

Emission and Air Quality Trends Review

Tennessee

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

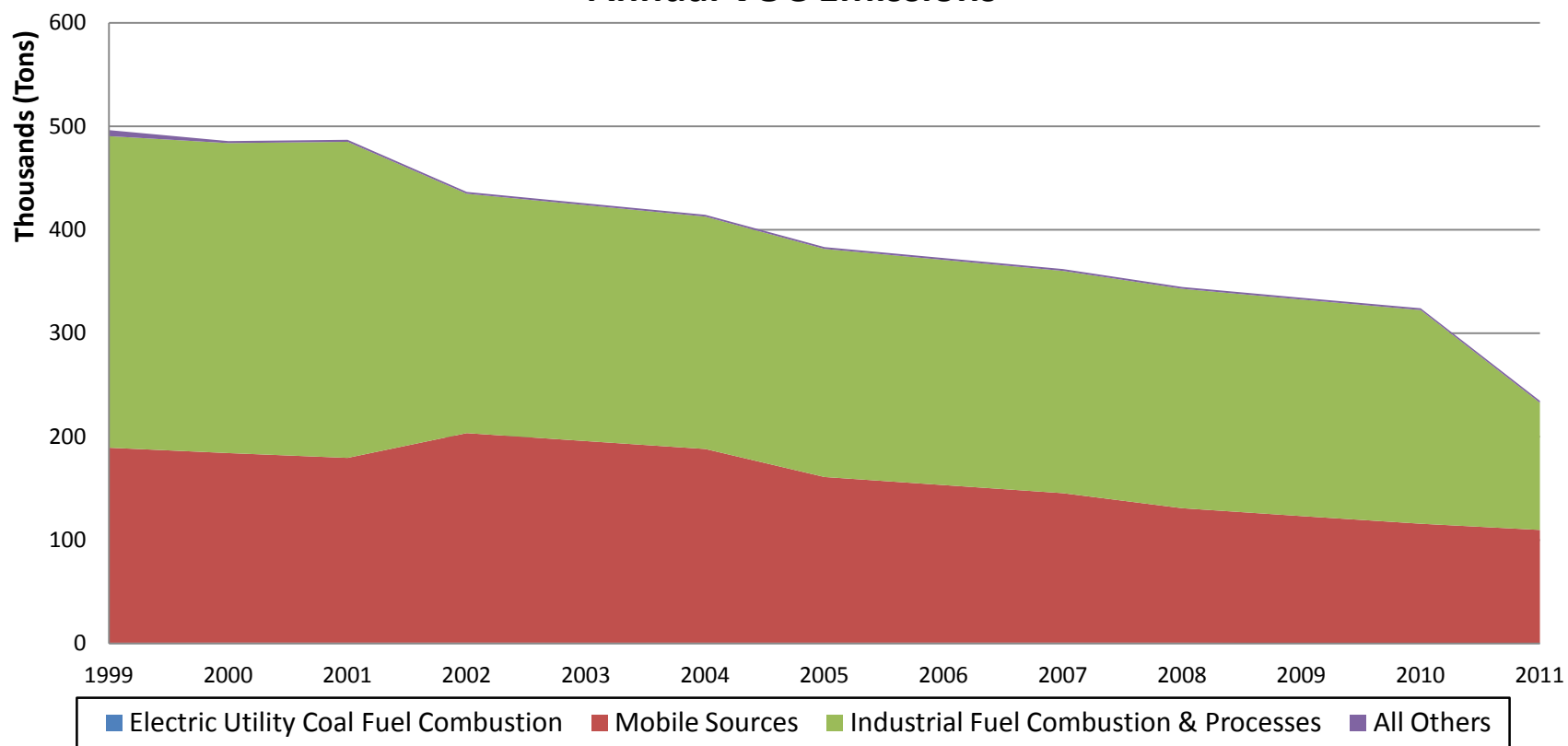
Tennessee Emission Trends (VOC)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	725	792	758	769	798	808	766	560	596	671
Mobile Sources	188,549	178,669	194,936	160,210	152,371	144,533	130,042	122,631	115,219	109,132
Industrial Fuel Combustion & Processes	301,203	305,557	228,008	220,446	217,656	214,865	212,074	209,283	206,492	122,873
All Others	5,820	1,942	1,782	1,798	1,794	1,789	1,781	1,775	1,785	1,975
Total	496,297	486,960	425,484	383,223	372,618	361,994	344,663	334,249	324,092	234,651

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	9%	5%	6%	10%	11%	6%	-23%	-18%	-7%
Mobile Sources	0%	-5%	3%	-15%	-19%	-23%	-31%	-35%	-39%	-42%
Industrial Fuel Combustion & Processes	0%	1%	-24%	-27%	-28%	-29%	-30%	-31%	-31%	-59%
All Others	0%	-67%	-69%	-69%	-69%	-69%	-69%	-69%	-69%	-66%
Total	0%	-2%	-14%	-23%	-25%	-27%	-31%	-33%	-35%	-53%

