

# Emission and Air Quality Trends Review

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## Rhode Island

May 2013

# Project Objective

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- 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

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- 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

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- 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<sub>x</sub>, SO<sub>2</sub>, and PM<sub>2.5</sub>
- Project Improvement
  - The Study Team augmented above data with year specific CEM emissions (2002 through 2011)

# Emission Changes

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- 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

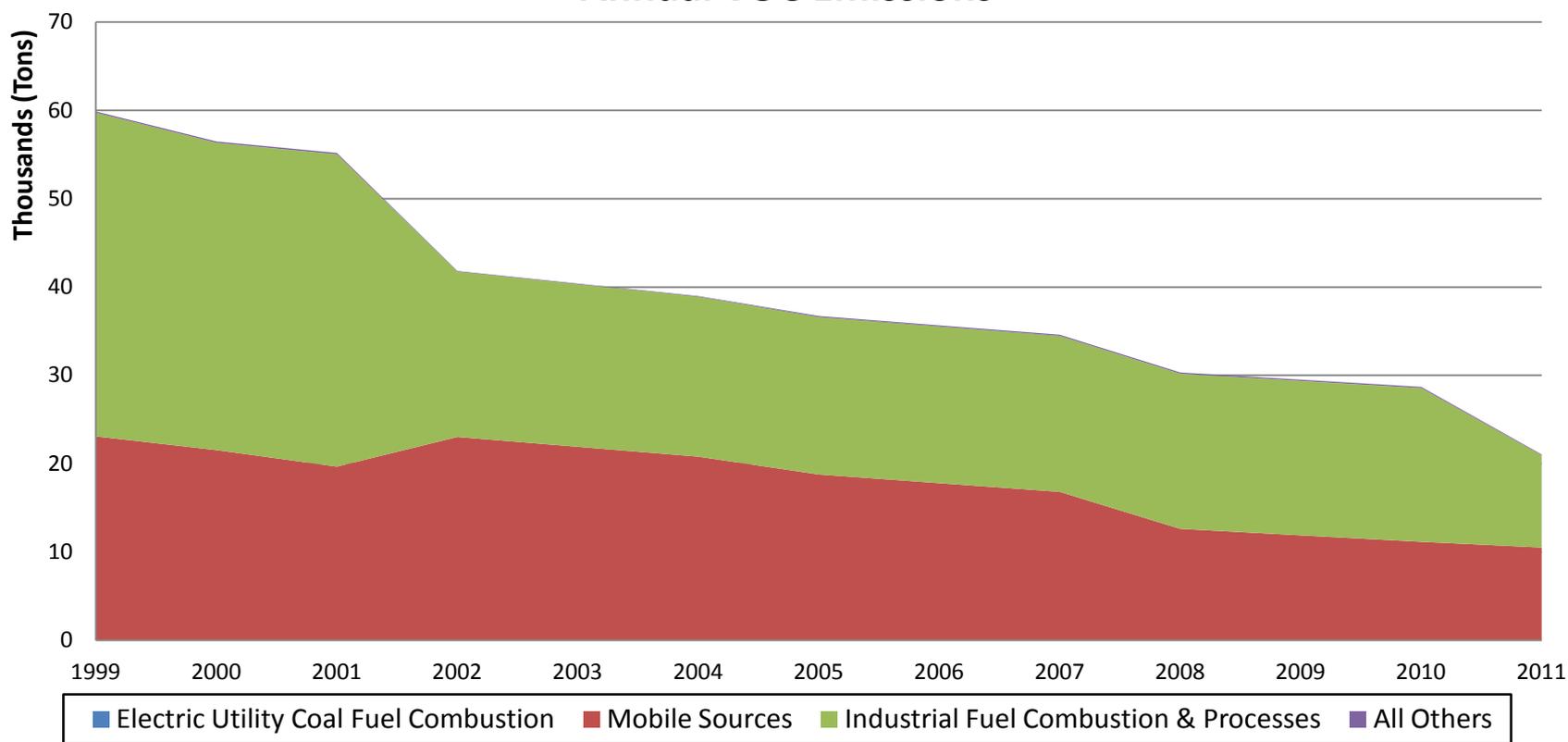
# Rhode Island Emission Trends (VOC)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0	0	0	0	0	0	0	0	0	0
Mobile Sources	23,083	19,660	21,903	18,772	17,788	16,804	12,613	11,879	11,145	10,500
Industrial Fuel Combustion & Processes	36,645	35,366	18,425	17,815	17,735	17,655	17,575	17,495	17,415	10,443
All Others	142	153	62	128	127	136	134	133	131	94
<b>Total</b>	<b>59,869</b>	<b>55,180</b>	<b>40,390</b>	<b>36,714</b>	<b>35,650</b>	<b>34,595</b>	<b>30,323</b>	<b>29,508</b>	<b>28,692</b>	<b>21,037</b>

