Emission and Air Quality Trends Review

Massachusetts

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, NOx, SO_2, 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

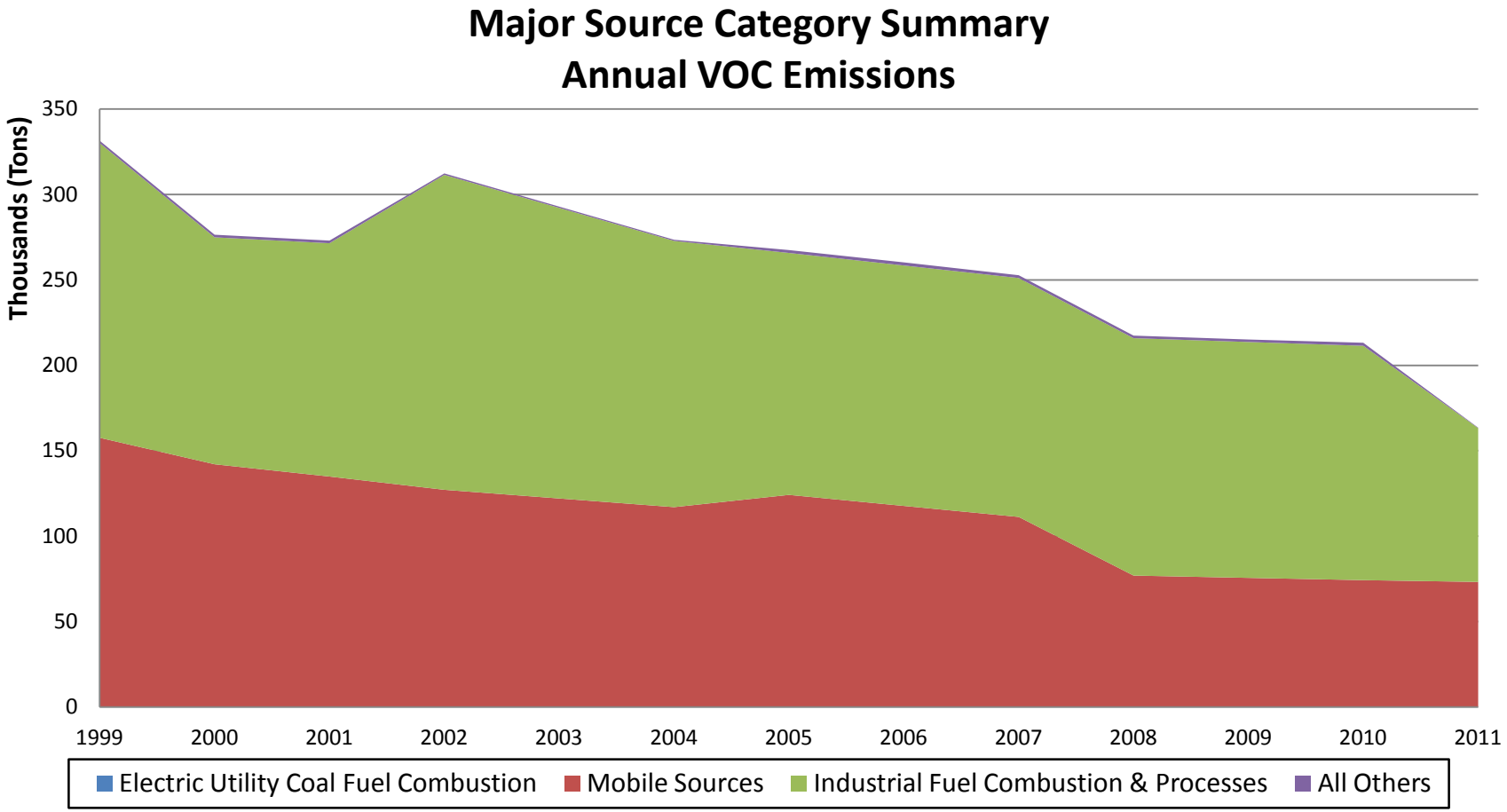
- Negative values indicate decrease in emissions, positive values indicate an increase

Massachusetts Emission Trends (VOC)

	Annual Emissions (Tons)									
Source Category	**1999**	**2001**	**2003**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Electric Utility Coal Fuel Combustion	130	135	124	135	125	136	122	106	98	51
Mobile Sources	157,446	134,767	121,937	124,030	117,576	111,121	76,813	75,486	74,158	73,172
Industrial Fuel Combustion & Processes	172,456	136,537	170,062	141,590	140,708	139,825	138,935	138,049	137,162	90,010
All Others	1,381	1,549	738	1,684	1,830	1,638	1,508	1,454	1,777	269
Total	**331,412**	**272,987**	**292,862**	**267,439**	**260,239**	**252,720**	**217,377**	**215,095**	**213,195**	**163,502**

	Annual Emissions Change (Percent since 1999)									
Source Category	**1999**	**2001**	**2003**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Electric Utility Coal Fuel Combustion	0%	4%	-5%	4%	-4%	4%	-6%	-19%	-25%	-61%
Mobile Sources	0%	-14%	-23%	-21%	-25%	-29%	-51%	-52%	-53%	-54%
Industrial Fuel Combustion & Processes	0%	-21%	-1%	-18%	-18%	-19%	-19%	-20%	-20%	-48%
All Others	0%	12%	-47%	22%	32%	19%	9%	5%	29%	-81%
Total	**0%**	**-18%**	**-12%**	**-19%**	**-21%**	**-24%**	**-34%**	**-35%**	**-36%**	**-51%**

