# Recent Regional Emissions and Air Quality Trends – The News Improves!

**Introduction**

In February 2012, the U.S. Environmental Protection Agency published its latest-to-date report evaluating the status and trends in our nation's emissions and air quality[1]. This is part of a series of publications documenting national air quality for the six compounds for which EPA has National Ambient Air Quality Standards (NAAQS); ground-level ozone ($O_3$), particle pollution ($PM_{2.5}$ and $PM_{10}$), lead (Pb), nitrogen dioxide ($NO_2$), carbon monoxide (CO), and sulfur dioxide ($SO_2$). Additionally, the air pollutant emissions contributing to these compounds have been tracked and initiating with estimates from 1980 were documented in the reports.

Concurrent to this report, national numeric trends of air pollutant emissions continue to be released for ozone and particle pollution compound precursors and air quality concentration trends and are also publicly available through various EPA websites. Together, these documents and data present EPA's latest national-scale picture of how our nation's air has been improving since 1980.

Taking this effort to a more detailed level, Alpine Geophysics, LLC (Alpine) and ENVIRON International Corporation (ENVIRON) were tasked with preparing similar presentation materials as was published by EPA, but developed on regional and State geographic scales.

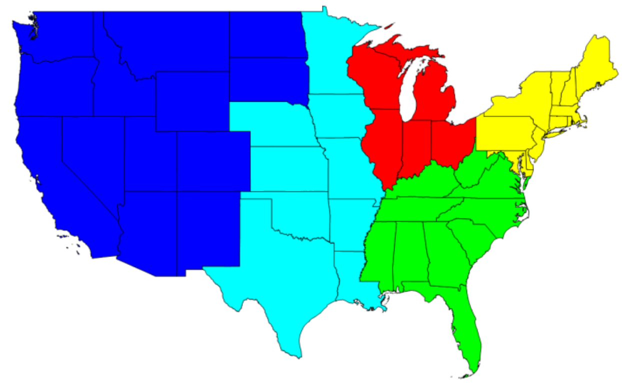

**Figure 1. Regional aggregation of Alpine reports.**

Using the same data and methods as published by EPA, refined to include state-of-science year- and source-specific data and models, Alpine prepared a series of presentations and fact sheets documenting these trends[2] in ozone and particulate matter precursor emissions and developed methods and output to present State-wide maximum and average design value (dv) data for 8-hr ozone and annual and 24-hr $PM_{2.5}$ concentrations. The Alpine reports confirm on State levels what EPA's data indicate on a national level; that emissions have significantly decreased and air quality is significantly improved as a result of recently adopted regulations and are on track to continue to improve as these regulations are fully implemented in the upcoming years.

[1] http://www.epa.gov/airtrends/2011/index.html

[2] http://www.midwestozonegroup.com/AirTrendsJuly2013Public.html

## Air Pollutant Emission Trends

Emissions for this study were obtained from EPA's distribution of the National Emission Inventories (NEI)[3] and emission trend summaries[4]. Initial calculations involved consistent methodology to EPA's trends calculations, namely the interpolation and/or extrapolation of major emission categories for years not reported under the periodic inventory collection rules[5,6]. Year specific wildfire emissions (2005 through 2011) and continuous emissions monitoring (CEM) data (2002 through 2011) augmented interpolated values for these categories and respective pollutants in Alpine's reports.

Similar to EPA's reporting of air pollutant emissions by source category, Alpine used major category groupings to present annual emissions data for a subset of the typically reported primary precursor emissions (volatile organic compounds (VOC), nitrogen oxides ($NO_x$), sulfur dioxides ($SO_2$), and particulate matter [particles 2.5 micrometers in diameter and smaller ($PM_{2.5}$)) in our reports.

The groupings selected were electric utility coal combustion, industrial fuel combustion and industrial processes, mobile sources and all others. Cross-reference between these category groupings and EPA's trends categories are shown in Table 1. The relative contribution of each category differed depending on the region and the pollutant of presentation. In most regions, with the exception of a handful of non-regulated source types and associated releases, air pollutant emissions have decreased over the time period of our study (1999 through 2011).