Tennessee Emission Trends (VOC)

**Major Source Category Summary
Annual VOC Emissions**



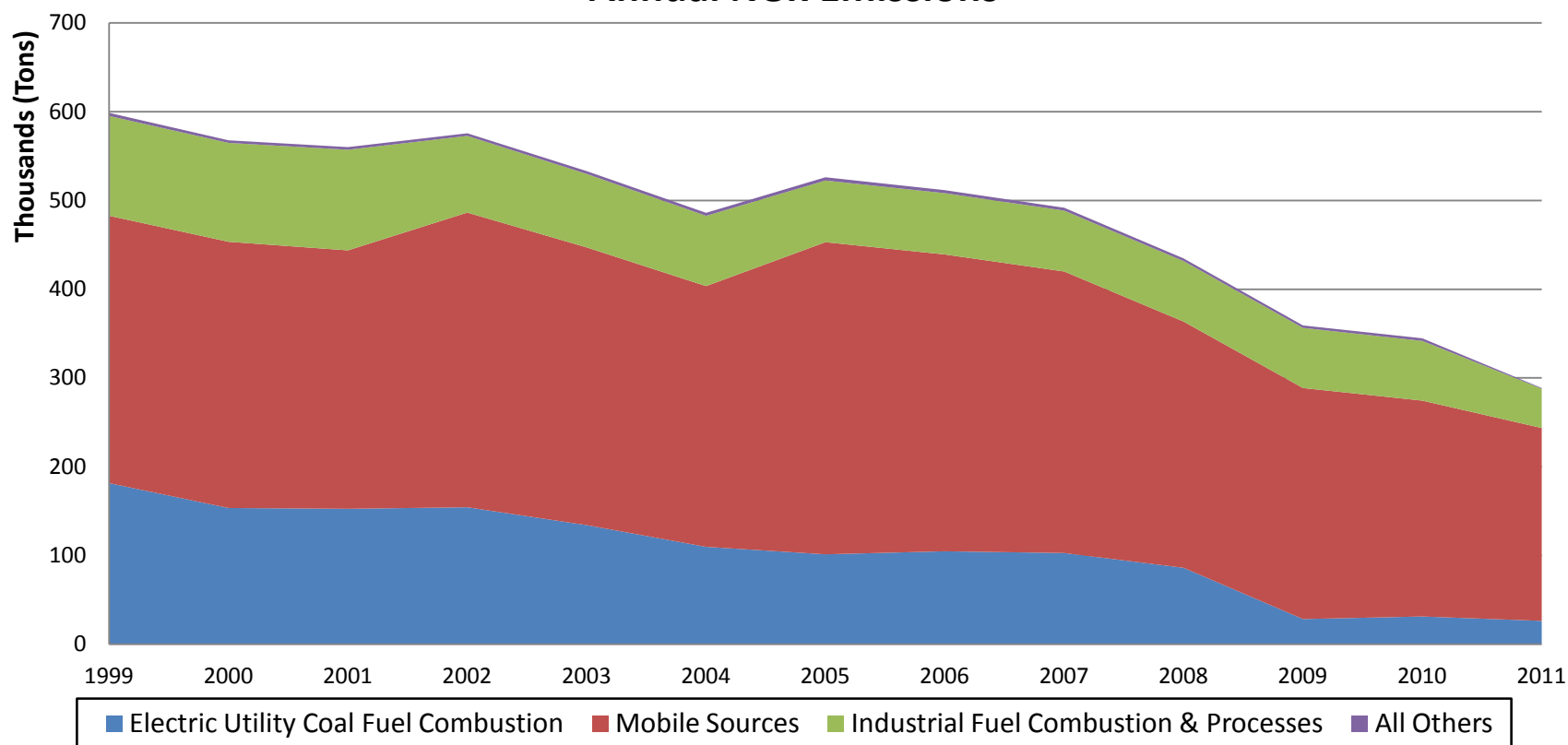
Tennessee Emission Trends (NO_x)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	181,501	152,571	134,210	101,328	104,729	102,775	86,122	28,386	31,261	26,350
Mobile Sources	301,166	291,168	312,843	351,610	334,378	317,146	277,368	260,275	243,182	217,232
Industrial Fuel Combustion & Processes	112,471	113,357	82,814	69,487	69,052	68,618	68,183	67,748	67,313	44,309
All Others	3,487	2,965	3,145	3,662	3,394	3,189	2,993	2,753	2,891	787
Total	598,625	560,062	533,012	526,086	511,553	491,728	434,666	359,162	344,647	288,678

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	-16%	-26%	-44%	-42%	-43%	-53%	-84%	-83%	-85%
Mobile Sources	0%	-3%	4%	17%	11%	5%	-8%	-14%	-19%	-28%
Industrial Fuel Combustion & Processes	0%	1%	-26%	-38%	-39%	-39%	-39%	-40%	-40%	-61%
All Others	0%	-15%	-10%	5%	-3%	-9%	-14%	-21%	-17%	-77%
Total	0%	-6%	-11%	-12%	-15%	-18%	-27%	-40%	-42%	-52%