Massachusetts Emission Trends (VOC)

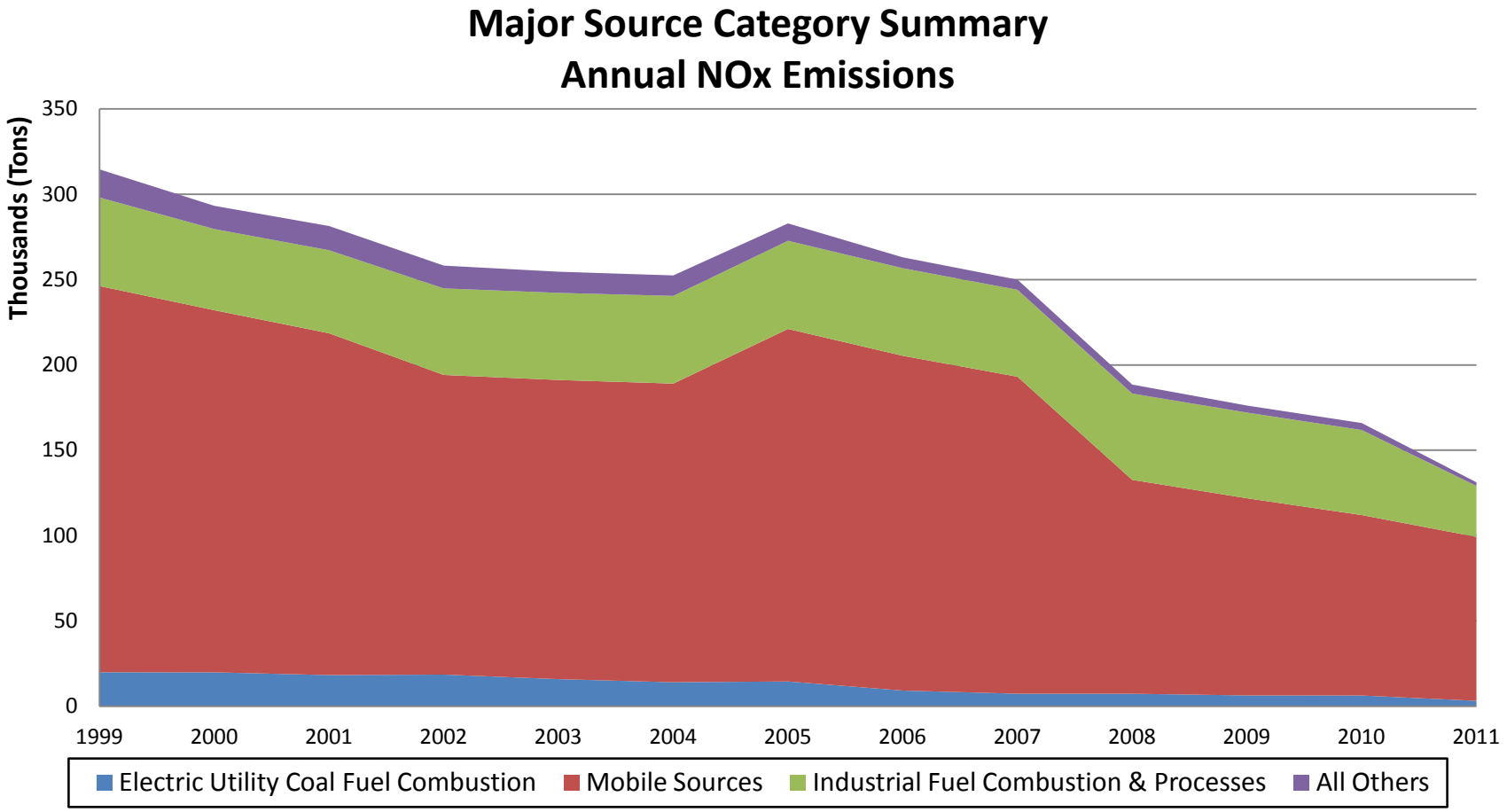


Massachusetts Emission Trends (NOx)

	Annual Emissions (Tons)									
Source Category	**1999**	**2001**	**2003**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Electric Utility Coal Fuel Combustion	19,934	18,265	15,900	14,537	9,209	7,346	7,326	6,356	6,318	3,191
Mobile Sources	226,260	200,259	175,269	206,536	196,133	185,729	125,324	115,513	105,701	96,055
Industrial Fuel Combustion & Processes	51,865	48,663	51,035	51,652	51,323	50,927	50,566	50,199	49,835	29,860
All Others	16,480	14,170	12,392	10,179	6,364	5,946	5,265	4,118	4,089	2,110
Total	**314,539**	**281,357**	**254,596**	**282,903**	**263,029**	**249,949**	**188,481**	**176,186**	**165,944**	**131,217**

