HEI

APPENDIX AVAILABLE ON REQUEST

Special Report

Reanalysis of the Harvard Six Cities Study and the American Cancer Society Study of Particulate Air Pollution and Mortality

Part II: Sensitivity Analyses

Appendix D. Alternate Air Pollution Data in the ACS Study

Daniel Krewski, Richard T. Burnett, Mark S. Goldberg, Kristin Hoover, Jack Siemiatycki, Michael Jerrett, Michal Abrahamowicz, Warren H. White, and Others

---

Correspondence may be addressed to Dr Daniel Krewski, Professor of Epidemiology and Statistics, Department of Epidemiology and Community Medicine, Room 3229C, 451 Smyth Road, University of Ottawa, Ottawa Ontario K1H 8M5, Canada

Although this document was produced with partial funding by the United States Environmental Protection Agency under Assistance Award R824835 to the Health Effects Institute, it has not been subjected to the Agency's peer and administrative review and therefore may not necessarily reflect the views of the Agency, and no official endorsement by it should be inferred. The contents of this document also have not been reviewed by private party institutions, including those that support the Health Effects Institute; therefore, it may not reflect the views or policies of these parties, and no endorsement by them should be inferred.

This document was reviewed by the HEI Health Review Committee but did not undergo the HEI scientific editing and production process.

UNIVERSITY OF OTTAWA

Faculty of Medicine **Faculty of Health Sciences**

Re-analysis of the Harvard Six-Cities Study and the American Cancer Society Study of Air Pollution and Mortality, Phase II: Sensitivity Analysis

Appendix A, B, C, D, E, F, G, H, and I

R. Samuel McLaughlin Center for Population Health Risk Assessment
Institute of Population Health
University of Ottawa

August, 2000

APPENDIX D: ALTERNATE AIR POLLUTION DATA IN THE ACS STUDY

INTRODUCTION

The Reanalysis Team assembled an independent set of air pollution data in order to evaluate the sensitivity of the ACS findings to other sets of pollution data from the same time period. This sensitivity analyses was particularly important given the difficulty experienced in attempting to audit the air pollution data that was used in the ACS Study. The preliminary work in deriving the new dataset was done at the Center for Airpollution Impact and Trend Analysis (CAPITA) at Washington University in St Louis.

DATA ACQUISITION

At a request from the Reanalysis Team, in July 1999 CAPITA downloaded 1980 to 1989 data from the EPA's Aerometric Information Retrieval System database and converted it into fixed-length ASCII files using the AIRS to Voyager Transformer. CAPITA obtained Total Suspended Particulate matter (TSP), sulfate from TSP, and gaseous species data (O_3, NO_2, CO, and SO_2).

The AIRS database includes 24-hour cumulative samples of particulate matter taken every sixth day. For each of the monitors in each of the counties specified by the Reanalysis Team (see Table F.1 in Appendix F), CAPITA aggregated this data into: annual averages, annual means and number of data points per year. This data were provided to the Reanalysis Team along with information about the location of the monitor.

The same procedure was followed in obtaining gaseous species data for the specified counties except that, in this case, hourly data were available from the AIRS database. The hourly data were aggregated into daily means, medians, maximums and numbers of observations. Only those days for which there were 12 or more data points available were used for subsequent calculations. The daily averages and maximums were then used to aggregate to annual averages, medians and numbers of data points.

CAPITA supplied the Reanalysis Team with three sets of data for each pollutant: daily data, yearly data (as outlined above) and monitor location data. The location information provided for each monitor included: AIRS location code, street address, longitude, latitude, altitude, location code and land-use code. The location code consisted of three categories: urban and center city, suburban and rural. The land-use code contained eight categories: residential, commercial, industrial, agricultural, forestry, desert, mobile, and blighted.

