	-2.22
391530017	Summit	12.6	29	-0.47	-1.24
391530023	Summit	11.7	27	-0.47	-1.50

Note: Only monitoring sites meeting data completeness criteria listed

Air Quality Trends Summary

- Average O_3 and $PM_{2.5}$ design values have decreased since 1999 in Ohio

- O_3 and $PM_{2.5}$ design values have decreased since 1999 in all currently designated O_3 and $PM_{2.5}$ non-attainment areas in Ohio in which monitoring data met the 1999–2011 trends completeness criteria. Additional O_3 or $PM_{2.5}$ non-attainment areas in Ohio in which monitoring data did not meet the 1999–2011 trends completeness criteria include:
  - Canton-Massillon, OH (Annual & 24-Hour $PM_{2.5}$)