Table 1. Tier category cross-reference to EPA trends categories.

| **Trends Categories** | | **EPA Trends Categories** |
|---|---|---|
| Electric Utility Coal Fuel Combustion | | Fuel Comb. Elec. Util. - Coal |
| | | |
| Industrial Fuel Combustion & Processes | | Fuel Comb. Industrial |
| | | Fuel Comb. Other |
| | | Chemical & Allied Product Mfg |
| | | Metals Processing |
| | | Petroleum & Related Industries |
| | | Other Industrial Processes |
| | | Solvent Utilization |
| | | Storage & Transport |
| | | Waste Disposal & Recycling |
| | | |
| Mobile Sources | | Highway Vehicles |
| | | Off-Highway |
| | | |
| All Others | | Fuel Comb. Elec. Util. - Non-Coal |
| | | Natural Sources |
| | | Miscellaneous |

[3] ftp://ftp.epa.gov/EmisInventory/
[4] http://www.epa.gov/ttn/chief/trends/index.html
[5] http://www.epa.gov/ttn/chief/aerr/
[6] http://www.epa.gov/ttn/chief/cerr/index.html

Figure 2 presents one example of the graphical displays available for each region or State, by pollutant, from the Alpine reports. This Figure shows the resultant NOx, SO2, VOC and $PM_{2.5}$ emission trends, by major category, for the State of Illinois for the 1999 through 2011 timeframe. Consistent with findings on regional scales, emissions from EGU and mobile source categories show the greatest decline over time as the result of ongoing implementation of various federal, state, and local regulations.

$NO_x$ emission reductions during the period of 1999 to 2011 range from a low thirty-one percent (31%) in the central States to a high of forty-seven percent (47%) in the southeastern domain. These percentages are largely attributable to the tonnage associated with coal-fired EGU source category control.

Tables 2 and 3 present example NOx and SO2 emission reductions for the southeastern and northeastern domains, respectively, as identified in Figure 1. As can been seen in these Tables, in 2011, coal fuel combustion EGU sources achieved NOx reductions of 1,297,074 tons from 1999 levels in the southeast and an additional 1,135,015 ton reduction of SO2 in the northeast.

