Risk and Exposure Assessment to Support the Review of the NO_2 Primary National Ambient Air Quality Standard: Second Draft Appendices

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Appendix A. Supplement to the NO_2 Air Quality Characterization

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A-1 Overview

This appendix contains supplemental descriptions of the data and methods used in the NO_2 air quality characterization, as well as detailed results from the analyses performed. First, ambient monitoring data form years 1995 through 2006 have been characterized based on siting characteristics, proximity to stationary source emissions, and distance to roadways. Then, ambient NO_2 concentration trends were evaluated considering the year of monitoring and distribution of monitors within a location.

The primary output of the air quality characterization was the numbers of exceedances of potential health effect benchmark levels identified in the Integrated Science Assessment. The ambient NO_2 concentrations were evaluated for the numbers of exceedances of the selected benchmarks in several locations and considering four scenarios. The first scenario considered *as is* air quality as obtained from EPA's Air Quality System (US EPA, 2007a; 2007b). A second scenario used a portion of the *as is* air quality to estimate on-road NO_2 concentrations. A third and fourth scenario followed in a similar manner, only these used air quality adjusted to just meeting the current and potential alternative standards. Each of these scenarios, in addition to the reasoning for the methods and data used, are described in detail in the sections that follow.

A-2 Air Quality Data Screen

A-2.1 Introduction

The current NO_2 standard of 53 ppb annual arithmetic average was set in 1971 and has been retained since by subsequent reviews (i.e., 1985, 1995). Minor revisions to the standard made in 1985 included an explicit rounding convention, stated annual averages would be determined on a calendar year basis, and indicated an explicit 75% completeness requirement for monitoring (60 FR 52874). Each of these components of the standard were considered in characterizing the air quality monitoring data, beginning first with the selection of valid data.

A-2.2 Approach

NO_2 air quality data from years 1995 through 2006 and associated documentation were downloaded from EPA's Air Quality System (US EPA, 2007a; 2007b). As of the date of the analyses performed, hourly measurements for year 2006 were only available for January 1 through October 31, 2006. A *site* was defined by the state, county, site code, and parameter occurrence code (POC), which gives a 10-digit monitor ID code. The POC identifies collocated measurements at the same monitoring location, so that each measuring instrument is treated as a different site. Typically there was only one POC at a given monitoring location.

As required by the NO_2 NAAQS, a valid year of monitoring data is needed to calculate the annual average concentration. A valid year at a monitoring site is comprised of 75% of valid days in a year, with at least 18 hourly measurements for a valid day (thus at least 274 or 275 valid days depending on presence of a leap year, a minimum of 4,932 or 4,950 hours). This served as a screening criterion for data to be used for analysis.

Site-years of data are the total numbers of years the collective monitors in a location were in operation. For example, from years 1995-2006, the Boston CMSA had 27 total monitors in operation, some of which did not contain sufficient numbers of monitoring values, while others contained upwards of 11 years (Table A-1). Thus in summing the number of operating years, this particular location contained a total of 105 site-years of data across the monitoring period.

In all of the subsequent analyses, where hourly values were missing they were treated as such. Reported values of zero (0) concentration were also retained as is. For certain illustrations, values of zero were substituted with 0.5 ppb, derived from one-half the lowest recorded 1-hour concentration (1 ppb).

A-2.3 Results

Of a total of 5,243 site-years of data in the entire NO_2 1-hour concentration database, 1,039 site-years did not meet the above criterion and were excluded from any further analyses. In addition, since shorter term average concentrations are of interest, the remaining site-years of data were further screened for 75% completeness on hourly measures in a year (i.e., containing a minimum of 6,570 or 6,588, depending on presence of a leap year). Twenty-seven additional site-years were excluded, resulting in 4,177 complete site-years in the analytical database. Table

A-2 provides a summary of the site-years included in the analysis, relative to those excluded, by location and by two site-year groupings.[1] Location selection is defined in the Section A-1.2.

Table A-1. Example of ambient monitor years of operation, using the Boston CMSA.

	Year of monitoring (1995-2006)												Totals	
Monitor ID	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**	**05**	**06**	**Complete**	**Incomplete**
2303130021	i	c	c	c	i	c	c	c	c	i	i		7	4
2500510021								i					0	1
2500510051		i	c	c	i	i	i						2	4
2500900051								i					0	1
2500920061	c	c	c	c	i	i	c	c	c	c	c	c	10	2
2500940041	c	c	c	c	i	i	c	i	i	i	i	i	5	7
2500950051										i	c	c	2	1
2502100091	c												1	0
2502130031								i	i	i	i	i	0	5
2502500021	c	c	c	c	c	c	c	c	i	c	c	c	11	1
2502500211	c	c	c	c	c	c	c	c					8	0
2502500351	c												1	0
2502500361	c												1	0
2502500401	c	c	c	c	c	c	c	c	c	c	c	i	11	1
2502500411					i	i	c	i	i	i	i	i	1	7
2502500421						i	c	c	c	c	c	c	6	1
2502510031	c	c	c	c	c								5	0
2502700201	c	c	c	c	c	c	c	c	i				8	1
2502700231										c	c	c	3	0
3301100161	c	c	c	c	i								4	1
3301100191					i	c	i						1	2
3301100201							i	c	c	c	c	c	5	1
3301110111										i	i	i	0	3
3301500091	c	c	c	c	c	i	i						5	2
3301500131				i	c	c	c	c	i				4	2
3301500141									i	c	c	c	3	1
3301500151							i	c	i				1	2
Complete	**12**	**10**	**11**	**11**	**7**	**7**	**10**	**10**	**5**	**7**	**8**	**7**	**105**	
Incomplete	**1**	**1**	**0**	**1**	**7**	**6**	**5**	**5**	**8**	**6**	**5**	**5**		**50**

Notes:
c = met criteria for valid year of monitoring data.
i = did not met criteria for valid year of monitoring data.

[1] 14 of 18 named locations and the 2 grouped locations contained enough data to be considered valid for year 2006.

Table A-2. Counts of complete site-years of NO_2 monitoring data.

Location	Number of Site-Years				% Complete	
	Complete		Incomplete			
	1995-2000	2001-2006	1995-2000	2001-2006	1995-2000	2001-2006
Boston	58	47	16	34	78%	58%
Chicago	47	36	20	22	70%	62%
Cleveland	11	11	2	2	85%	85%
Denver	26	10	10	4	72%	71%
Detroit	12	12	4	1	75%	92%
Los Angeles	193	177	16	19	92%	90%
Miami	24	20	1	4	96%	83%
New York	93	81	12	24	89%	77%
Philadelphia	46	39	6	8	88%	83%
Washington	69	66	21	18	77%	79%
Atlanta	24	29	5	1	83%	97%
Colorado Springs	26	0	4	4	87%	0%
El Paso	14	30	11	0	56%	100%
Jacksonville	6	4	0	2	100%	67%
Las Vegas	16	35	4	9	80%	80%
Phoenix	22	27	8	25	73%	52%
Provo	6	6	0	0	100%	100%
St. Louis	56	43	3	9	95%	83%
Other CMSA	1135	1177	249	235	82%	83%
Not MSA	200	243	112	141	64%	63%
Total	**4177**		**1066**		**80%**	

A-3 Selection of Locations

A-3.1 Introduction

The next step in this analysis was to identify similarities and differences in air quality among locations for the purpose of either aggregating or segregating data using a combination of descriptive statistics and health based criteria. *Location* in this context would include a geographic area that encompasses more than a single air quality monitor (e.g., particular city, consolidated metropolitan statistical area or CMSA).

A-3.2 Approach

Criteria were established for selecting sites with high annual means and/or frequent exceedances of potential health effect benchmarks. Selected locations were those that had a maximum annual mean NO_2 level at a particular monitor greater than or equal to 25.7 ppb, which represents the 90th percentile across all locations and site-years, and/or had at least one reported 1-hour NO_2 level greater than or equal to 200 ppb, the lowest level of the potential health effect benchmarks. A *location* in this context would include a geographic area that encompasses more than a single air quality monitor (e.g., particular city, metropolitan statistical area (MSA), or consolidated metropolitan statistical area or CMSA). First, all monitors were identified as either belonging to a CMSA, a MSA, or neither. Then, locations of interest were identified through statistical analysis of the ambient NO_2 air quality data for each site within a location.

A-3.3 Results

Fifteen locations met both selection criteria, that is, having at least one site-year annual mean above 25.7 ppb and at least one exceedance of 200 ppb. Upon further analysis of the more recent ambient data (2001-2006), four additional locations were observed to have met at least one of the criteria (either high annual mean and/or at least one exceedance of 200 ppb). New Haven, CT, while meeting the earlier criteria, did not have any recent exceedances of 200 ppb and contained one of the lowest maximum concentration-to-mean ratios, therefore was not separated out as a specific location. Thus, 14 locations were retained from the initial selection and 4 locations selected from a second screening to provide additional geographical representation. In addition to these 18 specific locations, the remaining sites were grouped into two broad location groupings. The *Other CMSA* location contains all the other sites that are in MSAs or CMSAs but are not in any of the 18 specified locations. The *Not MSA* location contains all the sites that are not in an MSA or CMSA. The selected locations are summarized in Table A-3.

The final database for analysis included air quality data from a total of 205 monitors within the named locations, 331 monitors in the Other CMSA group, and 92 monitors in the Not MSA group. Again, the monitors that were retained contained the criteria for estimating a valid annual average concentration described above.

Table A-3. Locations selected for NO_2 Air Quality Characterization, associated abbreviations, and values of selection criteria.

Location				Maximum # of Exceedances of 200 ppb	Maximum Annual Mean (ppb)
Type[1]	Code	Description	Abbreviation		
CMSA*	1122	Boston-Worcester-Lawrence, MA-NH-ME-CT	Boston	1	31.1
CMSA	1602	Chicago-Gary-Kenosha, IL-IN-WI	Chicago	0	33.6
CMSA*	1692	Cleveland-Akron, OH	Cleveland	1	28.1
CMSA*	2082	Denver-Boulder-Greeley, CO	Denver	2	36.8
CMSA*	2162	Detroit-Ann Arbor-Flint, MI	Detroit	12	25.9
CMSA*	4472	Los Angeles-Riverside-Orange County, CA	Los Angeles	5	50.6
CMSA	4992	Miami-Fort Lauderdale, FL	Miami	3	16.8
CMSA*	5602	New York-Northern New Jersey-Long Island, NY-NJ-CT-PA	New York	3	42.2
CMSA*	6162	Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD	Philadelphia	3	34.00
CMSA*	8872	Washington-Baltimore, DC-MD-VA-WV	Washington DC	2	27.2
MSA*	0520	Atlanta, GA	Atlanta	1	26.6
MSA*	1720	Colorado Springs, CO	Colorado Springs	69	34.8
MSA*	2320	El Paso, TX	El Paso	2	35.1
MSA	3600	Jacksonville, FL	Jacksonville	2	15.9
MSA*	4120	Las Vegas, NV-AZ	Las Vegas	11	27.1
MSA*	6200	Phoenix-Mesa, AZ	Phoenix	37	40.5
MSA	6520	Provo-Orem, UT	Provo	0	28.9
MSA*	7040	St, Louis, MO-IL	St. Louis	8	27.2
MSA/CMSA	-	Other MSA/CMSA	Other CMSA	10	31.9
-	-	Other Not MSA	Not MSA	2	19.7

[1] CMSA is consolidated metropolitan statistical area; MSA is metropolitan statistical area according to the 1999 Office of Management and Budget definitions (January 28, 2002 revision).
* Indicates locations that satisfied both the annual average and exceedance criteria.

A-4 Ambient Monitoring Site Characteristics

A-4.1 Introduction

Siting of monitors is of particular importance, recognizing that proximity of local sources could influence on measured NO_2 concentrations. As part of the risk and exposure scope and methods document (US EPA, 2007c), both mobile and stationary sources (in particular power generating utilities using fossil fuels) were indicated as significant contributors to nitrogen oxides (NO_x) emissions in the U.S. Analyses were performed to determine the distance of all location-specific monitors to these source categories. In addition, emissions of NO_x from stationary sources within close proximity of the location-specific monitoring sites were estimated.

A-4.2 Approach

Major road distances to each monitor were calculated using GIS.[2] Distances of monitoring sites to stationary sources and those source's emissions were estimated using data within the 2002 National Emissions Inventory (NEI; US EPA, 2007d). The NEI database reports emissions of NO_x in tons per year (tpy) for 131,657 unique emission sources at various points of release. The release locations were all taken from the latitude longitude values within the NEI. First, all NO_x emissions were summed for identical latitude and longitude entries while retaining source codes for the emissions (e.g., Standard Industrial Code (SIC), or North American Industrial Classification System (NAICS)). Therefore, any facility containing similar emission processes were summed at the stack location, resulting in 40,855 observations. These data were then screened for sources with emissions greater than 5 tpy, yielding 18,798 unique NO_x emission sources. Locations of these stationary source emissions were compared with ambient monitoring locations using the following formula:

$$d = \arccos(\sin(lat_1) \times \sin(lat_2) + \cos(lat_1) \times \cos(lat_2) \times \cos(lon_2 - lon_1)) \times r$$

where

d	=	distance (kilometers)
lat_1	=	latitude of a monitor (radians)
lat_2	=	latitude of source emission (radians)
lon_1	=	longitude of monitor (radians)
lon_2	=	longitude of source emission (radians)
r	=	approximate radius of the earth (or 6,371 km)

Location data for monitors and sources provided in the AQS and NEI data bases were given in units of degrees therefore, these were first converted to radians by dividing by 180/π. For each monitor, source emissions with estimated distances within 10 km were retained.

[2] Distances between monitors and major roads were first determined using a Tele-Atlas roads database in a GIS application. For road-monitor pairs that showed particularly close distances, the values were fine-tuned using GoogleEarth® to estimate the distance to road edge.

A-4.3 Summary Results

Summary statistics for the monitoring site characteristics are presented in Tables A-4 through A-6 for the selected locations. Detailed results for the distance to major roadways, the distance and emissions from stationary sources for each ambient monitor are provided in section A-3.4, Tables A-7 and A-8.

The distribution of the nearest distance of the ambient monitors to major roads for each of the named locations is summarized in Table A-4. On average, most monitors are placed at a distance of 50 meters or greater from a major road, however in locations with a large monitoring network such as Boston, Chicago, or New York CMSA, there may be one or two monitors sited within close proximity (<10 meters) of a road. Since there is potential for roadway emissions to affect concentrations at monitors sited close to major roads, the ambient monitors were further categorized based on the monitor distance from major roads. Two proximity bins were identified, the first containing those monitors sited within 100 meters of a road (<100 m) and those located at least 100 meters from a major road (≥100 m).

Table A-4. Distribution of the distance of ambient monitors to the nearest major road in selected locations.

		Distance (m) of monitor to nearest major road						
Location	**n**	**mean**	**std**	**min**	**2.5**	**50**	**97.5**	**max**
Atlanta	4	488	283	134	134	505	809	809
Boston	21	101	93	7	7	70	337	337
Chicago	12	158	212	2	2	93	738	738
Cleveland	4	114	90	2	2	134	187	187
Colorado Springs	6	196	103	79	79	180	386	386
Denver	7	166	260	18	18	65	748	748
Detroit	3	382	39	339	339	393	415	415
El Paso	7	282	266	33	33	128	718	718
Jacksonville	1	144						
Las Vegas	10	244	286	1	1	181	914	914
Los Angeles	43	155	150	1	2	89	522	570
Miami	4	57	45	15	15	55	103	103
New York	26	145	130	6	6	119	508	508
Philadelphia	10	247	199	45	45	167	630	630
Phoenix	7	190	177	7	7	141	433	433
Provo	1	353						
St Louis	13	126	123	5	5	97	421	421
Washington DC	16	129	104	14	14	83	338	338

[1] n is the number of monitors operating in a particular location between 1995 and 2006. The min, 2.5, med, 97.5, and max represent the minimum, 2.5^{th}, median, 97.5^{th}, and maximum percentiles of the distribution for the distance in meters (m) to the nearest major road. Monitors > 1km from road are not included.

Table A-5 contains a summary of the distance of stationary source emissions to monitors within each named location. There were a number of sources emitting >5 tpy of NO_x and located within a 10 km radius for many of the monitors. On average though, most monitors are placed at greater distances from stationary source emissions than roads with most sources at a distance of greater than 5 km. Most of the stationary source emissions of NO_x within a 10 km radius of monitors were less than 50 tpy (Table A-6). Details regarding individual monitors are provided in Table A-8.

Table A-5. Distribution of the distance of ambient monitors to stationary sources with NO_x emissions >5 tons per year and within a 10 kilometers radius.

Location	n[1]	Distance of monitor to NO_x emission source (m)[2]						
		mean	std	min	2.5	50	97.5	max
Atlanta	9	6522	3164	656	656	7327	9847	9847
Boston	595	5333	2603	142	761	5363	9733	9988
Chicago	394	6586	2657	411	770	7277	9834	9994
Cleveland	19	7092	2439	956	956	7278	9884	9884
Colorado Springs	66	6109	2632	782	1034	6340	9847	9933
Denver	140	5655	2593	910	1029	5904	9862	9979
Detroit	87	6889	2254	321	1963	7549	9974	9997
El Paso	126	5694	3185	119	1384	6085	9945	9991
Jacksonville	20	5125	2962	708	708	5720	9558	9558
Las Vegas	18	6700	2184	3837	3837	7237	9950	9950
Los Angeles	523	6003	2435	140	1483	6165	9801	9991
Miami	11	6184	3151	1323	1323	7611	9117	9117
New York	736	6101	2555	103	1383	6467	9818	9983
Philadelphia	382	5837	2474	231	1299	5689	9754	9982
Phoenix	59	6298	2279	833	1312	6355	9803	9890
Provo	7	6558	3664	1214	1214	8178	9433	9433
St Louis	253	6799	2337	396	1989	7120	9863	9990
Washington DC	160	6173	2425	288	704	6254	9777	9973

[1] n is the number of sources emitting >5 tons per year (tpy) NO_x within a 10 kilometer radius of a monitor in a particular location.
[2] The min, 2.5, med, 97.5, and max represent the minimum, 2.5^{th}, median, 97.5^{th}, and maximum percentiles of the distribution for the distance in meters (m) to the source emission.

Table A-6. Distribution of NO_x emissions from stationary sources within 10 kilometers of monitoring site, where emissions were >5 tons per year.

Location	n[1]	Emissions (tpy) of NO_x from sources within 10 km of monitor[2]						
		mean	std	min	2.5	50	97.5	max
Atlanta	9	709	1621	22	22	35	4895	4895
Boston	595	128	344	5	5	10	1155	3794
Chicago	394	204	919	5	5	10	2204	8985
Cleveland	19	702	612	126	126	284	1476	1476
Colorado Springs	66	387	1091	5	5	19	4205	4205
Denver	140	252	1286	5	5	15	5404	9483
Detroit	87	251	637	5	6	24	2398	3762
El Paso	126	117	286	5	5	31	912	1679
Jacksonville	20	201	407	5	5	31	1642	1642
Las Vegas	18	483	636	18	18	84	1665	1665
Los Angeles	523	70	310	5	5	12	577	4256
Miami	11	24	16	8	8	22	51	51
New York	736	284	1024	5	6	31	3676	9022
Philadelphia	382	154	408	5	5	29	1304	4968
Phoenix	59	85	234	5	5	14	1049	1049
Provo	7	60	38	7	7	83	102	102
St Louis	253	167	1032	5	5	16	848	14231
Washington DC	160	320	1254	6	6	34	6009	10756

[1] n is the number of sources emitting >5 tons per year (tpy) of NO_x within a 10 kilometer radius of a monitor in a particular location.
[2] The min, 2.5, med, 97.5, and max represent the minimum, 2.5^{th}, median, 97.5^{th}, and maximum percentiles of the distribution for the source emissions.

A-4.4 Detailed Monitoring Site Characteristics

Detailed physical attributes of each monitor used within the named locations (i.e., 18 specific locations were defined; it does not include the broadly grouped locations of "Other CMSA" or Not MSA). Each of these monitors met the criteria for containing a valid number of reported concentrations and were used throughout the air quality characterization. Data provided include monitor location and purpose, ground height and elevation above sea level, and distance to the nearest major roadway (Table A-7). In addition, the distances and emissions of stationary sources that emit > 5 tons NO_x per year were calculated for each monitor (Table A-8)

Table A-7. Attributes of location-specific ambient monitors used for air quality characterization and the distance to nearest major roadway.

Location	ID	Latitude	Longitude	Land Use	Location Type[1]	Objective[2]	Monitor[3]		Roadway[4]	
							Ht (m)	Elev (m)	Dist (m)	Type
Atlanta	130890002	33.69	-84.29	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	5	308	432	3
Atlanta	130893001	33.85	-84.21	RESIDENTIAL	RURAL	OTHER	5	0	579	2
Atlanta	131210048	33.78	-84.40	COMMERCIAL	URBAN AND CENTER CITY	HIGHEST CONCENTRATION	5	290	134	3
Atlanta	132230003	33.93	-85.05	AGRICULTURAL	RURAL	GENERAL/BACKGROUND	4	417	>1000	-
Atlanta	132470001	33.59	-84.07	AGRICULTURAL	RURAL	POPULATION EXPOSURE	5	219	809	3
Boston	230313002	43.08	-70.75	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	-	40	70	2
Boston	250051005	42.06	-71.15	AGRICULTURAL	RURAL	POPULATION EXPOSURE	4	61	17	3
Boston	250092006	42.47	-70.97	COMMERCIAL	URBAN AND CENTER CITY	POPULATION EXPOSURE	5	52	158	3
Boston	250094004	42.79	-70.81	RESIDENTIAL	SUBURBAN	MAX OZONE CONCENTRATION	4	1	15	3
Boston	250095005	42.76	-71.11	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	-	0	337	3
Boston	250210009	42.32	-71.13	RESIDENTIAL	URBAN AND CENTER CITY	UNKNOWN	4	0	144	3
Boston	250250002	42.35	-71.10	COMMERCIAL	URBAN AND CENTER CITY	HIGHEST CONCENTRATION	5	6	7	2
Boston	250250021	42.38	-71.03	RESIDENTIAL	URBAN AND CENTER CITY	HIGHEST CONCENTRATION	4	6	7	3
Boston	250250035	42.33	-71.12	RESIDENTIAL	URBAN AND CENTER CITY	UNKNOWN	-	0	158	3
Boston	250250036	42.33	-71.12	RESIDENTIAL	URBAN AND CENTER CITY	UNKNOWN	-	0	158	3
Boston	250250040	42.35	-71.04	INDUSTRIAL	URBAN AND CENTER CITY	POPULATION EXPOSURE	4	0	37	3
Boston	250250041	42.32	-70.97	COMMERCIAL	RURAL	POPULATION EXPOSURE	6	10	>1000	-
Boston	250250042	42.33	-71.08	COMMERCIAL	URBAN AND CENTER CITY	POPULATION EXPOSURE	5	6	26	3
Boston	250251003	42.40	-71.03	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	4	59	228	4
Boston	250270020	42.27	-71.80	COMMERCIAL	URBAN AND CENTER CITY	UNKNOWN	3	145	44	3
Boston	250270023	42.27	-71.79	COMMERCIAL	URBAN AND CENTER CITY	POPULATION EXPOSURE	4	145	49	3
Boston	330110016	42.99	-71.46	COMMERCIAL	URBAN AND CENTER CITY	UNKNOWN	5	75	168	3
Boston	330110019	43.00	-71.47	COMMERCIAL	URBAN AND CENTER CITY	UNKNOWN	-	61	70	3
Boston	330110020	43.00	-71.47	COMMERCIAL	URBAN AND CENTER CITY	UNKNOWN	5	61	70	3
Boston	330150009	43.08	-70.76	COMMERCIAL	SUBURBAN	UNKNOWN	3	3	48	3
Boston	330150013	43.00	-71.20	RESIDENTIAL	RURAL	OTHER	1	0	>1000	-
Boston	330150014	43.08	-70.75	RESIDENTIAL	URBAN AND CENTER CITY	POPULATION EXPOSURE	2	4	266	3
Boston	330150015	43.08	-70.76	COMMERCIAL	SUBURBAN	POPULATION EXPOSURE	4	3	38	3
Chicago	170310037	41.98	-87.67	RESIDENTIAL	URBAN AND CENTER CITY	UNKNOWN	-	183	17	3
Chicago	170310063	41.88	-87.63	MOBILE	URBAN AND CENTER CITY	HIGHEST CONCENTRATION	3	181	68	3
Chicago	170310064	41.79	-87.60	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	15	180	346	3
Chicago	170310075	41.96	-87.66	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	15	180	136	3
Chicago	170310076	41.75	-87.71	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	4	186	2	3
Chicago	170313101	41.97	-87.88	MOBILE	SUBURBAN	HIGHEST CONCENTRATION	3	197	20	2
Chicago	170313103	41.97	-87.88	MOBILE	SUBURBAN	HIGHEST CONCENTRATION	4	195	20	2
Chicago	170314002	41.86	-87.75	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	4	184	118	3
Chicago	170314201	42.14	-87.80	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	8	198	239	2

Table A-7. Attributes of location-specific ambient monitors used for air quality characterization and the distance to nearest major roadway.										
							Monitor[3]		Roadway[4]	
Location	ID	Latitude	Longitude	Land Use	Location Type[1]	Objective[2]	Ht (m)	Elev (m)	Dist (m)	Type
Chicago	170314201	42.14	-87.80	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	8	198	239	2
Chicago	170318003	41.63	-87.57	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	4	179	2	3
Chicago	171971011	41.22	-88.19	AGRICULTURAL	RURAL	GENERAL/BACKGROUND	5	181	>1000	-
Chicago	180890022	41.61	-87.30	INDUSTRIAL	URBAN AND CENTER CITY	HIGHEST CONCENTRATION	5	183	738	1
Chicago	180891016	41.60	-87.33	RESIDENTIAL	URBAN AND CENTER CITY	POPULATION EXPOSURE	14	183	187	3
Cleveland	390350043	41.46	-81.58	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	4	287	187	2
Cleveland	390350060	41.49	-81.68	COMMERCIAL	URBAN AND CENTER CITY	POPULATION EXPOSURE	4	206	2	4
Cleveland	390350066	41.46	-81.58	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	5	287	187	2
Cleveland	390350070	41.46	-81.59	RESIDENTIAL	URBAN AND CENTER CITY	POPULATION EXPOSURE	4	278	81	3
Colorado Springs	080416001	38.63	-104.72	INDUSTRIAL	RURAL	UNKNOWN	4	1673	>1000	-
Colorado Springs	080416004	38.92	-104.81	RESIDENTIAL	URBAN AND CENTER CITY	UNKNOWN	4	1931	150	1
Colorado Springs	080416005	38.76	-104.76	AGRICULTURAL	URBAN AND CENTER CITY	UNKNOWN	4	1747	79	3
Colorado Springs	080416006	38.92	-105.00	RESIDENTIAL	RURAL	UNKNOWN	4	2313	199	2
Colorado Springs	080416009	38.64	-104.71	INDUSTRIAL	RURAL	UNKNOWN	4	1707	>1000	-
Colorado Springs	080416011	38.85	-104.83	RESIDENTIAL	URBAN AND CENTER CITY	UNKNOWN	3	1832	198	3
Colorado Springs	080416013	38.81	-104.82	RESIDENTIAL	URBAN AND CENTER CITY	UNKNOWN	3	1823	386	4
Colorado Springs	080416018	38.81	-104.75	COMMERCIAL	URBAN AND CENTER CITY	UNKNOWN	3	1795	163	2
Denver	080013001	39.84	-104.95	AGRICULTURAL	RURAL	POPULATION EXPOSURE	4	1559	748	3
Denver	080050003	39.66	-105.00	COMMERCIAL	SUBURBAN	HIGHEST CONCENTRATION	4	1654	138	2
Denver	080310002	39.75	-104.99	COMMERCIAL	URBAN AND CENTER CITY	HIGHEST CONCENTRATION	-	1589	18	3
Denver	080590006	39.91	-105.19	INDUSTRIAL	RURAL	UNKNOWN	-	1774	65	3
Denver	080590008	39.88	-105.17	INDUSTRIAL	RURAL	GENERAL/BACKGROUND	4	1715	31	3
Denver	080590009	39.86	-105.20	INDUSTRIAL	RURAL	GENERAL/BACKGROUND	4	1848	99	3
Denver	080590010	39.90	-105.24	AGRICULTURAL	RURAL	UNKNOWN	4	1877	63	2
Detroit	260990009	42.73	-82.79	COMMERCIAL	SUBURBAN	UNKNOWN	-	189	415	3
Detroit	261630016	42.36	-83.10	RESIDENTIAL	URBAN AND CENTER CITY	HIGHEST CONCENTRATION	4	191	393	5
Detroit	261630019	42.43	-83.00	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	4	192	339	3
El Paso	481410027	31.76	-106.49	COMMERCIAL	URBAN AND CENTER CITY	GENERAL/BACKGROUND	5	1140	33	4
El Paso	481410028	31.75	-106.40	RESIDENTIAL	SUBURBAN	SOURCE ORIENTED	5	1126	718	3
El Paso	481410037	31.77	-106.50	COMMERCIAL	URBAN AND CENTER CITY	MAX OZONE CONCENTRATION	4	1143	128	3
El Paso	481410044	31.77	-106.46	COMMERCIAL	URBAN AND CENTER CITY	MAX PRECURSOR EMISSIONS IMPACT	5	1128	38	3
El Paso	481410055	31.75	-106.40	COMMERCIAL	URBAN AND CENTER CITY	UPWIND BACKGROUND	5	0	127	3
El Paso	481410057	31.66	-106.30	RESIDENTIAL	SUBURBAN	GENERAL/BACKGROUND	5	0	450	3
El Paso	481410058	31.89	-106.43	RESIDENTIAL	URBAN AND CENTER CITY	POPULATION EXPOSURE	5	0	478	3
Jacksonville	120310032	30.36	-81.64	COMMERCIAL	SUBURBAN	UNKNOWN	3	7	144	1
Las Vegas	320030022	36.39	-114.91	INDUSTRIAL	RURAL	SOURCE ORIENTED	3.5	0	122	2

Table A-7. Attributes of location-specific ambient monitors used for air quality characterization and the distance to nearest major roadway.

Location	ID	Latitude	Longitude	Land Use	Location Type[1]	Objective[2]	Monitor[3] Ht (m)	Monitor[3] Elev (m)	Roadway[4] Dist (m)	Roadway[4] Type
Las Vegas	320030023	36.81	-114.06	RESIDENTIAL	RURAL	POPULATION EXPOSURE	4	490	303	3
Las Vegas	320030073	36.17	-115.33	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	3.5	0	515	2
Las Vegas	320030078	35.47	-114.92	DESERT	RURAL	REGIONAL TRANSPORT	4	1094	25	3
Las Vegas	320030539	36.14	-115.09	MOBILE	SUBURBAN	POPULATION EXPOSURE	3.5	533	11	3
Las Vegas	320030557	36.16	-115.11	RESIDENTIAL	SUBURBAN	UNKNOWN	3	567	1	3
Las Vegas	320030563	36.18	-115.10	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	4	570	254	3
Las Vegas	320030601	35.98	-114.84	COMMERCIAL	SUBURBAN	POPULATION EXPOSURE	4	0	52	3
Las Vegas	320031019	35.79	-115.36	DESERT	RURAL	GENERAL/BACKGROUND	4	950	914	3
Las Vegas	320032002	36.19	-115.12	COMMERCIAL	URBAN AND CENTER CITY	POPULATION EXPOSURE	3.5	0	240	3
Los Angeles	060370002	34.14	-117.92	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	2	183	329	3
Los Angeles	060370016	34.14	-117.85	RESIDENTIAL	SUBURBAN	UNKNOWN	6	275	300	3
Los Angeles	060370030	34.04	-118.22	RESIDENTIAL	URBAN AND CENTER CITY	UNKNOWN	5	65	50	3
Los Angeles	060370113	34.05	-118.46	MOBILE	URBAN AND CENTER CITY	UNKNOWN	5	91	190	3
Los Angeles	060370206	33.96	-117.84	COMMERCIAL	URBAN AND CENTER CITY	UNKNOWN	-	300	>1000	-
Los Angeles	060371002	34.18	-118.32	COMMERCIAL	URBAN AND CENTER CITY	UNKNOWN	5	168	58	3
Los Angeles	060371103	34.07	-118.23	RESIDENTIAL	URBAN AND CENTER CITY	HIGHEST CONCENTRATION	13	87	55	3
Los Angeles	060371201	34.20	-118.53	COMMERCIAL	SUBURBAN	UNKNOWN	6	226	206	3
Los Angeles	060371301	33.93	-118.21	COMMERCIAL	URBAN AND CENTER CITY	UNKNOWN	7	27	29	3
Los Angeles	060371601	34.01	-118.06	COMMERCIAL	SUBURBAN	POPULATION EXPOSURE	6	75	78	3
Los Angeles	060371701	34.07	-117.75	COMMERCIAL	SUBURBAN	UNKNOWN	6	270	15	3
Los Angeles	060372005	34.13	-118.13	RESIDENTIAL	URBAN AND CENTER CITY	UNKNOWN	4	250	385	3
Los Angeles	060374002	33.82	-118.19	RESIDENTIAL	SUBURBAN	UNKNOWN	6	6	1	3
Los Angeles	060375001	33.92	-118.37	COMMERCIAL	URBAN AND CENTER CITY	UNKNOWN	-	21	10	3
Los Angeles	060375005	33.95	-118.43	RESIDENTIAL	SUBURBAN	UPWIND BACKGROUND	4	21	149	3
Los Angeles	060376002	34.39	-118.53	COMMERCIAL	SUBURBAN	POPULATION EXPOSURE	-	375	2	3
Los Angeles	060376012	34.38	-118.53	COMMERCIAL	SUBURBAN	UNKNOWN	-	397	143	3
Los Angeles	060379002	34.69	-118.13	COMMERCIAL	URBAN AND CENTER CITY	UNKNOWN	5	725	61	3
Los Angeles	060379033	34.67	-118.13	COMMERCIAL	URBAN AND CENTER CITY	UNKNOWN	3	725	146	3
Los Angeles	060590001	33.83	-117.94	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	5	45	225	3
Los Angeles	060590007	33.83	-117.94	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	4	10	225	3
Los Angeles	060591003	33.67	-117.93	RESIDENTIAL	SUBURBAN	UNKNOWN	6	0	202	3
Los Angeles	060595001	33.93	-117.95	RESIDENTIAL	SUBURBAN	UNKNOWN	82	82	570	3
Los Angeles	060650012	33.92	-116.86	COMMERCIAL	SUBURBAN	POPULATION EXPOSURE	4	677	432	1
Los Angeles	060655001	33.85	-116.54	RESIDENTIAL	SUBURBAN	UNKNOWN	6	171	75	3
Los Angeles	060658001	34.00	-117.42	RESIDENTIAL	SUBURBAN	UNKNOWN	4	250	133	3
Los Angeles	060659001	33.68	-117.33	RESIDENTIAL	SUBURBAN	UNKNOWN	-	1440	522	4
Los Angeles	060710001	34.90	-117.02	COMMERCIAL	URBAN AND CENTER CITY	UNKNOWN	8	690	64	3

Table A-7. Attributes of location-specific ambient monitors used for air quality characterization and the distance to nearest major roadway.										
							Monitor[3]		Roadway[4]	
Location	ID	Latitude	Longitude	Land Use	Location Type[1]	Objective[2]	Ht (m)	Elev (m)	Dist (m)	Type
Los Angeles	060710012	34.43	-117.56	COMMERCIAL	RURAL	UNKNOWN	-	4100	30	3
Los Angeles	060710014	34.51	-117.33	RESIDENTIAL	SUBURBAN	UNKNOWN	4	876	18	3
Los Angeles	060710015	35.78	-117.37	INDUSTRIAL	SUBURBAN	UNKNOWN	-	498	42	3
Los Angeles	060710017	34.14	-116.06	MOBILE	URBAN AND CENTER CITY	UNKNOWN	4	607	64	3
Los Angeles	060710306	34.51	-117.33	RESIDENTIAL	SUBURBAN	UNKNOWN	4	913	38	3
Los Angeles	060711004	34.10	-117.63	RESIDENTIAL	URBAN AND CENTER CITY	UPWIND BACKGROUND	6	369	349	2
Los Angeles	060712002	34.10	-117.49	INDUSTRIAL	SUBURBAN	UNKNOWN	5	381	81	3
Los Angeles	060711234	35.76	-117.40	DESERT	RURAL	OTHER	1	545	>1000	-
Los Angeles	060714001	34.42	-117.28	RESIDENTIAL	SUBURBAN	UNKNOWN	-	1006	111	3
Los Angeles	060719004	34.11	-117.27	COMMERCIAL	SUBURBAN	HIGHEST CONCENTRATION	5	0	169	3
Los Angeles	061110005	33.20	-117.37	UNKNOWN	UNKNOWN	POPULATION EXPOSURE	1	320	63	3
Los Angeles	061110007	32.71	-117.15	COMMERCIAL	URBAN AND CENTER CITY	POPULATION EXPOSURE	5	244	89	3
Los Angeles	061111003	34.45	-119.27	MOBILE	SUBURBAN	UNKNOWN	-	231	18	2
Los Angeles	061111004	34.45	-119.23	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	4	262	56	3
Los Angeles	061112002	34.28	-118.68	RESIDENTIAL	SUBURBAN	HIGHEST CONCENTRATION	4	314	471	1
Los Angeles	061112003	34.28	-119.31	RESIDENTIAL	SUBURBAN	GENERAL/BACKGROUND	2	3	90	1
Los Angeles	061113001	34.26	-119.14	RESIDENTIAL	RURAL	POPULATION EXPOSURE	4	43	307	3
Miami	120110003	26.28	-80.28	INDUSTRIAL	RURAL	HIGHEST CONCENTRATION	6	3	22	3
Miami	120110031	26.27	-80.30	RESIDENTIAL	SUBURBAN	MAX PRECURSOR EMISSIONS IMPACT	4	3	103	4
Miami	120118002	26.09	-80.11	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	4	3	>1000	-
Miami	120860027	25.73	-80.16	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	16	2	15	3
Miami	120864002	25.80	-80.21	COMMERCIAL	URBAN AND CENTER CITY	HIGHEST CONCENTRATION	4	5	87	3
New York	090010113	41.18	-73.19	COMMERCIAL	URBAN AND CENTER CITY	HIGHEST CONCENTRATION	4	3	8	3
New York	090019003	41.12	-73.34	FOREST	RURAL	POPULATION EXPOSURE	5	4	508	4
New York	090090027	41.30	-72.90	COMMERCIAL	URBAN AND CENTER CITY	POPULATION EXPOSURE	3.67	11	237	1
New York	090091123	41.31	-72.92	RESIDENTIAL	URBAN AND CENTER CITY	UNKNOWN	9	18	14	2
New York	340030001	40.81	-73.99	RESIDENTIAL	SUBURBAN	UNKNOWN	4	61	82	3
New York	340030005	40.90	-74.03	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	3	6	172	5
New York	340130011	40.73	-74.14	INDUSTRIAL	URBAN AND CENTER CITY	UNKNOWN	4	3	232	1
New York	340130016	40.72	-74.15	INDUSTRIAL	URBAN AND CENTER CITY	POPULATION EXPOSURE	5	3	6	1
New York	340131003	40.76	-74.20	COMMERCIAL	URBAN AND CENTER CITY	HIGHEST CONCENTRATION	4	48.45	25	3
New York	340170006	40.67	-74.13	COMMERCIAL	URBAN AND CENTER CITY	POPULATION EXPOSURE	5	3	266	3
New York	340210005	40.28	-74.74	RESIDENTIAL	SUBURBAN	MAX OZONE CONCENTRATION	4	30	442	1
New York	340230011	40.46	-74.43	AGRICULTURAL	RURAL	POPULATION EXPOSURE	4	21	298	3
New York	340273001	40.79	-74.68	AGRICULTURAL	RURAL	UNKNOWN	5	274	227	3
New York	340390004	40.64	-74.21	INDUSTRIAL	SUBURBAN	HIGHEST CONCENTRATION	4	5.4	37	4

Table A-7. Attributes of location-specific ambient monitors used for air quality characterization and the distance to nearest major roadway.

Location	ID	Latitude	Longitude	Land Use	Location Type[1]	Objective[2]	Monitor[3] Ht (m)	Monitor[3] Elev (m)	Roadway[4] Dist (m)	Roadway[4] Type
New York	340390008	40.60	-74.44	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	4	0	99	3
New York	360050080	40.84	-73.92	RESIDENTIAL	URBAN AND CENTER CITY	HIGHEST CONCENTRATION	15	15	122	3
New York	360050083	40.87	-73.88	COMMERCIAL	URBAN AND CENTER CITY	UNKNOWN	15	24	132	5
New York	360050110	40.82	-73.90	RESIDENTIAL	URBAN AND CENTER CITY	UNKNOWN	-	0	76	3
New York	360470011	40.73	-73.95	INDUSTRIAL	URBAN AND CENTER CITY	HIGHEST CONCENTRATION	6	9	171	3
New York	360590005	40.74	-73.59	COMMERCIAL	SUBURBAN	HIGHEST CONCENTRATION	5	27	32	3
New York	360610010	40.74	-73.99	RESIDENTIAL	URBAN AND CENTER CITY	HIGHEST CONCENTRATION	38	38	55	3
New York	360610056	40.76	-73.97	COMMERCIAL	URBAN AND CENTER CITY	HIGHEST CONCENTRATION	10	15	62	3
New York	360810097	40.76	-73.76	RESIDENTIAL	URBAN AND CENTER CITY	GENERAL/BACKGROUND	12	0	197	3
New York	360810098	40.78	-73.85	RESIDENTIAL	URBAN AND CENTER CITY	UNKNOWN	8	6	9	3
New York	360810124	40.74	-73.82	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	-	8	150	3
New York	361030009	40.83	-73.06	RESIDENTIAL	SUBURBAN	UNKNOWN	-	0	116	2
Philadelphia	100031003	39.76	-75.49	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	-	65	189	2
Philadelphia	100031007	39.55	-75.73	AGRICULTURAL	RURAL	OTHER	-	20	144	3
Philadelphia	100032004	39.74	-75.56	COMMERCIAL	URBAN AND CENTER CITY	UNKNOWN	-	0	82	3
Philadelphia	340070003	39.92	-75.10	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	5	7.6	405	3
Philadelphia	420170012	40.11	-74.88	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	2	12	393	3
Philadelphia	420450002	39.84	-75.37	INDUSTRIAL	URBAN AND CENTER CITY	POPULATION EXPOSURE	2	3	413	3
Philadelphia	420910013	40.11	-75.31	RESIDENTIAL	SUBURBAN	UNKNOWN	4	53	630	1
Philadelphia	421010004	40.01	-75.10	RESIDENTIAL	URBAN AND CENTER CITY	POPULATION EXPOSURE	7	22	45	3
Philadelphia	421010029	39.96	-75.17	COMMERCIAL	URBAN AND CENTER CITY	HIGHEST CONCENTRATION	11	25	103	3
Philadelphia	421010047	39.94	-75.17	RESIDENTIAL	URBAN AND CENTER CITY	POPULATION EXPOSURE	11	21	66	2
Phoenix	040130019	33.48	-112.14	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	4.3	333	401	3
Phoenix	040133002	33.46	-112.05	RESIDENTIAL	URBAN AND CENTER CITY	HIGHEST CONCENTRATION	9	339	141	3
Phoenix	040133003	33.48	-111.92	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	5.8	368	78	3
Phoenix	040133010	33.46	-112.12	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	4.2	325	7	3
Phoenix	040134005	33.41	-111.93	RESIDENTIAL	URBAN AND CENTER CITY	UNKNOWN	4	352	259	3
Phoenix	040134011	33.37	-112.62	AGRICULTURAL	RURAL	SOURCE ORIENTED	4	258	12	3
Phoenix	040139997	33.50	-112.10	RESIDENTIAL	URBAN AND CENTER CITY	POPULATION EXPOSURE	-	346	433	3
Provo	490490002	40.25	-111.66	COMMERCIAL	URBAN AND CENTER CITY	UNKNOWN	4	1402	353	2
St. Louis	171630010	38.61	-90.16	INDUSTRIAL	SUBURBAN	POPULATION EXPOSURE	4	125	18	4
St. Louis	291830010	38.58	-90.84	AGRICULTURAL	RURAL	UNKNOWN	3	0	340	3
St. Louis	291831002	38.87	-90.23	AGRICULTURAL	RURAL	POPULATION EXPOSURE	4	131	31	3
St. Louis	291890001	38.52	-90.34	RESIDENTIAL	SUBURBAN	UNKNOWN	4	183	161	2
St. Louis	291890004	38.53	-90.38	RESIDENTIAL	SUBURBAN	UNKNOWN	4	183	95	2
St. Louis	291890006	38.61	-90.50	RESIDENTIAL	RURAL	UNKNOWN	4	175	97	3
St. Louis	291893001	38.64	-90.35	COMMERCIAL	SUBURBAN	UNKNOWN	4	161	5	1

Table A-7. Attributes of location-specific ambient monitors used for air quality characterization and the distance to nearest major roadway.

Location	ID	Latitude	Longitude	Land Use	Location Type[1]	Objective[2]	Monitor[3] Ht (m)	Monitor[3] Elev (m)	Roadway[4] Dist (m)	Roadway[4] Type
St. Louis	291895001	38.77	-90.29	COMMERCIAL	SUBURBAN	UNKNOWN	2	168	421	3
St. Louis	291897002	38.73	-90.38	RESIDENTIAL	SUBURBAN	UNKNOWN	4	168	59	3
St. Louis	291897003	38.72	-90.37	RESIDENTIAL	SUBURBAN	HIGHEST CONCENTRATION	4	0	112	3
St. Louis	295100072	38.62	-90.20	COMMERCIAL	URBAN AND CENTER CITY	UNKNOWN	14	154	43	4
St. Louis	295100080	38.68	-90.25	RESIDENTIAL	URBAN AND CENTER CITY	HIGHEST CONCENTRATION	4	152	116	3
St. Louis	295100086	38.67	-90.24	RESIDENTIAL	URBAN AND CENTER CITY	HIGHEST CONCENTRATION	4	0	133	3
Washington DC	110010017	38.90	-77.05	COMMERCIAL	URBAN AND CENTER CITY	HIGHEST CONCENTRATION	10	20	54	3
Washington DC	110010025	38.98	-77.02	COMMERCIAL	URBAN AND CENTER CITY	POPULATION EXPOSURE	11	91	106	3
Washington DC	110010041	38.90	-76.95	RESIDENTIAL	URBAN AND CENTER CITY	UNKNOWN	-	8	141	4
Washington DC	110010043	38.92	-77.01	COMMERCIAL	URBAN AND CENTER CITY	HIGHEST CONCENTRATION	-	50	278	3
Washington DC	240053001	39.31	-76.47	RESIDENTIAL	SUBURBAN	MAX PRECURSOR EMISSIONS IMPACT	4.6	5	186	3
Washington DC	245100040	39.30	-76.60	RESIDENTIAL	URBAN AND CENTER CITY	HIGHEST CONCENTRATION	4.2	12	14	3
Washington DC	245100050	39.32	-76.58	RESIDENTIAL	URBAN AND CENTER CITY	POPULATION EXPOSURE	4	49	338	2
Washington DC	510130020	38.86	-77.06	COMMERCIAL	URBAN AND CENTER CITY	UNKNOWN	7	171	80	3
Washington DC	510590005	38.89	-77.47	AGRICULTURAL	RURAL	POPULATION EXPOSURE	4	77	315	5
Washington DC	510590018	38.74	-77.08	RESIDENTIAL	SUBURBAN	UNKNOWN	4	11	54	3
Washington DC	510591004	38.87	-77.14	COMMERCIAL	SUBURBAN	UNKNOWN	11	110	84	5
Washington DC	510591005	38.84	-77.16	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	-	83.9	50	3
Washington DC	510595001	38.93	-77.20	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	4	106	18	5
Washington DC	511071005	39.02	-77.49	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	4	0	75	3
Washington DC	511530009	38.86	-77.64	RESIDENTIAL	SUBURBAN	POPULATION EXPOSURE	4	111	196	2
Washington DC	515100009	38.81	-77.04	RESIDENTIAL	URBAN AND CENTER CITY	UNKNOWN	11	23	83	3

Notes:
[1] Land use indicates the prevalent land use within 1/4 mile of that site.
[2] Objective Indicates the reason for measuring air quality by the monitor.
[3] Monitor probe height (Ht) and site elevation (Elev) above sea level are given in meters (m).
[4] Distances (Dist) to roadway are given in meters (m). Major road types are defined as: 1=primary limited access or interstate, 2=primary US and State highways, 3=Secondary State and County, 4=freeway ramp, 5=other ramps.

Table A-8. Distance of location-specific ambient monitors to stationary sources emitting > 5 tons of NO_x per year, within a 10 kilometer distance of monitoring site.

			Distance (km) to Source emissions >5 tpy and within 10 km							Emissions (tpy) of Sources within 10 km and >5 tpy						
Location	ID	n[1]	mean	std	min	2.5	50	97.5	max	mean	std	min	2.5	50	97.5	max
Atlanta	130890002	1	4.9		4.9	4.9	4.9	4.9	4.9	34		34	34	34	34	34
Atlanta	130893001	3	7.2	4.0	2.7	2.7	9.2	9.8	9.8	34	2	32	32	34	36	36
Atlanta	131210048	5	6.4	3.3	0.7	0.7	7.3	8.9	8.9	1249	2106	22	22	39	4895	4895
Atlanta	132230003	0														
Atlanta	132470001	0														
Boston	230313002	5	3.5	1.5	1.0	1.0	3.8	4.9	4.9	642	769	31	31	203	1860	1860
Boston	250051005	3	6.7	1.6	5.5	5.5	6.0	8.5	8.5	9	4	5	5	8	14	14
Boston	250092006	12	6.8	2.7	2.5	2.5	7.4	9.9	9.9	439	1083	5	5	21	3794	3794
Boston	250094004	0														
Boston	250095005	10	5.8	2.3	1.7	1.7	6.7	8.6	8.6	201	347	6	6	29	923	923
Boston	250210009	57	5.8	2.5	1.0	1.8	5.9	9.9	9.9	106	283	5	5	9	1155	1419
Boston	250250002	62	4.6	2.4	0.6	1.1	4.3	9.4	9.7	98	273	5	5	9	1155	1419
Boston	250250021	55	6.1	2.3	1.5	1.7	6.5	9.8	9.8	130	304	5	5	11	1155	1419
Boston	250250035	62	5.1	2.6	0.3	0.8	5.1	9.0	9.6	99	273	5	5	9	1155	1419
Boston	250250036	62	5.1	2.6	0.3	0.8	5.1	9.0	9.6	99	273	5	5	9	1155	1419
Boston	250250040	56	5.3	2.4	0.4	0.9	5.6	9.0	9.3	106	286	5	5	9	1155	1419
Boston	250250041	25	7.8	2.0	0.7	0.7	8.2	9.9	9.9	81	206	5	5	11	957	957
Boston	250250042	65	5.3	2.8	0.7	1.0	4.9	10.0	10.0	94	267	5	5	9	1155	1419
Boston	250251003	49	6.4	2.4	0.6	1.0	7.0	9.6	9.6	145	319	5	5	11	1155	1419
Boston	250270020	28	3.7	2.5	0.1	0.1	2.9	8.6	8.6	58	165	5	5	13	868	868
Boston	250270023	28	3.6	2.4	0.4	0.4	3.0	8.4	8.4	58	165	5	5	13	868	868
Boston	330110016	0														
Boston	330110019	0														
Boston	330110020	0														
Boston	330150009	5	3.3	1.0	2.0	2.0	3.3	4.4	4.4	642	769	31	31	203	1860	1860
Boston	330150013	1	8.4		8.4	8.4	8.4	8.4	8.4	29		29	29	29	29	29
Boston	330150014	5	4.0	1.8	1.0	1.0	4.4	5.5	5.5	642	769	31	31	203	1860	1860
Boston	330150015	5	3.1	0.9	1.9	1.9	3.0	4.1	4.1	642	769	31	31	203	1860	1860
Chicago	170310037	17	5.6	2.7	0.7	0.7	5.7	9.5	9.5	18	31	5	5	7	126	126
Chicago	170310063	57	4.9	3.2	0.4	0.5	4.9	9.4	10.0	110	416	5	5	9	1677	2465
Chicago	170310064	33	6.9	2.5	1.2	1.2	6.9	10.0	10.0	94	428	5	5	10	2465	2465
Chicago	170310075	31	7.3	2.7	0.8	0.8	8.4	9.9	9.9	10	7	5	5	7	36	36
Chicago	170310076	46	7.8	2.3	1.3	1.6	8.4	9.8	9.9	170	463	5	5	10	1677	2204
Chicago	170313101	30	6.6	2.2	2.7	2.7	7.2	9.7	9.7	313	1638	5	5	9	8985	8985
Chicago	170313103	30	6.6	2.2	2.7	2.7	7.2	9.7	9.7	313	1638	5	5	9	8985	8985

Table A-8. Distance of location-specific ambient monitors to stationary sources emitting > 5 tons of NO_x per year, within a 10 kilometer distance of monitoring site.

Location	ID	n[1]	Distance (km) to Source emissions >5 tpy and within 10 km							Emissions (tpy) of Sources within 10 km and >5 tpy						
			mean	std	min	2.5	50	97.5	max	mean	std	min	2.5	50	97.5	max
Chicago	170314002	63	6.7	2.6	0.5	0.5	7.2	9.8	9.9	122	407	5	5	9	1677	2465
Chicago	170314201	7	6.5	1.5	4.0	4.0	6.6	9.0	9.0	8	3	5	5	8	14	14
Chicago	170314201	7	6.5	1.5	4.0	4.0	6.6	9.0	9.0	8	3	5	5	8	14	14
Chicago	170318003	63	7.3	2.0	1.7	2.3	8.0	9.6	9.7	361	1201	5	5	18	6216	7141
Chicago	171971011	1	4.0		4.0	4.0	4.0	4.0	4.0	20		20	20	20	20	20
Chicago	180890022	8	5.1	3.8	0.8	0.8	4.1	9.4	9.4	815	1680	8	8	243	4936	4936
Chicago	180891016	8	4.7	2.4	2.1	2.1	4.1	7.6	7.6	815	1680	8	8	243	4936	4936
Cleveland	390350043	5	8.1	1.9	5.2	5.2	8.3	9.9	9.9	673	664	126	126	284	1476	1476
Cleveland	390350060	4	4.1	2.4	1.0	1.0	4.4	6.4	6.4	810	681	165	165	800	1476	1476
Cleveland	390350066	5	8.0	1.9	5.2	5.2	8.3	9.8	9.8	673	664	126	126	284	1476	1476
Cleveland	390350070	5	7.6	1.8	5.5	5.5	7.3	9.7	9.7	673	664	126	126	284	1476	1476
Colorado Springs	080416001	4	5.1	4.4	0.8	0.8	5.1	9.1	9.1	780	1374	16	16	133	2835	2835
Colorado Springs	080416004	10	5.9	2.2	3.5	3.5	5.6	9.8	9.8	48	80	5	5	17	267	267
Colorado Springs	080416005	9	7.5	2.1	3.3	3.3	8.1	9.5	9.5	490	1393	5	5	11	4205	4205
Colorado Springs	080416006	0														
Colorado Springs	080416009	4	5.2	4.3	1.0	1.0	5.3	9.3	9.3	780	1374	16	16	133	2835	2835
Colorado Springs	080416011	14	5.0	2.3	2.0	2.0	5.8	9.6	9.6	345	1113	5	5	22	4205	4205
Colorado Springs	080416013	14	6.3	2.9	2.1	2.1	6.9	9.9	9.9	346	1113	5	5	27	4205	4205
Colorado Springs	080416018	11	6.9	1.7	4.3	4.3	7.1	9.6	9.6	430	1254	5	5	34	4205	4205
Denver	080013001	34	5.3	1.8	1.6	1.6	4.7	9.5	9.5	310	1622	5	5	15	9483	9483
Denver	080050003	19	6.7	3.7	1.0	1.0	9.1	10.0	10.0	313	1233	5	5	17	5404	5404
Denver	080310002	52	5.3	2.5	0.9	0.9	5.8	9.7	9.8	319	1495	5	5	14	5404	9483
Denver	080590006	9	5.9	2.1	2.7	2.7	6.3	8.6	8.6	63	66	11	11	39	182	182
Denver	080590008	9	6.2	2.0	3.7	3.7	6.1	10.0	10.0	59	68	8	8	13	182	182
Denver	080590009	10	6.5	3.2	2.5	2.5	7.0	9.9	9.9	53	66	6	6	13	182	182
Denver	080590010	7	5.5	3.1	1.1	1.1	5.6	9.2	9.2	73	71	12	12	44	182	182
Detroit	260990009	4	4.9	3.2	0.3	0.3	5.7	7.7	7.7	63	70	7	7	46	152	152
Detroit	261630016	51	7.4	2.1	1.3	2.0	7.9	9.8	9.9	387	797	5	6	41	3087	3762
Detroit	261630019	32	6.3	2.2	2.6	2.6	6.5	10.0	10.0	57	168	5	5	12	837	837
El Paso	481410027	22	8.1	1.6	1.5	1.5	8.6	9.3	9.3	99	195	5	5	29	912	912
El Paso	481410028	24	2.2	1.9	0.9	0.9	1.6	9.3	9.3	127	338	5	5	32	1679	1679
El Paso	481410037	15	8.7	2.6	0.1	0.1	9.4	10.0	10.0	135	230	5	5	38	912	912
El Paso	481410044	25	5.9	1.2	4.4	4.4	5.6	9.5	9.5	158	366	5	5	32	1679	1679
El Paso	481410055	24	2.8	1.8	1.6	1.6	2.2	9.6	9.6	127	338	5	5	32	1679	1679
El Paso	481410057	0														
El Paso	481410058	16	8.8	0.4	8.4	8.4	8.6	9.5	9.5	31	30	5	5	23	106	106
Jacksonville	120310032	20	5.1	3.0	0.7	0.7	5.7	9.6	9.6	201	407	5	5	31	1642	1642

Table A-8. Distance of location-specific ambient monitors to stationary sources emitting > 5 tons of NO_x per year, within a 10 kilometer distance of monitoring site.

Location	ID	n[1]	Distance (km) to Source emissions >5 tpy and within 10 km							Emissions (tpy) of Sources within 10 km and >5 tpy						
			mean	std	min	2.5	50	97.5	max	mean	std	min	2.5	50	97.5	max
Las Vegas	320030022	7	4.6	0.9	3.8	3.8	3.9	5.6	5.6	175	222	30	30	77	650	650
Las Vegas	320030023	0														
Las Vegas	320030073	0														
Las Vegas	320030078	0														
Las Vegas	320030539	5	6.9	1.2	4.7	4.7	7.2	7.9	7.9	816	760	18	18	851	1665	1665
Las Vegas	320030557	4	9.1	1.2	7.3	7.3	9.7	9.7	9.7	807	877	18	18	772	1665	1665
Las Vegas	320030563	1	7.6		7.6	7.6	7.6	7.6	7.6	84		84	84	84	84	84
Las Vegas	320030601	0														
Las Vegas	320031019	0														
Las Vegas	320032002	1	9.9		9.9	9.9	9.9	9.9	9.9	84		84	84	84	84	84
Los Angeles	060370002	7	3.1	1.1	1.6	1.6	2.9	4.5	4.5	10	4	5	5	9	16	16
Los Angeles	060370016	7	7.5	1.8	4.5	4.5	8.5	8.9	8.9	12	8	5	5	9	29	29
Los Angeles	060370030	35	5.5	2.3	2.1	2.1	5.2	9.8	9.8	23	27	5	5	11	115	115
Los Angeles	060370113	7	4.3	3.1	1.3	1.3	3.2	9.8	9.8	15	10	5	5	13	36	36
Los Angeles	060370206	11	5.6	2.2	2.3	2.3	5.8	9.2	9.2	32	31	6	6	20	109	109
Los Angeles	060371002	18	5.7	2.6	0.1	0.1	6.0	9.9	9.9	47	59	6	6	24	215	215
Los Angeles	060371103	31	6.5	2.7	1.8	1.8	7.2	10.0	10.0	18	21	5	5	10	86	86
Los Angeles	060371201	7	5.1	1.2	3.3	3.3	5.5	6.5	6.5	10	4	6	6	10	15	15
Los Angeles	060371301	45	6.8	2.1	1.2	2.5	7.1	9.7	10.0	22	24	5	5	12	86	115
Los Angeles	060371601	22	6.5	2.3	2.3	2.3	7.2	9.7	9.7	28	33	5	5	12	115	115
Los Angeles	060371701	13	6.1	3.0	1.1	1.1	7.0	9.7	9.7	22	20	5	5	16	70	70
Los Angeles	060372005	10	5.2	3.5	0.2	0.2	5.5	10.0	10.0	12	8	5	5	9	30	30
Los Angeles	060374002	55	6.4	2.3	1.7	2.2	6.2	9.9	9.9	76	159	5	5	16	744	789
Los Angeles	060375001	32	5.1	2.4	0.3	0.3	4.8	9.6	9.6	205	754	6	6	21	4256	4256
Los Angeles	060375005	25	4.6	2.4	1.4	1.4	4.6	9.9	9.9	224	850	6	6	21	4256	4256
Los Angeles	060376002	5	5.6	1.8	3.6	3.6	5.8	7.8	7.8	29	20	8	8	18	54	54
Los Angeles	060376012	6	6.2	2.5	3.0	3.0	6.8	9.7	9.7	26	19	8	8	18	54	54
Los Angeles	060379002	4	7.8	1.0	6.8	6.8	7.7	9.2	9.2	22	28	6	6	9	64	64
Los Angeles	060379033	4	6.3	0.8	5.3	5.3	6.4	7.1	7.1	22	28	6	6	9	64	64
Los Angeles	060590001	17	6.4	2.4	2.8	2.8	7.2	9.4	9.4	14	12	5	5	8	46	46
Los Angeles	060590007	17	6.4	2.4	2.8	2.8	7.2	9.4	9.4	14	12	5	5	8	46	46
Los Angeles	060591003	14	6.1	2.2	2.1	2.1	6.0	9.3	9.3	65	116	5	5	10	434	434
Los Angeles	060595001	16	7.9	1.6	3.4	3.4	8.2	9.5	9.5	19	26	6	6	9	109	109
Los Angeles	060650012	0														
Los Angeles	060655001	0														
Los Angeles	060658001	12	7.4	2.2	3.6	3.6	7.4	9.8	9.8	119	358	5	5	10	1254	1254
Los Angeles	060659001	2	4.6	5.9	0.4	0.4	4.6	8.7	8.7	11	9	5	5	11	17	17

Table A-8. Distance of location-specific ambient monitors to stationary sources emitting > 5 tons of NO_x per year, within a 10 kilometer distance of monitoring site.