	Annual Emissions Change (Percent since 1999)									
Source Category	**1999**	**2001**	**2003**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Electric Utility Coal Fuel Combustion	0%	-8%	-20%	-27%	-54%	-63%	-63%	-68%	-68%	-84%
Mobile Sources	0%	-11%	-23%	-9%	-13%	-18%	-45%	-49%	-53%	-58%
Industrial Fuel Combustion & Processes	0%	-6%	-2%	0%	-1%	-2%	-3%	-3%	-4%	-42%
All Others	0%	-14%	-25%	-38%	-61%	-64%	-68%	-75%	-75%	-87%
Total	**0%**	**-11%**	**-19%**	**-10%**	**-16%**	**-21%**	**-40%**	**-44%**	**-47%**	**-58%**

Massachusetts Emission Trends (NOx)

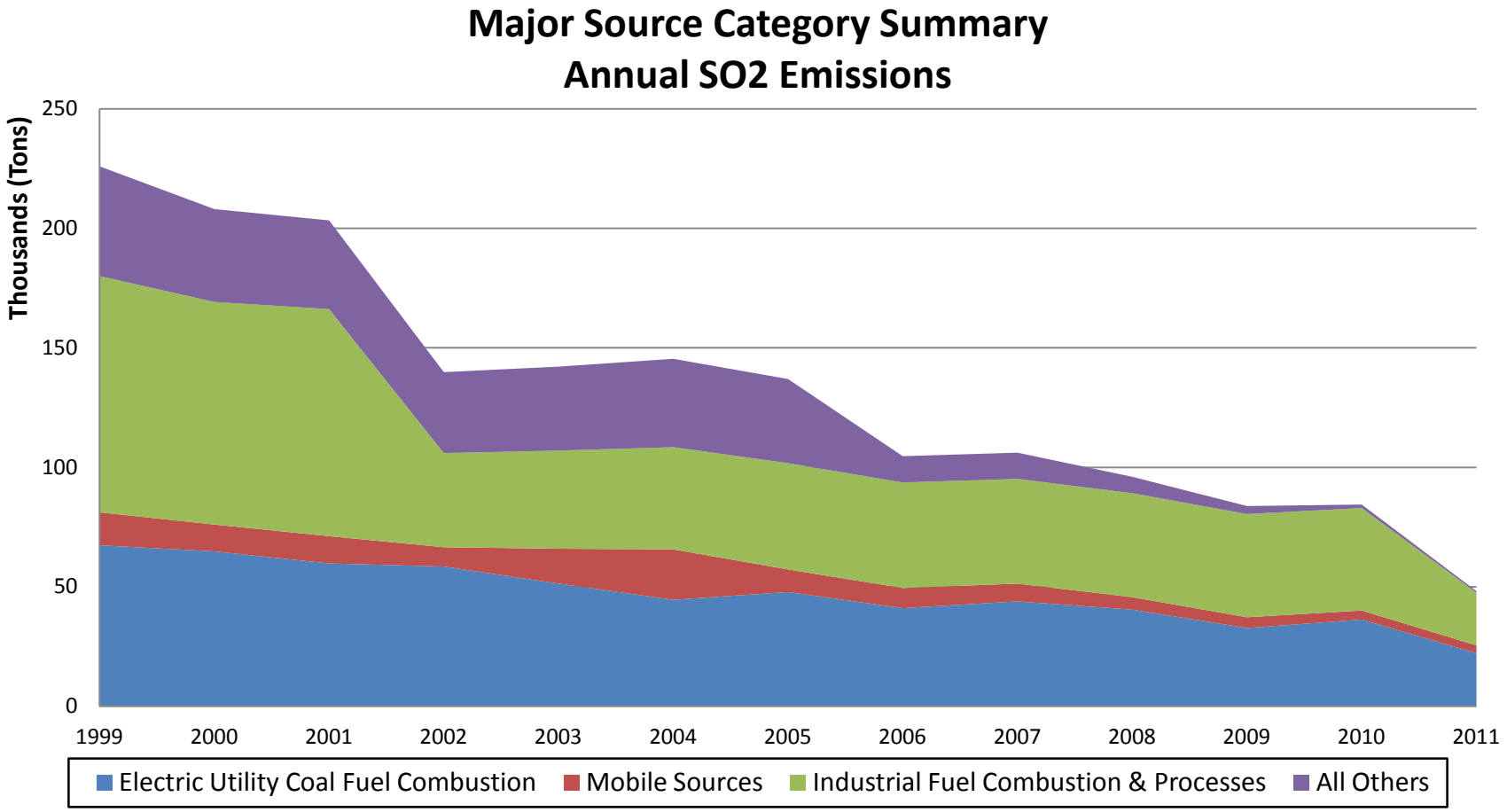


Massachusetts Emission Trends (SO_2)

	Annual Emissions (Tons)									
Source Category	**1999**	**2001**	**2003**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Electric Utility Coal Fuel Combustion	67,375	59,782	51,342	47,802	41,057	43,889	40,438	32,737	36,284	22,211
Mobile Sources	13,775	11,406	14,589	9,453	8,439	7,425	5,223	4,508	3,793	3,283
Industrial Fuel Combustion & Processes	98,885	95,026	41,074	44,468	44,152	43,836	43,519	43,202	42,886	22,044
All Others	45,912	37,120	35,132	35,234	11,014	10,976	6,857	3,351	1,455	657
Total	**225,946**	**203,334**	**142,137**	**136,957**	**104,661**	**106,126**	**96,036**	**83,798**	**84,417**	**48,195**