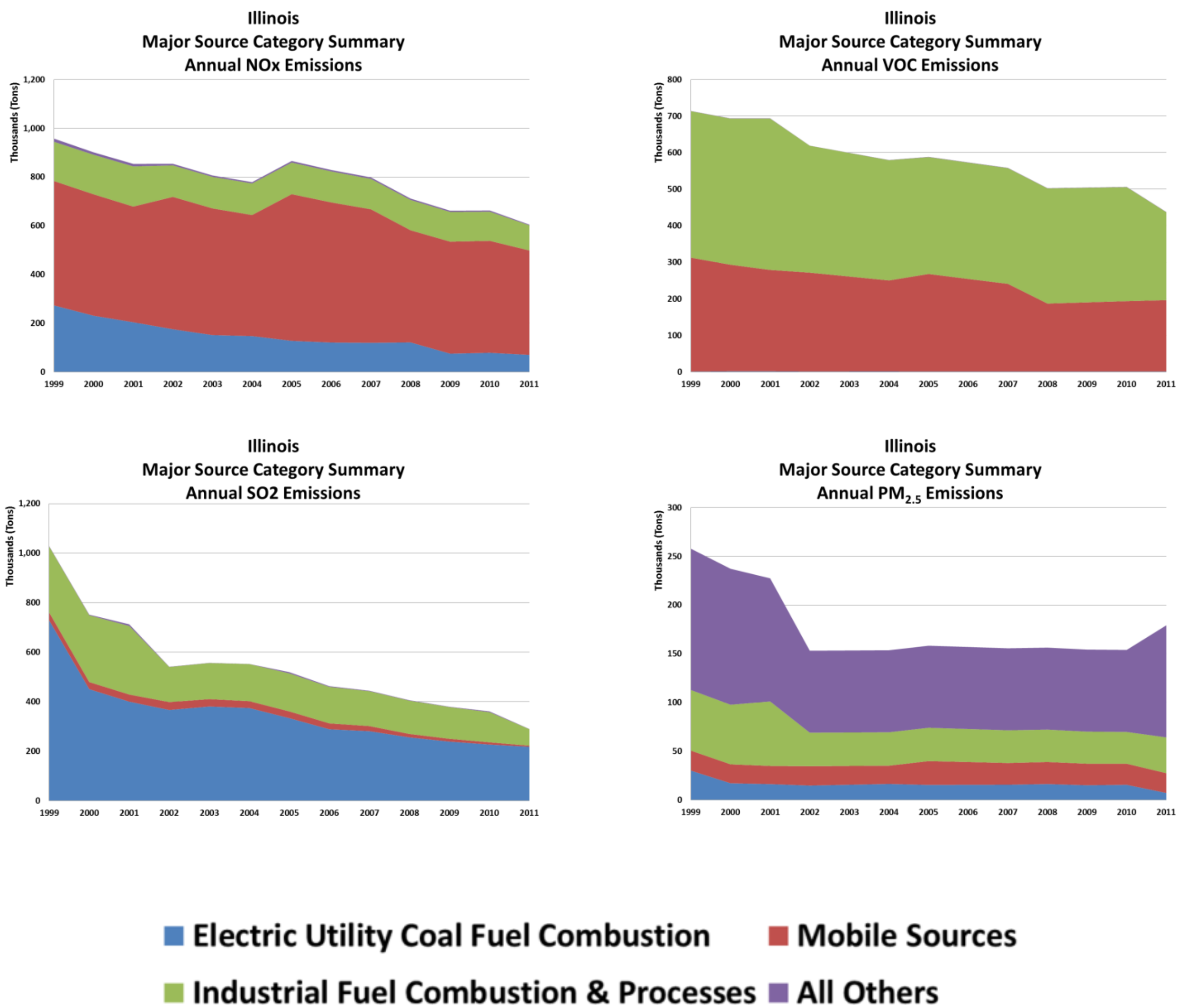


**Figure 2. Annual NOx, SO2 and VOC emission trends by major source category for Illinois.**

**Table 2. Annual NOx emission reduction (1999 to 2011) in southeastern States.**

| | Annual Emissions Reduction (Tons) | | | | |
|---|---|---|---|---|---|
| **Source Category** | **2000** | **2002** | **2005** | **2008** | **2011** |
| Electric Utility Coal Fuel Combustion | 164,103 | 311,456 | 669,590 | 909,773 | 1,297,074 |
| Mobile Sources | -126,328 | -76,417 | -396,572 | 147,338 | 674,723 |
| Industrial Fuel Combustion & Processes | 7,233 | 228,589 | 300,400 | 315,763 | 574,054 |
| All Others | 22,340 | 69,035 | 112,622 | 156,051 | 173,996 |
| **Total** | **67,348** | **532,662** | **686,039** | **1,528,924** | **2,719,847** |

| | Annual Emissions Change (Percent since 1999) | | | | |
|---|---|---|---|---|---|
| **Source Category** | **2000** | **2002** | **2005** | **2008** | **2011** |
| Electric Utility Coal Fuel Combustion | -10% | -18% | -39% | -53% | -75% |
| Mobile Sources | 4% | 3% | 14% | -5% | -24% |
| Industrial Fuel Combustion & Processes | -1% | -23% | -30% | -31% | -57% |
| All Others | -9% | -28% | -46% | -64% | -71% |
| **Total** | **-1%** | **-9%** | **-12%** | **-26%** | **-47%** |