			Distance (km) to Source emissions >5 tpy and within 10 km							Emissions (tpy) of Sources within 10 km and >5 tpy						
Location	ID	n[1]	mean	std	min	2.5	50	97.5	max	mean	std	min	2.5	50	97.5	max
Los Angeles	060710001	3	6.9	1.9	5.3	5.3	6.5	9.0	9.0	209	321	10	10	38	579	579
Los Angeles	060710012	0														
Los Angeles	060710014	3	6.0	2.6	3.5	3.5	5.9	8.6	8.6	199	327	6	6	15	577	577
Los Angeles	060710015	3	4.4	4.6	1.7	1.7	1.8	9.7	9.7	752	1045	12	12	296	1948	1948
Los Angeles	060710017	0														
Los Angeles	060710306	3	6.1	2.6	3.6	3.6	5.7	8.9	8.9	199	327	6	6	15	577	577
Los Angeles	060711004	19	7.3	1.7	4.3	4.3	7.4	9.8	9.8	57	120	5	5	18	492	492
Los Angeles	060711234	2	1.6	0.4	1.3	1.3	1.6	1.9	1.9	1122	1168	296	296	1122	1948	1948
Los Angeles	060712002	20	5.7	2.2	2.0	2.0	5.8	9.6	9.6	44	65	5	5	17	250	250
Los Angeles	060714001	1	6.5		6.5	6.5	6.5	6.5	6.5	577		577	577	577	577	577
Los Angeles	060719004	8	5.8	2.5	1.5	1.5	5.7	9.0	9.0	171	438	5	5	10	1254	1254
Los Angeles	061110005	5	6.9	2.5	3.1	3.1	7.7	9.6	9.6	68	118	8	8	19	278	278
Los Angeles	061110007	20	4.7	2.2	1.7	1.7	4.2	9.3	9.3	25	20	5	5	18	76	76
Los Angeles	061111003	0														
Los Angeles	061111004	0														
Los Angeles	061112002	4	6.6	1.0	5.2	5.2	6.8	7.5	7.5	63	113	5	5	7	232	232
Los Angeles	061112003	3	5.5	1.3	4.1	4.1	5.6	6.7	6.7	18	4	14	14	20	22	22
Los Angeles	061113001	7	5.1	2.3	1.9	1.9	5.9	7.4	7.4	35	51	5	5	13	146	146
Miami	120110003	0														
Miami	120110031	0														
Miami	120118002	0														
Miami	120860027	3	4.1	4.2	1.6	1.6	1.8	8.9	8.9	31	19	14	14	27	51	51
Miami	120864002	8	7.0	2.6	1.3	1.3	7.8	9.1	9.1	22	15	8	8	18	51	51
New York	090010113	7	4.4	3.1	1.4	1.4	3.4	8.8	8.8	538	711	48	48	192	1689	1689
New York	090019003	3	6.3	2.0	4.0	4.0	7.4	7.5	7.5	127	179	12	12	37	333	333
New York	090090027	5	2.7	1.0	1.3	1.3	2.7	3.9	3.9	280	484	14	14	86	1144	1144
New York	090091123	6	3.3	2.8	1.2	1.2	2.4	8.9	8.9	234	447	7	7	64	1144	1144
New York	340030001	48	6.5	2.2	2.9	2.9	6.3	9.8	9.9	468	1506	6	7	31	4440	9022
New York	340030005	18	6.8	2.9	0.1	0.1	7.4	10.0	10.0	53	79	6	6	21	307	307
New York	340130011	43	5.4	2.9	0.7	0.8	5.8	9.4	9.5	273	1372	5	5	18	640	9022
New York	340130016	44	5.5	2.8	0.1	1.0	6.3	9.4	9.6	267	1357	5	5	18	640	9022
New York	340131003	32	6.4	2.0	2.1	2.1	6.8	9.3	9.3	77	149	5	5	22	640	640
New York	340170006	42	6.9	2.5	1.1	1.6	7.7	9.5	9.5	369	1420	5	6	24	2213	9022
New York	340210005	8	5.4	1.7	3.2	3.2	5.5	7.3	7.3	115	244	8	8	32	718	718
New York	340230011	20	6.1	2.8	1.0	1.0	7.0	9.5	9.5	95	175	6	6	36	792	792
New York	340273001	1	8.5		8.5	8.5	8.5	8.5	8.5	20		20	20	20	20	20
New York	340390004	46	6.3	2.4	0.7	0.9	6.6	9.6	9.7	134	341	5	6	21	594	2213

Table A-8. Distance of location-specific ambient monitors to stationary sources emitting > 5 tons of NO_x per year, within a 10 kilometer distance of monitoring site.

			Distance (km) to Source emissions >5 tpy and within 10 km							Emissions (tpy) of Sources within 10 km and >5 tpy						
Location	ID	n[1]	mean	std	min	2.5	50	97.5	max	mean	std	min	2.5	50	97.5	max
New York	340390008	12	7.2	2.1	3.2	3.2	8.0	10.0	10.0	23	36	5	5	10	134	134
New York	360050080	54	6.4	2.3	1.8	1.8	6.4	9.9	9.9	241	776	6	6	29	3676	4440
New York	360050083	37	6.0	2.8	1.6	1.6	6.3	9.9	9.9	171	725	6	6	21	4440	4440
New York	360050110	55	5.9	2.2	2.1	2.6	5.7	9.6	9.9	236	769	6	6	29	3676	4440
New York	360470011	56	5.9	2.7	0.7	1.5	5.7	9.7	10.0	296	787	7	7	42	3676	4440
New York	360590005	7	6.3	3.4	1.9	1.9	8.1	9.8	9.8	372	500	7	7	223	1451	1451
New York	360610010	52	5.9	2.5	0.3	1.4	6.1	9.6	9.8	494	1453	5	7	50	4440	9022
New York	360610056	54	5.4	2.6	0.3	1.4	5.5	9.9	10.0	470	1429	7	7	50	4440	9022
New York	360810097	11	6.3	2.1	2.9	2.9	6.9	9.5	9.5	65	77	13	13	26	246	246
New York	360810098	48	7.1	2.3	1.6	2.8	7.8	9.8	9.8	262	820	6	7	31	3676	4440
New York	360810124	24	7.0	2.6	2.1	2.1	8.0	10.0	10.0	436	1136	8	8	26	4440	4440
New York	361030009	3	3.8	3.2	2.0	2.0	2.0	7.6	7.6	537	759	40	40	161	1410	1410
Philadelphia	100031003	39	5.5	2.5	1.6	1.6	6.2	9.7	9.7	282	481	5	5	62	2058	2058
Philadelphia	100031007	11	9.2	0.6	8.0	8.0	9.3	9.8	9.8	323	494	6	6	63	1351	1351
Philadelphia	100032004	32	4.8	1.9	0.7	0.7	4.7	8.4	8.4	223	403	5	5	45	1312	1312
Philadelphia	340070003	69	7.7	2.3	1.8	2.0	8.5	10.0	10.0	87	196	5	5	24	477	1478
Philadelphia	420170012	10	4.1	2.3	1.2	1.2	4.2	9.4	9.4	85	96	11	11	57	275	275
Philadelphia	420450002	30	4.8	2.6	0.2	0.2	5.4	9.5	9.5	504	1055	5	5	73	4968	4968
Philadelphia	420910013	12	5.1	2.5	1.4	1.4	4.3	8.8	8.8	89	232	5	5	12	823	823
Philadelphia	421010004	32	5.9	2.5	1.0	1.0	5.6	9.9	9.9	58	111	5	5	20	571	571
Philadelphia	421010029	74	5.7	2.1	1.1	1.8	5.6	9.7	9.7	74	148	5	5	19	477	1033
Philadelphia	421010047	73	5.2	2.1	0.6	0.8	4.8	9.6	9.7	95	221	5	5	19	1033	1478
Phoenix	040130019	11	6.8	2.2	4.2	4.2	6.7	9.8	9.8	106	313	5	5	10	1049	1049
Phoenix	040133002	6	4.1	2.3	1.3	1.3	4.1	6.9	6.9	21	19	5	5	15	56	56
Phoenix	040133003	10	6.7	1.4	4.1	4.1	6.6	9.0	9.0	50	80	9	9	24	272	272
Phoenix	040133010	10	5.0	0.9	3.5	3.5	4.9	6.6	6.6	115	328	5	5	10	1049	1049
Phoenix	040134005	11	5.8	2.9	0.8	0.8	7.0	9.4	9.4	81	116	6	6	38	350	350
Phoenix	040134011	1	6.4		6.4	6.4	6.4	6.4	6.4	18		18	18	18	18	18
Phoenix	040139997	10	8.5	1.2	5.6	5.6	8.7	9.9	9.9	115	328	5	5	10	1049	1049
Provo	490490002	7	6.6	3.7	1.2	1.2	8.2	9.4	9.4	60	38	7	7	83	102	102
St Louis	171630010	48	7.0	2.8	1.3	1.9	8.0	9.8	9.9	112	178	5	5	17	538	848
St Louis	291830010	1	1.7		1.7	1.7	1.7	1.7	1.7	7821		7821	7821	7821	7821	7821
St Louis	291831002	9	7.5	2.1	4.3	4.3	7.7	9.9	9.9	1868	4704	7	7	8	14231	14231
St Louis	291890001	10	7.7	1.3	6.2	6.2	7.4	9.8	9.8	24	20	5	5	15	60	60
St Louis	291890004	6	8.9	1.5	6.9	6.9	9.8	10.0	10.0	38	37	7	7	28	105	105
St Louis	291890006	8	7.0	1.7	4.2	4.2	7.9	8.7	8.7	25	34	6	6	11	105	105
St Louis	291893001	16	7.3	2.0	3.4	3.4	7.6	9.6	9.6	22	43	5	5	11	181	181

Table A-8. Distance of location-specific ambient monitors to stationary sources emitting > 5 tons of NO_x per year, within a 10 kilometer distance of monitoring site.

Location	ID	n[1]	Distance (km) to Source emissions >5 tpy and within 10 km							Emissions (tpy) of Sources within 10 km and >5 tpy						
			mean	std	min	2.5	50	97.5	max	mean	std	min	2.5	50	97.5	max
St Louis	291895001	11	7.5	1.7	4.3	4.3	7.7	9.7	9.7	46	62	5	5	15	181	181
St Louis	291897002	16	5.7	1.8	2.0	2.0	5.4	9.7	9.7	28	37	5	5	15	143	143
St Louis	291897003	16	6.2	2.0	2.5	2.5	6.0	9.6	9.6	24	33	5	5	15	143	143
St Louis	295100072	46	6.3	2.5	0.7	2.0	6.5	9.9	9.9	77	150	5	5	16	508	848
St Louis	295100080	31	6.9	2.2	0.4	0.4	7.3	10.0	10.0	98	176	5	5	17	848	848
St Louis	295100086	35	6.7	2.3	1.7	1.7	6.6	9.9	9.9	94	168	5	5	17	848	848
Washington DC	110010017	13	5.4	2.4	2.9	2.9	4.5	9.7	9.7	557	1643	11	11	34	6009	6009
Washington DC	110010025	6	6.4	1.0	4.8	4.8	6.5	7.6	7.6	40	35	11	11	26	98	98
Washington DC	110010041	10	6.1	2.4	0.6	0.6	6.1	9.8	9.8	124	137	11	11	66	410	410
Washington DC	110010043	12	5.0	3.2	0.3	0.3	4.6	9.8	9.8	109	129	11	11	46	410	410
Washington DC	240053001	11	7.5	2.1	2.6	2.6	7.9	9.7	9.7	1034	3225	6	6	45	10756	10756
Washington DC	245100040	26	5.0	2.5	0.3	0.3	4.9	9.5	9.5	122	220	6	6	56	1118	1118
Washington DC	245100050	24	6.2	2.1	2.4	2.4	6.0	10.0	10.0	129	227	6	6	56	1118	1118
Washington DC	510130020	14	6.2	2.6	1.5	1.5	5.4	9.8	9.8	558	1579	11	11	46	6009	6009
Washington DC	510590005	2	4.9	4.8	1.4	1.4	4.9	8.3	8.3	13	7	8	8	13	18	18
Washington DC	510590018	6	8.4	0.4	8.0	8.0	8.4	9.2	9.2	1104	2413	9	9	13	6009	6009
Washington DC	510591004	10	7.4	1.6	3.7	3.7	7.8	9.3	9.3	80	173	14	14	19	571	571
Washington DC	510591005	8	6.3	2.0	4.6	4.6	5.5	9.4	9.4	94	193	14	14	19	571	571
Washington DC	510595001	4	6.5	2.8	3.2	3.2	6.8	9.2	9.2	30	19	17	17	22	58	58
Washington DC	511071005	5	7.1	2.3	4.5	4.5	6.5	9.6	9.6	14	8	8	8	12	27	27
Washington DC	511530009	0														
Washington DC	515100009	9	7.0	2.4	1.1	1.1	7.9	8.8	8.8	809	1959	14	14	156	6009	6009

n is the number of sources emitting >5 tons per year (tpy) NO_x within a 10 kilometer radius of a monitor in a particular location.
[2] The min, 2.5, med, 97.5, and max represent the minimum, 2.5th, median, 97.5th, and maximum percentiles of the distribution for the distance in meters (m) to the source emission.

A-5 Spatial and Temporal Air Quality Analyses

A-5.1 Introduction

An analysis of the air quality was performed to determine spatial and temporal trends, considering locations, monitoring sites within locations, and time-averaging of ambient NO_2 concentrations collected from 1995 through 2006. The purpose is to present relevant information on the air quality as it relates to both the current form of the standard (annual average concentration) and the exposure concentration and duration associated with adverse health effects (1-hour).

A-5.2 Approach

To evaluate variability in NO_2 concentrations, temporal and spatial distributions of summary statistics were computed in addition to use of statistical tests to compare distributions between years and/or monitors and/or locations. For a given location, the variability within that location is defined by the distribution of the annual summary statistics across years and monitors and by the distribution of the hourly concentrations across hours and monitors. The summary statistics were compiled into tables and used to construct figures for visual comparison and for statistical analysis.

Boxplots were constructed to display the distribution across sites and years (or hours for the hourly concentrations) for a single location. The box extends from the 25th to the 75th percentile, with the median shown as the line inside the box. The whiskers extend from the box to the 5th and 95th percentiles. The extreme values in the upper and lower tails beyond the 5th and 95th percentiles are not shown to allow for similar scaling along the y-axis for the plotted independent variables. The mean is plotted as a dot; typically it would appear inside the box, however it will fall outside the box if the distribution is highly skewed. All concentrations are shown in parts per billion (ppb).

Q-Q plots also display the distribution in the calculated air quality metrics across sites and years (or hours for the hourly concentrations) for a single location. The Q-Q plot is used to compare the observed cumulative distribution to a standard statistical distribution. In this case the observed distributions are compared with a log-normal distribution, so that the vertical scale is logarithmic. The horizontal scale is the quantile of a standard normal distribution, so that if there are N observed values, then the k^{th} highest value is plotted against the quantile probit(p), where probit is the inverse of the standard normal distribution function, and *p* is the plotting point. The plotting points were chosen as $p = (k-3/8)/(N+1/4)$ for the annual statistics and $p = k/(N+1)$ for the hourly concentrations. If the distribution were exactly log-normal, then the curve would be a straight line. The median value is the y-value when the normal quantile equals zero. The slope of the line is related to the standard deviation of the logarithms, so that the higher the slope, the higher the coefficient of variation (standard deviation divided by the mean for the raw data, before taking logarithms).

In addition to the tabular and graphical comparisons of the summary statistics, the distributions of each variable were compared using various statistical tests. An F-Statistic comparison compares the mean values between locations using a one way analysis of variance (ANOVA). This test assumed that for each location, the site-year or site-hour variables are normally distributed, with a mean that may vary with the location and a constant variance (i.e., the same for each location). Statistical significance was assigned for p-values less than or equal to 0.05. The Kruskal-Wallis Statistics are non-parametric tests that are extensions of the more familiar Wilcoxon tests to two or more groups. The analysis is valid if the difference between the variable and the location median has the same distribution for each location. If so, this procedure tests whether the location medians are equal. The test is also consistent under weaker assumptions against more general alternatives. The Mood Statistic comparisons are non-parametric tests that compare the scale statistics for two or more groups. The scale statistic measures variation about the central value, which is a non-parametric generalization of the standard deviation. This test assumes that all the groups have the same median. Specifically, suppose there is a total of N values, summing across all the locations to be compared. These N values are ranked from 1 to N, and the j^{th} highest value is given a score of $\{j - (N+1)/2\}^2$. The Mood statistic uses a one-way ANOVA statistic to compare the mean scores for each location. Thus the Mood statistic compares the variability between the different locations assuming that the medians are equal.

A-5.3 Summary Results by Locations

A summary of the important trends in NO_2 concentrations is reported in this section. Detailed air quality results (i.e., by year and within-location) are presented in section A-5.4, containing both tabular and graphic summaries of the spatial and temporal concentration distributions.

A broad view of the NO_2 monitoring concentrations across locations is presented in Figures A-1 and A-2. In general there is variability in NO_2 concentrations between the 20 locations. For example, in Los Angeles, the mean of annual means is approximately 24.3 ppb over the period of analysis, while considering the Not MSA grouping, the mean annual mean was about 7.0 ppb. Phoenix contained the highest mean annual mean of 27.3 ppb. Variability in the annual average concentrations was also present within locations, the magnitude of which varied by location. On average, the coefficient of variation in the annual mean concentrations was about 35%, however locations such as Jacksonville or Provo had COVs as low as 6% while locations such as Las Vegas and Not MSA contained COVs above 60%. Reasons for differing variability arise from the size of the monitoring network in a location, level of the annual mean concentration, underlying influence of temporal variability within particular locations, among others.

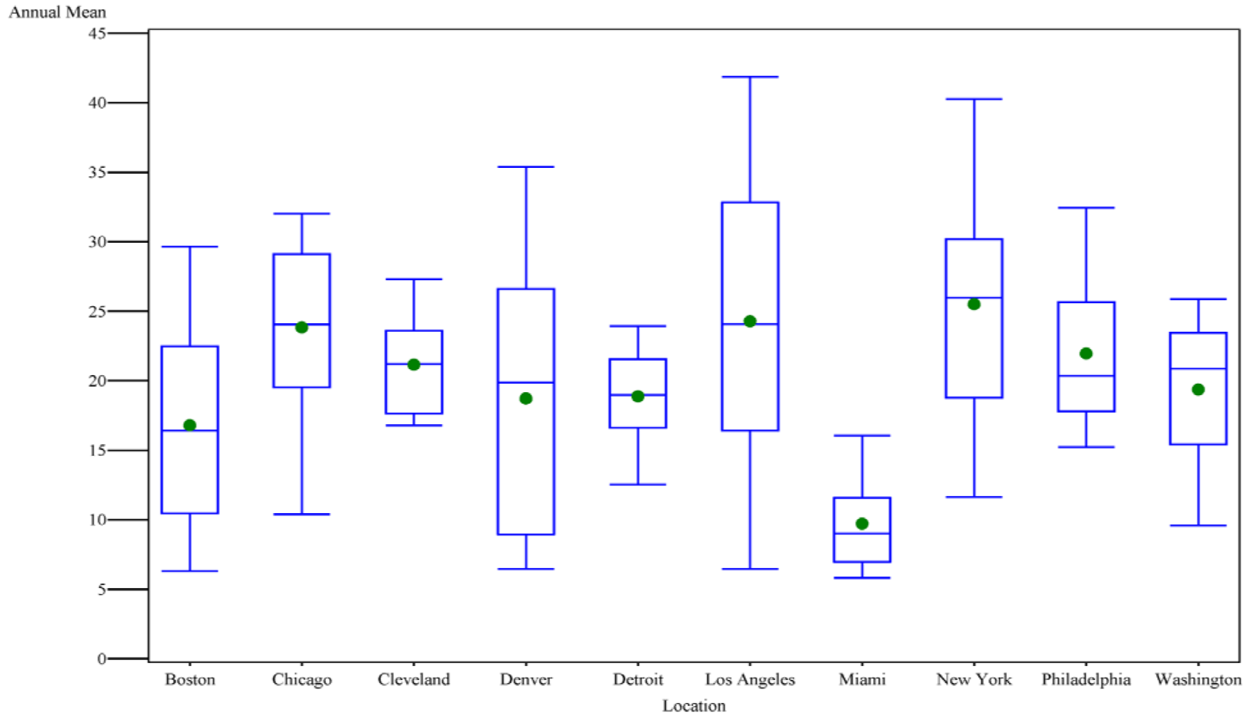

Figure A-1. Distributions of annual mean NO_2 ambient monitoring concentrations for selected CMSA locations, years 1995-2006.

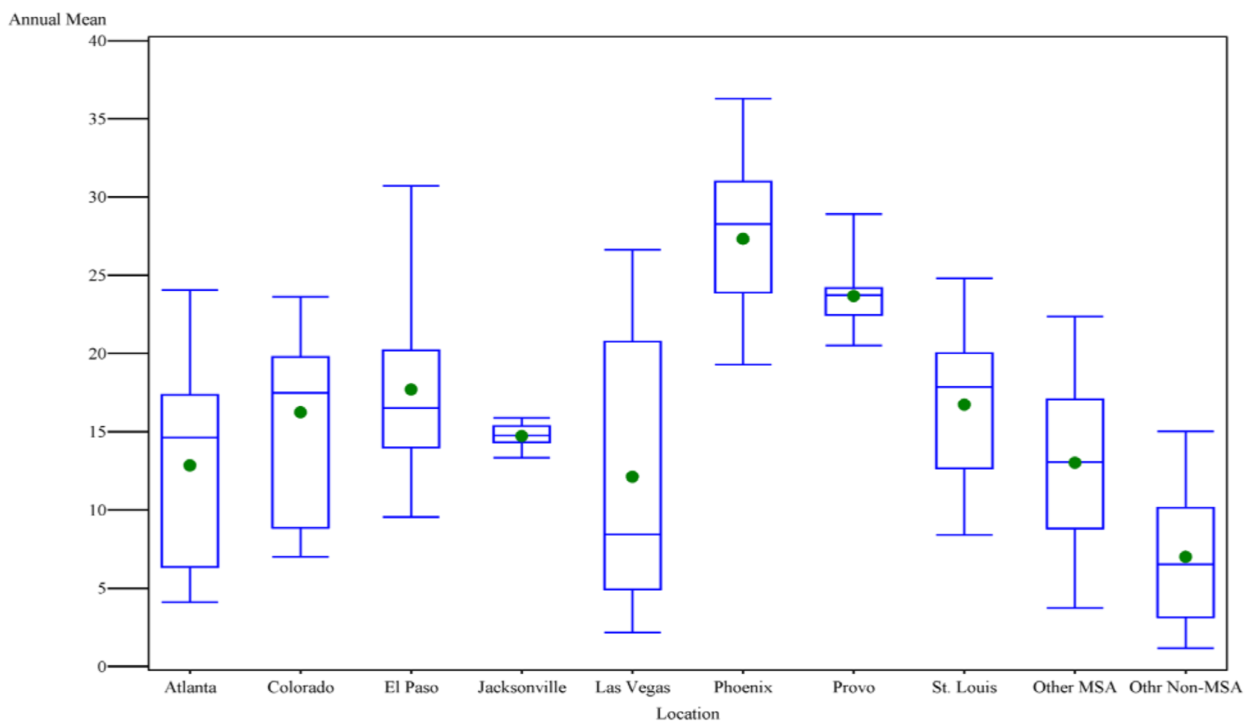

Figure A-2. Distributions of annual mean NO_2 ambient monitoring concentrations for selected MSA and grouped locations, years 1995-2006.

Differences in the distributions of hourly concentrations were of course consistent with that observed for the annual mean concentrations, and as expected there were differences in the

COVs across locations, ranging from about 60 to 120%. However, in comparing the 90 percent intervals (from the 5th to the 95th percentiles) of hourly concentrations across locations, the ranges are somewhat similar (for example see Figure 3 for the CMSA locations). This means that the intervals for the annual mean differ more than that of the hourly concentrations between locations likely due to the influence of high 1-hour NO_2 concentrations for certain locations.

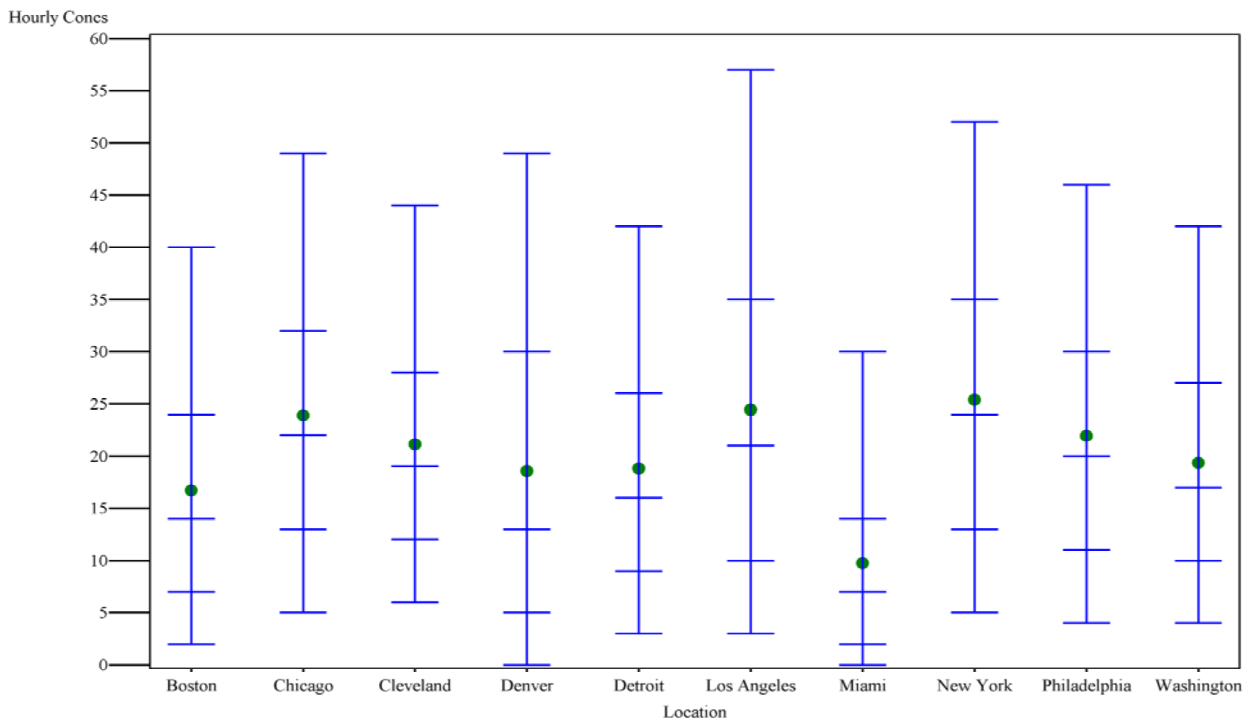

Figure A-3. Distributions[3] of hourly NO_2 ambient monitoring concentrations for selected CMSA locations, years 1995-2006.

This presence of extreme NO_2 concentrations is best illustrated in Figure 4 using a Q-Q plot that captures the full concentration distribution for each CMSA location. The Q-Q plots are generally curved rather than straight, such that the distributions do not appear to be log-normal. However, the annual mean and hourly concentration curves do tend to be approximately straight and parallel for values above the median (normal quantile = 0) through the 3rd quantile, suggesting that these upper tails of the distributions are approximately log-normal with approximately the same coefficients of variation. Beyond the 3rd quantile though, each distribution similarly and distinctly curves upwards, indicating a number of uncharacteristic NO_2 concentrations at each location when compared with the rest of their respective concentration distributions.

[3] The boxplots for hourly concentrations were created using a different procedure than for the annual statistics, because of the large number of hourly values and the inability of the graphing procedure to allow frequency weights. Therefore, the appropriate weighted percentiles and means were calculated and plotted as shown, but the vertical lines composing the sides of the box were omitted.

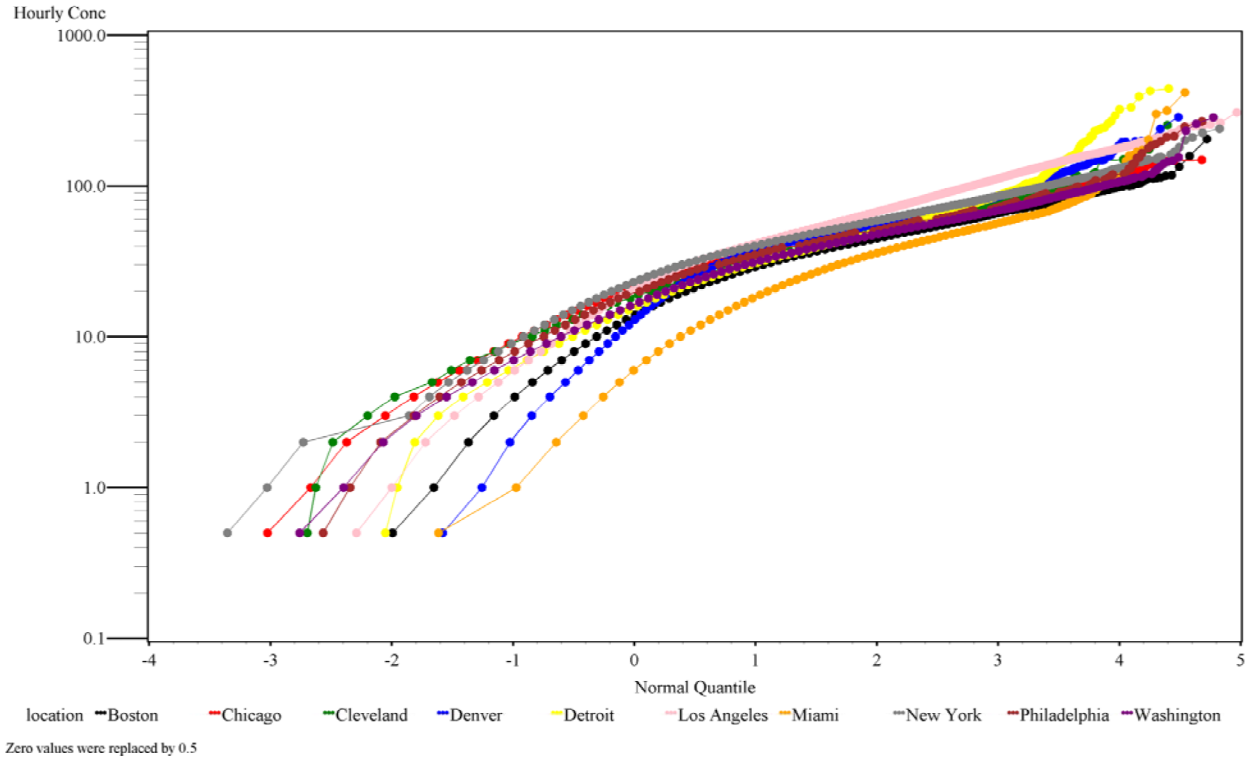

Figure A-4. Distributions of hourly NO_2 ambient concentration for selected CMSA locations, years 1995-2006.

Distributions of each variable (annual means and hourly concentrations) were compared between the different locations using statistical tests. The results in Table A-9 show statistically significant differences between locations for both variables and all three summary statistics (means, medians, and scales). This supports the previous observation that the distributions for the different locations are dissimilar.

Table A-9. Statistical test results for spatial comparisons of all location parameter distributions.

Concentration Parameter	Means Comparison		Central Values Comparison		Scales Comparison	
	F Statistic	p-value	Kruskal-Wallis	p-value	Mood	p-value
Annual Mean	148	<0.0001	1519	<0.0001	729	<0.0001
Hourly	330272	<0.0001	5414056	<0.0001	1354075	<0.0001

The distributions of NO_2 concentrations within locations were also evaluated. As an example, Figure A-5 illustrates the distribution of the annual mean NO_2 concentration at 10 monitoring sites within Philadelphia. The mean annual means vary from a minimum of 14.8 ppb (site 1000310071) to a maximum of 30.5 ppb (site 4210100471). The range of within-site variability can be attributed to the number of monitoring years available coupled with the observed trends in temporal variability across the monitoring period (discussed below in Section 2.4.4).

Distributions of each variable (annual means and hourly NO_2 concentrations) within locations (i.e., site distributions) were compared using statistical tests. The results in Table A-10 indicate statistically significant differences within locations for both variables and the central tendency statistics (means and medians), while scales were statistically significant for 38 out of 40 possible tests. This supports the previous observation that the distributions for the different locations are dissimilar.

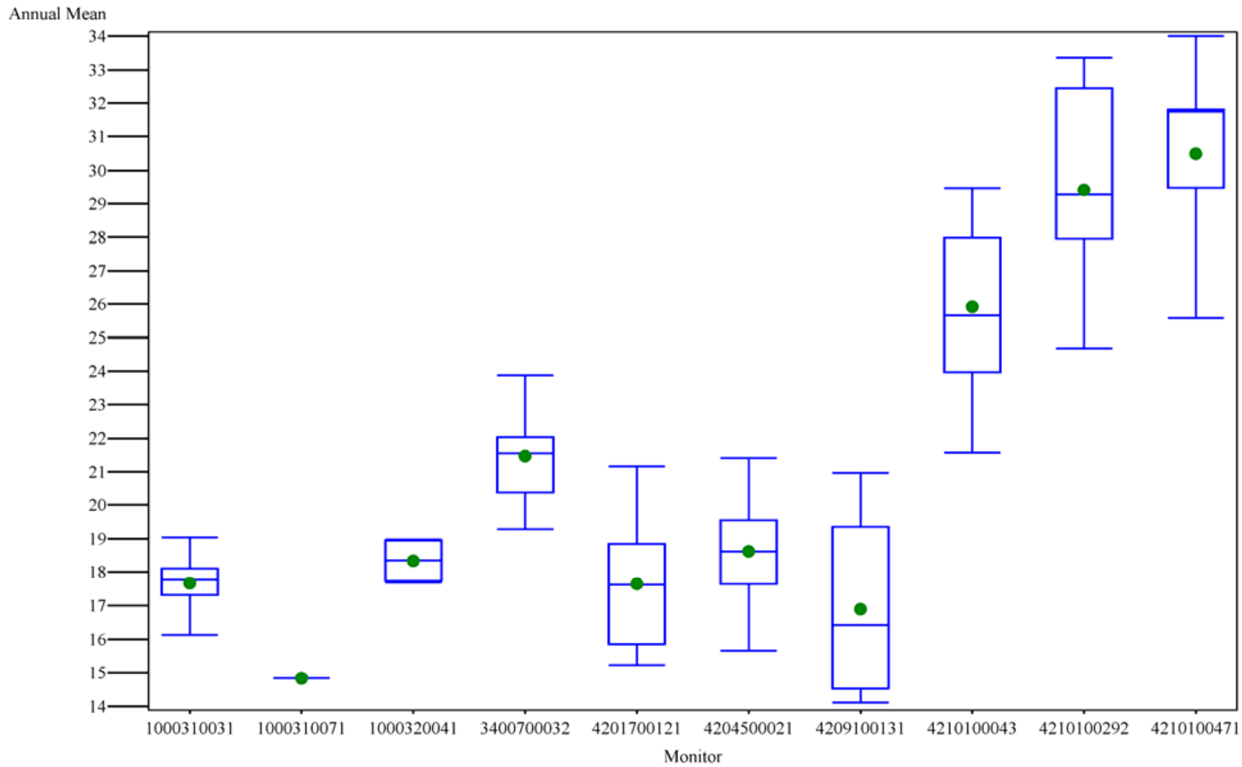

Figure A-5. Distributions of annual average NO_2 concentrations among 10 monitoring sites in Philadelphia CMSA, years 1995-2006.

Table A-10. Statistical test results for spatial comparisons of within location parameter distributions.

Concentration Parameter	Location	Means Comparison F Statistic	p-value	Central Values Comparison Kruskal-Wallis	p-value	Scales Comparison Mood	p-value
Annual Mean	Boston	47.3	<0.001	96.5	<0.001	79.9	<0.001
	Chicago	123	<0.001	76.7	<0.001	68.5	<0.001
	Cleveland	12.1	<0.001	15.4	0.002	7.5	0.058
	Denver	85.3	<0.001	32.0	<0.001	23.0	0.001
	Detroit	13.2	<0.001	13.1	0.001	7.8	0.020
	Los Angeles	49.0	<0.001	325	<0.001	240	<0.001
	Miami	111	<0.001	36.2	<0.001	29.9	<0.001
	New York	106	<0.001	163	<0.001	151	<0.001
	Philadelphia	48.9	<0.001	68.8	<0.001	33.0	<0.001
	Washington DC	48.6	<0.001	104	<0.001	71.2	<0.001
	Atlanta	119	<0.001	45.2	<0.001	28.6	<0.001
	Colorado Springs	8.7	<0.001	18.8	0.009	8.7	0.273
	El Paso	36.0	<0.001	31.6	<0.001	35.3	<0.001
	Las Vegas	137	<0.001	45.4	<0.001	35.2	<0.001

Concentration Parameter	Location	Means Comparison F Statistic	p-value	Central Values Comparison Kruskal-Wallis	p-value	Scales Comparison Mood	p-value
	Phoenix	20.4	<0.001	32.2	<0.001	23.6	0.001
	St. Louis	51.5	<0.001	82.1	<0.001	69.0	<0.001
	Other CMSA	82.5	<0.001	2152	<0.001	1934	<0.001
	Not MSA	76.9	<0.001	424	<0.001	372	<0.001
Hourly	Boston	17884	<0.001	312994	<0.001	59896	<0.001
	Chicago	11611	<0.001	142034	<0.001	37224	<0.001
	Cleveland	4191	<0.001	14102	<0.001	1985	<0.001
	Denver	25130	<0.001	104800	<0.001	2864	<0.001
	Detroit	4125	<0.001	10442	<0.001	424	<0.001
	Los Angeles	27288	<0.001	1050310	<0.001	269190	<0.001
	Miami	10669	<0.001	68580	<0.001	43090	<0.001
	New York	20052	<0.001	404234	<0.001	91104	<0.001
	Philadelphia	13759	<0.001	112129	<0.001	4903	<0.001
	Washington	14262	<0.001	223040	<0.001	30974	<0.001
	Atlanta	35917	<0.001	137022	<0.001	17330	<0.001
	Colorado Springs	5541	<0.001	48252	<0.001	3921	<0.001
	El Paso	10503	<0.001	57694	<0.001	18334	<0.001
	Las Vegas	22567	<0.001	136455	<0.001	28972	<0.001
	Phoenix	5626	<0.001	35645	<0.001	6747	<0.001
	St. Louis	14807	<0.001	178180	<0.001	47842	<0.001
	Other CMSA	19557	<0.001	6306431	<0.001	2164452	<0.001
	Not MSA	17630	<0.001	1580139	<0.001	491390	<0.001

A-5.4 Summary Results by Year

A broad view of the trend of NO_2 monitoring concentrations over time is presented in Figure A-6. The annual mean concentrations were calculated for each monitor site within each year to create a distribution of annual mean concentrations for each year. The distribution of annual mean concentrations generally decreases with each increasing year. On average, mean annual mean NO_2 concentrations consistently decrease from a high of 17.5 ppb in 1995 to the most recent mean of 12.3 ppb. Also notable is the consistent pattern in the decreasing concentrations across each years distribution, the shape of each curve is similar indicating that while concentrations have declined, the variability within each year is similar from year to year. The variability within a given year is representing spatial differences in annual average concentrations across the 20 locations.

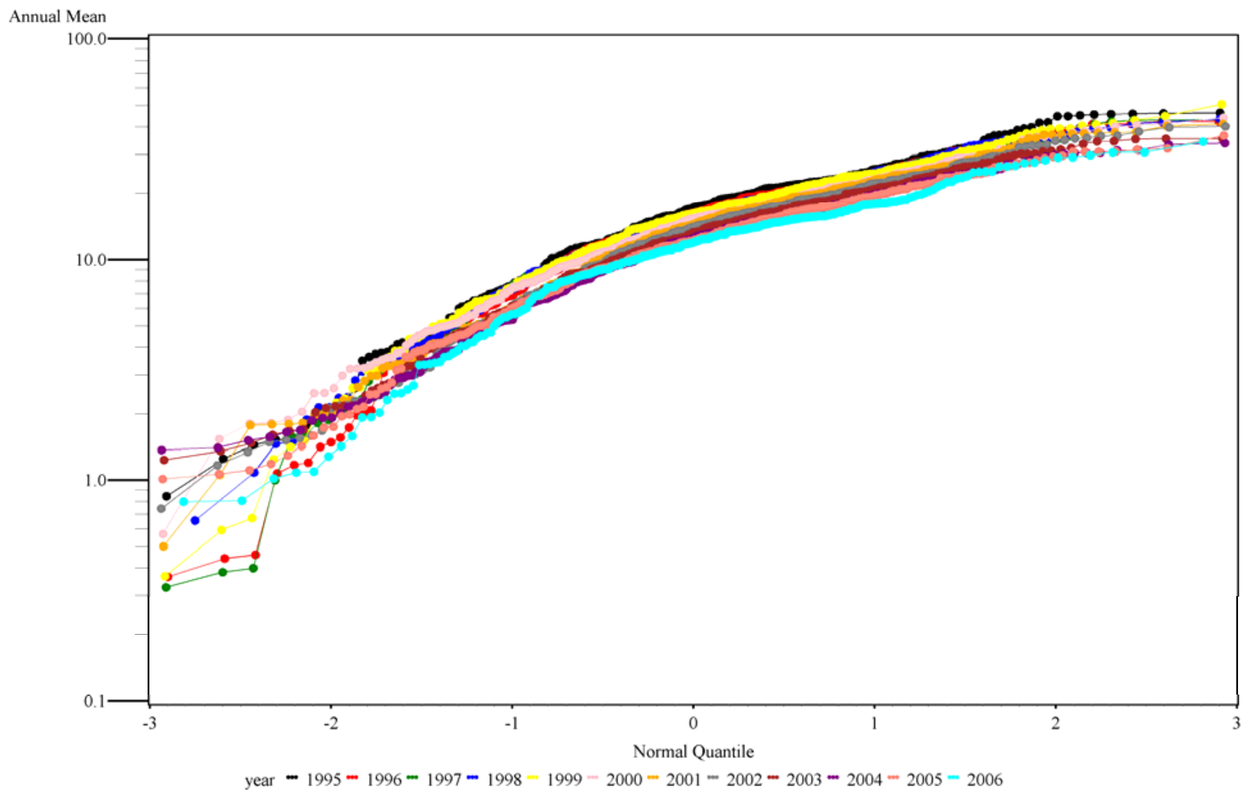

Figure A-6. Distributions of annual mean NO_2 concentrations for all monitors, years 1995-2006.

In general, temporal trends within a location were also consistent with the trends observed in all monitors, particularly where the location's monitoring network was comprised of several monitors. For example, Figure A-7 illustrates the temporal distributions of annual average NO_2 concentration in the Philadelphia CMSA, each comprising between 4 and 8 monitors in operation per year. Clearly NO_2 concentrations are decreased with increasing calendar year of monitoring with the lowest NO_2 concentrations in the more recent years of monitoring. The pattern of variability in NO_2 concentration within a year at this location is also similar when comparing across years based on similarities in the shape of each years respective curve.

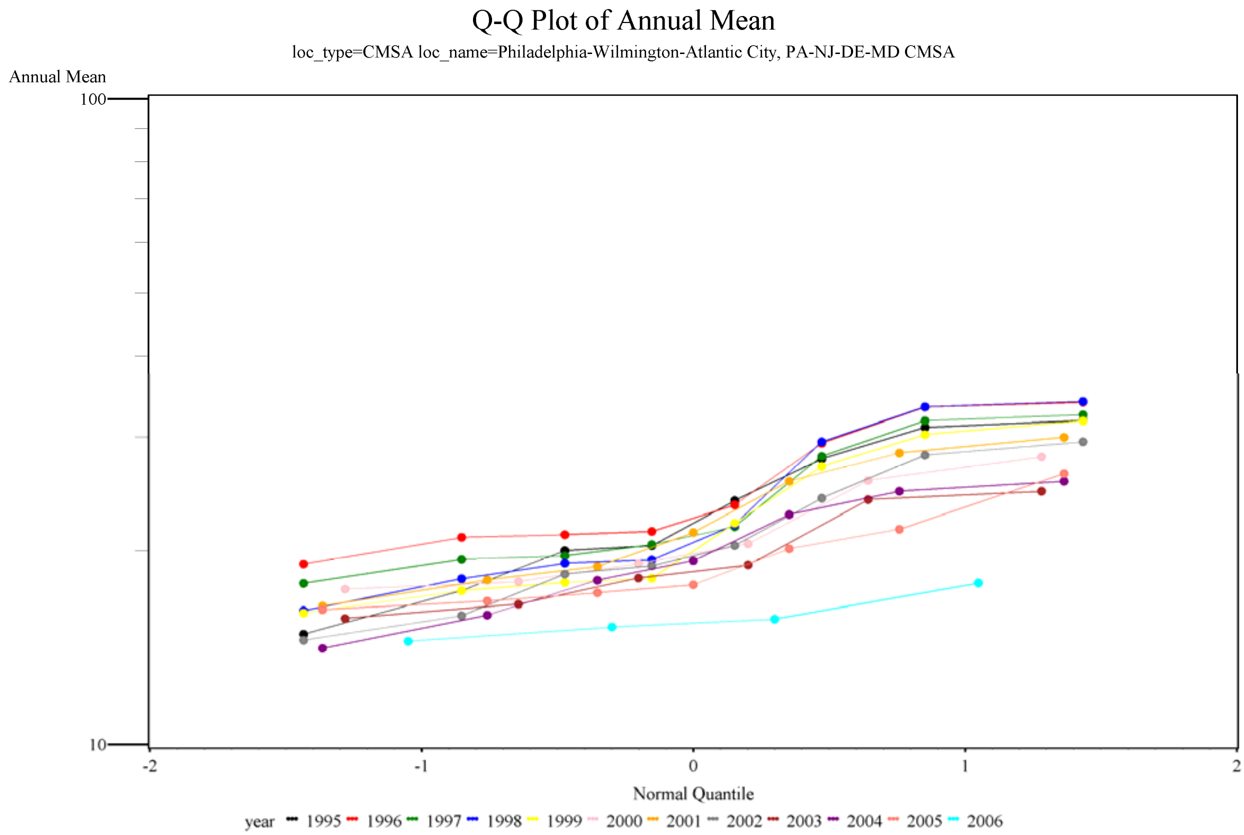

Figure A-7. Distributions of annual mean NO_2 concentrations for the Philadelphia CMSA, years 1995-2006.

In general, temporal trends within a location considering the hourly concentration data were consistent with the above, particularly where the monitoring network was comprised of several monitors. For example, Figure A-8 illustrates the temporal distribution for hourly NO_2 concentration in the Los Angeles CMSA, comprising between 26 and 36 monitors in operation per year. NO_2 concentrations are decreased with increasing calendar year of monitoring with the distribution of hourly concentrations lowest in the more recent years of monitoring. The pattern of variability in NO_2 concentration within a year at this location is also similar when comparing across years based on similarities in the shape of each years respective curve.

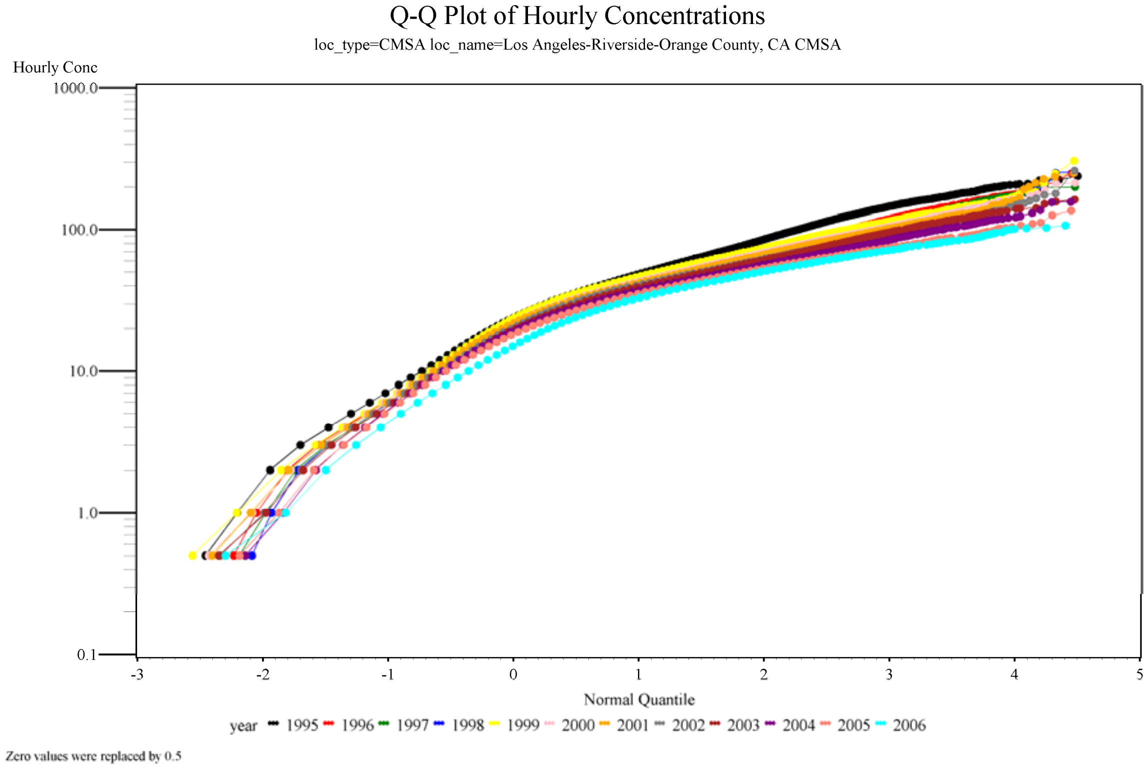

Figure A-8. Distributions of hourly NO_2 concentrations in the Los Angeles CMSA, years 1995-2006.

These temporal trends were confirmed by statistical comparison tests. The means and medians of the annual means and hourly concentrations compared across the different years were statistically significant (all $p<0.0001$). A Mood test indicated that, for the annual means, the scales were also significantly different (both the annual and hourly $p<0.001$). Note, however, that the Mood test derivation assumes that the medians of the annual means are the same for each year, whereas the plots and the Kruskall-Wallis test result implies that the medians are not the same. As noted before, Figure A-8 indicates that the Q-Q curves for different years have similar slopes but different intercepts, which implies that the annual means for different years have different mean values but similar coefficients of variation. In fact the coefficients of variation of the annual means are nearly identical for different years, ranging from 52 % to 55 %.

There were some exceptions to this temporal trend, particularly when considering the distribution of hourly concentrations and where a given location had only few monitors per year. Using Jacksonville as an example, Figure A-9 illustrates the same temporal trend in NO_2 concentrations as was observed above for much of the distribution, however distinctions are noted at the upper tails of the distribution for two years of data, 2002 and 2004. For Jacksonville, each years' hourly concentration distribution was based on only a single monitor. Where few monitors exist in a given location, atypical variability in one or a few monitors from year to year can greatly influence the distribution of short-term concentrations, particularly at the upper percentiles.

The same follows for assignment of statistical significance to temporal trends within locations. While annual average concentrations are observed to have declined over time within a location, the number of sites were typically few thus limiting the power of the statistical tests.

Only Los Angeles, El Paso, Phoenix, and Other CMSA were significant ($p<0.05$) for the central tendency tests, while only Los Angeles and Other CMSA were significant ($p<0.05$) for scale (data not shown). All hourly concentrations comparison tests for years within each location were statistically significant ($p<0.05$) for all three test statistics (mean, median, scale).

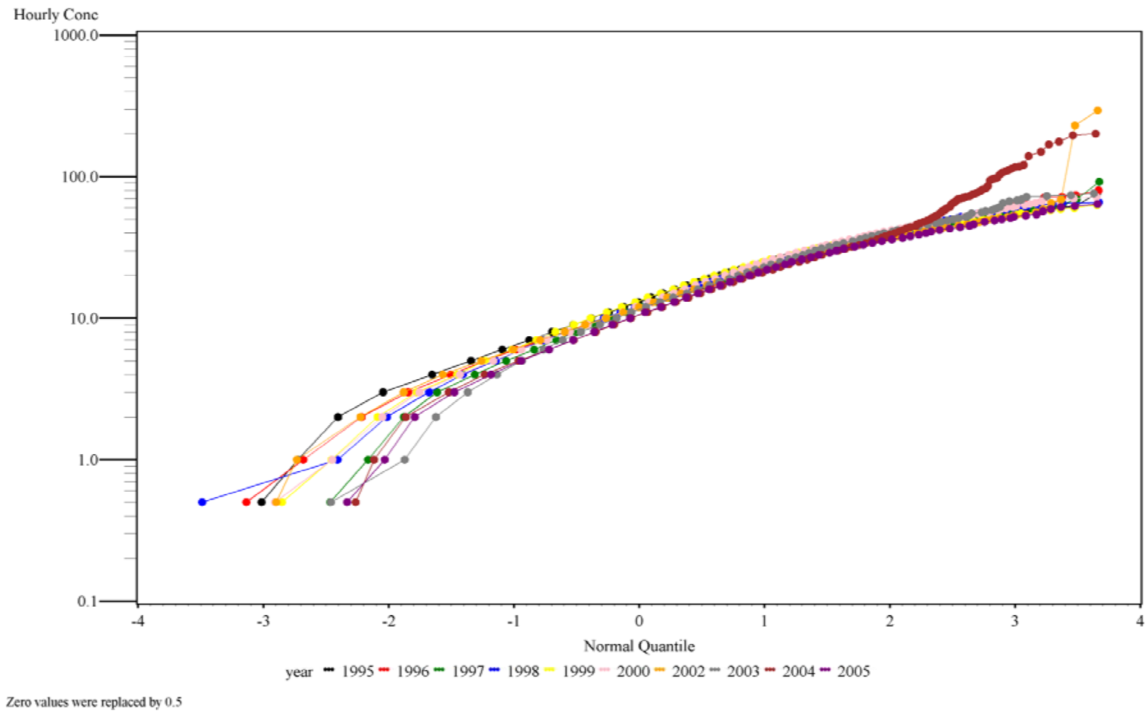

Figure A-9. Distributions of hourly NO_2 concentrations in the Jacksonville MSA, years 1995-2006, one monitor.

There is very little difference in annual average concentrations across the 1995-2006 monitoring period for the grouped Not MSA location. While percentage-wise the reduction in concentration is about 25%, on a concentration basis this amounts to a reduction of about 2 ppb over the 11 year period (Figure A-10). When considering the last 5 years of data, the reduction in annual average concentration was only 0.5 ppb. This could indicate that many of these monitoring sites are affected less by local sources of NO_2 (e.g., emissions from major roads and stationary sources) compared with the other locations. Therefore, the areas that these monitors represent may also be less likely to see significant benefit by changes in source emissions and/or NO_2 standard levels compared with the named CMSA/MSA locations.

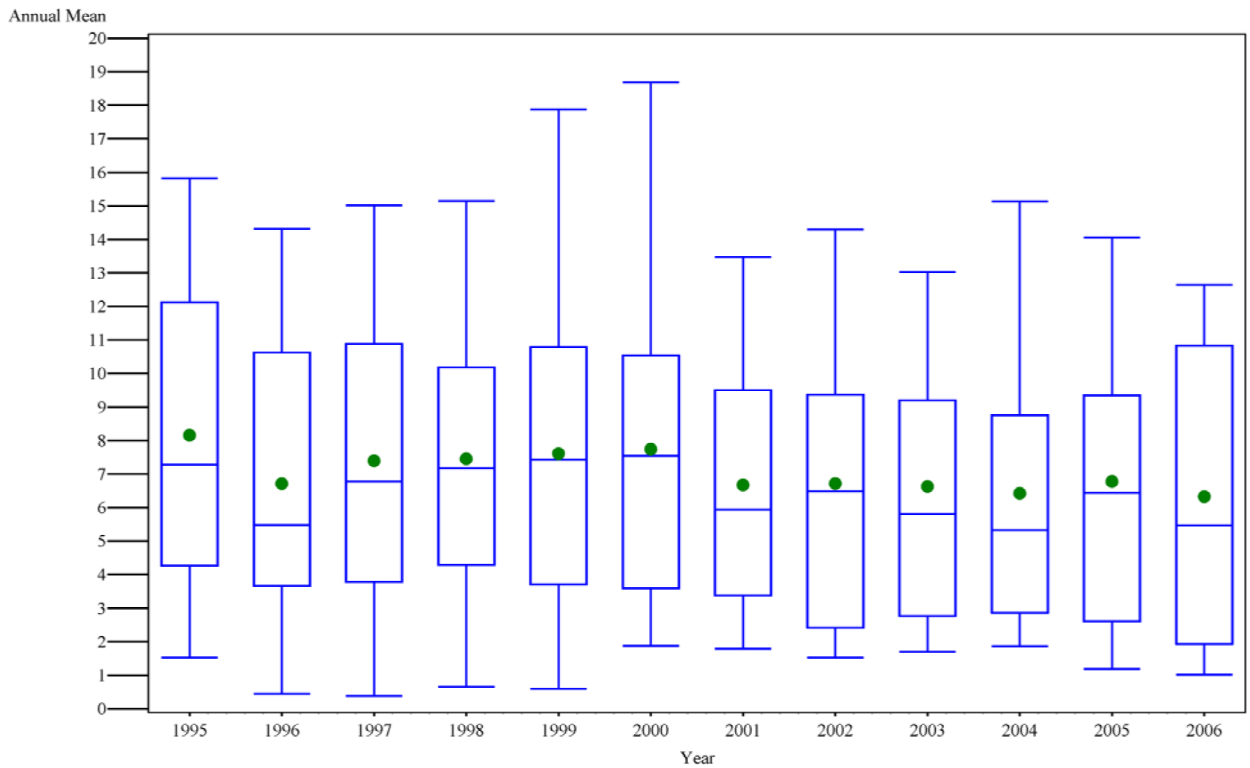

Figure A-10. Distributions of annual average NO_2 concentrations in the Not MSA group location, years 1995-2006.

A-5.5 Detailed Results by Year and Location

This section contains the ambient air quality analysis results by year for each of the named locations. Boxplots were constructed to display the annual average and hourly concentration distributions across years for a single location. The box extends from the 25th to the 75th percentile, with the median shown as the line inside the box. The whiskers extend from the box to the 5th and 95th percentiles. The extreme values in the upper and lower tails beyond the 5th and 95th percentiles are not shown to allow for similar scaling along the y-axis for the plotted independent variables. The mean is plotted as a dot; typically it would appear inside the box, however it will fall outside the box if the distribution is highly skewed. All concentrations are shown in parts per billion (ppb). The boxplots for hourly concentrations were created using a different procedure than for the annual statistics, because of the large number of hourly values and the inability of the graphing procedure to allow frequency weights. Therefore, the appropriate weighted percentiles and means were calculated and plotted as shown, but the vertical lines composing the sides of the box are essentially omitted. Tables are provided that summarize the complete distribution, with percentiles given in segments of 10.