It is important to note that no filtering was done by CAPITA in obtaining and aggregating the air pollution data except for excluding days of gaseous copollutant measurement if fewer than 12 data points were obtained. AIRS monitors recording sulfate data derived from total suspended particles (TSP) decreased significantly in number between 1980 and 1989. In 1980 sulfate information was available for 132 cities, this decreased to 124 in 1981 and to 60 cities in 1989. The Reanalysis Team restricted its attention to those years which had data for at least 124 cities (1980 and 1981). Out of concern for the stability of the air pollution estimates, the analysis was also restricted to cities for which there were at least

20 observations among all monitoring stations per year. This resulted in a reduction to 107 eligible cities in 1980, and 111 cities in 1981. When 1980 and 1981 data were combined, there were a total of 126 cities with sulfate concentration data. There were a total of 156 cities for which TSP data were available in either 1980 or 1981.

The Reanalysis Team also obtained data from the Inhalable Particle Monitoring Network (IPMN) directly from the EPA. This dataset contained dichotomous sampler information on PM_{15}(DC), $PM_{10-2.5}$(DC) and $PM_{2.5}$ (DC), as well as TSP (IPMN) and high-volume sampler PM_{15} (SSI). For each method and instrument that recorded mass, sulfate concentrations were also available. We were able to obtain sulfate data on 144 of the 151 cities examined by the Original Investigators by combining information on sulfate concentrations from the National Aerometric Database and the Inhalable Particle Network

In order to test whether the land-use in the area around the monitor influenced the city air pollution averages obtained, the Reanalysis Team also did an analysis using sulfate data from only those monitors which had a land-use code of residential, mobile or urban. In this way those monitors in areas of industry, agriculture, forestry, desert, and blight were excluded. This data is not listed. This restriction on land use reduced the number of cities available for analysis from 126 to 120 (based on our selection criteria of at least 20 observations per year). All other analyses discussed were conducted with all of the monitors (including those marked agricultural and industrial etc.) used.

ADJUSTING FOR FILTER ARTIFACTS

The high-volume samplers employed in the AIRS Network used glass fiber filters which were subject to artifacts due to the presence of sulfur dioxide. This artifact is a function of the amount of sulfur dioxide in the atmosphere near the monitor, temperature, and relative humidity, in addition to the alkalinity of the filter. Sulfate concentrations obtained from the IPMN used Teflon fiber filters which are not subject to such artifacts.

We developed a conversion equation from sulfate obtained via the high-volume sampler (SO_4^{2-}(HV)), and sulfate obtained from the dichotomous sampler ((SO_4^{2-}(DC)) by first selecting all days in which data were available from both sampling systems in the same community for data spanning the period 1980 to 1981 inclusive. There were 41 cities in which both systems were operating, with a total of 488 days. The average value of sulfate from both systems was determined by city and compared using the linear regression equation.

$$SO_4^{2-}(DC) = -3.02\ (0.839) + 0.933\ (0.071)\ SO_4^{2-}(HV),$$

where the standard errors of the intercept and slope are given in parentheses. The coefficient of determination (r^2) was 0.82. SO_4^{2-}(HV) values based on 1980 and 1981 averages were converted to SO_4^{2-}(DC) concentrations using this equation. Any negative predicted values were set to zero. Data collected in 1980 and 1981 from the IPMN for SO_4^{2-}(DC) were supplemented by adjusted SO_4^{2-}(TSP) data. The Reanalysis Team averaged the daily values corresponding to those cities which had both types of sulfate data. Adjusted sulfate values based on the combined data from the two networks are denoted as $SO_4^{2-}{}_{(cb\text{-}adj)}$. Sulfate data which is not adjusted for the artifactual sulfate prior to combing with the SO_4^{2-} (DC) data, is also reported $SO_4^{2-}{}_{(cb\text{-}unadj)}$.