**Table 3. Annual SO2 emission reduction (1999 to 2011) in northeastern States.**

| | Annual Emissions Reduction (Tons) | | | | |
|---|---|---|---|---|---|
| **Source Category** | **2000** | **2002** | **2005** | **2008** | **2011** |
| Electric Utility Coal Fuel Combustion | 905 | 59,928 | 59,571 | 317,325 | 1,135,015 |
| Mobile Sources | 17,829 | 12,805 | 21,862 | 62,781 | 82,623 |
| Industrial Fuel Combustion & Processes | -8,469 | 229,126 | 241,103 | 264,474 | 498,676 |
| All Others | 48,798 | 133,892 | 106,542 | 236,446 | 253,448 |
| **Total** | **59,063** | **435,751** | **429,078** | **881,026** | **1,969,761** |

| | Annual Emissions Change (Percent since 1999) | | | | |
|---|---|---|---|---|---|
| **Source Category** | **2000** | **2002** | **2005** | **2008** | **2011** |
| Electric Utility Coal Fuel Combustion | 0% | -4% | -4% | -20% | -72% |
| Mobile Sources | -15% | -11% | -19% | -55% | -72% |
| Industrial Fuel Combustion & Processes | 1% | -28% | -30% | -33% | -61% |
| All Others | -18% | -49% | -39% | -87% | -93% |
| **Total** | **-2%** | **-16%** | **-15%** | **-32%** | **-71%** |

## Air Quality Concentration Trends

Concurrently, ENVIRON computed and summarized ozone and fine particulate matter ($PM_{2.5}$) design value (dv) trends for each region and lower 48 State for the same period of 1999 through 2011. These dvs were calculated at both State and regional levels and for each three year period we computed the average of dvs across monitoring sites.

The 8-hr ozone and 24-hr and annual particulate matter dvs for each overlapping three-year period started with 1999-2001 and ended with 2009-2011 and were calculated based on EPA data handling conventions. Our results found that average 8-hr ozone and both the average annual and 24-hour $PM_{2.5}$ design values have decreased in all five regions during the study period (Figures 3, 4 and 5) and with the exception of 8-hr ozone from the western State average calculation, each geographic domain generally achieves the current standard for each pollutant.

Ozone dvs were calculated as the annual 4th highest daily maximum 8-hour average averaged over three consecutive years with the current standard equaling 0.075 parts per million (ppm).

The $PM_{2.5}$ annual dv is calculated as the annual arithmetic mean of quarterly means averaged over three consecutive years. The current annual PM2.5 standard is 12 micrograms per cubic meter (ug/m$^3$). The 24-hr $PM_{2.5}$ dv was calculated as the annual 98th percentile of daily averages averaged over three consecutive years with the current standard equaling 35 ug/m$^3$.