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%	0%	0%	0%	0%	0%	0%	0%	0%
Mobile Sources	0%	-15%	-5%	-19%	-23%	-27%	-45%	-49%	-52%	-55%
Industrial Fuel Combustion & Processes	0%	-3%	-50%	-51%	-52%	-52%	-52%	-52%	-52%	-72%
All Others	0%	8%	-56%	-10%	-10%	-4%	-5%	-6%	-7%	-33%
<b>Total</b>	<b>0%</b>	<b>-8%</b>	<b>-33%</b>	<b>-39%</b>	<b>-40%</b>	<b>-42%</b>	<b>-49%</b>	<b>-51%</b>	<b>-52%</b>	<b>-65%</b>

# Rhode Island Emission Trends (VOC)

**Major Source Category Summary  
Annual VOC Emissions**



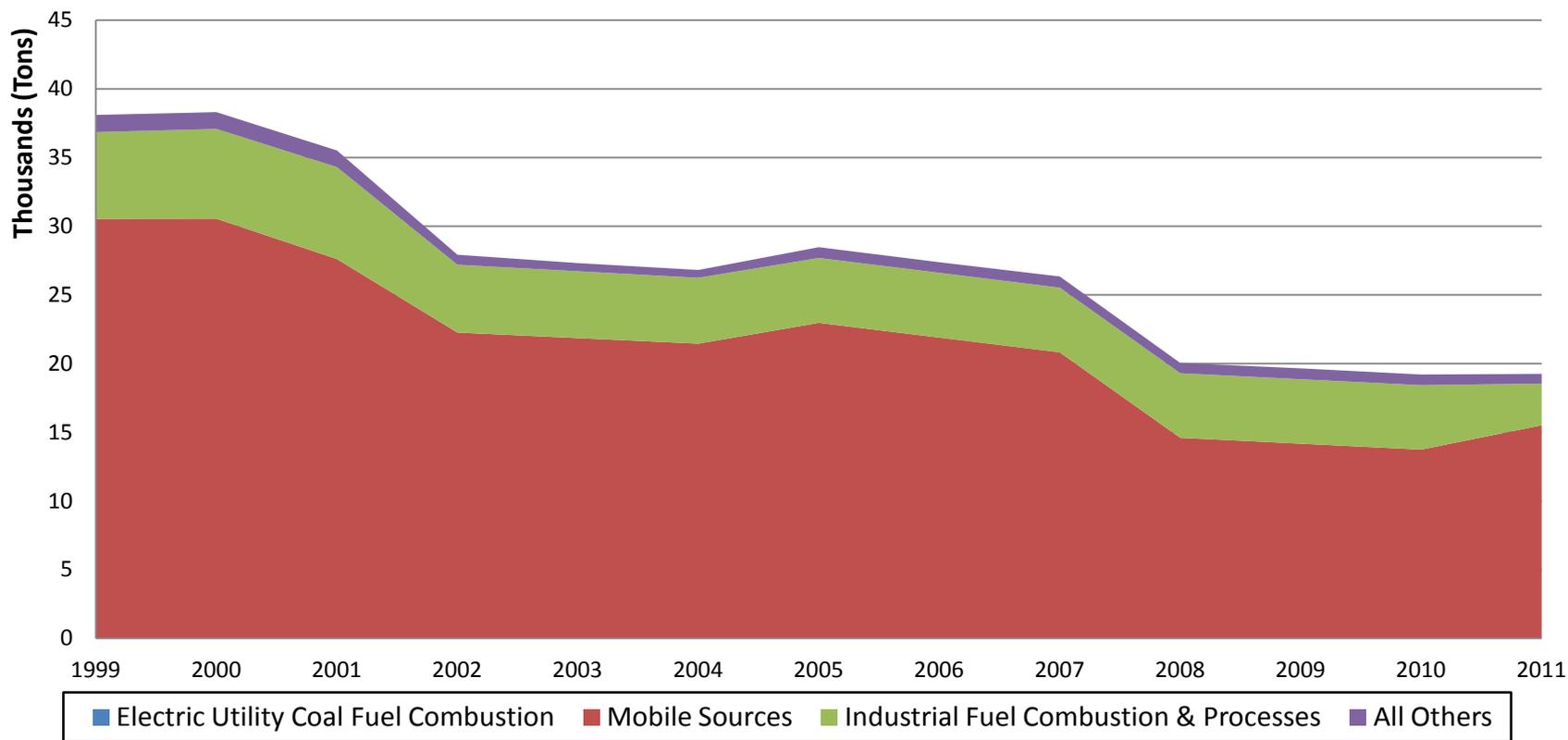
# Rhode Island Emission Trends (NO<sub>x</sub>)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0	0	0	0	0	0	0	0	0	0
Mobile Sources	30,533	27,609	21,854	22,963	21,889	20,816	14,595	14,168	13,740	15,508
Industrial Fuel Combustion & Processes	6,317	6,695	4,870	4,728	4,721	4,713	4,706	4,698	4,691	3,041
All Others	1,251	1,210	592	783	769	812	744	786	774	703
<b>Total</b>	<b>38,101</b>	<b>35,515</b>	<b>27,316</b>	<b>28,474</b>	<b>27,379</b>	<b>26,341</b>	<b>20,045</b>	<b>19,652</b>	<b>19,205</b>	<b>19,251</b>