Since the amount of the artifact depends on SO_2concentrations, we also considered region-specific adjustments. We divided the 41 cities into three groups: 1) West, which included cities in the States of Arizona, California, Colorado, Kansas, New Mexico, Texas, and Washington; 2) East – Alabama, Florida, Georgia, North Carolina, Minnesota, Tennessee, DC, Maryland, and Virginia; 3) Ohio Valley /Northeast – Ohio, Pennsylvania, West Virginia, Indiana, Massachusetts, New York, Rode Island, New Jersey. There were 13, 12, and 16 cities in each region respectively. The following regression equations were obtained,

West:	$SO_4^{2-}(DC) = 0.738\ (1.213) + 0.410\ (0.174)\ SO_4^{2-}(HV)$	($r^2 = 0.33$)
East:	$SO_4^{2-}(DC) = -1.836\ (1.087) + 0.803\ (0.867)\ SO_4^{2-}(HV)$	($r^2 = 0.90$)
Ohio Valley/ Northeast:	$SO_4^{2-}(DC) = -9.898\ (1.890) + 1.432\ (0.134)\ SO_4^{2-}(HV)$	($r^2 = 0.89$)

Both sulfate and sulfur dioxide concentrations tended to be lower in the West, moderate in the East, and highest in the Ohio Valley/Northeast, although not uniformly for all cities. The slope estimates increased across regions in a similar pattern to the increasing pollution concentrations. The weakest association was observed for the West in which the lowest pollution concentrations were found.

We then divided the United States into three regions corresponding to the cities used in the artifact adjustment analysis: West – Washington, Oregon, California, Montana, Utah, New Mexico, Nevada, Arizona, Colorado, North Dakota, Nebraska, Kansas, Oklahoma, Texas; East – Minnesota, Wisconsin, Illinois, Iowa, Missouri, Arkansas, Louisiana, Alabama, Mississippi, Georgia, Florida, South Carolina, North Carolina, Kentucky, Tennessee, Virginia, Maryland, DC, New Hampshire, Maine; Ohio Valley/Northeast – Indiana, Ohio, Pennsylvania, West Virginia, New York, Rode Island, Connecticut, New Jersey, and Massachusetts. We adjusted the sulfate data from the high-volume samplers using three separate equations and combined the data for form a single dataset, denoted by $SO_{4(cb\text{-}region)}$, which was then compared to the mortality data using the Cox regression model.

We also considered separate calibration equations by season:

April–September:	$SO_4^{2-}(DC) = -3.17\ (0.982) + 0.970\ (0.079)\ SO_4^{2-}(HV)$	($r^2 = 0.80$)
October–March:	$SO_4^{2-}(DC) = -1.04\ (0.736) + 0.660\ (0.075)\ SO_4^{2-}(HV)$	($r^2 = 0.74$)

City-specific average sulfate values, obtained using high-volume samplers with glass fiber filters, were convert to values adjusted for the artifactual sulfate for each season separately. A summary average value for each city was obtained by a weighted average of the two seasonally adjusted values, weighted by the number of observations in each season. These seasonally adjusted sulfate values were augmented by sulfate data for those cities with IPMN monitors. These adjusted values [$SO_{4(cb\text{-}season)}$] were then compared to cause specific mortality using the Cox regression model.

Table D.1. Annual mean/median levels of particulate air pollution[a] by city in the American Cancer Society Study (in μg/m^3)