	Annual Emissions Change (Percent since 1999)									
Source Category	**1999**	**2001**	**2003**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Electric Utility Coal Fuel Combustion	0%	-11%	-24%	-29%	-39%	-35%	-40%	-51%	-46%	-67%
Mobile Sources	0%	-17%	6%	-31%	-39%	-46%	-62%	-67%	-72%	-76%
Industrial Fuel Combustion & Processes	0%	-4%	-58%	-55%	-55%	-56%	-56%	-56%	-57%	-78%
All Others	0%	-19%	-23%	-23%	-76%	-76%	-85%	-93%	-97%	-99%
Total	**0%**	**-10%**	**-37%**	**-39%**	**-54%**	**-53%**	**-57%**	**-63%**	**-63%**	**-79%**

Massachusetts Emission Trends (SO_2)

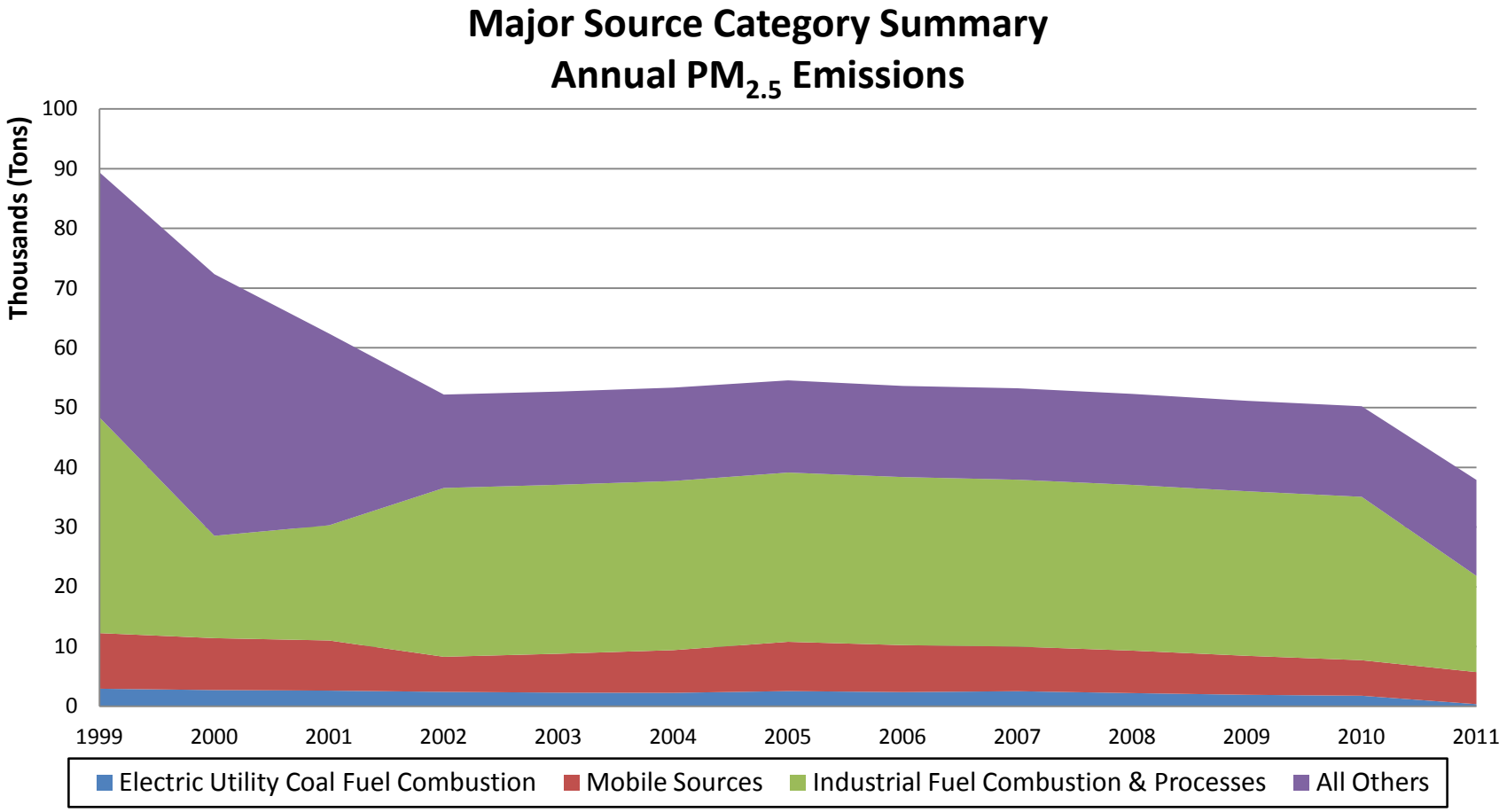


Massachusetts Emission Trends ($PM_{2.5}$)

	Annual Emissions (Tons)									
Source Category	**1999**	**2001**	**2003**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Electric Utility Coal Fuel Combustion	2,939	2,620	2,282	2,538	2,372	2,520	2,203	1,919	1,763	356
Mobile Sources	9,306	8,394	6,511	8,251	7,859	7,468	7,110	6,527	5,944	5,366
Industrial Fuel Combustion & Processes	36,088	19,279	28,286	28,332	28,136	27,940	27,744	27,548	27,351	16,097
All Others	41,017	32,092	15,600	15,433	15,254	15,303	15,232	15,140	15,160	16,070
Total	**89,350**	**62,385**	**52,679**	**54,554**	**53,622**	**53,231**	**52,290**	**51,134**	**50,218**	**37,888**