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%	0%	0%	0%	0%	0%	0%	0%	0%
Mobile Sources	0%	-10%	-28%	-25%	-28%	-32%	-52%	-54%	-55%	-49%
Industrial Fuel Combustion & Processes	0%	6%	-23%	-25%	-25%	-25%	-26%	-26%	-26%	-52%
All Others	0%	-3%	-53%	-37%	-39%	-35%	-40%	-37%	-38%	-44%
<b>Total</b>	<b>0%</b>	<b>-7%</b>	<b>-28%</b>	<b>-25%</b>	<b>-28%</b>	<b>-31%</b>	<b>-47%</b>	<b>-48%</b>	<b>-50%</b>	<b>-49%</b>

# Rhode Island Emission Trends (NO<sub>x</sub>)

**Major Source Category Summary  
Annual NO<sub>x</sub> Emissions**



# Rhode Island Emission Trends (SO<sub>2</sub>)

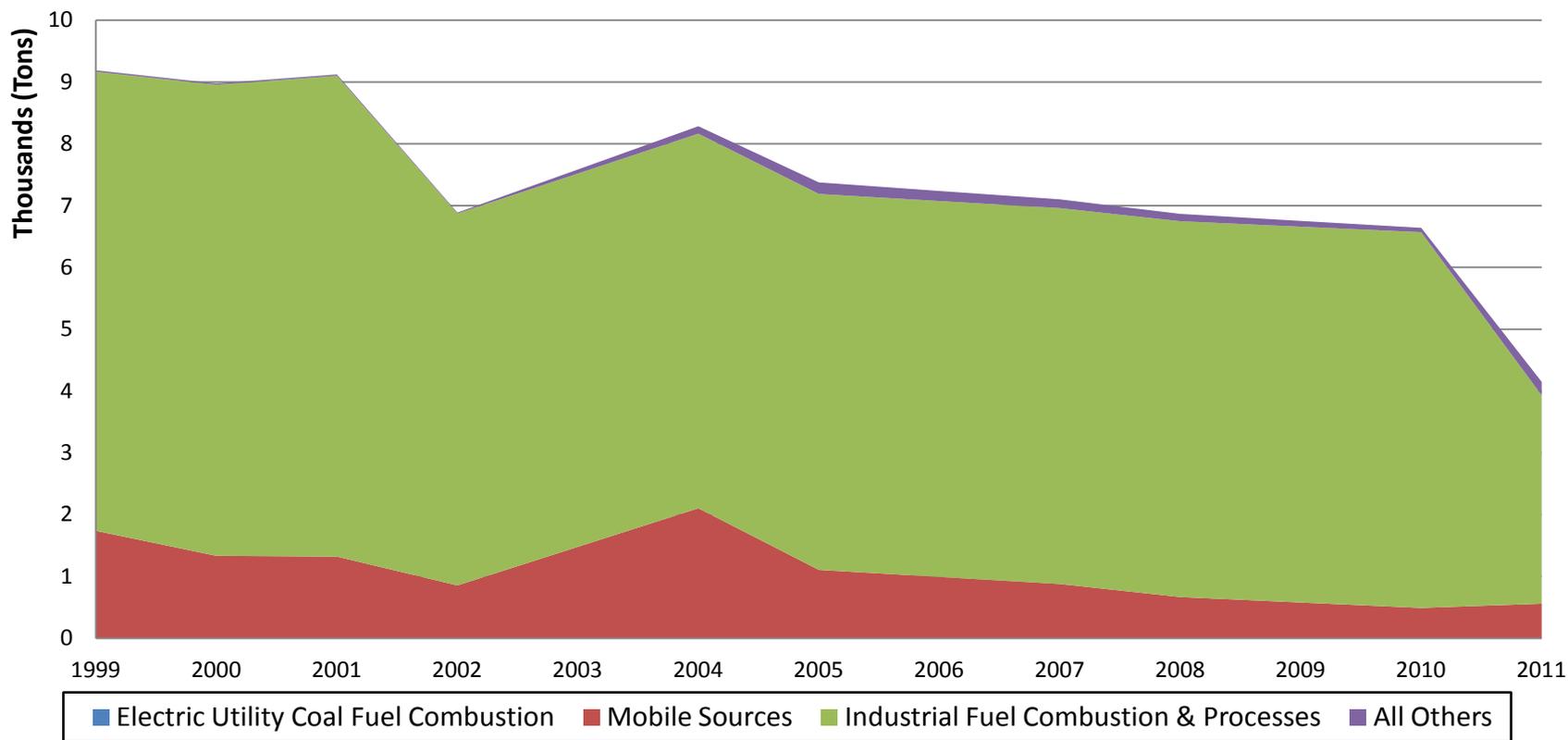
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Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0	0	0	0	0	0	0	0	0	0
Mobile Sources	1,738	1,322	1,480	1,107	993	879	668	580	491	560
Industrial Fuel Combustion & Processes	7,428	7,779	6,038	6,081	6,080	6,080	6,079	6,079	6,078	3,369
All Others	22	21	66	187	163	142	119	94	70	220
<b>Total</b>	<b>9,188</b>	<b>9,122</b>	<b>7,584</b>	<b>7,376</b>	<b>7,237</b>	<b>7,101</b>	<b>6,866</b>	<b>6,752</b>	<b>6,640</b>	<b>4,149</b>