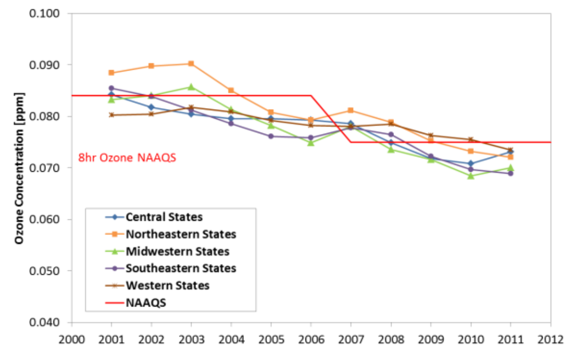


**Figure 3. Regional average 8-hr ozone design value trends.**

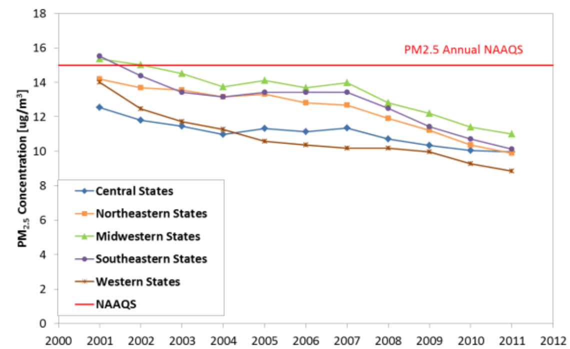


**Figure 4. Regional average annual PM-2.5 design value trends.**

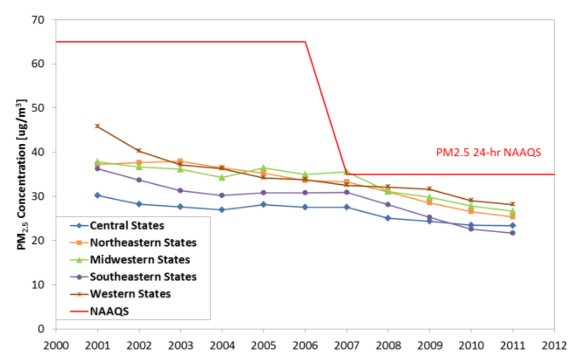


**Figure 5. Regional average 24-hr PM-2.5 design value trends.**

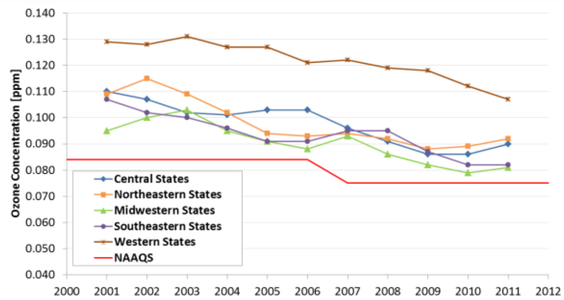


Figure 6. Regional maximum 8-hr ozone design value trends.

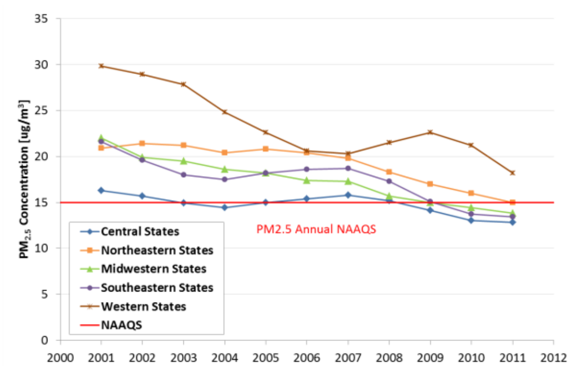


Figure 7. Regional maximum annual PM-2.5 design value trends.

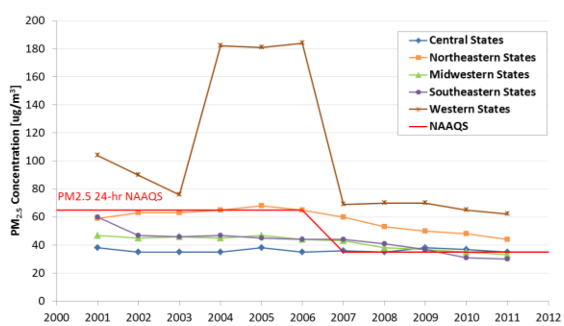


Figure 8. Regional maximum 24-hr PM-2.5 design value trends.

Linear in state-wide maximum dv and average dv were computed using least squares regression analyses. These maximum and average dvs were calculated over all valid trend monitoring sites in each state in each overlapping three year period.

Ozone and annual and 24-hr PM2.5 dvs were calculated in States meeting a required percent of valid observations based on EPA data handling conventions. Data associated with exceptional events that have received EPA concurrence were omitted from the ozone dv calculations.

For PM dvs, data extracted from monitors that had a non-regulatory monitoring type were omitted and for both pollutants, the selection of trend sites required valid dvs in at least 8 out of 11 three-year periods between 1999 and 2011.

Regional, maximum 8-hr ozone design values showed an eighteen percent (18%) improvement from 1999 to 2011 as demonstrated in Figure 6.

Comparatively, and as shown in Figure 7, maximum annual PM2.5 design values, averaged over every region, saw an improvement of thirty-three percent (33%), while maximum 24-hr PM2.5 design values (Figure 8), improved over this same timeframe by thirty-one percent (31%).

Graphical representations of the air quality and design value trends were also prepared for each region and for each monitor achieving the minimum data requirements of the trends calculation methodology.