Tennessee Emission Trends (NO_x)

**Major Source Category Summary
Annual NO_x Emissions**



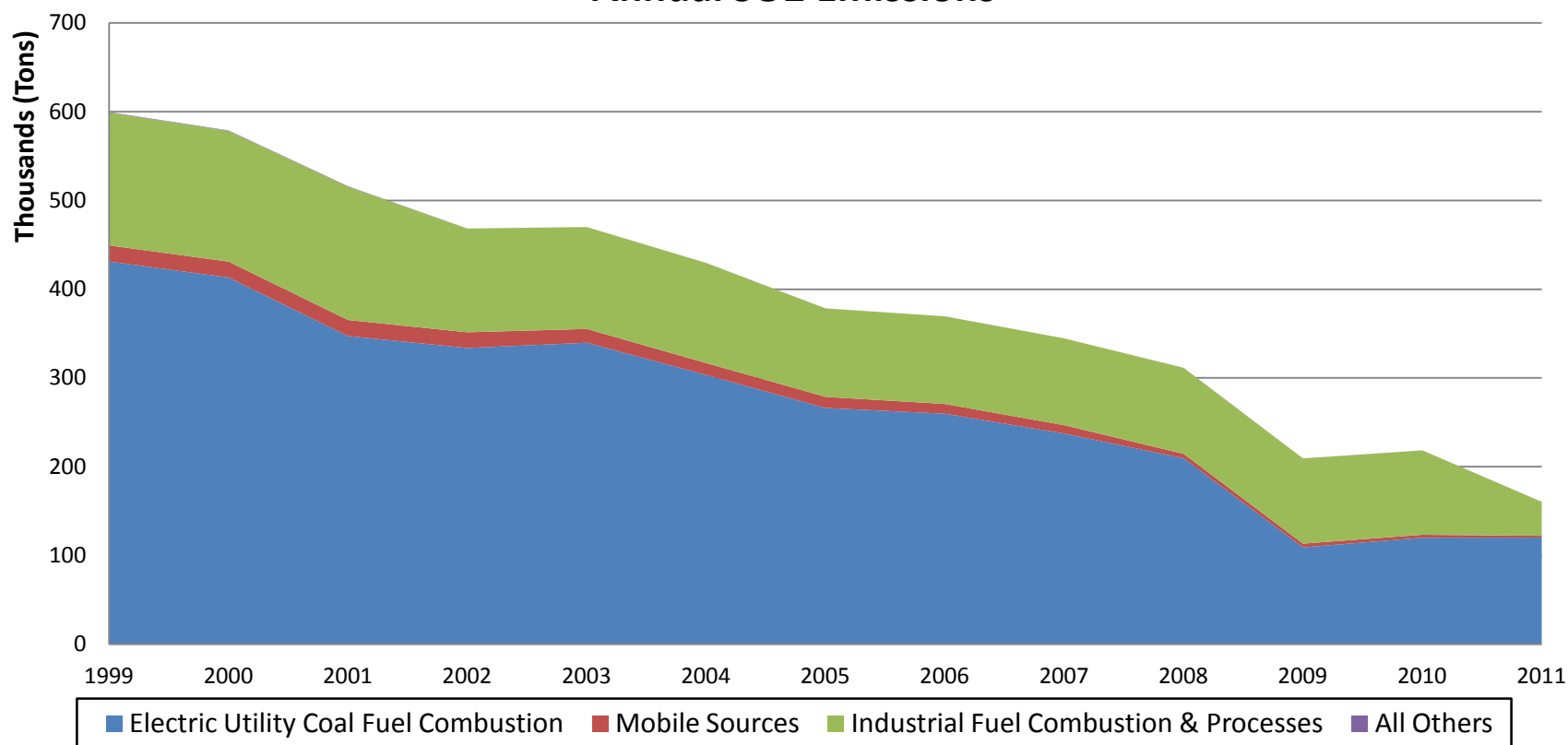
Tennessee Emission Trends (SO₂)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	431,153	347,223	339,656	266,171	259,709	237,335	209,552	109,188	119,975	120,108
Mobile Sources	18,161	18,081	15,554	12,529	10,972	9,415	4,980	4,169	3,357	2,035
Industrial Fuel Combustion & Processes	149,610	150,227	114,764	99,617	98,697	97,777	96,857	95,937	95,017	38,250
All Others	554	516	70	61	45	41	76	69	94	61
Total	599,479	516,046	470,044	378,379	369,424	344,568	311,465	209,363	218,443	160,454

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	-19%	-21%	-38%	-40%	-45%	-51%	-75%	-72%	-72%
Mobile Sources	0%	0%	-14%	-31%	-40%	-48%	-73%	-77%	-82%	-89%
Industrial Fuel Combustion & Processes	0%	0%	-23%	-33%	-34%	-35%	-35%	-36%	-36%	-74%
All Others	0%	-7%	-87%	-89%	-92%	-93%	-86%	-88%	-83%	-89%
Total	0%	-14%	-22%	-37%	-38%	-43%	-48%	-65%	-64%	-73%

