# NOACA Air Quality Public Advisory Task Force

# Emissions Inventory and Source Apportionment

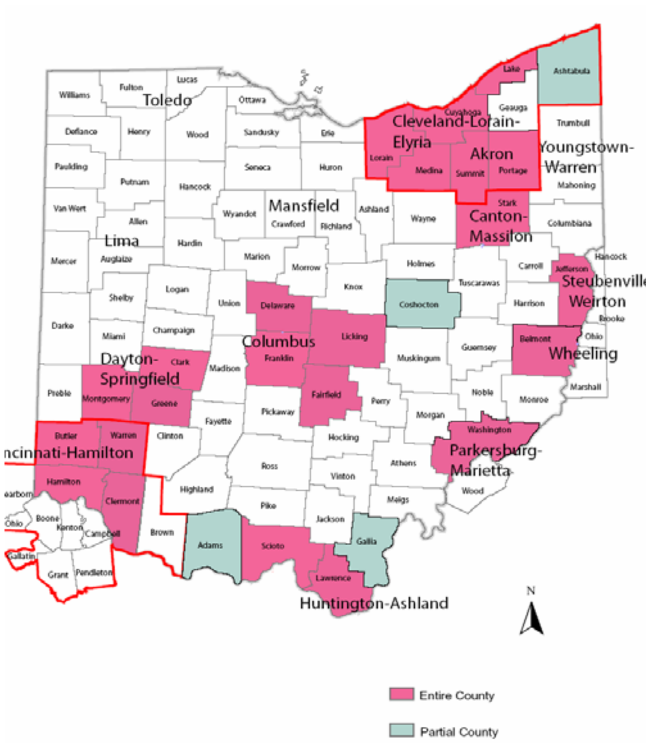
**$PM_{2.5}$ SIP Recommendations**
**June 11, 2007**

# Northeast Ohio and $PM_{2.5}$ Nonattainment

A. Introduction to Nonattainment

On December 17, 2004, the United States Environmental Protection Agency (USEPA) designated Ashtabula (partial), Cuyahoga, Lake, Lorain, Medina, Portage, and Summit Counties as in nonattainment for the annual fine particulate ($PM_{2.5}$) standard. "$PM_{2.5}$" stands for "particulate matter smaller than 2.5 micrometers in diameter," which is so small as to be essentially invisible until it accumulates to the point where a brown haze can be seen by the observer.

This map shows the State of Ohio and its $PM_{2.5}$ nonattainment areas:




To be in "nonattainment" means not to be achieving the federal National Ambient Air Quality Standards (NAAQS), which are health-based limits set by USEPA for the six criteria pollutants named in the federal Clean Air Act.

The NAAQS for $PM_{2.5}$ include an annual standard set at 15 micrograms per cubic meter (15 $\mu g/m^3$), based on the 3-year average of annual mean $PM_{2.5}$ concentrations. There is also a 24-hour standard, recently revised from 65 $\mu g/m^3$ to 35 $\mu g/m^3$ based on the 3-year average of the 98$^{th}$ percentile of 24-hour concentrations. Currently, Northeast Ohio is in nonattainment for the **annual** standard. Designations under the new 24-hour standard will not be made until late 2008 or early 2009. The following charts show Northeast Ohio's current trends for both standards (charts courtesy of Ohio EPA):

