

Emission and Air Quality Trends Review 1999-2011

Minnesota

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, 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

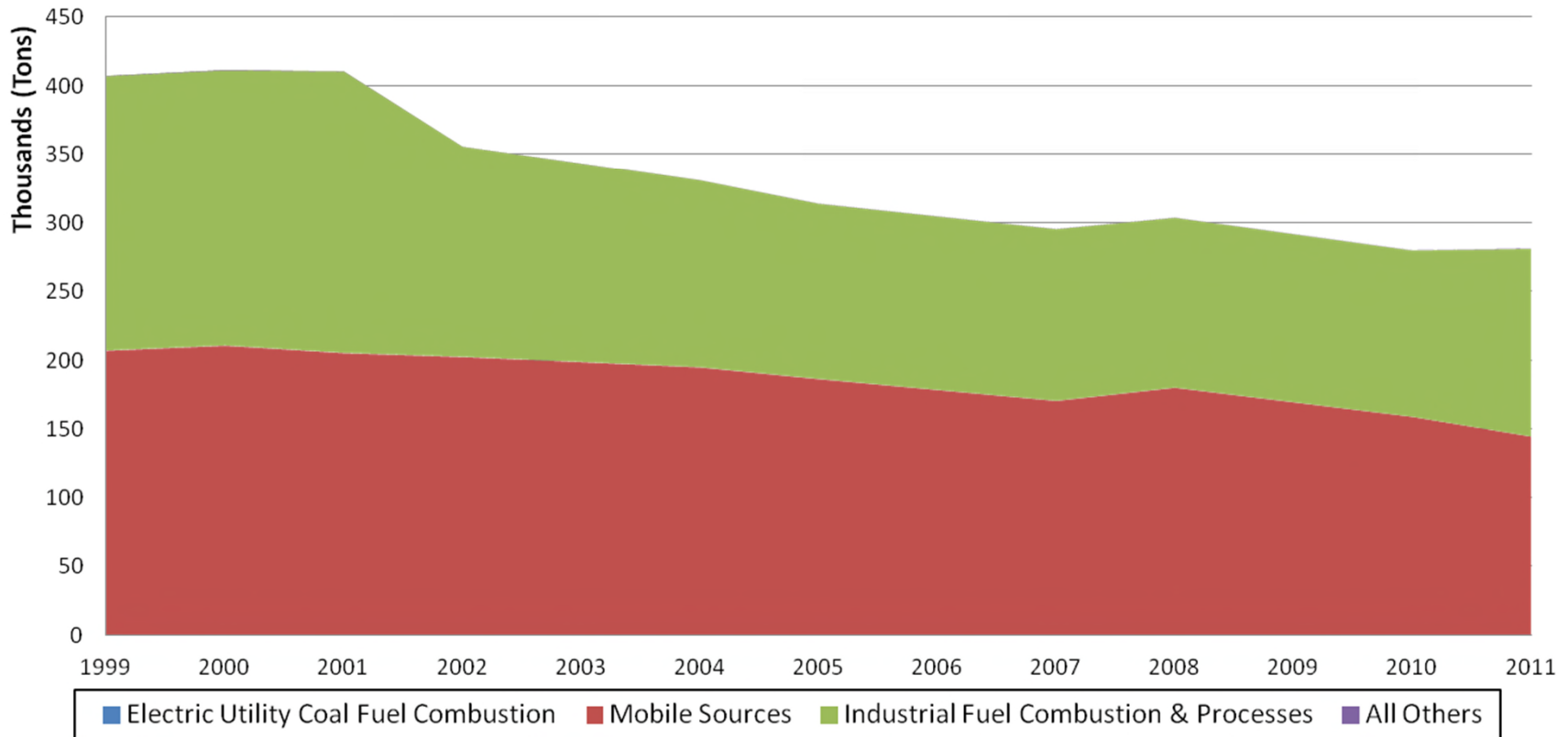
Minnesota Emission Trends (VOC)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	550	632	623	567	542	524	493	464	448	499
Mobile Sources	206,740	204,977	198,398	186,155	178,249	170,343	179,958	169,425	158,891	144,511
Industrial Fuel Combustion & Processes	199,690	204,680	144,043	126,787	125,481	124,174	122,867	121,560	120,253	135,809
All Others	279	208	154	158	150	156	164	150	166	240
Total	407,258	410,497	343,218	313,668	304,422	295,197	303,481	291,599	279,759	281,059