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%	0%	0%	0%	0%	0%	0%	0%	0%
Mobile Sources	0%	-24%	-15%	-36%	-43%	-49%	-62%	-67%	-72%	-68%
Industrial Fuel Combustion & Processes	0%	5%	-19%	-18%	-18%	-18%	-18%	-18%	-18%	-55%
All Others	0%	-6%	204%	760%	649%	553%	446%	332%	222%	910%
<b>Total</b>	<b>0%</b>	<b>-1%</b>	<b>-17%</b>	<b>-20%</b>	<b>-21%</b>	<b>-23%</b>	<b>-25%</b>	<b>-27%</b>	<b>-28%</b>	<b>-55%</b>

# Rhode Island Emission Trends (SO<sub>2</sub>)

**Major Source Category Summary  
Annual SO<sub>2</sub> Emissions**



# Rhode Island Emission Trends (PM<sub>2.5</sub>)

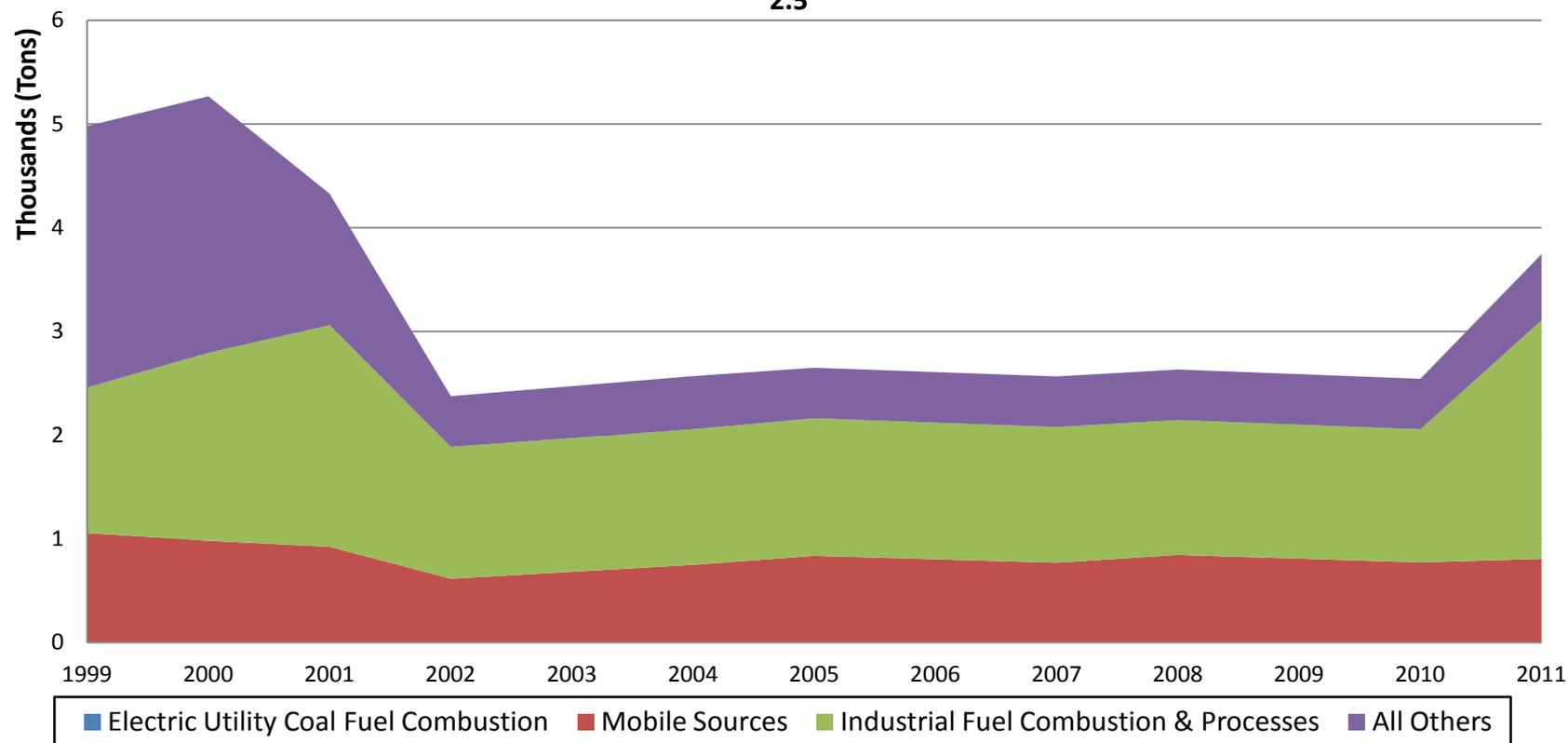
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Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0	0	0	0	0	0	0	0	0	0
Mobile Sources	1,055	923	682	836	802	769	844	808	772	806
Industrial Fuel Combustion & Processes	1,404	2,137	1,289	1,326	1,318	1,309	1,301	1,292	1,283	2,300
All Others	2,520	1,268	501	488	488	488	488	488	487	639
<b>Total</b>	<b>4,979</b>	<b>4,328</b>	<b>2,472</b>	<b>2,650</b>	<b>2,608</b>	<b>2,566</b>	<b>2,633</b>	<b>2,588</b>	<b>2,543</b>	<b>3,745</b>