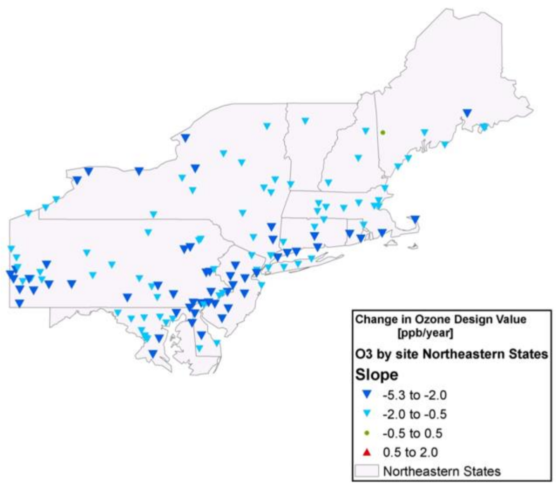


**Figure 9. 8-hr ozone design value trends in northeastern States.**

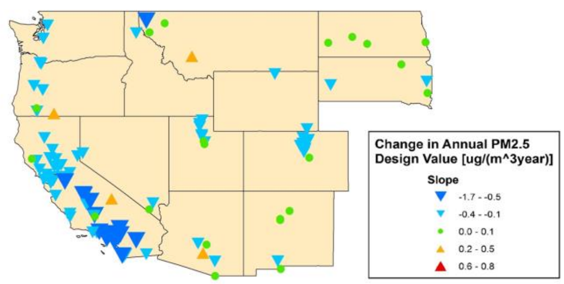


**Figure 30. Annual $PM_{2.5}$ design value trends in western States.**

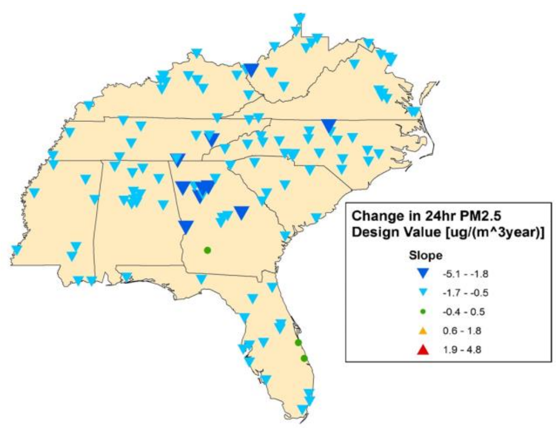


**Figure 41. 24-hr $PM_{2.5}$ design value trends in southeastern States.**

Figures 9, 10, and 11 present 8-hr ozone, annual $PM_{2.5}$, and 24-hr $PM_{2.5}$ design value trends, respectively, for various geographical regions of the U.S.

Blue triangles represent a downward design value trend (improving air quality) while red triangles represent an upward trend (poorer air quality). The size of the triangle represents the relative change in the trend (larger size is greater change from 1999 levels).

As can be seen in these three Figures, 8-hr ozone, annual and 24-hr $PM_{2.5}$ design values have shown widespread decrease since 1999 showing an improvement in air quality as the result of existing emission regulation implemented at federal, state, and local levels.

On January 15, 2013, the EPA published its national ambient air quality standards final rule for fine particulate matter (78 Fed Reg 3086). This rule strengthens the annual health standard for fine particles by setting the standard at a level of 12 ug/$m^3$. The previous annual standard, 15 ug/$m^3$, had been in place since 1997.

And so while these trends demonstrate marked improvement in air quality on a regional basis for the period from 1999 through 2011, it is clear that there still remain areas in the U.S. that require additional control to achieve the existing and proposed ozone and $PM_{2.5}$ NAAQS.

These residual non-attainment areas, identified in Tables 4, 5 and 6, respectively, will require the continued implementation of existing regulation and introduction of new air pollutant emission controls, both regionally and locally, to attain these existing and proposed NAAQS.