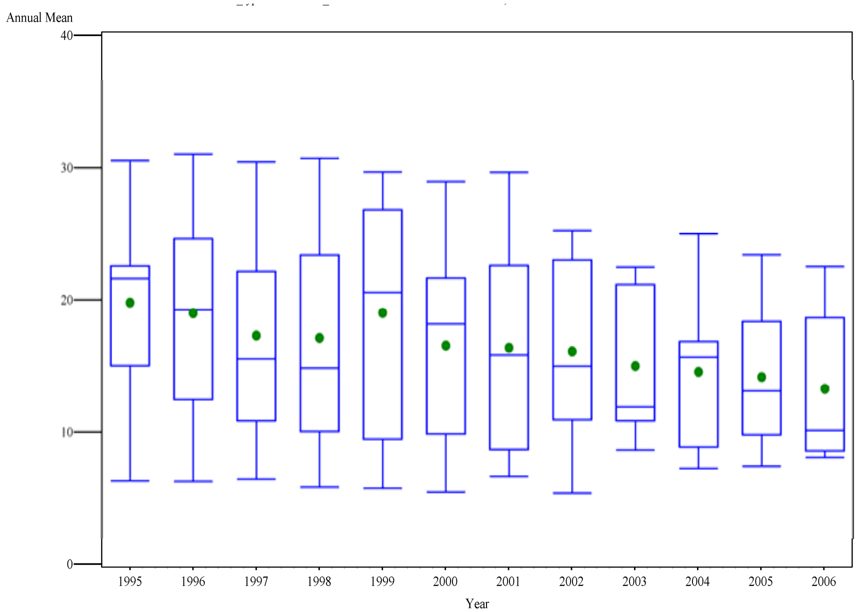

Figure A-11. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Boston CMSA.

Table A-11. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Boston CMSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	12	20	7	34	6	12	14	16	21	22	22	23	23	27	31
1996	10	19	8	42	6	8	11	14	17	19	21	24	26	29	31
1997	11	17	8	44	6	9	11	13	15	16	19	22	22	27	30
1998	11	17	8	48	6	8	10	12	15	15	19	23	23	28	31
1999	7	19	9	45	6	6	9	20	20	21	21	21	27	30	30
2000	7	17	8	49	5	5	10	11	11	18	20	20	22	29	29
2001	10	16	8	50	7	7	8	10	12	16	20	22	24	28	30
2002	10	16	7	43	5	7	10	12	13	15	19	22	24	25	25
2003	5	15	6	42	9	9	10	11	11	12	17	21	22	22	22
2004	7	15	6	41	7	7	9	12	12	16	16	16	17	25	25
2005	8	14	6	39	7	7	10	10	11	13	15	18	19	23	23
2006	7	13	6	42	8	8	9	10	10	10	15	15	19	23	23

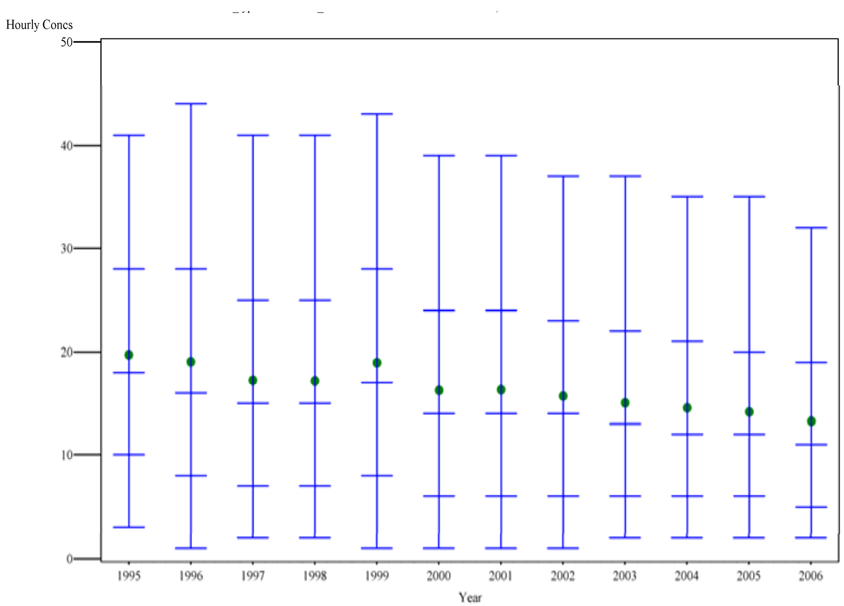

Figure A-12. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Boston CMSA.

Table A-12. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Boston CMSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	99946	20	12	62	0	5	9	12	15	18	22	26	30	36	100
1996	83541	19	14	72	0	3	7	10	13	16	21	25	30	38	205
1997	90161	17	12	72	0	3	6	9	11	15	18	23	28	35	134
1998	89710	17	13	75	0	3	5	8	11	15	18	23	28	35	112
1999	54043	19	13	70	0	3	7	10	13	17	21	25	30	37	117
2000	56196	16	12	76	0	2	5	7	11	14	18	22	27	34	95
2001	82048	16	13	77	0	2	4	7	10	14	18	22	27	34	114
2002	80472	16	12	75	0	2	5	7	10	14	17	21	26	32	93
2003	41198	15	11	75	0	3	5	7	10	13	16	19	24	31	99
2004	56831	15	10	71	0	3	5	7	10	12	15	19	23	29	96
2005	66244	14	11	75	0	3	5	7	9	12	15	18	23	29	113
2006	57681	13	10	74	0	3	4	6	8	11	14	17	22	28	79

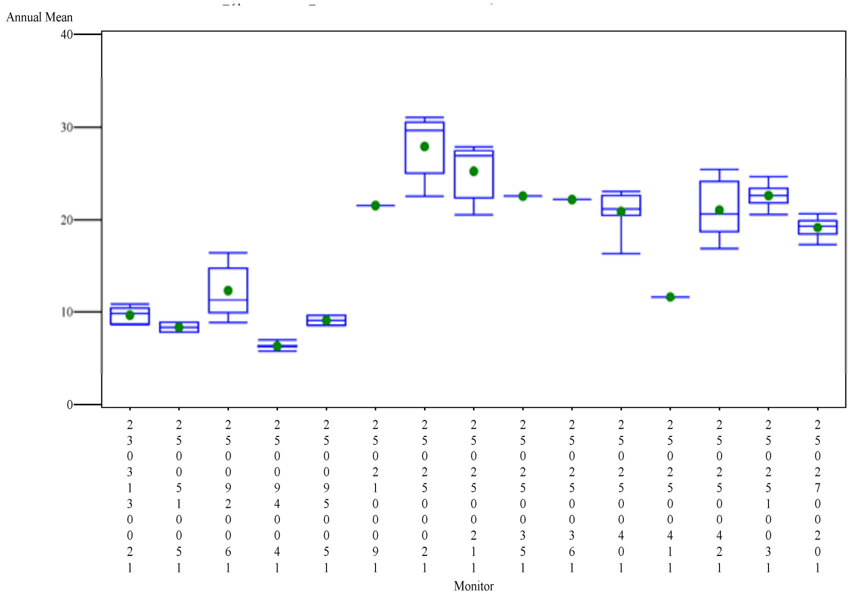

Figure A-13. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Boston CMSA set A, 1995-2006.

Table A-13. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Boston CMSA set A, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
2303130021	7	10	1	9	9	9	9	9	9	10	10	10	10	11	11
2500510051	2	8	1	9	8	8	8	8	8	8	9	9	9	9	9
2500920061	10	12	3	22	9	9	10	10	11	11	13	15	15	16	16
2500940041	5	6	0	7	6	6	6	6	6	6	6	6	7	7	7
2500950051	2	9	1	8	9	9	9	9	9	9	10	10	10	10	10
2502100091	1	22			22	22	22	22	22	22	22	22	22	22	22
2502500021	11	28	3	11	23	23	25	25	29	30	30	30	31	31	31
2502500211	8	25	3	12	21	21	22	23	27	27	27	27	28	28	28
2502500351	1	23			23	23	23	23	23	23	23	23	23	23	23
2502500361	1	22			22	22	22	22	22	22	22	22	22	22	22
2502500401	11	21	2	10	16	18	20	21	21	21	22	22	23	23	23
2502500411	1	12			12	12	12	12	12	12	12	12	12	12	12
2502500421	6	21	3	16	17	17	19	19	19	21	22	24	24	25	25
2502510031	5	23	2	7	21	21	21	22	22	23	23	23	24	25	25
2502700201	8	19	1	6	17	17	18	19	19	19	19	20	20	21	21

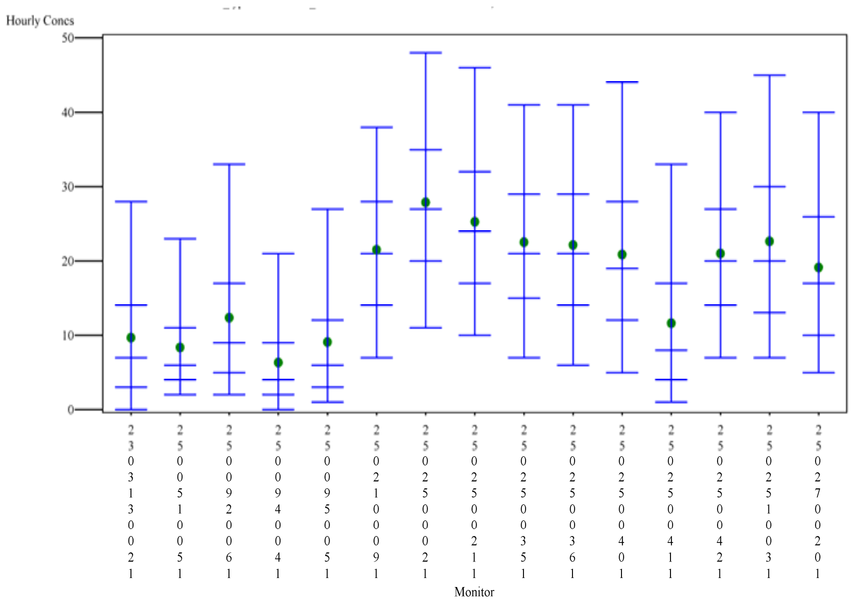

Figure A-14. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Boston CMSA set A, 1995-2006.

Table A-14. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Boston CMSA set A, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
2303130021	58123	10	9	94	0	1	2	4	5	7	9	12	16	23	100
2500510051	16732	8	7	81	0	2	3	4	5	6	8	10	13	18	50
2500920061	80761	12	10	80	0	3	4	6	7	9	12	15	20	27	90
2500940041	41337	6	7	108	0	0	1	2	3	4	6	7	10	16	70
2500950051	16228	9	8	91	0	2	3	4	5	6	8	11	14	22	51
2502100091	8546	22	10	46	0	9	13	15	18	21	23	27	30	35	75
2502500021	87534	28	11	40	0	14	18	21	24	27	30	33	37	43	134
2502500211	63990	25	11	45	0	13	16	18	21	24	26	30	34	40	205
2502500351	8539	23	10	47	0	10	13	16	19	21	24	27	31	37	74
2502500361	8542	22	11	49	0	9	12	15	19	21	24	28	31	36	100
2502500401	91196	21	12	59	1	7	10	13	16	19	22	26	31	38	113
2502500411	8319	12	10	89	0	2	3	5	6	8	11	15	19	27	81
2502500421	48078	21	10	48	0	9	12	15	17	20	22	25	29	35	79

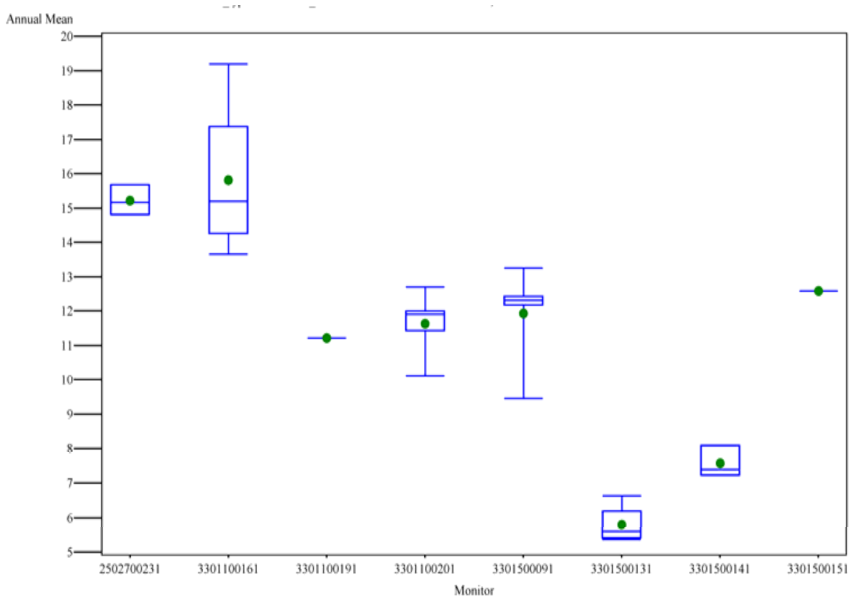

Figure A-15. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Boston CMSA set B, 1995-2006.

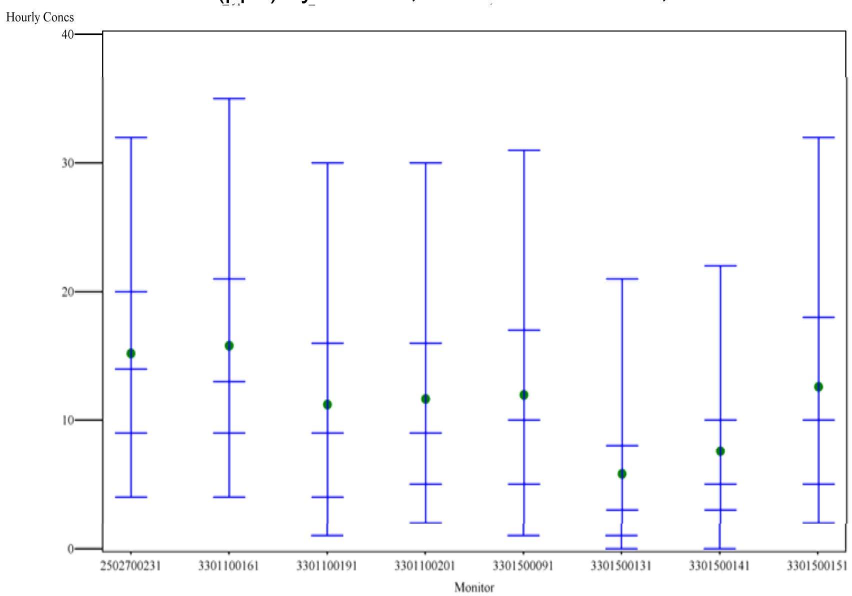

Figure A-16. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Boston CMSA set B, 1995-2006.

Table A-15. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Boston CMSA set B, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
2502700231	3	15	0	3	15	15	15	15	15	15	15	16	16	16	16
3301100161	4	16	2	15	14	14	14	15	15	15	16	16	19	19	19
3301100191	1	11			11	11	11	11	11	11	11	11	11	11	11
3301100201	5	12	1	8	10	10	11	11	12	12	12	12	12	13	13
3301500091	5	12	1	12	9	9	11	12	12	12	12	12	13	13	13
3301500131	4	6	1	10	5	5	5	5	5	6	6	6	7	7	7
3301500141	3	8	0	6	7	7	7	7	7	7	7	8	8	8	8
3301500151	1	13			13	13	13	13	13	13	13	13	13	13	13

Table A-16. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Boston CMSA set B, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
2502510031	40775	23	12	54	0	9	12	14	17	20	24	28	33	40	94
2502700201	63836	19	11	59	0	6	9	11	14	17	21	24	29	35	95
2502700231	24267	15	9	58	0	5	8	10	12	14	16	19	22	27	93
3301100161	33436	16	10	64	0	6	8	9	11	13	16	19	23	29	158
3301100191	8022	11	9	81	0	2	3	5	7	9	11	14	18	24	54
3301100201	41325	12	9	75	0	3	4	6	7	9	11	14	18	25	62
3301500091	40978	12	9	77	0	2	4	6	8	10	12	15	19	25	63
3301500131	33536	6	7	118	0	0	1	2	2	3	5	7	10	15	50
3301500141	25372	8	7	94	0	1	2	3	4	5	7	9	12	17	48
3301500151	8599	13	9	75	0	3	5	6	8	10	12	16	20	27	65

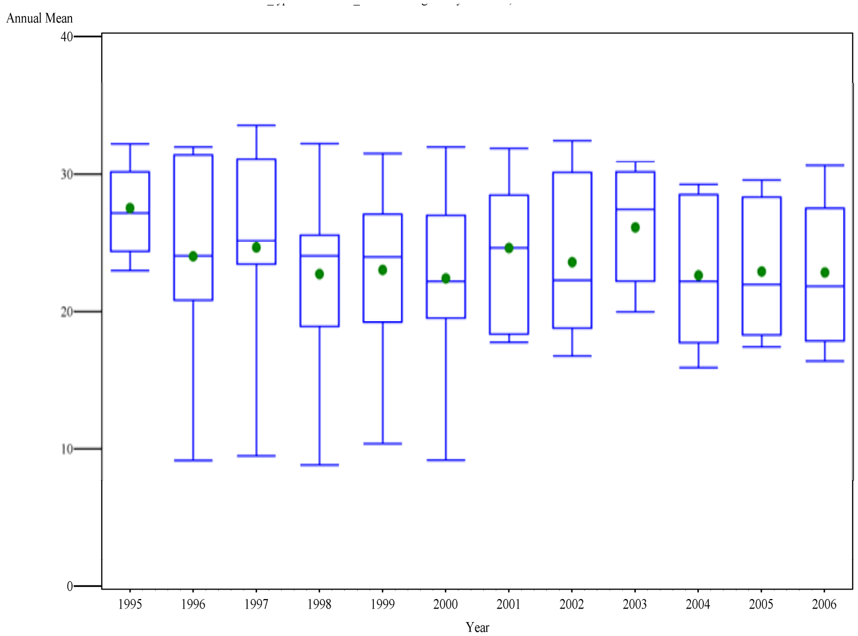

Figure A-17. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Chicago CMSA.

Table A-17. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Chicago CMSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	7	28	3	12	23	23	24	26	26	27	29	29	30	32	32
1996	7	24	8	32	9	9	21	23	23	24	28	28	31	32	32
1997	6	25	8	34	9	9	23	23	24	25	27	31	31	34	34
1998	9	23	7	32	9	9	17	19	23	24	25	26	31	32	32
1999	9	23	7	29	10	10	17	19	22	24	24	27	31	32	32
2000	9	22	7	30	9	9	18	20	21	22	23	27	29	32	32
2001	7	25	5	21	18	18	18	24	24	25	28	28	28	32	32
2002	7	24	6	24	17	17	19	22	22	22	23	23	30	32	32
2003	5	26	5	19	20	20	21	22	25	27	29	30	31	31	31
2004	6	23	6	25	16	16	18	18	20	22	24	29	29	29	29
2005	6	23	5	23	17	17	18	18	20	22	24	28	28	30	30
2006	5	23	6	27	16	16	17	18	20	22	25	28	29	31	31

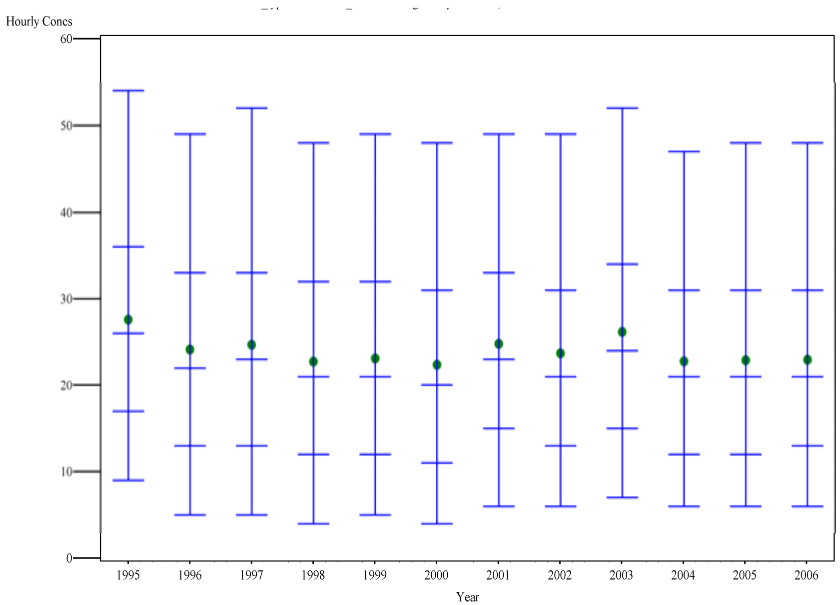

Figure A-18. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Chicago CMSA.

Table A-18. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Chicago CMSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	58998	28	14	51	0	11	15	19	22	26	29	33	38	47	113
1996	59447	24	14	58	0	7	11	15	18	22	26	31	36	43	127
1997	51443	25	15	59	0	7	11	15	19	23	27	31	36	44	113
1998	76365	23	14	61	0	6	10	13	17	21	25	29	34	41	112
1999	74985	23	14	61	0	7	10	13	17	21	25	30	35	42	113
2000	75327	22	14	62	0	6	10	13	17	20	24	29	34	41	108
2001	58268	25	13	54	0	9	13	16	20	23	27	31	36	43	114
2002	58383	24	14	59	0	8	12	15	18	21	25	29	34	42	149
2003	42406	26	14	54	0	10	14	17	21	24	28	32	37	45	122
2004	49210	23	13	57	0	8	11	14	18	21	25	28	33	41	101
2005	51043	23	13	59	0	8	11	14	17	21	24	29	34	41	106
2006	42009	23	13	57	0	8	11	14	17	21	25	29	34	41	137

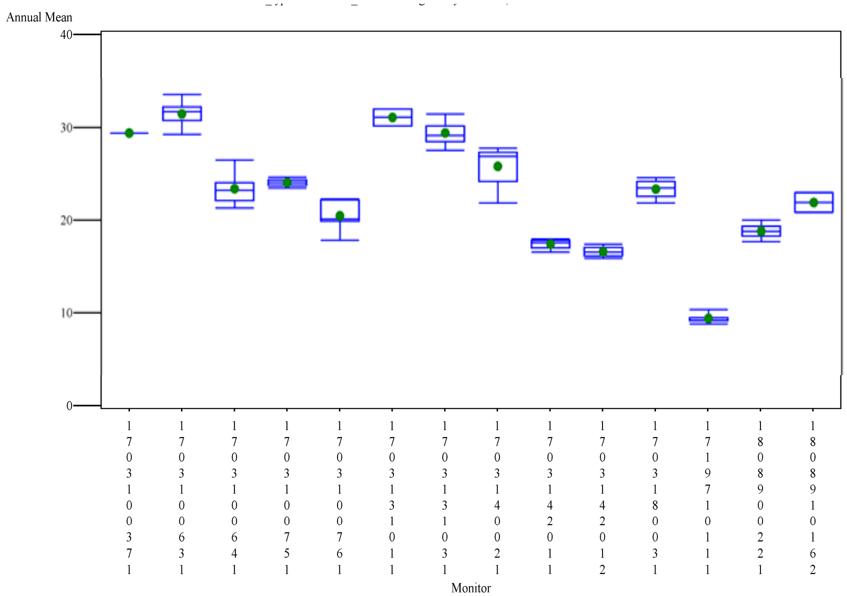

Figure A-19. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Chicago CMSA, 1995-2006.

Table A-19. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Chicago CMSA, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1703100371	1	29			29	29	29	29	29	29	29	29	29	29	29
1703100631	12	31	1	4	29	30	31	31	31	32	32	32	32	32	34
1703100641	6	23	2	8	21	21	22	22	23	23	24	24	24	26	26
1703100751	4	24	0	2	23	23	23	24	24	24	24	24	25	25	25
1703100761	5	20	2	9	18	18	19	20	20	20	21	22	22	22	22
1703131011	3	31	1	3	30	30	30	30	31	31	31	32	32	32	32
1703131031	9	29	1	5	28	28	28	28	29	29	30	30	31	31	31
1703140021	12	26	2	8	22	23	24	24	26	27	27	27	27	28	28
1703142011	4	17	1	4	17	17	17	17	17	18	18	18	18	18	18
1703142012	4	17	1	4	16	16	16	16	16	17	17	17	17	17	17
1703180031	8	23	1	4	22	22	22	23	23	23	24	24	24	25	25
1719710111	5	9	1	6	9	9	9	9	9	9	9	9	10	10	10
1808900221	8	19	1	4	18	18	18	18	19	19	19	19	20	20	20
1808910162	2	22	2	7	21	21	21	21	21	22	23	23	23	23	23

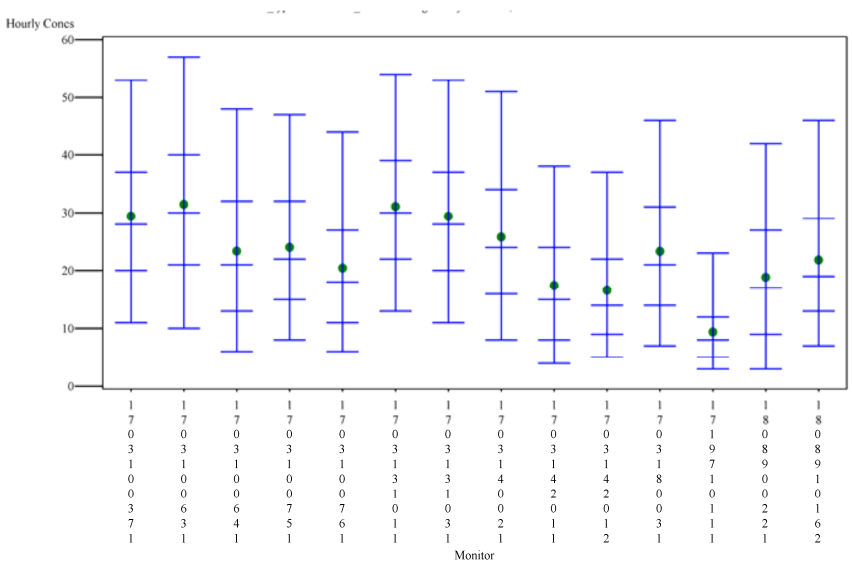

Figure A-20. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Chicago CMSA, 1995-2006.

Table A-20. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Chicago CMSA, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1703100371	8630	29	13	44	0	15	19	22	25	28	31	35	39	47	113
1703100631	101935	31	15	46	0	13	19	23	27	30	34	38	43	51	137
1703100641	52139	23	13	57	0	8	11	15	18	21	25	29	34	41	127
1703100751	34028	24	12	52	0	10	13	16	19	22	26	29	34	41	113
1703100761	42946	20	12	59	0	7	10	12	15	18	21	25	30	37	98
1703131011	25141	31	13	41	3	16	20	23	27	30	33	37	41	48	105
1703131031	75061	29	13	44	0	14	18	22	25	28	31	35	39	47	149
1703140021	102779	26	13	51	0	11	14	17	20	24	27	31	36	44	106
1703142011	32625	17	11	64	0	5	7	10	12	15	19	22	27	33	77
1703142012	32552	17	10	62	0	6	8	10	12	14	17	20	25	31	70
1703180031	68952	23	12	53	0	9	12	15	18	21	25	29	33	40	97
1719710111	41227	9	6	69	0	3	4	5	6	8	9	11	13	18	52
1808900221	63295	19	12	66	0	4	7	10	13	17	20	25	29	36	131
1808910162	16574	22	12	56	3	9	12	14	16	19	22	26	31	39	125

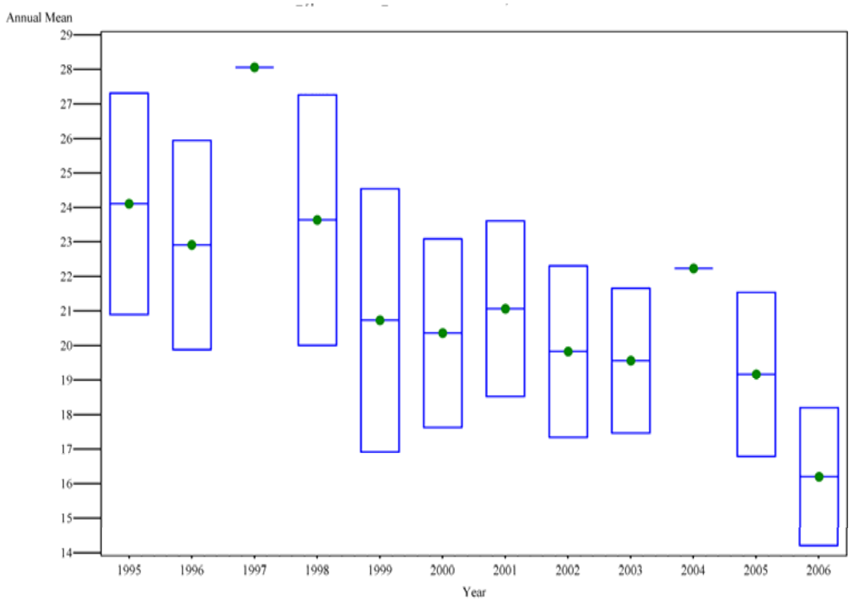

Figure A-21. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Cleveland CMSA.

Table A-21. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Cleveland CMSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	2	24	5	19	21	21	21	21	21	24	27	27	27	27	27
1996	2	23	4	19	20	20	20	20	20	23	26	26	26	26	26
1997	1	28		0	28	28	28	28	28	28	28	28	28	28	28
1998	2	24	5	22	20	20	20	20	20	24	27	27	27	27	27
1999	2	21	5	26	17	17	17	17	17	21	25	25	25	25	25
2000	2	20	4	19	18	18	18	18	18	20	23	23	23	23	23
2001	2	21	4	17	19	19	19	19	19	21	24	24	24	24	24
2002	2	20	4	18	17	17	17	17	17	20	22	22	22	22	22
2003	2	20	3	15	17	17	17	17	17	20	22	22	22	22	22
2004	1	22		0	22	22	22	22	22	22	22	22	22	22	22
2005	2	19	3	17	17	17	17	17	17	19	22	22	22	22	22
2006	2	16	3	17	14	14	14	14	14	16	18	18	18	18	18

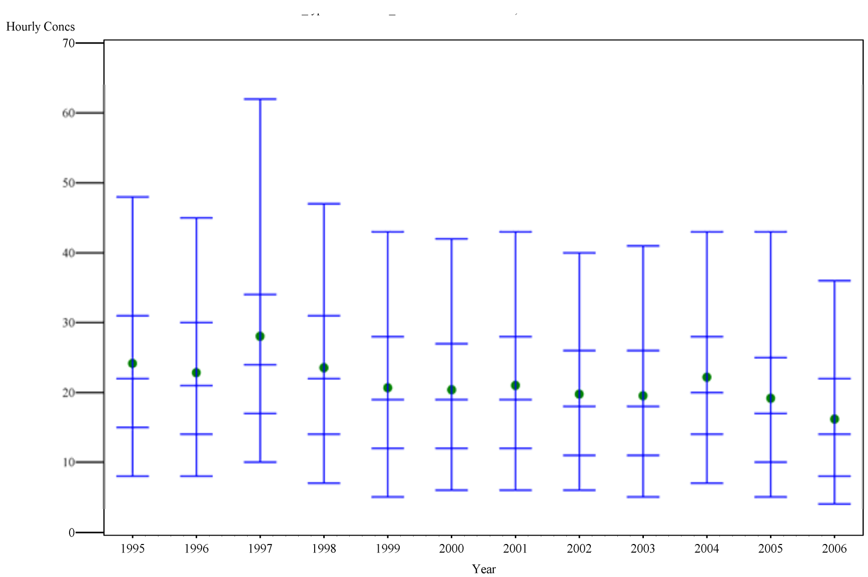

Figure A-22. Temporal distribution of hourly NO_2 ambient concentrations (ppb) by year, Cleveland CMSA.

Table A-22. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Cleveland CMSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	16042	24	13	53	2	10	13	16	19	22	25	29	34	41	108
1996	16593	23	12	52	1	9	13	15	18	21	24	28	32	39	148
1997	8300	28	17	59	0	12	15	18	21	24	28	32	38	49	253
1998	16680	24	13	53	0	9	13	16	19	22	25	29	33	40	89
1999	16743	21	12	58	0	7	10	13	16	19	22	26	30	37	86
2000	16399	20	11	55	0	8	10	13	16	19	22	25	30	36	74
2001	16566	21	12	56	0	8	10	13	16	19	22	26	30	37	103
2002	16464	20	11	56	1	8	10	12	15	18	21	24	28	35	88
2003	16948	20	11	57	0	7	10	13	15	18	20	24	28	35	90
2004	8484	22	11	51	0	10	13	15	18	20	23	26	30	37	83
2005	16558	19	12	60	0	7	9	12	14	17	20	23	28	35	85
2006	16853	16	10	64	0	5	8	10	12	14	16	20	24	30	175

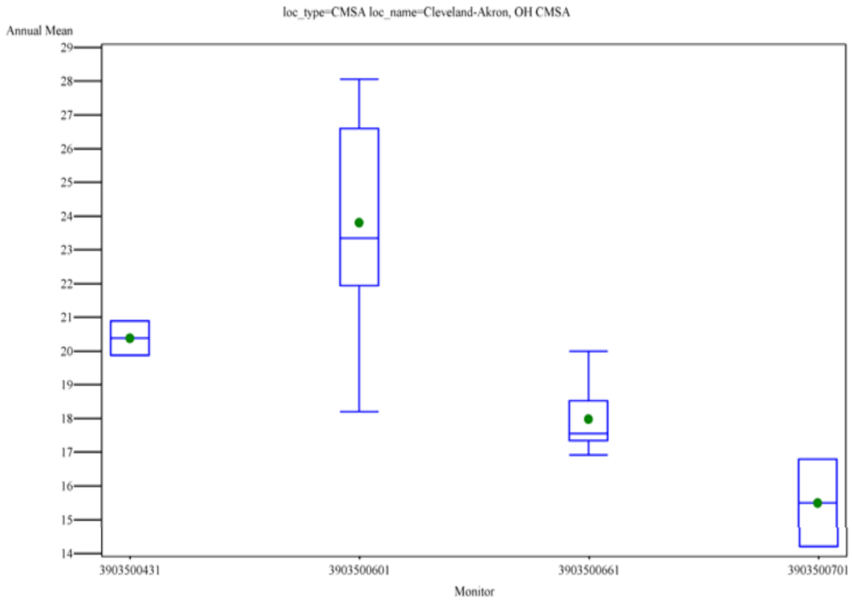

Figure A-23. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Cleveland CMSA, 1995-2006.

Table A-23. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Cleveland CMSA, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
3903500431	2	20	1	4	20	20	20	20	20	20	21	21	21	21	21
3903500601	12	24	3	12	18	22	22	22	22	23	25	26	27	27	28
3903500661	6	18	1	6	17	17	17	17	17	18	18	19	19	20	20
3903500701	2	15	2	12	14	14	14	14	14	15	17	17	17	17	17

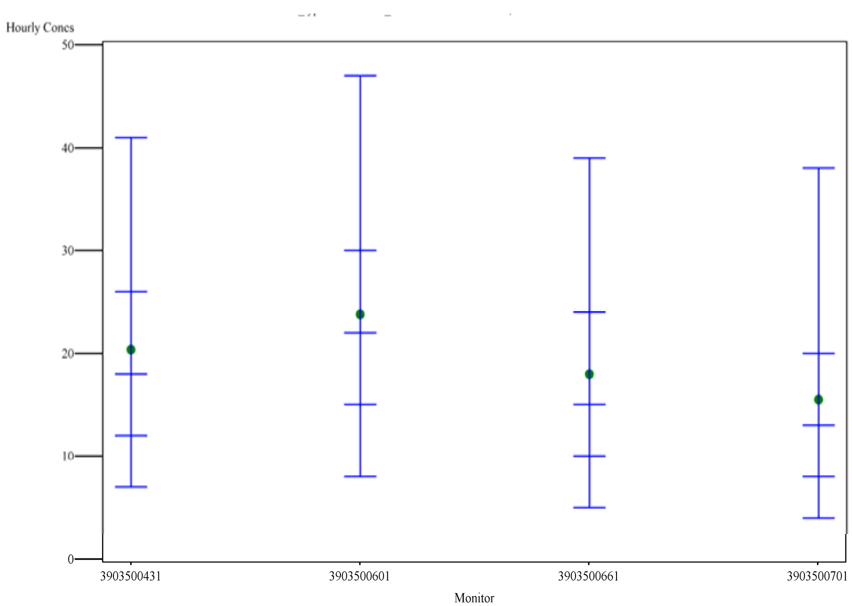

Figure A-24. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Cleveland CMSA, 1995-2006.

Table A-24. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Cleveland CMSA, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
3903500431	16215	20	11	54	1	8	11	13	16	18	21	24	28	35	92
3903500601	99696	24	13	53	0	10	13	16	19	22	25	28	33	40	253
3903500661	50100	18	11	60	0	7	9	11	13	15	18	22	26	33	103
3903500701	16619	15	11	70	0	5	7	9	10	13	15	18	23	30	175

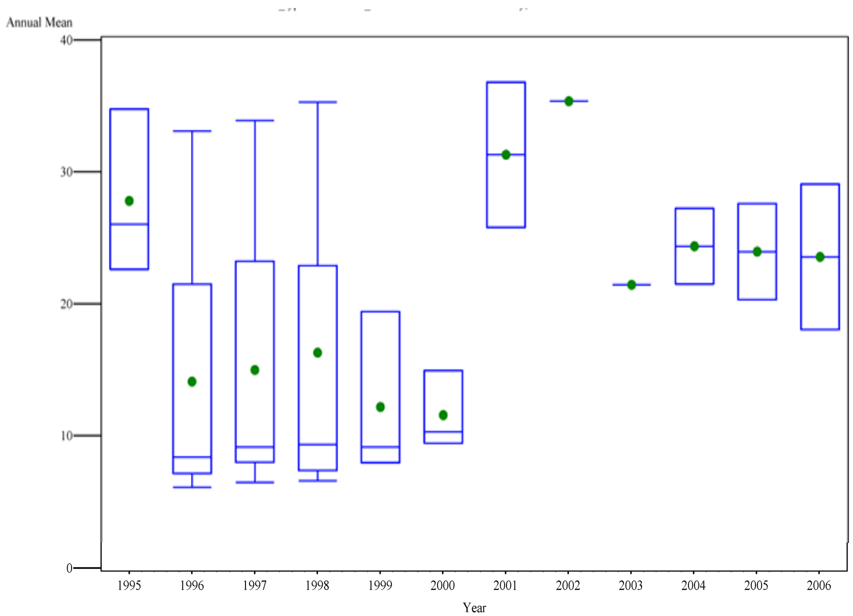

Figure A-25. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Denver CMSA.

Table A-25. Temporal distribution of annual average NO_2 ambient concentrations (ppb) by year, Denver CMSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	3	28	6	23	23	23	23	23	26	26	26	35	35	35	35
1996	6	14	11	77	6	6	7	7	8	8	9	22	22	33	33
1997	6	15	11	74	6	6	8	8	9	9	9	23	23	34	34
1998	5	16	13	77	7	7	7	7	8	9	16	23	29	35	35
1999	3	12	6	52	8	8	8	8	9	9	9	19	19	19	19
2000	3	12	3	26	9	9	9	9	10	10	10	15	15	15	15
2001	2	31	8	25	26	26	26	26	26	31	37	37	37	37	37
2002	1	35		0	35	35	35	35	35	35	35	35	35	35	35
2003	1	21		0	21	21	21	21	21	21	21	21	21	21	21
2004	2	24	4	17	21	21	21	21	21	24	27	27	27	27	27
2005	2	24	5	21	20	20	20	20	20	24	28	28	28	28	28
2006	2	24	8	33	18	18	18	18	18	24	29	29	29	29	29

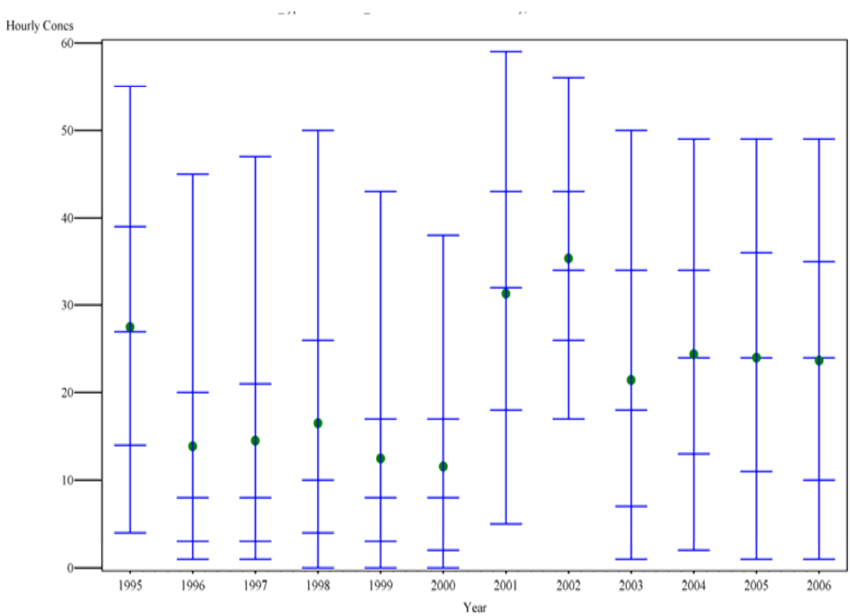

Figure A-26. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Denver CMSA.

Table A-26. Temporal distribution of hourly NO_2 ambient concentrations (ppb) by year, Denver CMSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	23204	28	17	62	0	6	11	16	22	27	32	36	41	48	286
1996	46816	14	15	108	0	1	2	4	6	8	11	16	25	37	137
1997	45049	15	15	106	0	1	3	4	6	8	12	17	26	39	141
1998	40258	17	17	100	0	1	3	5	7	10	15	22	31	42	148
1999	23164	12	13	108	0	0	2	4	6	8	10	14	21	33	96
2000	24649	12	13	108	0	0	1	3	5	8	10	14	19	30	141
2001	15204	31	17	55	0	8	15	21	27	32	36	41	45	52	157
2002	7688	35	13	36	0	20	24	28	31	34	38	41	45	51	159
2003	6989	21	17	78	0	3	5	8	13	18	25	31	37	44	136
2004	15878	24	15	60	0	4	10	16	20	24	28	32	37	43	115
2005	15467	24	16	65	0	3	8	14	19	24	29	33	38	44	114
2006	13775	24	15	65	0	3	7	13	19	24	28	33	38	44	169

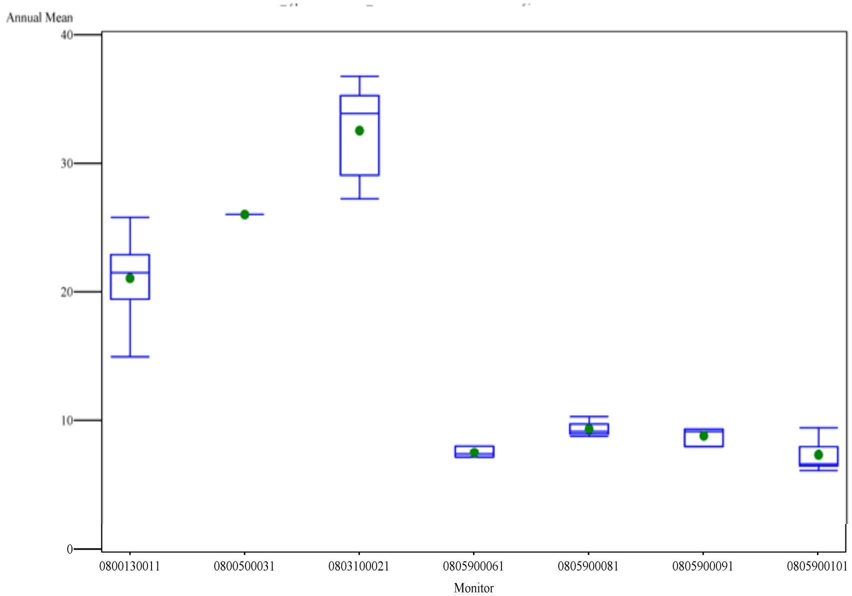

Figure A-27. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Denver CMSA, 1995-2006.

Table A-27. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Denver CMSA, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
0800130011	11	21	3	14	15	18	19	20	21	21	22	23	23	23	26
0800500031	1	26			26	26	26	26	26	26	26	26	26	26	26
0803100021	9	33	4	11	27	27	28	29	33	34	35	35	35	37	37
0805900061	3	7	0	6	7	7	7	7	7	7	7	8	8	8	8
0805900081	4	9	1	7	9	9	9	9	9	9	9	9	10	10	10
0805900091	3	9	1	8	8	8	8	8	9	9	9	9	9	9	9
0805900101	5	7	1	19	6	6	6	6	7	7	7	8	9	9	9

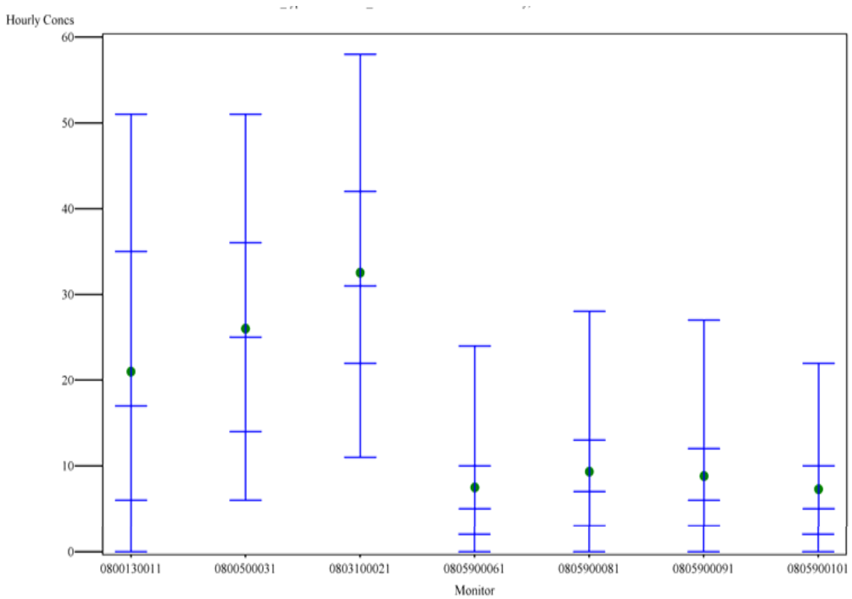

Figure A-28. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Denver CMSA, 1995-2006.

Table A-28. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Denver CMSA, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
0800130011	83703	21	17	82	0	2	4	7	11	17	25	32	38	45	239
0800500031	7790	26	15	57	0	8	12	16	20	25	29	34	39	45	176
0803100021	68630	33	15	46	0	15	20	24	28	31	35	39	44	51	286
0805900061	22077	7	8	109	0	1	1	3	4	5	6	9	12	18	66
0805900081	32449	9	9	97	0	0	2	3	5	7	9	12	15	22	68
0805900091	24368	9	9	100	0	1	2	3	5	6	8	10	14	20	88
0805900101	39124	7	8	106	0	1	2	2	4	5	6	9	12	17	98

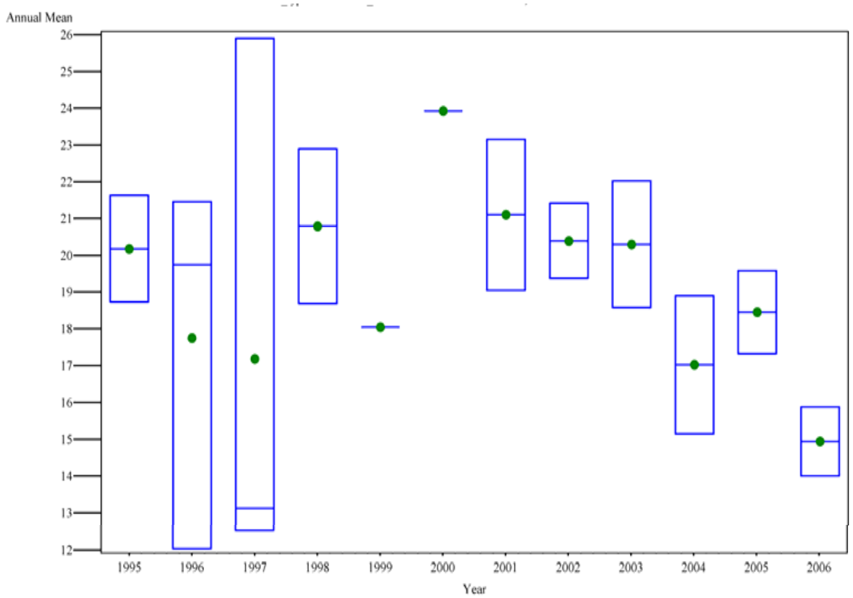

Figure A-29. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Detroit CMSA.

Table A-29. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Detroit CMSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	2	20	2	10	19	19	19	19	19	20	22	22	22	22	22
1996	3	18	5	28	12	12	12	12	20	20	20	21	21	21	21
1997	3	17	8	44	13	13	13	13	13	13	13	26	26	26	26
1998	2	21	3	14	19	19	19	19	19	21	23	23	23	23	23
1999	1	18		0	18	18	18	18	18	18	18	18	18	18	18
2000	1	24		0	24	24	24	24	24	24	24	24	24	24	24
2001	2	21	3	14	19	19	19	19	19	21	23	23	23	23	23
2002	2	20	1	7	19	19	19	19	19	20	21	21	21	21	21
2003	2	20	2	12	19	19	19	19	19	20	22	22	22	22	22
2004	2	17	3	16	15	15	15	15	15	17	19	19	19	19	19
2005	2	18	2	9	17	17	17	17	17	18	20	20	20	20	20
2006	2	15	1	9	14	14	14	14	14	15	16	16	16	16	16

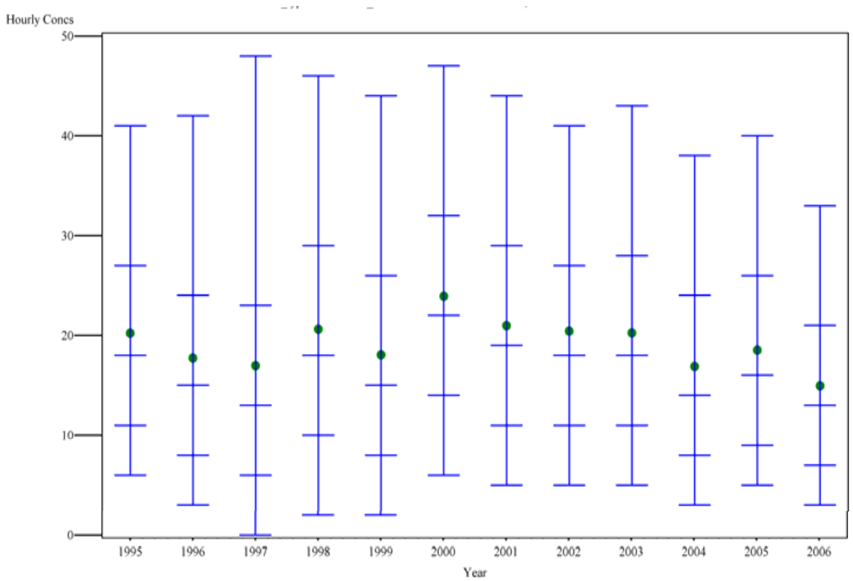

Figure A-30. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Detroit CMSA.

Table A-30. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Detroit CMSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	16629	20	12	58	0	8	10	12	15	18	21	25	29	35	117
1996	23600	18	13	74	0	4	7	9	12	15	18	22	27	35	167
1997	24117	17	16	94	0	2	5	7	10	13	16	21	26	36	322
1998	14863	21	14	68	0	5	9	12	15	18	22	27	31	39	136
1999	7110	18	13	73	0	4	7	9	12	15	19	24	29	36	104
2000	8590	24	13	56	0	8	12	15	19	22	26	30	35	42	128
2001	15154	21	13	61	0	7	9	12	15	19	23	27	32	38	194
2002	16623	20	15	73	0	7	10	12	15	18	22	25	30	36	443
2003	16569	20	13	62	0	7	9	12	15	18	21	25	30	36	139
2004	14779	17	11	66	0	5	7	9	12	14	17	21	26	33	78
2005	15827	19	12	63	0	6	8	10	13	16	19	23	28	35	84
2006	17273	15	10	64	0	4	6	8	10	13	16	19	23	29	58

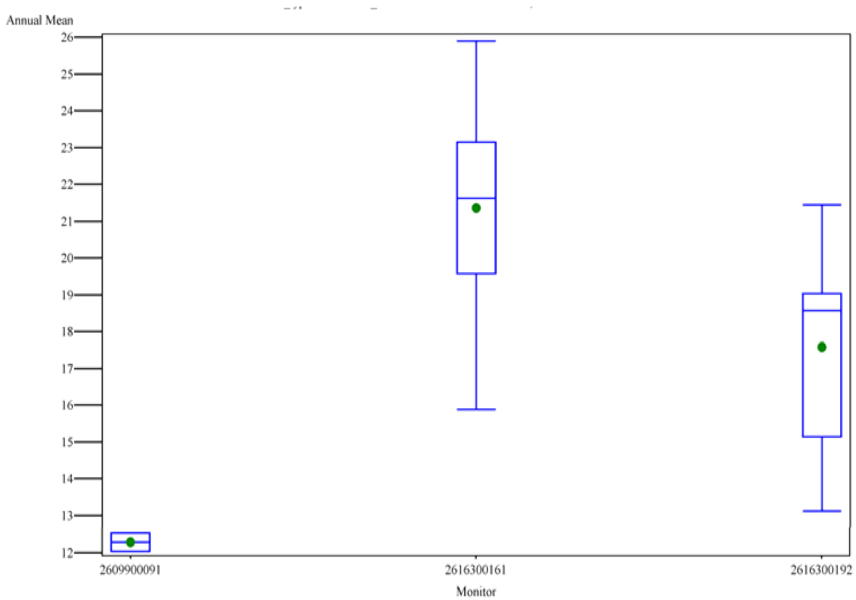

Figure A-31. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Detroit CMSA, 1995-2006.

Table A-31. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Detroit CMSA, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
2609900091	2	12	0	3	12	12	12	12	12	12	13	13	13	13	13
2616300161	11	21	3	13	16	19	20	20	21	22	22	23	23	24	26
2616300192	11	18	3	14	13	14	15	17	18	19	19	19	19	19	21

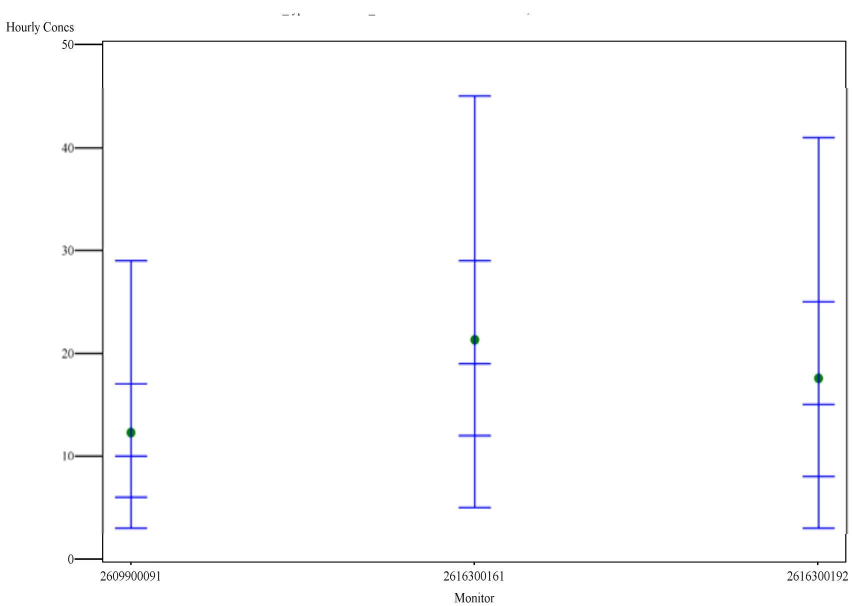

Figure A-32. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Detroit CMSA, 1995-2006.

Table A-32. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Detroit CMSA, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
2609900091	16523	12	9	75	0	3	5	6	8	10	12	15	19	25	322
2616300161	86487	21	13	62	0	7	10	13	16	19	23	26	31	38	244
2616300192	88124	18	13	75	0	5	7	9	12	15	18	22	27	35	443

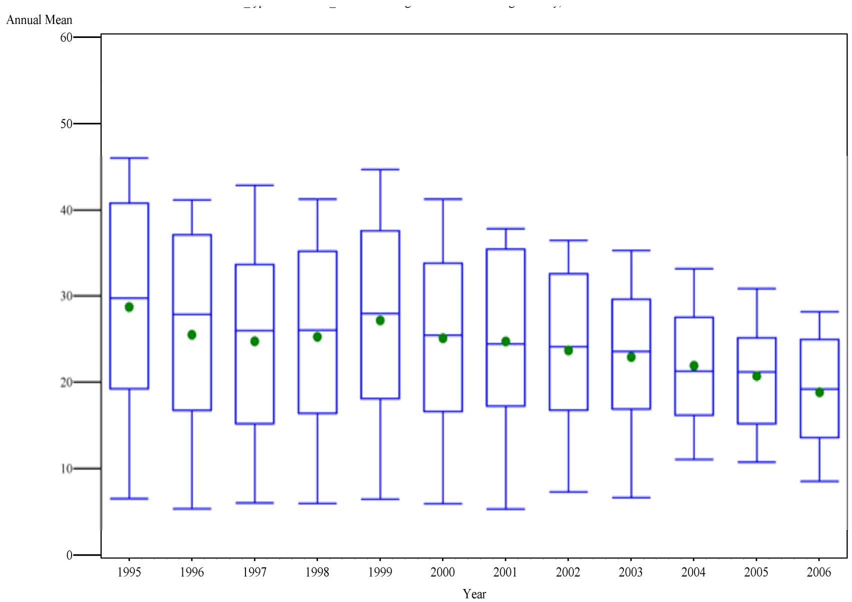

Figure A-33. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Los Angeles CMSA.

Table A-33. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Los Angeles CMSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	36	29	13	47	5	8	18	20	23	30	37	39	45	46	46
1996	29	25	12	46	4	6	15	17	21	28	31	35	38	41	42
1997	33	25	12	47	4	8	14	16	20	26	29	33	34	42	43
1998	32	25	11	44	4	9	16	19	21	26	33	34	36	39	43
1999	31	27	12	44	5	10	18	20	23	28	32	35	39	39	51
2000	32	25	11	43	4	10	16	20	22	25	28	32	36	39	44
2001	31	25	11	43	4	9	17	19	24	24	27	33	36	37	41
2002	32	24	9	39	5	10	16	18	22	24	25	29	33	36	40
2003	32	23	9	37	5	11	15	18	21	24	26	29	31	34	35
2004	28	22	7	33	5	13	15	17	20	21	24	27	30	31	34
2005	28	21	7	34	5	12	14	16	19	21	22	25	27	31	31
2006	26	19	7	35	5	9	13	15	17	19	20	23	25	27	30

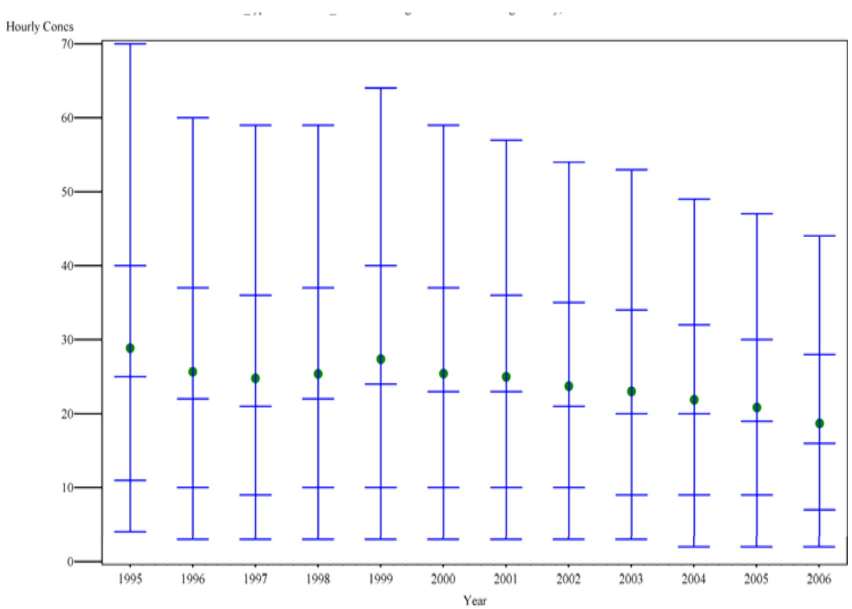

Figure A-34. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Los Angeles CMSA.