# PM-2.5 Annual Averages
## Data through December 2006

| Site | County | Year 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | Average '99-'01 | Average '00-'02 | Average '01-'03 | Average '02-'04 | Average '03-'05 | Average '04-'06 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 39-009-0003 | Athens | 13.9 | 13.9 | 12.4 | 12.7 | 12.3 | 11.4 | 13.3 | 11.8 | 13.40 | 13.00 | 12.47 | 12.13 | 12.33 | 12.17 |
| 39-017-0003 | Butler | 18.8 | 17.0 | 16.4 | 16.8 | 15.4 | 14.1 | 19.0 | 14.1 | 17.38 | 16.72 | 16.20 | 15.43 | 16.17 | 15.73 |
| 39-017-0016 | | | 18.9 | 15.9 | 15.3 | 15.8 | 14.7 | 17.9 | 14.0 | 17.38 | 16.68 | 15.67 | 15.27 | 16.13 | 15.53 |
| 39-017-0017 | | | 17.9 | 15.8 | 15.5 | 14.7 | 14.2 | 17.2 | | 16.67 | 16.41 | 15.33 | 14.80 | 15.37 | |
| 39-017-1004 | | | | 11.6 | 13.9 | 15.0 | 13.6 | 16.9 | 13.4 | | | 13.50 | 14.17 | 15.17 | 14.63 |
| 39-017-1004(3) | | | | | | 13.4 | 15.4 | 15.4 | | | | | | 14.73 | |
| 39-023-0005 | Clark | | 16.4 | 14.8 | 15.1 | 14.1 | 13.5 | 16.7 | 13.1 | 15.60 | 15.43 | 14.67 | 14.23 | 14.77 | 14.43 |
| 39-025-0022 | Clermont | | | | | | | 15.7 | 12.7 | | | | | | |
| 39-035-0013 | Cuyahoga | 17.9 | 19.7 | 17.7 | 16.9 | 16.7 | | | | 18.42 | 18.09 | 17.10 | 15.80 | 16.70 | |
| 39-035-0027 | | 18.4 | 17.2 | 17.8 | 16.5 | 15.4 | 15.6 | 17.3 | 13.0 | 17.80 | 17.17 | 16.57 | 15.83 | 16.10 | 15.30 |
| 39-035-0034 | | | 15.6 | 15.0 | 14.3 | 13.4 | 12.6 | 16.3 | 11.5 | 15.30 | 14.97 | 14.23 | 13.43 | 14.10 | 13.47 |
| 39-035-0038 | | 21.0 | 20.1 | 19.8 | 17.7 | 17.6 | 17.5 | 19.2 | 14.9 | 20.30 | 19.20 | 18.37 | 17.60 | 18.10 | 17.20 |
| 39-035-0045 | | 13.9 | 18.8 | 17.4 | 16.2 | 16.4 | 15.3 | 19.3 | 14.1 | 18.10 | 17.47 | 16.67 | 15.97 | 17.00 | 16.23 |
| 39-035-0060 | | 18.6 | 19.5 | 17.7 | 17.5 | 17.2 | 16.4 | 19.4 | 15.0 | 18.60 | 18.23 | 17.47 | 17.03 | 17.67 | 16.93 |
| 39-035-0060 (3) | | | | | 13.4 | 18.4 | | | | | | | | | |
| 39-035-0065 | | 17.6 | 18.5 | 16.6 | 15.8 | 15.6 | 15.2 | 18.6 | 13.1 | 17.57 | 16.97 | 16.00 | 15.53 | 16.47 | 15.63 |
| 39-035-0066 | | 14.5 | 15.4 | 14.6 | 14.2 | 13.9 | 11.7 | | | 14.83 | 14.73 | 14.23 | 13.27 | 12.80 | |
| 39-035-1002 | | 15.6 | 15.0 | 14.8 | 15.1 | 13.9 | 13.2 | 16.8 | 11.6 | 15.13 | 14.97 | 14.60 | 14.07 | 14.63 | 13.87 |
| 39-049-0024 | Franklin | 18.4 | 17.8 | 17.9 | 15.8 | 16.4 | 15.1 | 18.4 | 13.6 | 18.03 | 17.17 | 16.70 | 15.77 | 15.97 | 15.03 |
| 39-049-0025 | | 17.7 | 17.1 | 16.9 | 16.1 | 15.5 | 14.6 | 16.5 | 13.8 | 17.23 | 16.70 | 16.17 | 15.40 | 15.53 | 14.97 |
| 39-049-0028 (3) | | | 4.1 | 11.7 | 10.3 | 9.9 | 12.6 | 11.6 | | | | 10.63 | 10.93 | 11.37 | |
| 39-049-0029 (3) | | | 10.4 | 12.5 | 10.8 | 10.2 | 13.3 | 21.3 | | | | 11.17 | 11.43 | 14.93 | |
| 39-049-0081 | | 17.1 | 18.3 | 16.8 | 16.2 | 14.9 | 13.6 | 14.6 | 12.9 | 17.40 | 17.10 | 15.97 | 14.90 | 14.37 | 13.70 |
| 39-057-0005 | Greene | | | | | 9.5 | 12.1 | 15.5 | 11.9 | | | | | 12.37 | 13.17 |
| 39-061-0006 | Hamilton | | | | | | | 16.6 | 13.3 | | | | | | |
| 39-061-0014 | | 20.1 | 19.3 | 18.6 | 17.9 | 17.0 | 15.9 | 19.6 | 15.5 | 19.33 | 18.60 | 17.83 | 16.93 | 17.57 | 17.07 |
| 39-061-0040 | | 15.7 | 16.7 | 15.9 | 15.3 | 15.5 | 14.6 | 17.5 | 13.6 | 16.10 | 15.97 | 15.57 | 15.13 | 15.87 | 15.23 |
| 39-061-0040 (3) | | | | 15.3 | 14.8 | 14.6 | 14.1 | 15.5 | | | | 14.90 | 14.50 | 14.73 | |
| 39-061-0041 | | 18.6 | 17.3 | 16.1 | 15.1 | 15.3 | 14.6 | 15.8 | | 17.33 | 16.17 | 15.50 | 15.00 | 15.23 | |
| 39-061-0042 | | | 20.6 | 17.6 | 16.8 | 16.7 | 16.0 | 19.1 | 14.9 | 19.10 | 18.33 | 17.03 | 16.50 | 17.27 | 16.67 |
| 39-061-0043 | | | 19.1 | 16.1 | 15.4 | 15.7 | 14.9 | 16.9 | 14.5 | 17.60 | 16.87 | 15.73 | 15.33 | 15.83 | 15.43 |
| 39-061-7001 | | 17.5 | 17.2 | 16.8 | 16.1 | 16.0 | 15.3 | 18.4 | 14.4 | 17.17 | 16.70 | 16.30 | 15.80 | 16.57 | 16.03 |
| 39-061-8001 | | 20.9 | 19.3 | 17.0 | 17.0 | 17.3 | 16.4 | 20.0 | 15.9 | 19.07 | 17.77 | 17.10 | 16.90 | 17.90 | 17.43 |
| 39-081-0016 | Jefferson | 19.6 | 19.2 | 18.2 | 17.6 | 17.7 | | | | 19.00 | 18.33 | 17.83 | | | |
| 39-080-0017 | | | | | | 15.2 | 15.9 | 16.4 | 13.8 | | | | | 15.83 | 15.37 |
| 39-081-1001 | | 18.4 | 17.4 | 18.9 | 17.1 | 17.3 | 16.2 | 18.1 | 14.6 | 18.23 | 17.80 | 17.77 | 16.87 | 17.20 | 16.30 |
| 39-085-1001 | Lake | 14.1 | 14.0 | 14.0 | 13.6 | 12.7 | 11.7 | 15.1 | | 14.03 | 13.87 | 13.43 | 12.67 | 13.17 | |
| 39-085-3002 | | | | | | | | | 12.0 | | | | | | |
| 39-087-0010 | Lawrence | 17.9 | 17.4 | 17.7 | 15.5 | 14.3 | 13.3 | 17.0 | 14.4 | 17.67 | 16.87 | 15.83 | 14.37 | 14.87 | 14.90 |
| 39-093-0016 | Lorain | | 13.5 | 14.6 | 14.0 | 13.1 | 12.9 | 16.4 | 11.5 | 14.05 | 14.03 | 13.90 | 13.33 | 14.13 | 13.60 |
| 39-093-2003 | | 15.3 | 15.6 | 14.5 | | | | | | 15.13 | | | | | |
| 39-093-3002 | | | | | 14.0 | 11.8 | 11.9 | 14.7 | 11.4 | | | | 12.57 | 12.80 | 12.67 |
| 39-093-3002 (3) | | | | | | | 11.2 | 9.2 | | | | | | | |
| 39-095-0024 | Lucas | 15.7 | 19.5 | 15.7 | 15.0 | 14.5 | 13.7 | 15.8 | 12.7 | 16.97 | 16.73 | 15.07 | 14.40 | 14.67 | 14.07 |
| 39-095-0024 (3) | | | | | 7.4 | 9.8 | 9.6 | 10.4 | | | | | 8.93 | 9.93 | |
| 39-095-0025 | | 13.5 | 15.7 | 14.4 | 15.3 | 14.3 | 13.3 | 15.5 | 11.9 | 14.53 | 15.13 | 14.67 | 14.30 | 14.37 | 13.57 |
| 39-095-0026 | | 16.5 | 15.1 | 15.5 | 14.9 | 14.3 | 13.0 | 15.7 | 12.6 | 15.70 | 15.17 | 14.90 | 14.07 | 14.33 | 13.77 |
| 39-099-0005 | Mahoning | 16.9 | 16.0 | 16.4 | 14.8 | 14.4 | 14.2 | 16.4 | 13.0 | 16.43 | 15.73 | 15.20 | 14.47 | 15.00 | 14.53 |
| 39-099-0014 | | | | | 13.2 | 15.0 | 14.7 | 16.9 | 13.5 | | | | 14.30 | 15.53 | 15.03 |
| 39-099-0014 (3) | | | | | 8.8 | 11.5 | 11.3 | 12.3 | | | | | 10.53 | 11.70 | |
| 39-103-0003 | Medina | | | | | | | | 11.9 | | | | | | |
| 39-113-0014 | Montgomery | 17.4 | 18.3 | 17.5 | | | | | | 17.73 | | | | | |
| 39-113-0031 | | 16.2 | 16.3 | 16.1 | 15.2 | 14.4 | 13.9 | 16.8 | 13.1 | 16.20 | 15.87 | 15.23 | 14.50 | 15.03 | 14.60 |
| 39-113-0031 (3) | | | | 15.1 | 18.4 | 19.9 | 16.7 | 18.1 | | | | 17.80 | 18.33 | 18.23 | |
| 39-113-0032 | | | | 16.0 | 16.2 | 15.9 | 14.5 | 17.4 | 13.6 | | 16.10 | 16.03 | 15.53 | 15.93 | 15.17 |
| 39-113-0032 (3) | | | | | 17.4 | 18.6 | 17.3 | 19.5 | | | | | 17.77 | 18.47 | |
| 39-133-0002 | Portage | 15.0 | 15.7 | 15.2 | 14.6 | 12.7 | 12.5 | 15.0 | 12.0 | 15.30 | 15.17 | 14.17 | 13.27 | 13.40 | 13.17 |
| 39-135-1001 | Preble | 14.7 | 15.2 | 13.5 | 13.5 | 13.6 | 12.5 | 15.6 | 12.5 | 14.47 | 14.07 | 13.53 | 13.20 | 13.90 | 13.53 |
| 39-135-1001 (3) | | | | | | 11.2 | 14.0 | 14.5 | | | | | 12.60 | 13.23 | |
| 39-145-0013 | Scioto | 24.7 | 21.1 | 20.3 | 16.7 | 14.7 | 13.0 | 16.2 | 14.3 | 22.03 | 19.37 | 17.23 | 14.80 | 14.63 | 14.50 |
| 39-145-0013 (3) | | | | | | 19.9 | | | | | | | | | |
| 39-151-0017 | Stark | 18.4 | 18.7 | 17.8 | 17.4 | 16.8 | 15.7 | 17.8 | 14.6 | 18.30 | 17.97 | 17.33 | 16.63 | 16.77 | 16.03 |
| 39-151-0020 | | 17.1 | 16.9 | 16.6 | 15.8 | 15.0 | 14.1 | 16.6 | 11.9 | 16.87 | 16.43 | 15.80 | 14.97 | 15.23 | 14.20 |
| 39-151-0020 (3) | | | | | 11.2 | 10.9 | 10.5 | 11.3 | | | | | 10.87 | 10.90 | |
| 39-153-0017 | Summit | 18.0 | 16.6 | 17.6 | 16.7 | 15.4 | 15.0 | 16.4 | 13.5 | 17.40 | 16.97 | 16.57 | 15.70 | 15.60 | 14.97 |
| 39-153-0017 (3) | | | | | 9.1 | 11.3 | 15.8 | 17.4 | | | | | 12.07 | 14.83 | |
| 39-153-0023 | | 16.5 | 16.3 | 15.9 | 16.8 | 14.2 | 13.9 | 15.7 | 12.8 | 16.23 | 16.33 | 15.63 | 14.97 | 14.60 | 14.13 |
| 39-155-0007 | Trumbull | 16.7 | 15.7 | 16.2 | 15.0 | 14.0 | 13.8 | 16.4 | 12.9 | 16.20 | 15.63 | 15.07 | 14.27 | 14.73 | 14.37 |