	Annual Emissions Change (Percent since 1999)									
Source Category	**1999**	**2001**	**2003**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Electric Utility Coal Fuel Combustion	0%	-11%	-22%	-14%	-19%	-14%	-25%	-35%	-40%	-88%
Mobile Sources	0%	-10%	-30%	-11%	-16%	-20%	-24%	-30%	-36%	-42%
Industrial Fuel Combustion & Processes	0%	-47%	-22%	-21%	-22%	-23%	-23%	-24%	-24%	-55%
All Others	0%	-22%	-62%	-62%	-63%	-63%	-63%	-63%	-63%	-61%
Total	**0%**	**-30%**	**-41%**	**-39%**	**-40%**	**-40%**	**-41%**	**-43%**	**-44%**	**-58%**

Massachusetts Emission Trends ($PM_{2.5}$)



Emission Trends Summary

- All pollutants have decreased since 1999 in aggregate across Massachusetts
- 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

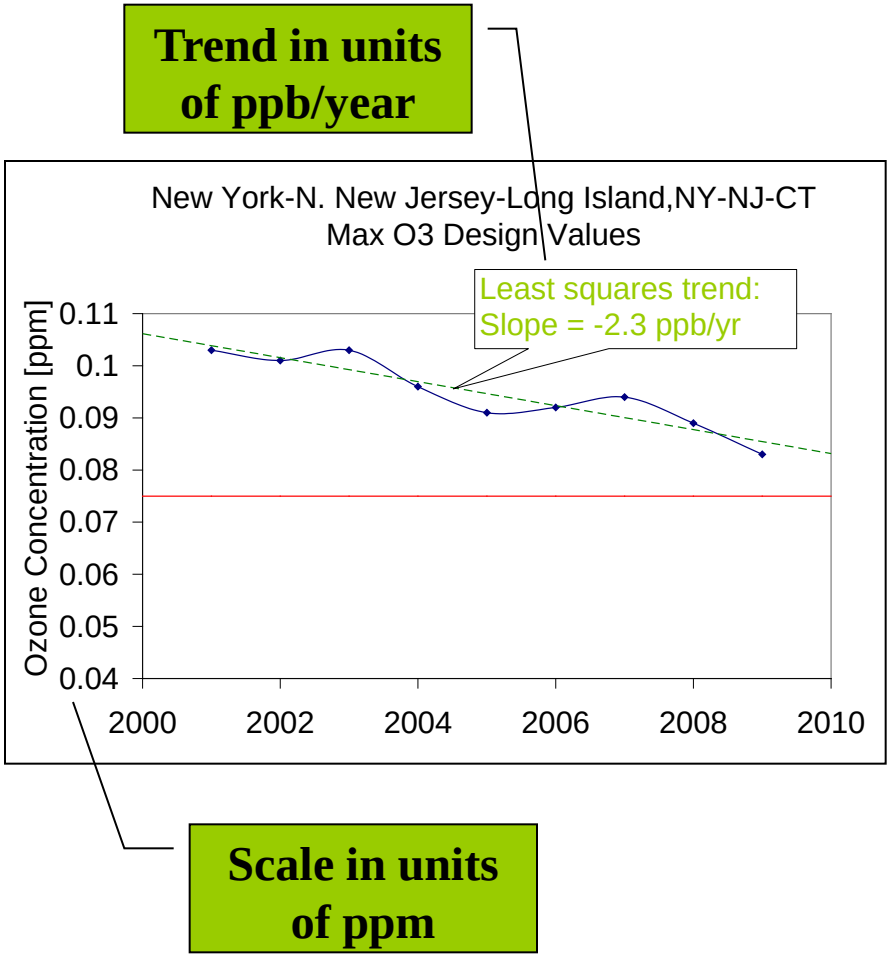
Data Handling Procedures

- 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

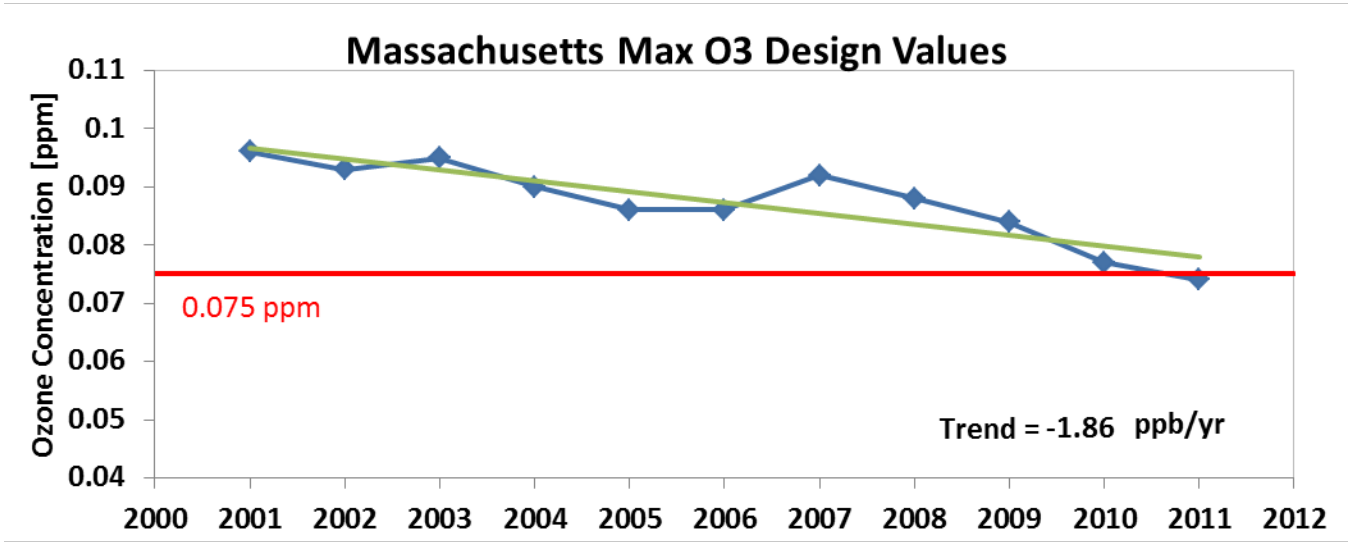
- Annual $PM_{2.5}$ DV and 24-hr $PM_{2.5}$ DV for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
  - DV calculations based on EPA data handling conventions
  - Data extracted from monitors that have a non-regulatory monitoring type are omitted
  - Selection of trend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