Tennessee Emission Trends (SO₂)

**Major Source Category Summary
Annual SO₂ Emissions**



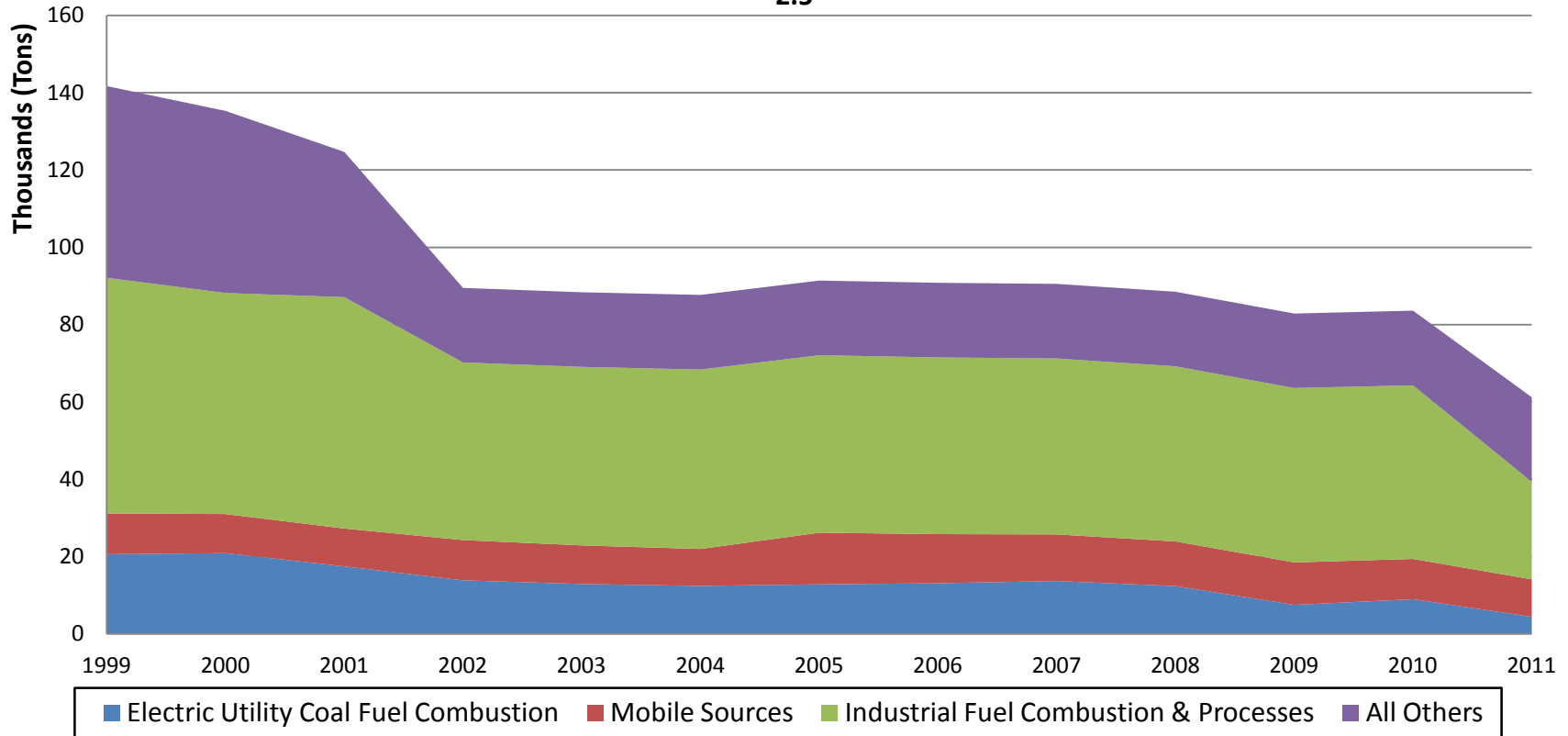
Tennessee Emission Trends (PM_{2.5})

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	20,617	17,469	12,906	12,822	13,103	13,679	12,373	7,507	8,965	4,423
Mobile Sources	10,535	9,796	9,987	13,359	12,707	12,056	11,541	10,985	10,429	9,689
Industrial Fuel Combustion & Processes	60,973	59,859	46,188	45,910	45,711	45,511	45,312	45,112	44,913	25,209
All Others	49,596	37,570	19,299	19,316	19,309	19,301	19,286	19,274	19,318	21,900
Total	141,720	124,695	88,380	91,407	90,830	90,547	88,513	82,879	83,625	61,222