(3) continuous

## PM-2.5 24-Hr 98th Percentile

Data Through December 2006

| Site | County | Year 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | Average '99-'01 | Average '00-'02 | Average '01-'03 | Average '02-'04 | Average '03-'05 | Average '04-'06 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 39-009-0003 | Athens | 38.5 | 30.4 | 31.8 | 32.7 | 29.2 | 33.1 | 33.1 | 29.3 | 32.90 | 31.63 | 31.23 | 31.67 | 31.80 | 31.83 |
| 39-017-0003 | Butler | 37.0 | 38.1 | 41.7 | 40.7 | 38.6 | 37.2 | 47.6 | 30.2 | 38.93 | 40.17 | 40.33 | 38.83 | 41.13 | 38.33 |
| 39-017-0016 | | | 43.8 | 41.5 | 33.6 | 34.8 | 32.2 | 43.4 | 35.2 | | 39.63 | 36.63 | 33.53 | 36.80 | 36.93 |
| 39-017-0017 | | | 38.7 | 44.8 | 33.8 | 34.6 | 34.3 | 44.9 | | | 39.10 | 37.73 | 34.23 | 37.93 | |
| 39-017-1004 | | | | 16.5 | 30.9 | 33.0 | 31.6 | 45.4 | 32.7 | | | 26.80 | 31.83 | 36.67 | 36.57 |
| 39-017-1004(3) | | | | | | 24.0 | 35.8 | 43.5 | | | | | | 34.43 | |
| 39-023-0005 | Clark | | 39.9 | 37.0 | 34.1 | 31.2 | 32.1 | 41.6 | 30.5 | 38.45 | 37.00 | 34.10 | 32.47 | 34.97 | 34.73 |
| 39-025-0022 | Clermont | | | | | | | 38.3 | 31.6 | | | | | | |
| 39-035-0013 | Cuyahoga | 39.7 | 44.6 | 43.2 | 40.1 | 38.5 | 39.5 | | | 42.50 | 42.63 | 40.60 | 39.37 | | |
| 39-035-0027 | | 47.8 | 42.6 | 44.9 | 40.9 | 41.3 | 40.9 | 35.7 | 31.5 | 45.10 | 42.80 | 42.37 | 41.03 | 39.30 | 36.03 |
| 39-035-0034 | | | 38.1 | 39.7 | 36.8 | 37.2 | 32.9 | 43.8 | 29.1 | | 38.20 | 37.90 | 35.63 | 37.97 | 35.27 |
| 39-035-0038 | | 49.2 | 42.4 | 47.3 | 44.5 | 47.3 | 42.5 | 51.2 | 38.1 | 46.30 | 44.73 | 46.37 | 44.77 | 47.00 | 43.27 |
| 39-035-0045 | | 21.7 | 43.6 | 43.1 | 38.4 | 42.2 | 36.1 | 46.2 | 29.5 | 36.13 | 41.70 | 41.23 | 38.90 | 41.50 | 37.27 |
| 39-035-0060 | | 43.0 | 45.8 | 42.7 | 39.8 | 45.5 | 42.2 | 49.5 | 31.0 | 43.83 | 42.77 | 42.67 | 42.50 | 45.73 | 40.90 |
| 39-035-0060 (3) | | | | | 40.8 | 44.8 | | | | | | | | | |
| 39-035-0065 | | 41.3 | 43.3 | 42.2 | 37.3 | 39.1 | 36.1 | 47.9 | 27.8 | 42.27 | 40.93 | 39.53 | 37.50 | 41.03 | 37.27 |
| 39-035-0066 | | 33.8 | 36.9 | 40.2 | 35.3 | 34.4 | 32.0 | | | 36.97 | 37.47 | 36.63 | 33.90 | | |
| 39-035-1002 | | 34.4 | 28.1 | 39.8 | 35.7 | 31.9 | 30.5 | 41.6 | 27.7 | 34.10 | 34.53 | 35.80 | 32.70 | 34.67 | 33.27 |
| 39-049-0024 | Franklin | 39.8 | 40.0 | 41.0 | 39.2 | 39.2 | 35.1 | 45.0 | 34.0 | 40.27 | 40.07 | 39.80 | 37.83 | 39.77 | 38.03 |
| 39-049-0025 | | 39.6 | 41.0 | 39.0 | 40.2 | 37.0 | 35.5 | 44.9 | 34.0 | 39.87 | 40.07 | 38.73 | 37.57 | 39.13 | 38.13 |
| 39-049-0028 (3) | | | 10.9 | 39.8 | 32.9 | 29.4 | 33.5 | 32.6 | | | 27.87 | 34.03 | 31.93 | 31.83 | |
| 39-049-0029 (3) | | | 34.8 | 37.2 | 36.1 | 30.6 | 30.7 | 48.4 | | | 36.03 | 34.63 | 32.47 | 36.57 | |
| 39-049-0081 | | 36.5 | 36.5 | 41.3 | 39.3 | 33.7 | 34.1 | 34.7 | 31.2 | 38.10 | 39.03 | 38.10 | 35.70 | 34.17 | 33.33 |
| 39-057-0005 | Greene | | | | | 18.2 | 27.7 | 40.0 | 26.5 | | | | | 28.63 | 31.40 |
| 39-061-0006 | Hamilton | | | | | | | 45.0 | 33.3 | | | | | | |
| 39-061-0014 | | 40.5 | 44.3 | 44.0 | 43.7 | 37.8 | 42.0 | 38.5 | 35.2 | 42.93 | 44.00 | 41.83 | 41.17 | 39.43 | 38.57 |
| 39-061-0040 | | 34.1 | 34.3 | 5.0 | 37.7 | 31.9 | 30.5 | 45.8 | 32.8 | 24.47 | 25.67 | 24.87 | 33.37 | 36.07 | 36.37 |
| 39-061-0040 (3) | | | | 42.2 | 40.2 | 35.5 | 31.4 | 41.2 | | | | 39.30 | 35.70 | 36.03 | |
| 39-061-0041 | | 37.8 | 38.0 | 41.9 | 33.6 | 34.4 | 32.2 | 37.4 | | 39.23 | 37.83 | 36.63 | 33.40 | 34.67 | |
| 39-061-0042 | | | 44.8 | 46.6 | 40.0 | 33.8 | 31.9 | 44.4 | 34.5 | | 43.80 | 40.13 | 35.23 | 36.70 | 36.93 |
| 39-061-0043 | | | 41.2 | 40.1 | 34.8 | 37.3 | 31.4 | 39.9 | 34.9 | | 38.70 | 37.40 | 34.50 | 36.20 | 35.40 |
| 39-061-7001 | | 38.0 | 39.1 | 42.3 | 40.7 | 37.1 | 34.6 | 47.1 | 34.0 | 39.80 | 40.70 | 40.03 | 37.47 | 39.60 | 38.57 |
| 39-061-8001 | | 39.5 | 40.1 | 37.0 | 40.1 | 35.8 | 33.9 | 51.4 | 36.1 | 38.87 | 39.07 | 37.63 | 36.60 | 40.37 | 40.47 |
| 39-081-0016 | Jefferson | 40.0 | 47.3 | 47.0 | 47.5 | 37.0 | | | | 44.77 | 47.27 | 43.83 | 41.98 | | |
| 39-081-0017 | | | | | | 39.6 | 43.6 | 43.8 | 32.1 | | | | | 42.40 | 39.90 |
| 39-081-1001 | | 42.2 | 35.0 | 45.4 | 42.3 | 40.9 | 51.5 | 44.2 | 32.9 | 40.87 | 40.90 | 42.87 | 44.90 | 45.53 | 42.87 |
| 39-085-1001 | Lake | 34.1 | 39.5 | 44.3 | 39.2 | 36.2 | 31.6 | 43.5 | | 39.30 | 41.00 | 39.90 | 35.73 | 37.17 | |
| 39-085-3002 | | | | | | | | | 32.9 | | | | | | |
| 39-087-0010 | Lawrence | 34.2 | 40.2 | 41.0 | 42.4 | 29.3 | 31.2 | 38.5 | 30.8 | 38.47 | 41.20 | 37.57 | 34.30 | 33.00 | 33.50 |
| 39-093-0016 | Lorain | | 46.3 | 36.9 | 32.3 | 36.1 | 30.0 | 39.7 | 24.9 | | 38.50 | 35.10 | 32.80 | 35.27 | 31.53 |
| 39-093-2003 | | 37.5 | 38.5 | 42.6 | | | | | | 39.53 | | | | | |
| 39-093-3002 | | | | | 35.8 | 31.4 | 31.1 | 33.9 | 27.4 | | | | | 32.13 | 30.80 |
| 39-093-3002 (3) | | | | | | | | 31.1 | | | | | | | |
| 39-095-0024 | Lucas | 41.0 | 35.1 | 36.7 | 37.3 | 36.4 | 34.3 | 45.3 | 25.9 | 37.60 | 36.37 | 36.80 | 36.00 | 38.67 | 35.17 |
| 39-095-0024 (3) | | | | | 15.7 | 29.2 | 28.2 | 28.9 | | | | | 24.37 | 28.77 | |
| 39-095-0025 | | 30.7 | 38.3 | 35.0 | 39.0 | 34.4 | 31.6 | 44.6 | 25.2 | 34.67 | 37.43 | 36.13 | 35.00 | 36.87 | 33.80 |
| 39-095-0026 | | 40.0 | 36.1 | 38.3 | 38.1 | 36.7 | 30.6 | 42.9 | 27.1 | 38.13 | 37.50 | 37.70 | 35.13 | 36.73 | 33.53 |
| 39-099-0005 | Mahoning | 38.6 | 34.6 | 45.7 | 38.3 | 31.3 | 34.4 | 41.6 | 28.6 | 39.63 | 39.53 | 38.43 | 34.67 | 35.77 | 34.87 |
| 39-099-0014 | | | | | 27.8 | 36.0 | 36.0 | 42.6 | 31.1 | | | | 33.27 | 38.20 | 36.57 |
| 39-099-0014 (3) | | | | | 26.9 | 30.0 | 31.7 | 36.4 | | | | | 29.53 | 32.70 | |
| 39-103-0003 | Medina | | | | | | | 38.8 | 28.5 | | | | | | |
| 39-113-0014 | Montgomery | 33.6 | 42.6 | 40.2 | | | | | | 38.80 | | | | | |
| 39-113-0031 | | 34.6 | 36.4 | 41.9 | 38.1 | 37.0 | 31.5 | 42.9 | 28.9 | 37.63 | 38.80 | 39.00 | 35.53 | 37.13 | 34.43 |
| 39-113-0031 (3) | | | | 29.6 | 46.6 | 46.7 | 44.6 | 45.1 | | | | 40.97 | 45.97 | 45.47 | |
| 39-113-0032 | | | | 42.4 | 36.9 | 42.7 | 32.5 | 45.0 | 30.3 | | | 40.67 | 37.37 | 40.07 | 35.93 |
| 39-113-0032 (3) | | | | | 48.8 | 43.0 | 40.7 | 48.1 | | | | | 44.17 | 43.93 | |
| 39-133-0002 | Portage | 34.0 | 35.9 | 42.7 | 37.0 | 30.7 | 29.6 | 42.2 | 30.5 | 37.53 | 38.53 | 36.80 | 32.50 | 34.23 | 34.17 |
| 39-135-1001 | Preble | 32.8 | 35.7 | 38.4 | 29.0 | 34.3 | 27.7 | 39.0 | 28.7 | 35.63 | 34.37 | 33.90 | 30.33 | 33.67 | 31.80 |
| 39-135-1001 (3) | | | | | | 24.7 | 36.7 | 39.8 | | | | | | 33.73 | |
| 39-145-0013 | Scioto | 43.2 | 43.5 | 49.2 | 42.1 | 32.8 | 29.4 | 40.3 | 30.5 | 45.30 | 44.93 | 41.37 | 34.77 | 34.17 | 33.40 |
| 39-145-0013 (3) | | | | | | | | | | | | | | | |
| 39-151-0017 | Stark | 42.1 | 40.1 | 45.0 | 41.0 | 34.2 | 36.3 | 47.6 | 33.1 | 42.40 | 42.03 | 40.07 | 37.17 | 39.37 | 39.00 |
| 39-151-0020 | | 41.3 | 37.5 | 44.2 | 39.8 | 34.5 | 32.6 | 42.8 | 26.1 | 41.00 | 40.50 | 39.50 | 35.70 | 36.70 | 33.90 |
| 39-151-0020 (3) | | | | | 37.6 | 30.4 | 32.3 | 35.7 | | | | | 33.43 | 32.80 | |
| 39-153-0017 | Summit | 40.6 | 37.5 | 45.6 | 42.3 | 36.9 | 36.9 | 45.2 | 31.5 | 41.23 | 41.80 | 41.60 | 38.70 | 39.67 | 37.87 |
| 39-153-0017 (3) | | | | | 26.2 | 31.2 | 43.2 | 46.5 | | | | | 33.53 | 40.30 | |
| 39-153-0023 | | 42.3 | 36.8 | 42.6 | 41.5 | 33.4 | 37.0 | 42.3 | 30.4 | 40.57 | 40.30 | 39.17 | 37.30 | 37.57 | 36.57 |
| 39-155-0007 | Trumbull | 36.5 | 35.0 | 48.3 | 36.1 | 34.9 | 33.5 | 45.1 | 28.7 | 39.93 | 39.80 | 39.77 | 35.50 | 37.83 | 35.77 |