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	15%	13%	3%	-1%	-5%	-10%	-16%	-18%	-9%
Mobile Sources	0%	-1%	-4%	-10%	-14%	-18%	-13%	-18%	-23%	-30%
Industrial Fuel Combustion & Processes	0%	2%	-28%	-37%	-37%	-38%	-38%	-39%	-40%	-32%
All Others	0%	-25%	-45%	-43%	-46%	-44%	-41%	-46%	-41%	-14%
Total	0%	1%	-16%	-23%	-25%	-28%	-25%	-28%	-31%	-31%

Minnesota Emission Trends (VOC)

**Major Source Category Summary
Annual VOC Emissions**



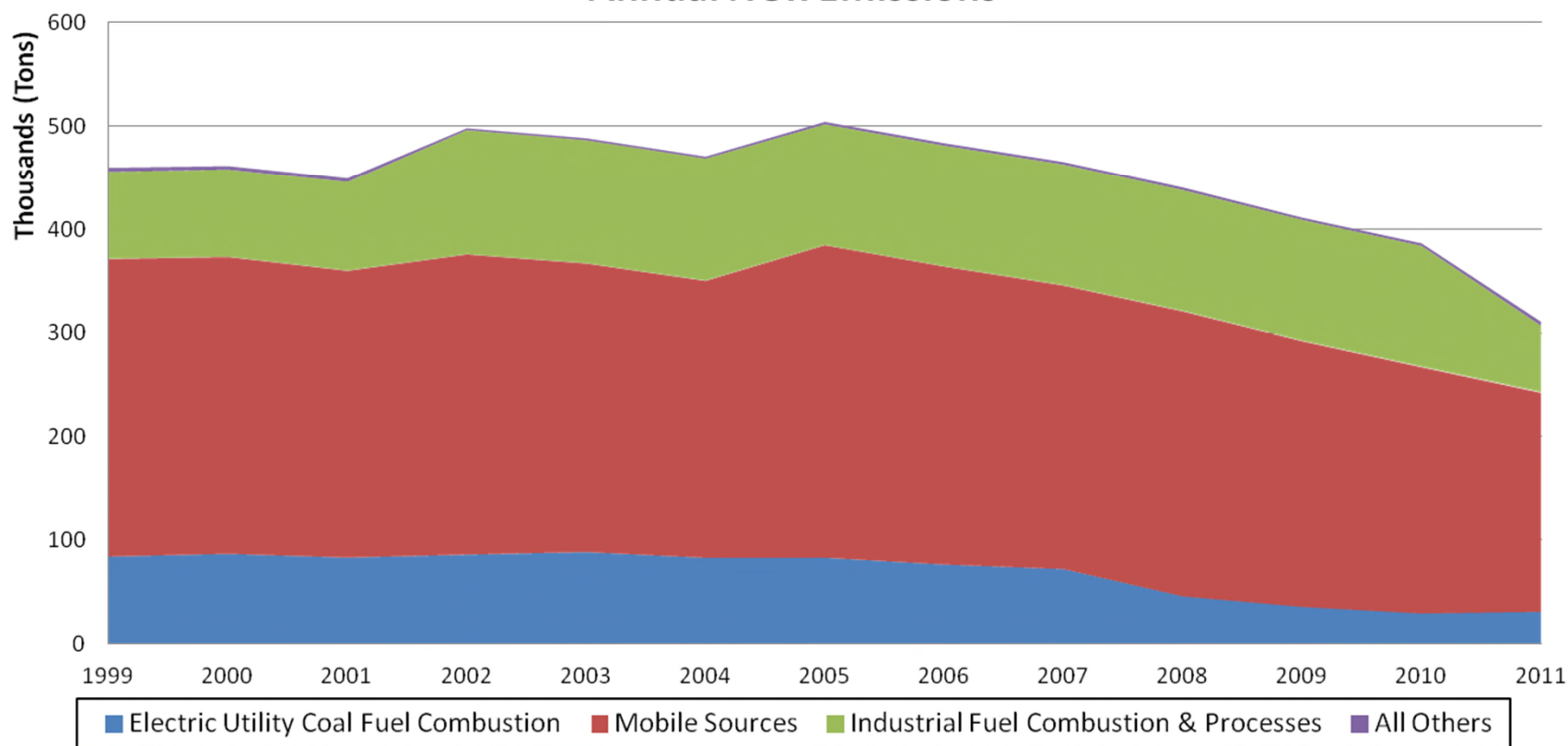
Minnesota Emission Trends (NO_x)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	84,451	83,430	88,795	83,357	76,735	72,392	46,114	35,943	29,543	31,231
Mobile Sources	287,063	276,710	278,402	301,456	287,530	273,605	274,979	256,424	237,869	211,577
Industrial Fuel Combustion & Processes	84,601	85,918	119,746	117,552	117,359	117,166	116,973	116,780	116,587	64,093
All Others	3,921	3,419	1,766	2,221	2,272	2,313	2,423	2,059	2,382	3,734
Total	460,035	449,478	488,708	504,587	483,897	465,475	440,489	411,206	386,381	310,635