Table 4. Areas Previously Designated Nonattainment for the 2008 8-Hour Ozone NAAQS[7].

| Designated Area | Status | Classification | 2010-2012 DV (ppm) |
|---|---|---|---|
| Los Angeles South Coast Air Basin, CA | Nonattainment | Extreme | 0.106 |
| Morongo Indian Reservation, CA | Nonattainment | Serious | 0.100 |
| San Joaquin Valley, CA | Nonattainment | Extreme | 0.098 |
| Los Angeles & San Bernardino Counties (W Mojave), CA | Nonattainment | Severe | 0.097 |
| Sacramento Metro, CA | Nonattainment | Severe | 0.095 |
| Baltimore, MD | Nonattainment | Moderate | 0.093 |
| Riverside County (Coachella Valley), CA | Nonattainment | Severe | 0.092 |
| Houston-Galveston-Brazoria, TX | Nonattainment | Marginal | 0.088 |
| Pechanga Indian Reservation, CA | Nonattainment | Moderate | 0.088 |
| Dallas-Fort Worth, TX | Nonattainment | Moderate | 0.087 |
| New York-N. New Jersey-Long Island, NY-NJ-CT | Nonattainment | Marginal | 0.087 |
| Philadelphia-Wilmington-Atlantic City, PA-NJ-MD-DE | Nonattainment | Marginal | 0.087 |
| Sheboygan, WI | Nonattainment | Marginal | 0.087 |
| Washington, DC-MD-VA | Nonattainment | Marginal | 0.087 |
| St. Louis-St. Charles-Farmington, MO-IL | Nonattainment | Marginal | 0.086 |
| Cincinnati, OH-KY-IN | Nonattainment | Marginal | 0.085 |
| Chicago-Naperville, IL-IN-WI | Nonattainment | Marginal | 0.084 |
| Atlanta, GA | Nonattainment | Marginal | 0.083 |
| Charlotte-Gastonia-Rock Hill, NC-SC | Nonattainment | Marginal | 0.083 |
| Cleveland-Akron-Lorain, OH | Nonattainment | Marginal | 0.083 |
| Columbus, OH | Nonattainment | Marginal | 0.082 |
| Denver-Boulder-Greeley-Ft Collins-Loveland, CO | Nonattainment | Marginal | 0.082 |
| Lancaster, PA | Nonattainment | Marginal | 0.082 |
| Pittsburgh-Beaver Valley, PA | Nonattainment | Marginal | 0.082 |
| Greater Connecticut, CT | Nonattainment | Marginal | 0.081 |
| Imperial County, CA | Nonattainment | Marginal | 0.081 |
| Phoenix-Mesa, AZ | Nonattainment | Marginal | 0.081 |
| San Diego County, CA | Nonattainment | Marginal | 0.081 |
| Seaford, DE | Nonattainment | Marginal | 0.081 |
| Ventura County, CA | Nonattainment | Serious | 0.081 |
| Dukes County, MA | Nonattainment | Marginal | 0.080 |
| Upper Green River Basin, WY | Nonattainment | Marginal | 0.080 |
| Baton Rouge, LA | Nonattainment | Marginal | 0.079 |
| Kern County (Eastern Kern), CA | Nonattainment | Marginal | 0.079 |
| Knoxville, TN | Nonattainment | Marginal | 0.079 |
| Memphis, TN-MS-AR | Nonattainment | Marginal | 0.079 |
| Reading, PA | Nonattainment | Marginal | 0.079 |
| San Luis Obispo County (Eastern part), CA | Nonattainment | Marginal | 0.079 |
| Allentown-Bethlehem-Easton, PA | Nonattainment | Marginal | 0.078 |
| Mariposa County, CA | Nonattainment | Marginal | 0.078 |
| Nevada County (Western part), CA | Nonattainment | Marginal | 0.078 |
| Chico (Butte County), CA | Nonattainment | Marginal | 0.077 |
| Calaveras County, CA | Nonattainment | Marginal | 0.076 |
| Jamestown, NY | Nonattainment | Marginal | 0.076 |
| Tuscan Buttes, CA | Nonattainment | Marginal | 0.076 |