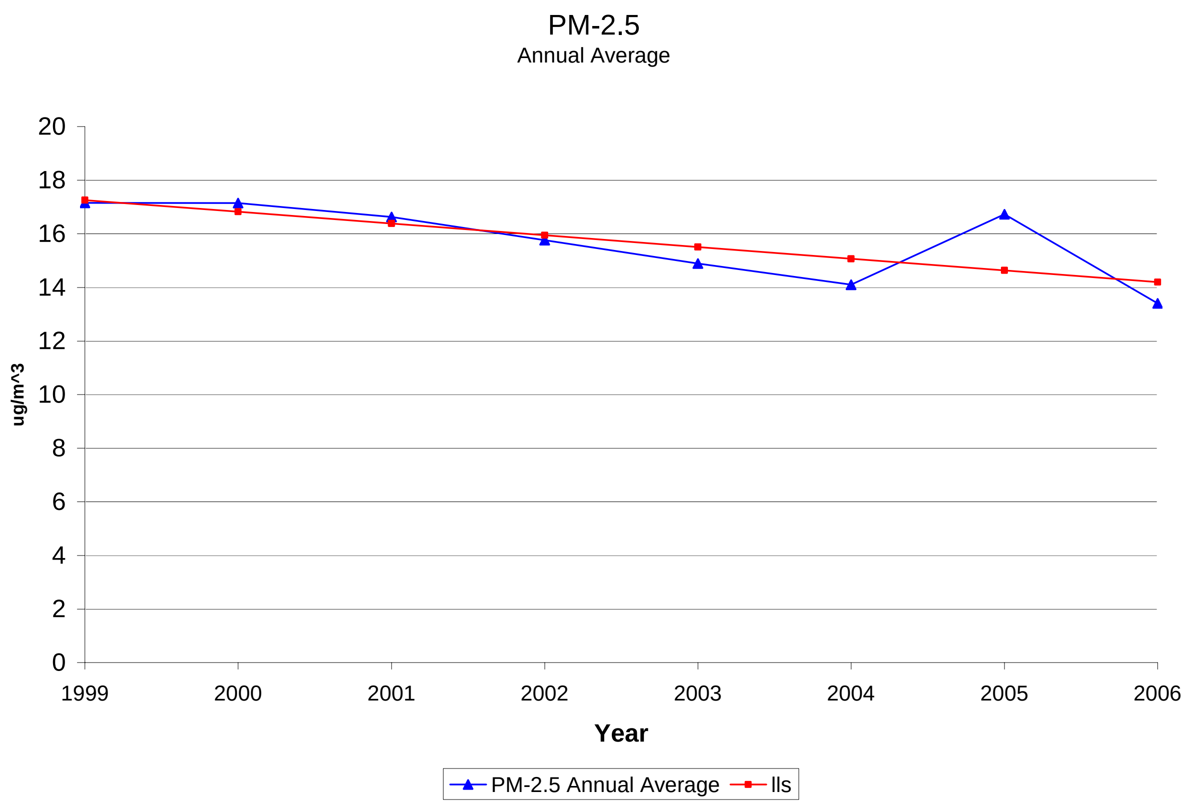
(3) continuous

For comparison purposes, please note the following 2001-2003 averages, which placed their areas into nonattainment:

| | |
|---|---|
| **•Northeast Ohio:** | **18.37 µg/m³** |
| **•Cincinnati:** | **17.83 µg/m³** |
| **•Columbus:** | **16.70 µg/m³** |
| **•Steubenville:** | **17.83 µg/m³** |
| **•Detroit** | **19.5 µg/m³** |
| **•Chicago** | **17.7 µg/m³** |
| **•Pittsburgh** | **16.9 µg/m³** |

**Annual Standard = 15 µg/m³**
**2004-2006 average for Northeast Ohio is 17.20 µg/m³ - a downward trend.**
**Attainment will be based on 2007-2009 data, submitted in 2010.**

For the trend across the entire state of Ohio, please see the following graph from Ohio EPA:



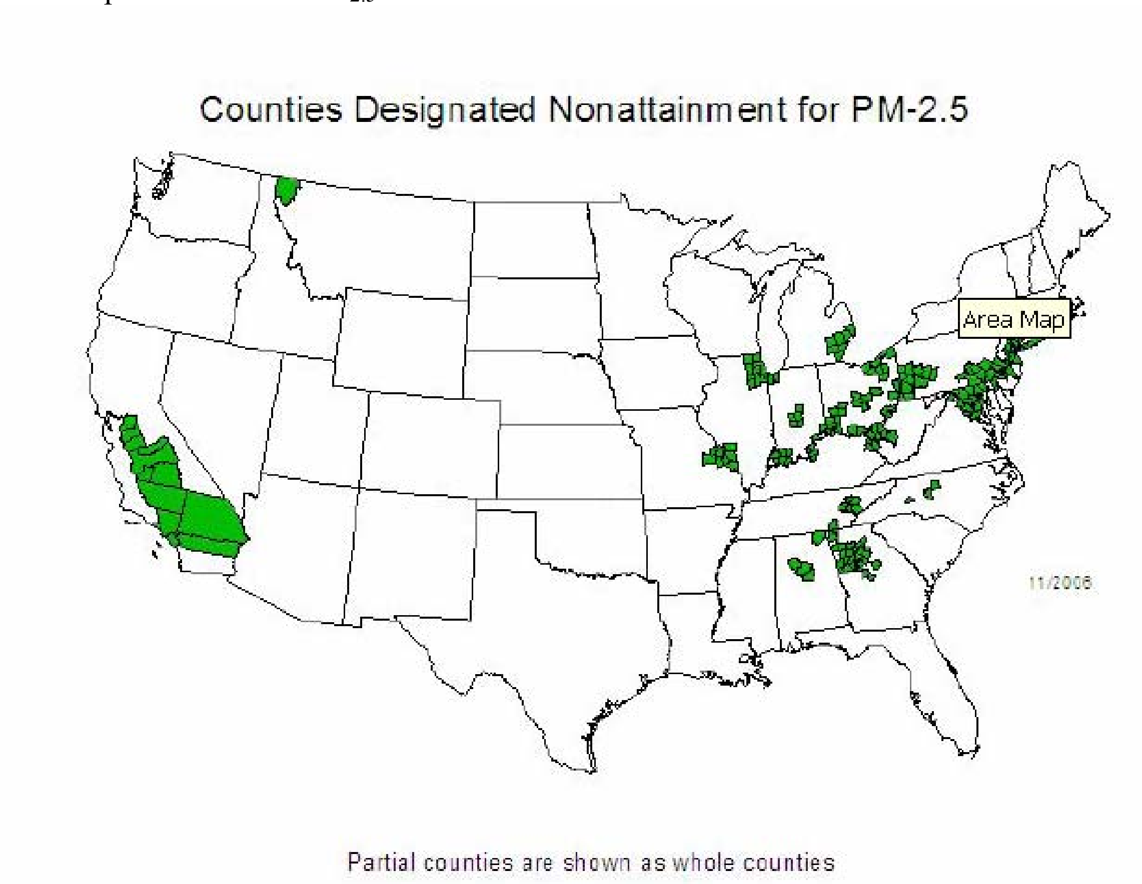
B. Federal Requirement: A State Implementation Plan (SIP)
In order to improve air quality, states must draft a plan known as a State Implementation Plan (SIP) to improve the air quality in nonattainment areas. The plan outlines the measures that the state will take in order to improve air quality.

$PM_{2.5}$ nonattainment areas are required to submit to USEPA a SIP by April 2008. Control measures have to be in place by 2009.

The area must demonstrate attainment by April 2010, with possible extensions available until 2015, if control measures are not feasible.

Ohio EPA is responsible for submitting all SIPs for Ohio. NOACA will contribute recommendations through the efforts of the NOACA Air Quality Public Advisory Task Force, as it did for the 8-Hour Ozone SIP, which is due to USEPA this year.

This map shows all the $PM_{2.5}$ nonattainment areas across the United States:




SIPs are due to USEPA for each of the nonattainment areas. Please bear this larger image in mind throughout the discussion of sources of fine particle matter in the Northeast Ohio nonattainment area.

C. Background and Complications in Creating a $PM_{2.5}$ SIP

The following passages were taken from the work of the National Association of Clean Air Agencies, in their report: *"Controlling Fine Particulate Matter Under the Clean Air Act: A Menu of Options"* (STAPPA/ALAPCO, now NACAA, March 2006) (Emphasis has been added in **bold** where needed, and headings have been added for ease in reading):

> NAAQS
>
> "Areas throughout the eastern United States and California (and one area in Montana) currently exceed USEPA's National Ambient Air Quality Standards (NAAQS) for $PM_{2.5}$, and states must submit State Implementation Plans (SIPs) by April 2008 detailing their plans for achieving the national standards."
>
> Health Benefits
>
> "USEPA estimates that meeting the current $PM_{2.5}$ standards would avoid tens of thousands of premature deaths annually and save hundreds of thousands of people from significant respiratory and cardiovascular disease. The Agency further estimates that the monetized health benefits of improvements in $PM_{2.5}$ air quality exceed the cost by a substantial margin." (p. 1-2)
>
> Formation
>
> "**The chemistry and physics of $PM_{2.5}$ formation in the atmosphere are incompletely understood.** Some $PM_{2.5}$ is released directly to the atmosphere, and some forms from emissions of sulfur dioxide ($SO_2$) and nitrogen oxides (NOx) (which are currently viewed as the most significant precursors and are the only ones addressed in this report. Ammonia and volatile organic compounds (VOCs), which are not included in this report, can also contribute to ambient $PM_{2.5}$.) Direct $PM_{2.5}$ emissions may be largely responsible for one area's nonattainment, while $SO_2$ emissions may cause the problem elsewhere. The choice of whether to focus on reducing direct $PM_{2.5}$, $SO_2$, or NOx – or all of them – or ammonia or VOCs – will depend on local source contributions and atmospheric chemistry."
>
> Data
>
> "There are further challenges for SIP writers. **In a perfect world, control-efficiency and cost-effectiveness data would be at hand; however, it is not consistently available.** Of course, even when information of this sort can be found, it may not be applicable to all sources."
>
> Filterable vs. Condensable Particles
>
> "And another source of uncertainty complicates the job. … (T)here are important distinctions between filterable and condensable $PM_{2.5}$. Further, some methods used to measure PM emissions reflect only the filterable components and, to exacerbate the problem, the filterable components vary depending on the test method used. … (T)he distinction between filterables and condensables also raises regulatory and permitting issues." (p.1-2)

Constituents

"The common chemical constituents of PM include sulfates, nitrates, ammonium, elemental carbon, a variety of organic compounds, water and crustal material (including metals, dust, sea salt, and other trace elements). Sulfates, ammonium, elemental carbon, and secondary organic compounds are found primarily in the $PM_{2.5}$ range. Crustal material – including calcium, aluminum, and silicon – is found primary in the coarse particle range (larger than 2.5 μm). Nitrates are found in both the $PM_{2.5}$ and coarse particle size ranges." (p. 24)

Seasons

"$PM_{2.5}$ concentrations exhibit seasonal variability. For example, $PM_{2.5}$ values in the eastern half of the United States are typically higher from July to September, when sulfates are more readily formed from sulfur dioxide ($SO_2$) emissions. By contrast, $PM_{2.5}$ concentrations tend to be higher in the winter months in many areas of the west – in part because fine particle nitrates are more readily formed in cooler weather, but also because the use of wood stoves and fireplaces produces more carbon." (p. 25)

Sources

"The sources of $PM_{2.5}$ and $PM_{2.5}$-precursor emissions are highly diverse, including both natural (biogenic) and human-made (anthropogenic) sources. Sources include motor vehicles, power plants, industrial facilities, wood stoves and fireplaces, forest fires, sea salt, paved and unpaved roads and many others." (p. 26)

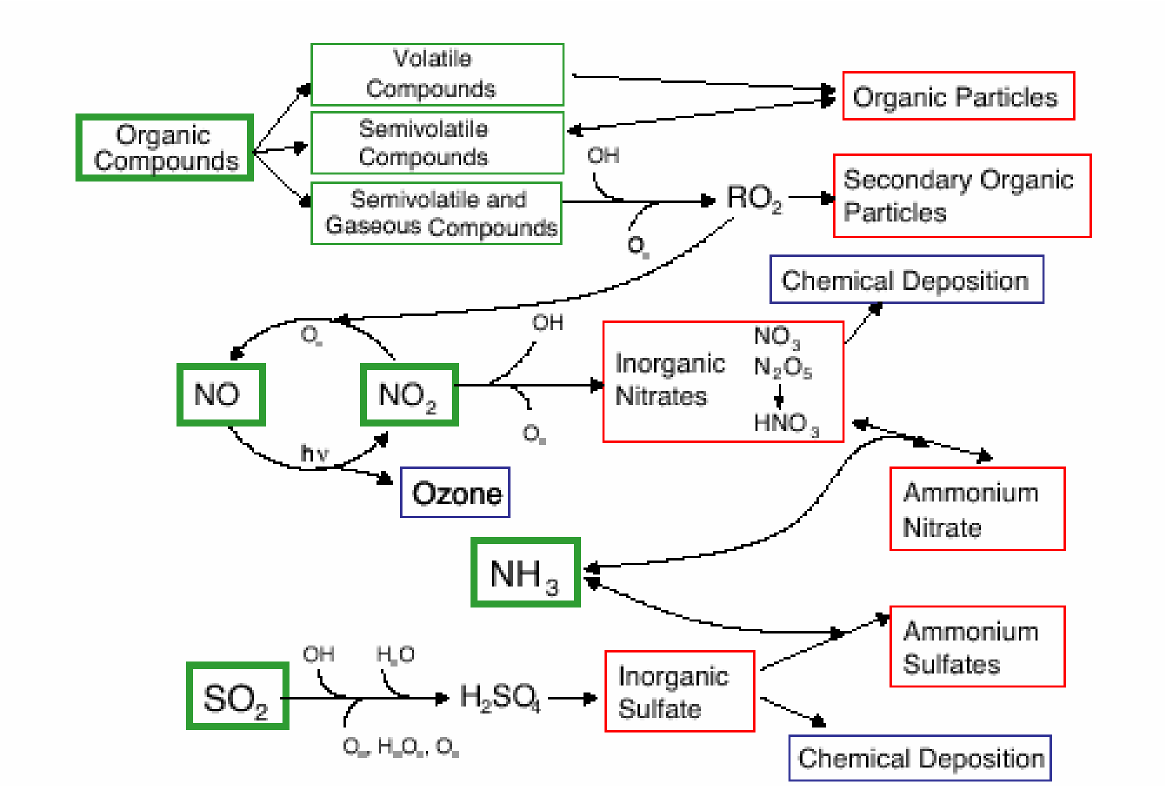
Inventories

"Additionally, the contribution of various sources to $PM_{2.5}$ formation varies by geography, time of year, and even by time of day. As a result, national and regional inventories of $PM_{2.5}$ and $PM_{2.5}$-precursor emissions – although suggestive of the primary contributors to ambient particulate concentrations – may not provide an accurate characterization of the major sources of emissions at a specific location or during a particular time period." (p. 26)