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%	5%	-1%	-9%	-14%	-45%	-57%	-65%	-63%
Mobile Sources	0%	-4%	-3%	5%	0%	-5%	-4%	-11%	-17%	-26%
Industrial Fuel Combustion & Processes	0%	2%	42%	39%	39%	38%	38%	38%	38%	-24%
All Others	0%	-13%	-55%	-43%	-42%	-41%	-38%	-47%	-39%	-5%
Total	0%	-2%	6%	10%	5%	1%	-4%	-11%	-16%	-32%

Minnesota Emission Trends (NO_x)

**Major Source Category Summary
Annual NO_x Emissions**



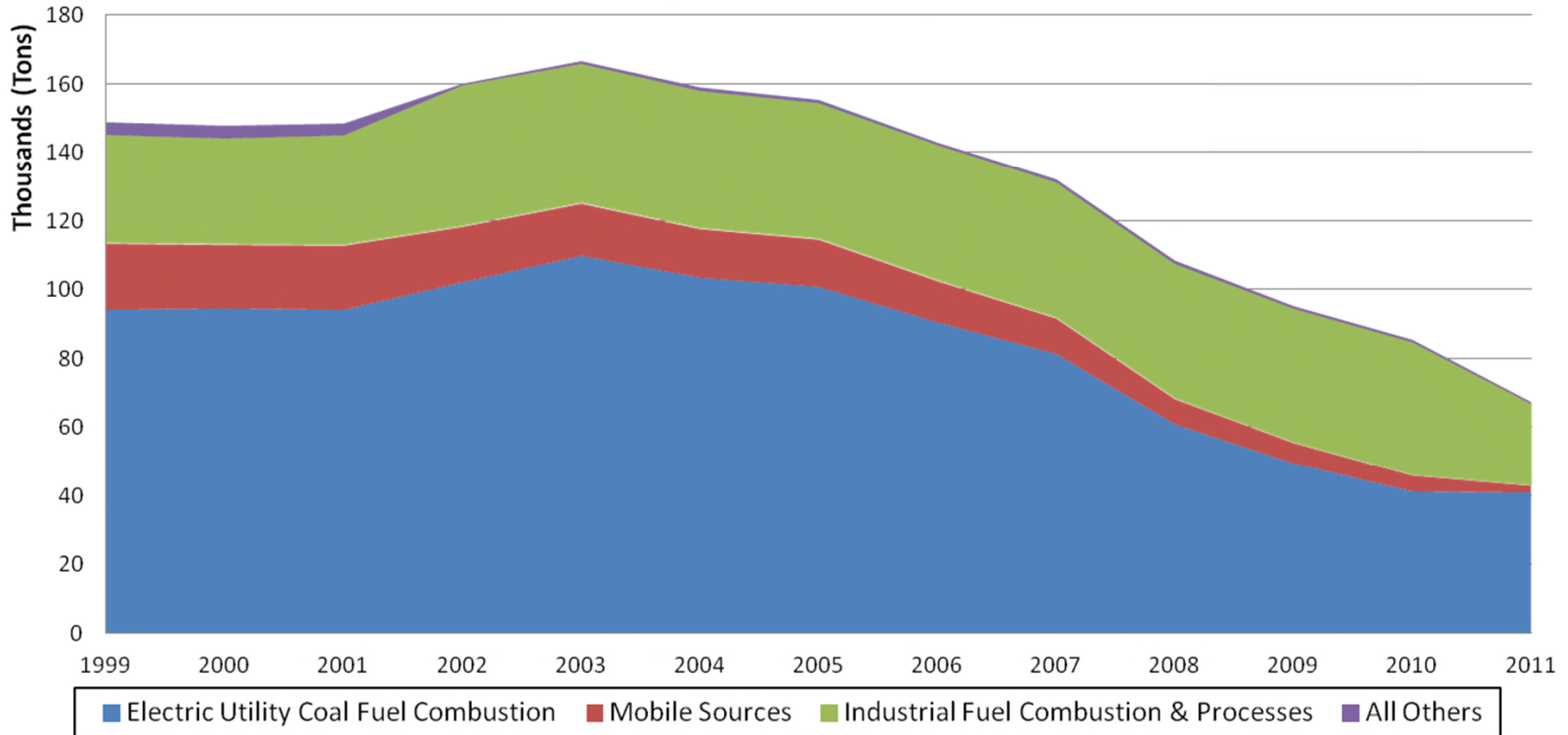
Minnesota Emission Trends (SO₂)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	94,231	94,202	109,912	100,886	90,524	81,370	60,884	49,415	41,165	40,792
Mobile Sources	19,176	18,645	15,150	13,706	12,013	10,321	7,316	5,980	4,644	2,002
Industrial Fuel Combustion & Processes	31,754	32,178	40,768	39,800	39,638	39,476	39,314	39,152	38,990	24,150
All Others	3,694	3,470	783	962	727	931	978	741	725	538
Total	148,854	148,495	166,614	155,354	142,902	132,097	108,492	95,288	85,525	67,482

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	0%	17%	7%	-4%	-14%	-35%	-48%	-56%	-57%
Mobile Sources	0%	-3%	-21%	-29%	-37%	-46%	-62%	-69%	-76%	-90%
Industrial Fuel Combustion & Processes	0%	1%	28%	25%	25%	24%	24%	23%	23%	-24%
All Others	0%	-6%	-79%	-74%	-80%	-75%	-74%	-80%	-80%	-85%
Total	0%	0%	12%	4%	-4%	-11%	-27%	-36%	-43%	-55%

Minnesota Emission Trends (SO₂)