No.	City	State	$Pm_{2.5}$ (OI, DC, MD)	$S0_4$ (OI)	$Pm_{2.5}$ (DC, MD)	$Pm_{2.5}$ (DC)	TSP (hi-vol)	Pm_{15} (SSI)	$Pm_{10-2.5}$ (DC)	Pm_{15} (DC)	$S0_4$ (DC)	TSP	$S0_4$ (cb-unadj)	$S0_4$ (USA)	$S0_4$ (Region)	$S0_4$ (Season)
1	Birmingham	AL	24.5	13.1	25.2	28.7	98.5	76.9	30.0	58.7	8.8	90.6	15.6	11.6	10.7	11.7
2	Huntsville	AL		12.0								53.9	12.7	8.8	8.4	8.8
3	Mobile	AL	20.9	12.6	20.9	22.0			20.6	42.6	6.1	67.9	12.6	8.8	8.3	8.7
4	Little Rock	AR	17.8	5.9	18.6	20.6	65.3	52.2	18.0	38.6	4.8	68.8	5.9	2.5	2.9	2.6
5	Phoenix	AZ	15.2	4.3	13.9	18.5	107.8	73.9	38.7	57.2	2.9	124.7	5.4	2.0	1.5	2.2
6	Tucson	AZ		4.4								77.4	5.2	1.8	1.4	2.0
7	Ahaheim	CA		11.5								100.9	10.8	7.0	3.7	7.0
8	Fresno	CA	10.3	5.8	10.3	10.3	112.0	100.8	31.7	42.1	2.2	106.0	5.8	2.4	1.6	2.7
9	Los Angeles	CA	21.8	14.0	21.8	26.8	78.8	67.9	19.8	46.5	6.2	106.9	12.4	8.5	4.3	8.8
10	Riverside	CA		14.6								111.8	12.9	9.0	4.5	8.8
11	Sacramento	CA		5.8								65.0	5.0	1.6	1.3	1.9
12	San Diego	CA		11.2		18.9	55.0		19.6	38.5	2.4	79.8	10.6	6.9	3.6	6.8
13	San Francisco	CA	12.2	6.6	12.2	16.4	58.7		15.0	31.3	3.4	49.1	4.2	0.9	1.0	0.9
14	San Jose	CA	12.4	6.2	12.4	17.8	87.5	62.8	20.8	38.6	2.5	71.3	5.0	1.6	1.3	1.8
15	Colorado Springs	CO		6.1								77.2	4.4	1.1	1.1	1.6
16	Denver	CO	16.1	6.2	7.8	10.8	70.7	51.0	19.4	30.1	1.6	109.9	6.8	3.3	2.1	3.5
17	Fort Collins	CO		5.2								73.9	4.3	1.0	1.0	1.5
18	Greely	CO		4.7								79.0	4.2	0.9	1.0	1.3
19	Peublo	CO		6.7		10.9	68.2	59.7	15.3	26.2	1.2	70.0	6.1	2.7	1.8	2.9
20	Bridgeport	CT		9.9								52.1	8.8	5.2	2.8	5.4
21	Hartford	CT	14.8	9.4	14.8	18.4	60.1	45.4	15.0	33.4	6.6	40.3	7.0	7.0	7.0	7.0
22	New Haven	CT		8.5								60.1	5.7	2.2	0.0	2.7
23	Washington	DC	22.5	14.9	22.5	25.9	69.2	51.6	16.0	41.9	10.3	53.2	11.4	7.6	7.4	7.6
24	Wilmington	DE		19.4		20.4	51.7	41.7	13.0	33.4	9.9	56.6	19.4	15.0	13.7	15.6
25	Fort Lauderdale	FL		6.9								50.1	6.7	3.2	3.6	3.3
26	Jacksonville	FL		11.2								59.9	11.2	7.4	7.2	7.1
27	Orlando	FL		7.9								49.2	7.9	4.3	4.5	4.3
28	Tampa	FL	11.4	10.3	11.5	13.7			21.9	35.7	5.3	58.0	10.0	6.3	6.2	6.2
29	Atlanta	GA	20.3	12.0	20.7	22.6	65.2	56.5	14.8	37.4	8.1	57.3	12.4	8.5	8.1	8.4
30	Columbus	GA		9.4								56.6	9.8	6.1	6.0	6.1
31	Savanhah	GA				17.8			23.3	41.1	6.5	61.8	12.3	8.5	8.1	8.2