The Nonlinear Relationship

"The relationship between changes in precursor emissions and ambient $PM_{2.5}$ concentrations, moreover, can be nonlinear. Generally, $SO_2$ emissions reductions lead to reductions in concentrations of sulfate aerosols and nitrogen oxide (NOx) emissions reductions lead to reductions in nitrate aerosols. However, **the direction and extent of changes in ambient $PM_{2.5}$ concentration as a result of a given level of emissions reduction vary by location and season and depend on fluctuations in ammonia emissions and changes in prevailing meteorology and photochemistry. This complicates the task for state and local officials attempting to prioritize their $PM_{2.5}$ control strategies.**" (p. 26)

The chart that follows shows actual $PM_{2.5}$ formation, from *"Particulate Matter Science for Policy Makers,"* NARSTO, February 2003:




Conclusion: The task at hand is not an easy one.

D. $PM_{2.5}$ in Northeast Ohio

The following passages are taken from *"$PM_{2.5}$ in Urban Areas in the Upper Midwest"* (Lake Michigan Air Directors' Consortium (LADCO) February 12, 2004) (again, emphasis has been added in **bold**):

> "$PM_{2.5}$ mass in each of the (studied) cities (including Cleveland) is comprised of mostly ammonium sulfate, organic carbon, and ammonium nitrate. **The regional and local urban contributions vary by chemical species, with regional contributions comprising approximately all of the sulfates, one-half to two-thirds of the nitrates, and one-third to one-half of the organics.**" (p. iii)

The $PM_{2.5}$ monitors (known as intermittent or FRM for "federal reference method") are shown in this map from LADCO, p. 71:

In the Cleveland MSA, there are 12 sites with FRM monitors and three sites with speciation monitors. The map below shows the location of these monitoring sites.

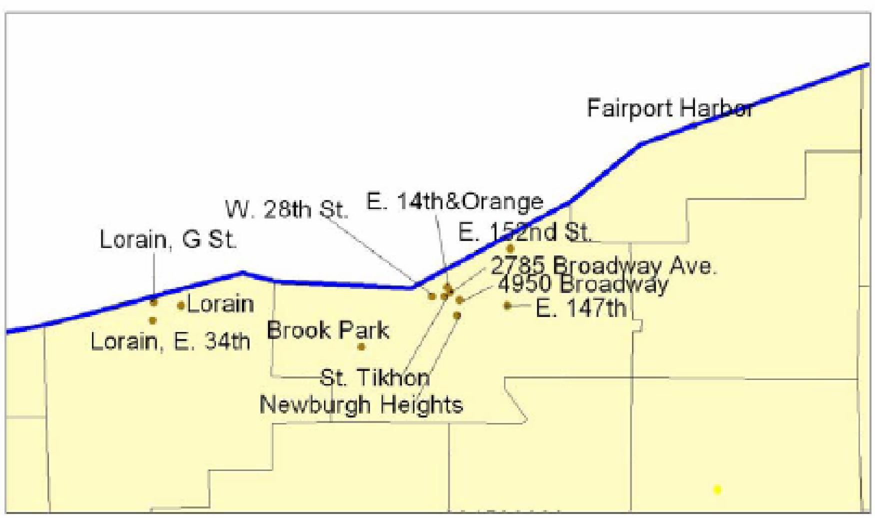
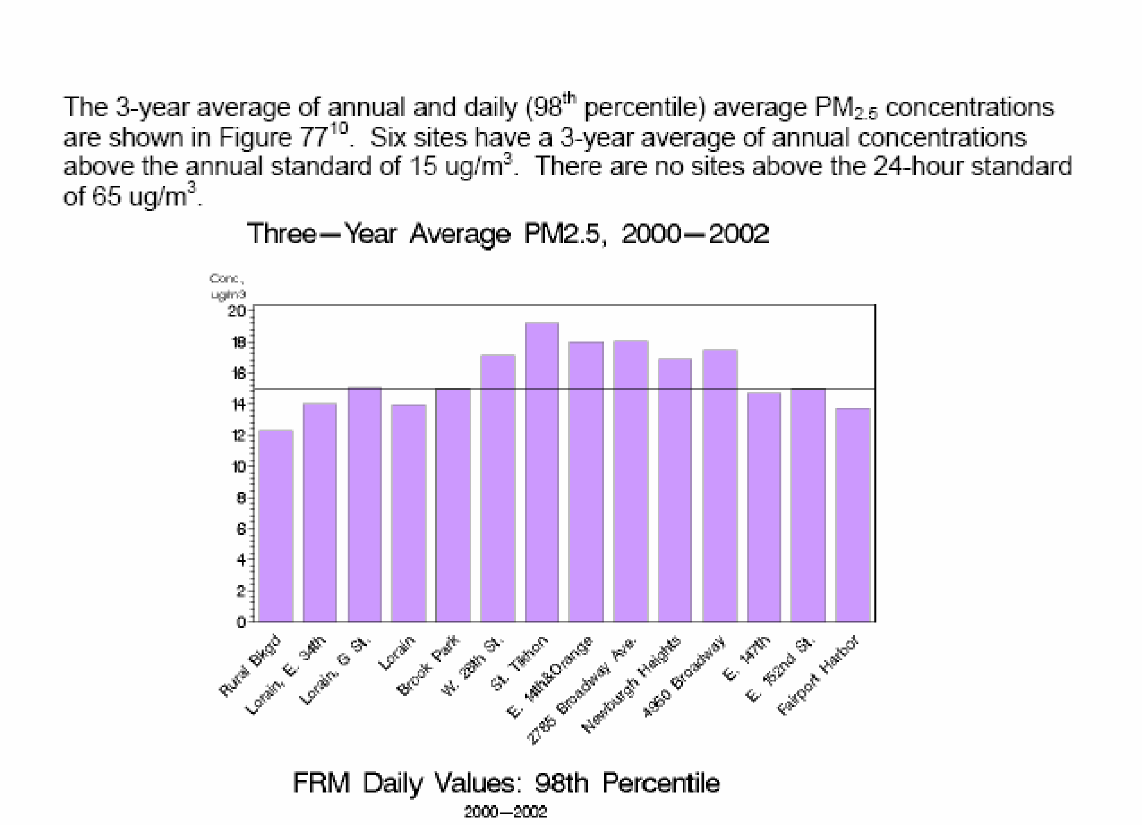



**Figure 75. Map of $PM_{2.5}$ Monitoring Sites in Cleveland MSA**

The counties shown on the map are, from left to right, Lorain County, Cuyahoga County, and Lake County.

The following LADCO graph, from p. 72, shows the Northeast Ohio $PM_{2.5}$ monitors for the baseline period. Again, note that the annual standard is 15 µg/m$^3$. **Note, too, that the monitors averaging above the standard are in the Cleveland urban area.**



The 3-year average of annual and daily (98th percentile) average $PM_{2.5}$ concentrations are shown in Figure 77[10]. Six sites have a 3-year average of annual concentrations above the annual standard of 15 ug/m$^3$. There are no sites above the 24-hour standard of 65 ug/m$^3$.



The next LADCO map from p. 13 shows the regional background (light blue) versus the portion of $PM_{2.5}$ created locally (dark blue).

The large spatial extent of high concentrations in the eastern U.S. is indicative of the regional nature of $PM_{2.5}$ in this part of the country. This regionality is further demonstrated in the plot below, which compares annual average concentrations from urban and upwind rural sites for metropolitan areas in Region V. As can be seen, urban concentrations, which are represented by the total height of each bar, are dominated by sizable rural (regional) concentrations, which are represented by the bottom (light blue shaded) portion of each bar.