**Major Source Category Summary
Annual SO₂ Emissions**



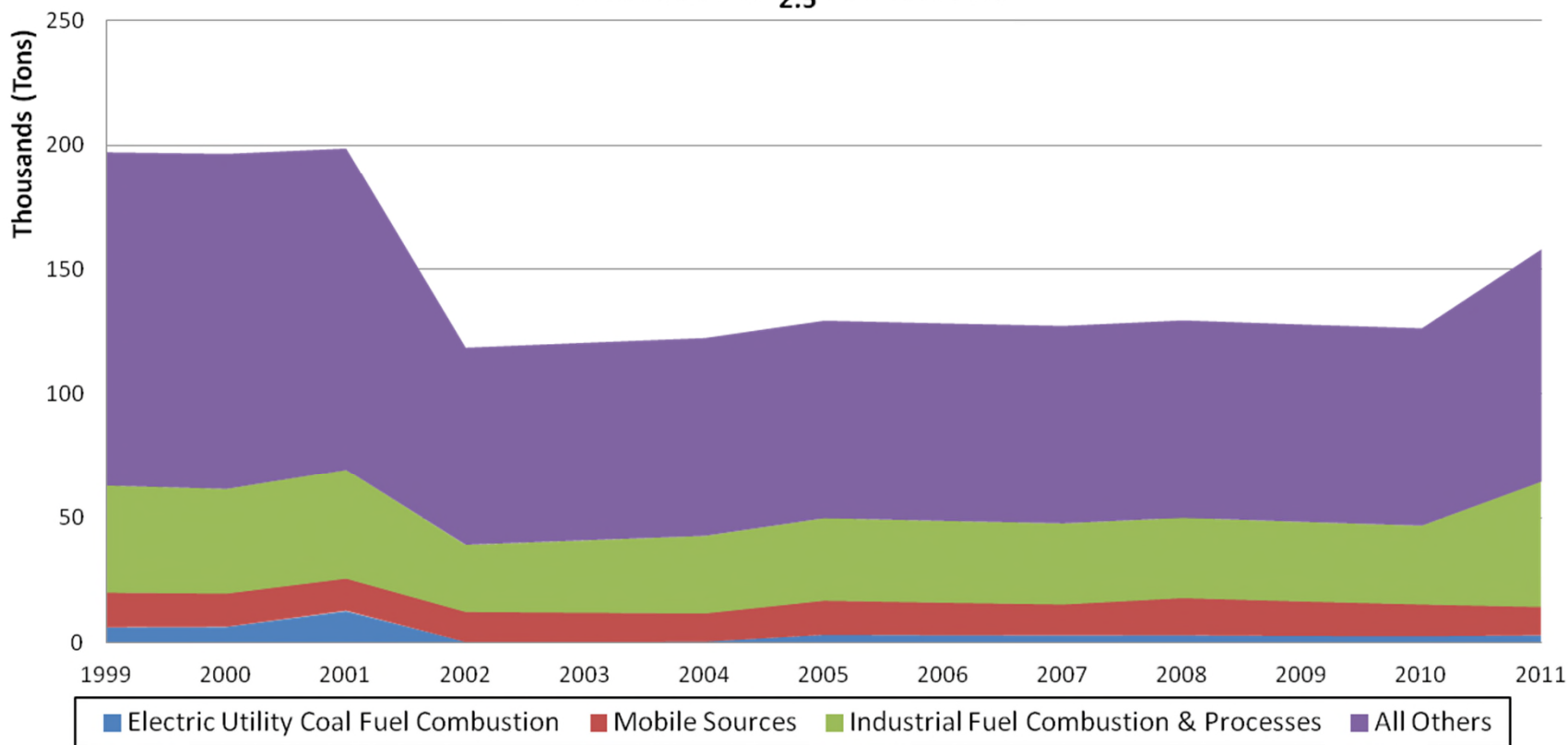
Minnesota Emission Trends (PM_{2.5})

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	6,053	12,708	246	3,018	2,858	2,782	2,848	2,582	2,462	2,840
Mobile Sources	14,067	13,040	11,870	13,892	13,270	12,648	15,122	14,043	12,964	11,577
Industrial Fuel Combustion & Processes	42,907	43,732	28,926	33,012	32,710	32,407	32,105	31,803	31,501	50,170
All Others	134,228	129,264	79,501	79,502	79,493	79,479	79,469	79,454	79,459	93,411
Total	197,255	198,744	120,542	129,425	128,331	127,316	129,544	127,882	126,386	157,998

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	110%	-96%	-50%	-53%	-54%	-53%	-57%	-59%	-53%
Mobile Sources	0%	-7%	-16%	-1%	-6%	-10%	7%	0%	-8%	-18%
Industrial Fuel Combustion & Processes	0%	2%	-33%	-23%	-24%	-24%	-25%	-26%	-27%	17%
All Others	0%	-4%	-41%	-41%	-41%	-41%	-41%	-41%	-41%	-30%
Total	0%	1%	-39%	-34%	-35%	-35%	-34%	-35%	-36%	-20%

Minnesota 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 the Minnesota
- ❑ NO_x and SO₂ from Electric Utility Fuel Combustion sources show significant decrease over time as a result of Acid Rain 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