No.	City	State	$Pm_{2.5}$ (OI, DC, MD)	$S0_4$ (OI)	$Pm_{2.5}$ (DC, MD)	$Pm_{2.5}$ (DC)	TSP (hi-vol)	Pm_{15} (SSI)	$Pm_{10\text{-}2.5}$ (DC)	Pm_{15} (DC)	$S0_4$ (DC)	TSP	$S0_4$ (cb-unadj)	$S0_4$ (USA)	$S0_4$ (Region)	$S0_4$ (Season)
32	Boise City	ID	12.1		12.1	18.0	85.7	67.1	19.9	37.9	1.7	74.8	1.9	1.9	1.9	1.9
33	Chicago	IL	21.0		20.3	23.0	72.2	61.7	17.3	40.2	7.3	72.4	8.5	8.5	8.5	8.5
34	Bloomining-ton	IN		13.7								59.5	13.9	10.0	10.0	9.9
35	Evansville	IN		14.2								73.8	14.7	10.7	11.1	10.4
36	Gary	IN	25.2	19.1	25.2	27.5	113.2	84.1	33.2	60.7	12.9	78.9	16.5	12.3	13.7	12.0
37	Indianapolis	IN	21.1	12.6	21.4	23.1	65.8	52.1	19.6	42.7	5.7	69.9				
38	South Bend	IN		11.7								62.9	13.0	9.1	8.7	8.7
39	Terrehaute	IN		13.2								59.9	13.8	9.8	9.8	9.6
40	Cedar Rapids	IO		10.6								82.3	9.7	6.0	6.0	5.9
41	Des Moines	IO		10.6								88.8	9.7	6.0	5.9	5.7
42	Dubuque	IO		8.9								62.7	9.4	5.8	5.7	5.8
43	Waterloo	IO		9.1								72.4	8.7	5.1	5.2	5.1
44	Topeka	KS	10.3	6.8	10.3	11.8	70.8	56.4	17.5	29.3	2.6	66.6	5.8	2.4	1.6	2.7
45	Wichita	KS	13.6	4.9	13.9	15.0			24.7	39.7	3.1	72.2	8.4	4.8	2.7	5.0
46	Lexington	KY		14.3								60.2	13.8	9.9	9.3	9.4
47	Baton Rouge	LA		11.2								60.7	12.1	8.3	7.9	8.2
48	New Orleans	LA		14.6								63.7	14.3	10.3	9.6	9.9
49	Shreveport	LA		10.1								55.4	9.3	5.6	5.6	5.5
50	Boston	MA		11.0		18.1	60.6	44.8	15.0	33.0	6.2	52.8	9.5	5.9	3.7	5.7
51	New Bedford	MA		11.8								50.3	11.7	7.9	6.9	7.5
52	Springfield	MA		12.8		17.6		41.8	11.4	28.9	6.5	64.0	9.9	6.2	4.3	5.6
53	Worcester	MA		10.7		16.3		44.8	16.7	33.0	5.5	55.3	10.5	6.8	5.2	6.6
54	Baltimore	MD		13.0		21.7	62.0	62.6	13.9	35.6	7.0	67.7	18.3	14.1	12.9	14.2
55	Bangor	ME		10.2								48.9	12.0	8.2	7.8	7.3
56	Lewiston	ME		10.7								55.5	10.6	6.9	6.7	6.4
57	Portland	ME		11.3								46.4	10.1	6.4	6.3	6.2
58	Detroit	MI		14.7			88.8	65.7				63.2	15.7	11.6	10.8	11.6
59	Flint	MI		9.5								61.8	11.3	7.5	7.2	7.4
60	Lansing	MI		13.1								57.3	13.0	9.1	8.6	9.2
61	Saginaw	MI		11.3								56.8				
62	Duluth	MN		7.0			66.7	46.8				57.2	7.3	3.8	4.0	3.8
63	Minneapolis	MN	13.7	8.4	13.6	15.5	60.3	50.8	16.7	32.2	3.8	71.4	7.3	3.8	4.0	3.9
64	Kansas City	MO		10.2		17.8	85.4	64.7	27.0	44.8	4.3	72.8	8.2	4.6	4.8	4.8
65	Saint Louis	MO		13.5		22.7	88.5	68.5	25.9	48.6	7.6	90.2				