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%	-37%	-38%	-36%	-34%	-40%	-64%	-57%	-79%
Mobile Sources	0%	-7%	-5%	27%	21%	14%	10%	4%	-1%	-8%
Industrial Fuel Combustion & Processes	0%	-2%	-24%	-25%	-25%	-25%	-26%	-26%	-26%	-59%
All Others	0%	-24%	-61%	-61%	-61%	-61%	-61%	-61%	-61%	-56%
Total	0%	-12%	-38%	-36%	-36%	-36%	-38%	-42%	-41%	-57%

Tennessee 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 Tennessee
- 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

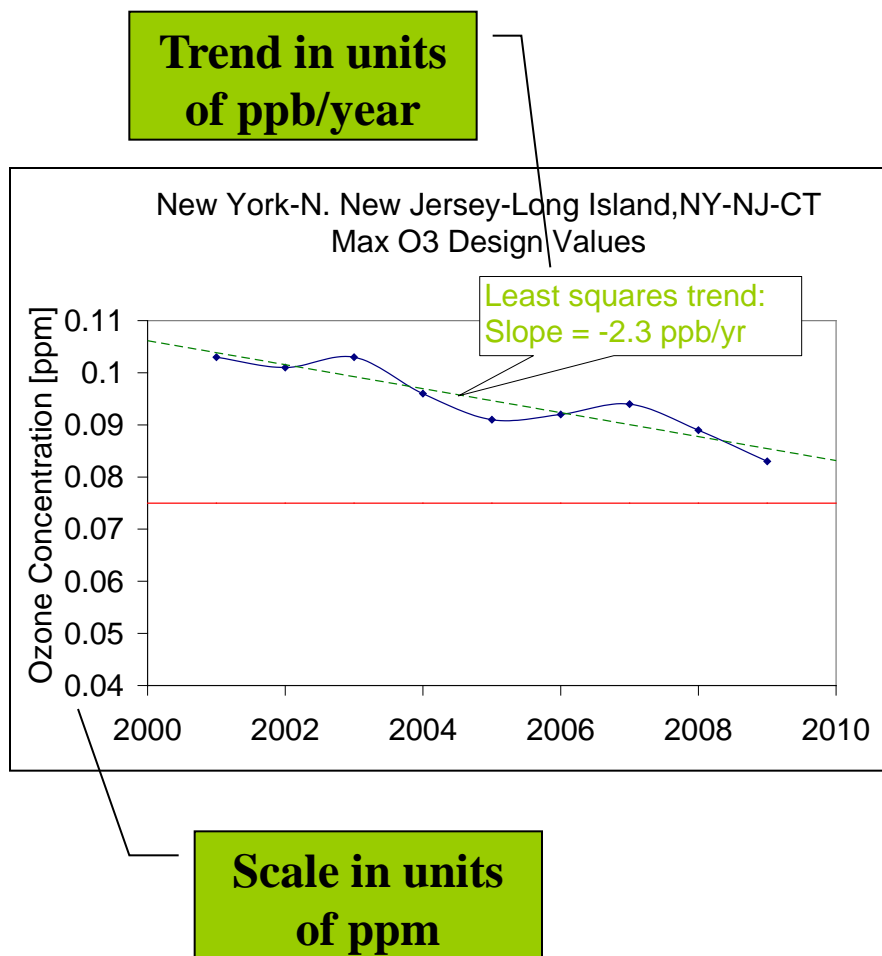
Data Handling Procedures

- 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

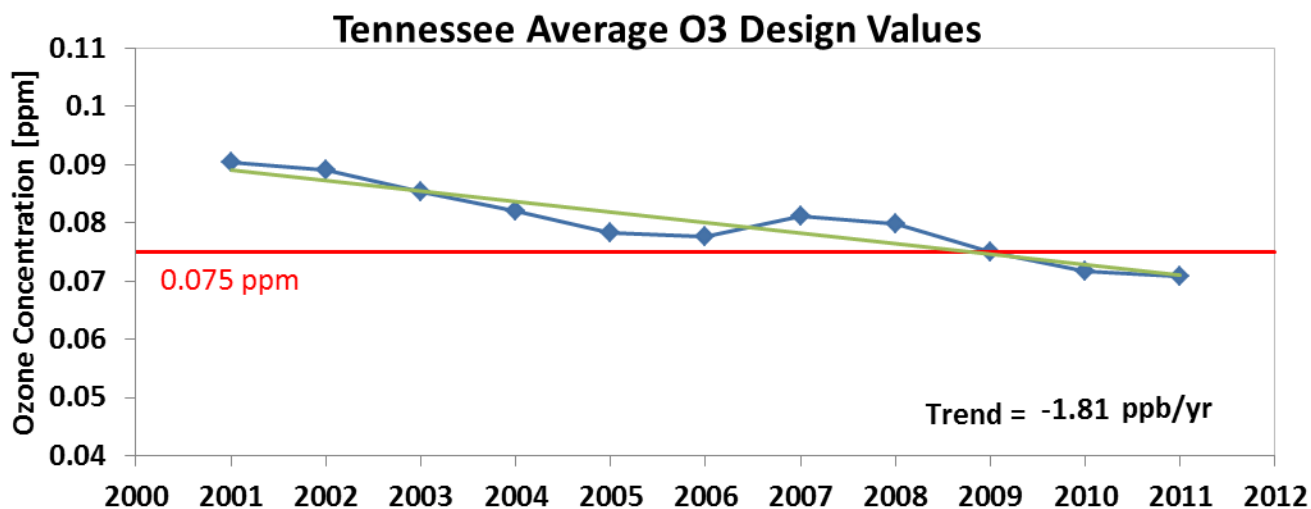
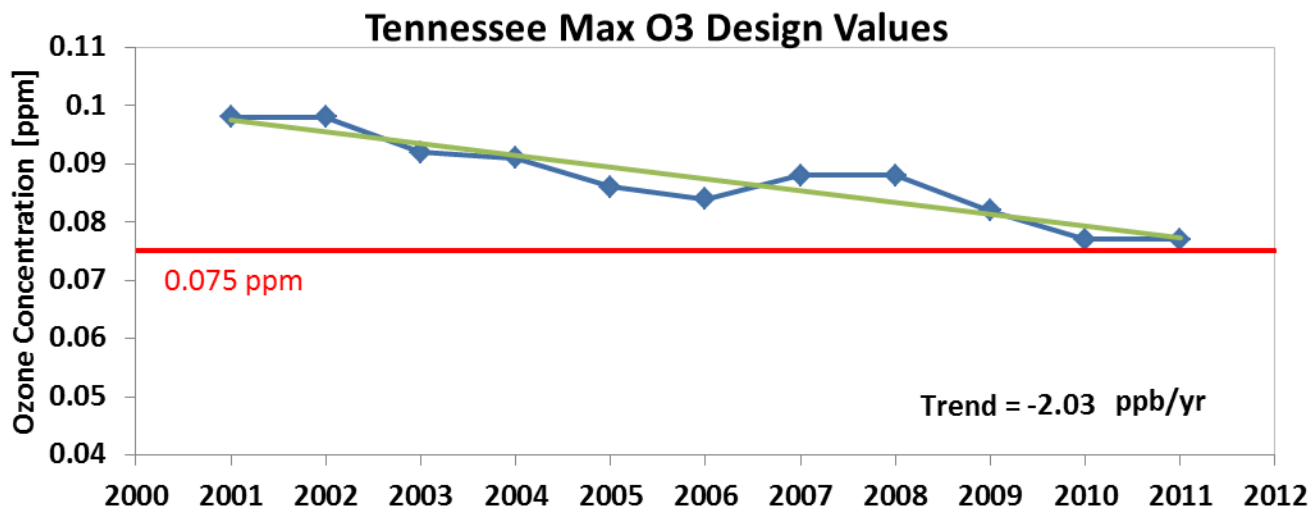
- Annual $PM_{2.5}$ DV and 24-hr $PM_{2.5}$ DV for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
 - DV calculations based on EPA data handling conventions
 - Data extracted from monitors that have a non-regulatory monitoring type are omitted
 - Selection of trend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

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
4700101014420101	Anderson, TN	0.07	-2.17
4700901014420101	Blount, TN	0.077	-1.95
4700901024420101	Blount, TN	0.068	-1.20
4703700114420101	Davidson, TN	0.063	-0.77
4703700264420101	Davidson, TN	0.067	-1.55
4706510114420101	Hamilton, TN	0.072	-1.98
4708900024420101	Jefferson, TN	0.073	-2.31
4709300214420101	Knox, TN	N/A	-2.12
4709310204420101	Knox, TN	N/A	-1.81
4712101044420101	Meigs, TN	0.071	-2.29
4714901014420101	Rutherford, TN	0.067	-1.53