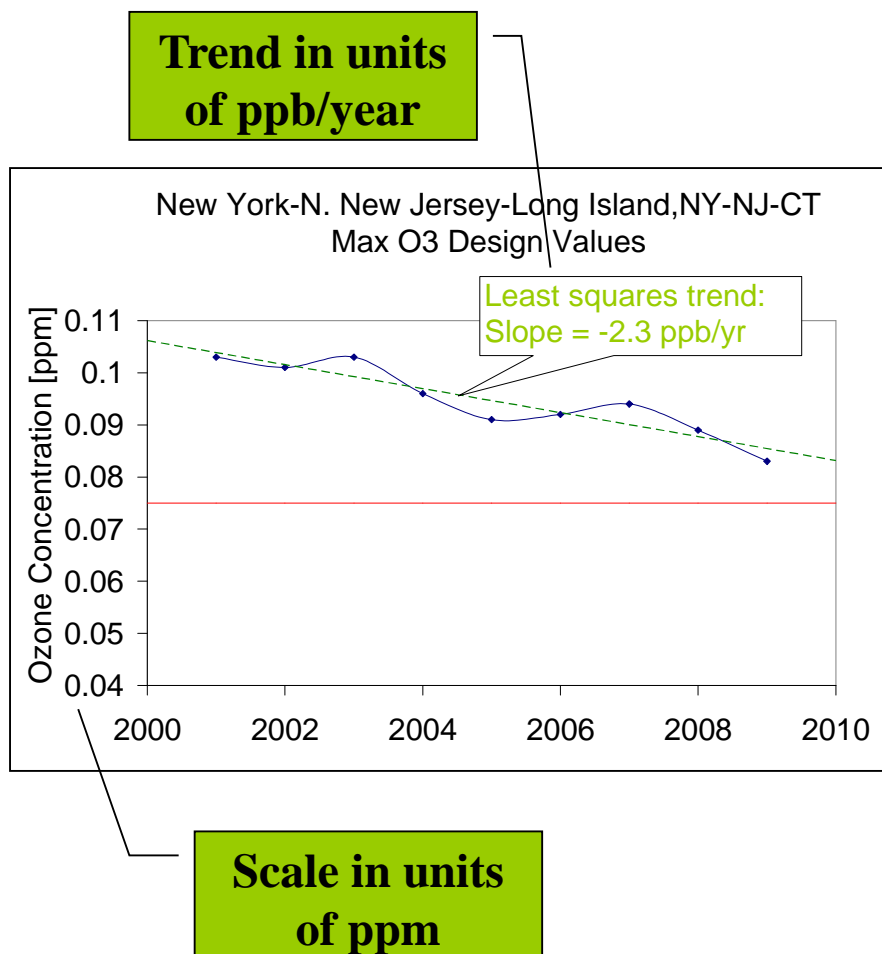
Data Handling Procedures

- 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



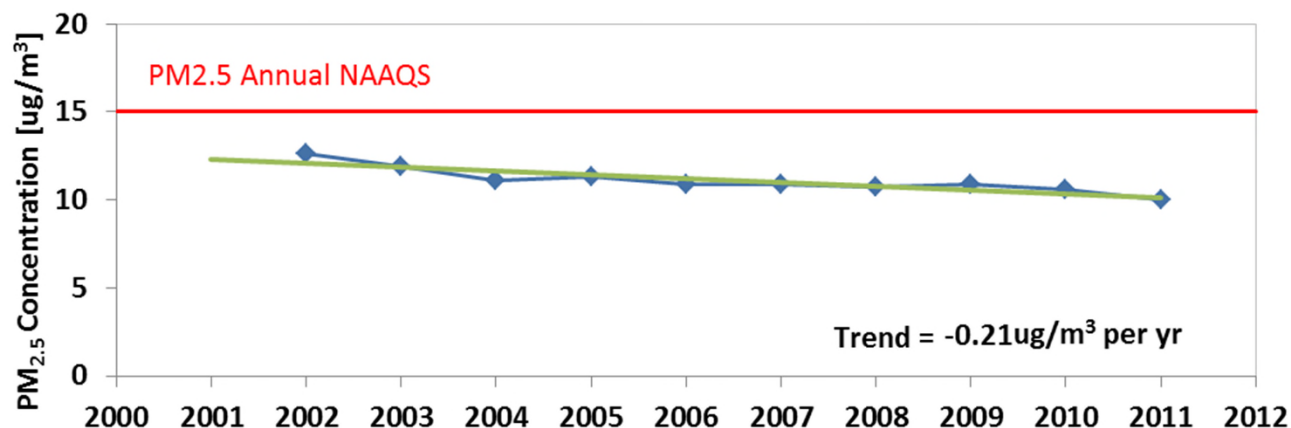
- Trends based on linear least squares fit to rolling three year design values (DVs)
- Negative trend indicates improving air quality
- DVs based on each 3-year period: 1999-2001, 2000-2002, ... 2009-2011
- Notes
 - On plots, DVs are for three year period ending in year shown (i.e., 2009-2011 DV plotted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