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%	0%	0%	0%	0%	0%	0%	0%	0%
Mobile Sources	0%	-13%	-35%	-21%	-24%	-27%	-20%	-23%	-27%	-24%
Industrial Fuel Combustion & Processes	0%	52%	-8%	-6%	-6%	-7%	-7%	-8%	-9%	64%
All Others	0%	-50%	-80%	-81%	-81%	-81%	-81%	-81%	-81%	-75%
<b>Total</b>	<b>0%</b>	<b>-13%</b>	<b>-50%</b>	<b>-47%</b>	<b>-48%</b>	<b>-48%</b>	<b>-47%</b>	<b>-48%</b>	<b>-49%</b>	<b>-25%</b>

# Rhode Island Emission Trends (PM<sub>2.5</sub>)

**Major Source Category Summary  
Annual PM<sub>2.5</sub> Emissions**



# Emission Trends Summary

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- ❑ All pollutants have decreased since 1999 in aggregate across Rhode Island
- ❑ 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

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## □ Ozone

- Annual 4<sup>th</sup> highest daily maximum 8-hour average averaged over three consecutive years
- Current standard = 0.075 ppm

## □ PM<sub>2.5</sub> Annual

- Annual arithmetic mean of quarterly means averaged over three consecutive years
- Current standard = 12 ug/m<sup>3</sup>

## □ PM<sub>2.5</sub> 24-Hour

- Annual 98<sup>th</sup> percentile of daily averages averaged over three consecutive years
- Current standard = 35 ug/m<sup>3</sup>

# State-Wide Design Value (DV) Trends

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- 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

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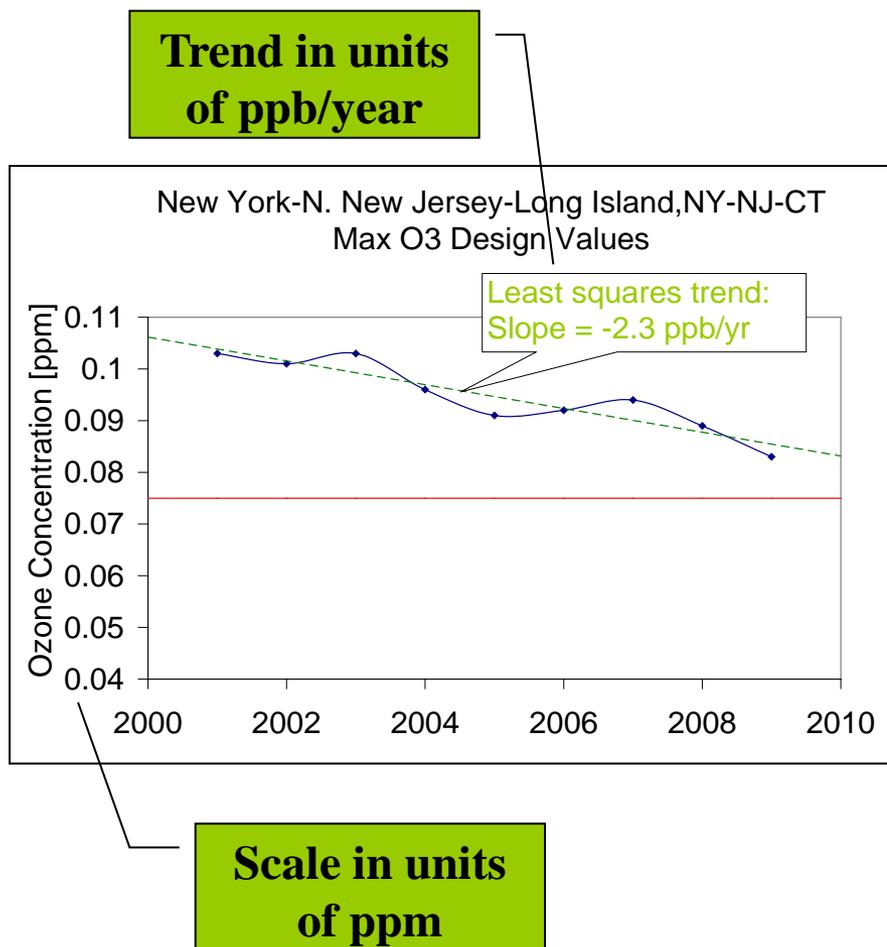
- O<sub>3</sub> design value (DV) for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
  - DV calculated using annual 4<sup>th</sup> highest daily max 8-hr averages and percent of valid observations, based on EPA data handling conventions
  - Data associated with exceptional 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