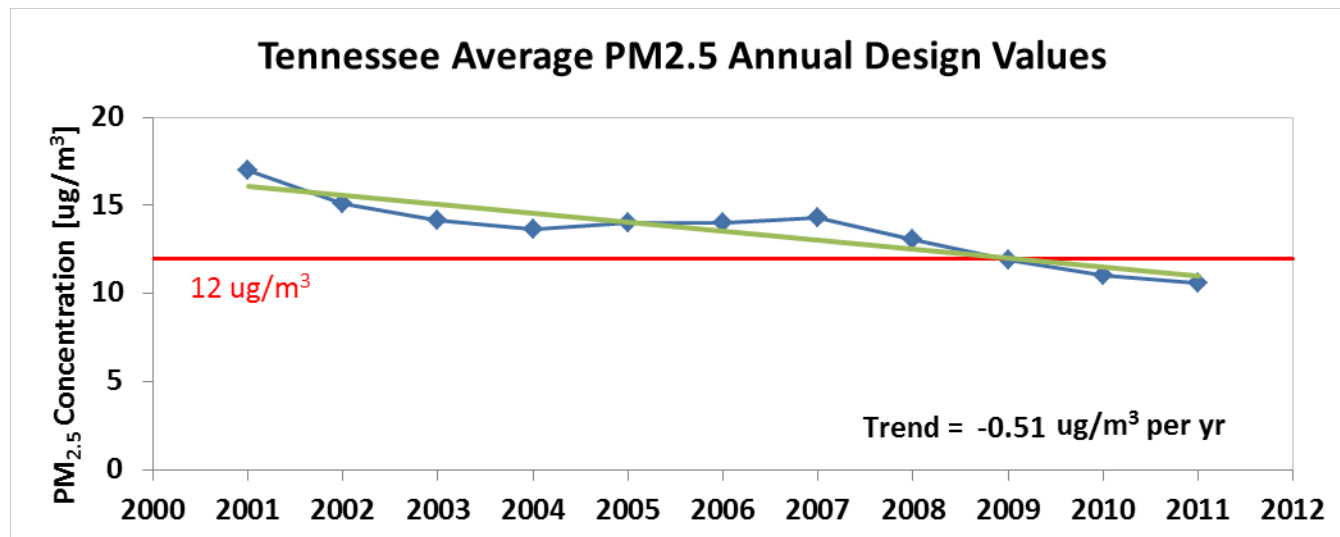
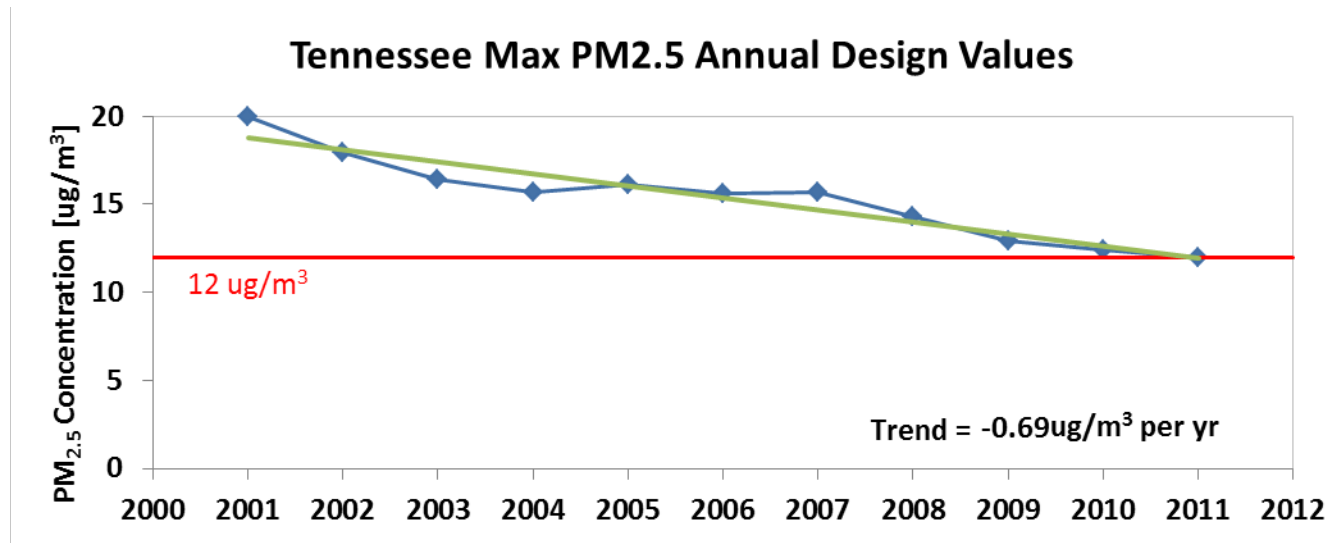
Note: Only monitoring sites meeting data completeness criteria listed

Ozone Trends by Site in Tennessee

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
4715501014420101	Sevier, TN	0.075	-2.07
4715501024420101	Sevier, TN	N/A	-2.32
4715700214420101	Shelby, TN	0.074	-1.36
4715710044420101	Shelby, TN	0.073	-1.98
4716320024420101	Sullivan, TN	0.07	-1.79
4716320034420101	Sullivan, TN	0.07	-1.95
4716500074420101	Sumner, TN	0.075	-1.44
4716501014420101	Sumner, TN	0.071	-1.77
4718701064420101	Williamson, TN	0.069	-2.00
4718901034420101	Wilson, TN	0.071	-1.30