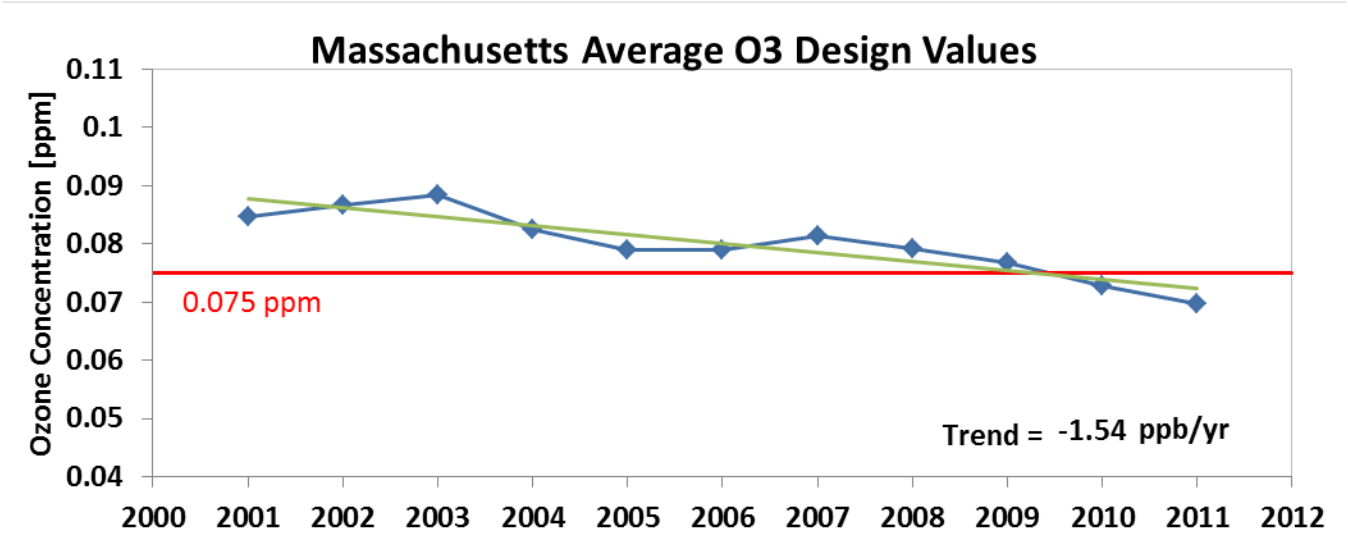
Trend Calculation



- 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



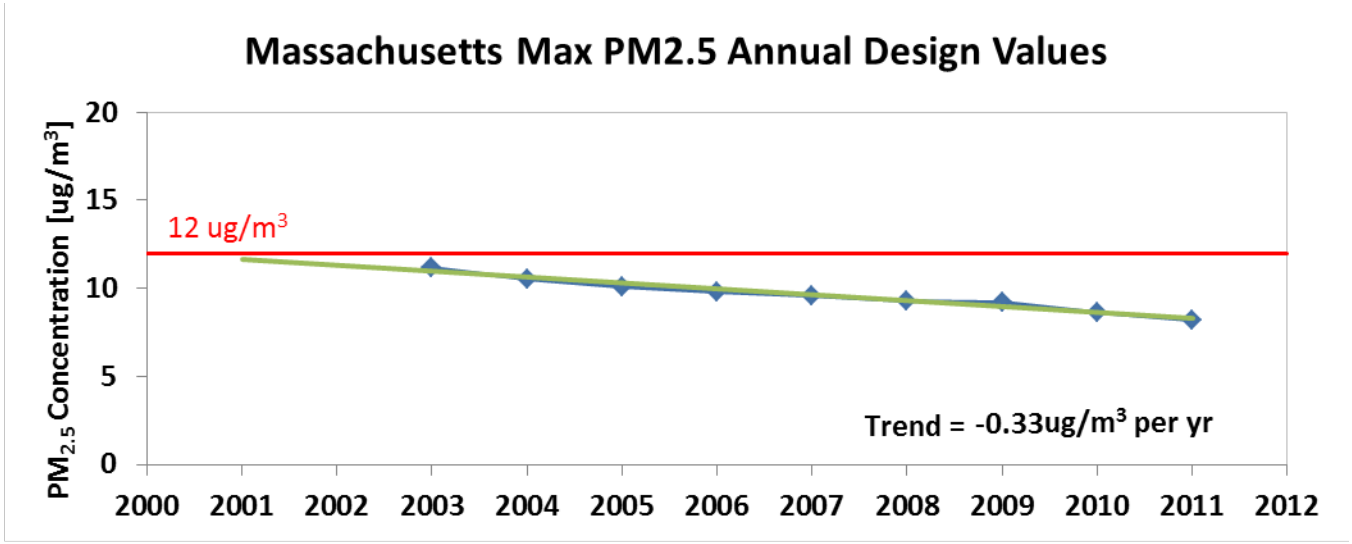


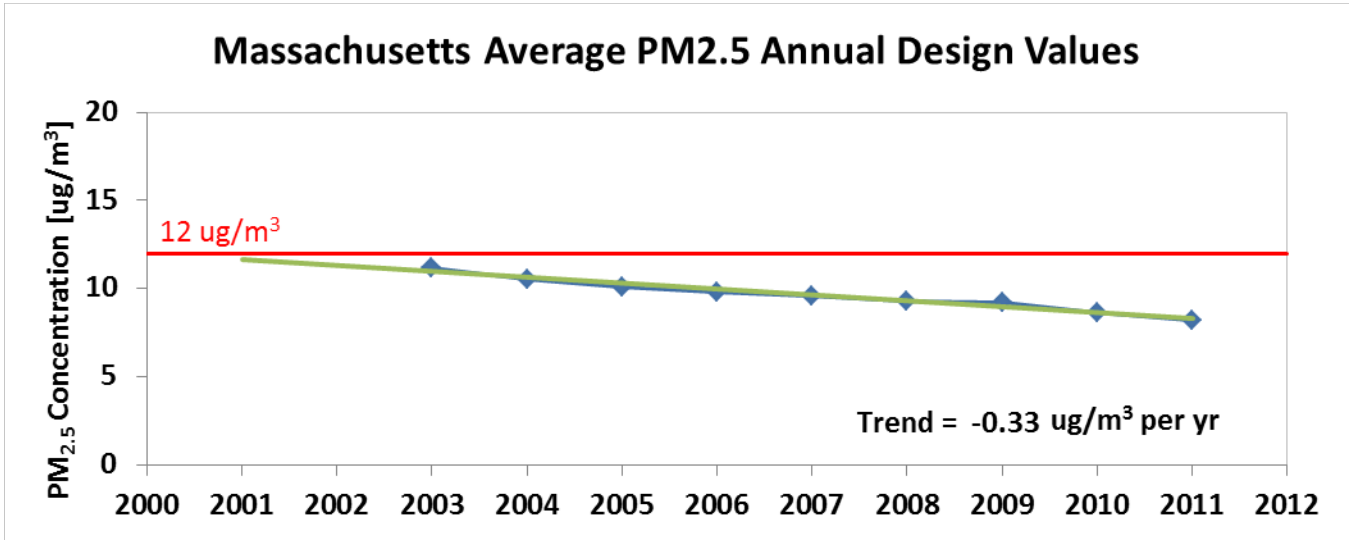
Ozone Trends by Site in Massachusetts

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
2500100024420101	Barnstable, MA	0.072	-2.48
2500510024420101	Bristol, MA	0.074	-2.18
2500920064420101	Essex, MA	0.071	-1.75
2500940044420101	Essex, MA	N/A	-1.32
2501300084420101	Hampden, MA	0.074	-1.32
2501501034420101	Hampshire, MA	0.066	-0.67
2501540024420101	Hampshire, MA	0.072	-1.35
2501711024420101	Middlesex, MA	0.067	-1.90
2502500414420101	Suffolk, MA	0.07	-1.89
2502500424420101	Suffolk, MA	0.061	-0.96
2502700154420101	Worcester, MA	0.07	-1.06