No.	City	State	$Pm_{2.5}$ (OI, DC, MD)	$S0_4$ (OI)	$Pm_{2.5}$ (DC, MD)	$Pm_{2.5}$ (DC)	TSP (hi-vol)	Pm_{15} (SSI)	$Pm_{10-2.5}$ (DC)	Pm_{15} (DC)	$S0_4$ (DC)	TSP	$S0_4$ (cb-unadj)	$S0_4$ (USA)	$S0_4$ (Region)	$S0_4$ (Season)
66	Jackson	MS	15.7	8.8	15.9	18.1			18.7	36.8	7.5	64.9	8.6	5.0	5.1	4.9
67	Billings	MT		7.1								67.4	7.1	3.6	2.2	3.6
68	Great Falls	MT		3.6								55.5	3.0	0.0	0.5	0.3
69	Lincoln	NB		6.6								71.2	5.3	1.9	1.4	2.1
70	Omaha	NB	13.1	8.7	13.1	15.3	65.3	52.4	28.7	44.0	2.9	76.3	7.8	4.2	2.5	4.2
71	Charlotte	NC	22.6	11.5	22.4	24.1	60.3	50.0	12.9	37.1	6.8	55.2	12.2	8.3	7.9	8.6
72	Greensboro	NC		12.9								59.5	10.6	6.9	6.7	7.0
73	Raleigh	NC	16.8	11.9	18.3	21.0	44.1	36.3	9.2	30.2	7.3	56.9	12.1	8.3	7.9	8.3
74	Bismark	ND		5.3								61.1				
75	Grand Forks	ND		6.3								54.9				
76	Fargo	ND		4.8								68.4				
77	Manchester	NH		11.1								50.7	9.8	6.1	6.0	6.0
78	Portsmouth	NH		8.7								53.3	8.9	5.3	5.3	4.8
79	Jersey City	NJ	17.3	13.8	17.2	19.9	74.6	55.3	14.3	34.2	6.7	75.3	13.9	9.9	9.9	9.7
80	Newark	NJ		11.4								56.3	12.3	8.4	7.7	8.3
81	Paterson	NJ		12.8								50.2	14.1	10.1	10.3	9.8
82	Trenton	NJ		12.1								51.8	12.6	8.8	8.2	8.4
83	Albuquerque	NM	9.0	4.5	9.0	12.9	83.4	60.5	24.4	37.3	1.8	90.8	4.7	1.4	1.2	1.7
84	Las Vegas	NV		4.2								86.2	4.2	0.9	1.0	1.4
85	Reno	NV	11.8	4.1	11.8	13.1	81.6	65.8	21.0	34.1	1.3	73.3	3.8	0.5	0.8	0.8
86	Albany	NY		10.5								49.3	10.7	7.0	5.4	6.8
87	Buffalo	NY	23.5	11.7	23.0	26.5	85.1	62.9	20.7	47.2	9.2	72.9	12.9	9.0	8.6	8.6
88	Elimira	NY		6.6								47.1	7.6	4.1	1.0	4.2
89	Nassau	NY		8.4								47.3	9.2	5.5	3.2	5.5
90	New York	NY		10.7		23.9	71.6	62.3	12.8	36.7	7.2	52.6	10.7	7.0	5.5	6.9
91	Poughkeepsie	NY		8.1								41.9	8.1	4.5	1.7	4.3
92	Rochester	NY		9.9								46.8	10.5	6.7	5.1	6.6
93	Syracuse	NY		10.2								54.2	10.9	7.1	5.7	7.0
94	Utica	NY		8.6								51.2	8.7	5.1	2.6	5.0
95	Akron	OH	24.6	14.1	24.6	26.0	67.8	53.5	20.1	46.1	10.6	66.3	12.4	8.6	7.9	8.1
96	Canton	OH		13.6								65.9	13.7	9.7	9.7	9.4
97	Cincinnati	OH	23.1	14.3	23.1	25.0	56.8	51.5	16.1	41.1	10.4	61.9	13.1	9.2	8.9	8.8
98	Cleveland	OH	24.6	13.7	24.6	27.9	106.9	66.9	27.8	55.7	10.0	73.8	12.3	8.4	7.7	8.0
99	Columbus	OH		11.8			66.2	51.7				66.3	12.2	8.3	7.5	8.0
100	Dayton	OH	18.8	13.5	18.8	20.8	65.9	61.6	14.4	35.2	6.7	63.6	12.5	8.6	8.0	8.3