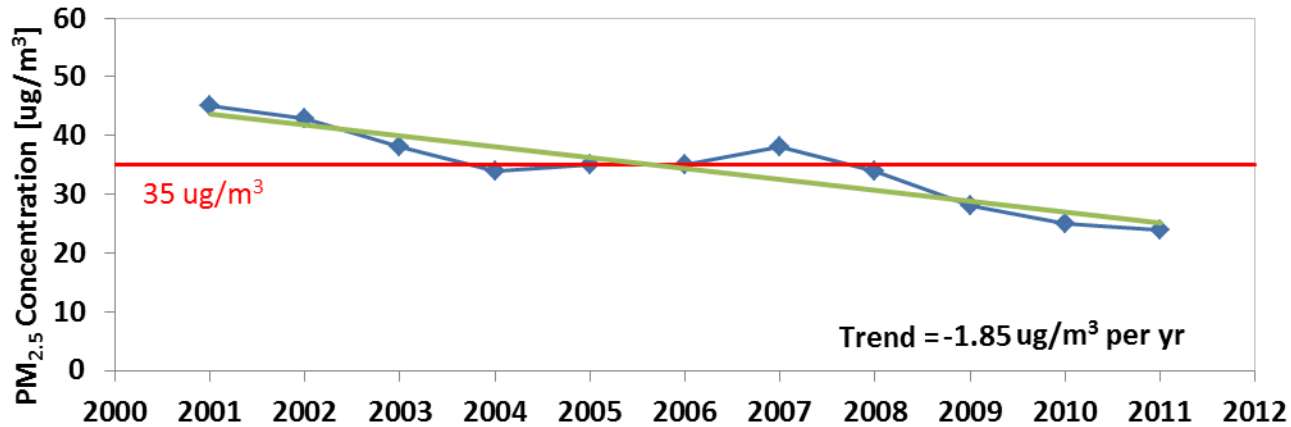
Note: Only monitoring sites meeting data completeness criteria listed

Max/Ave PM_{2.5} Annual DVs and Trend

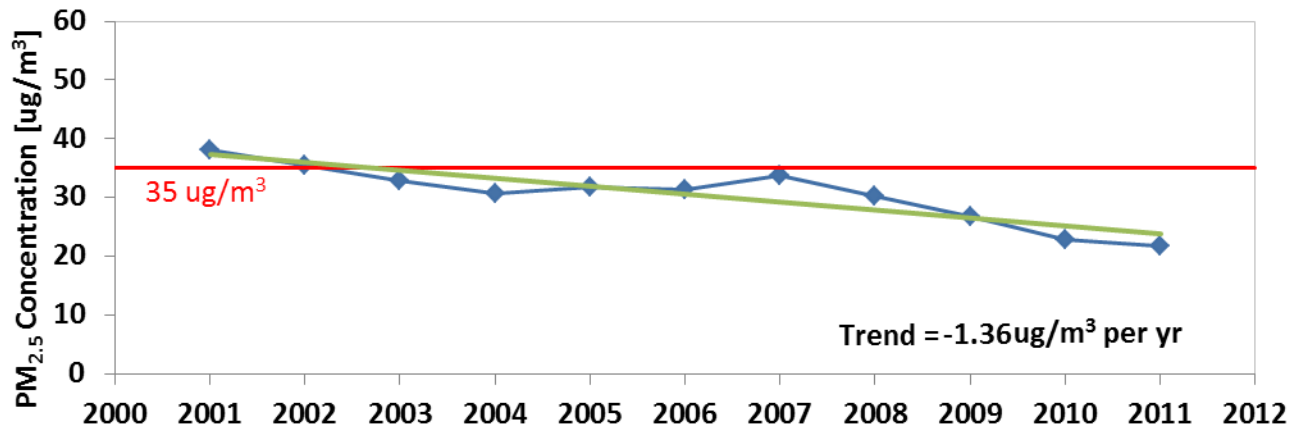


Max/Ave PM_{2.5} 24-Hour DVs and Trend

Tennessee Max PM_{2.5} 24-Hour Design Values



Tennessee Average PM_{2.5} 24-Hour Design Values



PM_{2.5} Trends by Site in Tennessee

Monitoring Site	County	2009-2011 DV [ug/m ³]		Trend [ug/m ³ per year]	
		Annual	24-Hr	Annual DV	24-Hr DV
470090011	Blount	11.0	21	-0.36	-1.85
470450004	Dyer	9.7	21	-0.28	-0.87
470650031	Hamilton	11.2	24	-0.68	-2.00
470654002	Hamilton	11.1	23	-0.53	-1.41
470930028	Knox	N/A	24	N/A	-1.43
470931017	Knox	12.0	N/A	-0.68	N/A
470931020	Knox	11.3	N/A	-0.59	N/A
470990002	Lawrence	8.6	19	-0.39	-1.04

Note: Only monitoring sites meeting data completeness criteria listed

PM_{2.5} Trends by Site in Tennessee

Monitoring Site	County	2009-2011 DV [ug/m ³]		Trend [ug/m ³ per year]	
		Annual	24-Hr	Annual DV	24-Hr DV
471071002	McMinn	10.9	N/A	-0.47	N/A
471192007	Mauzy	9.2	19	-0.44	-1.25
471251009	Montgomery	10.4	23	-0.34	-0.71
471450004	Roane	11.2	23	-0.40	-1.52
471570047	Shelby	10.4	21	-0.48	-1.26
471631007	Sullivan	10.7	22	-0.52	-1.52
471650007	Sumner	10.2	21	-0.45	-1.09

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 Tennessee.
- O₃ and PM_{2.5} design values have decreased in all currently designated non-attainment areas in Tennessee.