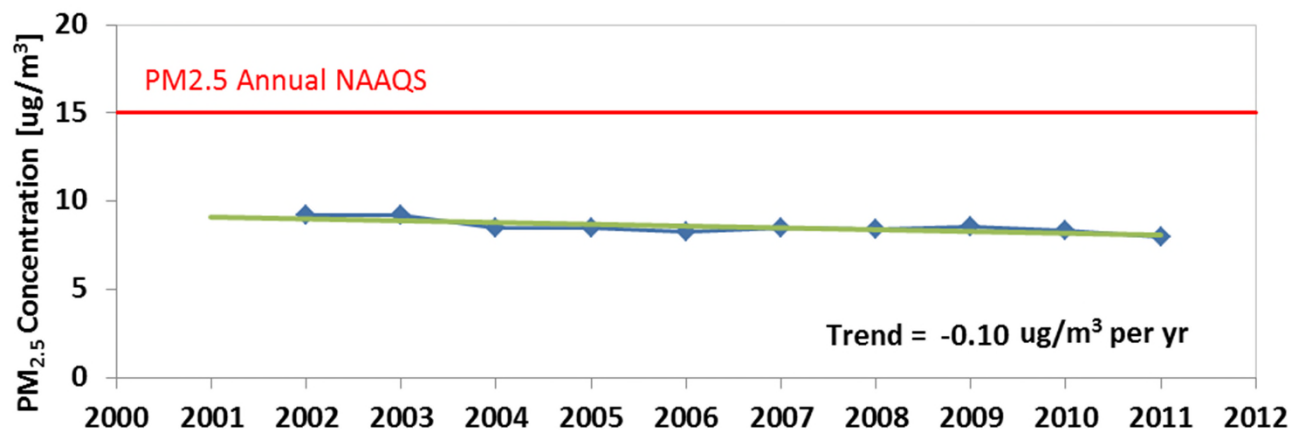
Note: No ozone monitoring sites in Minnesota meet the data completeness requirements established for this analysis and therefore no trends are presented.