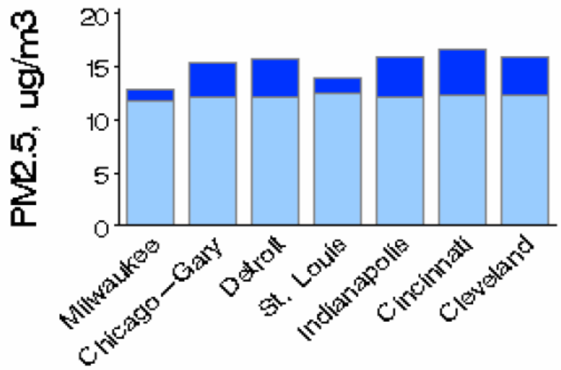
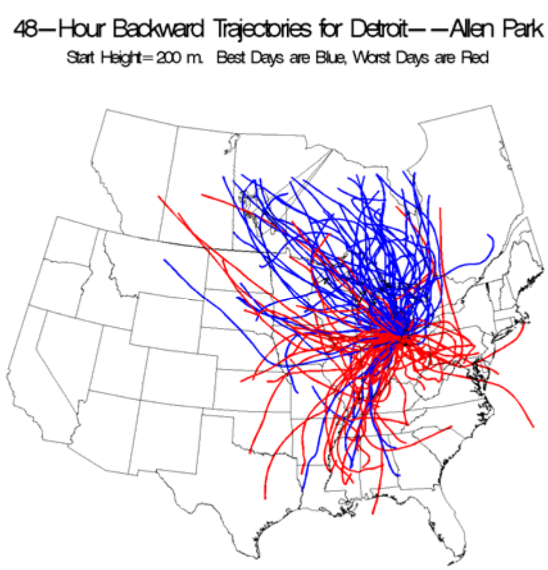
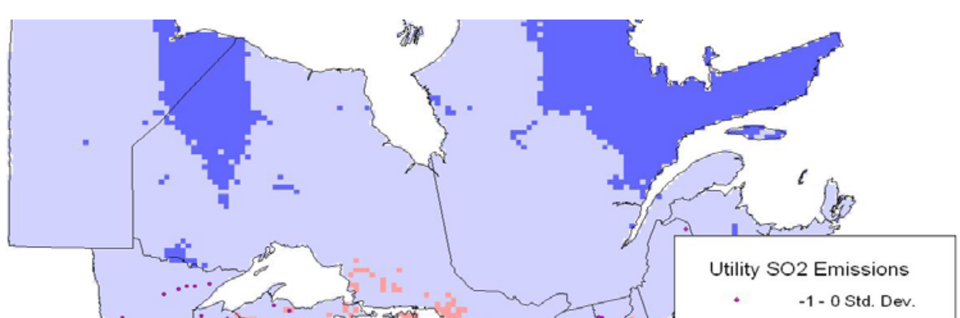



**Figure 6. Urban v. Rural $PM_{2.5}$ Contributions**

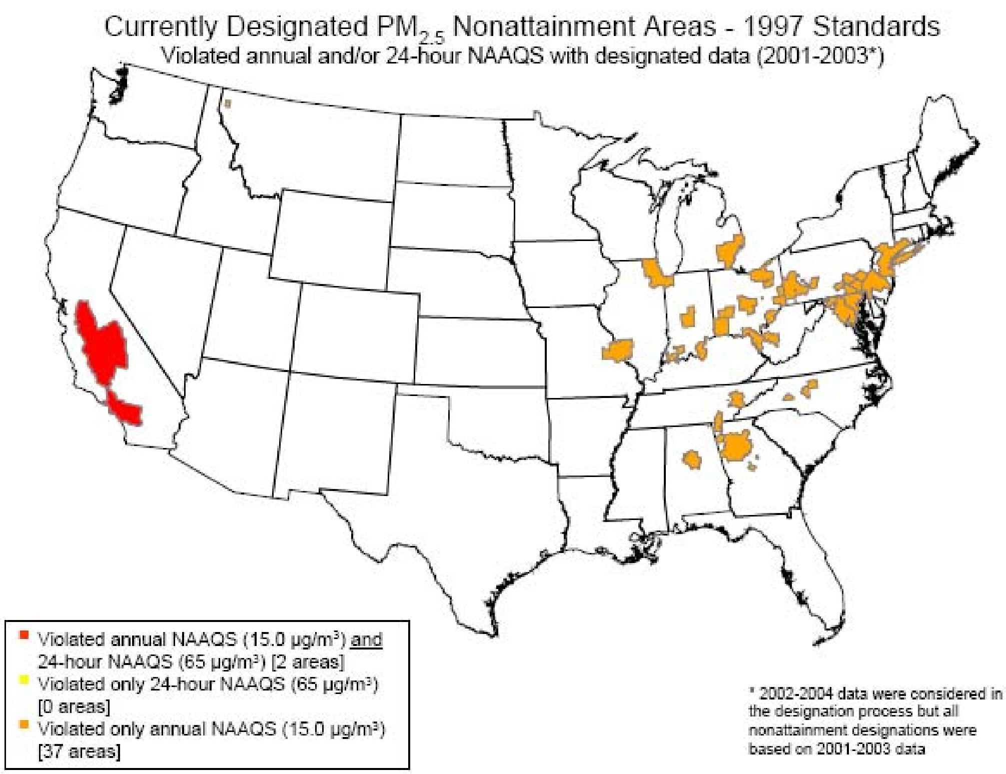
Related to the concept of the amount of $PM_{2.5}$ and $PM_{2.5}$ precursors that reach Northeast Ohio from other areas, the following "wind rose" map from LADCO (Dr. Donna Kenski, presentation to Air Quality Subcommittee, Jan. 2007) shows wind patterns reaching Detroit, Michigan, on "clean air days" in blue and "high PM days" in red. (No map was available for Northeast Ohio.)




Finally, this map of electric utilities (coal-fired power plants) across the United States demonstrates the probable origin of much of the ammonium sulfates that reach nonattainment areas, including Northeast Ohio:

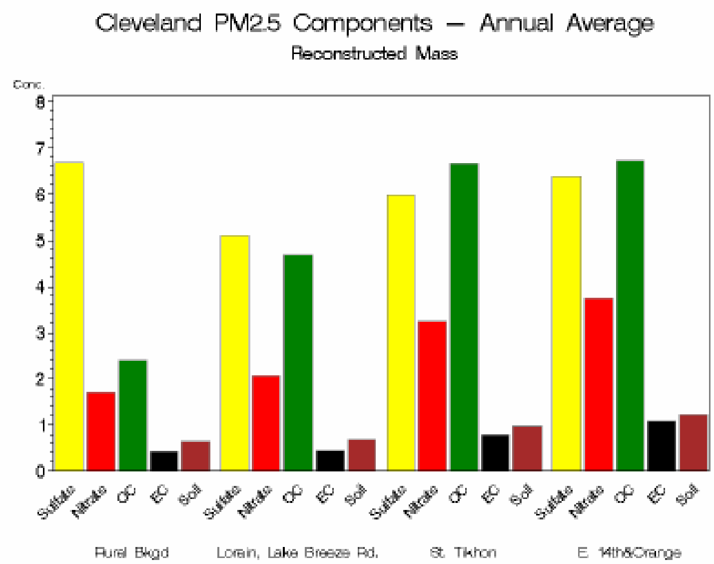


Again, the national map of PM2.5 nonattainment areas is:




This chart, from LADCO p. 79, demonstrates the constituents of $PM_{2.5}$ in Northeast Ohio:

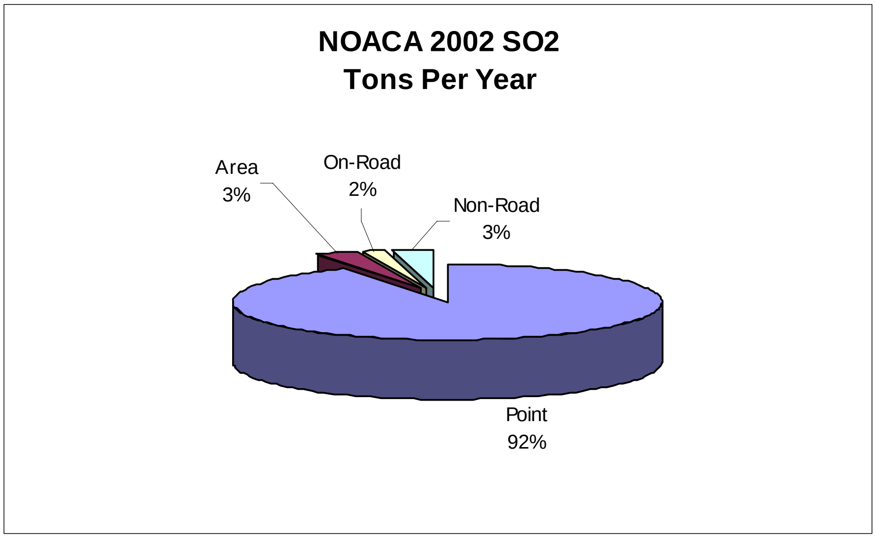
Ammonium sulfate and organic carbon comprise the largest fraction of $PM_{2.5}$ in Cleveland, followed by ammonium nitrate (see Figure 84). Elemental carbon and soil make up a small percentage of $PM_{2.5}$.