Table A-34. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Los Angeles CMSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	290519	29	22	78	0	6	9	14	19	25	30	37	45	57	239
1996	232203	26	19	74	0	5	8	12	17	22	28	34	40	50	250
1997	263050	25	19	75	0	4	7	11	16	21	27	33	40	50	200
1998	257541	25	19	74	0	5	8	12	17	22	28	34	40	50	255
1999	253401	27	20	73	0	5	8	13	18	24	30	37	43	54	307
2000	263311	25	18	72	0	5	8	12	17	23	28	34	40	50	214
2001	251895	25	18	71	0	5	8	12	17	23	28	33	39	48	251
2002	258452	24	17	71	0	5	8	11	16	21	26	32	38	46	262
2003	259935	23	17	72	0	4	7	11	15	20	25	31	37	45	163
2004	225075	22	15	70	0	4	7	11	15	20	25	29	35	42	157
2005	227769	21	14	69	0	4	7	11	15	19	23	28	33	40	136
2006	184205	19	14	74	0	3	6	9	12	16	20	25	31	38	107

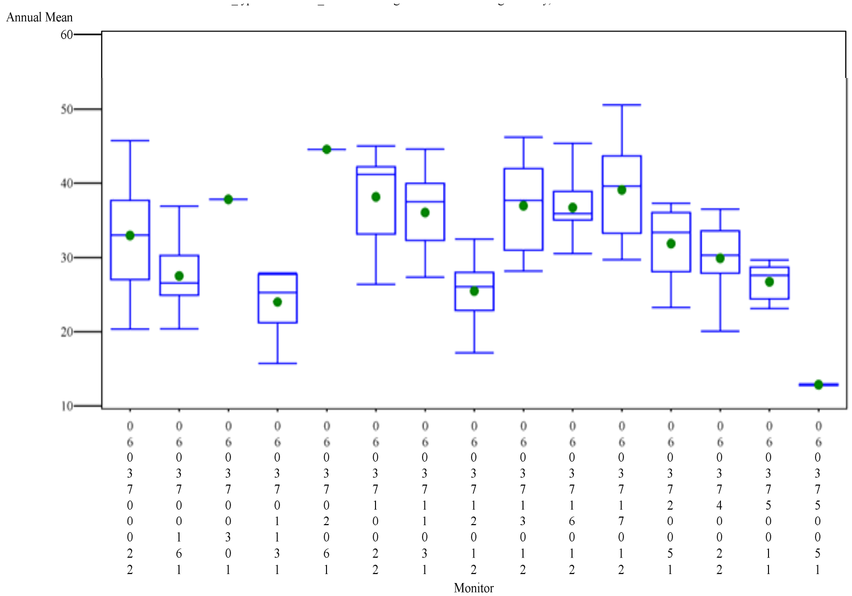

Figure A-35. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Los Angeles CMSA set A, 1995-2006.

Table A-35. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Los Angeles CMSA set A, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
0603700022	12	33	7	22	20	25	25	29	33	33	36	36	39	41	46
0603700161	12	28	5	17	20	22	24	26	26	27	28	29	32	33	37
0603700301	1	38			38	38	38	38	38	38	38	38	38	38	38
0603701131	12	24	4	18	16	17	20	23	24	25	26	28	28	28	28
0603702061	1	45			45	45	45	45	45	45	45	45	45	45	45
0603710022	11	38	6	16	26	29	33	35	40	41	41	41	42	45	45
0603711031	11	36	6	16	27	27	32	33	34	37	39	39	40	43	45
0603712012	12	26	4	17	17	20	21	24	25	26	26	28	28	31	32
0603713012	12	37	6	16	28	30	31	31	36	38	39	41	43	43	46
0603716012	10	37	4	11	31	33	35	35	35	36	37	38	39	42	45
0603717012	12	39	7	17	30	31	31	35	36	40	43	43	44	46	51
0603720051	12	32	5	15	23	24	27	29	32	33	34	35	37	37	37
0603740022	11	30	5	16	20	24	28	29	29	30	32	33	34	34	37
0603750011	9	27	2	9	23	23	23	24	27	28	28	29	29	30	30
0603750051	2	13	0	1	13	13	13	13	13	13	13	13	13	13	13

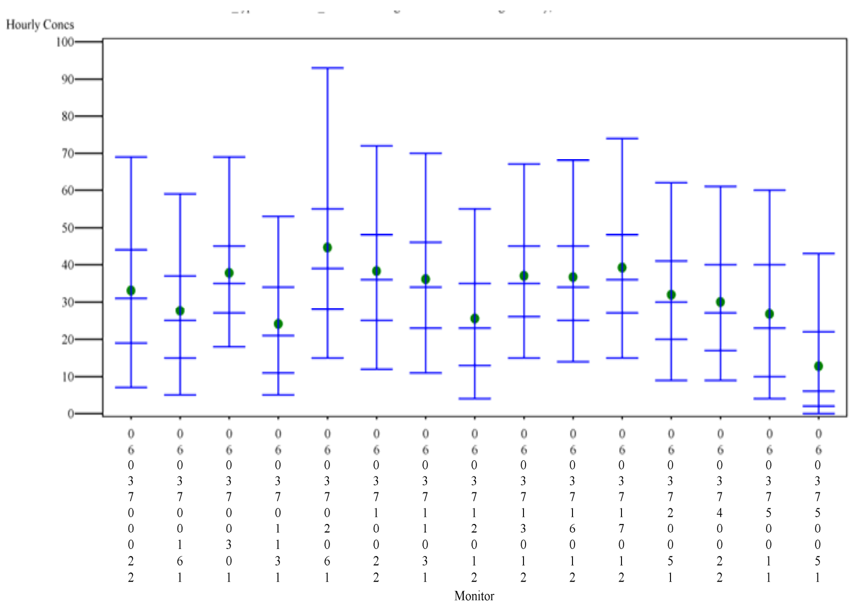

Figure A-36. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Los Angeles CMSA set A, 1995-2006.

Table A-36. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Los Angeles CMSA set A, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
0603700022	97734	33	20	59	0	11	16	21	26	31	35	41	47	58	223
0603700161	97838	28	18	63	0	8	13	17	21	25	29	34	40	50	196
0603700301	6817	38	17	44	8	21	25	28	32	35	38	42	48	57	160
0603701131	97124	24	16	67	0	7	9	12	16	21	26	32	37	45	201
0603702061	7604	45	25	56	0	19	25	30	34	39	45	51	60	75	208
0603710022	88656	38	19	49	0	17	23	28	32	36	41	45	52	62	262
0603711031	88425	36	19	52	0	15	20	25	30	34	38	43	49	60	239
0603712012	96922	26	16	64	0	7	11	15	19	23	28	33	38	47	163
0603713012	97352	37	17	45	0	19	24	28	31	35	39	43	48	57	250
0603716012	81411	37	18	48	0	17	23	27	31	34	38	42	48	58	225
0603717012	98551	39	18	47	0	19	25	29	33	36	40	45	52	63	184
0603720051	98151	32	17	54	0	13	18	22	26	30	34	38	44	52	225
0603740022	88730	30	17	58	0	12	16	19	23	27	31	37	43	52	208
0603750011	74014	27	19	72	0	5	9	12	17	23	30	37	43	51	178
0603750051	15047	13	15	114	0	0	1	2	4	6	10	17	26	36	91

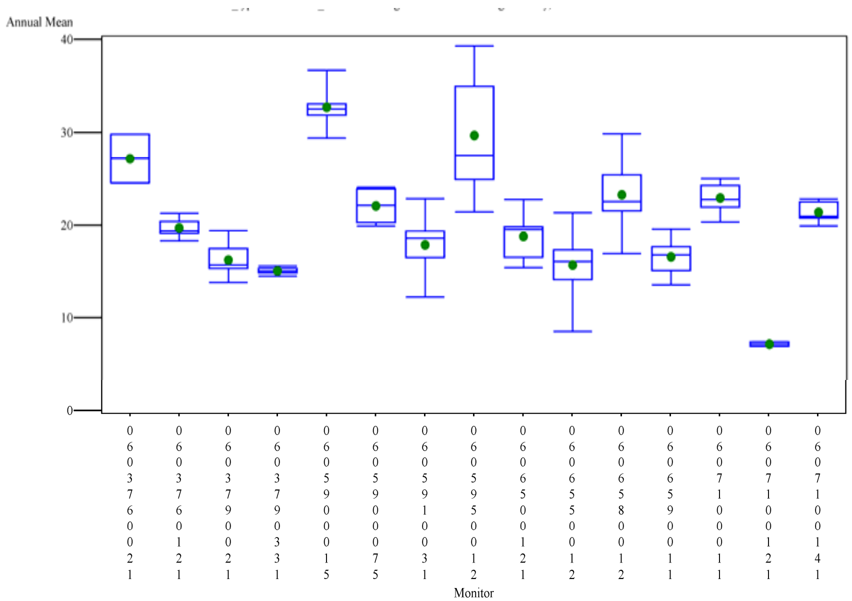

Figure A-37. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Los Angeles CMSA set B 1995-2006.

Table A-37. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Los Angeles CMSA set B, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
0603760021	2	27	4	14	25	25	25	25	25	27	30	30	30	30	30
0603760121	5	20	1	6	18	18	19	19	19	19	20	20	21	21	21
0603790021	6	16	2	12	14	14	15	15	16	16	16	18	18	19	19
0603790331	5	15	0	3	15	15	15	15	15	15	15	15	15	16	16
0605900015	5	33	3	8	29	29	31	32	32	33	33	33	35	37	37
0605900075	4	22	2	10	20	20	20	21	21	22	24	24	24	24	24
0605910031	12	18	3	16	12	13	16	17	18	19	19	19	20	20	23
0605950012	11	30	6	19	21	25	25	25	27	28	33	34	35	35	39
0606500121	9	19	3	14	15	15	16	17	18	20	20	20	22	23	23
0606550012	12	16	3	22	9	12	13	15	16	16	16	17	18	20	21
0606580012	12	23	4	16	17	19	21	22	22	23	24	25	26	29	30
0606590011	12	17	2	11	14	14	15	15	17	17	17	18	18	19	20
0607100011	12	23	1	6	20	21	22	22	22	23	24	24	24	25	25
0607100121	2	7	0	5	7	7	7	7	7	7	7	7	7	7	7
0607100141	5	21	1	6	20	20	20	21	21	21	22	23	23	23	23

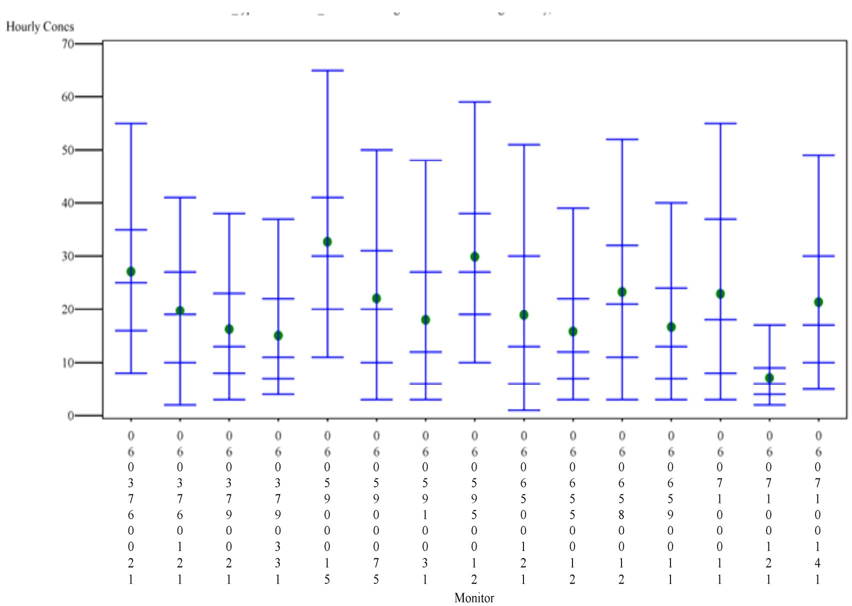

Figure A-38. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Los Angeles CMSA set B, 1995-2006.

Table A-38. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Los Angeles CMSA set B, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
0603760021	16534	27	15	57	0	10	14	18	21	25	28	32	37	46	159
0603760121	39399	20	12	61	0	4	9	12	16	19	22	25	30	36	120
0603790021	46871	16	11	69	0	5	7	9	11	13	17	21	26	32	140
0603790331	40341	15	11	73	0	5	6	7	9	11	14	18	25	32	103
0605900015	40987	33	17	53	0	14	19	22	26	30	34	38	44	55	175
0605900075	33847	22	15	70	0	5	9	10	14	20	23	30	36	42	127
0605910031	97546	18	15	85	0	4	6	7	9	12	16	23	31	40	183
0605950012	88510	30	16	54	0	12	17	20	24	27	31	35	41	50	192
0606500121	69857	19	17	91	0	3	5	7	10	13	18	25	34	43	307
0606550012	95624	16	12	73	0	4	6	8	10	12	15	19	25	33	82
0606580012	95642	23	16	67	0	6	10	13	17	21	25	30	35	44	150
0606590011	95010	17	13	75	0	4	6	8	10	13	17	22	27	34	127
0607100011	94741	23	17	76	0	5	7	9	12	18	25	33	40	48	196
0607100121	14753	7	5	69	0	2	4	4	5	6	7	8	10	14	57
0607100141	39719	21	14	67	0	7	9	11	14	17	22	27	33	41	113

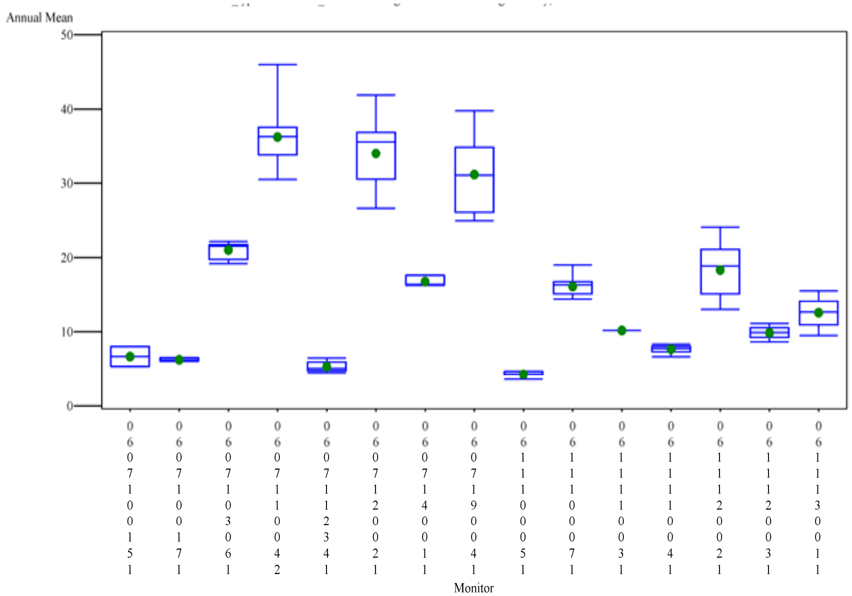

Figure A-39. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Los Angeles CMSA set C 1995-2006.

Table A-39. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Los Angeles CMSA set C, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
0607100151	2	7	2	28	5	5	5	5	5	7	8	8	8	8	8
0607100171	3	6	0	4	6	6	6	6	6	6	6	7	7	7	7
0607103061	7	21	1	5	19	19	20	21	21	22	22	22	22	22	22
0607110042	11	36	4	12	31	31	34	34	36	36	37	38	38	39	46
0607112341	9	5	1	12	5	5	5	5	5	5	5	6	6	6	6
0607120021	12	34	5	13	27	27	30	31	33	36	36	36	38	38	42
0607140011	3	17	1	4	16	16	16	16	16	16	16	18	18	18	18
0607190041	12	31	5	16	25	26	26	26	29	31	33	34	35	38	40
0611100051	7	4	0	8	4	4	4	4	4	4	4	4	5	5	5
0611100071	9	16	1	9	14	14	14	15	16	16	16	17	17	19	19
0611110031	1	10			10	10	10	10	10	10	10	10	10	10	10
0611110041	7	8	1	7	7	7	7	8	8	8	8	8	8	8	8
0611120021	12	18	4	20	13	14	15	15	17	19	20	20	22	22	24
0611120031	9	10	1	8	9	9	9	9	9	10	10	11	11	11	11
0611130011	12	13	2	16	9	10	11	11	11	13	14	14	14	15	16

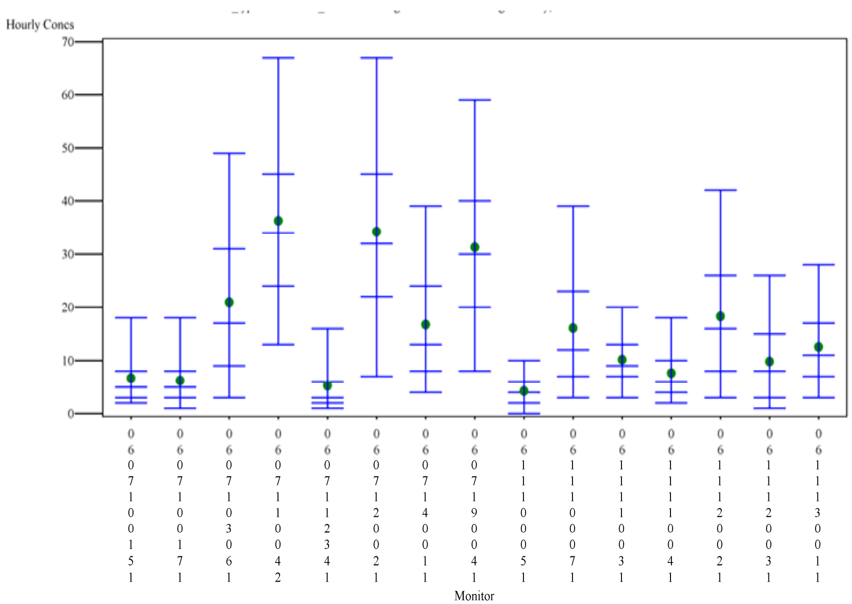

Figure A-40. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Los Angeles CMSA set C 1995-2006.

Table A-40. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Los Angeles CMSA set C, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
0607100151	15531	7	6	82	0	2	3	3	4	5	6	7	10	14	60
0607100171	23713	6	5	84	0	2	3	3	4	5	6	7	9	13	73
0607103061	56831	21	15	70	0	5	8	11	13	17	22	28	34	42	100
0607110042	88766	36	17	48	0	17	22	26	30	34	38	43	49	58	199
0607112341	69325	5	5	103	0	1	2	2	3	3	4	5	7	12	62
0607120021	95054	34	18	54	0	12	19	24	28	32	37	42	48	58	170
0607140011	24587	17	11	68	0	6	7	9	11	13	16	21	27	34	86
0607190041	97785	31	16	51	0	12	18	22	26	30	33	38	43	51	162
0611100051	54034	4	4	89	0	0	1	3	3	4	5	5	6	8	81
0611100071	73031	16	12	74	0	4	6	8	10	12	16	20	26	33	123
0611110031	8240	10	5	52	0	4	6	7	8	9	10	12	14	16	61
0611110041	56869	8	5	66	0	3	4	5	6	6	7	9	11	14	66
0611120021	94238	18	13	70	0	4	7	9	12	16	19	24	29	36	124
0611120031	70332	10	8	85	0	1	2	4	6	8	10	13	17	21	93
0611130011	95263	13	8	65	0	4	6	7	9	11	13	15	18	23	127

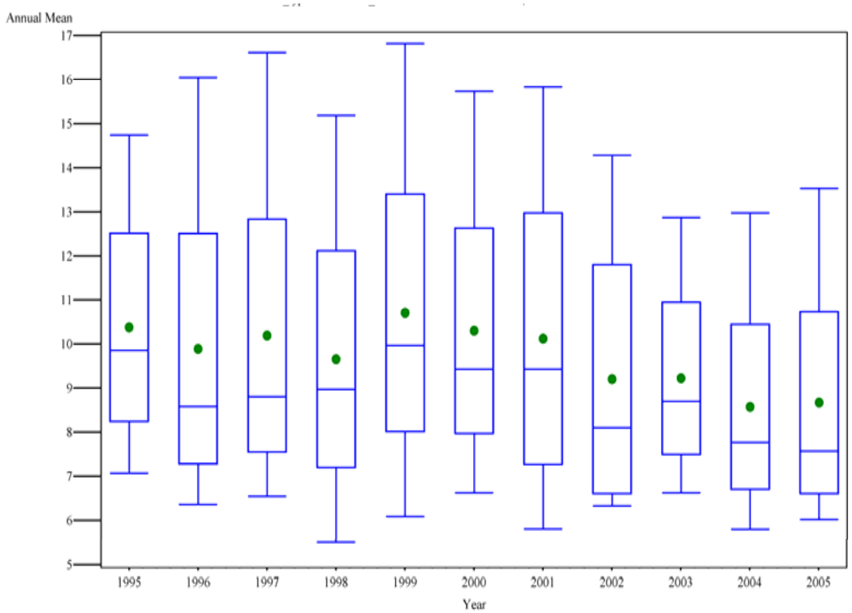

Figure A-41. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Miami CMSA.

Table A-41. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Miami CMSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	4	10	3	31	7	7	7	9	9	10	10	10	15	15	15
1996	4	10	4	43	6	6	6	8	8	9	9	9	16	16	16
1997	4	10	4	43	7	7	7	9	9	9	9	9	17	17	17
1998	4	10	4	42	6	6	6	9	9	9	9	9	15	15	15
1999	4	11	4	42	6	6	6	10	10	10	10	10	17	17	17
2000	4	10	4	37	7	7	7	9	9	9	10	10	16	16	16
2001	4	10	4	42	6	6	6	9	9	9	10	10	16	16	16
2002	4	9	4	39	6	6	6	7	7	8	9	9	14	14	14
2003	4	9	3	29	7	7	7	8	8	9	9	9	13	13	13
2004	4	9	3	36	6	6	6	8	8	8	8	8	13	13	13
2005	4	9	3	38	6	6	6	7	7	8	8	8	14	14	14

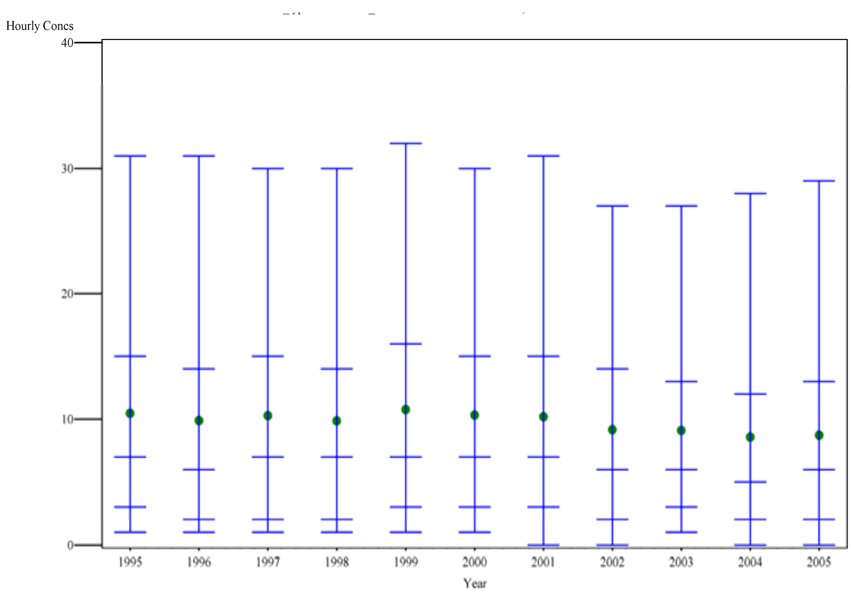

Figure A-42. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Miami CMSA.

Table A-42. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Miami CMSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	32713	10	10	95	0	1	2	3	5	7	10	13	18	25	75
1996	33086	10	10	103	0	1	2	3	4	6	9	12	17	25	96
1997	32754	10	10	97	0	1	2	3	5	7	10	13	18	25	94
1998	30849	10	10	98	0	1	2	3	5	7	10	12	16	23	69
1999	32721	11	11	99	0	1	2	3	5	7	10	14	18	26	128
2000	31833	10	10	99	0	1	2	4	5	7	10	13	17	24	203
2001	33063	10	10	98	0	1	2	3	5	7	10	13	17	24	86
2002	33755	9	9	96	0	1	2	3	4	6	9	12	16	22	80
2003	31031	9	9	97	0	1	2	3	4	6	8	11	15	21	85
2004	33625	9	10	117	0	1	2	2	4	5	7	10	14	21	417
2005	32342	9	10	109	0	0	1	2	4	6	8	11	15	22	94

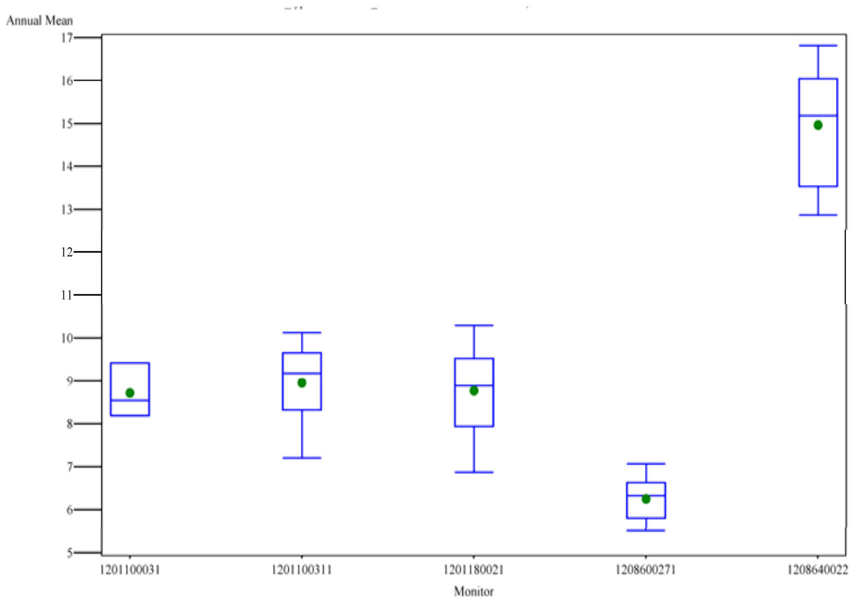

Figure A-43. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Miami CMSA, 1995-2006.

Table A-43. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Miami CMSA, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1201100031	3	9	1	7	8	8	8	8	9	9	9	9	9	9	9
1201100311	8	9	1	12	7	7	8	9	9	9	9	9	10	10	10
1201180021	11	9	1	11	7	8	8	8	9	9	9	9	10	10	10
1208600271	11	6	0	7	6	6	6	6	6	6	6	7	7	7	7
1208640022	11	15	1	9	13	13	14	14	15	15	16	16	16	17	17

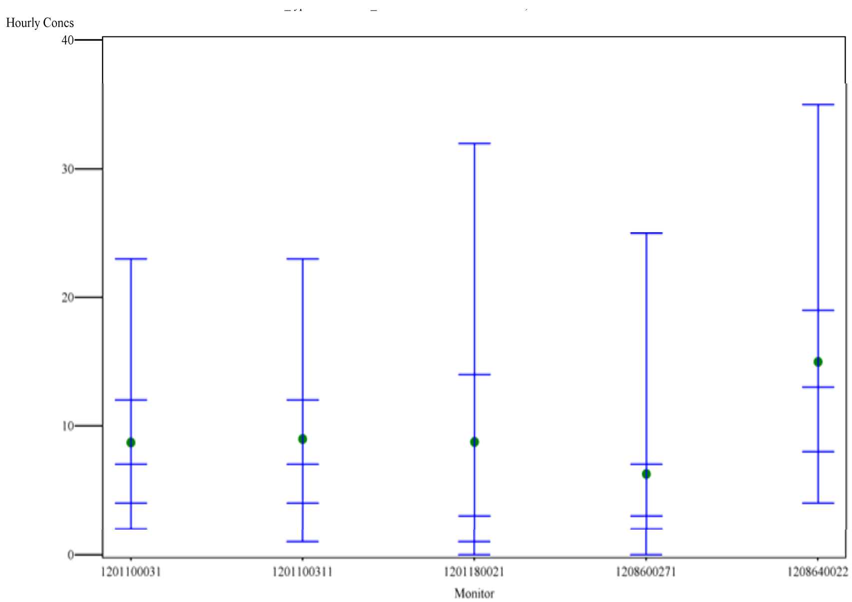

Figure A-44. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Miami CMSA, 1995-2006.

Table A-44. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Miami CMSA, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1201100031	24440	9	7	81	0	2	3	4	5	7	8	10	13	18	65
1201100311	63306	9	7	78	0	2	3	5	6	7	9	11	14	18	64
1201180021	92241	9	11	128	0	0	1	1	2	3	5	11	18	26	128
1208600271	87068	6	8	132	0	1	1	2	2	3	4	5	9	17	75
1208640022	90717	15	10	67	0	5	7	9	11	13	15	18	22	28	417

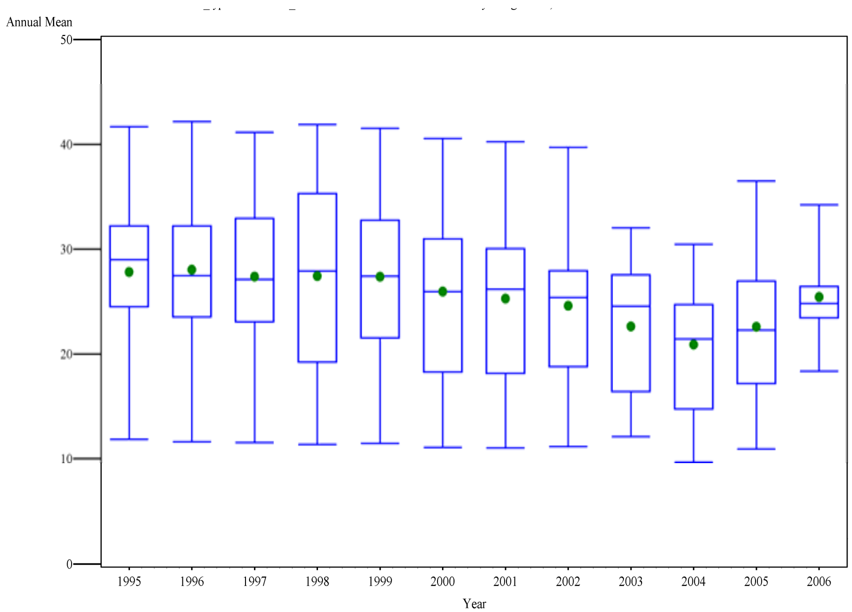

Figure A-45. Distribution of annual average NO_2 ambient concentrations (ppb) by year, New York CMSA.

Table A-45. Distribution of annual average NO_2 ambient concentrations (ppb) by year, New York CMSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	16	28	8	28	12	16	24	25	26	29	30	31	33	39	42
1996	15	28	8	29	12	17	22	26	27	27	29	32	34	41	42
1997	16	27	8	30	12	17	23	24	26	27	29	31	35	40	41
1998	14	27	9	34	11	15	18	22	27	28	30	33	36	40	42
1999	16	27	9	31	11	17	19	24	26	27	29	33	33	41	42
2000	16	26	8	32	11	16	18	19	25	26	29	30	32	38	41
2001	14	25	8	32	11	17	17	21	24	26	27	27	31	38	40
2002	17	25	8	31	11	16	17	20	22	25	28	28	29	38	40
2003	15	23	6	28	12	14	16	18	21	25	26	27	29	30	32
2004	14	21	7	31	10	13	14	17	20	21	24	24	28	30	30
2005	16	23	7	31	11	13	16	18	22	22	25	27	27	32	36
2006	5	25	6	23	18	18	21	23	24	25	26	26	30	34	34

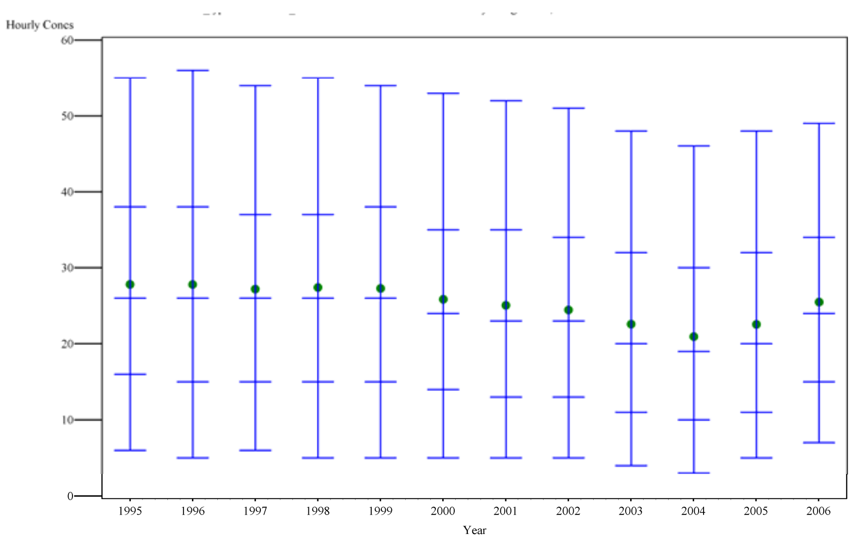

Figure A-46. Distribution of hourly NO_2 ambient concentrations (ppb) by year, New York CMSA.

Table A-46. Distribution of hourly NO_2 ambient concentrations (ppb) by year, New York CMSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	133504	28	16	56	0	9	14	18	22	26	31	35	40	48	162
1996	122074	28	16	57	0	8	13	18	22	26	31	35	40	48	162
1997	131144	27	15	56	0	9	13	17	22	26	30	35	40	47	181
1998	116748	27	16	58	0	8	13	17	22	26	31	35	40	48	240
1999	132646	27	16	57	0	8	13	17	22	26	30	35	40	48	148
2000	134037	26	15	58	0	8	12	16	20	24	28	33	38	46	118
2001	114478	25	15	61	0	7	10	15	19	23	28	33	38	45	142
2002	141480	24	15	60	0	7	11	14	18	23	27	32	37	44	129
2003	122724	23	14	61	0	6	10	13	16	20	25	29	35	42	138
2004	115578	21	13	64	0	5	8	12	15	19	23	27	32	40	156
2005	133856	23	14	63	1	6	9	13	16	20	24	29	35	42	119
2006	42223	25	13	51	0	10	13	17	20	24	28	32	37	43	92

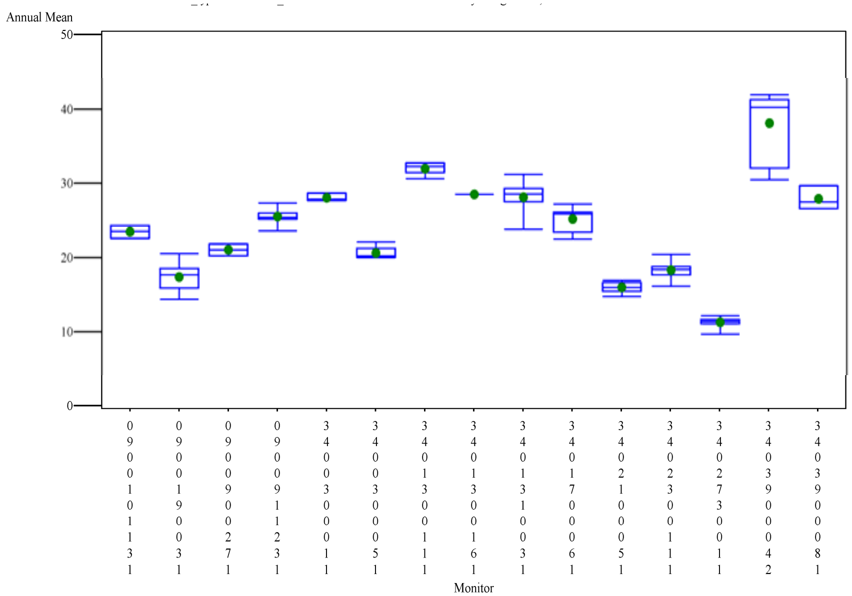

Figure A-47. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, New York CMSA set a, 1995-2006.

Table A-47. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, New York CMSA set A, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
0900101131	3	23	1	4	23	23	23	23	24	24	24	24	24	24	24
0900190031	8	17	2	11	14	14	15	16	18	18	18	18	19	21	21
0900900271	2	21	1	5	20	20	20	20	20	21	22	22	22	22	22
0900911231	9	26	1	4	24	24	25	25	25	25	26	26	27	27	27
3400300011	3	28	1	2	28	28	28	28	28	28	28	29	29	29	29
3400300051	4	21	1	5	20	20	20	20	20	20	20	20	22	22	22
3401300111	5	32	1	3	31	31	31	31	32	32	32	33	33	33	33
3401300161	1	29			29	29	29	29	29	29	29	29	29	29	29
3401310031	11	28	2	7	24	26	27	28	28	29	29	29	29	29	31
3401700061	11	25	2	6	22	23	23	25	26	26	26	26	26	27	27
3402100051	11	16	1	4	15	15	15	16	16	16	16	17	17	17	17
3402300111	11	18	1	6	16	17	18	18	18	18	19	19	19	19	20
3402730011	11	11	1	6	10	11	11	11	11	11	11	12	12	12	12
3403900042	11	38	4	12	30	32	32	39	40	40	41	41	41	42	42
3403900081	3	28	2	6	27	27	27	27	27	27	27	30	30	30	30

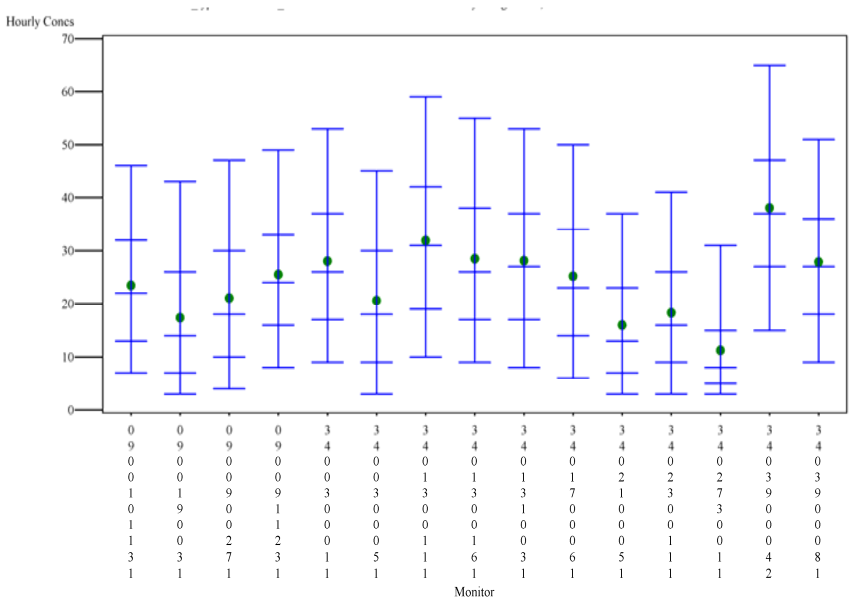

Figure A-48. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, New York CMSA set a, 1995-2006.

Table A-48. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, New York CMSA set A, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
0900101131	25148	23	13	55	0	9	12	15	18	22	25	29	34	40	109
0900190031	67123	17	13	75	0	4	6	8	10	14	18	23	29	36	103
0900900271	16002	21	14	65	0	6	8	11	14	18	22	27	33	40	101
0900911231	76418	26	13	50	0	11	14	17	20	24	27	31	36	43	240
3400300011	25620	28	14	50	3	11	15	19	23	26	31	35	40	47	119
3400300051	34090	21	14	66	3	5	8	11	14	18	22	27	33	40	124
3401300111	41642	32	16	50	3	12	17	21	26	31	35	40	45	53	148
3401300161	8368	29	15	52	3	11	15	18	22	26	31	36	41	49	103
3401310031	93578	28	14	51	3	11	15	19	23	27	31	35	40	47	150
3401700061	93886	25	14	56	2	9	12	16	19	23	27	32	37	44	147
3402100051	94591	16	11	67	2	4	7	8	11	13	16	20	25	32	79
3402300111	94366	18	12	65	3	5	8	10	13	16	19	23	28	35	99
3402730011	92642	11	9	82	0	3	3	5	7	8	10	13	17	24	95
3403900042	92472	38	15	41	3	19	25	29	33	37	41	45	50	58	225
3403900081	23611	28	13	47	3	11	16	20	24	27	30	34	38	44	122

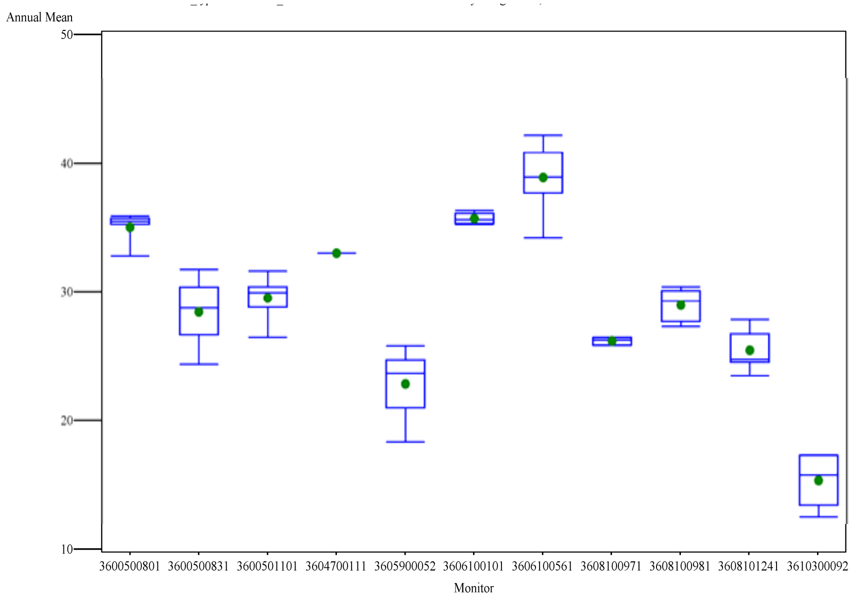

Figure A-49. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, New York CMSA set b, 1995-2006.

Table A-49. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, New York CMSA set B, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
3600500801	5	35	1	4	33	33	34	35	35	35	36	36	36	36	36
3600500831	12	28	2	9	24	25	27	27	28	29	30	30	31	31	32
3600501101	6	30	2	6	26	26	29	29	30	30	30	30	30	32	32
3604700111	1	33			33	33	33	33	33	33	33	33	33	33	33
3605900052	11	23	2	10	18	20	21	22	22	24	24	24	25	25	26
3606100101	4	36	1	1	35	35	35	35	35	36	36	36	36	36	36
3606100561	10	39	2	6	34	35	37	38	38	39	40	40	41	42	42
3608100971	3	26	0	1	26	26	26	26	26	26	26	26	26	26	26
3608100981	7	29	1	4	27	27	28	28	28	29	30	30	30	30	30
3608101241	5	25	2	7	23	23	24	25	25	25	26	27	27	28	28
3610300092	6	15	2	14	13	13	13	13	14	16	17	17	17	17	17

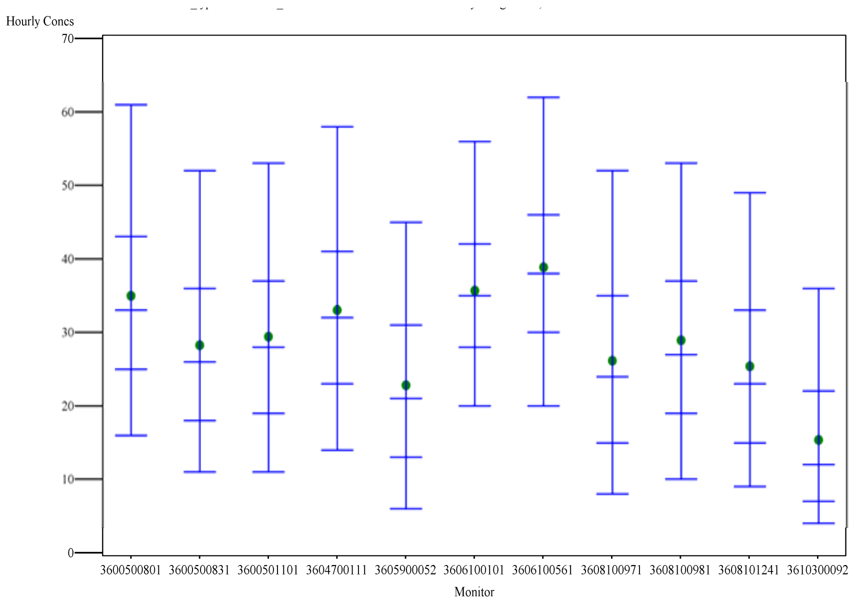

Figure A-50. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, New York CMSA set b, 1995-2006.

Table A-50. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, New York CMSA set B, 1995-2006.

3600500801	41120	35	14	40	0	19	23	26	30	33	37	40	45	54	181
3600500831	95448	28	13	47	0	13	17	20	23	26	30	34	39	46	136
3600501101	46299	29	13	45	0	14	18	21	24	28	31	35	40	47	119
3604700111	8300	33	14	41	3	17	21	25	28	32	35	39	43	51	155
3605900052	89801	23	13	56	0	8	11	14	18	21	25	29	34	40	162
3606100101	30694	36	11	31	0	23	27	29	32	35	37	40	44	50	118
3606100561	81341	39	13	33	0	24	28	32	35	38	41	44	48	55	162
3608100971	24104	26	14	54	0	10	13	17	20	24	28	33	38	45	95
3608100981	56186	29	13	46	0	13	17	20	24	27	31	35	40	47	114
3608101241	39406	25	13	50	0	11	14	17	20	23	27	31	36	43	144
3610300092	48236	15	10	67	0	5	7	8	10	12	15	19	24	31	86

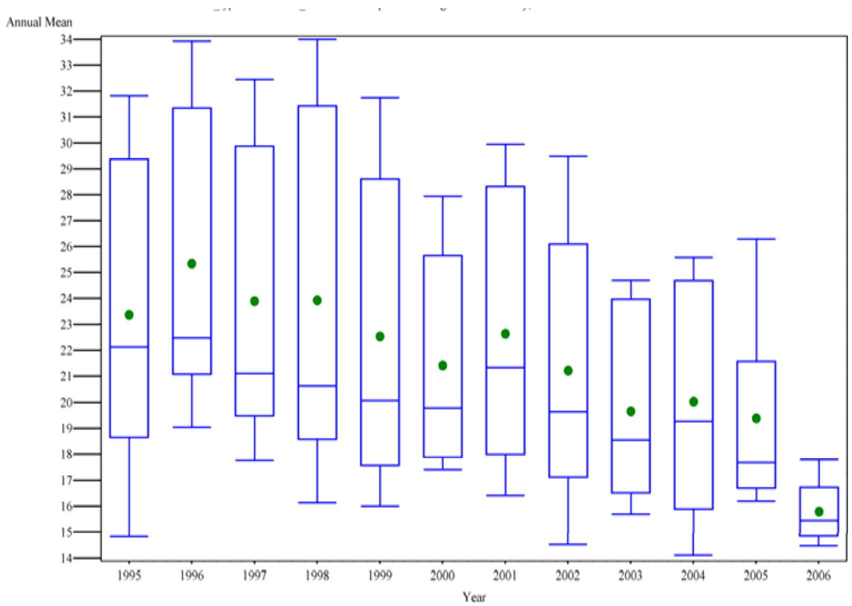

Figure A-51. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Philadelphia CMSA.

Table A-51. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Philadelphia CMSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	8	23	6	27	15	15	17	20	20	22	24	28	31	32	32
1996	8	25	6	24	19	19	21	21	21	22	24	29	33	34	34
1997	8	24	6	25	18	18	19	20	20	21	22	28	32	32	32
1998	8	24	7	30	16	16	18	19	19	21	22	29	33	34	34
1999	8	23	6	28	16	16	17	18	18	20	22	27	30	32	32
2000	6	21	4	20	17	17	18	18	19	20	20	26	26	28	28
2001	7	23	5	24	16	16	18	19	19	21	26	26	28	30	30
2002	8	21	5	26	15	15	16	18	19	20	20	24	28	29	29
2003	6	20	4	19	16	16	17	17	18	19	19	24	24	25	25
2004	7	20	4	22	14	14	16	18	18	19	23	23	25	26	26
2005	7	19	4	19	16	16	17	17	17	18	20	20	22	26	26
2006	4	16	1	9	14	14	14	15	15	15	16	16	18	18	18

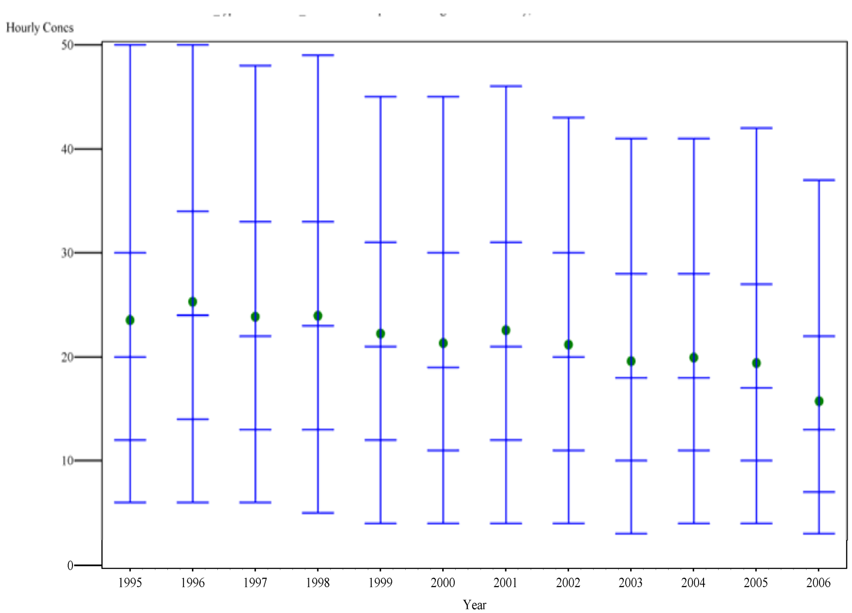

Figure A-52. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Philadelphia CMSA.

Table A-52. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Philadelphia CMSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	65415	24	14	60	0	8	10	14	19	20	26	30	35	40	140
1996	67989	25	14	55	0	8	11	17	20	24	30	30	40	42	100
1997	68291	24	14	57	0	8	11	15	19	22	26	30	35	42	247
1998	66847	24	14	58	0	7	11	15	19	23	27	31	36	42	97
1999	64813	22	13	59	0	6	10	14	17	21	25	29	33	40	109
2000	51145	21	13	60	0	6	10	13	16	19	23	27	32	39	97
2001	59227	23	13	59	0	6	10	14	17	21	25	29	34	40	96
2002	66779	21	12	59	0	6	10	13	16	20	23	27	32	38	268
2003	49256	20	12	62	0	5	8	11	15	18	22	26	30	36	105
2004	58509	20	12	59	0	6	9	12	15	18	22	26	30	36	101
2005	56459	19	12	62	0	6	9	11	14	17	21	25	29	36	120
2006	32357	16	11	69	0	4	6	8	10	13	16	20	25	31	95

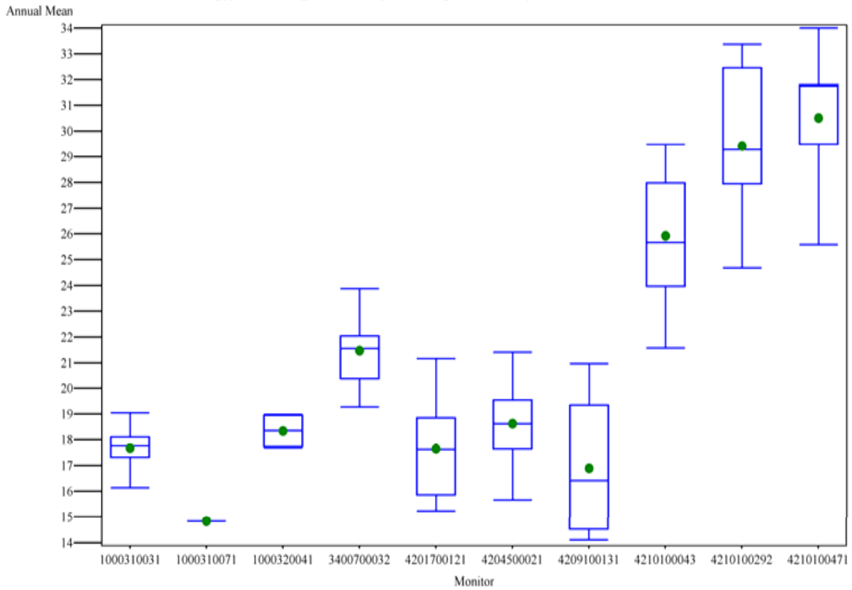

Figure A-53. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Philadelphia CMSA, 1995-2006.

Table A-53. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, **Philadelphia** CMSA, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1000310031	5	18	1	6	16	16	17	17	18	18	18	18	19	19	19
1000310071	1	15			15	15	15	15	15	15	15	15	15	15	15
1000320041	4	18	1	4	18	18	18	18	18	18	19	19	19	19	19
3400700032	10	21	1	7	19	20	20	20	21	22	22	22	23	24	24
4201700121	12	18	2	11	15	16	16	16	17	18	18	18	20	20	21
4204500021	12	19	2	8	16	17	17	18	18	19	19	19	20	20	21
4209100131	11	17	2	13	14	14	15	16	16	16	17	18	19	19	21
4210100043	11	26	3	10	22	23	24	24	26	26	27	28	28	29	29
4210100292	10	29	3	11	25	25	26	28	28	29	31	32	33	33	33
4210100471	9	31	3	10	26	26	26	29	30	32	32	32	34	34	34

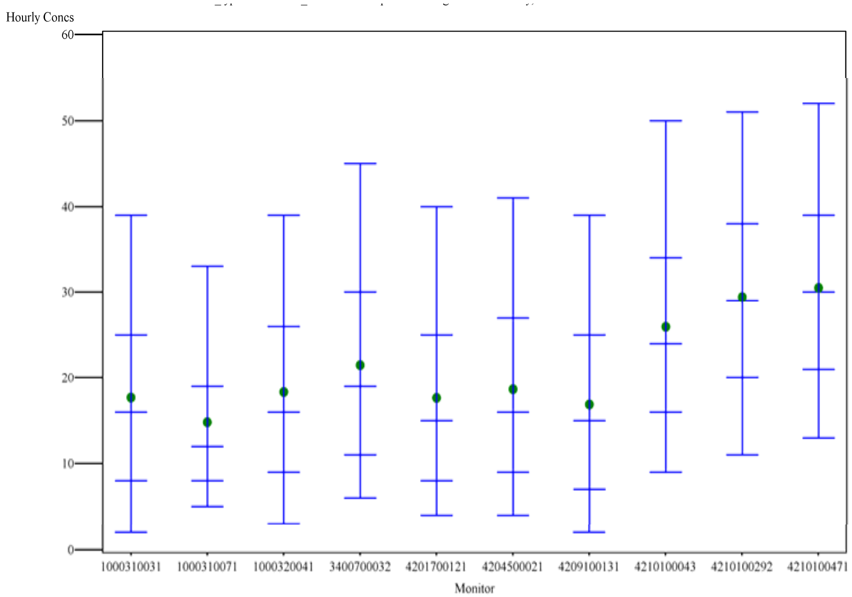

Figure A-54. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Philadelphia CMSA, 1995-2006.

Table A-54. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Philadelphia CMSA, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1000310031	40363	18	12	69	0	4	7	10	12	16	19	23	28	34	247
1000310071	6611	15	9	62	1	6	7	9	10	12	15	17	21	28	69
1000320041	31615	18	12	63	0	5	8	11	13	16	20	23	28	34	115
3400700032	84603	22	13	59	3	7	10	13	16	19	23	27	32	39	114
4201700121	102584	18	12	67	0	5	7	9	12	15	19	23	28	34	106
4204500021	100344	19	12	64	0	5	8	10	13	16	20	24	29	36	268
4209100131	93572	17	12	69	0	4	6	9	11	15	18	22	27	33	99
4210100043	90975	26	13	49	0	10	14	18	20	24	28	31	37	43	190
4210100292	81218	29	13	43	0	15	19	21	25	29	30	35	40	46	120
4210100471	75202	31	12	40	0	16	20	23	26	30	31	36	40	47	140

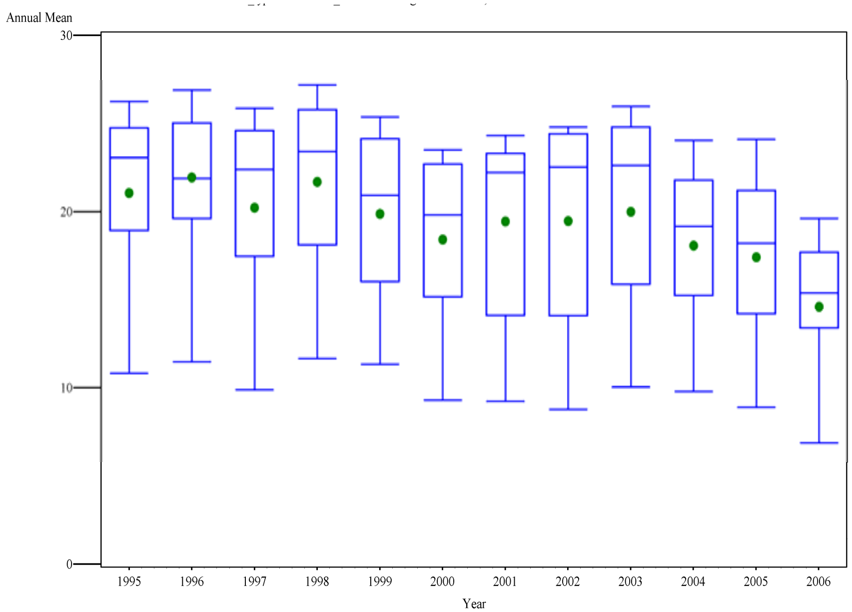

Figure A-55. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Washington DC CMSA.

Table A-55. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Washington DC CMSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	12	21	5	25	11	11	19	19	22	23	23	25	25	26	26
1996	11	22	4	20	11	20	20	21	22	22	24	24	25	26	27
1997	11	20	5	27	10	11	17	19	21	22	22	24	25	26	26
1998	11	22	5	23	12	15	18	20	22	23	24	25	26	26	27
1999	12	20	5	25	11	12	14	18	20	21	23	24	24	25	25
2000	12	18	5	27	9	10	13	17	18	20	21	23	23	23	23
2001	11	19	5	28	9	11	14	19	20	22	23	23	23	24	24
2002	10	19	6	31	9	10	13	16	20	23	23	24	25	25	25
2003	11	20	6	28	10	12	16	18	18	23	23	23	25	26	26
2004	12	18	5	27	10	10	15	15	17	19	21	21	22	23	24
2005	12	17	5	28	9	10	14	15	17	18	21	21	21	22	24
2006	10	15	4	30	7	7	10	14	15	15	16	17	18	19	20

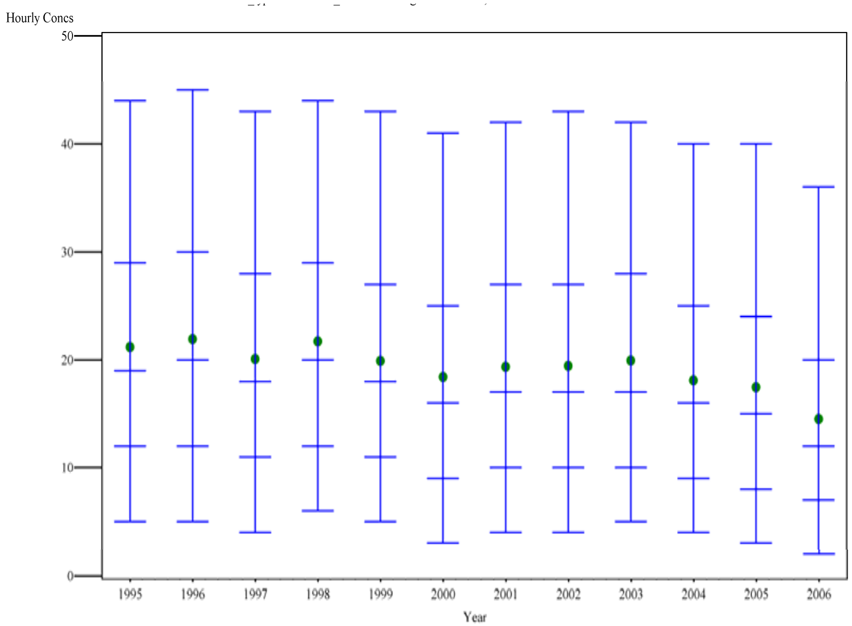

Figure A-56. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Washington DC CMSA.

Table A-56. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Washington DC CMSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	98349	21	13	59	0	7	10	13	16	19	23	27	31	38	145
1996	91551	22	12	57	0	7	11	14	17	20	24	28	32	39	107
1997	87646	20	12	62	0	6	9	12	15	18	21	25	30	37	155
1998	89335	22	12	57	0	8	11	14	16	20	23	27	32	38	285
1999	100112	20	12	61	0	6	9	12	15	18	21	25	30	37	114
2000	101494	18	12	64	0	5	8	11	13	16	19	23	28	35	141
2001	91594	19	12	62	0	6	9	11	14	17	20	24	29	36	89
2002	83969	19	12	64	0	6	9	11	14	17	20	24	30	37	108
2003	93111	20	12	61	0	6	9	12	14	17	21	25	30	37	102
2004	99370	18	11	63	0	5	8	10	13	16	19	23	28	34	115
2005	96396	17	12	68	0	5	7	10	12	15	18	22	27	34	115
2006	83691	15	11	73	0	4	6	7	9	12	14	18	23	30	129

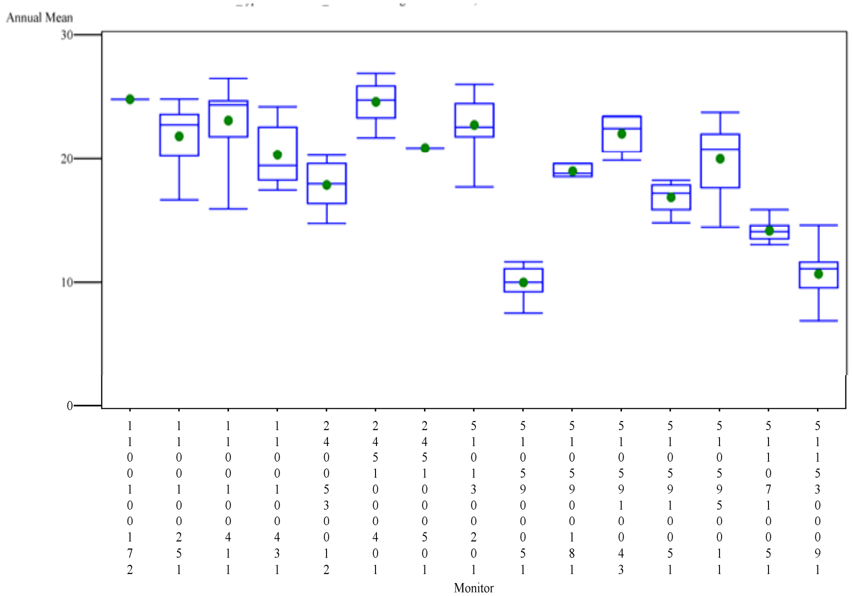

Figure A-57. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Washington DC CMSA set A, 1995-2006.