Max/Ave PM_{2.5} Annual DVs and Trend

Minnesota Max PM2.5 Annual Design Values

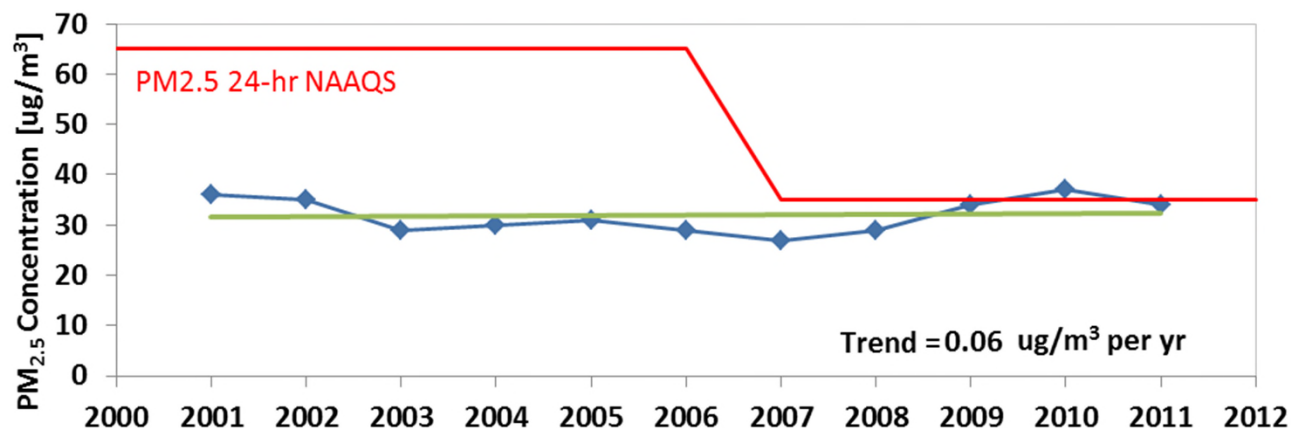


Minnesota Average PM2.5 Annual Design Values

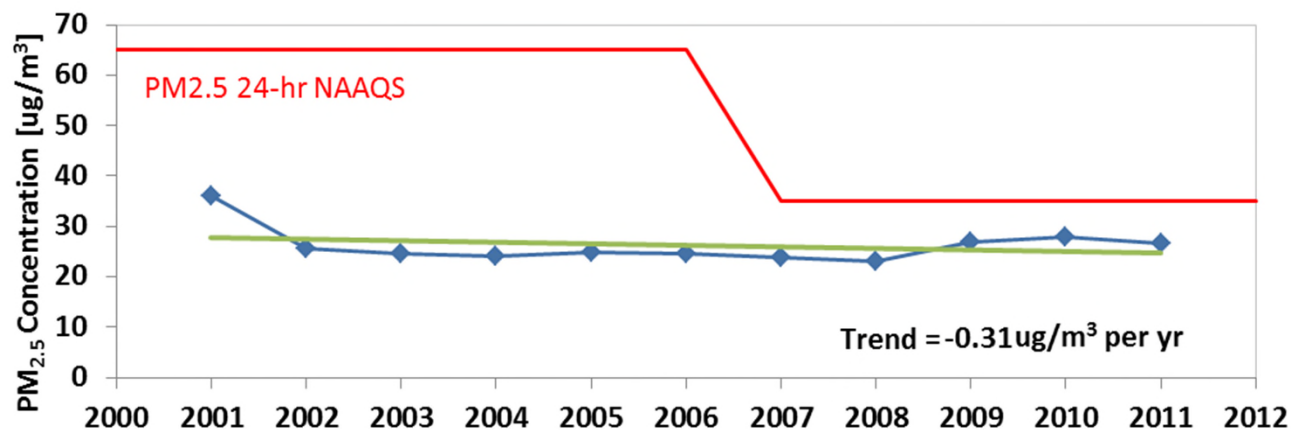


Max/Ave PM_{2.5} 24-Hour DVs and Trend

Minnesota Max PM_{2.5} 24-Hour Design Values



Minnesota Average PM_{2.5} 24-Hour Design Values



PM_{2.5} Trends by Site in Minnesota

Monitoring Site	County	2009-2011 DV [ug/m ³]		Trend [ug/m ³ per year]	
		Annual	24-Hr	Annual DV	24-Hr DV
270370470	Dakota	9.2	31	0.00	0.83
270530963	Hennepin	9.5	30	-0.07	0.32
271230868	Ramsey	10.0	34	-0.21	-0.05
271230871	Ramsey	N/A	33	N/A	1.18
271377001	St. Louis	5.4	17	-0.16	-0.65
271377550	St. Louis	5.8	19	-0.08	0.33
271377551	St. Louis	6.6	21	-0.16	-0.15
271390505	Scott	8.8	28	-0.12	0.16
271453052	Stearns	8.6	N/A	-0.09	N/A

Note: Only monitoring sites meeting data completeness criteria listed

Air Quality Trends Summary

- There are no ozone monitors in Minnesota with sufficient data completeness to compute 1999 – 2011 trend. Average 24-hr $PM_{2.5}$ design values have remained largely unchanged since 2002 in Minnesota; average annual $PM_{2.5}$ design values have decreased slightly since 2000 (incomplete data in 1999)
- There are no currently designated O_3 or $PM_{2.5}$ non-attainment areas in Minnesota