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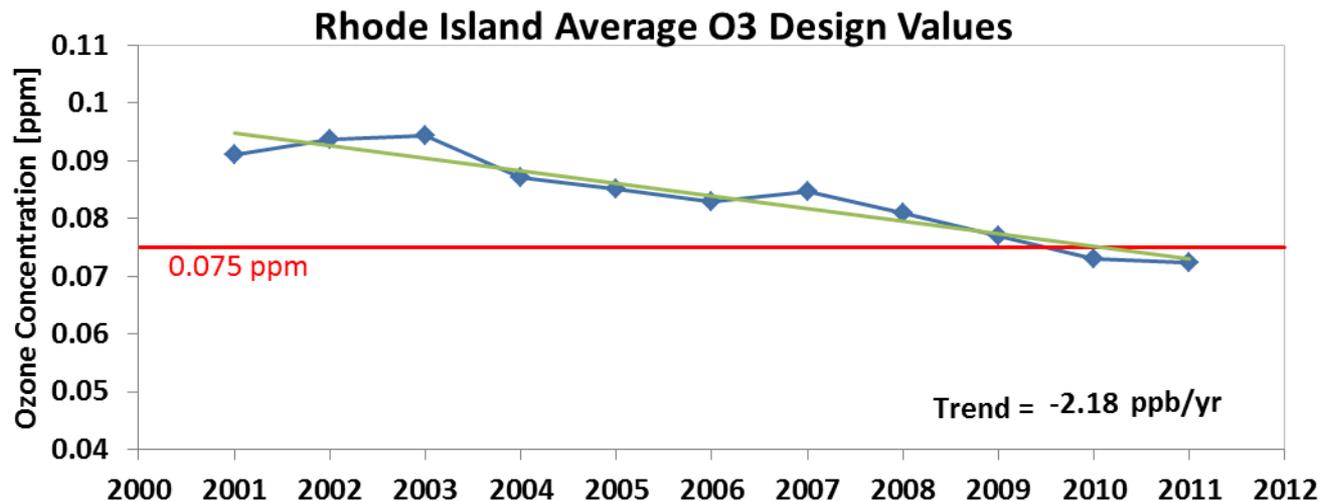
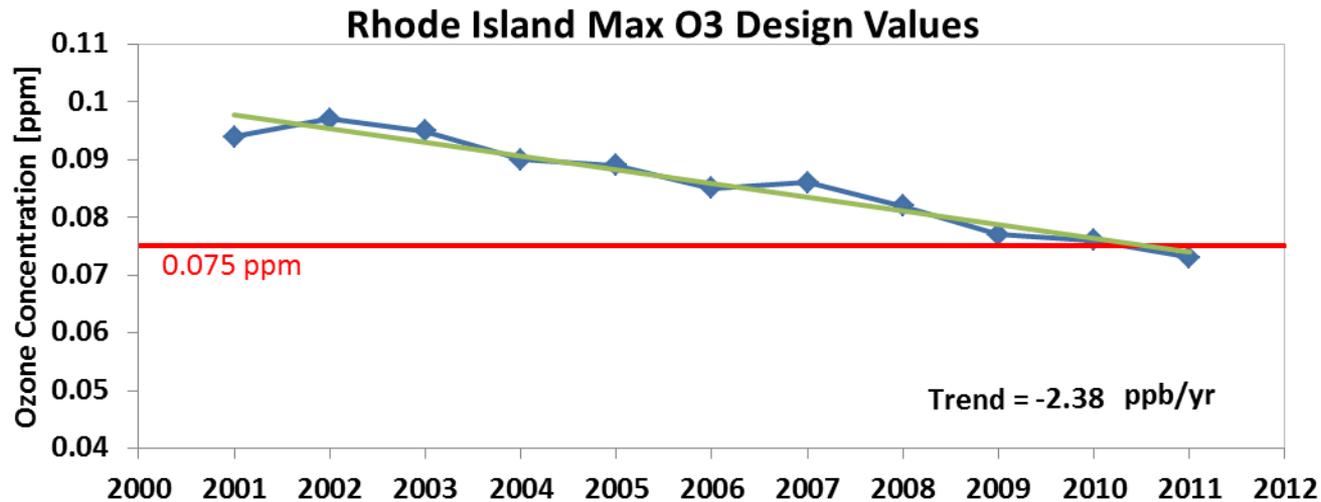
- Annual  $PM_{2.5}$  DV and 24-hr  $PM_{2.5}$  DV for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
  - DV calculations based on EPA data handling conventions
  - Data extracted from monitors that have a non-regulatory monitoring type are omitted
  - Selection 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<sub>3</sub> DVs and Trend