Table A-57. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Washington DC CMSA set A, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1100100172	1	25			25	25	25	25	25	25	25	25	25	25	25
1100100251	12	22	2	11	17	19	20	21	22	23	23	23	24	24	25
1100100411	12	23	3	12	16	21	21	23	23	24	24	25	25	25	26
1100100431	12	20	2	12	17	18	18	18	19	19	21	22	23	23	24
2400530012	8	18	2	11	15	15	15	17	18	18	18	19	20	20	20
2451000401	11	25	2	7	22	23	23	23	24	25	26	26	26	26	27
2451000501	1	21			21	21	21	21	21	21	21	21	21	21	21
5101300201	12	23	2	10	18	21	21	22	22	23	23	24	25	25	26
5105900051	11	10	1	12	7	9	9	10	10	10	10	11	11	11	12
5105900181	3	19	1	3	19	19	19	19	19	19	19	20	20	20	20
5105910043	6	22	2	7	20	20	21	21	22	22	23	23	23	23	23
5105910051	4	17	1	9	15	15	15	17	17	17	17	17	18	18	18
5105950011	10	20	3	15	14	16	17	19	20	21	22	22	22	23	24
5110710051	8	14	1	6	13	13	13	14	14	14	14	14	15	16	16
5115300091	12	11	2	18	7	9	9	10	10	11	11	11	12	12	15

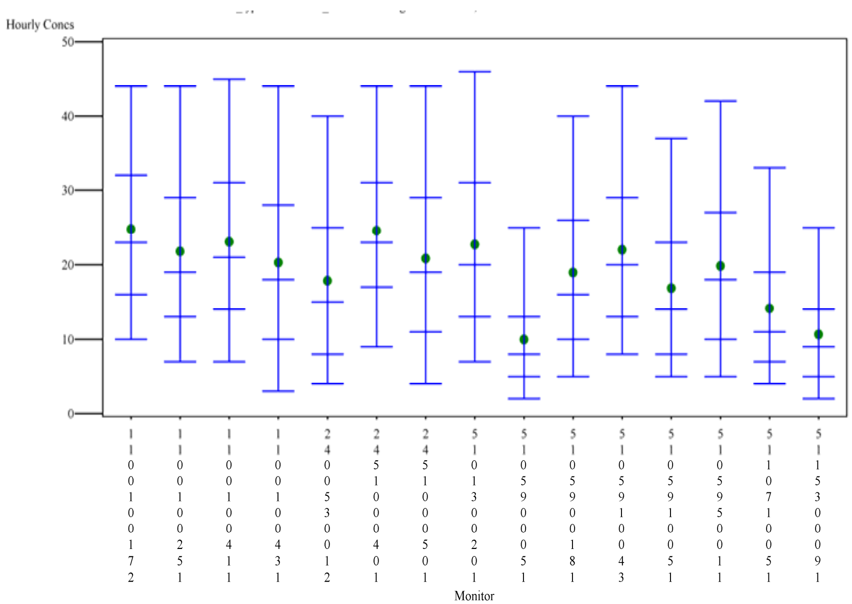

Figure A-58. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Washington DC CMSA set A, 1995-2006.

Table A-58. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Washington DC CMSA set A, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1100100172	8584	25	11	45	4	12	15	18	20	23	27	30	33	39	113
1100100251	102444	22	12	55	0	9	11	14	16	19	23	27	32	39	285
1100100411	103173	23	12	53	0	9	12	15	18	21	24	28	33	39	141
1100100431	102217	20	13	64	0	6	9	12	15	18	22	26	31	38	258
2400530012	63983	18	12	65	0	5	7	10	12	15	19	23	28	34	114
2451000401	89589	25	11	44	0	12	15	18	21	23	26	29	33	39	108
2451000501	7872	21	12	60	0	6	9	12	16	19	23	27	32	38	75
5101300201	97517	23	13	56	0	8	11	14	17	20	24	28	34	41	110
5105900051	89964	10	7	73	0	3	4	5	6	8	10	12	15	20	101
5105900181	22689	19	11	60	0	6	9	11	13	16	20	24	29	36	89
5105910043	50294	22	11	52	0	10	12	14	17	20	23	27	31	38	91
5105910051	34022	17	11	63	0	6	8	9	12	14	17	21	26	32	129
5105950011	79051	20	12	61	0	6	9	12	14	18	21	25	30	36	155
5110710051	65327	14	9	65	0	5	7	8	10	11	14	17	21	28	64
5115300091	101671	11	7	68	0	3	5	6	7	9	11	13	16	21	84

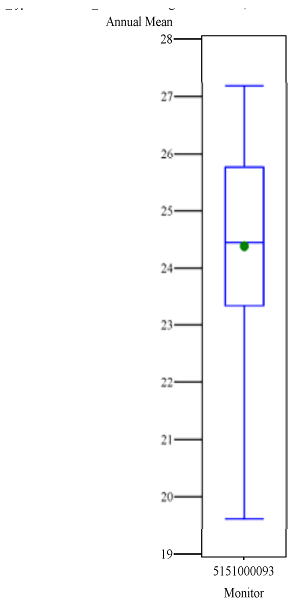

Figure A-59. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Washington DC CMSA set B, 1995-2006.

Table A-59. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Washington DC CMSA set B, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
5151000093	12	24	2	8	20	23	23	23	24	24	25	26	26	26	27

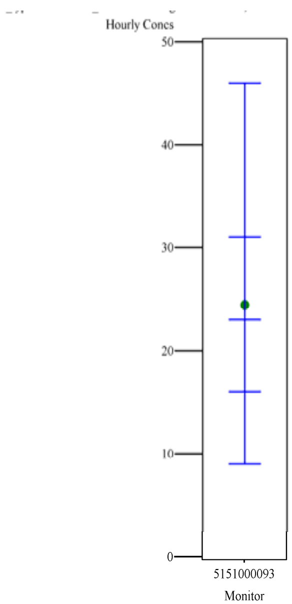

Figure A-60. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Washington DC CMSA set B, 1995-2006.

Table A-60. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Washington DC CMSA set B, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
5151000093	98221	24	12	48	0	11	14	17	20	23	26	29	34	40	115

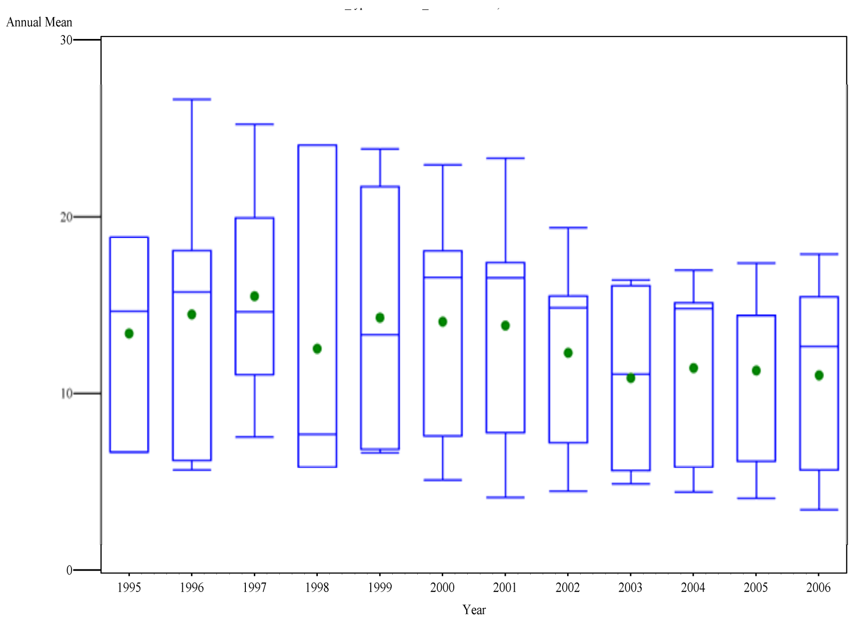

Figure A-61. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Atlanta MSA.

Table A-61. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Atlanta MSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	3	13	6	46	7	7	7	7	15	15	15	19	19	19	19
1996	5	14	9	61	6	6	6	6	11	16	17	18	22	27	27
1997	4	15	7	47	8	8	8	15	15	15	15	15	25	25	25
1998	3	13	10	80	6	6	6	6	8	8	8	24	24	24	24
1999	4	14	9	61	7	7	7	7	7	13	20	20	24	24	24
2000	5	14	7	53	5	5	6	8	12	17	17	18	21	23	23
2001	5	14	8	56	4	4	6	8	12	17	17	17	20	23	23
2002	5	12	6	51	4	4	6	7	11	15	15	16	17	19	19
2003	4	11	6	56	5	5	5	6	6	11	16	16	16	16	16
2004	5	11	6	51	4	4	5	6	10	15	15	15	16	17	17
2005	5	11	6	51	4	4	5	6	10	14	14	14	16	17	17
2006	5	11	6	57	3	3	5	6	9	13	14	15	17	18	18

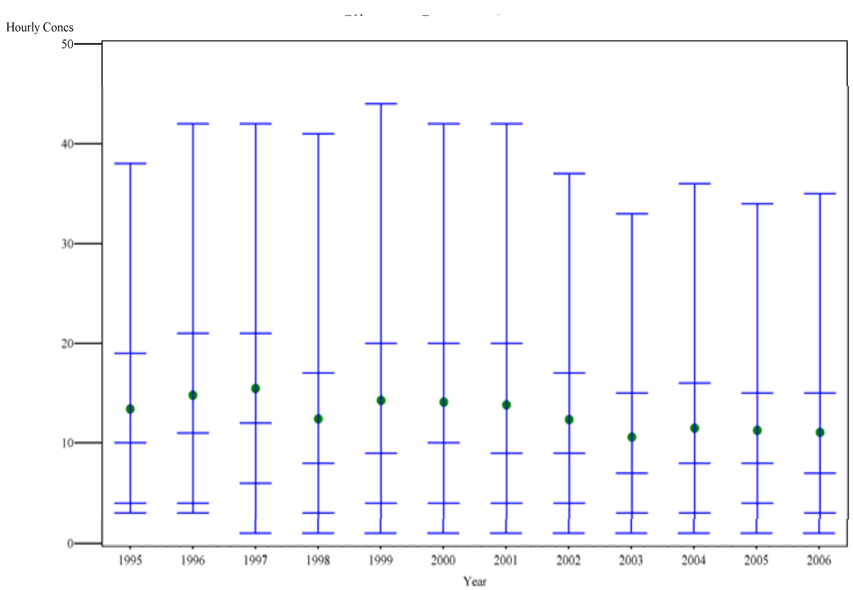

Figure A-62. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Atlanta MSA.

Table A-62. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Atlanta MSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	25213	13	12	89	1	3	3	5	7	10	13	16	22	30	93
1996	40576	15	13	89	1	3	3	5	8	11	14	18	24	34	122
1997	31069	15	13	86	1	3	5	7	9	12	15	18	23	33	181
1998	24142	12	13	105	0	1	3	4	6	8	11	14	20	30	124
1999	31121	14	14	99	0	2	4	5	7	9	12	17	23	35	242
2000	40584	14	14	97	1	1	3	5	7	10	13	17	23	33	110
2001	42761	14	14	98	1	1	3	5	7	9	13	17	23	33	172
2002	42076	12	12	95	1	1	3	5	6	9	11	15	20	29	136
2003	32215	11	11	101	0	1	2	3	5	7	9	13	17	26	91
2004	42124	11	11	98	1	1	3	4	6	8	10	14	19	28	127
2005	42279	11	11	96	1	1	3	4	6	8	10	13	18	27	97
2006	41052	11	11	98	1	2	3	4	5	7	9	13	18	27	73

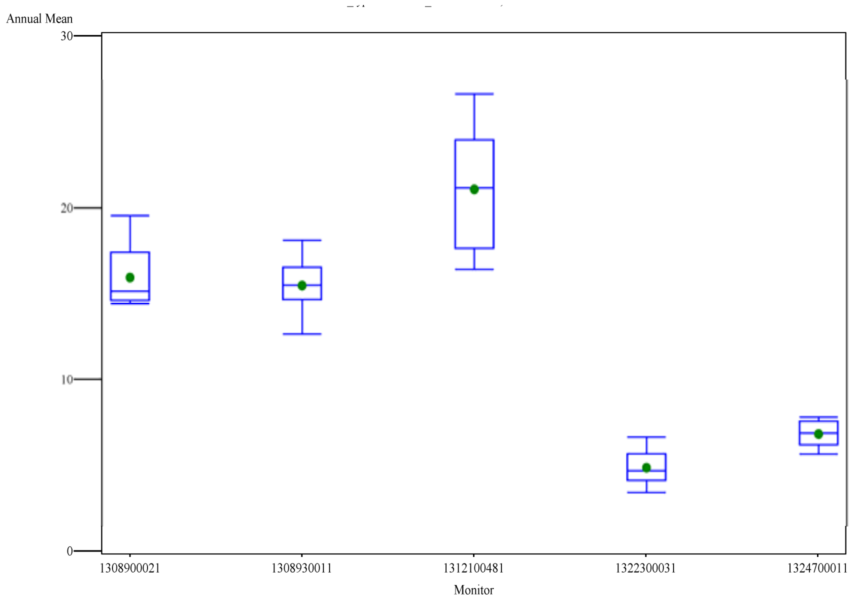

Figure A-63. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Atlanta MSA, 1995-2006.

Table A-63. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Atlanta MSA, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1308900021	10	16	2	11	14	14	15	15	15	15	16	17	18	19	20
1308930011	9	15	2	10	13	13	14	15	15	16	16	17	17	18	18
1312100481	12	21	4	17	16	17	17	18	19	21	23	24	24	25	27
1322300031	10	5	1	20	3	4	4	4	4	5	5	5	6	6	7
1324700011	12	7	1	11	6	6	6	6	6	7	7	8	8	8	8

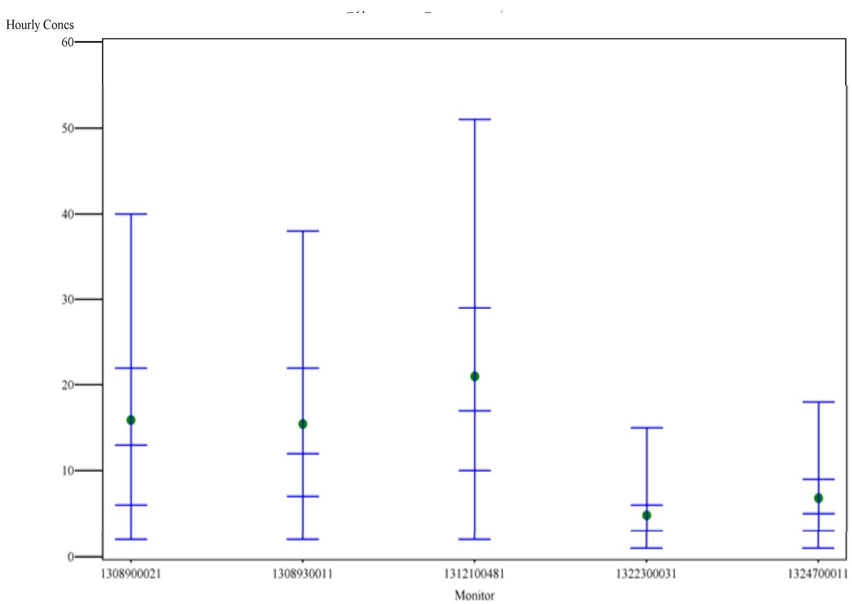

Figure A-64. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Atlanta MSA, 1995-2006.

Table A-64. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Atlanta MSA, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1308900021	83891	16	12	77	0	3	5	8	10	13	16	20	25	33	139
1308930011	72029	15	11	73	1	4	6	8	10	12	15	19	24	32	95
1312100481	98975	21	15	73	0	5	8	11	14	17	21	26	33	43	181
1322300031	80168	5	5	108	0	1	1	2	3	3	4	5	7	11	70
1324700011	100149	7	6	81	0	2	3	3	4	5	6	8	10	14	242

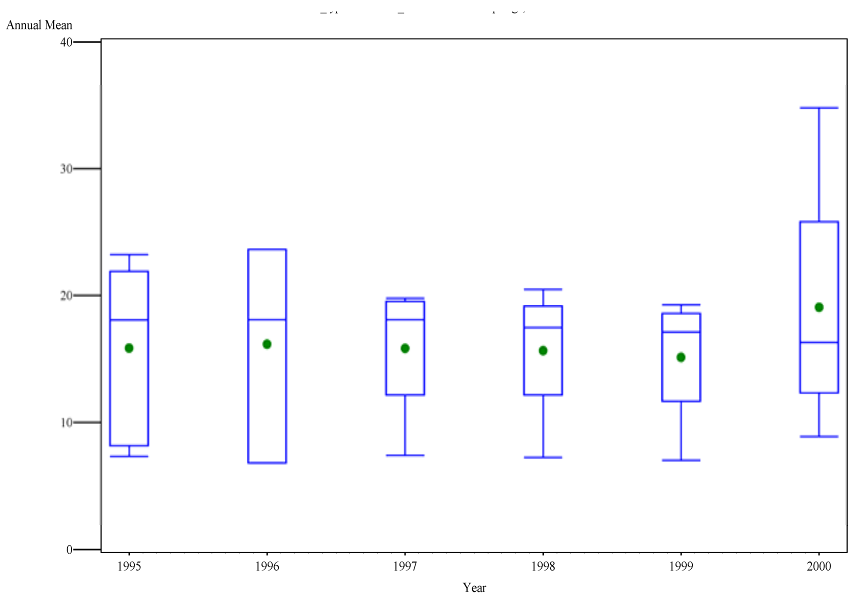

Figure A-65. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Colorado Springs MSA.

Table A-65. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Colorado Springs MSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	7	16	7	42	7	7	8	12	12	18	21	21	22	23	23
1996	3	16	9	53	7	7	7	7	18	18	18	24	24	24	24
1997	4	16	6	36	7	7	7	17	17	18	19	19	20	20	20
1998	4	16	6	37	7	7	7	17	17	17	18	18	20	20	20
1999	4	15	6	37	7	7	7	16	16	17	18	18	19	19	19
2000	4	19	11	58	9	9	9	16	16	16	17	17	35	35	35

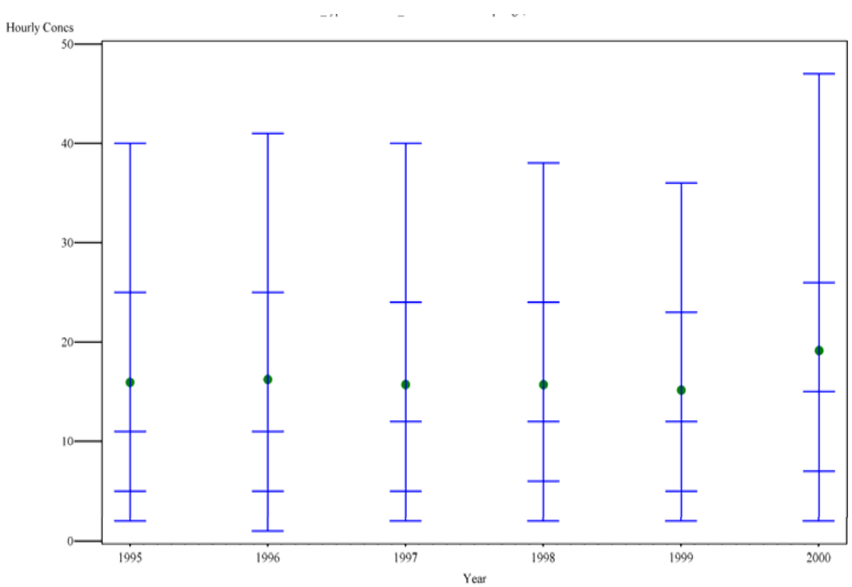

Figure A-66. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Colorado Springs MSA.

Table A-66. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Colorado Springs MSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	58569	16	14	91	0	2	4	6	8	11	16	22	29	36	148
1996	25387	16	16	101	0	2	4	6	8	11	16	21	28	35	246
1997	33469	16	13	80	0	3	5	6	9	12	16	21	27	35	118
1998	34509	16	12	76	0	3	5	7	9	12	16	22	27	34	85
1999	34472	15	12	82	0	3	4	6	9	12	16	21	26	32	230
2000	33956	19	20	106	0	3	6	8	11	15	20	24	28	34	308

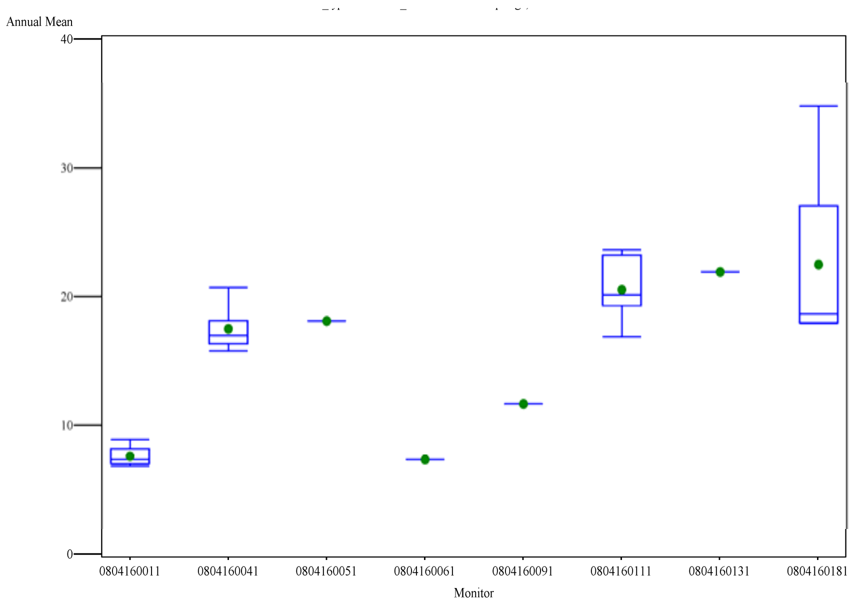

Figure A-67. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Colorado Springs MSA, 1995-2006.

Table A-67. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Colorado Springs MSA, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
0804160011	6	8	1	10	7	7	7	7	7	7	7	8	8	9	9
0804160041	6	17	2	10	16	16	16	16	17	17	17	18	18	21	21
0804160051	1	18			18	18	18	18	18	18	18	18	18	18	18
0804160061	1	7			7	7	7	7	7	7	7	7	7	7	7
0804160091	1	12			12	12	12	12	12	12	12	12	12	12	12
0804160111	6	21	3	12	17	17	19	19	20	20	20	23	23	24	24
0804160131	1	22			22	22	22	22	22	22	22	22	22	22	22
0804160181	4	22	8	37	18	18	18	18	18	19	19	19	35	35	35

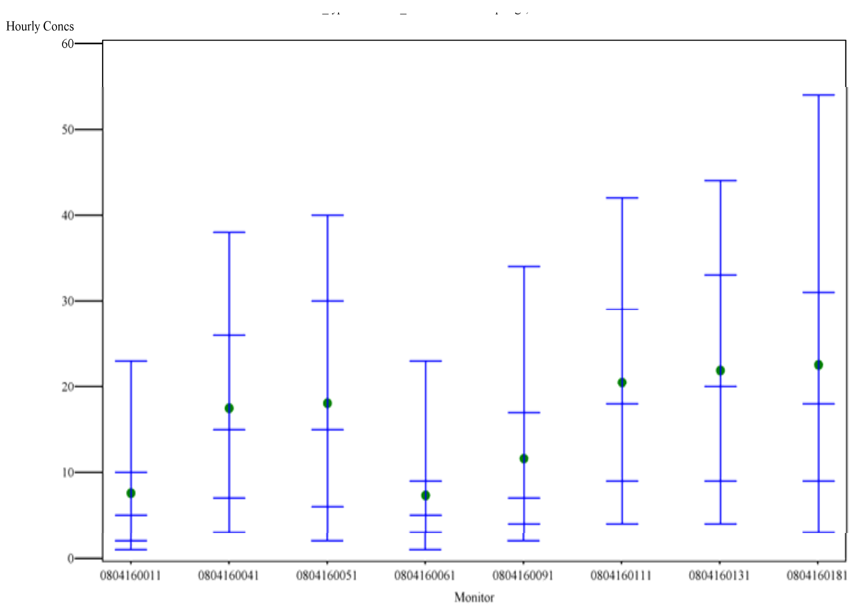

Figure A-68. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Colorado Springs MSA, 1995-2006.

Table A-68. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Colorado Springs MSA, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
0804160011	51373	8	7	94	0	1	2	3	4	5	7	9	12	18	59
0804160041	51288	17	11	66	0	4	6	9	12	15	20	24	28	34	115
0804160051	8345	18	13	74	1	3	5	7	10	15	21	27	32	36	143
0804160061	7993	7	7	99	0	1	2	3	4	5	6	8	11	16	49
0804160091	8282	12	10	89	0	2	3	4	6	7	10	14	20	29	56
0804160111	50707	21	16	77	0	5	7	10	14	18	23	27	31	37	246
0804160131	8637	22	14	62	0	5	8	11	15	20	26	31	36	41	87
0804160181	33737	23	21	94	0	5	7	10	14	18	23	28	33	41	308

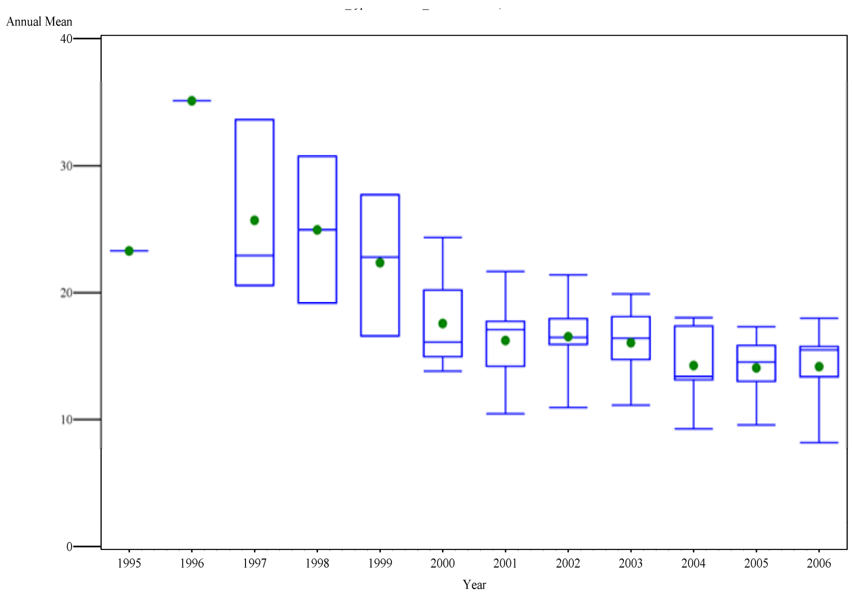

Figure A-69. Distribution of annual average NO_2 ambient concentrations (ppb) by year, El Paso MSA.

Table A-69. Distribution of annual average NO_2 ambient concentrations (ppb) by year, El Paso MSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	1	23		0	23	23	23	23	23	23	23	23	23	23	23
1996	1	35		0	35	35	35	35	35	35	35	35	35	35	35
1997	3	26	7	27	21	21	21	21	23	23	23	34	34	34	34
1998	2	25	8	33	19	19	19	19	19	25	31	31	31	31	31
1999	3	22	6	25	17	17	17	17	23	23	23	28	28	28	28
2000	4	18	5	26	14	14	14	16	16	16	16	16	24	24	24
2001	5	16	4	26	10	10	12	14	16	17	17	18	20	22	22
2002	5	17	4	23	11	11	13	16	16	16	17	18	20	21	21
2003	5	16	3	21	11	11	13	15	16	16	17	18	19	20	20
2004	5	14	4	25	9	9	11	13	13	13	15	17	18	18	18
2005	5	14	3	21	10	10	11	13	14	15	15	16	17	17	17
2006	5	14	4	26	8	8	11	13	14	15	16	16	17	18	18

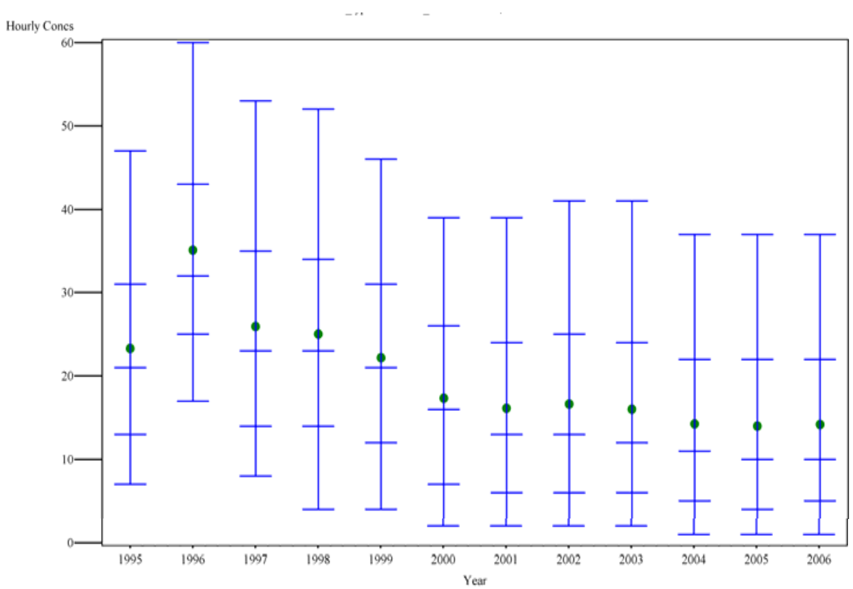

Figure A-70. Distribution of hourly NO_2 ambient concentrations (ppb) by year, El Paso MSA.

Table A-70. Distribution of hourly NO_2 ambient concentrations (ppb) by year, El Paso MSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	6960	23	13	58	3	9	12	14	17	21	25	29	34	41	113
1996	6627	35	15	43	2	20	23	27	29	32	36	40	46	54	219
1997	22888	26	15	58	0	10	13	16	20	23	28	32	38	45	174
1998	15523	25	15	61	0	7	12	15	19	23	27	32	37	45	166
1999	23447	22	13	60	0	6	10	14	17	21	25	28	33	40	108
2000	30772	17	13	72	0	3	5	8	12	16	20	24	28	34	125
2001	38020	16	12	77	0	3	5	7	10	13	16	21	27	34	102
2002	41466	17	13	77	0	4	5	7	10	13	17	22	28	35	153
2003	39968	16	13	80	0	3	5	7	9	12	16	21	27	35	106
2004	41952	14	12	83	0	2	4	6	8	11	14	19	25	32	97
2005	41496	14	12	86	0	2	4	5	7	10	14	19	24	31	87
2006	37203	14	12	84	0	2	4	6	8	10	14	19	25	32	99

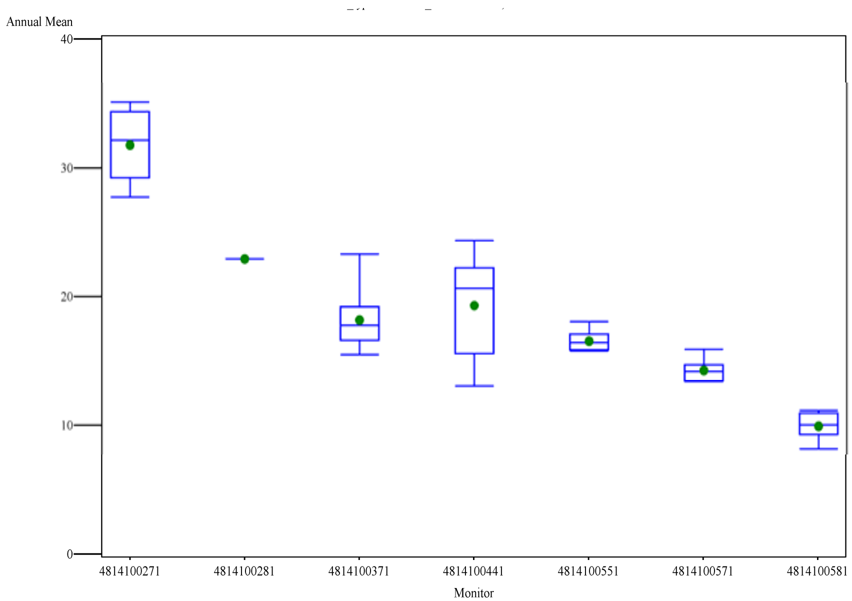

Figure A-71. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, El Paso MSA, 1995-2006.

Table A-71. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, El Paso MSA, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
4814100271	4	32	3	10	28	28	28	31	31	32	34	34	35	35	35
4814100281	1	23			23	23	23	23	23	23	23	23	23	23	23
4814100371	11	18	2	12	15	16	17	17	17	18	18	18	19	21	23
4814100441	8	19	4	22	13	13	13	18	20	21	21	22	23	24	24
4814100551	7	17	1	5	16	16	16	16	16	16	16	16	17	18	18
4814100571	7	14	1	6	13	13	13	14	14	14	15	15	15	16	16
4814100581	6	10	1	11	8	8	9	9	10	10	10	11	11	11	11

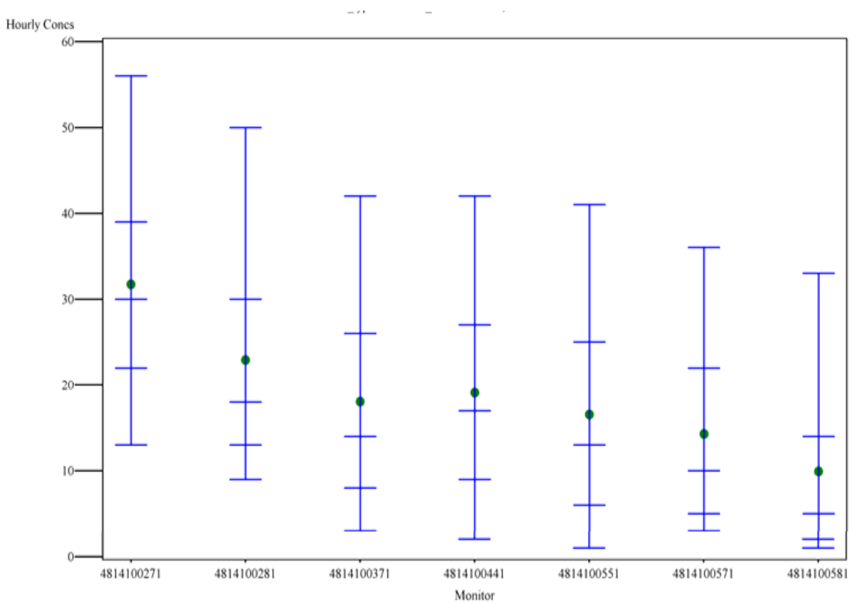

Figure A-72. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, El Paso MSA, 1995-2006.

Table A-72. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, El Paso MSA, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
4814100271	29730	32	14	45	1	16	20	24	27	30	33	37	42	49	219
4814100281	8045	23	14	60	5	10	12	13	15	18	22	27	34	42	117
4814100371	87748	18	13	71	0	5	7	9	12	14	18	23	29	36	153
4814100441	62362	19	13	67	0	5	8	11	14	17	21	25	30	36	125
4814100551	53960	17	13	78	0	3	5	7	10	13	18	23	28	35	87
4814100571	57229	14	11	79	0	3	4	6	8	10	14	19	25	31	85
4814100581	47248	10	11	109	0	1	2	3	4	5	7	11	18	27	84

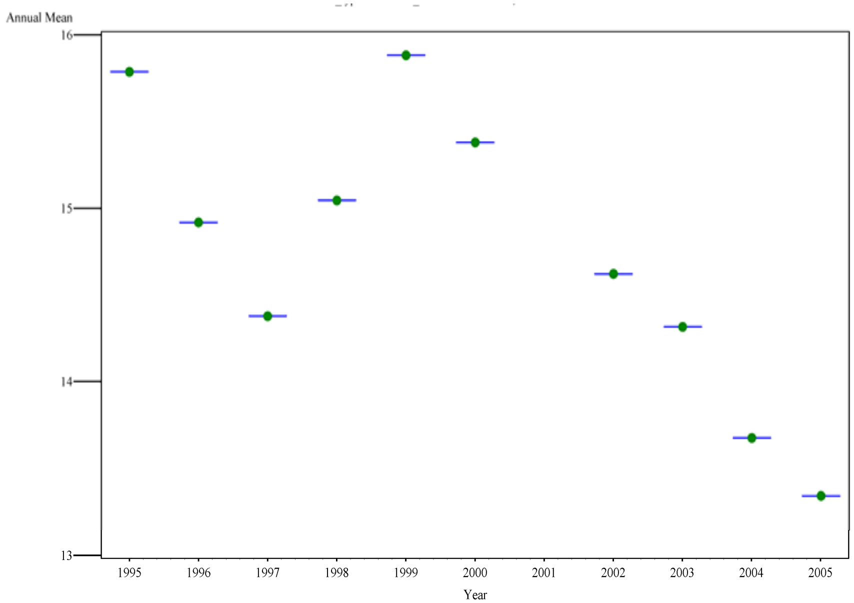

Figure A-73. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Jacksonville MSA.

Table A-73. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Jacksonville MSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	1	16		0	16	16	16	16	16	16	16	16	16	16	16
1996	1	15		0	15	15	15	15	15	15	15	15	15	15	15
1997	1	14		0	14	14	14	14	14	14	14	14	14	14	14
1998	1	15		0	15	15	15	15	15	15	15	15	15	15	15
1999	1	16		0	16	16	16	16	16	16	16	16	16	16	16
2000	1	15		0	15	15	15	15	15	15	15	15	15	15	15
2002	1	15		0	15	15	15	15	15	15	15	15	15	15	15
2003	1	14		0	14	14	14	14	14	14	14	14	14	14	14
2004	1	14		0	14	14	14	14	14	14	14	14	14	14	14
2005	1	13		0	13	13	13	13	13	13	13	13	13	13	13

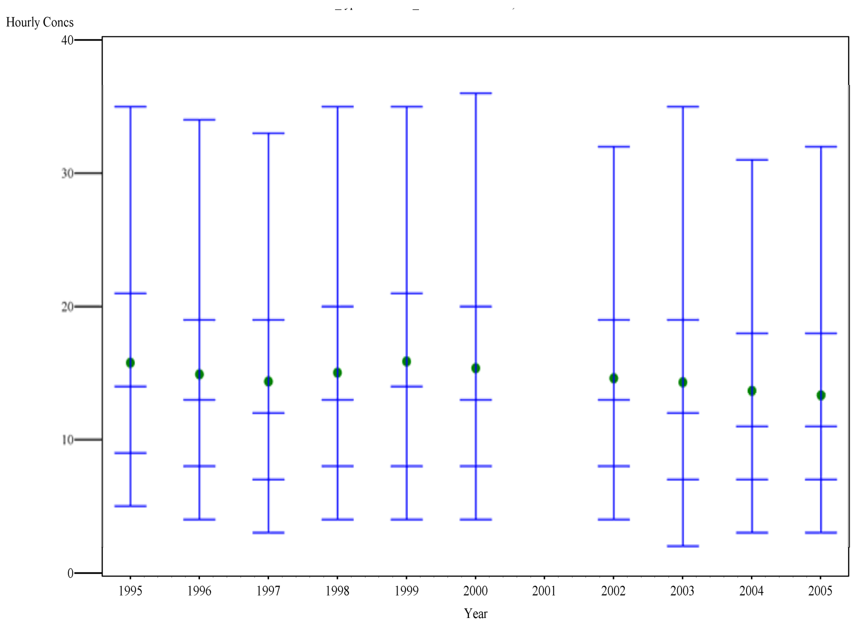

Figure A-74. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Jacksonville MSA.

Table A-74. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Jacksonville MSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	7755	16	10	60	0	6	8	9	11	14	16	19	23	29	76
1996	8148	15	10	64	0	5	7	9	11	13	15	18	21	28	80
1997	8326	14	9	65	0	5	6	8	10	12	15	17	21	27	92
1998	8211	15	10	65	0	5	7	9	11	13	15	18	22	28	66
1999	7795	16	10	61	0	5	7	9	12	14	16	20	24	30	63
2000	7661	15	10	67	0	5	7	9	11	13	15	18	23	30	72
2002	7944	15	10	66	0	5	7	9	11	13	15	17	21	27	294
2003	7041	14	10	71	0	4	6	8	10	12	14	17	21	28	76
2004	7451	14	11	83	0	4	6	7	9	11	13	16	20	26	201
2005	7890	13	9	67	0	4	6	8	9	11	13	16	20	26	64

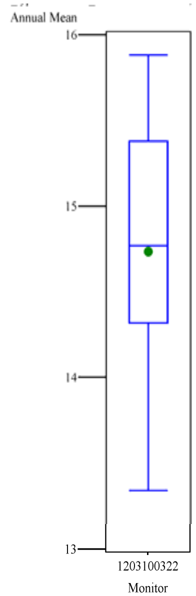

Figure A-75. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Jacksonville MSA, 1995-2006.

Table A-75. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Jacksonville MSA, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1203100322	10	15	1	6	13	14	14	14	15	15	15	15	16	16	16

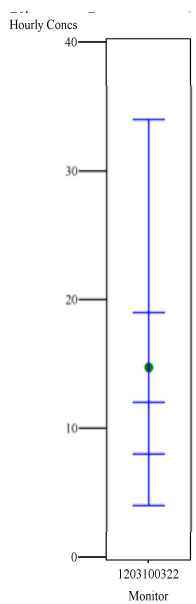

Figure A-76. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Jacksonville MSA, 1995-2006.

Table A-76. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Jacksonville MSA, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1203100322	78222	15	10	67	0	5	7	9	10	12	15	18	22	28	294

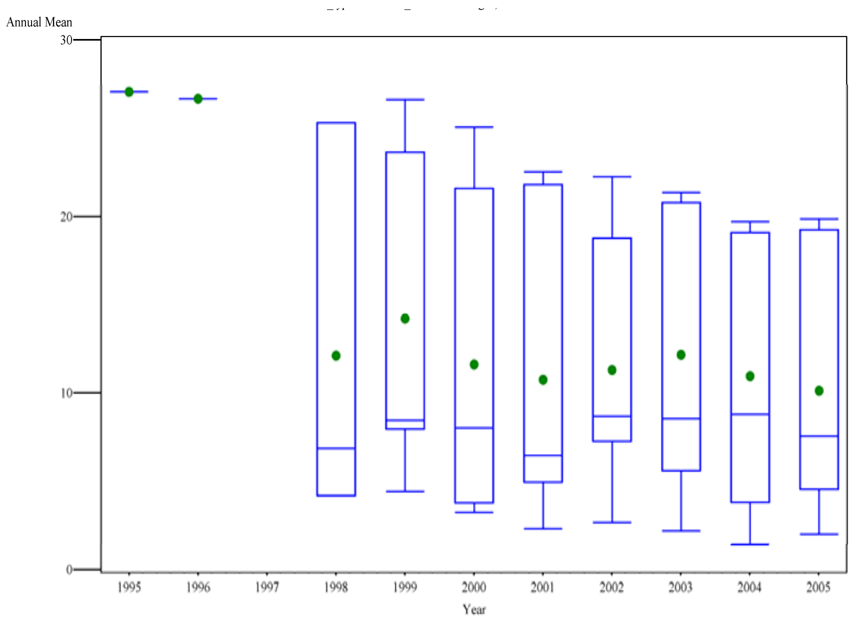

Figure A-77. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Las Vegas MSA.

Table A-77. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Las Vegas MSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	1	27		0	27	27	27	27	27	27	27	27	27	27	27
1996	1	27		0	27	27	27	27	27	27	27	27	27	27	27
1998	3	12	12	95	4	4	4	4	7	7	7	25	25	25	25
1999	5	14	10	71	4	4	6	8	8	8	16	24	25	27	27
2000	6	12	9	81	3	3	4	4	8	8	8	22	22	25	25
2001	6	11	9	84	2	2	5	5	6	6	7	22	22	23	23
2002	9	11	8	68	3	3	3	7	7	9	10	19	22	22	22
2003	7	12	8	66	2	2	6	8	8	9	19	19	21	21	21
2004	7	11	8	73	1	1	4	5	5	9	19	19	19	20	20
2005	6	10	8	76	2	2	5	5	6	8	9	19	19	20	20

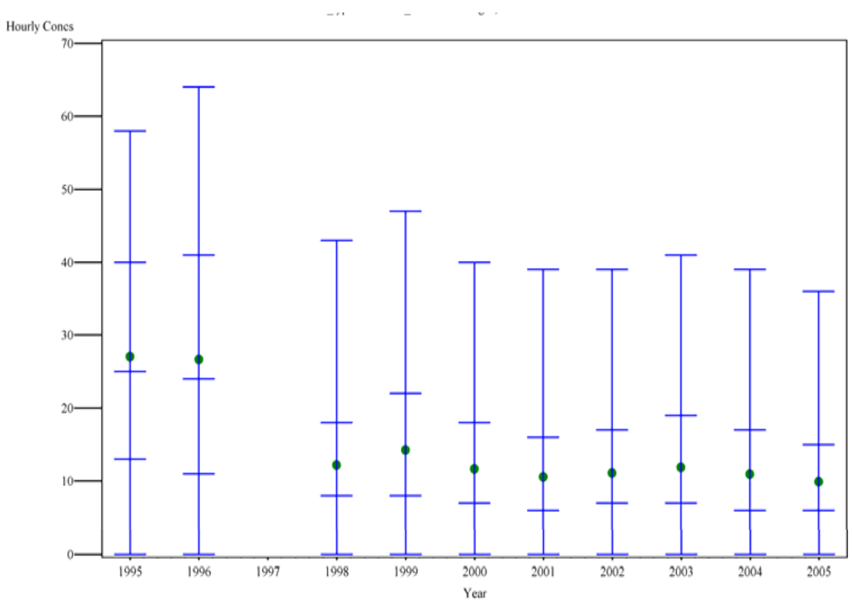

Figure A-78. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Las Vegas MSA.

Table A-78. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Las Vegas MSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	7951	27	20	74	0	0	11	15	20	25	31	37	42	50	410
1996	8723	27	22	81	0	0	9	12	17	24	31	38	44	54	149
1998	25234	12	14	118	0	0	0	0	5	8	10	14	23	35	103
1999	43110	14	16	110	0	0	0	5	6	8	12	18	28	39	110
2000	46403	12	14	119	0	0	0	0	5	7	10	15	23	34	100
2001	49734	11	14	128	0	0	0	0	0	6	8	13	21	33	104
2002	74814	11	13	117	0	0	0	0	5	7	10	14	21	32	87
2003	58398	12	14	119	0	0	0	0	5	7	10	15	24	35	103
2004	57484	11	13	120	0	0	0	0	0	6	9	14	23	33	73
2005	48911	10	12	123	0	0	0	0	0	6	9	12	18	30	75

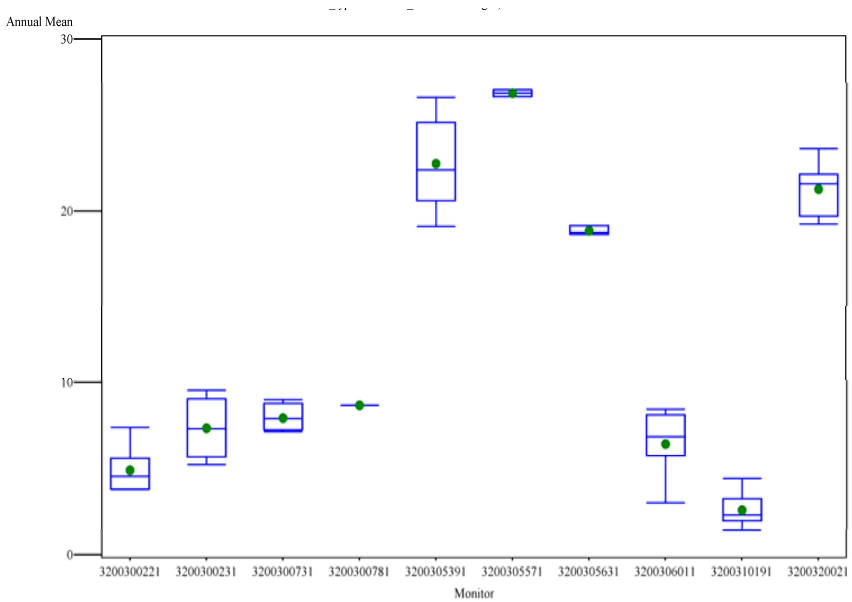

Figure A-79. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Las Vegas MSA, 1995-2006.

Table A-79. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Las Vegas MSA, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
3200300221	7	5	1	26	4	4	4	4	4	5	5	5	6	7	7
3200300231	4	7	2	28	5	5	5	6	6	7	9	9	10	10	10
3200300731	7	8	1	9	7	7	7	8	8	8	8	8	9	9	9
3200300781	1	9			9	9	9	9	9	9	9	9	9	9	9
3200305391	8	23	3	12	19	19	20	21	22	22	23	25	25	27	27
3200305571	2	27	0	1	27	27	27	27	27	27	27	27	27	27	27
3200305631	3	19	0	1	19	19	19	19	19	19	19	19	19	19	19
3200306011	5	6	2	34	3	3	4	6	6	7	7	8	8	8	8
3200310191	7	3	1	38	1	1	2	2	2	2	3	3	3	4	4
3200320021	7	21	2	7	19	19	20	21	21	22	22	22	22	24	24

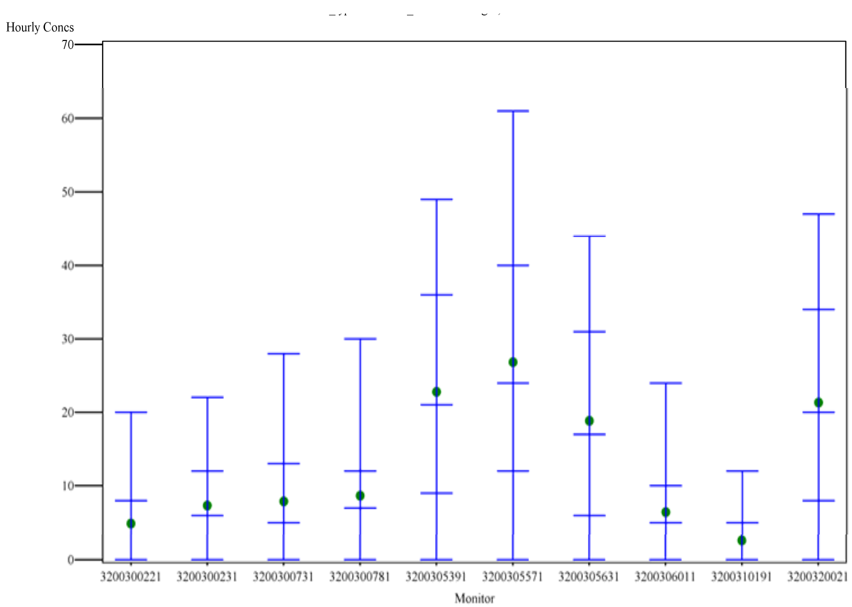

Figure A-80. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Las Vegas MSA, 1995-2006.

Table A-80. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Las Vegas MSA, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
3200300221	58087	5	7	152	0	0	0	0	0	0	5	7	10	15	91
3200300231	34550	7	8	105	0	0	0	0	5	6	8	10	13	18	52
3200300731	56906	8	10	124	0	0	0	0	0	5	8	11	15	22	104
3200300781	8672	9	10	115	0	0	0	0	5	7	8	10	14	22	87
3200305391	64921	23	16	70	0	5	7	10	14	21	28	33	38	44	103
3200305571	16674	27	21	78	0	0	10	14	19	24	31	37	43	52	410
3200305631	25061	19	15	78	0	0	5	7	11	17	23	28	33	39	87
3200306011	42417	6	8	124	0	0	0	0	0	5	7	8	12	18	51
3200310191	57230	3	5	186	0	0	0	0	0	0	0	0	6	9	71
3200320021	56244	21	16	73	0	0	6	9	13	20	27	32	36	42	110

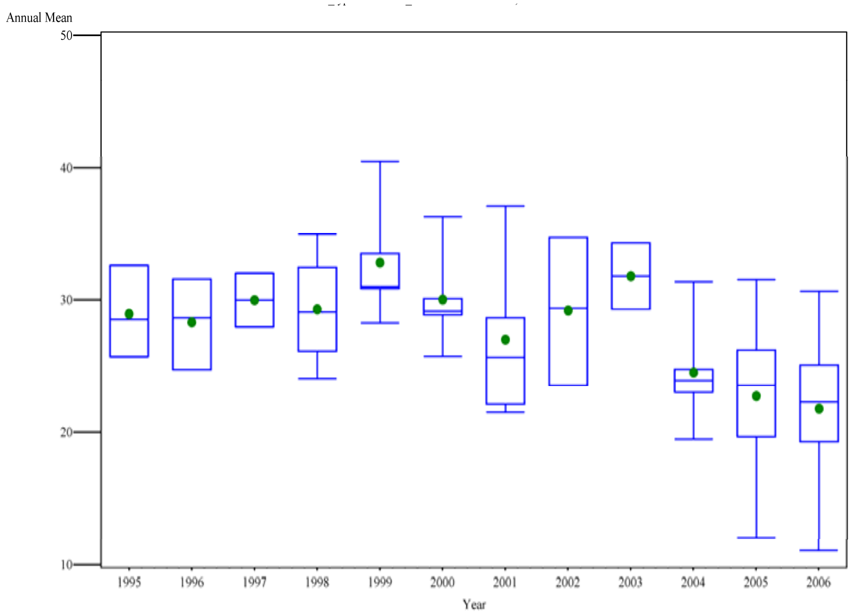

Figure A-81. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Phoenix MSA.

Table A-81. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Phoenix MSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	3	29	3	12	26	26	26	26	29	29	29	33	33	33	33
1996	3	28	3	12	25	25	25	25	29	29	29	32	32	32	32
1997	2	30	3	10	28	28	28	28	28	30	32	32	32	32	32
1998	4	29	5	15	24	24	24	28	28	29	30	30	35	35	35
1999	5	33	5	14	28	28	30	31	31	31	32	34	37	40	40
2000	5	30	4	13	26	26	27	29	29	29	30	30	33	36	36
2001	5	27	6	23	22	22	22	22	24	26	27	29	33	37	37
2002	3	29	6	19	24	24	24	24	29	29	29	35	35	35	35
2003	2	32	4	11	29	29	29	29	29	32	34	34	34	34	34
2004	5	25	4	18	19	19	21	23	23	24	24	25	28	31	31
2005	6	23	7	29	12	12	20	20	24	24	24	26	26	32	32
2006	6	22	7	30	11	11	19	19	21	22	24	25	25	31	31

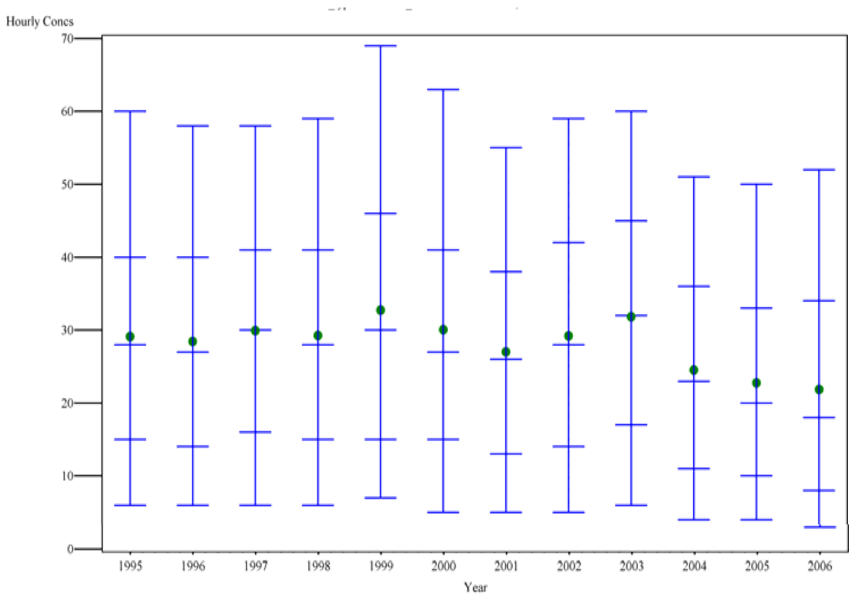

Figure A-82. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Phoenix MSA.

Table A-82. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Phoenix MSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	23196	29	17	59	0	8	12	17	23	28	33	37	44	53	128
1996	23598	28	17	59	0	8	12	17	22	27	32	37	43	51	115
1997	14629	30	16	55	0	8	13	18	25	30	35	39	44	52	114
1998	32078	29	17	58	0	8	12	17	23	28	33	38	44	52	116
1999	40996	33	22	66	0	9	13	18	24	30	36	42	49	60	198
2000	41686	30	21	71	0	8	12	17	22	27	32	38	45	54	267
2001	40463	27	16	59	1	7	11	15	21	26	31	36	41	49	118
2002	25028	29	17	59	0	7	12	17	23	28	34	39	45	53	108
2003	14195	32	17	55	0	8	14	20	27	32	37	42	48	55	101
2004	42176	25	15	62	0	6	9	13	18	23	28	33	39	45	104
2005	50583	23	15	66	0	5	8	12	16	20	25	31	36	44	131
2006	48791	22	16	73	0	4	7	10	13	18	24	30	37	46	111

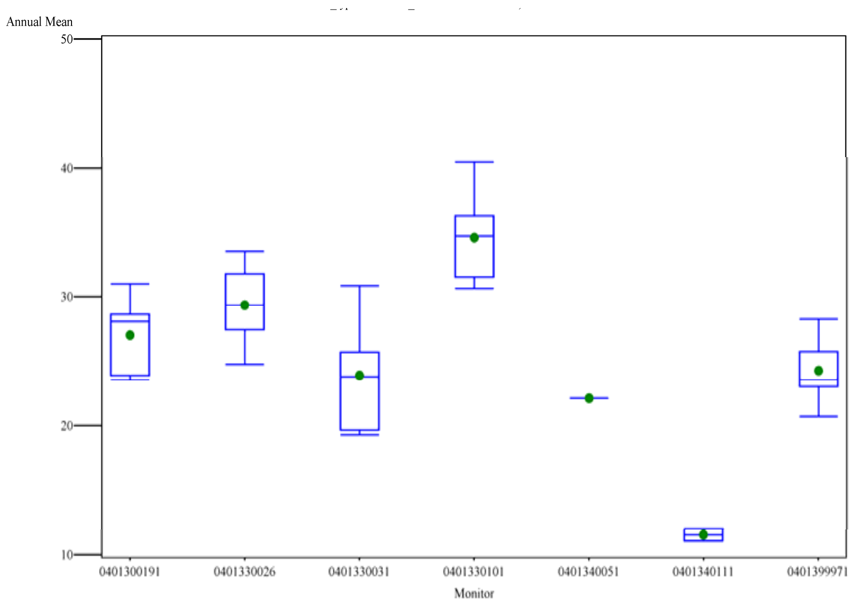

Figure A-83. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Phoenix MSA, 1995-2006.