No.	City	State	$Pm_{2.5}$ (OI, DC, MD)	SO_4 (OI)	$Pm_{2.5}$ (DC, MD)	$Pm_{2.5}$ (DC)	TSP (hi-vol)	Pm_{15} (SSI)	$Pm_{10-2.5}$ (DC)	Pm_{15} (DC)	SO_4 (DC)	TSP	SO_4 (cb-unadj)	SO_4 (USA)	SO_4 (Region)	SO_4 (Season)
101	Hamilton	OH		13.2								64.3	12.6	8.7	8.1	8.3
102	Mansfield	OH		13.1								71.7	12.1	8.2	7.4	7.6
103	SPRI	OH														
104	Steubenville	OH	23.1	23.5	24.2	29.7	99.7	74.9	19.1	48.8	9.4	89.8	18.8	14.5	17.0	13.5
105	Toledo	OH		10.8								66.6	12.5	8.6	8.0	8.1
106	Youngstown	OH	20.2	15.7	20.2	22.9	85.0	65.5	23.1	46.0	7.7	81.2	14.0	10.1	10.2	9.5
107	Oklahoma City	OK	15.9	6.3	15.9	15.0	65.7	52.0	25.0	40.0	4.3	71.6	6.3	2.8	1.8	3.0
108	Eugene	OR				17.2	49.8	40.0	13.5	30.7	2.0	49.3	2.0	2.0	2.0	2.0
109	Portland	OR	14.7	7.7	14.7	19.8	73.8	56.0	27.9	47.7	3.3	72.7	7.2	3.7	2.2	3.7
110	Allentown	PA	17.9	14.5	17.9	19.5	65.6	53.0	13.4	33.0	6.8	65.1	13.7	9.8	9.7	9.4
111	Altoona	PA		14.2								76.6	13.5	9.6	9.5	9.4
112	Erie	PA		12.1								60.3	12.0	8.2	7.3	8.2
113	Harrisburg	PA		11.9								58.9	11.5	7.7	6.6	7.5
114	Johnstown	PA		17.2								81.4	16.0	11.9	13.1	11.6
115	Lancaster	PA		12.5								67.9	12.3	8.4	7.7	8.1
116	North Hampton	PA		11.7												
117	Philadelphia	PA	21.4	11.5	21.2	24.1	64.7	54.7	17.7	41.7	8.4	63.2	12.1	8.3	7.5	8.1
118	Pittsburg	PA		15.8		30.0	75.5	73.4	20.0	50.0	10.3	77.2	14.6	10.6	11.1	10.3
119	Reading	PA		12.1								58.4	12.3	8.5	7.7	8.2
120	State College	PA		15.3								66.6	14.2	10.2	10.4	9.9
121	Sharon	PA		12.4								88.7	13.1	9.2	8.9	9.0
122	Willamsburg	PA		12.4								69.4	12.1	8.3	7.5	8.2
123	York	PA		13.2								71.6	12.8	8.9	8.5	8.7
124	Providence	RI	12.9	8.7	12.8	14.2		34.2	10.9	25.2	4.4	52.9	9.5	5.9	3.7	5.8
125	Charlotte	SC		13.8								65.4	12.7	8.8	8.4	8.6
126	Columbia	SC		16.0								58.0	10.6	6.9	6.7	7.2
127	Greenville	SC		11.0								55.2	11.4	7.6	7.3	7.8
128	Sioux Falls	SO										59.8				
129	Chattanooga	TN	16.6	13.9	19.1	20.4	82.6	57.8	14.8	35.2	6.3	63.5	13.2	9.2	8.7	9.1
130	Knoxville	TN		13.9								65.6	15.7	11.6	10.8	12.1
131	Memphis	TN		12.8								68.3	13.1	9.2	8.7	8.7
132	Nashville	TN	20.5	8.7	20.5	22.6	74.8	58.2	13.1	35.7	4.6	61.2	8.2	4.6	4.7	4.8
133	Beaumont/															