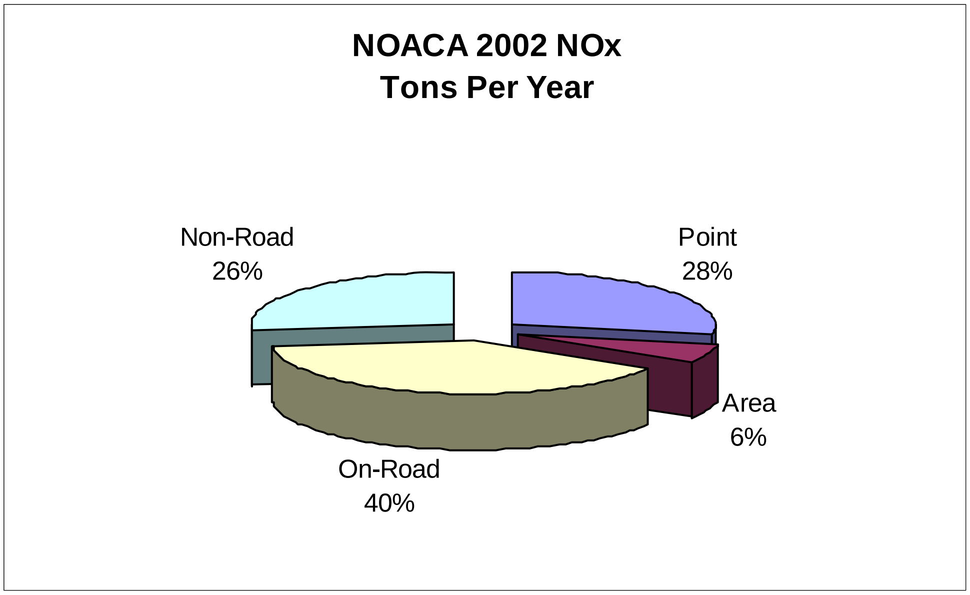

<u>2002 Emissions Inventory – Ohio EPA</u>
The following three pie charts represent the sources that contribute several of the largest precursors to $PM_{2.5}$: Primary (directly emitted) PM2.5 itself; oxides of nitrogen (NOx), and sulfur dioxide (SO2):

| | |
|---|---|
| "Point": | Large stationary sources, which may be industrial or institutional. |
| "On-Road" | Motor vehicles including cars, trucks, buses, and motorcycles. |
| "Non-Road" | Motor vehicles including construction equipment and agricultural equipment. |
| "Area | Fugitive dust, dirt, open burning, stone quarrying, fuel combustion (residential and small commercial), and incineration. |

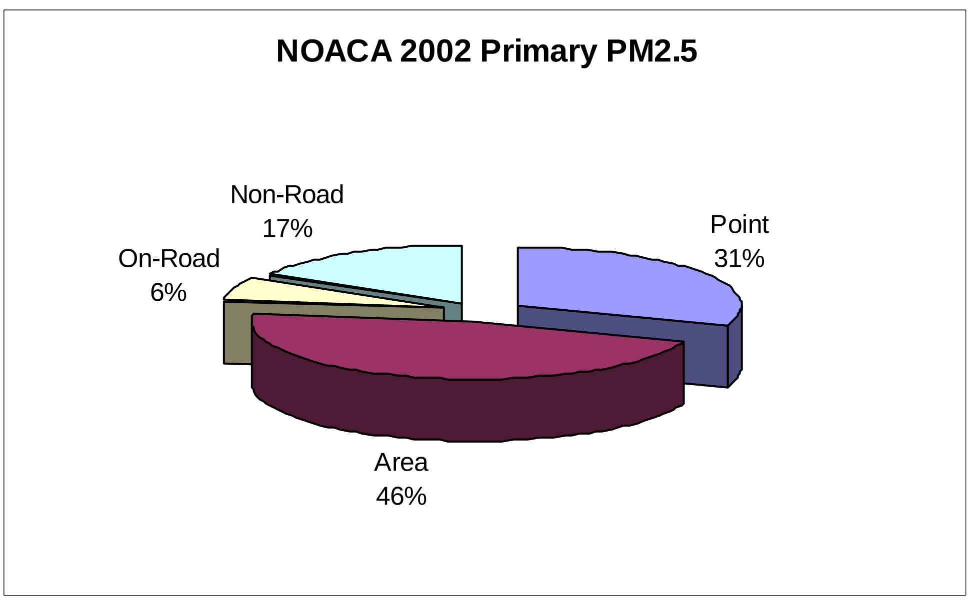
Sulfur Dioxide – Northeast Ohio $PM_{2.5}$ Nonattainment area – Ohio EPA




Nitrogen Oxides – Northeast Ohio $PM_{2.5}$ Nonattainment Area – Ohio EPA



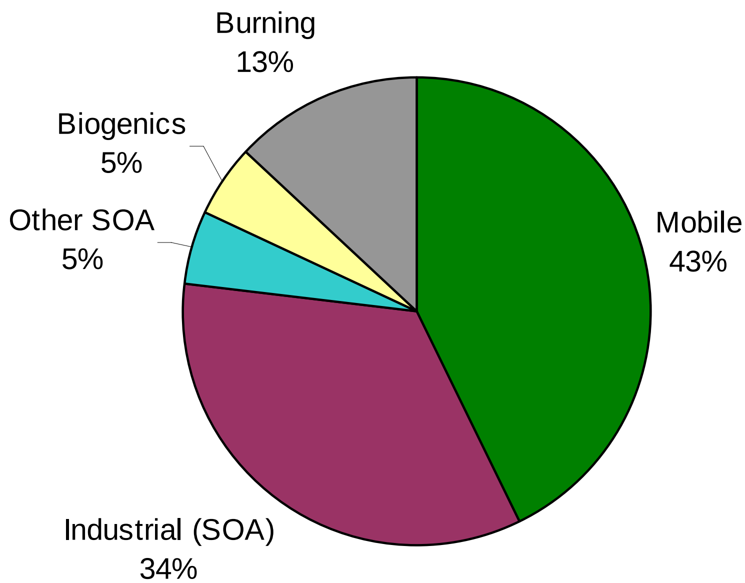

Primary (Directly Emitted) $PM_{2.5}$ – Northeast Ohio PM2.5 Nonattainment Area – Ohio EPA



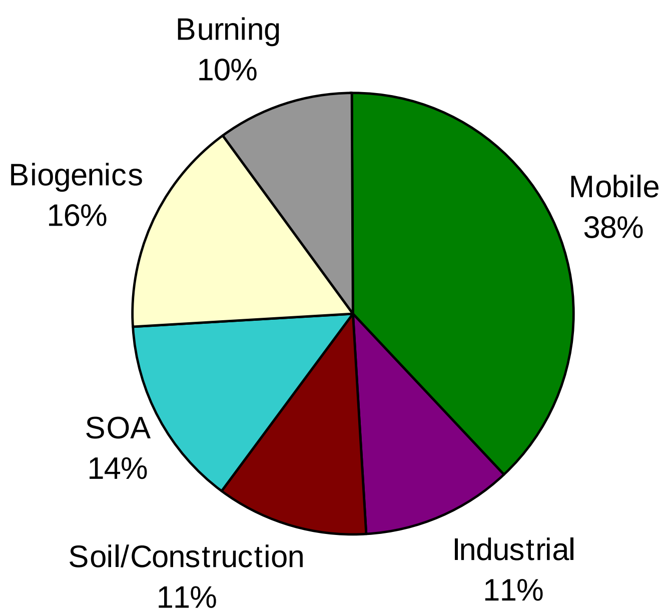
Finally, because no inventory of organic carbon has been provided to Northeast Ohio by the Ohio EPA, the following charts for similar areas are provided, courtesy of LADCO:

Source Contribution to Organic Carbon – Detroit and Cincinnati
(SOA = secondary organic aerosols)

Detroit




Cincinnati



# Conclusions

The following conclusions can tentatively be drawn from the information in this report:

- Ammonium sulfates are brought to the Northeast Ohio nonattainment area from coal-fired power plants across the midwest, with the sulfur dioxide supplied from the combustion of coal and the ammonia supplied from midwestern farming operations.

- Ammonium nitrates are both transported to Northeast Ohio and created in Northeast Ohio, when NOx is generated from combustion of all kinds (industrial and motor vehicle).

- Primary $PM_{2.5}$ is transported to Northeast Ohio and is created in Northeast Ohio as a product of combustion (industrial, motor vehicle, residential) and as crustal material, including dirt, dust, and road salt.

- Organic carbon may be a product of combustion (motor vehicle) and may be a product of crustal materials and background. Further study is needed and will be provided through the Lake Michigan Air Directors' Consortium (LADCO) in December 2007.

- Because of the significant regional background levels, only a small percentage of $PM_{2.5}$ formation can be affected locally, but impacting it may be enough to bring the area into attainment by the federal deadline.