Table A-83. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Phoenix MSA, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
0401300191	10	27	3	10	24	24	24	25	27	28	28	29	29	30	31
0401330026	12	29	3	10	25	25	26	29	29	29	30	32	32	33	34
0401330031	10	24	4	17	19	19	20	21	23	24	24	25	28	30	31
0401330101	9	35	3	9	31	31	31	32	34	35	35	36	37	40	40
0401340051	1	22			22	22	22	22	22	22	22	22	22	22	22
0401340111	2	12	1	6	11	11	11	11	11	12	12	12	12	12	12
0401399971	5	24	3	12	21	21	22	23	23	24	25	26	27	28	28

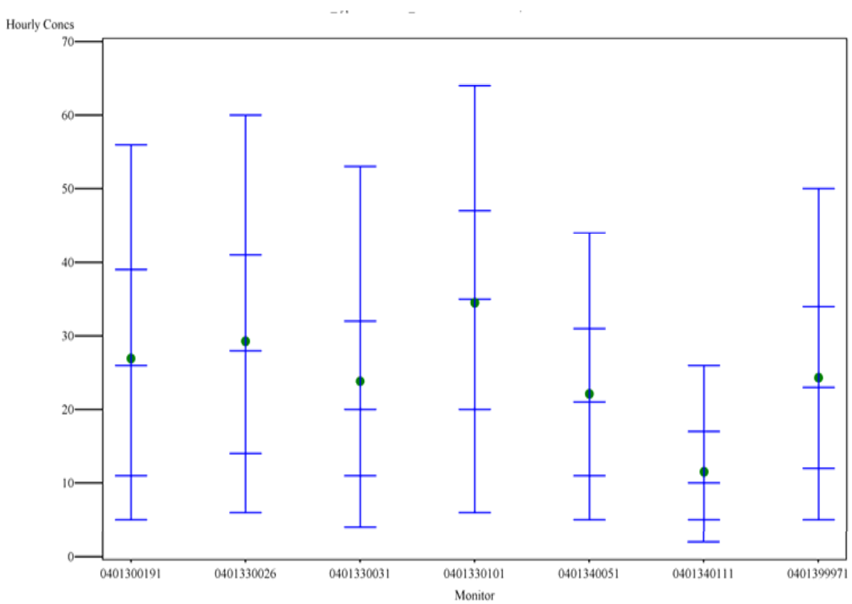

Figure A-84. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Phoenix MSA, 1995-2006.

Table A-84. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Phoenix MSA, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
0401300191	81411	27	17	63	0	6	9	14	20	26	32	37	42	50	148
0401330026	97376	29	17	59	0	8	12	17	23	28	33	38	44	53	151
0401330031	80162	24	19	78	0	6	9	12	16	20	25	30	35	45	267
0401330101	73070	35	18	53	0	9	16	23	30	35	40	45	50	58	164
0401340051	7420	22	13	58	2	7	9	13	17	21	25	29	33	39	99
0401340111	16459	12	8	69	0	2	4	6	8	10	13	16	18	22	53
0401399971	41521	24	15	60	0	7	10	14	19	23	27	32	37	45	131

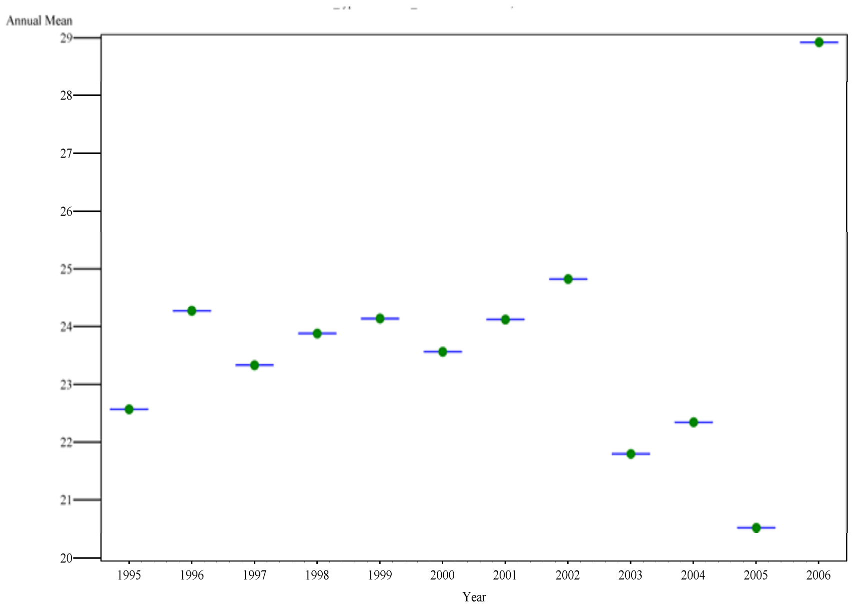

Figure A-85. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Provo MSA.

Table A-85. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Provo MSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	1	23		0	23	23	23	23	23	23	23	23	23	23	23
1996	1	24		0	24	24	24	24	24	24	24	24	24	24	24
1997	1	23		0	23	23	23	23	23	23	23	23	23	23	23
1998	1	24		0	24	24	24	24	24	24	24	24	24	24	24
1999	1	24		0	24	24	24	24	24	24	24	24	24	24	24
2000	1	24		0	24	24	24	24	24	24	24	24	24	24	24
2001	1	24		0	24	24	24	24	24	24	24	24	24	24	24
2002	1	25		0	25	25	25	25	25	25	25	25	25	25	25
2003	1	22		0	22	22	22	22	22	22	22	22	22	22	22
2004	1	22		0	22	22	22	22	22	22	22	22	22	22	22
2005	1	21		0	21	21	21	21	21	21	21	21	21	21	21
2006	1	29		0	29	29	29	29	29	29	29	29	29	29	29

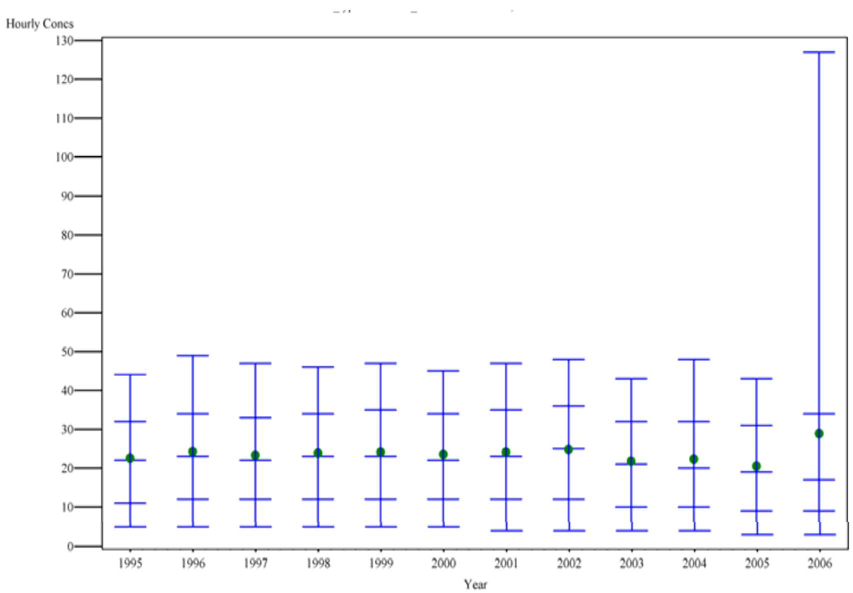

Figure A-86. Temporal distribution of hourly NO_2 ambient concentrations (ppb) by year, Provo MSA.

Table A-86. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Provo MSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	8002	23	13	55	0	7	10	13	17	22	26	30	34	40	67
1996	8430	24	15	61	0	7	10	14	18	23	28	32	37	43	97
1997	7034	23	13	57	0	7	10	14	18	22	26	31	35	41	81
1998	8210	24	13	56	0	7	10	14	18	23	28	32	37	42	78
1999	8563	24	13	55	0	7	11	14	19	23	28	33	37	42	77
2000	8406	24	13	56	0	7	10	14	18	22	27	32	37	42	74
2001	8501	24	14	57	0	6	10	14	19	23	28	33	38	43	72
2002	8200	25	14	57	0	6	10	15	20	25	30	34	38	43	80
2003	7730	22	13	59	0	6	8	12	16	21	26	30	34	39	72
2004	8302	22	15	66	0	5	8	12	16	20	25	30	35	42	90
2005	8502	21	13	62	0	5	8	11	15	19	23	28	33	39	64
2006	6993	29	34	118	0	5	7	10	13	17	22	30	38	61	164

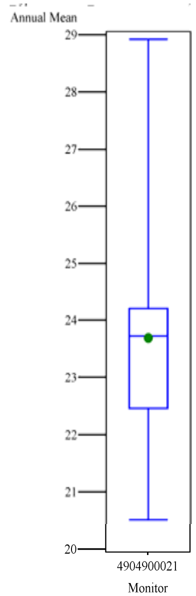

Figure A-87. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Provo MSA, 1995-2006.

Table A-87. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, Provo MSA, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
4904900021	12	24	2	9	21	22	22	23	23	24	24	24	24	25	29

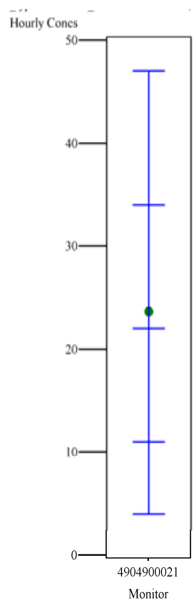

Figure A-88. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Provo MSA, 1995-2006.

Table A-88. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, Provo MSA, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
4904900021	96873	24	16	68	0	6	9	13	17	22	27	31	36	42	164

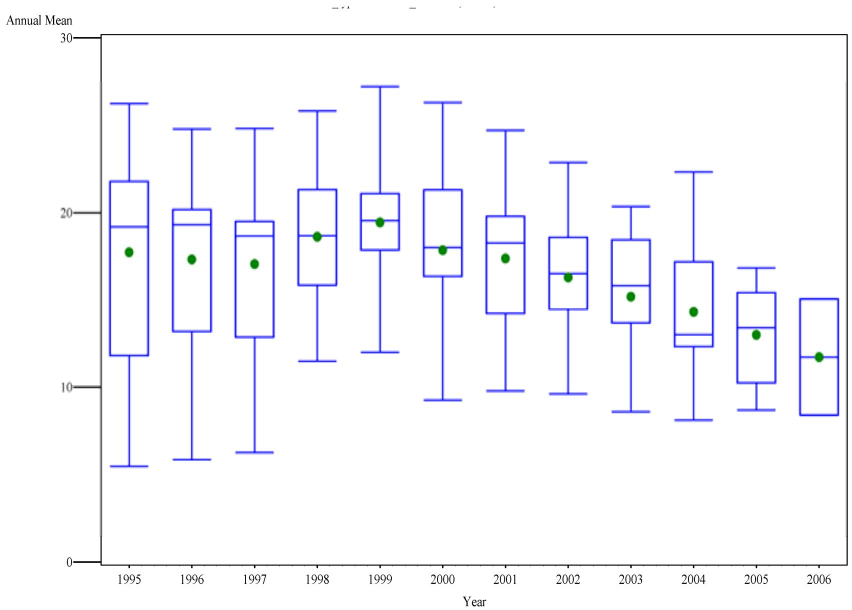

Figure A-89. Distribution of annual average NO_2 ambient concentrations (ppb) by year, St. Louis MSA.

Table A-89. Distribution of annual average NO_2 ambient concentrations (ppb) by year, St. Louis MSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	10	18	6	35	5	8	12	15	19	19	20	22	22	24	26
1996	10	17	6	33	6	8	12	16	19	19	20	20	21	23	25
1997	10	17	6	32	6	8	12	16	19	19	19	19	21	23	25
1998	8	19	5	25	11	11	13	18	19	19	19	20	22	26	26
1999	9	19	5	24	12	12	14	18	18	20	21	21	24	27	27
2000	9	18	5	29	9	9	12	16	17	18	19	21	21	26	26
2001	8	17	5	28	10	10	12	17	17	18	19	20	20	25	25
2002	9	16	4	26	10	10	11	14	15	16	17	19	21	23	23
2003	9	15	4	26	9	9	10	14	14	16	16	18	19	20	20
2004	9	14	4	31	8	8	10	12	13	13	16	17	18	22	22
2005	6	13	3	24	9	9	10	10	12	13	15	15	15	17	17
2006	2	12	5	40	8	8	8	8	8	12	15	15	15	15	15

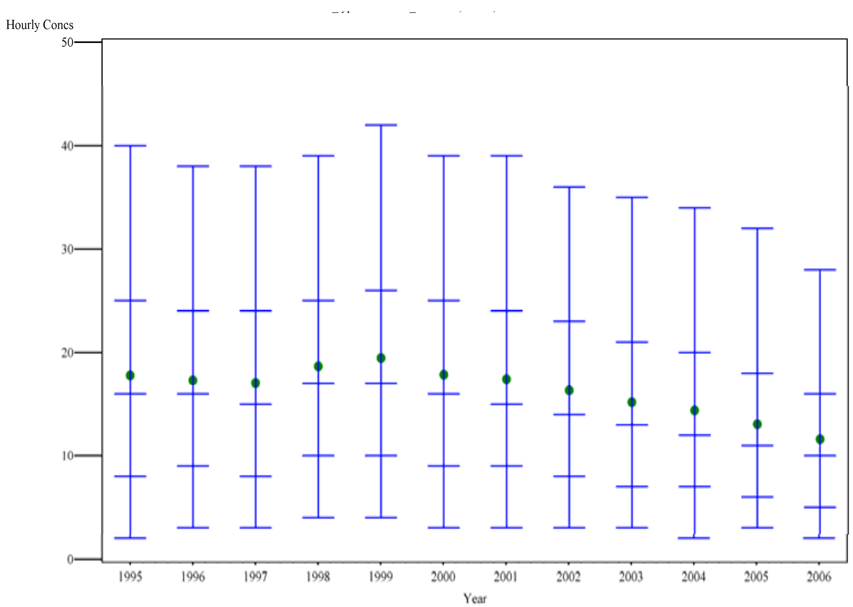

Figure A-90. Temporal distribution of hourly NO_2 ambient concentrations (ppb) by year, St. Louis MSA.

Table A-90. Distribution of hourly NO_2 ambient concentrations (ppb) by year, St. Louis MSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	85072	18	12	68	0	4	7	10	13	16	19	23	28	34	103
1996	86085	17	11	65		4	7	10	13	16	19	22	26	32	84
1997	86314	17	11	67	0	4	7	10	12	15	18	22	26	33	274
1998	68308	19	11	58	0	6	9	12	14	17	20	23	28	33	97
1999	77611	19	12	61	0	6	9	12	14	17	20	24	29	36	99
2000	77327	18	11	64	0	5	8	10	13	16	19	22	27	34	85
2001	67871	17	11	64	0	5	7	10	13	15	19	22	27	33	95
2002	76693	16	11	65	0	5	7	9	12	14	17	21	25	31	124
2003	77543	15	10	67	0	4	6	8	11	13	16	19	23	29	123
2004	75493	14	10	69	0	4	6	8	10	12	15	18	22	28	130
2005	49948	13	9	70	0	4	5	7	9	11	13	16	20	26	70
2006	16688	12	8	70	0	3	5	6	8	10	12	15	18	23	53

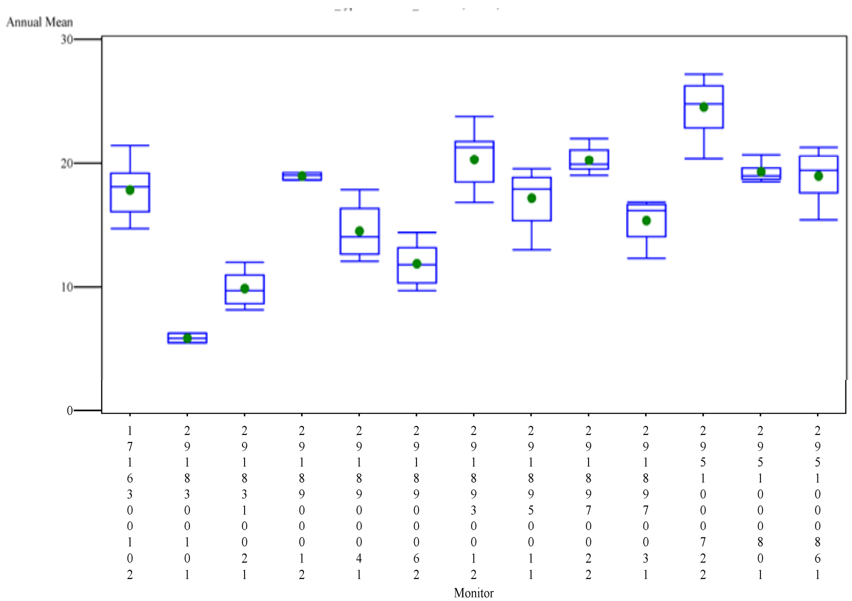

Figure A-91. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, St. Louis MSA, 1995-2006.

Table A-91. Distribution of annual average NO_2 ambient concentration (ppb) by monitor, St. Louis MSA, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1716300102	12	18	2	12	15	15	16	16	17	18	18	19	19	20	21
2918300101	3	6	0	7	5	5	5	5	6	6	6	6	6	6	6
2918310021	12	10	1	13	8	8	9	9	9	10	11	11	11	11	12
2918900012	3	19	0	2	19	19	19	19	19	19	19	19	19	19	19
2918900041	6	15	2	15	12	12	13	13	14	14	14	16	16	18	18
2918900062	11	12	1	12	10	10	10	11	12	12	12	13	13	13	14
2918930012	11	20	2	11	17	17	18	19	20	21	22	22	22	22	24
2918950011	10	17	2	13	13	14	15	16	17	18	19	19	19	19	20
2918970022	6	20	1	6	19	19	20	20	20	20	20	21	21	22	22
2918970031	4	15	2	14	12	12	12	16	16	16	16	16	17	17	17
2951000722	10	25	2	9	20	21	23	24	25	25	25	26	26	27	27
2951000801	5	19	1	5	19	19	19	19	19	19	19	20	20	21	21
2951000861	6	19	2	11	15	15	18	18	19	19	20	21	21	21	21

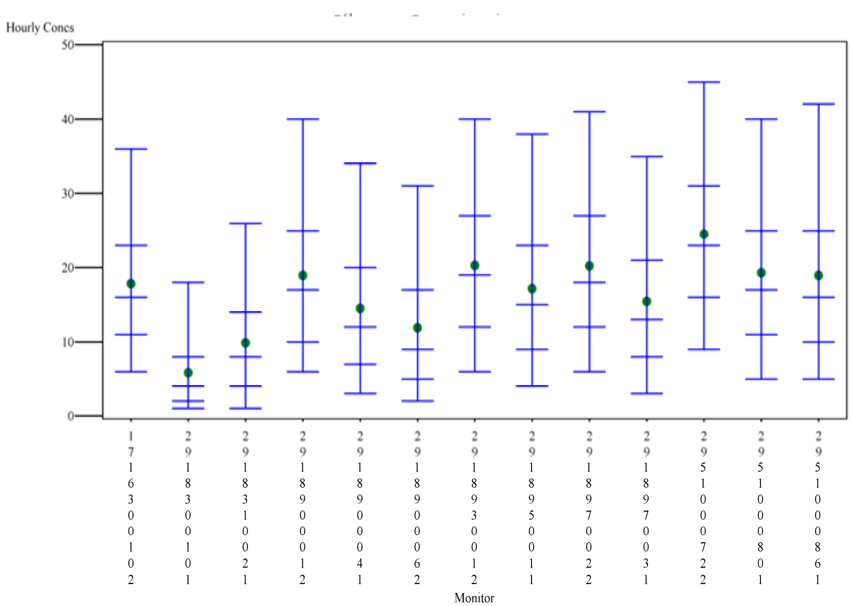

Figure A-92. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, St. Louis MSA, 1995-2006.

Table A-92. Distribution of hourly NO_2 ambient concentration (ppb) by monitor, St. Louis MSA, 1995-2006.

Monitor ID	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1716300102	101236	18	9	52	0	8	10	12	14	16	19	21	25	31	123
2918300101	25873	6	6	98	0	1	2	2	3	4	5	7	9	13	51
2918310021	99623	10	8	81	0	2	3	4	6	8	10	12	16	21	73
2918900012	25801	19	11	58	0	7	9	12	14	17	20	23	28	34	89
2918900041	51987	15	10	68	0	4	6	8	10	12	15	18	22	29	80
2918900062	93770	12	9	79	0	3	4	5	7	9	12	15	19	25	79
2918930012	95589	20	11	52	0	8	11	13	16	19	22	25	29	35	101
2918950011	86912	17	11	62	0	6	8	10	12	15	18	21	26	32	124
2918970022	51777	20	11	54	0	8	11	13	16	18	21	25	29	36	103
2918970031	32235	15	10	66	0	4	7	9	11	13	16	19	24	30	64
2951000722	85643	25	11	46	0	11	15	18	20	23	26	29	33	40	130
2951000801	42884	19	11	59	0	7	10	12	15	17	20	23	28	34	274
2951000861	51623	19	12	62	0	6	9	11	14	16	19	23	28	36	87

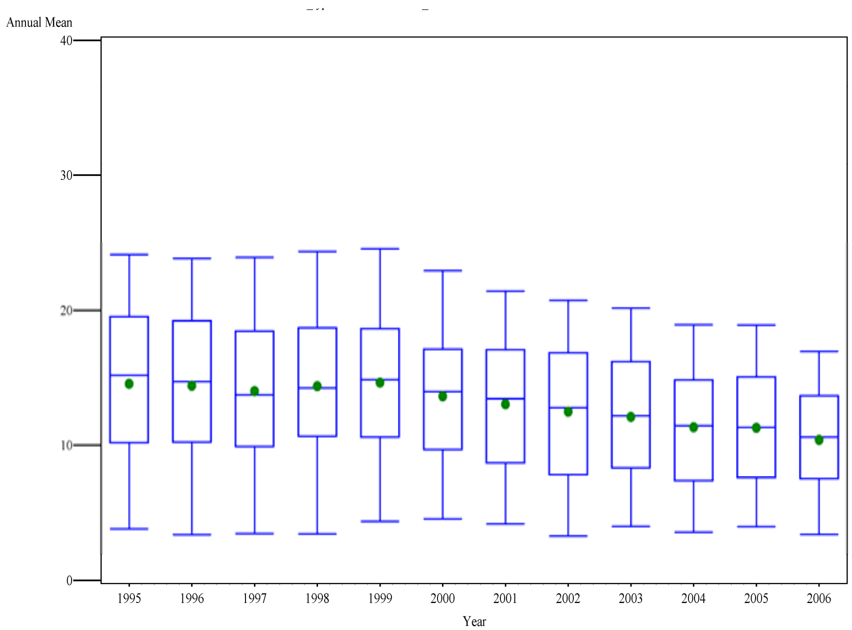

Figure A-93. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Other MSA/CMSA.

Table A-93. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Other MSA/CMSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	186	15	6	44	1	5	8	11	13	15	17	18	21	22	32
1996	186	14	6	43	1	5	9	11	13	15	16	18	20	22	30
1997	187	14	6	43	2	5	9	11	12	14	16	18	19	22	29
1998	185	14	6	43	1	5	10	11	13	14	16	18	20	22	31
1999	192	15	6	42	1	6	9	11	14	15	16	18	20	23	29
2000	199	14	6	41	1	5	8	11	12	14	16	17	18	21	26
2001	201	13	6	43	1	5	7	10	12	13	15	17	18	20	27
2002	209	12	6	45	1	5	7	9	11	13	14	16	17	20	27
2003	202	12	5	42	1	5	7	9	11	12	14	15	17	18	26
2004	211	11	5	44	1	5	7	9	10	11	13	14	16	17	25
2005	207	11	5	43	1	5	7	9	10	11	12	14	16	17	24
2006	147	10	4	41	1	4	6	9	9	11	12	13	14	16	18

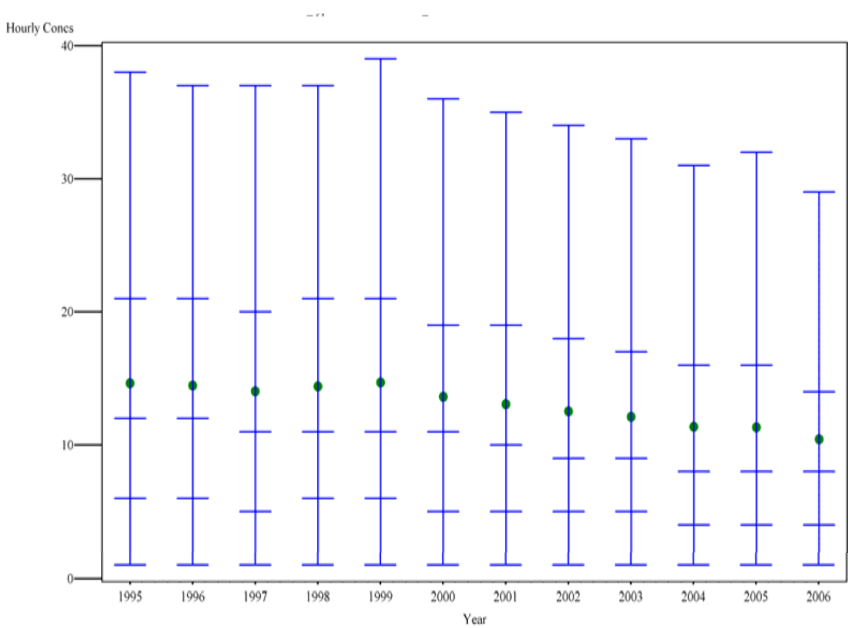

Figure A-94. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Other MSA/CMSA.

Table A-94. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Other MSA/CMSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	186	15	6	44	1	5	8	11	13	15	17	18	21	22	32
1996	1520743	14	12	81	0	2	5	7	9	12	15	18	23	31	336
1997	1520290	14	11	82	0	2	4	6	9	11	14	18	23	30	313
1998	1503051	14	11	80	0	2	5	7	9	11	15	18	23	31	300
1999	1560074	15	12	83	0	3	5	7	9	11	14	18	24	32	172
2000	1630060	14	11	81	0	2	4	6	8	11	13	17	22	29	289
2001	1648640	13	11	84	0	2	4	6	8	10	13	16	21	29	193
2002	1713558	13	11	85	0	2	4	5	7	9	12	15	20	28	158
2003	1661992	12	10	84	0	2	4	5	7	9	12	15	19	26	148
2004	1738133	11	10	87	0	2	3	5	7	8	11	14	18	25	160
2005	1706730	11	10	87	0	2	3	5	6	8	11	14	18	25	153
2006	1168444	10	9	87	0	2	3	5	6	8	10	13	17	23	240

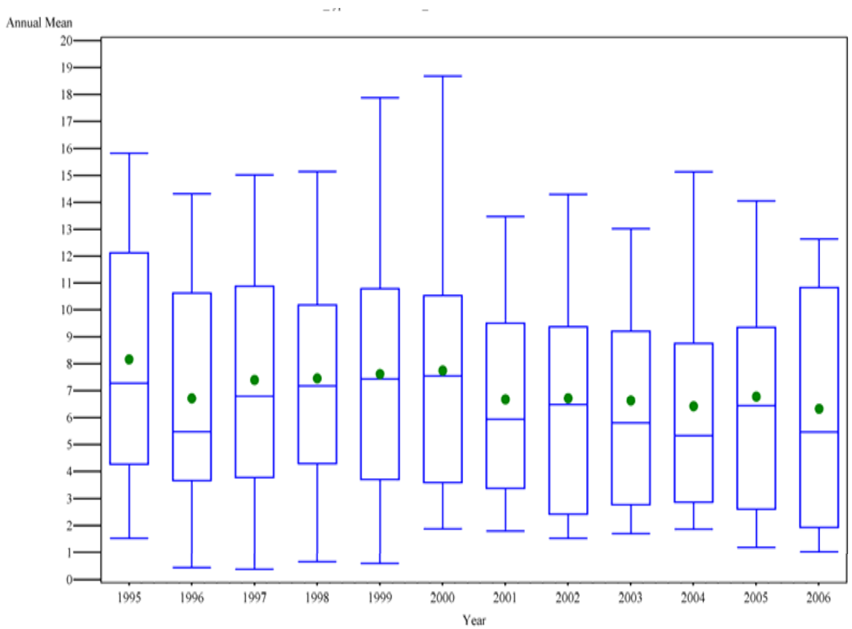

Figure A-95. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Other Not MSA.

Table A-95. Distribution of annual average NO_2 ambient concentrations (ppb) by year, Other Not MSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	28	8	5	59	1	2	4	5	7	7	8	10	13	15	19
1996	29	7	5	71	0	0	2	4	5	5	7	10	13	14	14
1997	35	7	5	67	0	1	3	4	5	7	9	10	12	14	20
1998	33	7	5	62	1	1	3	4	5	7	7	10	12	14	19
1999	36	8	5	67	0	1	3	4	5	7	8	9	12	16	20
2000	39	8	4	57	2	2	3	5	6	8	8	10	11	14	19
2001	41	7	4	60	1	2	3	4	5	6	8	9	10	13	17
2002	42	7	4	65	1	2	2	3	4	6	8	8	10	13	16
2003	44	7	4	61	1	2	3	3	4	6	8	9	11	13	15
2004	47	6	4	64	2	2	2	3	4	5	7	8	11	13	16
2005	43	7	4	63	1	2	2	3	5	6	8	9	11	12	17
2006	26	6	5	71	1	1	2	2	3	5	8	10	11	12	16

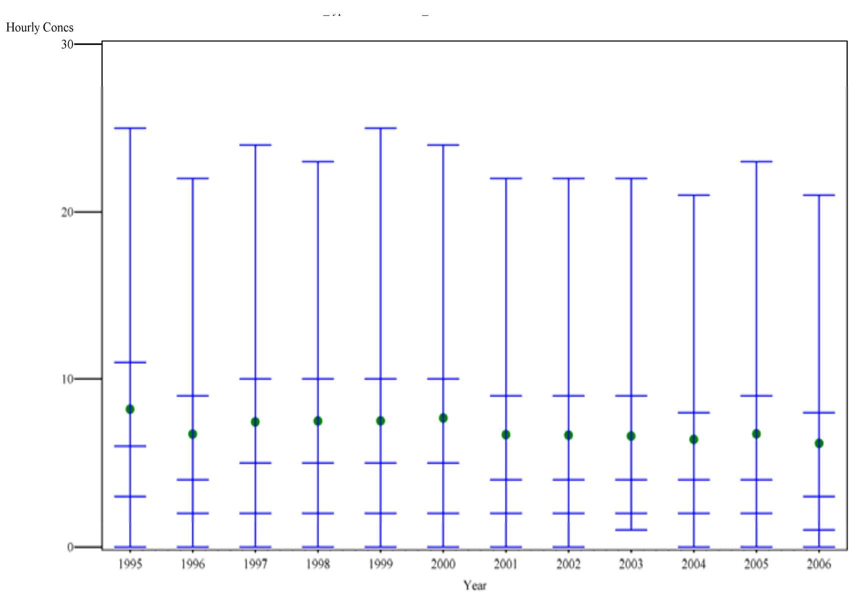

Figure A-96. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Other Not MSA.

Table A-96. Distribution of hourly NO_2 ambient concentrations (ppb) by year, Other Not MSA.

Year	n	Mean	SD	COV	Min	p10	p20	p30	p40	p50	p60	p70	p80	p90	Max
1995	225810	8	9	104	0	0	2	3	4	6	7	10	13	19	217
1996	234628	7	8	118	0	0	1	2	3	4	6	8	11	17	164
1997	278906	7	8	113	0	0	1	2	3	5	6	9	12	18	207
1998	264015	8	8	105	0	1	2	3	4	5	7	9	12	18	181
1999	290382	8	9	113	0	0	2	2	3	5	6	9	12	18	286
2000	316568	8	8	104	0	1	2	3	4	5	7	9	12	18	192
2001	328407	7	7	109	0	1	1	2	3	4	6	8	11	16	139
2002	340873	7	7	112	0	1	1	2	3	4	5	8	11	17	267
2003	351652	7	7	110	0	1	2	2	3	4	5	7	10	16	201
2004	375716	6	7	115	0	1	1	2	3	4	5	7	10	16	285
2005	353229	7	8	114	0	1	1	2	3	4	6	8	11	17	262
2006	207114	6	7	119	0	0	1	2	2	3	5	7	10	16	101

A-6 Technical Memorandum on Regression Modeling

This section provides a technical memorandum submitted to EPA by ICF International. The memo has been formatted for consistency with the entire appendix.

A-6.1 Summary

This section describes the regression analyses of 1995 to 2006 NO_2 hourly concentration data. Regression was used to estimate the annual number of exceedances of 150 ppb from the annual mean, in 20 locations (mostly large urban areas). Exposures to concentrations above certain thresholds may be associated with adverse health effects. These models were applied in an as-is scenario to estimate the annual exceedances at sites with annual means equal to the 1995-2006 current average for their location. These models were also applied in a current-standard scenario to predict the annual exceedances at sites with annual means equal to the current NO2 standard of 53 ppb. The current-standard scenario is an extrapolation to higher annual means than currently observed; the maximum annual mean across all complete site-years was 51 ppb, in Los Angeles.

We found these results unsatisfactory, both because the regression models did not show a strong relationship between the annual means and the exceedances, and because the predicted numbers of exceedances for the current-standard scenario were in many cases extremely high and quite uncertain. For this reason we decided not to apply the regression modeling to the other concentration levels of interest (200, 250, and 300 ppb) but instead decided to develop empirical exceedance estimates, as described elsewhere.

A-6.2 Data Used

All of the 1995 to 2006 NO_2 hourly concentration data from AQS were compiled and annual summary statistics for each site-year combination were computed. Of particular interest is the long-term air quality measured by the annual mean and the short-term air quality measured by the annual numbers of hourly exceedances of selected levels 150, 200, 250 and 300 ppb. Exposures to concentrations above these thresholds may be associated with adverse health effects. To make the results temporally representative, we restricted the analyses to the 20 percent of site-years that were 75 % complete, as defined by having data for 75 % of the hours in a year and having data for at least 75 % of the hours in a day (i.e., 18 hours or more) on at least 75 % of the days in a year. We also spatially grouped the data into 18 urban areas with high annual means and high exceedances; these locations were all CMSAs or MSAs either with at least one site-year annual mean above 25.7 ppb (the 90^{th} percentile) or with at least one exceedance of 200 ppb, as follows.

- Boston
- Cleveland
- Denver
- Detroit
- Los Angeles
- New York
- Philadelphia
- Washington DC
- Atlanta

- Colorado Springs
- El Paso
- Las Vegas
- Phoenix
- St. Louis
- Chicago
- Miami
- Jacksonville
- Provo.

The remaining site-years were analyzed as two additional location groups: "Other MSA/CMSA" site-years in an MSA or CMSA, and "Other Not MSA" site-years not in an MSA. Thus we have a total of 20 "locations."

A-6.3 Regression Models

The regression modeling of the 1995-2006 NO_2 data continues the analyses by McCurdy (1994)[4] of the 1988-1992 data. A regression model is used to estimate the mean number of exceedances from the annual mean. McCurdy (1994) assumed normally distributed exceedances and an exponential link function to estimate exceedances of 150, 200, 250, and 300 ppb based on the 1988-1992 data. In this section we present the results of the regression analyses for exceedances of 150 ppb using eight alternative models based on the 1995-2006 data. Throughout this discussion, "exceedances" will refer to annual numbers of hourly exceedances of 150 ppb, unless otherwise stated.

Of the eight models, the two selected regression models were the Poisson exponential model and the normal linear model, stratified by location. The Poisson exponential model is of the form:

- Number of exceedances has a Poisson distribution.
- Mean exceedances = exp(a + b × annual mean).
- The intercept a, and slope b, depend on the location.

The normal linear model is of the form:

- Number of exceedances has a normal distribution with standard deviation s.
- Mean exceedances = a + b × annual mean.
- The intercept a, slope b, and s all depend on the location.

The first issue to be resolved was to decide whether to apply the regression analyses to the means and exceedances for each season separately or to each year. We examined the exceedance data for Colorado Springs, which had the highest maximum number of annual exceedances of 200 ppb, 69, which occurred at site 804160181 in 2000. Of these 69 exceedances, 34 occurred in the winter on January 18-20, 2000, and 35 occurred in the summer on June 12-14, 2000. This limited analysis suggests that there is no clear pattern of seasonality in the exceedances. We decided to apply the regression modeling to the annual means and annual exceedances.

[4] McCurdy TR (1994). Analysis of high 1 hour NO2 values and associated annual averages using 1988-1992 data. Report to the Office of Air Quality Planning and Standards, Durham NC.

Table 1 describes the eight regression models fitted. As described shortly, we fitted two distributions (normal and Poisson), two link functions (identity and exponential), and two stratifications (all data and stratified by location). The McCurdy (1994) analysis used a normal distribution, an exponential link, and stratified by location into Los Angeles and Not Los Angeles.

We fitted generalized linear models where the number of exceedances has a given distribution (we fitted normal and Poisson distributions) and where the mean number of exceedances is a given function g of the annual mean. The function g(x) is called the link function. We can also define the link by defining the inverse link, i.e., the solution for x of the equation g(x) = y.

We fitted two link functions, an identity link g(x) = x and a logarithmic link g(x) = log(x), where "log" denote the natural logarithm. The corresponding inverse links are the identity link, which we also call the "linear" function, and the exponential function. Thus, the linear inverse link models are of the form:

$$\text{Mean exceedances} = a + b \times \text{annual mean}.$$

The exponential inverse link models are of the form:

$$\text{Mean exceedances} = \exp(a + b \times \text{annual mean}).$$

Table A-97. Goodness-of-fit statistics for eight generalized linear models.

Distribution	Inverse Link	Strata (a separate model is fitted in each stratum)	R squared for all data	Min R squared among locations	Max R squared among locations	Log-Likelihood	Number of strata in final model
Normal	Linear	All	0.033			-11527	1
Normal	Linear	Location	0.244	0.006	0.616	-6065	13**
Normal	Exponential	All	0.066			-11438	1
Normal	Exponential	Location	0.401	0.005	0.981	-8734	11***
Poisson	Linear	All	0.025			-4737	1
Poisson	Linear	Location	Not Shown*	Not Shown*	Not Shown*	Not Shown*	Not Shown*
Poisson	Exponential	All	0.064			-3660	1
Poisson	Exponential	Location	0.406	0.004	0.976	-2694	13**

Notes:
* Model converged for only Cleveland, Atlanta, and "Other Not MSA" locations. Results are not shown since the model failed to converge for the "Other MSA" location, so the overall goodness-of-fit is not comparable to the other seven models.
** "Other MSA" includes Chicago, Detroit, Philadelphia, Jacksonville, Las Vegas, Provo, St. Louis.
*** "Other MSA" includes Chicago, Cleveland, Detroit, Philadelphia, Jacksonville, Las Vegas, Phoenix, Provo, St. Louis.

For each link function we fitted models using the normal distribution and the Poisson distribution. The normal model is at best an approximation since the numbers of exceedances must be positive or zero integers, but the normal distribution is continuous and includes negative values. T he Poisson model takes the form:

$$\text{Prob(y exceedances)} = (M^y/y!)e^{-M}, y = 0, 1, 2, \ldots,$$

where M is the mean exceedances.

We fitted these four models (two links, two distributions) either to all the data or stratified by location. Thus the model fitted to all the data assumes that *a* and *b* have the same value for all site-years, and the model fitted by location assumes that a and b have the same value for all site-years at the same location but these values may vary between locations. For the normal models, the variance of the number of exceedances is assumed to be the same for all site-years in each stratum. For the Poisson models, the variance equals the mean number of exceedances.

The models stratified by location were fitted in two steps. First, each model was separately fitted to each of the 20 locations. For several models and locations, there were problem cases where the algorithm failed to converge to a solution, predicted a negative slope for the annual mean, or had only zero or one site-year with at least one exceedance. In the second case, if the slope is negative, then the model implies that exceedances decrease when the annual mean increases, which is unexpected and could lead to inconsistent results for projecting exceedances to the current-standard scenario. In the third case, there would be zero degrees of freedom and the model would be over-fitted for that location. To deal with these problem cases, we re-allocated all the problem locations into the "Other MSA" combined location and refitted the models. The results in Table 1 stratified by location are for the refitted models. The re-allocated locations are listed in the footnotes.

Table A-97 gives R squared and log-likelihood goodness-of-fit summary statistics. The R squared statistic is the squared Pearson correlation coefficient between the observed number of exceedances and the predicted mean number of exceedances. Negative predicted means are replaced by zero for this calculation. Values close to 1 indicate a good fit and values close to zero indicate a poor fit. For the models stratified by location, it is evident that the R squared value has a wide range across the locations, varying from a very poor fit at some locations to a very good fit at other locations.

For these models the log-likelihood is a better overall goodness-of-fit statistic. The log-likelihood is defined as the logarithm of the fitted joint density function to all 4,177 site-years. The better-fitting models are those with the highest values of the log-likelihood. (The log-likelihood can only be used to compare different models; its value for a single statistical model is not meaningful). Of the various normal models, the best-fitting is stratified by location and uses a linear inverse link. Of the various Poisson models, the best-fitting is stratified by location and uses an exponential inverse link. The Poisson models fit better than the normal models, which is to be expected since the actual data are positive or zero discrete count data and the numbers of exceedances are frequently zero, implying a very small mean.

We selected the Poisson exponential model stratified by location and the normal linear model stratified by location. The estimated parameter values for these models are displayed in Tables A-98 and A-99, respectively.

The fitted models for the CMSA locations are displayed in Figures A-97 to A-99. Figure A-97 and the first three attached plots show the number of exceedances plotted against the annual mean. These plots clearly show how weak the relationship between the exceedances and the annual mean is. Figure A-98 and the next three attached plots are for the Poisson exponential model, plotting predicted versus observed exceedances. Figure A-99 and the final three attached plots are for the normal linear model, plotting predicted versus observed exceedances (negative predictions were replaced by zero). Comparing the normal and Poisson model predictions, the normal model tends to under-predict the higher numbers of observed exceedances.

Tables A-100 and A-101 indicate the predictions for a mean of 53 ppb and for the mean annual mean for each the Poisson exponential model and the normal linear model, respectively. The predictions for a mean of 53 ppb estimate the number of exceedances for a hypothetical site-year with the highest annual mean concentration under the current-standard scenario, i.e., when the highest annual mean site-year for a given location just meets the annual standard. The predictions for a mean equal to the mean annual mean estimate the number of exceedances for the typical "as-is" scenario, i.e., for a hypothetical site-year with an annual mean that is the average annual mean for that location. 95 percent confidence and prediction intervals for the number of exceedances at given mean levels were also estimated using each model. In addition, exceedances were also estimated at alternative annual mean concentrations. Tables A-103 and A-104 give calculated predictions at annual mean values of 20, 30, 40, 50, 53, and 60 ppb and at the minimum, mean, and maximum annual mean value for each location using the Poisson exponential model and the normal linear model, respectively.

The 95% confidence interval gives the uncertainty of the expected value, i.e., of the average number of exceedances over hypothetically infinitely many site-years with the same annual mean. The 95% prediction interval gives the uncertainty of the value for a single site-year, taking into account both the uncertainty of the estimated parameters and the variability of the number of exceedances in a given site-year about the overall mean. All prediction intervals were truncated to be greater than or equal to zero and less than or equal to 1,000. The maximum possible number of exceedances in a year is the maximum number of hours in a leap year, 8,784. The maximum observed exceedances in a year was 69.

For annual means within the range of the data, the predicted numbers of exceedances are generally within the range of the observed numbers of exceedances. The normal model predictions tend to be lower than the Poisson model predictions. At annual mean levels above the range of the data, the Poisson model with the exponential inverse link sometimes gives extremely high estimates, well beyond the truncation limit of 1,000. This is mainly due to the exponential link; each increase of the annual mean by 1 ppb increases the predicted exceedances by a multiplicative factor of exp(b), where $b > 0$. The upper bounds of the normal linear model prediction intervals are at most a more reasonable 202, but these predictions are less reliable because the Poisson model with an exponential inverse link fits the data much better. For the normal linear model, each increase of the annual mean by 1 ppb increases the predicted exceedances by b ppb.

Not shown here are the results for the normal model with an exponential inverse link, which was the model formulation selected by McCurdy (1994). That model gives roughly similar predictions to the Poisson model with the exponential inverse link.

Table A-98. Parameters for Poisson exponential model stratified by location.

Location Type	Location Name	Parameter*	Estimate	Standard Error	Lower Confidence Bound	Upper Confidence Bound	P-value **
CMSA	Boston-Worcester-Lawrence, MA-NH-ME-CT CMSA	Intercept	-6.887	2.832	-14.693	-2.757	0.02
CMSA	Boston-Worcester-Lawrence, MA-NH-ME-CT CMSA	mean	0.144	0.116	-0.061	0.430	0.22
CMSA	Boston-Worcester-Lawrence, MA-NH-ME-CT CMSA	Scale	1.000	0.000	1.000	1.000	_
CMSA	Cleveland-Akron, OH CMSA	Intercept	-14.209	4.374	-25.210	-7.312	0.00
CMSA	Cleveland-Akron, OH CMSA	mean	0.548	0.164	0.283	0.952	0.00
CMSA	Cleveland-Akron, OH CMSA	Scale	1.000	0.000	1.000	1.000	_
CMSA	Denver-Boulder-Greeley, CO CMSA	Intercept	-4.399	1.186	-7.182	-2.435	0.00
CMSA	Denver-Boulder-Greeley, CO CMSA	mean	0.137	0.038	0.070	0.222	0.00
CMSA	Denver-Boulder-Greeley, CO CMSA	Scale	1.000	0.000	1.000	1.000	_
CMSA	Los Angeles-Riverside-Orange County, CA CMSA	Intercept	-5.628	0.253	-6.134	-5.142	0.00
CMSA	Los Angeles-Riverside-Orange County, CA CMSA	mean	0.181	0.006	0.169	0.194	0.00
CMSA	Los Angeles-Riverside-Orange County, CA CMSA	Scale	1.000	0.000	1.000	1.000	_
CMSA	Miami-Fort Lauderdale, FL CMSA	Intercept	-5.780	1.641	-9.774	-3.068	0.00
CMSA	Miami-Fort Lauderdale, FL CMSA	mean	0.342	0.114	0.138	0.606	0.00
CMSA	Miami-Fort Lauderdale, FL CMSA	Scale	1.000	0.000	1.000	1.000	_
CMSA	New York-Northern New Jersey-Long Island, NY-NJ-CT-PA CMS	Intercept	-6.800	1.269	-9.560	-4.537	0.00
CMSA	New York-Northern New Jersey-Long Island, NY-NJ-CT-PA CMS	mean	0.147	0.037	0.079	0.224	0.00
CMSA	New York-Northern New Jersey-Long Island, NY-NJ-CT-PA CMS	Scale	1.000	0.000	1.000	1.000	_
CMSA	Washington-Baltimore, DC-MD-VA-WV CMSA	Intercept	-6.559	3.054	-14.610	-2.054	0.03
CMSA	Washington-Baltimore, DC-MD-VA-WV CMSA	mean	0.145	0.135	-0.073	0.482	0.28
CMSA	Washington-Baltimore, DC-MD-VA-WV CMSA	Scale	1.000	0.000	1.000	1.000	_
MSA	Atlanta,GA	Intercept	-5.081	1.917	-9.975	-2.139	0.01
MSA	Atlanta,GA	mean	0.140	0.099	-0.040	0.363	0.16
MSA	Atlanta,GA	Scale	1.000	0.000	1.000	1.000	_
MSA	Colorado Springs,CO	Intercept	-4.846	0.401	-5.675	-4.097	0.00
MSA	Colorado Springs,CO	mean	0.284	0.012	0.261	0.309	0.00
MSA	Colorado Springs,CO	Scale	1.000	0.000	1.000	1.000	_
MSA	El Paso,TX	Intercept	-10.436	2.455	-16.783	-6.664	0.00
MSA	El Paso,TX	mean	0.350	0.074	0.233	0.538	0.00

Location Type	Location Name	Parameter*	Estimate	Standard Error	Lower Confidence Bound	Upper Confidence Bound	P-value **
MSA	El Paso,TX	Scale	1.000	0.000	1.000	1.000	_
MSA	Phoenix-Mesa,AZ	Intercept	-1.568	0.400	-2.363	-0.798	0.00
MSA	Phoenix-Mesa,AZ	mean	0.106	0.013	0.081	0.131	0.00
MSA	Phoenix-Mesa,AZ	Scale	1.000	0.000	1.000	1.000	_
MSA/CMSA	Other MSA/CMSA	Intercept	-5.137	0.222	-5.580	-4.711	0.00
MSA/CMSA	Other MSA/CMSA	mean	0.152	0.010	0.132	0.172	0.00
MSA/CMSA	Other MSA/CMSA	Scale	1.000	0.000	1.000	1.000	_
Not MSA	Other Not MSA	Intercept	-4.672	0.467	-5.654	-3.818	0.00
Not MSA	Other Not MSA	mean	0.227	0.036	0.158	0.300	0.00
Not MSA	Other Not MSA	Scale	1.000	0.000	1.000	1.000	_

Notes:
* using the report notation, a = “Intercept”, and b = “mean.” “Scale” equals 1, by definition, for this model.
** probability that the Chi-square test for that parameter = 0.

Table A-99. Parameters for normal linear model stratified by location.

Location Type	Location Name	Parameter*	Estimate	Standard Error	Lower Confidence Bound	Upper Confidence Bound	P-value **
CMSA	Boston-Worcester-Lawrence, MA-NH-ME-CT CMSA	Intercept	-0.023	0.034	-0.090	0.043	0.49
CMSA	Boston-Worcester-Lawrence, MA-NH-ME-CT CMSA	mean	0.003	0.002	-0.001	0.006	0.17
CMSA	Boston-Worcester-Lawrence, MA-NH-ME-CT CMSA	Scale	0.135	0.009	0.119	0.156	_
CMSA	Cleveland-Akron, OH CMSA	Intercept	-3.259	2.127	-7.617	1.098	0.13
CMSA	Cleveland-Akron, OH CMSA	mean	0.176	0.099	-0.027	0.378	0.08
CMSA	Cleveland-Akron, OH CMSA	Scale	1.755	0.265	1.341	2.436	_
CMSA	Denver-Boulder-Greeley, CO CMSA	Intercept	-0.439	0.383	-1.211	0.332	0.25
CMSA	Denver-Boulder-Greeley, CO CMSA	mean	0.044	0.018	0.008	0.080	0.01
CMSA	Denver-Boulder-Greeley, CO CMSA	Scale	1.097	0.129	0.885	1.408	_
CMSA	Los Angeles-Riverside-Orange County, CA CMSA	Intercept	-3.301	0.620	-4.519	-2.083	0.00
CMSA	Los Angeles-Riverside-Orange County, CA CMSA	mean	0.194	0.023	0.148	0.240	0.00
CMSA	Los Angeles-Riverside-Orange County, CA CMSA	Scale	4.723	0.174	4.402	5.085	_
CMSA	Miami-Fort Lauderdale, FL CMSA	Intercept	-0.496	0.384	-1.265	0.273	0.20
CMSA	Miami-Fort Lauderdale, FL CMSA	mean	0.070	0.037	-0.005	0.144	0.06

Location Type	Location Name	Parameter*	Estimate	Standard Error	Lower Confidence Bound	Upper Confidence Bound	P-value **
CMSA	Miami-Fort Lauderdale, FL CMSA	Scale	0.828	0.088	0.681	1.036	_
CMSA	New York-Northern New Jersey-Long Island, NY-NJ-CT-PA CMS	Intercept	-0.230	0.104	-0.435	-0.024	0.03
CMSA	New York-Northern New Jersey-Long Island, NY-NJ-CT-PA CMS	mean	0.013	0.004	0.005	0.020	0.00
CMSA	New York-Northern New Jersey-Long Island, NY-NJ-CT-PA CMS	Scale	0.407	0.022	0.368	0.454	_
CMSA	Washington-Baltimore, DC-MD-VA-WV CMSA	Intercept	-0.032	0.069	-0.167	0.104	0.64
CMSA	Washington-Baltimore, DC-MD-VA-WV CMSA	mean	0.003	0.003	-0.004	0.010	0.35
CMSA	Washington-Baltimore, DC-MD-VA-WV CMSA	Scale	0.208	0.013	0.186	0.236	_
MSA	Atlanta,GA	Intercept	-0.041	0.069	-0.178	0.096	0.55
MSA	Atlanta,GA	mean	0.008	0.005	-0.002	0.017	0.11
MSA	Atlanta,GA	Scale	0.226	0.022	0.189	0.277	_
MSA	Colorado Springs,CO	Intercept	-36.358	11.812	-60.391	-12.326	0.00
MSA	Colorado Springs,CO	mean	2.689	0.674	1.318	4.061	0.00
MSA	Colorado Springs,CO	Scale	22.519	3.123	17.551	30.362	_
MSA	El Paso,TX	Intercept	-2.017	0.440	-2.898	-1.135	0.00
MSA	El Paso,TX	mean	0.131	0.024	0.083	0.178	0.00
MSA	El Paso,TX	Scale	0.920	0.098	0.757	1.151	_
MSA	Phoenix-Mesa,AZ	Intercept	-7.102	15.545	-38.177	23.974	0.65
MSA	Phoenix-Mesa,AZ	mean	0.423	0.557	-0.689	1.536	0.45
MSA	Phoenix-Mesa,AZ	Scale	22.513	2.274	18.697	27.828	_
MSA/CMSA	Other MSA/CMSA	Intercept	-0.100	0.051	-0.201	0.000	0.05
MSA/CMSA	Other MSA/CMSA	mean	0.013	0.003	0.006	0.019	0.00
MSA/CMSA	Other MSA/CMSA	Scale	1.098	0.015	1.069	1.128	_
Not MSA	Other Not MSA	Intercept	-0.064	0.049	-0.160	0.031	0.19
Not MSA	Other Not MSA	mean	0.021	0.006	0.009	0.032	0.00
Not MSA	Other Not MSA	Scale	0.549	0.018	0.514	0.587	_

Notes:

Using the report notation, a = “Intercept”, b = “mean”, and standard deviation = “Scale.”

** probability that the Chi-square test for that parameter = 0.

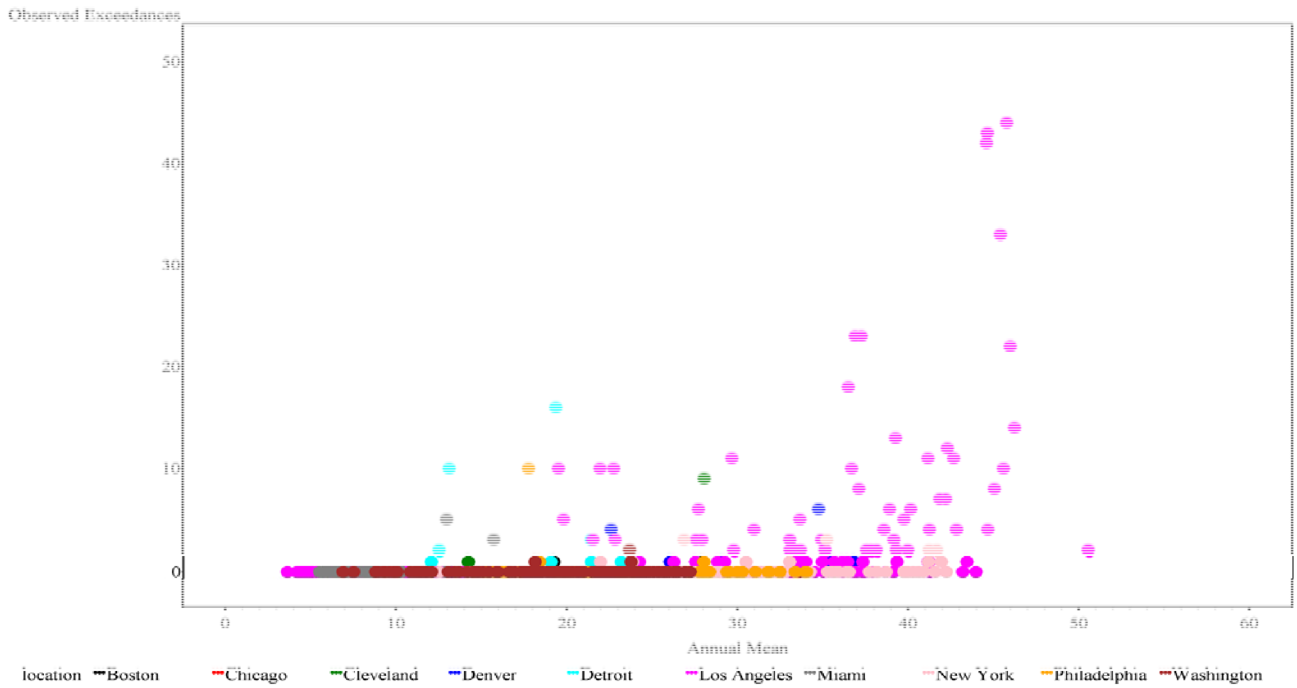

Figure A-97. Exceedances of 150 ppb versus annual mean concentrations (ppb) for CMSA locations.

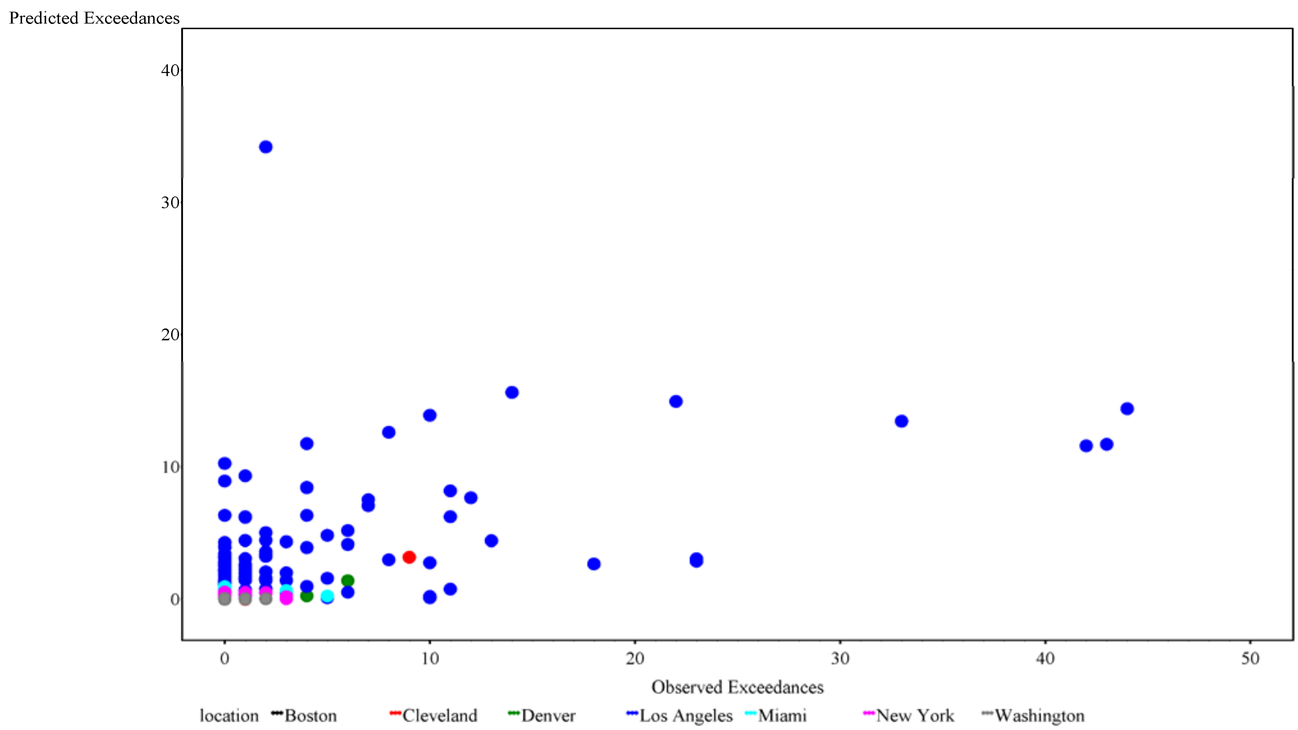

Figure A-98. Predicted and observed exceedances for CMSA locations using Poisson exponential model.

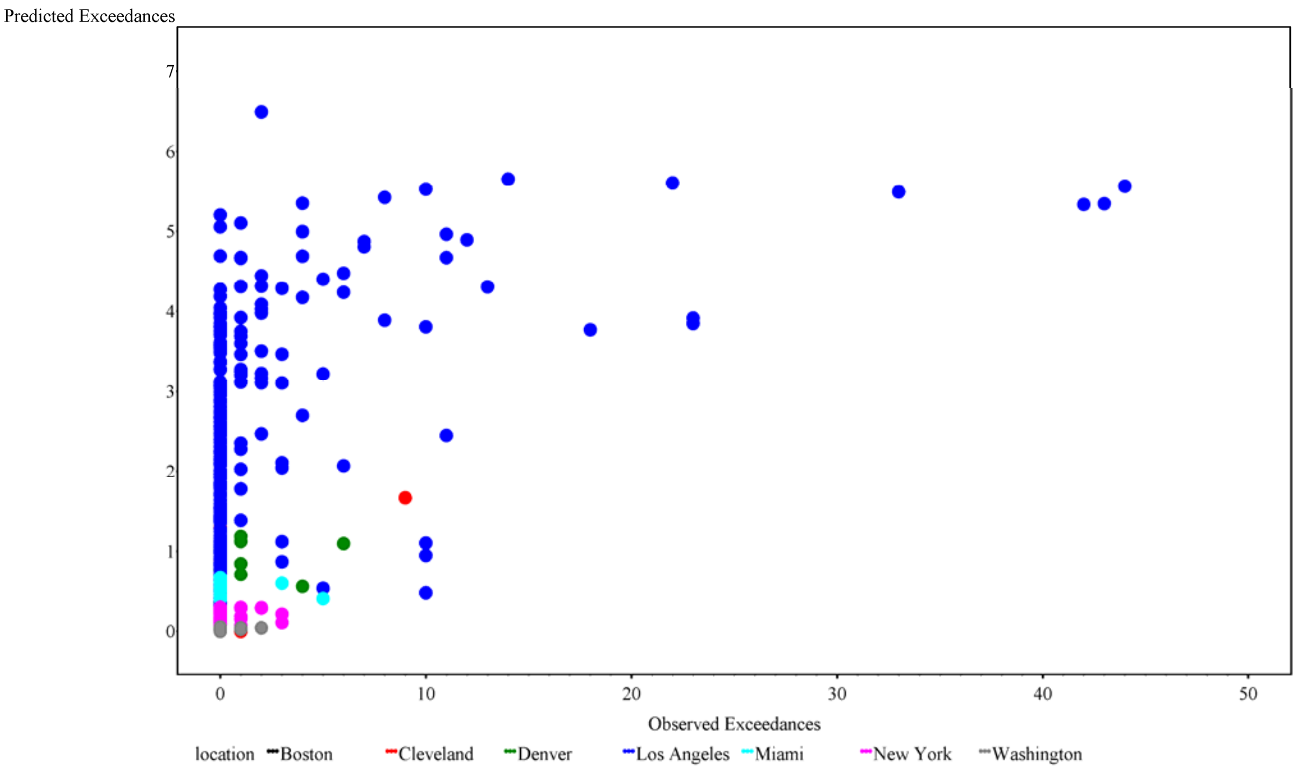

Figure A-99. Predicted and observed exceedances for CMSA locations using normal linear model

Table A-100. As-is and current-standard scenario predictions for Poisson exponential model, with separate coefficients for each location.