[7] http://www.epa.gov/airtrends/values.html

**Table 5. Areas Previously Designated Nonattainment for the PM2.5 1997 Annual NAAQS[8].**

| **Designated Area** | **Status** | **2010-2012 Annual DV (µg/m³)** |
|---|---|---|
| San Joaquin Valley | nonattainment | **19.0** |
| Los Angeles-South Coast Air Basin | nonattainment | **15.6** |
| Liberty-Clairton | nonattainment | **14.8** |
| St. Louis | nonattainment | **13.5** |
| Cincinnati-Hamilton | maintenance | **13.4** |
| Philadelphia-Wilmington | nonattainment | **13.4** |
| Louisville | nonattainment | **13.2** |
| Macon | nonattainment | **13.1** |
| Birmingham | maintenance | **13.0** |
| Canton-Massillon | nonattainment | **13.0** |
| Cleveland-Akron-Lorain | nonattainment | **13.0** |
| Atlanta | nonattainment | **12.9** |
| Wheeling | nonattainment | **12.8** |
| Chicago-Gary-Lake County [5] | nonattainment [5] | **12.7** |
| Indianapolis | maintenance | **12.7** |
| Steubenville-Weirton | nonattainment | **12.7** |
| Pittsburgh-Beaver Valley | nonattainment | **12.6** |
| Evansville | maintenance | **12.4** |
| Dayton-Springfield | nonattainment | **12.3** |
| Johnstown | nonattainment | **12.3** |
| Knoxville | nonattainment | **12.2** |
| Lancaster | nonattainment | **12.1** |
| Rome | nonattainment | **12.1** |

**Table 6. Areas Previously Designated Nonattainment for the PM2.5 2006 24-hour NAAQS[9].**

| **Designated Area** | **Status** | **2010-2012 24-hr DV (µg/m³)** |
|---|---|---|
| San Joaquin Valley | Nonattainment | **59** |
| Logan | Nonattainment | **47** |
| Fairbanks | Nonattainment | **46** |
| Liberty-Clairton | Nonattainment | **43** |
| Oakridge | Nonattainment | 38 |
| Salt Lake City | Nonattainment | 38 |
| Los Angeles-South Coast Air Basin | Nonattainment | **37** |
| Klamath Falls | Nonattainment | **35** |
| Provo | Nonattainment | **35** |

[8] http://www.epa.gov/airtrends/values.html

**Summary**

These findings are consistent with EPA's most recent trends publication citing a national decrease in national, aggregate emissions of fifty-nine percent (59%) since 1990[9]. Emissions of $NO_x$ and $SO_2$ show the largest decline during the study timeframe, largely as a result of the implementation of national and regional electric generating unit (EGU) regulation of these pollutants. Title IV reductions, the $NO_x$ State Implementation Plan (SIP) Call, and Clean Air Interstate Rule (CAIR) require emission reductions from EGUs on the order of up to seventy percent (70%) from baseline conditions in selected States across the eastern U.S.

Additional reductions from onroad mobile source vehicle fleet and fuel regulations have and are anticipated to generate additional reductions from these pollutants as covered by these rules, including the Tier 2/Gasoline Sulfur rule and Heavy Duty Engine/Vehicle and Highway Diesel Fuel rules. Secondary reductions of PM and other combustion by-products are additionally achieved via these promulgated regulations.

Further reductions can be expected from the additional Implementation of promulgated programs such as regulation on locomotives, marine vessels, and others. Air quality will continue to improve as emissions are reduced in line with the requirements of these environmental rules.

**Conclusion**

In conclusion, reductions in ozone and particulate precursor emissions and improvements in air quality are observed and recorded in all areas of the United States. Existing federal, State, and local air pollutant emission control programs are working and the benefits of these regulations are being realized today. It can only be expected that the continued implementation of promulgated rules will continue to decrease emissions and improve air quality.

[9] http://www.epa.gov/airtrends/2011/index.html