# Ozone Trends by Site in Rhode Island

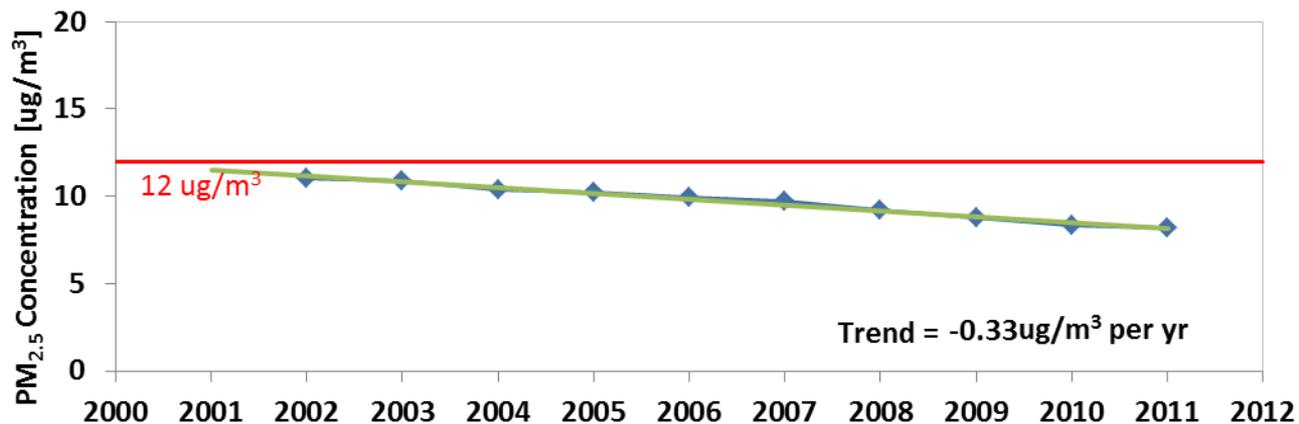
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Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
4400300024420101	Kent, RI	0.073	-2.50
4400710104420101	Providence, RI	0.071	-1.87
4400900074420101	Washington, RI	0.073	-2.18

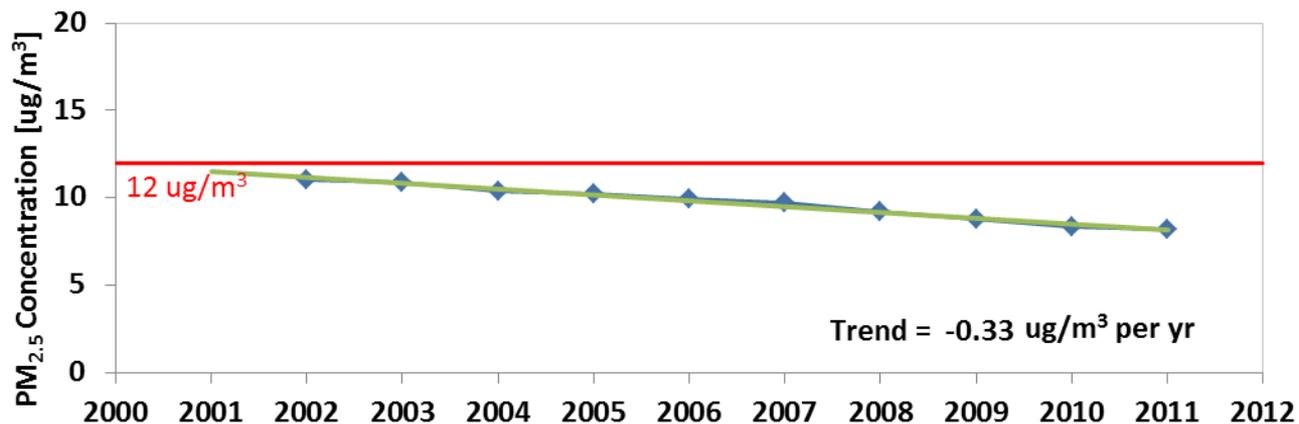
Note: Only monitoring sites meeting data completeness criteria listed