Location	Annual Mean (ppb)	Observed Mean Exceed-ances	Observed Max Exceed-ances	Predicted Exceed-ances	95% Confidence Interval for Mean Number of Exceedances		95% Prediction Interval for Number of Exceedances	
					Lower Bound	Upper Bound	Lower Bound	Upper Bound
Boston	53.0	0.019	1	2.081	0.002	1000.000	0	1000
Boston	16.8	0.019	1	0.011	0.001	0.091	0	0
Cleveland	53.0	0.455	9	1000.000	578.253	1000.000	364	1000
Cleveland	21.2	0.455	9	0.073	0.011	0.474	0	1
Denver	53.0	0.389	6	17.140	2.958	99.308	2	98
Denver	18.7	0.389	6	0.158	0.057	0.438	0	1
Los Angeles	53.0	1.403	44	53.244	44.092	64.297	37	73
Los Angeles	24.3	1.403	44	0.293	0.238	0.360	0	2
Miami	53.0	0.182	5	1000.000	35.520	1000.000	29	1000
Miami	9.7	0.182	5	0.086	0.026	0.281	0	1
New York	53.0	0.092	3	2.737	0.646	11.604	0	13
New York	25.5	0.092	3	0.048	0.022	0.104	0	1
Washington	53.0	0.030	2	3.038	0.001	1000.000	0	1000
Washington	19.4	0.030	2	0.023	0.007	0.082	0	0
Atlanta	53.0	0.057	1	10.242	0.012	1000.000	0	1000
Atlanta	12.9	0.057	1	0.038	0.008	0.181	0	1
Colorado Springs	53.0	7.346	143	1000.000	1000.000	1000.000	1000	1000
Colorado Springs	16.3	7.346	143	0.792	0.528	1.189	0	3
El Paso	53.0	0.295	7	1000.000	177.602	1000.000	156	1000
El Paso	17.7	0.295	7	0.015	0.001	0.142	0	1
Phoenix	53.0	4.469	147	56.901	31.702	102.130	26	106
Phoenix	27.3	4.469	147	3.760	3.221	4.389	0	8
Other MSA/CMSA	53.0	0.079	39	18.369	9.388	35.940	7	41
Other MSA/CMSA	13.9	0.079	39	0.048	0.040	0.058	0	1
Other Not MSA	53.0	0.081	7	1000.000	85.717	1000.000	75	1000
Other Not MSA	7.0	0.081	7	0.046	0.028	0.075	0	1

Table A-101. As-is and current-standard scenario predictions for Normal linear model, with separate coefficients for each location.

Location Name	Annual Mean (ppb)	Observed Mean Exceed-ances	Observed Max Exceed-ances	Predicted Exceed-ances	95% Confidence Interval for Mean Number of Exceedances		95% Prediction Interval for Number of Exceedances	
					Lower Bound	Upper Bound	Lower Bound	Upper Bound
Boston	53.0	0.019	1	0.111	0.000	0.245	0.000	0.412
Boston	16.8	0.019	1	0.019	0.000	0.045	0.000	0.289
Cleveland	53.0	0.455	9	6.046	0.000	12.267	0.000	13.612
Cleveland	21.2	0.455	9	0.455	0.000	1.188	0.000	4.198
Denver	53.0	0.389	6	1.906	0.645	3.168	0.000	4.490
Denver	18.7	0.389	6	0.389	0.031	0.747	0.000	2.648
Los Angeles	53.0	1.403	44	6.965	5.561	8.369	0.000	16.360
Los Angeles	24.3	1.403	44	1.403	0.921	1.884	0.000	10.703
Miami	53.0	0.182	5	3.199	0.024	6.375	0.000	6.871
Miami	9.7	0.182	5	0.182	0.000	0.426	0.000	1.871
New York	53.0	0.092	3	0.439	0.220	0.658	0.000	1.272
New York	25.5	0.092	3	0.092	0.031	0.152	0.000	0.897
Washington	53.0	0.030	2	0.136	0.000	0.364	0.000	0.608
Washington	19.4	0.030	2	0.030	0.000	0.065	0.000	0.443
Atlanta	53.0	0.057	1	0.360	0.000	0.739	0.000	0.957
Atlanta	12.9	0.057	1	0.057	0.000	0.117	0.000	0.514
Colorado Springs	53.0	7.346	143	106.169	56.853	155.486	36.477	175.862
Colorado Springs	16.3	7.346	143	7.346	0.000	16.002	0.000	54.709
El Paso	53.0	0.295	7	4.902	3.249	6.555	2.384	7.421
El Paso	17.7	0.295	7	0.295	0.024	0.567	0.000	2.172
Phoenix	53.0	4.469	147	15.339	0.000	44.043	0.000	69.369
Phoenix	27.3	4.469	147	4.469	0.000	10.773	0.000	50.219
Other MSA/CMSA	53.0	0.079	39	0.584	0.324	0.844	0.000	2.752
Other MSA/CMSA	13.9	0.079	39	0.079	0.037	0.120	0.000	2.232
Other Not MSA	53.0	0.081	7	1.036	0.505	1.566	0.000	2.238
Other Not MSA	7.0	0.081	7	0.081	0.030	0.132	0.000	1.161

We can compare these predictions with the predictions for Los Angeles from McCurdy (1994) based on 1988-1992 data. Table A-102 gives the McCurdy (1994) exceedance estimates for exceedances of 150 ppb together with our estimates for the 1995-2006 data based on the Poisson exponential model (see Table A-103) and the normal linear model (see Table A-104). It is easily seen that the McCurdy (1994) estimates agree reasonably well with our Poisson exponential model predictions, with predicted exceedances being a little lower for annual means up to 53 ppb, but a little higher at 60 ppb. The McCurdy (1994) model predicts 75 exceedances at 53 ppb, compared to our Poisson exponential model prediction of 53 exceedances. However, the McCurdy (1994) estimates are all much higher than our normal linear model predictions. For example, the McCurdy (1994) model predicts 75 exceedances at 53 ppb, compared to our normal linear model prediction of 7 exceedances. These findings are primarily due to the fact that McCurdy also used an exponential link function.

Table A-102. Comparison of predicted exceedances of 150 ppb using McCurdy (1994) for 1988-1992 data and the Poisson exponential and normal linear models for 1995-2006 data.

Annual Mean (ppb)	Predicted Exceedances of 150 ppb		
	McCurdy (1994) Normal exponential 1988-1992 data	Current Analysis Poisson exponential 1995-2006 data	Current Analysis Normal linear 1995-2006 data
20	4	0	1
30	9	1	3
40	33	5	4
50	57	31	6
53	75	53	7
60	142	189	8

A-6.4 Conclusion

These analyses found a poor relationship between the annual means and the exceedances of 150 ppb, as well as frequently unrealistically high predictions of exceedances of 150 ppb for the current-standard scenario. The uncertainty at higher exceedance threshold concentration levels (200 to 300 ppb) would be expected to be even higher because the numbers of site-years with non-zero exceedances are even lower (which implies a much weaker numerical relationship between the annual mean and the annual exceedances). For example, for Los Angeles, the maximum number of exceedances of 150 ppb was 44, but the maximum number of exceedances of 200 ppb was only 5. Therefore we chose not to continue the regression analyses to higher exceedance threshold concentration levels.

A-6.5 Detailed Regression Model Predictions

Table A-103. Predictions for Poisson exponential model, with separate coefficients for each location.

Location	Annual Mean (ppb)	Observed Mean Exceed-ances	Observed Max Exceed-ances	Predicted Exceed-ances	95% Confidence Interval for Mean Number of Exceedances		95% Prediction Interval for Number of Exceedances	
					Lower Bound	Upper Bound	Lower Bound	Upper Bound
Boston	20.0	0.019	1	0.018	0.004	0.090	0	1
Boston	30.0	0.019	1	0.076	0.010	0.576	0	1
Boston	40.0	0.019	1	0.321	0.006	17.564	0	14
Boston	50.0	0.019	1	1.352	0.003	661.873	0	680
Boston	53.0	0.019	1	2.081	0.002	1000.000	0	1000
Boston	60.0	0.019	1	5.692	0.001	1000.000	0	1000
Boston	5.4	0.019	1	0.002	0.000	0.175	0	0
Boston	16.8	0.019	1	0.011	0.001	0.091	0	0
Boston	31.0	0.019	1	0.089	0.010	0.801	0	1
Cleveland	20.0	0.455	9	0.039	0.004	0.358	0	1
Cleveland	30.0	0.455	9	9.244	2.693	31.732	2	32
Cleveland	40.0	0.455	9	1000.000	29.509	1000.000	23	1000
Cleveland	50.0	0.455	9	1000.000	291.652	1000.000	184	1000
Cleveland	53.0	0.455	9	1000.000	578.253	1000.000	364	1000
Cleveland	60.0	0.455	9	1000.000	1000.000	1000.000	1000	1000
Cleveland	14.2	0.455	9	0.002	0.000	0.092	0	0
Cleveland	21.2	0.455	9	0.073	0.011	0.474	0	1
Cleveland	28.1	0.455	9	3.193	1.490	6.845	0	9
Denver	20.0	0.389	6	0.189	0.074	0.482	0	2
Denver	30.0	0.389	6	0.740	0.438	1.251	0	3
Denver	40.0	0.389	6	2.902	1.201	7.014	0	9
Denver	50.0	0.389	6	11.376	2.426	53.350	1	53
Denver	53.0	0.389	6	17.140	2.958	99.308	2	98
Denver	60.0	0.389	6	44.600	4.659	426.973	4	454
Denver	6.1	0.389	6	0.028	0.004	0.186	0	1
Denver	18.7	0.389	6	0.158	0.057	0.438	0	1
Denver	36.8	0.389	6	1.871	0.925	3.786	0	6
Los Angeles	20.0	1.403	44	0.135	0.104	0.174	0	1
Los Angeles	30.0	1.403	44	0.825	0.713	0.954	0	3
Los Angeles	40.0	1.403	44	5.050	4.632	5.505	1	10
Los Angeles	50.0	1.403	44	30.917	26.439	36.154	20	44
Los Angeles	53.0	1.403	44	53.244	44.092	64.297	37	73
Los Angeles	60.0	1.403	44	189.281	144.681	247.629	138	260
Los Angeles	3.6	1.403	44	0.007	0.004	0.011	0	0
Los Angeles	24.3	1.403	44	0.293	0.238	0.360	0	2
Los Angeles	50.6	1.403	44	34.208	29.084	40.236	22	48
Miami	20.0	0.182	5	2.882	0.636	13.069	0	13
Miami	30.0	0.182	5	88.023	2.282	1000.000	2	1000
Miami	40.0	0.182	5	1000.000	7.591	1000.000	7	1000
Miami	50.0	0.182	5	1000.000	24.900	1000.000	33	1000
Miami	53.0	0.182	5	1000.000	35.520	1000.000	29	1000
Miami	60.0	0.182	5	1000.000	81.274	1000.000	40	1000
Miami	5.5	0.182	5	0.020	0.003	0.154	0	1

Location	Annual Mean (ppb)	Observed Mean Exceed-ances	Observed Max Exceed-ances	Predicted Exceed-ances	95% Confidence Interval for Mean Number of Exceedances		95% Prediction Interval for Number of Exceedances	
					Lower Bound	Upper Bound	Lower Bound	Upper Bound
Miami	9.7	0.182	5	0.086	0.026	0.281	0	1
Miami	16.8	0.182	5	0.970	0.380	2.475	0	4
New York	20.0	0.092	3	0.021	0.007	0.065	0	0
New York	30.0	0.092	3	0.092	0.052	0.163	0	1
New York	40.0	0.092	3	0.403	0.211	0.773	0	2
New York	50.0	0.092	3	1.760	0.507	6.107	0	7
New York	53.0	0.092	3	2.737	0.646	11.604	0	13
New York	60.0	0.092	3	7.677	1.121	52.548	0	53
New York	9.7	0.092	3	0.005	0.001	0.028	0	0
New York	25.5	0.092	3	0.048	0.022	0.104	0	1
New York	42.2	0.092	3	0.557	0.260	1.193	0	3
Washington	20.0	0.030	2	0.026	0.008	0.081	0	1
Washington	30.0	0.030	2	0.109	0.011	1.044	0	2
Washington	40.0	0.030	2	0.463	0.004	55.438	0	57
Washington	50.0	0.030	2	1.968	0.001	1000.000	0	1000
Washington	53.0	0.030	2	3.038	0.001	1000.000	0	1000
Washington	60.0	0.030	2	8.368	0.000	1000.000	0	1000
Washington	6.9	0.030	2	0.004	0.000	0.256	0	1
Washington	19.4	0.030	2	0.023	0.007	0.082	0	0
Washington	27.2	0.030	2	0.072	0.014	0.366	0	1
Atlanta	20.0	0.057	1	0.102	0.032	0.327	0	1
Atlanta	30.0	0.057	1	0.412	0.034	4.953	0	5
Atlanta	40.0	0.057	1	1.665	0.023	122.647	0	103
Atlanta	50.0	0.057	1	6.735	0.014	1000.000	0	1000
Atlanta	53.0	0.057	1	10.242	0.012	1000.000	0	1000
Atlanta	60.0	0.057	1	27.243	0.008	1000.000	0	1000
Atlanta	3.4	0.057	1	0.010	0.000	0.230	0	0
Atlanta	12.9	0.057	1	0.038	0.008	0.181	0	1
Atlanta	26.6	0.057	1	0.257	0.037	1.770	0	3
Colorado Springs	20.0	7.346	143	2.295	1.662	3.168	0	6
Colorado Springs	30.0	7.346	143	39.206	33.759	45.531	26	53
Colorado Springs	40.0	7.346	143	669.766	526.509	852.001	523	870
Colorado Springs	50.0	7.346	143	1000.000	1000.000	1000.000	1000	1000
Colorado Springs	53.0	7.346	143	1000.000	1000.000	1000.000	1000	1000
Colorado Springs	60.0	7.346	143	1000.000	1000.000	1000.000	1000	1000
Colorado Springs	6.8	7.346	143	0.054	0.029	0.102	0	1
Colorado Springs	16.3	7.346	143	0.792	0.528	1.189	0	3
Colorado Springs	34.8	7.346	143	153.247	130.906	179.401	121	189
El Paso	20.0	0.295	7	0.032	0.005	0.230	0	1

Location	Annual Mean (ppb)	Observed Mean Exceed-ances	Observed Max Exceed-ances	Predicted Exceed-ances	95% Confidence Interval for Mean Number of Exceedances		95% Prediction Interval for Number of Exceedances	
					Lower Bound	Upper Bound	Lower Bound	Upper Bound
El Paso	30.0	0.295	7	1.075	0.536	2.156	0	4
El Paso	40.0	0.295	7	35.703	11.290	112.906	11	119
El Paso	50.0	0.295	7	1000.000	95.081	1000.000	94	1000
El Paso	53.0	0.295	7	1000.000	177.602	1000.000	156	1000
El Paso	60.0	0.295	7	1000.000	757.520	1000.000	634	1000
El Paso	8.2	0.295	7	0.001	0.000	0.020	0	0
El Paso	17.7	0.295	7	0.015	0.001	0.142	0	1
El Paso	35.1	0.295	7	6.447	3.454	12.036	1	14
Phoenix	20.0	4.469	147	1.731	1.287	2.329	0	5
Phoenix	30.0	4.469	147	4.988	4.367	5.698	1	10
Phoenix	40.0	4.469	147	14.375	10.922	18.919	7	24
Phoenix	50.0	4.469	147	41.422	24.843	69.066	21	71
Phoenix	53.0	4.469	147	56.901	31.702	102.130	26	106
Phoenix	60.0	4.469	147	119.362	55.901	254.864	56	254
Phoenix	11.1	4.469	147	0.673	0.404	1.119	0	3
Phoenix	27.3	4.469	147	3.760	3.221	4.389	0	8
Phoenix	40.5	4.469	147	15.110	11.361	20.098	7	25
Other MSA/CMSA	20.0	0.079	39	0.122	0.107	0.140	0	1
Other MSA/CMSA	30.0	0.079	39	0.559	0.442	0.707	0	2
Other MSA/CMSA	40.0	0.079	39	2.552	1.681	3.874	0	6
Other MSA/CMSA	50.0	0.079	39	11.648	6.317	21.480	4	25
Other MSA/CMSA	53.0	0.079	39	18.369	9.388	35.940	7	41
Other MSA/CMSA	60.0	0.079	39	53.171	23.650	119.541	20	116
Other MSA/CMSA	0.5	0.079	39	0.006	0.004	0.010	0	0
Other MSA/CMSA	13.9	0.079	39	0.048	0.040	0.058	0	1
Other MSA/CMSA	34.0	0.079	39	1.025	0.756	1.391	0	4
Other Not MSA	20.0	0.081	7	0.878	0.459	1.681	0	3
Other Not MSA	30.0	0.081	7	8.514	2.297	31.556	1	32
Other Not MSA	40.0	0.081	7	82.532	11.133	611.822	10	573
Other Not MSA	50.0	0.081	7	799.989	53.545	1000.000	57	1000
Other Not MSA	53.0	0.081	7	1000.000	85.717	1000.000	75	1000
Other Not MSA	60.0	0.081	7	1000.000	256.785	1000.000	226	1000
Other Not MSA	0.3	0.081	7	0.010	0.004	0.025	0	0
Other Not MSA	7.0	0.081	7	0.046	0.028	0.075	0	1
Other Not MSA	19.7	0.081	7	0.823	0.438	1.547	0	3

Table A-104. Predictions for Normal linear model, with separate coefficients for each location.

Location Name	Annual Mean	Observed Mean Exceed-ances	Observed Max Exceed-ances	Predicted Exceed-ances	95% Confidence Interval for Mean Number of Exceedances		95% Prediction Interval for Number of Exceedances	
					Lower Bound	Upper Bound	Lower Bound	Upper Bound
Boston	20.0	0.019	1	0.027	0.000	0.056	0.000	0.297
Boston	30.0	0.019	1	0.052	0.000	0.107	0.000	0.327
Boston	40.0	0.019	1	0.078	0.000	0.166	0.000	0.361
Boston	50.0	0.019	1	0.103	0.000	0.226	0.000	0.399
Boston	53.0	0.019	1	0.111	0.000	0.245	0.000	0.412
Boston	60.0	0.019	1	0.128	0.000	0.287	0.000	0.441
Boston	5.4	0.019	1	0.000	0.000	0.039	0.000	0.263
Boston	16.8	0.019	1	0.019	0.000	0.045	0.000	0.289
Boston	31.0	0.019	1	0.055	0.000	0.113	0.000	0.330
Cleveland	20.0	0.455	9	0.252	0.000	1.019	0.000	4.003
Cleveland	30.0	0.455	9	2.008	0.141	3.874	0.000	6.173
Cleveland	40.0	0.455	9	3.763	0.035	7.492	0.000	9.163
Cleveland	50.0	0.455	9	5.519	0.000	11.163	0.000	12.553
Cleveland	53.0	0.455	9	6.046	0.000	12.267	0.000	13.612
Cleveland	60.0	0.455	9	7.275	0.000	14.846	0.000	16.125
Cleveland	14.2	0.455	9	0.000	0.000	0.769	0.000	3.243
Cleveland	21.2	0.455	9	0.455	0.000	1.188	0.000	4.198
Cleveland	28.1	0.455	9	1.667	0.140	3.194	0.000	5.673
Denver	20.0	0.389	6	0.446	0.085	0.807	0.000	2.706
Denver	30.0	0.389	6	0.888	0.353	1.424	0.000	3.185
Denver	40.0	0.389	6	1.331	0.499	2.163	0.000	3.720
Denver	50.0	0.389	6	1.773	0.613	2.934	0.000	4.306
Denver	53.0	0.389	6	1.906	0.645	3.168	0.000	4.490
Denver	60.0	0.389	6	2.216	0.716	3.716	0.000	4.933
Denver	6.1	0.389	6	0.000	0.000	0.402	0.000	2.136
Denver	18.7	0.389	6	0.389	0.031	0.747	0.000	2.648
Denver	36.8	0.389	6	1.189	0.458	1.920	0.000	3.543
Los Angeles	20.0	1.403	44	0.573	0.053	1.093	0.000	9.876
Los Angeles	30.0	1.403	44	2.510	1.962	3.058	0.000	11.814
Los Angeles	40.0	1.403	44	4.447	3.579	5.315	0.000	13.776
Los Angeles	50.0	1.403	44	6.384	5.109	7.660	0.000	15.760
Los Angeles	53.0	1.403	44	6.965	5.561	8.369	0.000	16.360
Los Angeles	60.0	1.403	44	8.321	6.612	10.031	0.000	17.766
Los Angeles	3.6	1.403	44	0.000	0.000	0.000	0.000	6.747
Los Angeles	24.3	1.403	44	1.403	0.921	1.884	0.000	10.703
Los Angeles	50.6	1.403	44	6.492	5.193	7.792	0.000	15.871
Miami	20.0	0.182	5	0.899	0.108	1.689	0.000	2.757
Miami	30.0	0.182	5	1.596	0.092	3.099	0.000	3.873
Miami	40.0	0.182	5	2.293	0.065	4.521	0.000	5.131
Miami	50.0	0.182	5	2.990	0.034	5.947	0.000	6.463
Miami	53.0	0.182	5	3.199	0.024	6.375	0.000	6.871
Miami	60.0	0.182	5	3.687	0.001	7.373	0.000	7.834
Miami	5.5	0.182	5	0.000	0.000	0.281	0.000	1.607
Miami	9.7	0.182	5	0.182	0.000	0.426	0.000	1.871
Miami	16.8	0.182	5	0.677	0.103	1.250	0.000	2.449
New York	20.0	0.092	3	0.023	0.000	0.096	0.000	0.829

Location Name	Annual Mean	Observed Mean Exceed-ances	Observed Max Exceed-ances	Predicted Exceed-ances	95% Confidence Interval for Mean Number of Exceedances		95% Prediction Interval for Number of Exceedances	
					Lower Bound	Upper Bound	Lower Bound	Upper Bound
New York	30.0	0.092	3	0.149	0.079	0.218	0.000	0.955
New York	40.0	0.092	3	0.275	0.148	0.401	0.000	1.088
New York	50.0	0.092	3	0.401	0.204	0.598	0.000	1.228
New York	53.0	0.092	3	0.439	0.220	0.658	0.000	1.272
New York	60.0	0.092	3	0.527	0.256	0.798	0.000	1.375
New York	9.7	0.092	3	0.000	0.000	0.028	0.000	0.707
New York	25.5	0.092	3	0.092	0.031	0.152	0.000	0.897
New York	42.2	0.092	3	0.302	0.161	0.444	0.000	1.118
Washington	20.0	0.030	2	0.032	0.000	0.067	0.000	0.445
Washington	30.0	0.030	2	0.063	0.000	0.143	0.000	0.483
Washington	40.0	0.030	2	0.095	0.000	0.237	0.000	0.531
Washington	50.0	0.030	2	0.127	0.000	0.335	0.000	0.589
Washington	53.0	0.030	2	0.136	0.000	0.364	0.000	0.608
Washington	60.0	0.030	2	0.158	0.000	0.432	0.000	0.654
Washington	6.9	0.030	2	0.000	0.000	0.081	0.000	0.412
Washington	19.4	0.030	2	0.030	0.000	0.065	0.000	0.443
Washington	27.2	0.030	2	0.054	0.000	0.117	0.000	0.471
Atlanta	20.0	0.057	1	0.110	0.020	0.201	0.000	0.573
Atlanta	30.0	0.057	1	0.186	0.015	0.357	0.000	0.672
Atlanta	40.0	0.057	1	0.262	0.001	0.522	0.000	0.787
Atlanta	50.0	0.057	1	0.337	0.000	0.689	0.000	0.916
Atlanta	53.0	0.057	1	0.360	0.000	0.739	0.000	0.957
Atlanta	60.0	0.057	1	0.413	0.000	0.857	0.000	1.055
Atlanta	3.4	0.057	1	0.000	0.000	0.092	0.000	0.452
Atlanta	12.9	0.057	1	0.057	0.000	0.117	0.000	0.514
Atlanta	26.6	0.057	1	0.161	0.019	0.303	0.000	0.637
Colorado Springs	20.0	7.346	143	17.426	7.454	27.398	0.000	65.075
Colorado Springs	30.0	7.346	143	44.318	24.197	64.439	0.000	95.397
Colorado Springs	40.0	7.346	143	71.210	38.662	103.758	13.462	128.958
Colorado Springs	50.0	7.346	143	98.102	52.682	143.522	31.411	164.793
Colorado Springs	53.0	7.346	143	106.169	56.853	155.486	36.477	175.862
Colorado Springs	60.0	7.346	143	124.994	66.550	183.438	47.873	202.115
Colorado Springs	6.8	7.346	143	0.000	0.000	0.000	0.000	31.109
Colorado Springs	16.3	7.346	143	7.346	0.000	16.002	0.000	54.709
Colorado Springs	34.8	7.346	143	57.235	31.241	83.228	3.296	111.173
El Paso	20.0	0.295	7	0.594	0.303	0.886	0.000	2.474
El Paso	30.0	0.295	7	1.900	1.270	2.529	0.000	3.866
El Paso	40.0	0.295	7	3.205	2.140	4.270	1.049	5.361
El Paso	50.0	0.295	7	4.511	2.994	6.027	2.085	6.936

Location Name	Annual Mean	Observed Mean Exceed-ances	Observed Max Exceed-ances	Predicted Exceed-ances	95% Confidence Interval for Mean Number of Exceedances		95% Prediction Interval for Number of Exceedances	
					Lower Bound	Upper Bound	Lower Bound	Upper Bound
El Paso	53.0	0.295	7	4.902	3.249	6.555	2.384	7.421
El Paso	60.0	0.295	7	5.816	3.844	7.789	3.065	8.568
El Paso	8.2	0.295	7	0.000	0.000	0.000	0.000	0.981
El Paso	17.7	0.295	7	0.295	0.024	0.567	0.000	2.172
El Paso	35.1	0.295	7	2.567	1.719	3.416	0.516	4.619
Phoenix	20.0	4.469	147	1.367	0.000	11.546	0.000	47.846
Phoenix	30.0	4.469	147	5.601	0.000	12.546	0.000	51.449
Phoenix	40.0	4.469	147	9.835	0.000	25.027	0.000	57.734
Phoenix	50.0	4.469	147	14.069	0.000	39.591	0.000	66.390
Phoenix	53.0	4.469	147	15.339	0.000	44.043	0.000	69.369
Phoenix	60.0	4.469	147	18.303	0.000	54.495	0.000	76.880
Phoenix	11.1	4.469	147	0.000	0.000	16.406	0.000	46.824
Phoenix	27.3	4.469	147	4.469	0.000	10.773	0.000	50.219
Phoenix	40.5	4.469	147	10.035	0.000	25.696	0.000	58.093
Other MSA/CMSA	20.0	0.079	39	0.158	0.100	0.216	0.000	2.311
Other MSA/CMSA	30.0	0.079	39	0.287	0.173	0.401	0.000	2.442
Other MSA/CMSA	40.0	0.079	39	0.416	0.239	0.593	0.000	2.576
Other MSA/CMSA	50.0	0.079	39	0.545	0.304	0.786	0.000	2.711
Other MSA/CMSA	53.0	0.079	39	0.584	0.324	0.844	0.000	2.752
Other MSA/CMSA	60.0	0.079	39	0.674	0.368	0.980	0.000	2.848
Other MSA/CMSA	0.5	0.079	39	0.000	0.000	0.003	0.000	2.061
Other MSA/CMSA	13.9	0.079	39	0.079	0.037	0.120	0.000	2.232
Other MSA/CMSA	34.0	0.079	39	0.339	0.200	0.477	0.000	2.495
Other Not MSA	20.0	0.081	7	0.351	0.193	0.508	0.000	1.440
Other Not MSA	30.0	0.081	7	0.558	0.290	0.827	0.000	1.669
Other Not MSA	40.0	0.081	7	0.766	0.384	1.148	0.000	1.910
Other Not MSA	50.0	0.081	7	0.973	0.477	1.469	0.000	2.161
Other Not MSA	53.0	0.081	7	1.036	0.505	1.566	0.000	2.238
Other Not MSA	60.0	0.081	7	1.181	0.571	1.791	0.000	2.421
Other Not MSA	0.3	0.081	7	0.000	0.000	0.035	0.000	1.024
Other Not MSA	7.0	0.081	7	0.081	0.030	0.132	0.000	1.161
Other Not MSA	19.7	0.081	7	0.345	0.190	0.499	0.000	1.434

A-7 Air Quality Simulations

A-7.1 Introduction

Every location across the U.S. meets the current NO_2 annual standard (US EPA, 2007e). Even considering air quality data as far back as 1995, no location/monitoring site exceeded the current standard. Therefore, simulation of air quality data was required to evaluate just meeting the current standard or standards that are more stringent.

In developing a simulation approach to adjust air quality to meet a particular standard level, policy-relevant background (PRB) levels in the U.S. were first considered. Policy-relevant background is defined as the distribution of NO_2 concentrations that would be observed in the U.S. in the absence of anthropogenic (man-made) emissions of NO_2 precursors in the U.S., Canada, and Mexico. Estimates of PRB have been reported in the draft ISA (Section 1.5.5) and the Annex (AX2.9), and for most of the continental U.S. the PRB is estimated to be less than 300 parts per trillion (ppt). In the Northeastern U.S. where present-day NO_2 concentrations are highest, this amounts to a contribution of about 1% percent of the total observed ambient NO_2 concentration (AX2.9). This low contribution of PRB to NO_2 concentrations provides support for a proportional method to adjust air quality, i.e., an equal adjustment of air quality values across the entire air quality distribution to just meet a target value.

Next, the variability in NO_2 concentrations was evaluated to determine whether a proportional approach would be reasonable if applied broadly across all years of data. Since the adjustment factor to meet the current standard would likely increase with increasing year, it was of interest to determine the trend in both the hourly concentrations and variability by year. Figure A-100 presents a summary of the annual average and hourly mean concentrations, as well as the coefficient of variation (COV, standard deviation as a percent of the mean) for each respective mean. Sample size for the annual average concentrations was about 350 per year, while hourly concentrations numbered about 3 million per year.

As expected, there was no observed difference in the mean concentrations when comparing each concentration metric within a year. The mean of the annual averages of all monitors is nearly identical to the mean of the hourly concentrations. However, statistically significant decreases in concentration are evident from year-to-year ($p<0.0001$), with concentrations decreasing by about 30% across the monitoring period. Contrary to this, there is no apparent trend in the COV for the annual average concentrations across the 12 years of data, generally centered about 53%. The COV of the hourly concentrations is larger than the annual COV as expected, however it increases with increasing year. The hourly COV ranges from a low of 84% in 1998 to a high of 92% in 2006, amounting to a relative percent difference of only 10% across the entire monitoring period. A non-parametric Mann-Whitney U-test indicates that there is a significant difference in the COVs when comparing each year-group ($p=0.004$). This may result in a small upward bias in the number of estimated exceedances of short-term (1-hour) potential health benchmark levels if using a proportional roll-up on the more recent monitoring data relative to that estimated by rolling up the historic data to just meet the current standard. While the trend of increasing COV is apparent across the entire monitoring period, based on the limited difference in COV from year-to-year for both the annual and hourly concentration data within each year-group (each is <4%), it is concluded that a proportional method could be broadly applied to each data set.

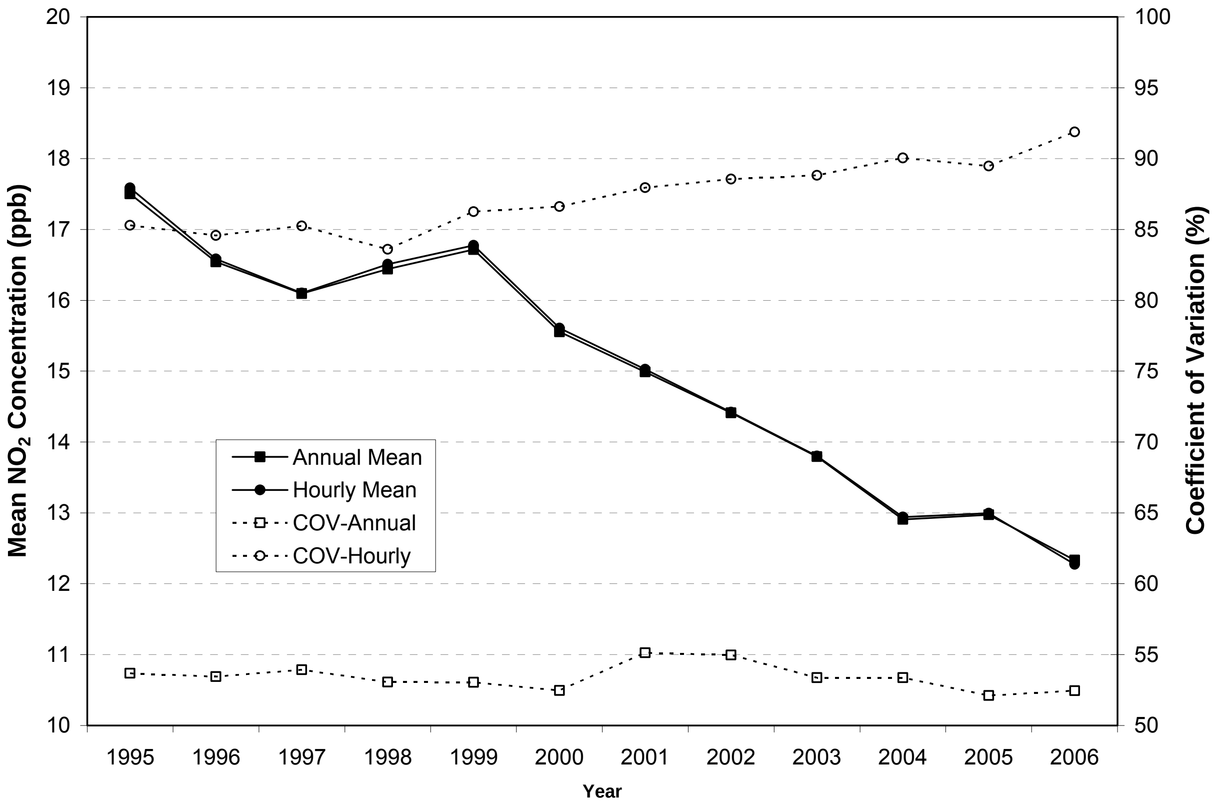

Figure A-100. Trends in hourly and annual average NO_2 ambient monitoring concentrations and their associated coefficients of variation (COV) for all monitors, years 1995-2006.

A-7.2 Approach

For the air quality characterization, data were first separated into two groups, an historic set of monitoring data (1995-2000) and one containing the most recent air quality (2001-2006). This grouping would further reduce any potential influential monitoring data affecting the variability in hourly concentrations that may exist in one year to the next within a location. The following air quality scenarios were considered for these sets of data:

- "*as is*" representing the historical and recent ambient monitoring hourly concentration data as reported by US EPA's Air Quality System (AQS).
- "*simulated*" concentrations to just meet the current NO_2 NAAQS (53 ppb annual average).

Based on the form of the current standard and observed trends in ambient monitoring, such as the retention of similar hourly and annual COVs over time while annual average concentrations significantly decrease over the same time period, NO_2 concentrations were proportionally modified at each location using the maximum annual average concentration that occurred in each year. To just meet the current standard adjustment factors *F* for each location (*i*) and year (*j*) were derived by the following

$$F_{ij} = 53 / C_{\max,ij} \qquad \text{equation (1)}$$

where,

F_{ij} = Adjustment factor (unitless)
$C_{max,ij}$ = Maximum annual average NO_2 concentration at a monitor in a location *i* (ppb)

Values for each air quality adjustment factor used for each location to simulate just meeting the current standard are given in Tables A-105 and A-106. It should be noted that a different monitor could have been used for each year to estimate *F*, the selection dependent only on whether the monitor contained the highest annual concentration for that year in the particular location. For each location and calendar year, all the hourly concentrations were multiplied by the same constant value *F* to make the highest annual mean equal to 53 ppb for that location and year. For example, for Boston in 1995, the maximum annual mean was 30.5 ppb, giving an adjustment factor of *F* = 53/30.5 = 1.74 using equation 1. All hourly concentrations in Boston in 1995 were multiplied by 1.74. Then, using the adjusted hourly concentrations, the distributions of the annual means and annual number of exceedances are computed in the same manner as the as-is scenario.[5]

Following review of the NO_2 ISA and summarization of relevant epidemiological and clinical health studies, alternative NO_2 standards of differing averaging time, form, and level were also considered. Much of the discussion regarding the selection of each of these components of the standard is provided in Chapter 5 of the 2nd draft NO2 REA, with only the broad conclusions provided here. For averaging time, the epidemiological evidence does not provide clear guidance in choosing between 1-hour and 24-hour averaging times, and given that the experimental literature provides support for the occurrence of effects following exposures of shorter duration than 24-hours (e.g., 1-hour), staff evaluated standards with 1-hour averaging times. For the form, we have focused on standards with statistical, concentration-based forms. Staff selected the 98th and 99th percentiles averaged over 3 years to balance the desire to provide a stable regulatory target with the desire to limit the occurrence of peak concentrations. Concentration levels ranging from 50 ppb to 200 ppb in increments of 50 ppb were selected by staff based largely on the observed concentrations from both epidemiologic and controlled human exposure studies. Based on these criteria for the investigated alternative standards, the following scenarios were considered using the most recent years of data (i.e., 2001-2006) and divided into two periods of analysis (years 2001-2003 and 2004-2006):

- "*as is*" representing the recent ambient monitoring hourly concentration data as reported by US EPA's Air Quality System (AQS).

[5] Because of the large database, we did not implement this procedure exactly as stated. For the annual means we computed and applied the adjustment factors directly to each annual mean. For the hourly concentrations we used the frequency distributions of the rounded hourly values, so that, in effect, we applied the adjustment factors to the hourly values after rounding them to the nearest integer. This has a negligible impact on the calculated number of exceedances.

- "*simulated*" concentrations to just meet the current NO_2 NAAQS (53 ppb annual average as described above) and alternative 1-hour standards.

Based on the averaging time and form of the alternative standards, ambient NO_2 concentrations were proportionally modified at each monitor using the maximum monitor percentile (98th or 99th) averaged across each three year group. To just meet each of the four alternative levels, the eight adjustment factors F for each location (i) and year-group (j) were derived by the following

$$F_{ij} = S / C_{\%ile,ij} \qquad \text{equation (2)}$$

where,

F_{ij} = Adjustment factor (unitless)
S = Alternative standard level (50, 100, 150, 200 ppb 1-hour concentration)
$C_{\%ile,ij}$ = Maximum 98th or 99th percentile 1-hour NO_2 concentration at a monitor in a location i (ppb)

Values for each air quality adjustment factor used for each location and year-group to simulate just meeting the alternatives standards are given in Tables A-107 and A-108. It should be noted that a different monitor could have been used for each year group to estimate F, the selection dependent only on whether the monitor contained the highest 98th or 99th 1-hour concentration averaged across the three year period in the particular location. For each location and year-group, all monitor hourly concentrations were multiplied by the same constant value F, whereas the monitor with the maximum averaged 98th or 99th percentile containing a three year average concentration at those same percentiles equivalent to the level of the alternative standard. For example, for Atlanta in years 2001-2003, the maximum 3-year average 98th percentile was 57 ppb, giving an adjustment factor F = 200/57 = 3.509 for the 1-hour alternative standard level of 200 ppb using equation (2). All hourly concentrations in Atlanta for each year in 2001-2003 were multiplied by 3.509. Then, using the adjusted hourly concentrations, the distributions of the annual number of exceedances are computed in the same manner as the as-is scenario.

Table A-105. Maximum annual average NO_2 concentrations and air quality adjustment factors (*F*) to just meet the current standard, historic monitoring data.

Location	Metric	1995	1996	1997	1998	1999	2000
Boston	Max Annual Mean	30.5	31.0	30.4	30.7	29.7	29.0
	F	1.74	1.71	1.74	1.73	1.79	1.83
Chicago	Max Annual Mean	32.2	32.0	33.6	32.2	31.5	32.0
	F	1.64	1.66	1.58	1.64	1.68	1.66
Cleveland	Max Annual Mean	27.3	25.9	28.1	27.3	24.5	23.1
	F	1.94	2.04	1.89	1.94	2.16	2.30
Denver	Max Annual Mean	34.8	33.1	33.9	35.3	19.4	14.9
	F	1.52	1.60	1.56	1.50	2.73	3.55
Detroit	Max Annual Mean	21.6	21.5	25.9	22.9	18.0	23.9
	F	2.45	2.47	2.05	2.31	2.94	2.22
Los Angeles	Max Annual Mean	46.2	42.3	43.2	43.4	50.6	43.9
	F	1.15	1.25	1.23	1.22	1.05	1.21
Miami	Max Annual Mean	14.7	16.0	16.6	15.2	16.8	15.7
	F	3.60	3.30	3.19	3.49	3.15	3.37
New York	Max Annual Mean	41.7	42.2	41.1	41.9	41.5	40.6
	F	1.27	1.26	1.29	1.26	1.28	1.31
Philadelphia	Max Annual Mean	31.8	33.9	32.4	34.0	31.7	27.9
	F	1.67	1.56	1.63	1.56	1.67	1.90
Washington DC	Max Annual Mean	26.2	26.9	25.9	27.2	25.4	23.5
	F	2.02	1.97	2.05	1.95	2.09	2.26
Atlanta	Max Annual Mean	18.8	26.6	25.2	24.1	23.8	22.9
	F	2.81	1.99	2.10	2.20	2.22	2.31
Colorado Springs	Max Annual Mean	23.2	23.6	19.8	20.5	19.3	34.8
	F	2.28	2.24	2.68	2.59	2.75	1.52
El Paso	Max Annual Mean	23.3	35.1	33.6	30.7	27.7	24.3
	F	2.27	1.51	1.58	1.72	1.91	2.18
Jacksonville	Max Annual Mean	15.8	14.9	14.4	15.0	15.9	15.4
	F	3.36	3.55	3.69	3.52	3.34	3.45
Las Vegas	Max Annual Mean	27.1	26.7		25.3	26.6	25.1
	F	1.96	1.99		2.09	1.99	2.12
Phoenix	Max Annual Mean	32.6	31.6	32.0	35.0	40.5	36.3
	F	1.63	1.68	1.66	1.52	1.31	1.46
Provo	Max Annual Mean	22.6	24.3	23.3	23.9	24.1	23.6
	F	2.35	2.18	2.27	2.22	2.20	2.25
St. Louis	Max Annual Mean	26.2	24.8	24.8	25.8	27.2	26.3
	F	2.02	2.14	2.14	2.05	1.95	2.02
Other CMSA	Max Annual Mean	31.9	30.3	29.4	31.0	29.3	26.5
	F	1.66	1.75	1.80	1.71	1.81	2.00
Not MSA	Max Annual Mean	19.1	14.5	19.7	18.8	19.7	18.7
	F	2.78	3.66	2.69	2.82	2.69	2.83

Table A-106. Maximum annual average NO_2 concentrations and air quality adjustment factors (*F*) to just meet the current standard, recent monitoring data.

Location	Metric	2001	2002	2003	2004	2005	2006
Boston	Max Annual Mean	29.7	25.3	22.5	25.0	23.4	22.5
	F	1.79	2.10	2.36	2.12	2.26	2.35
Chicago	Max Annual Mean	31.9	32.4	30.9	29.3	29.6	30.6
	F	1.66	1.63	1.72	1.81	1.79	1.73
Cleveland	Max Annual Mean	23.6	22.3	21.7	22.2	21.5	18.2
	F	2.25	2.38	2.45	2.38	2.46	2.91
Denver	Max Annual Mean	36.8	35.4	21.4	27.2	27.6	29.1
	F	1.44	1.50	2.47	1.95	1.92	1.82
Detroit	Max Annual Mean	23.2	21.4	22.0	18.9	19.6	15.9
	F	2.29	2.47	2.41	2.80	2.71	3.34
Los Angeles	Max Annual Mean	41.2	40.2	35.3	33.7	30.9	29.7
	F	1.29	1.32	1.50	1.57	1.72	1.78
Miami	Max Annual Mean	15.8	14.3	12.9	13.0	13.5	
	F	3.35	3.71	4.12	4.08	3.92	
New York	Max Annual Mean	40.3	39.7	32.0	30.5	36.5	34.2
	F	1.32	1.33	1.65	1.74	1.45	1.55
Philadelphia	Max Annual Mean	29.9	29.5	24.7	25.6	26.3	17.8
	F	1.77	1.80	2.15	2.07	2.02	2.98
Washington DC	Max Annual Mean	24.3	24.8	26.0	24.0	24.1	19.6
	F	2.18	2.14	2.04	2.20	2.20	2.70
Atlanta	Max Annual Mean	23.3	19.4	16.4	17.0	17.4	17.9
	F	2.27	2.73	3.23	3.12	3.05	2.96
Colorado Springs	Max Annual Mean						
	F						
El Paso	Max Annual Mean	21.7	21.4	19.9	18.0	17.3	18.0
	F	2.45	2.48	2.66	2.94	3.06	2.94
Jacksonville	Max Annual Mean		14.6	14.3	13.7	13.3	
	F		3.62	3.70	3.88	3.97	
Las Vegas	Max Annual Mean	22.5	22.3	21.4	19.7	19.9	
	F	2.35	2.38	2.48	2.69	2.67	
Phoenix	Max Annual Mean	37.1	34.7	34.3	31.4	31.5	30.6
	F	1.43	1.53	1.54	1.69	1.68	1.73
Provo	Max Annual Mean	24.1	24.8	21.8	22.3	20.5	28.9
	F	2.20	2.14	2.43	2.37	2.58	1.83
St. Louis	Max Annual Mean	24.7	22.9	20.3	22.3	16.8	15.0
	F	2.15	2.32	2.60	2.37	3.15	3.52
Other CMSA	Max Annual Mean	26.5	27.4	26.4	25.3	24.0	18.5
	F	2.00	1.93	2.01	2.09	2.21	2.87
Not MSA	Max Annual Mean	16.5	16.4	15.5	15.8	17.1	15.6
	F	3.21	3.23	3.42	3.36	3.11	3.39

Table A-107. Air quality adjustment factors (*F*) to just meet the alternative 1-hour standards, using recent monitoring data.

Year Group	Location	1-hour Standard	98th Percentile Maximum Monitor	98th Percentile Adjustment Factor[1]	99th Percentile Maximum Monitor	99th Percentile Adjustment Factor[1]
2001-2003	Boston	50	2502500401	0.955	2502500401	0.867
2001-2003	Boston	100	2502500401	1.911	2502500401	1.734
2001-2003	Boston	150	2502500401	2.866	2502500401	2.601
2001-2003	Boston	200	2502500401	3.822	2502500401	3.468
2001-2003	Chicago	50	1703100631	0.769	1703100631	0.708
2001-2003	Chicago	100	1703100631	1.538	1703100631	1.415
2001-2003	Chicago	150	1703100631	2.308	1703100631	2.123
2001-2003	Chicago	200	1703100631	3.077	1703100631	2.830
2001-2003	Cleveland	50	3903500601	0.974	3903500601	0.877
2001-2003	Cleveland	100	3903500601	1.948	3903500601	1.754
2001-2003	Cleveland	150	3903500601	2.922	3903500601	2.632
2001-2003	Cleveland	200	3903500601	3.896	3903500601	3.509
2001-2003	Denver	50	0803100021	0.741	0803100021	0.662
2001-2003	Denver	100	0803100021	1.481	0803100021	1.325
2001-2003	Denver	150	0803100021	2.222	0803100021	1.987
2001-2003	Denver	200	0803100021	2.963	0803100021	2.649
2001-2003	Detroit	50	2616300161	0.962	2616300161	0.838
2001-2003	Detroit	100	2616300161	1.923	2616300161	1.676
2001-2003	Detroit	150	2616300161	2.885	2616300161	2.514
2001-2003	Detroit	200	2616300161	3.846	2616300161	3.352
2001-2003	Los Angeles	50	0603700301	0.581	0603700301	0.505
2001-2003	Los Angeles	100	0603700301	1.163	0603700301	1.010
2001-2003	Los Angeles	150	0603700301	1.744	0603700301	1.515
2001-2003	Los Angeles	200	0603700301	2.326	0603700301	2.020
2001-2003	Miami	50	1208640022	1.271	1208640022	1.154
2001-2003	Miami	100	1208640022	2.542	1208640022	2.308
2001-2003	Miami	150	1208640022	3.814	1208640022	3.462
2001-2003	Miami	200	1208640022	5.085	1208640022	4.615
2001-2003	New York	50	3403900042	0.721	3403900042	0.661
2001-2003	New York	100	3403900042	1.442	3403900042	1.322
2001-2003	New York	150	3403900042	2.163	3403900042	1.982
2001-2003	New York	200	3403900042	2.885	3403900042	2.643
2001-2003	Philadelphia	50	4210100471	0.877	4210100471	0.820
2001-2003	Philadelphia	100	4210100471	1.754	4210100471	1.639
2001-2003	Philadelphia	150	4210100471	2.632	4210100471	2.459
2001-2003	Philadelphia	200	4210100471	3.509	4210100471	3.279
2001-2003	Washington DC	50	1100100251	0.926	1100100431	0.847
2001-2003	Washington DC	100	1100100251	1.852	1100100431	1.695
2001-2003	Washington DC	150	1100100251	2.778	1100100431	2.542
2001-2003	Washington DC	200	1100100251	3.704	1100100431	3.390
2001-2003	Atlanta	50	1312100481	0.877	1312100481	0.785
2001-2003	Atlanta	100	1312100481	1.754	1312100481	1.571
2001-2003	Atlanta	150	1312100481	2.632	1312100481	2.356

Year Group	Location	1-hour Standard	98th Percentile		99th Percentile	
			Maximum Monitor	Adjustment Factor[1]	Maximum Monitor	Adjustment Factor[1]
2001-2003	Atlanta	200	1312100481	3.509	1312100481	3.141
2001-2003	El Paso	50	4814100441	0.932	4814100441	0.843
2001-2003	El Paso	100	4814100441	1.863	4814100441	1.685
2001-2003	El Paso	150	4814100441	2.795	4814100441	2.528
2001-2003	El Paso	200	4814100441	3.727	4814100441	3.371
2001-2003	Jacksonville	50	1203100322	1.250	1203100322	1.124
2001-2003	Jacksonville	100	1203100322	2.500	1203100322	2.247
2001-2003	Jacksonville	150	1203100322	3.750	1203100322	3.371
2001-2003	Jacksonville	200	1203100322	5.000	1203100322	4.494
2001-2003	Las Vegas	50	3200305391	0.926	3200305391	0.852
2001-2003	Las Vegas	100	3200305391	1.852	3200305391	1.705
2001-2003	Las Vegas	150	3200305391	2.778	3200305391	2.557
2001-2003	Las Vegas	200	3200305391	3.704	3200305391	3.409
2001-2003	Phoenix	50	0401330101	0.728	0401330101	0.682
2001-2003	Phoenix	100	0401330101	1.456	0401330101	1.364
2001-2003	Phoenix	150	0401330101	2.184	0401330101	2.045
2001-2003	Phoenix	200	0401330101	2.913	0401330101	2.727
2001-2003	Provo	50	4904900021	0.993	4904900021	0.920
2001-2003	Provo	100	4904900021	1.987	4904900021	1.840
2001-2003	Provo	150	4904900021	2.980	4904900021	2.761
2001-2003	Provo	200	4904900021	3.974	4904900021	3.681
2001-2003	St. Louis	50	2951000861	1.000	2951000861	0.898
2001-2003	St. Louis	100	2951000861	2.000	2951000861	1.796
2001-2003	St. Louis	150	2951000861	3.000	2951000861	2.695
2001-2003	St. Louis	200	2951000861	4.000	2951000861	3.593
2001-2003	Other MSA/CMSA	50	4905700021	0.649	4905700021	0.552
2001-2003	Other MSA/CMSA	100	4905700021	1.299	4905700021	1.105
2001-2003	Other MSA/CMSA	150	4905700021	1.948	4905700021	1.657
2001-2003	Other MSA/CMSA	200	4905700021	2.597	4905700021	2.210
2001-2003	Other Not MSA	50	0602500061	1.000	0602500061	0.852
2001-2003	Other Not MSA	100	0602500061	2.000	0602500061	1.705
2001-2003	Other Not MSA	150	0602500061	3.000	0602500061	2.557
2001-2003	Other Not MSA	200	0602500061	4.000	0602500061	3.409
2004-2006	Boston	50	2502500021	1.064	2502500401	0.971
2004-2006	Boston	100	2502500021	2.128	2502500401	1.942
2004-2006	Boston	150	2502500021	3.191	2502500401	2.913
2004-2006	Boston	200	2502500021	4.255	2502500401	3.883
2004-2006	Chicago	50	1703100631	0.785	1703100631	0.714
2004-2006	Chicago	100	1703100631	1.571	1703100631	1.429
2004-2006	Chicago	150	1703100631	2.356	1703100631	2.143
2004-2006	Chicago	200	1703100631	3.141	1703100631	2.857
2004-2006	Cleveland	50	3903500601	1.034	3903500601	0.949

Year Group	Location	1-hour Standard	98th Percentile		99th Percentile	
			Maximum Monitor	Adjustment Factor[1]	Maximum Monitor	Adjustment Factor[1]
2004-2006	Cleveland	100	3903500601	2.069	3903500601	1.899
2004-2006	Cleveland	150	3903500601	3.103	3903500601	2.848
2004-2006	Cleveland	200	3903500601	4.138	3903500601	3.797
2004-2006	Denver	50	0803100021	0.904	0800130011	0.829
2004-2006	Denver	100	0803100021	1.807	0800130011	1.657
2004-2006	Denver	150	0803100021	2.711	0800130011	2.486
2004-2006	Denver	200	0803100021	3.614	0800130011	3.315
2004-2006	Detroit	50	2616300161	1.145	2616300161	1.042
2004-2006	Detroit	100	2616300161	2.290	2616300161	2.083
2004-2006	Detroit	150	2616300161	3.435	2616300161	3.125
2004-2006	Detroit	200	2616300161	4.580	2616300161	4.167
2004-2006	Los Angeles	50	0603711031	0.785	0603711031	0.711
2004-2006	Los Angeles	100	0603711031	1.571	0603711031	1.422
2004-2006	Los Angeles	150	0603711031	2.356	0603711031	2.133
2004-2006	Los Angeles	200	0603711031	3.141	0603711031	2.844
2004-2006	Miami	50	1208640022	1.205	1208640022	1.053
2004-2006	Miami	100	1208640022	2.410	1208640022	2.105
2004-2006	Miami	150	1208640022	3.614	1208640022	3.158
2004-2006	Miami	200	1208640022	4.819	1208640022	4.211
2004-2006	New York	50	3403900042	0.800	3403900042	0.730
2004-2006	New York	100	3403900042	1.600	3403900042	1.460
2004-2006	New York	150	3403900042	2.400	3403900042	2.190
2004-2006	New York	200	3403900042	3.200	3403900042	2.920
2004-2006	Philadelphia	50	4210100471	0.971	4210100043	0.901
2004-2006	Philadelphia	100	4210100471	1.942	4210100043	1.802
2004-2006	Philadelphia	150	4210100471	2.913	4210100043	2.703
2004-2006	Philadelphia	200	4210100471	3.883	4210100043	3.604
2004-2006	Washington DC	50	1100100431	0.993	1100100431	0.920
2004-2006	Washington DC	100	1100100431	1.987	1100100431	1.840
2004-2006	Washington DC	150	1100100431	2.980	1100100431	2.761
2004-2006	Washington DC	200	1100100431	3.974	1100100431	3.681
2004-2006	Atlanta	50	1312100481	0.943	1312100481	0.847
2004-2006	Atlanta	100	1312100481	1.887	1312100481	1.695
2004-2006	Atlanta	150	1312100481	2.830	1312100481	2.542
2004-2006	Atlanta	200	1312100481	3.774	1312100481	3.390
2004-2006	El Paso	50	4814100551	1.027	4814100551	0.943
2004-2006	El Paso	100	4814100551	2.055	4814100551	1.887
2004-2006	El Paso	150	4814100551	3.082	4814100551	2.830
2004-2006	El Paso	200	4814100551	4.110	4814100551	3.774
2004-2006	Jacksonville	50	1203100322	1.282	1203100322	1.099
2004-2006	Jacksonville	100	1203100322	2.564	1203100322	2.198
2004-2006	Jacksonville	150	1203100322	3.846	1203100322	3.297
2004-2006	Jacksonville	200	1203100322	5.128	1203100322	4.396
2004-2006	Las Vegas	50	3200305391	1.020	3200305391	0.962
2004-2006	Las Vegas	100	3200305391	2.041	3200305391	1.923

Year Group	Location	1-hour Standard	98th Percentile		99th Percentile	
			Maximum Monitor	Adjustment Factor[1]	Maximum Monitor	Adjustment Factor[1]
2004-2006	Las Vegas	150	3200305391	3.061	3200305391	2.885
2004-2006	Las Vegas	200	3200305391	4.082	3200305391	3.846
2004-2006	Phoenix	50	0401330101	0.781	0401330101	0.725
2004-2006	Phoenix	100	0401330101	1.563	0401330101	1.449
2004-2006	Phoenix	150	0401330101	2.344	0401330101	2.174
2004-2006	Phoenix	200	0401330101	3.125	0401330101	2.899
2004-2006	Provo	50	4904900021	0.610	4904900021	0.573
2004-2006	Provo	100	4904900021	1.220	4904900021	1.145
2004-2006	Provo	150	4904900021	1.829	4904900021	1.718
2004-2006	Provo	200	4904900021	2.439	4904900021	2.290
2004-2006	St. Louis	50	2951000722	1.020	2951000722	0.962
2004-2006	St. Louis	100	2951000722	2.041	2951000722	1.923
2004-2006	St. Louis	150	2951000722	3.061	2951000722	2.885
2004-2006	St. Louis	200	2951000722	4.082	2951000722	3.846
2004-2006	Other MSA/CMSA	50	4903530061	0.847	0607320071	0.758
2004-2006	Other MSA/CMSA	100	4903530061	1.695	0607320071	1.515
2004-2006	Other MSA/CMSA	150	4903530061	2.542	0607320071	2.273
2004-2006	Other MSA/CMSA	200	4903530061	3.390	0607320071	3.030
2004-2006	Other Not MSA	50	4900500041	0.980	0602500051	0.909
2004-2006	Other Not MSA	100	4900500041	1.961	0602500051	1.818
2004-2006	Other Not MSA	150	4900500041	2.941	0602500051	2.727
2004-2006	Other Not MSA	200	4900500041	3.922	0602500051	3.636

Notes:
1 The selected percentile (98^{th} or 99^{th}) in 1-hour concentration at each monitor was averaged across the 3-years of data (either 2001-2003 or 2004-2006), with the highest concentration monitor retained for use in calculating the adjustment to just meet the alternative standard.