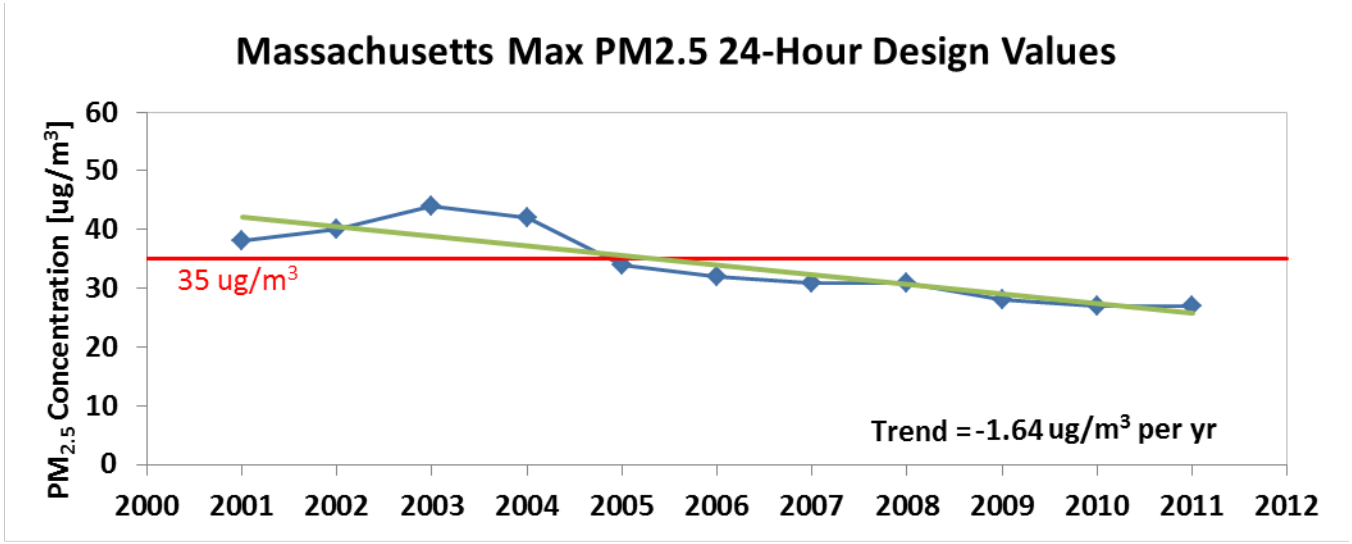
Note: Only monitoring sites meeting data completeness criteria listed

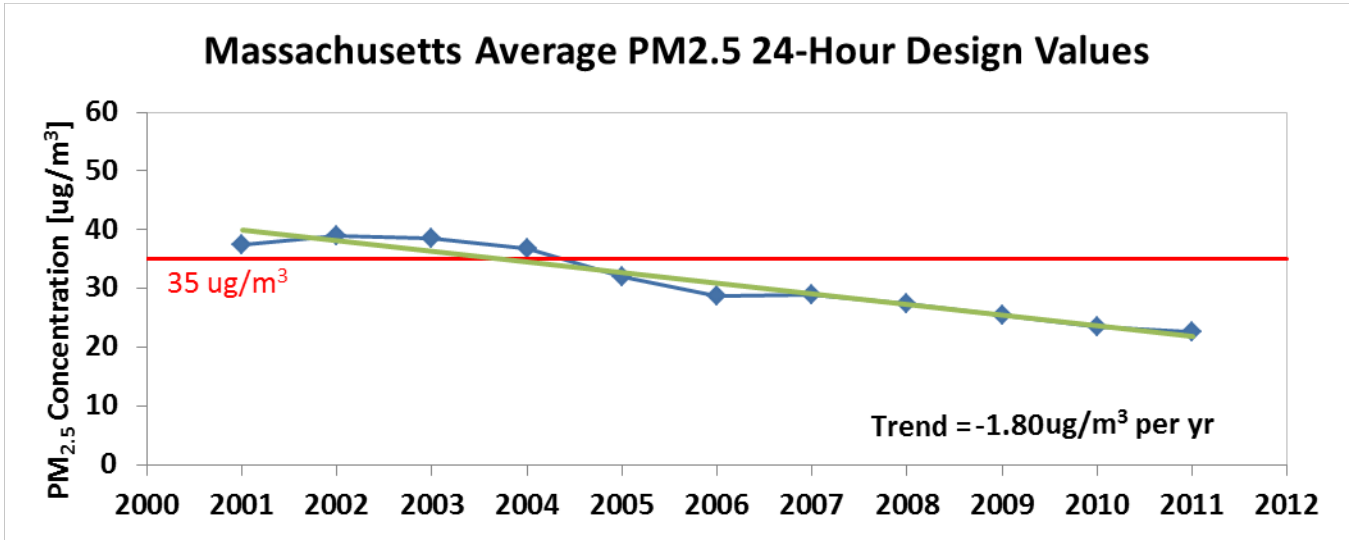
Max/Ave $PM_{2.5}$ Annual DVs and Trend





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





$PM_{2.5}$ Trends by Site in Massachusetts

		2009-2011 DV [ug/m³]		Trend [ug/m³ per year]	
Monitoring Site	County	Annual	24-Hr	Annual DV	24-Hr DV
250035001	Berkshire	N/A	26	N/A	-1.29
250092006	Essex	N/A	19	N/A	-2.62
250095005	Essex	N/A	19	N/A	-2.38
250130016	Hampden	N/A	27	N/A	-1.50
250230004	Plymouth	8.2	21	-0.33	-1.52
250250027	Suffolk	N/A	23	N/A	-1.93

Note: Only monitoring sites meeting data completeness criteria listed

Air Quality Trends Summary

- Average O_3 and 24-hr $PM_{2.5}$ design values have decreased since 1999 in Massachusetts. Based on data from one monitor station, average annual $PM_{2.5}$ design values have decreased since 2001 (incomplete data in 1999 and 2000) in Massachusetts

- The only currently designated O_3 non-attainment area in Massachusetts, Dukes County, MA, did not meet the 1999–2011 trends completeness criteria for this analysis. There are no currently designated $PM_{2.5}$ non-attainment areas in Massachusetts