No.	City	State	$Pm_{2.5}$ (OI, DC, MD)	SO_4 (OI)	$Pm_{2.5}$ (DC, MD)	$Pm_{2.5}$ (DC)	TSP (hi-vol)	Pm_{15} (SSI)	$Pm_{10-2.5}$ (DC)	Pm_{15} (DC)	SO_4 (DC)	TSP	SO_4 (cb-unadj)	SO_4 (USA)	SO_4 (Region)	SO_4 (Season)
	Port Arthur	TX		14.4								61.7	15.9	11.8	5.8	11.9
134	Corpus Christi	TX		8.8								68.8	13.3	9.4	4.7	7.3
135	Dallas	TX	16.5	10.0	16.5	18.8	75.9	57.9	18.5	37.2	4.4	64.7	10.0	6.3	3.4	6.2
136	El Paso	TX	15.7		13.3	16.9	102.2	98.7	41.7	58.6	3.0	105.5	7.2	3.7	2.2	3.5
137	Galveston	TX		9.0								65.3	10.0	6.3	3.4	5.5
138	Houston	TX	13.4	10.5	15.0	18.0	76.8	67.5	20.4	38.4	6.5	80.5	9.4	5.8	3.1	5.7
139	Lubbock	TX		4.5								99.7	5.2	1.9	1.4	2.1
140	San Angelo	TX		4.4								61.9	5.9	2.5	1.7	2.1
141	San Antonio	TX		6.6								60.2	6.4	3.0	1.9	3.1
142	Waco	TX		10.0								50.5	8.5	4.9	2.7	4.2
143	Wichita Falls	TX		6.9								64.4	7.8	4.3	2.5	4.4
144	Salt Lake City	UT	15.4	4.8	15.4	17.5	70.0	69.6	21.6	39.1	2.1	70.4	3.4	3.4	3.4	3.4
145	Danville	VA		13.6								51.4	13.6	9.6	9.1	9.4
146	Norfolk	VA	16.9	14.8	17.3	19.5	42.2	44.2	8.6	28.1	8.6	54.0	13.8	9.9	9.3	9.4
147	Richmond	VA		11.0			57.2	43.8				64.8	10.1	6.4	6.2	5.6
148	Roanoke	VA		12.4								55.2	12.4	8.6	8.1	8.8
149	Seattle	WA	11.9	7.5	11.9	14.9	75.3	55.3	15.8	30.7	2.4	71.9	7.0	3.5	2.1	3.6
150	Spokane	WA	9.4	5.6	9.4	13.5	87.2	68.1	28.2	41.7	1.6	127.0	5.2	1.8	1.4	2.1
151	Tacoma	WA		6.8								69.5	6.5	3.0	1.9	3.2
152	Eau Claire	WI		8.3								42.1	8.3	4.7	4.8	4.4
153	Kenosha	WI		10.8								58.9	10.8	7.0	6.8	6.7
154	Madison	WI		9.8								50.5	9.8	6.2	6.1	6.0
155	Milwaukee	WI		11.6								61.6	11.7	7.9	7.6	7.9
156	Racine	WI		11.1								55.8	11.1	7.3	7.1	6.8
157	Charleston	WV	20.1	17.8	20.1	21.7			17.8	39.5	7.2	66.4	17.4	13.2	15.0	13.7
158	Huntington	WV	33.4	15.3	33.4	37.8	106.3	53.8	39.5	77.2		71.9	11.1	7.4	6.1	7.2

a: Based on Inhalable Particulate Network, 1979-1983: $PM_{2.5}$(OI, MD) B median fine particle mass from Original Investigators; $PM_{2.5}$(DC, MD) median fine particulate mass from IP network: PM_{15}(DC) (inhalable fraction from dichotomous sampler), $PM_{10-2.5}$(DC) (coarse fraction), and $PM_{2.5}$ (DC) (fine fraction), SO_4(DC) sulfates from PM_{15}(DC), TSP(IP) - high-volume samplers measuring mass TSP, PM_{15}(SSI) - high-volume samplers recording PM_{15} using size selective inlet heads. All values are in means unless indicated by MD (median). ased on National Aerometric Database, 1980-1981: TSP B total suspended particulate matter from hi-volume samplers, SO_4(OI) sulfates from Original Investigator. SO_4(USA) sulfates from both Inhalable Particulate Network and National Aerometric Database with adjustment for SO_2 artifact based in all U.S. SO_4(Region) adjusted from SO_2 artifact by three regions calibrations. SO_4(Season) adjusted from SO_2 artifact by two seasons calibrations (April to September and October to March).