# Max/Ave PM<sub>2.5</sub> Annual DVs and Trend

## Rhode Island Max PM<sub>2.5</sub> Annual Design Values

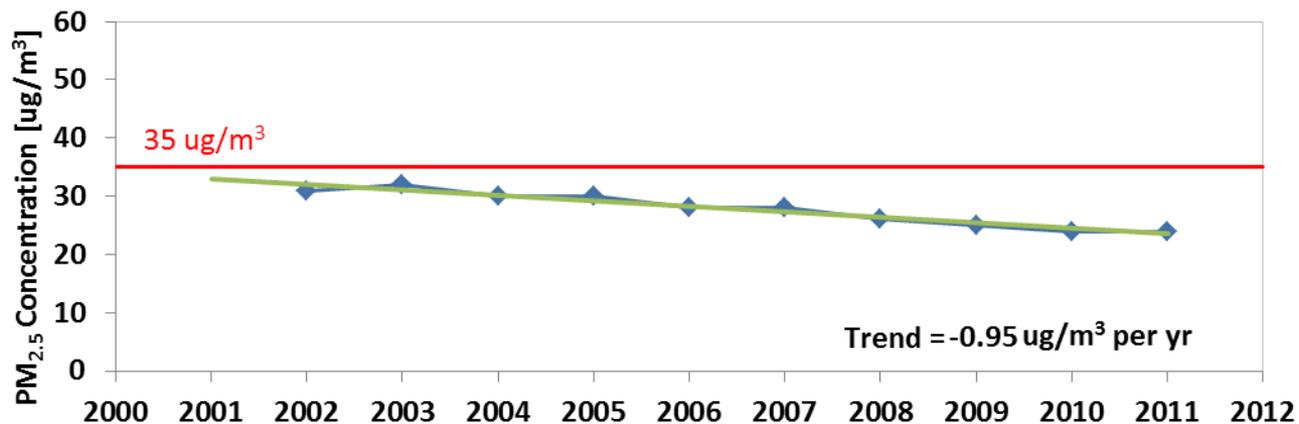


## Rhode Island Average PM<sub>2.5</sub> Annual Design Values

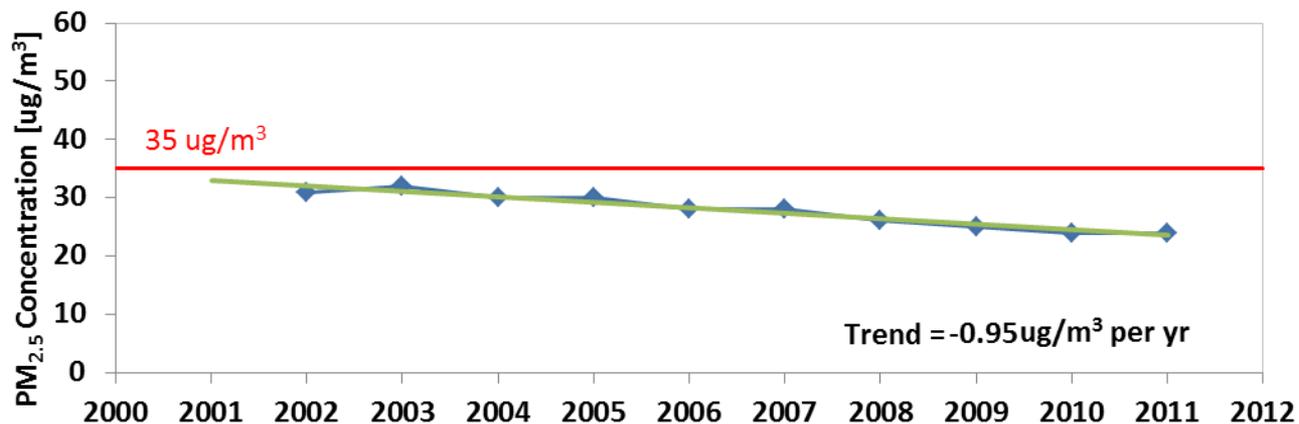


# Max/Ave PM<sub>2.5</sub> 24-Hour DVs and Trend

## Rhode Island Max PM<sub>2.5</sub> 24-Hour Design Values



## Rhode Island Average PM<sub>2.5</sub> 24-Hour Design Values



# PM<sub>2.5</sub> Trends by Site in Rhode Island

Monitoring Site	County	2009-2011 DV [ug/m <sup>3</sup> ]		Trend [ug/m <sup>3</sup> per year]	
		Annual	24-Hr	Annual DV	24-Hr DV
440071010	Providence	8.2	24	-0.33	-0.95

Note: Only monitoring sites meeting data completeness criteria listed

# Air Quality Trends Summary

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- Average O<sub>3</sub> design values have decreased since 1999 in Rhode Island. Average PM<sub>2.5</sub> design values have decreased since 2000 (incomplete data in 1999) based on data from one monitor station.
- There are no currently designated O<sub>3</sub> or PM<sub>2.5</sub> non-attainment areas in Rhode Island