A-8 Method for Estimating On-Road Concentrations

A-8.1 Introduction

As an additional step in the air quality characterization, the potential impact of motor vehicles on the surrogate exposure metrics was evaluated. Several studies have shown that concentrations of NO_2 are at elevated levels when compared to ambient concentrations measured at a distance from the roadway (e.g., Rodes and Holland, 1981; Gilbert et al., 2003; Cape et al., 2004; Pleijel et al., 2004; Singer et al., 2004). On average, concentrations on or near a roadway are from 1.5 to 2 times greater than ambient concentrations (US EPA, 2007f), but on occasion, as high as 7 times greater (Bell and Ashenden, 1997; Bignal et al., 2007). A strong relationship between measured on-road NO_2 concentrations and those with increasing distance from the road has been reported under a variety of conditions (e.g., variable traffic counts, different seasons, wind direction) and can be described (e.g., Cape et al., 2004) with an exponential decay equation of the form

$$C_x = C_b + C_v e^{-kx} \qquad \text{equation (3)}$$

where,

- C_x = NO_2 concentration at a given distance (x) from a roadway (ppb)
- C_b = NO_2 concentration (ppb) at a distance from a roadway, not directly influenced by road or non-road source emissions
- C_v = NO_2 concentration contribution from vehicles on a roadway (ppb)
- k = Rate constant describing NO_2 combined formation/decay with perpendicular distance from roadway (meters^{-1})
- x = Distance from roadway (meters)

As a function of reported concentration measures and the derived relationship, much of the decline in NO_2 concentrations with distance from the road has been shown to occur within the first few meters (approximately 90% within 10 meter distance), returning to near ambient levels between 200 to 500 meters (Rodes and Holland, 1981; Bell and Ashenden, 1997; Gilbert et al., 2003; Pleijel et al., 2004). At a distance of 0 meters, referred to here as *on-road*, the equation reduces to the sum of the non-source influenced NO_2 concentration and the concentration contribution expected from vehicle emissions on the roadway using

$$C_r = C_a (1 + m) \qquad \text{equation (4)}$$

where,

- C_r = 1-hour on-road NO_2 concentration (ppb)
- C_a = 1-hour ambient monitoring NO_2 concentration (ppb) either *as is* or modified to just meet the current standard
- m = Modification factor derived from estimates of C_v/C_b (from eq (1))

and assuming that $C_a = C_b$.[6]

A-8.2 Derivation of On-Road Factors

A literature review was conducted to identify published studies containing NO_2 concentrations both on-roads and with various distances from roadways. Principal criteria for inclusion in this analysis were that either tabular, graphical, or equations were provided in the paper that related distances from roadways and associated NO_2 concentrations. Eleven papers were identified using these criteria, spanning several countries, various time periods, roadway locations, seasons, and wind direction (Table A-108). The final data set contained 501 data points, encompassing multiple NO_2 measurements from a total of 56 individual roads.

Table A-108. Reviewed studies containing NO_2 concentrations at a distance from roadways.

First Author	Year	Country/State	Season	Type	Wind Direction
Bell	1987	Wales	Summer, winter	Rural	Up, down
Bignal	2004	England	Summer, fall	Urban	Combined
Cape	2002	Scotland	Annual	Urban	Combined
Gilbert	2001	Quebec	Summer	Urban	Down, up, combined
Maruo	2001	Japan	Summer	Urban	Combined
Monn	1995	Switzerland	Summer, Winter	Urban	Combined
Nitta	1982	Japan	Not reported	Urban	Combined
Pleijel	1994	Sweden	Summer	Rural	Combined
Rodes	1978	California	Summer	Urban	Down
Roorda-Knape	1995	Holland	Summer	Urban	Combined
Singer	2001	California	Spring through fall	Urban	Up, Down

Although there were, on occasion, several roads within a particular study, data for factors thought to influence on-road concentrations were very limited or were not distinct for all studies. The relationship noted in eq (1) was solved using the data collected from the above reviewed literature and employing the SAS procedure ***proc nlin***, generally as follows,

```
proc nlin data=no2 maxiter=1000 noprint NOITPRINT;
   parms    Cb=0 to 80 by 1
            Cv= 0 to 80 by 1
            k= 0 to 1 by .025;
   model Cr=Cb + Cv*exp(-k*x);
   by author road season wind;
   output out=outdata parms=Cb Cv k;
run;
```

The procedure was run for all individual roads identified within each study location. Results of this analysis were screened for data that yielded no unique solutions (lack of model convergence) or irrational parameters. Criteria for censoring data included the following, as well as the number of individual roads censored:

- Model did not converge (n=5)

[6] Note that C_a differs from C_b since C_a may include the influence of on-road as well as non-road sources. However, it is expected that for most monitors the influence of on-road emissions is minimal so that $C_a \cong C_b$.

- k<0 (n=1)
- k>1 (n=2)
- Both k=0 and C_v =0 (n=1)
- Extremely large C_v (>8,000 ppb; n=2)
- C_b<0 (n=1)

Data were evaluated for trends using available influential factors and considering the number of samples available for potential groupings. In general, the measurements reported in the summer and resultant parameter estimates were observed as distinct from the measures and parameter estimates from other seasons. The data were then grouped accordingly into two seasonal groups, *summer* and *not summer*, containing 23 and 21 samples, respectively. These two groups were also censored for any unusual parameter estimates. Resulting criteria for censoring the grouped data included the following:

- Extreme value of k compared with others in group (n=1)
- Extreme values of estimated m due to combined low estimated C_b relative to high estimated C_v (n=2)

Two approaches were considered for estimating m from the C_v and C_b pairs in each season. The first approach was to regress C_b on C_v (either with or without an intercept) and use the fitted slope to estimate m. Ignoring meteorological effects, Equation 1 implies that C_v results solely from on-road emission sources and that C_b results solely from non-road emission sources. Since these two source types are likely to have quite different diurnal profiles, we expect the hourly C_v and C_b values to be approximately independent.[7] Regressing C_b against C_v would imply that there is some correlation between the values, which would be inconsistent with the conceptual model underlying Equation 1. Further, if C_b were regressed against C_v using an intercept, the physical meaning of the intercept would be unclear.

An empirical method was selected for the approach to estimate m based on the two seasonal sets of ratios of C_v/C_b. The resulting distribution for each group is presented in Figure A-101. Neither group could be assigned to a particular distribution (e.g., normal, lognormal, exponential, gamma). Means from the two seasons were tested for significant difference using a Student's t (p=0.026), while the season distributions were compared using a Kolmogorov-Smirnov test (p= 0.196). It was decided to retain the groups as separate to allow for some apportioning of variability resulting from an apparent seasonal influence, even though the statistical test results were mixed.

[7] Although the fact that C_v and C_b are subject to the same meteorology introduces some correlation, because meteorology tends to vary on a longer time scale than hourly, it is likely to have less influence than the emissions on the correlation between hourly concentrations.

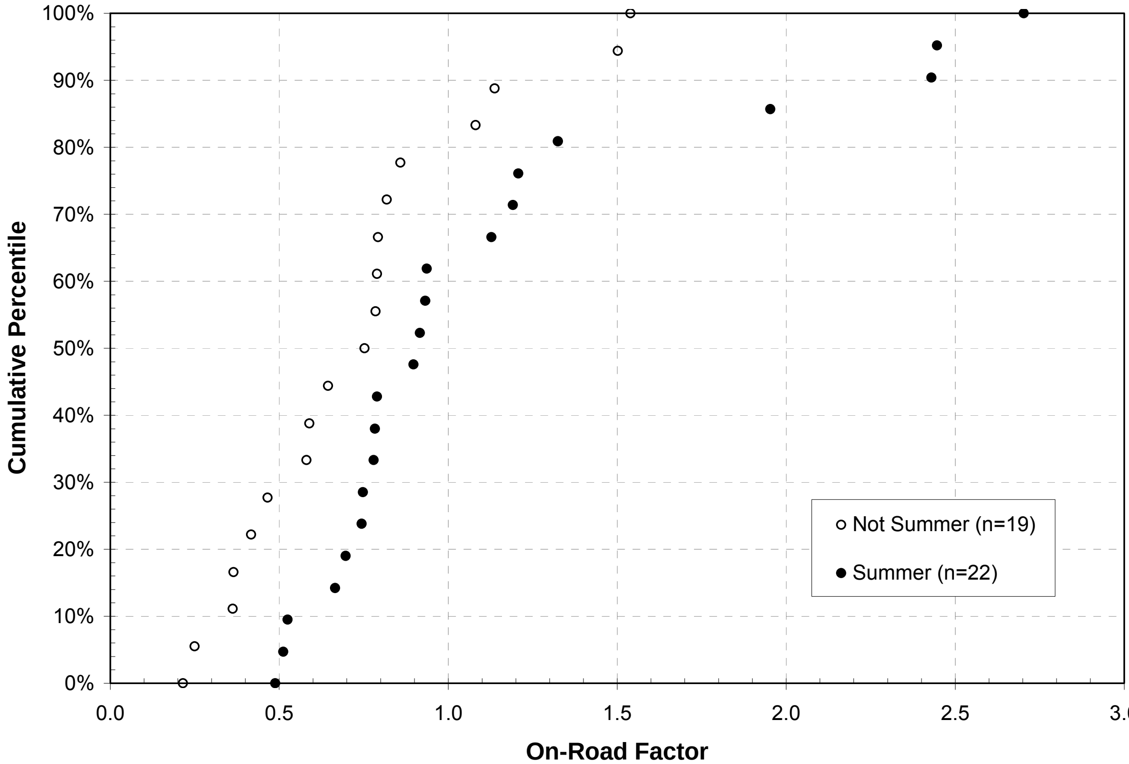

Figure A-101. Distribution of on-road factors (C_v/C_b or *m*) for two season groups.

A-8.3 Application of On-Road Factors

The purpose of this particular analysis was to estimate on-road concentrations using equation (4) above along with the required inputs, namely, the hourly ambient monitoring concentrations and derived on-road factors. The derived on-road factors for the two season groups could not be assigned a particular statistical distribution (e.g., normal, lognormal, gamma) with confidence. Therefore, an empirical approach was selected to still allow for some seasonal variability in the on-road concentration estimates. Summer months were first defined as *June*, *July*, *August*, while the remaining months were not summer. Although there may be distinctions among what may be designated as a summer month across the U.S., the reviewed data are not robust to allow for such an application.

Each monitor site was then randomly assigned two on-road factors selected from the derived empirical distribution for a given year, one for summer months and one for the other months, using the appropriate distribution. Because the influence of on-road and non-road sources is likely different in each location and at each monitor, it would be expected that the empirical relationship between the two values C_v and C_b to vary from place to place. If source category emissions data for each study location were available to derive an equation (3) regression, that could have been used to match each of the study locations here, or, perhaps, each of the monitoring sites, to a similar equation (3) study area for assigning an appropriate ratio. However, since this information was not available, an empirical approach was used to randomly match the literature-derived ratios to the NO_2 site-seasons.

A particular *summer* on-road factor has a 1/22 chance of selection, while a specific *not summer* value has a 1/19 probability of selection, based on respective sample sizes. This random assignment was repeated for all site-years of data. Hourly NO_2 concentrations were estimated for each site-year of data in a location using equation (4) and the randomly assigned on-road factors. Finally, the process was simulated 100 times for each site-year of hourly data. For example, the Boston CMSA location had 210 random selections from the on-road distributions applied independently to the total site-years of data (105). Following 100 simulations, a total of 10,500 site-years of data were generated using this procedure (along with 21,000 randomly assigned on-road values selected from the appropriate empirical distribution).

Simulated on-road NO_2 concentrations were used to generate concentration distributions for the annual average concentrations and distributions for the number of exceedances of short-term potential health effect benchmark levels. Means and median values are reported to represent the central tendency of each parameter estimate. Since there were multiple simulations performed at each location using all available site-years of data, results for the upper percentiles were expanded to the 95^{th}, 98^{th} and 99^{th} percentiles of the distribution, rather than estimate a 95% interval as was done above for the non-road scenarios. It is more appropriate to apply the parameter estimates outside the central tendencies to particular sites, areas within locations, or for certain conditions. Minimum values for the annual mean and annual number of exceedances were also estimated. One approach would have been to use the minimum values across the 100 simulations. However, that approach may not give the lowest possible value, because it is unlikely that in 100 simulations for a site-year there is a simulation where both seasonal adjustment factors are chosen to be the lowest values of $1 + m$. To obtain the lowest value, two simulations were conducted for each site-year. The Summer seasonal adjustment factor was set to the lowest possible value (1.49) and the Not-Summer seasonal adjustment factor was the lowest possible value (1.22). The annual means and exceedances for those two separate simulations were used to compute the minimum values for each distribution.

As part of the air quality characterization, these data were used to estimate the number of short-term concentrations above selected levels that might occur on roadways using the estimated hourly C_r values, associated with air quality as is. For evaluating just meeting the current annual and alternative standards, the approach described in Section A-7 to adjust the ambient concentrations was applied before estimating on-road NO_2 concentrations.

A-8.4 Interpretation of Estimated On-Road Concentrations

The simulated on-road concentrations are estimates of what might occur on or near roadways. The algorithm is not designed to estimate concentrations on a particular roadway, all roads, or to estimate on-road exposures in a location. The algorithm assumes that the monitor is measuring the concentrations that would be observed at a distance of a particular road; monitor data within close proximity of a major road (>100m) have been screened out, likely controlling any potential influence from major roads. It then follows that the monitors within a location are linked proportionally to the distribution of roads (and types) in a location. This is likely not the case, particularly in locations with few monitoring sites, therefore available monitors will likely be either over- or under-representative of some roadway types.

The simulation is designed to estimate the potential concentrations associated with potential on-road exposures, developing central tendencies and bounds to be interpreted qualitatively with the expected emissions that would occur on-roads within a location. That is, the higher-traveled roadways would be better represented by on-road concentration estimates at the upper tails of the distribution, while other roads with less traffic density would be better represented at the lower tails of the distribution. Additional consideration should be given to where few monitor sites were available in a location, or even where monitor sites are more densely distributed within a particular area of a location, before interpreting estimated concentrations.

A-9 Supplemental Results Tables

A-9.1 Results Tables of Historic NO_2 Ambient Monitoring Data (1995-2000) Adjusted to Just Meeting the Current Standard

Table 109. Number of exceedances of short-term (1-hour) potential health effect benchmark levels in a year, 1995-2000 historic NO_2 air quality adjusted to just meeting the current annual average standard (0.053 ppm) using monitors sited ≥100 m of a major road.

	Exceedances of 150 ppb [1]						Exceedances of 200 ppb [1]						Exceedances of 250 ppb [1]						Exceedances of 300 ppb [1]					
Location	mean	min	med	p95	P98	p99	mean	min	med	p95	p98	p99	mean	min	med	p95	p98	p99	mean	min	med	p95	p98	p99
Boston	1	0	0	7	7	7	0	0	0	1	1	1	0	0	0	1	1	1	0	0	0	0	0	0
Chicago	1	0	1	5	7	7	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Cleveland	2	0	1	7	7	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Denver	141	1	12	648	648	648	24	0	2	141	141	141	5	0	1	28	28	28	2	0	0	9	9	9
Detroit	75	2	65	162	162	162	13	0	13	25	25	25	4	0	2	15	15	15	2	0	1	10	10	10
Los Angeles	9	0	2	56	83	96	1	0	0	4	6	8	0	0	0	1	2	2	0	0	0	0	1	2
Miami	72	4	91	133	133	133	10	0	10	27	27	27	1	0	0	6	6	6	0	0	0	2	2	2
New York	1	0	0	4	7	7	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0
Philadelphia	2	0	0	10	18	18	0	0	0	0	12	12	0	0	0	0	9	9	0	0	0	0	5	5
Washington	9	0	3	34	38	38	1	0	0	3	4	4	0	0	0	2	3	3	0	0	0	1	2	2
Atlanta	42	0	2	197	233	233	4	0	0	19	21	21	0	0	0	2	3	3	0	0	0	1	1	1
Colorado Springs	50	0	3	283	318	318	32	0	0	180	241	241	16	0	0	123	135	135	8	0	0	72	83	83
El Paso	16	1	9	69	69	69	2	0	1	14	14	14	0	0	0	2	2	2	0	0	0	0	0	0
Jacksonville	122	82	137	147	147	147	12	2	15	20	20	20	2	0	1	7	7	7	0	0	0	1	1	1
Las Vegas	3	0	1	11	11	11	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Phoenix	8	0	5	26	26	26	0	0	0	4	4	4	0	0	0	0	0	0	0	0	0	0	0	0
Provo	16	2	4	71	71	71	1	0	0	5	5	5	0	0	0	0	0	0	0	0	0	0	0	0
St, Louis	4	0	1	16	16	16	1	0	0	15	15	15	1	0	0	14	14	14	1	0	0	13	13	13
Other MSA/CMSA	2	0	0	13	28	40	0	0	0	1	3	6	0	0	0	0	1	1	0	0	0	0	0	1
Other Not MSA	20	0	0	116	241	336	4	0	0	18	53	87	1	0	0	4	15	42	1	0	0	1	8	21

Notes:
[1] The mean number of exceedances represents the number of exceedances occurring at all monitors in a particular location divided by the number of site-years across the monitoring period. The min, med, p95, p98, and p99 represent the minimum, median, 95th, 98th, and 99th percentiles of the distribution for the number of exceedances in any one year within the monitoring period.

Table 110. Number of exceedances of short-term (1-hour) potential health effect benchmark levels in a year, 1995-2000 historic NO_2 air quality adjusted to just meeting the current annual average standard (0.053 ppm) using monitors sited <100 m of a major road.

	Exceedances of 150 ppb [1]						Exceedances of 200 ppb [1]						Exceedances of 250 ppb [1]						Exceedances of 300 ppb [1]					
Location	**mean**	**min**	**med**	**p95**	**P98**	**p99**	**mean**	**min**	**med**	**p95**	**p98**	**p99**	**mean**	**min**	**med**	**p95**	**p98**	**p99**	**mean**	**min**	**med**	**p95**	**p98**	**p99**
Boston	2	0	0	11	22	22	0	0	0	1	2	2	0	0	0	0	1	1	0	0	0	0	1	1
Chicago	4	0	2	16	16	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cleveland	35	9	16	110	110	110	5	0	1	24	24	24	2	0	0	10	10	10	1	0	0	3	3	3
Denver	12	0	0	77	77	77	1	0	0	10	10	10	0	0	0	5	5	5	0	0	0	2	2	2
Los Angeles	8	0	0	42	56	79	1	0	0	6	8	9	0	0	0	0	1	2	0	0	0	0	0	0
Miami	70	2	56	161	161	161	9	0	7	34	34	34	2	0	0	15	15	15	1	0	0	8	8	8
New York	1	0	0	6	10	10	0	0	0	1	3	3	0	0	0	0	3	3	0	0	0	0	1	1
Philadelphia	5	0	3	26	26	26	0	0	0	3	3	3	0	0	0	1	1	1	0	0	0	1	1	1
Washington DC	12	0	9	47	61	61	1	0	0	9	17	17	0	0	0	0	3	3	0	0	0	0	2	2
Colorado Springs	7	7	7	7	7	7	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1
El Paso	23	5	24	36	36	36	6	0	7	13	13	13	2	0	1	6	6	6	0	0	0	2	2	2
Las Vegas	47	0	25	226	226	226	6	0	1	28	28	28	3	0	0	13	13	13	1	0	0	11	11	11
Phoenix	77	0	9	339	339	339	32	0	1	198	198	198	12	0	0	92	92	92	4	0	0	31	31	31
St, Louis	2	0	1	11	13	13	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0

Notes:
[1] The mean number of exceedances represents the number of exceedances occurring at all monitors in a particular location divided by the number of site-years across the monitoring period. The min, med, p95, p98, and p99 represent the minimum, median, 95th, 98th, and 99th percentiles of the distribution for the number of exceedances in any one year within the monitoring period.

Table A-111. Number of exceedances of short-term (1-hour) potential health effect benchmark levels in a year on-roads, 1995-2000 historic NO_2 air quality adjusted to just meeting the current annual average standard (0.053 ppm).

	Exceedances of 150 ppb [1]						Exceedances of 200 ppb [1]						Exceedances of 250 ppb [1]						Exceedances of 300 ppb [1]					
Location	**mean**	**min**	**med**	**p95**	**P98**	**p99**	**mean**	**min**	**med**	**p95**	**p98**	**p99**	**mean**	**min**	**med**	**p95**	**p98**	**p99**	**mean**	**min**	**med**	**p95**	**p98**	**p99**
Boston	231	0	108	930	1282	1394	53	0	11	299	369	390	14	0	1	95	132	161	4	0	0	28	52	65
Chicago	386	0	242	1288	1609	1802	111	0	32	498	615	707	36	0	2	195	289	364	13	0	0	86	153	196
Cleveland	526	42	407	1305	1568	1762	157	1	83	457	586	700	51	0	13	215	269	306	18	0	1	102	131	149
Denver	980	15	585	2765	3021	3149	497	0	111	2097	2304	2451	254	0	26	1467	1695	1930	126	0	12	866	1182	1286
Detroit	982	5	860	2413	2771	2882	405	2	284	1227	1439	1589	175	2	97	576	776	872	80	0	40	317	424	482
Los Angeles	323	0	154	1219	1555	1935	97	0	24	427	671	865	32	0	4	158	264	366	11	0	0	54	105	172
Miami	802	33	788	1637	1885	2043	359	2	289	985	1201	1353	159	0	95	550	683	797	72	0	26	297	364	451
New York	199	0	64	950	1251	1384	50	0	5	313	475	602	14	0	0	103	175	230	4	0	0	35	64	81
Philadelphia	362	0	174	1352	1967	2536	86	0	21	400	689	865	24	0	2	125	245	341	7	0	0	38	76	138
Washington	562	0	358	1843	2409	2563	176	0	64	721	949	1073	60	0	9	316	411	478	23	0	1	133	217	247
Atlanta	597	0	215	2122	2566	2778	251	0	42	1094	1472	1640	106	0	7	535	843	947	45	0	1	277	435	514
Colorado Springs	866	0	565	2666	3106	3332	308	0	80	1348	1792	1902	123	0	11	574	803	934	61	0	1	299	373	421
El Paso	488	19	317	1443	2106	2391	152	0	67	545	997	1126	54	0	16	186	440	485	21	0	6	83	190	251
Jacksonville	1381	365	1328	2485	2677	3110	610	40	549	1426	1515	1801	263	2	195	773	839	1002	114	0	66	407	443	470
Las Vegas	348	0	47	1618	2108	2908	106	0	6	663	894	1248	38	0	1	318	526	596	15	0	0	98	297	355
Phoenix	811	15	605	2493	2818	2922	229	0	88	954	1293	1375	63	0	12	304	436	544	17	0	2	78	132	181
Provo	1434	84	1363	3215	3526	3729	443	1	230	1643	1871	2058	135	0	32	543	697	817	43	0	2	208	303	339
St, Louis	486	0	368	1402	1630	1843	144	0	51	523	693	728	46	0	9	232	289	323	16	0	0	92	133	163
Other MSA/CMSA	199	0	65	858	1262	1572	52	0	6	268	444	592	15	0	0	84	156	231	5	0	0	25	57	90
Other Not MSA	247	0	45	1234	1771	2130	95	0	7	549	928	1203	39	0	1	221	438	635	17	0	0	91	198	318

Notes:
[1] The mean number of exceedances represents the number of exceedances occurring at all monitors in a particular location divided by the number of site-years across the monitoring period. The min, med, p95, p98, and p99 represent the minimum, median, 95th, 98th, and 99th percentiles of the distribution for the number of exceedances in any one year within the monitoring period.

A-9.2 Results Tables of Recent NO_2 Ambient Monitoring Data (2001-2006) As Is and Just Meeting the Current and Alternative Standards

Table A-112. Estimated annual average NO_2 concentrations for monitors ≥100 m from a major road following adjustment to just meeting the current and alternative standards, 2001-2003 air quality.

Location	Scenario	Percentile	Site-Years	Annual Mean (ppb) Mean	Min	Med	p99
Boston	As is		6	10	5	11	12
Boston	Current std		6	19	11	21	26
Boston	50	98	6	9	5	10	11
Boston	50	99	6	8	5	9	10
Boston	100	98	6	18	10	21	22
Boston	100	99	6	16	9	19	20
Boston	150	98	6	27	15	31	33
Boston	150	99	6	25	14	28	30
Boston	200	98	6	36	21	42	45
Boston	200	99	6	33	19	38	40
Chicago	As is		9	22	17	20	28
Chicago	Current std		9	36	27	34	47
Chicago	50	98	9	17	13	15	21
Chicago	50	99	9	15	12	14	20
Chicago	100	98	9	33	26	31	43
Chicago	100	99	9	31	24	28	39
Chicago	150	98	9	50	39	46	64
Chicago	150	99	9	46	36	42	59
Chicago	200	98	9	66	52	62	85
Chicago	200	99	9	61	47	57	79
Cleveland	As is		3	18	17	17	19
Cleveland	Current std		3	42	41	42	43
Cleveland	50	98	3	17	17	17	18
Cleveland	50	99	3	16	15	15	16
Cleveland	100	98	3	35	34	34	36
Cleveland	100	99	3	31	30	31	32
Cleveland	150	98	3	52	51	51	54
Cleveland	150	99	3	47	46	46	49
Cleveland	200	98	3	69	68	68	72
Cleveland	200	99	3	62	61	61	65
Denver	As is		2	24	21	24	26
Denver	Current std		2	45	37	45	53
Denver	50	98	2	17	16	17	19
Denver	50	99	2	16	14	16	17
Denver	100	98	2	35	32	35	38
Denver	100	99	2	31	28	31	34
Denver	150	98	2	52	48	52	57
Denver	150	99	2	47	43	47	51

Location	Scenario	Percentile	Site-Years	Annual Mean (ppb)			
				Mean	Min	Med	p99
Denver	200	98	2	70	64	70	76
Denver	200	99	2	63	57	63	68
Detroit	As is		6	21	19	20	23
Detroit	Current std		6	49	44	50	53
Detroit	50	98	6	20	18	20	22
Detroit	50	99	6	17	16	17	19
Detroit	100	98	6	40	36	39	45
Detroit	100	99	6	35	31	34	39
Detroit	150	98	6	59	54	59	67
Detroit	150	99	6	52	47	51	58
Detroit	200	98	6	79	71	78	89
Detroit	200	99	6	69	62	68	78
Los Angeles	As is		51	22	5	24	37
Los Angeles	Current std		51	31	7	32	52
Los Angeles	50	98	51	13	3	14	22
Los Angeles	50	99	51	11	2	12	19
Los Angeles	100	98	51	26	6	28	43
Los Angeles	100	99	51	23	5	24	38
Los Angeles	150	98	51	39	8	41	65
Los Angeles	150	99	51	34	7	36	57
Los Angeles	200	98	51	52	11	55	87
Los Angeles	200	99	51	45	10	48	75
Miami	As is		6	9	7	9	10
Miami	Current std		6	32	26	34	37
Miami	50	98	6	11	9	11	13
Miami	50	99	6	10	8	10	12
Miami	100	98	6	22	17	23	26
Miami	100	99	6	20	16	20	23
Miami	150	98	6	33	26	34	39
Miami	150	99	6	30	24	31	35
Miami	200	98	6	44	35	45	51
Miami	200	99	6	40	32	41	47
New York	As is		26	20	11	18	31
New York	Current std		26	29	15	27	44
New York	50	98	26	14	8	13	23
New York	50	99	26	13	7	12	21
New York	100	98	26	29	16	27	45
New York	100	99	26	26	15	24	41
New York	150	98	26	43	24	40	68
New York	150	99	26	40	22	37	62
New York	200	98	26	58	32	53	90
New York	200	99	26	53	29	49	82
Philadelphia	As is		14	20	15	18	28
Philadelphia	Current std		14	37	26	35	53
Philadelphia	50	98	14	17	13	16	25

Location	Scenario	Percentile	Site-Years	Annual Mean (ppb)			
				Mean	Min	Med	p99
Philadelphia	50	99	14	16	12	15	23
Philadelphia	100	98	14	34	25	32	50
Philadelphia	100	99	14	32	24	30	46
Philadelphia	150	98	14	52	38	48	75
Philadelphia	150	99	14	48	36	45	70
Philadelphia	200	98	14	69	51	64	99
Philadelphia	200	99	14	64	48	60	93
Washington DC	As is		18	18	9	21	25
Washington DC	Current std		18	39	19	44	53
Washington DC	50	98	18	17	8	19	23
Washington DC	50	99	18	16	7	18	21
Washington DC	100	98	18	34	16	39	46
Washington DC	100	99	18	31	15	35	42
Washington DC	150	98	18	51	24	58	69
Washington DC	150	99	18	47	22	53	63
Washington DC	200	98	18	68	32	77	92
Washington DC	200	99	18	62	30	71	84
Atlanta	As is		14	12	4	15	23
Atlanta	Current std		14	33	9	39	53
Atlanta	50	98	14	11	4	13	20
Atlanta	50	99	14	10	3	12	18
Atlanta	100	98	14	22	7	27	41
Atlanta	100	99	14	20	6	24	37
Atlanta	150	98	14	33	11	40	61
Atlanta	150	99	14	29	10	36	55
Atlanta	200	98	14	44	14	53	82
Atlanta	200	99	14	39	13	48	73
El Paso	As is		12	15	10	16	18
El Paso	Current std		12	38	26	40	48
El Paso	50	98	12	14	10	15	17
El Paso	50	99	12	13	9	14	15
El Paso	100	98	12	28	20	30	34
El Paso	100	99	12	25	18	27	31
El Paso	150	98	12	42	29	45	51
El Paso	150	99	12	38	26	41	46
El Paso	200	98	12	56	39	60	68
El Paso	200	99	12	51	35	54	61
Jacksonville	As is		2	14	14	14	15
Jacksonville	Current std		2	53	53	53	53
Jacksonville	50	98	2	18	18	18	18
Jacksonville	50	99	2	16	16	16	16
Jacksonville	100	98	2	36	36	36	37
Jacksonville	100	99	2	33	32	33	33
Jacksonville	150	98	2	54	54	54	55
Jacksonville	150	99	2	49	48	49	49

Location	Scenario	Percentile	Site-Years	Annual Mean (ppb)			
				Mean	Min	Med	p99
Jacksonville	200	98	2	72	72	72	73
Jacksonville	200	99	2	65	64	65	66
Las Vegas	As is		16	10	2	7	22
Las Vegas	Current std		16	25	5	18	53
Las Vegas	50	98	16	10	2	7	20
Las Vegas	50	99	16	9	2	6	19
Las Vegas	100	98	16	19	4	14	41
Las Vegas	100	99	16	18	4	13	38
Las Vegas	150	98	16	29	6	21	61
Las Vegas	150	99	16	27	6	19	57
Las Vegas	200	98	16	39	8	28	82
Las Vegas	200	99	16	36	7	25	75
Phoenix	As is		5	27	22	29	29
Phoenix	Current std		5	40	32	41	45
Phoenix	50	98	5	20	16	21	21
Phoenix	50	99	5	18	15	20	20
Phoenix	100	98	5	39	32	42	43
Phoenix	100	99	5	37	30	39	40
Phoenix	150	98	5	59	48	63	64
Phoenix	150	99	5	55	45	59	60
Phoenix	200	98	5	79	64	83	86
Phoenix	200	99	5	74	60	78	80
Provo	As is		3	24	22	24	25
Provo	Current std		3	53	53	53	53
Provo	50	98	3	23	22	24	25
Provo	50	99	3	22	20	22	23
Provo	100	98	3	47	43	48	49
Provo	100	99	3	43	40	44	46
Provo	150	98	3	70	65	72	74
Provo	150	99	3	65	60	67	69
Provo	200	98	3	94	87	96	99
Provo	200	99	3	87	80	89	91
St. Louis	As is		9	17	14	17	21
St. Louis	Current std		9	41	36	38	49
St. Louis	50	98	9	17	14	17	21
St. Louis	50	99	9	16	13	15	18
St. Louis	100	98	9	35	29	34	41
St. Louis	100	99	9	31	26	30	37
St. Louis	150	98	9	52	43	51	62
St. Louis	150	99	9	47	38	45	55
St. Louis	200	98	9	69	57	67	82
St. Louis	200	99	9	62	51	61	74
Other MSA/CMSA	As is		612	13	1	13	24
Other MSA/CMSA	Current std		612	25	1	25	48
Other MSA/CMSA	50	98	612	8	0	8	16

Location	Scenario	Percentile	Site-Years	Annual Mean (ppb)			
				Mean	Min	Med	p99
Other MSA/CMSA	50	99	612	7	0	7	13
Other MSA/CMSA	100	98	612	16	1	17	31
Other MSA/CMSA	100	99	612	14	1	14	27
Other MSA/CMSA	150	98	612	24	1	25	47
Other MSA/CMSA	150	99	612	21	1	21	40
Other MSA/CMSA	200	98	612	33	1	33	63
Other MSA/CMSA	200	99	612	28	1	28	53
Other Not MSA	As is		127	7	1	6	16
Other Not MSA	Current std		127	22	3	20	53
Other Not MSA	50	98	127	7	1	6	16
Other Not MSA	50	99	127	6	1	5	14
Other Not MSA	100	98	127	13	2	12	33
Other Not MSA	100	99	127	11	2	10	28
Other Not MSA	150	98	127	20	3	18	49
Other Not MSA	150	99	127	17	3	15	42
Other Not MSA	200	98	127	27	4	24	66
Other Not MSA	200	99	127	23	4	20	56

Table A-113. Estimated annual average NO_2 concentrations for monitors <100 m from a major road following adjustment to just meeting the current and alternative standards, 2001-2003 air quality.

Location	Scenario	Percentile	Site-Years	Annual Mean			
				Mean	Min	Med	p99
Boston	As is		19	18	7	21	30
Boston	Current std		19	37	13	37	53
Boston	50	98	19	17	7	20	28
Boston	50	99	19	16	6	18	26
Boston	100	98	19	34	13	39	57
Boston	100	99	19	31	12	36	51
Boston	150	98	19	52	20	59	85
Boston	150	99	19	47	18	53	77
Boston	200	98	19	69	27	78	113
Boston	200	99	19	63	24	71	103
Chicago	As is		10	27	22	29	32
Chicago	Current std		10	46	36	48	53
Chicago	50	98	10	21	17	23	25
Chicago	50	99	10	19	15	21	23
Chicago	100	98	10	42	34	45	50
Chicago	100	99	10	39	31	41	46
Chicago	150	98	10	63	50	68	75
Chicago	150	99	10	58	46	62	69
Chicago	200	98	10	84	67	90	100
Chicago	200	99	10	77	62	83	92
Cleveland	As is		3	23	22	22	24
Cleveland	Current std		3	53	53	53	53
Cleveland	50	98	3	22	21	22	23
Cleveland	50	99	3	20	19	20	21
Cleveland	100	98	3	44	42	43	46
Cleveland	100	99	3	40	38	39	41
Cleveland	150	98	3	66	63	65	69
Cleveland	150	99	3	59	57	59	62
Cleveland	200	98	3	88	84	87	92
Cleveland	200	99	3	79	76	78	83
Denver	As is		2	36	35	36	37
Denver	Current std		2	53	53	53	53
Denver	50	98	2	27	26	27	27
Denver	50	99	2	24	23	24	24
Denver	100	98	2	53	52	53	55
Denver	100	99	2	48	47	48	49
Denver	150	98	2	80	79	80	82
Denver	150	99	2	72	70	72	73
Denver	200	98	2	107	105	107	109
Denver	200	99	2	96	94	96	97
Los Angeles	As is		44	25	4	27	41
Los Angeles	Current std		44	35	5	37	53
Los Angeles	50	98	44	15	2	16	24
Los Angeles	50	99	44	13	2	14	21

Location	Scenario	Percentile	Site-Years	Annual Mean			
				Mean	Min	Med	p99
Los Angeles	100	98	44	30	5	31	48
Los Angeles	100	99	44	26	4	27	42
Los Angeles	150	98	44	44	7	47	72
Los Angeles	150	99	44	38	6	41	62
Los Angeles	200	98	44	59	10	62	96
Los Angeles	200	99	44	51	8	54	83
Miami	As is		6	10	6	10	16
Miami	Current std		6	38	19	40	53
Miami	50	98	6	13	7	12	20
Miami	50	99	6	12	7	11	18
Miami	100	98	6	26	15	25	40
Miami	100	99	6	24	13	22	37
Miami	150	98	6	39	22	37	60
Miami	150	99	6	36	20	34	55
Miami	200	98	6	52	30	50	80
Miami	200	99	6	47	27	45	73
New York	As is		20	30	21	28	40
New York	Current std		20	42	30	40	53
New York	50	98	20	21	15	20	29
New York	50	99	20	20	14	19	27
New York	100	98	20	43	30	41	58
New York	100	99	20	39	28	37	53
New York	150	98	20	64	45	61	87
New York	150	99	20	59	42	56	80
New York	200	98	20	85	61	81	116
New York	200	99	20	78	55	75	106
Philadelphia	As is		7	24	19	24	30
Philadelphia	Current std		7	46	34	45	53
Philadelphia	50	98	7	21	17	21	26
Philadelphia	50	99	7	20	16	20	25
Philadelphia	100	98	7	43	33	42	53
Philadelphia	100	99	7	40	31	39	49
Philadelphia	150	98	7	64	50	63	79
Philadelphia	150	99	7	60	47	59	74
Philadelphia	200	98	7	86	66	85	105
Philadelphia	200	99	7	80	62	79	98
Washington DC	As is		14	21	14	23	26
Washington DC	Current std		14	45	30	48	53
Washington DC	50	98	14	20	13	21	24
Washington DC	50	99	14	18	12	19	22
Washington DC	100	98	14	39	26	42	48
Washington DC	100	99	14	36	24	39	44
Washington DC	150	98	14	59	39	63	72
Washington DC	150	99	14	54	36	58	66
Washington DC	200	98	14	79	52	84	96
Washington DC	200	99	14	72	48	77	88
El Paso	As is		3	21	20	21	22

Location	Scenario	Percentile	Site-Years	Annual Mean			
				Mean	Min	Med	p99
El Paso	Current std		3	53	53	53	53
El Paso	50	98	3	20	19	20	20
El Paso	50	99	3	18	17	18	18
El Paso	100	98	3	39	37	40	40
El Paso	100	99	3	35	34	36	37
El Paso	150	98	3	59	56	60	61
El Paso	150	99	3	53	50	54	55
El Paso	200	98	3	78	74	80	81
El Paso	200	99	3	71	67	72	73
Las Vegas	As is		6	14	3	15	23
Las Vegas	Current std		6	33	7	37	53
Las Vegas	50	98	6	13	3	14	21
Las Vegas	50	99	6	12	3	13	19
Las Vegas	100	98	6	26	6	28	42
Las Vegas	100	99	6	24	5	26	38
Las Vegas	150	98	6	39	8	42	63
Las Vegas	150	99	6	36	8	38	58
Las Vegas	200	98	6	52	11	56	83
Las Vegas	200	99	6	47	10	51	77
Phoenix	As is		5	30	22	34	37
Phoenix	Current std		5	45	31	53	53
Phoenix	50	98	5	22	16	25	27
Phoenix	50	99	5	21	15	23	25
Phoenix	100	98	5	44	31	50	54
Phoenix	100	99	5	41	29	47	51
Phoenix	150	98	5	66	47	75	81
Phoenix	150	99	5	62	44	70	76
Phoenix	200	98	5	88	63	100	108
Phoenix	200	99	5	82	59	94	101
St. Louis	As is		17	16	9	16	25
St. Louis	Current std		17	37	21	40	53
St. Louis	50	98	17	16	9	16	25
St. Louis	50	99	17	14	8	15	22
St. Louis	100	98	17	31	17	33	49
St. Louis	100	99	17	28	15	29	44
St. Louis	150	98	17	47	26	49	74
St. Louis	150	99	17	42	23	44	67
St. Louis	200	98	17	63	34	65	99
St. Louis	200	99	17	56	31	59	89

Table A-114. Estimated annual average NO_2 concentrations for monitors ≥100 m from a major road following adjustment to just meeting the current and alternative standards, 2004-2006 air quality.

Location	Scenario	Percentile	Site-Years	Annual Mean			
				Mean	Min	Med	p99
Boston	As is		8	9	7	9	10
Boston	Current std		8	20	15	20	23
Boston	50	98	8	9	8	9	11
Boston	50	99	8	8	7	8	10
Boston	100	98	8	18	15	19	21
Boston	100	99	8	17	14	17	19
Boston	150	98	8	28	23	28	32
Boston	150	99	8	25	21	25	29
Boston	200	98	8	37	31	37	42
Boston	200	99	8	34	28	34	39
Chicago	As is		8	19	16	18	24
Chicago	Current std		8	35	28	32	44
Chicago	50	98	8	15	12	14	19
Chicago	50	99	8	14	11	13	17
Chicago	100	98	8	31	25	28	38
Chicago	100	99	8	28	23	26	35
Chicago	150	98	8	46	37	42	57
Chicago	150	99	8	42	34	39	52
Chicago	200	98	8	61	50	57	76
Chicago	200	99	8	56	45	51	69
Denver	As is		3	20	18	20	21
Denver	Current std		3	38	33	39	42
Denver	50	98	3	18	16	18	19
Denver	50	99	3	17	15	17	18
Denver	100	98	3	36	33	37	39
Denver	100	99	3	33	30	34	36
Denver	150	98	3	54	49	55	58
Denver	150	99	3	50	45	51	53
Denver	200	98	3	72	65	73	78
Denver	200	99	3	66	60	67	71
Detroit	As is		6	17	14	17	20
Detroit	Current std		6	49	42	50	53
Detroit	50	98	6	19	16	19	22
Detroit	50	99	6	18	15	17	20
Detroit	100	98	6	38	32	38	45
Detroit	100	99	6	35	29	35	41
Detroit	150	98	6	58	48	57	67
Detroit	150	99	6	53	44	52	61
Detroit	200	98	6	77	64	76	90
Detroit	200	99	6	70	58	69	82
Los Angeles	As is		54	18	5	18	31
Los Angeles	Current std		54	30	8	31	53
Los Angeles	50	98	54	14	4	14	24
Los Angeles	50	99	54	13	3	13	22

Location	Scenario	Percentile	Site-Years	Annual Mean			
				Mean	Min	Med	p99
Los Angeles	100	98	54	28	7	28	49
Los Angeles	100	99	54	26	6	25	44
Los Angeles	150	98	54	43	11	42	73
Los Angeles	150	99	54	39	10	38	66
Los Angeles	200	98	54	57	14	56	97
Los Angeles	200	99	54	51	13	51	88
Miami	As is		4	8	7	8	8
Miami	Current std		4	31	28	31	32
Miami	50	98	4	9	9	9	10
Miami	50	99	4	8	8	8	8
Miami	100	98	4	18	17	19	19
Miami	100	99	4	16	15	16	17
Miami	150	98	4	28	26	28	29
Miami	150	99	4	24	23	25	25
Miami	200	98	4	37	35	37	38
Miami	200	99	4	32	30	33	33
New York	As is		22	19	10	20	27
New York	Current std		22	30	16	32	43
New York	50	98	22	15	8	16	21
New York	50	99	22	14	7	15	19
New York	100	98	22	31	15	32	43
New York	100	99	22	28	14	29	39
New York	150	98	22	46	23	48	64
New York	150	99	22	42	21	44	58
New York	200	98	22	61	31	64	85
New York	200	99	22	56	28	59	78
Philadelphia	As is		12	17	14	16	25
Philadelphia	Current std		12	39	29	39	51
Philadelphia	50	98	12	17	14	16	24
Philadelphia	50	99	12	16	13	15	22
Philadelphia	100	98	12	34	27	32	48
Philadelphia	100	99	12	31	25	30	44
Philadelphia	150	98	12	50	41	48	72
Philadelphia	150	99	12	47	38	44	67
Philadelphia	200	98	12	67	55	64	96
Philadelphia	200	99	12	62	51	59	89
Washington DC	As is		17	15	7	16	22
Washington DC	Current std		17	36	19	42	51
Washington DC	50	98	17	15	7	16	22
Washington DC	50	99	17	14	6	15	20
Washington DC	100	98	17	30	14	32	44
Washington DC	100	99	17	28	13	29	41
Washington DC	150	98	17	45	20	48	66
Washington DC	150	99	17	42	19	44	61
Washington DC	200	98	17	61	27	63	88
Washington DC	200	99	17	56	25	59	81
Atlanta	As is		15	11	3	14	18

Location	Scenario	Percentile	Site-Years	Annual Mean			
				Mean	Min	Med	p99
Atlanta	Current std		15	34	10	44	53
Atlanta	50	98	15	11	3	14	17
Atlanta	50	99	15	10	3	12	15
Atlanta	100	98	15	21	6	27	34
Atlanta	100	99	15	19	6	24	30
Atlanta	150	98	15	32	10	41	51
Atlanta	150	99	15	29	9	37	45
Atlanta	200	98	15	42	13	54	67
Atlanta	200	99	15	38	12	49	61
El Paso	As is		12	14	8	15	18
El Paso	Current std		12	42	24	45	53
El Paso	50	98	12	14	8	15	19
El Paso	50	99	12	13	8	14	17
El Paso	100	98	12	29	17	31	37
El Paso	100	99	12	26	15	28	34
El Paso	150	98	12	43	25	46	56
El Paso	150	99	12	40	23	42	51
El Paso	200	98	12	58	34	62	74
El Paso	200	99	12	53	31	57	68
Jacksonville	As is		2	14	13	14	14
Jacksonville	Current std		2	53	53	53	53
Jacksonville	50	98	2	17	17	17	18
Jacksonville	50	99	2	15	15	15	15
Jacksonville	100	98	2	35	34	35	35
Jacksonville	100	99	2	30	29	30	30
Jacksonville	150	98	2	52	51	52	53
Jacksonville	150	99	2	45	44	45	45
Jacksonville	200	98	2	69	68	69	70
Jacksonville	200	99	2	59	59	59	60
Las Vegas	As is		11	9	1	6	20
Las Vegas	Current std		11	24	4	16	53
Las Vegas	50	98	11	9	1	6	20
Las Vegas	50	99	11	9	1	6	19
Las Vegas	100	98	11	18	3	12	40
Las Vegas	100	99	11	17	3	12	38
Las Vegas	150	98	11	27	4	19	60
Las Vegas	150	99	11	26	4	18	57
Las Vegas	200	98	11	37	6	25	80
Las Vegas	200	99	11	34	5	23	76
Phoenix	As is		9	24	21	24	26
Phoenix	Current std		9	41	36	40	44
Phoenix	50	98	9	19	16	19	20
Phoenix	50	99	9	17	15	17	19
Phoenix	100	98	9	37	32	37	41
Phoenix	100	99	9	35	30	35	38
Phoenix	150	98	9	56	49	56	61
Phoenix	150	99	9	52	45	52	57

Location	Scenario	Percentile	Site-Years	Annual Mean			
				Mean	Min	Med	p99
Phoenix	200	98	9	75	65	75	82
Phoenix	200	99	9	69	60	69	76
Provo	As is		3	24	21	22	29
Provo	Current std		3	53	53	53	53
Provo	50	98	3	15	13	14	18
Provo	50	99	3	14	12	13	17
Provo	100	98	3	29	25	27	35
Provo	100	99	3	27	23	26	33
Provo	150	98	3	44	38	41	53
Provo	150	99	3	41	35	38	50
Provo	200	98	3	58	50	55	71
Provo	200	99	3	55	47	51	66
St. Louis	As is		4	15	12	14	18
St. Louis	Current std		4	38	29	36	49
St. Louis	50	98	4	15	13	15	18
St. Louis	50	99	4	14	12	14	17
St. Louis	100	98	4	30	25	29	36
St. Louis	100	99	4	28	24	27	34
St. Louis	150	98	4	45	38	44	54
St. Louis	150	99	4	42	36	41	51
St. Louis	200	98	4	60	50	58	72
St. Louis	200	99	4	56	47	55	68
Other MSA/CMSA	As is		565	11	1	11	23
Other MSA/CMSA	Current std		565	26	2	26	52
Other MSA/CMSA	50	98	565	9	1	9	20
Other MSA/CMSA	50	99	565	8	1	8	18
Other MSA/CMSA	100	98	565	19	1	19	40
Other MSA/CMSA	100	99	565	17	1	17	35
Other MSA/CMSA	150	98	565	28	2	28	59
Other MSA/CMSA	150	99	565	25	2	25	53
Other MSA/CMSA	200	98	565	38	3	38	79
Other MSA/CMSA	200	99	565	34	2	34	71
Other Not MSA	As is		116	7	1	6	16
Other Not MSA	Current std		116	21	3	19	53
Other Not MSA	50	98	116	6	1	6	15
Other Not MSA	50	99	116	6	1	6	14
Other Not MSA	100	98	116	13	2	12	31
Other Not MSA	100	99	116	12	1	11	29
Other Not MSA	150	98	116	19	2	18	46
Other Not MSA	150	99	116	18	2	17	43
Other Not MSA	200	98	116	26	3	24	62
Other Not MSA	200	99	116	24	3	22	57

Table A-115. Estimated annual average NO_2 concentrations for monitors <100 m from a major road following adjustment to just meeting the current and alternative standards, 2004-2006 air quality.

Location	Scenario	Percentile	Site-Years	Annual Mean			
				Mean	Min	Med	p99
Boston	As is		14	17	10	17	25
Boston	Current std		14	38	24	36	53
Boston	50	98	14	18	11	18	27
Boston	50	99	14	17	10	16	24
Boston	100	98	14	36	22	35	53
Boston	100	99	14	33	20	32	49
Boston	150	98	14	54	32	53	80
Boston	150	99	14	50	29	48	73
Boston	200	98	14	73	43	71	106
Boston	200	99	14	66	39	64	97
Chicago	As is		9	26	18	28	31
Chicago	Current std		9	46	31	51	53
Chicago	50	98	9	20	14	22	24
Chicago	50	99	9	18	13	20	22
Chicago	100	98	9	40	28	44	48
Chicago	100	99	9	37	25	40	44
Chicago	150	98	9	61	42	67	72
Chicago	150	99	9	55	38	61	66
Chicago	200	98	9	81	56	89	96
Chicago	200	99	9	74	51	81	87
Cleveland	As is		5	19	14	18	22
Cleveland	Current std		5	48	41	53	53
Cleveland	50	98	5	19	15	19	23
Cleveland	50	99	5	18	13	17	21
Cleveland	100	98	5	38	29	38	46
Cleveland	100	99	5	35	27	35	42
Cleveland	150	98	5	58	44	56	69
Cleveland	150	99	5	53	40	52	63
Cleveland	200	98	5	77	59	75	92
Cleveland	200	99	5	71	54	69	84
Denver	As is		3	28	27	28	29
Denver	Current std		3	53	53	53	53
Denver	50	98	3	25	25	25	26
Denver	50	99	3	23	23	23	24
Denver	100	98	3	51	49	50	53
Denver	100	99	3	46	45	46	48
Denver	150	98	3	76	74	75	79
Denver	150	99	3	70	68	69	72
Denver	200	98	3	101	98	100	105
Denver	200	99	3	93	90	91	96
Los Angeles	As is		28	25	9	27	34
Los Angeles	Current std		28	42	15	47	53
Los Angeles	50	98	28	20	7	21	26
Los Angeles	50	99	28	18	6	19	24

Location	Scenario	Percentile	Site-Years	Annual Mean			
				Mean	Min	Med	p99
Los Angeles	100	98	28	40	13	43	53
Los Angeles	100	99	28	36	12	39	48
Los Angeles	150	98	28	59	20	64	79
Los Angeles	150	99	28	54	18	58	72
Los Angeles	200	98	28	79	27	86	106
Los Angeles	200	99	28	72	24	78	96
Miami	As is		4	10	6	9	14
Miami	Current std		4	38	24	38	53
Miami	50	98	4	12	7	11	16
Miami	50	99	4	10	6	10	14
Miami	100	98	4	23	14	23	33
Miami	100	99	4	20	12	20	28
Miami	150	98	4	35	21	34	49
Miami	150	99	4	30	18	30	43
Miami	200	98	4	46	28	46	65
Miami	200	99	4	40	24	40	57
New York	As is		13	28	18	28	36
New York	Current std		13	43	28	42	53
New York	50	98	13	22	15	23	29
New York	50	99	13	20	13	21	27
New York	100	98	13	44	29	45	58
New York	100	99	13	41	27	41	53
New York	150	98	13	67	44	68	88
New York	150	99	13	61	40	62	80
New York	200	98	13	89	59	90	117
New York	200	99	13	81	54	82	107
Philadelphia	As is		6	22	18	22	26
Philadelphia	Current std		6	48	36	50	53
Philadelphia	50	98	6	21	17	22	26
Philadelphia	50	99	6	20	16	20	24
Philadelphia	100	98	6	43	34	43	51
Philadelphia	100	99	6	40	32	40	47
Philadelphia	150	98	6	64	51	65	77
Philadelphia	150	99	6	59	48	60	71
Philadelphia	200	98	6	85	69	86	102
Philadelphia	200	99	6	79	64	80	95
Washington DC	As is		17	18	13	18	24
Washington DC	Current std		17	43	30	40	53
Washington DC	50	98	17	18	13	18	24
Washington DC	50	99	17	17	12	16	22
Washington DC	100	98	17	37	27	35	48
Washington DC	100	99	17	34	25	32	44
Washington DC	150	98	17	55	40	53	72
Washington DC	150	99	17	51	37	49	67
Washington DC	200	98	17	73	53	70	96
Washington DC	200	99	17	68	49	65	89
El Paso	As is		3	15	13	13	18

Location	Scenario	Percentile	Site-Years	Annual Mean			
				Mean	Min	Med	p99
El Paso	Current std		3	44	39	40	53
El Paso	50	98	3	15	13	14	18
El Paso	50	99	3	14	12	12	17
El Paso	100	98	3	30	27	27	37
El Paso	100	99	3	28	25	25	34
El Paso	150	98	3	45	40	41	55
El Paso	150	99	3	42	37	37	51
El Paso	200	98	3	61	54	54	74
El Paso	200	99	3	56	49	50	68
Las Vegas	As is		2	19	19	19	20
Las Vegas	Current std		2	52	51	52	53
Las Vegas	50	98	2	20	19	20	20
Las Vegas	50	99	2	19	18	19	19
Las Vegas	100	98	2	40	39	40	41
Las Vegas	100	99	2	37	37	37	38
Las Vegas	150	98	2	60	58	60	61
Las Vegas	150	99	2	56	55	56	57
Las Vegas	200	98	2	79	78	79	81
Las Vegas	200	99	2	75	73	75	76
Phoenix	As is		8	22	11	20	32
Phoenix	Current std		8	37	19	33	53
Phoenix	50	98	8	17	9	15	25
Phoenix	50	99	8	16	8	14	23
Phoenix	100	98	8	34	17	31	49
Phoenix	100	99	8	32	16	28	46
Phoenix	150	98	8	51	26	46	74
Phoenix	150	99	8	48	24	43	69
Phoenix	200	98	8	68	35	61	99
Phoenix	200	99	8	63	32	57	91
St. Louis	As is		13	13	8	13	22
St. Louis	Current std		13	37	19	38	53
St. Louis	50	98	13	13	8	13	23
St. Louis	50	99	13	13	8	12	21
St. Louis	100	98	13	27	17	26	46
St. Louis	100	99	13	25	16	24	43
St. Louis	150	98	13	40	25	39	68
St. Louis	150	99	13	38	23	37	64
St. Louis	200	98	13	54	33	52	91
St. Louis	200	99	13	51	31	49	86

Table A-116. Estimated number of exceedances of 1-hour concentration levels (100, 150, and 200 ppb) for monitors ≥100 m from a major road following adjustment to just meeting the current and alternative standards, 2001-2003 air quality.

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99	Mean	Min	Med	p99
Boston	As is		0	0	0	0	0	0	0	0	0	0	0	0
Boston	Current std		8	0	2	31	0	0	0	0	0	0	0	0
Boston	50	98	0	0	0	0	0	0	0	0	0	0	0	0
Boston	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Boston	100	98	4	0	2	18	0	0	0	2	0	0	0	0
Boston	100	99	2	0	1	10	0	0	0	0	0	0	0	0
Boston	150	98	163	31	170	307	4	0	2	18	1	0	0	5
Boston	150	99	72	12	68	165	2	0	1	10	0	0	0	2
Boston	200	98	546	155	624	874	56	8	53	138	4	0	2	18
Boston	200	99	426	117	494	701	21	1	15	68	2	0	1	10
Chicago	As is		1	0	0	5	0	0	0	0	0	0	0	0
Chicago	Current std		71	1	36	314	2	0	0	8	0	0	0	1
Chicago	50	98	0	0	0	1	0	0	0	0	0	0	0	0
Chicago	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Chicago	100	98	37	1	17	160	1	0	0	5	0	0	0	1
Chicago	100	99	15	0	8	71	1	0	0	3	0	0	0	0
Chicago	150	98	525	132	373	1176	37	1	17	160	2	0	0	8
Chicago	150	99	339	62	203	893	15	0	8	71	1	0	0	5
Chicago	200	98	1568	680	1343	2868	301	50	180	819	37	1	17	160
Chicago	200	99	1187	440	989	2345	182	23	119	563	15	0	8	71
Cleveland	As is		0	0	0	1	0	0	0	0	0	0	0	0
Cleveland	Current std		233	166	208	326	11	7	9	18	1	0	1	3
Cleveland	50	98	0	0	0	1	0	0	0	0	0	0	0	0
Cleveland	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Cleveland	100	98	72	49	75	92	2	1	2	3	0	0	0	1
Cleveland	100	99	33	29	32	38	1	0	1	2	0	0	0	0
Cleveland	150	98	674	602	673	747	72	49	75	92	6	6	6	6
Cleveland	150	99	466	396	467	534	33	29	32	38	2	1	2	4
Cleveland	200	98	1707	1576	1622	1922	398	340	410	443	72	49	75	92
Cleveland	200	99	1276	1163	1224	1440	239	166	269	281	33	29	32	38
Denver	As is		2	1	2	2	0	0	0	0	0	0	0	0
Denver	Current std		525	41	525	1008	62	1	62	123	3	0	3	5

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99	Mean	Min	Med	p99
Denver	50	98	1	0	1	1	0	0	0	0	0	0	0	0
Denver	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Denver	100	98	58	54	58	61	2	1	2	2	1	0	1	1
Denver	100	99	13	12	13	14	1	0	1	1	0	0	0	0
Denver	150	98	932	675	932	1189	58	54	58	61	3	2	3	4
Denver	150	99	465	336	465	593	13	12	13	14	2	1	2	2
Denver	200	98	2318	1808	2318	2827	465	336	465	593	58	54	58	61
Denver	200	99	1798	1315	1798	2281	230	187	230	273	13	12	13	14
Detroit	As is		9	0	3	34	3	0	1	16	2	0	0	12
Detroit	Current std		438	341	431	520	45	10	30	101	15	1	6	45
Detroit	50	98	8	0	3	30	3	0	1	15	2	0	0	12
Detroit	50	99	6	0	1	28	3	0	1	13	2	0	0	9
Detroit	100	98	146	88	140	217	18	1	7	47	8	0	3	30
Detroit	100	99	63	21	54	117	12	1	4	39	6	0	1	28
Detroit	150	98	1058	770	1088	1295	146	88	140	217	28	4	14	72
Detroit	150	99	587	438	586	748	63	21	54	117	17	1	6	45
Detroit	200	98	2461	2073	2450	2860	664	497	672	839	146	88	140	217
Detroit	200	99	1753	1395	1786	2048	328	258	311	408	63	21	54	117
Los Angeles	As is		7	0	2	34	0	0	0	10	0	0	0	4
Los Angeles	Current std		63	0	38	259	4	0	0	23	0	0	0	8
Los Angeles	50	98	0	0	0	5	0	0	0	0	0	0	0	0
Los Angeles	50	99	0	0	0	4	0	0	0	0	0	0	0	0
Los Angeles	100	98	21	0	9	112	1	0	0	13	0	0	0	5
Los Angeles	100	99	7	0	2	37	0	0	0	10	0	0	0	4
Los Angeles	150	98	241	0	172	1019	21	0	9	112	2	0	0	19
Los Angeles	150	99	118	0	85	563	7	0	2	37	1	0	0	13
Los Angeles	200	98	914	3	893	2712	129	0	96	603	21	0	9	112
Los Angeles	200	99	500	0	461	1717	54	0	34	282	7	0	2	37
Miami	As is		0	0	0	0	0	0	0	0	0	0	0	0
Miami	Current std		438	215	341	835	76	13	35	216	9	0	3	33
Miami	50	98	1	0	0	2	0	0	0	0	0	0	0	0
Miami	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Miami	100	98	85	5	43	243	6	0	4	18	1	0	0	2
Miami	100	99	50	3	26	149	3	0	2	10	0	0	0	0

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99	Mean	Min	Med	p99
Miami	150	98	454	154	392	893	85	5	43	243	13	0	6	47
Miami	150	99	352	100	291	723	50	3	26	149	6	0	4	21
Miami	200	98	1044	602	994	1575	315	86	256	665	85	5	43	243
Miami	200	99	827	412	753	1381	214	46	149	514	50	3	26	149
New York	As is		1	0	0	4	0	0	0	0	0	0	0	0
New York	Current std		23	0	9	148	1	0	0	6	0	0	0	1
New York	50	98	0	0	0	0	0	0	0	0	0	0	0	0
New York	50	99	0	0	0	0	0	0	0	0	0	0	0	0
New York	100	98	19	0	9	89	0	0	0	4	0	0	0	0
New York	100	99	9	0	6	47	0	0	0	2	0	0	0	0
New York	150	98	331	27	244	872	19	0	9	89	1	0	0	8
New York	150	99	201	11	117	619	9	0	6	47	1	0	0	4
New York	200	98	1299	244	1165	2482	177	9	97	563	19	0	9	89
New York	200	99	963	166	857	1953	93	0	47	334	9	0	6	47
Philadelphia	As is		0	0	0	1	0	0	0	1	0	0	0	1
Philadelphia	Current std		95	6	67	291	2	0	2	10	0	0	0	1
Philadelphia	50	98	0	0	0	1	0	0	0	1	0	0	0	1
Philadelphia	50	99	0	0	0	1	0	0	0	1	0	0	0	1
Philadelphia	100	98	58	4	33	244	1	0	1	3	0	0	0	1
Philadelphia	100	99	33	1	19	163	1	0	1	3	0	0	0	1
Philadelphia	150	98	777	266	641	1779	58	4	33	244	3	0	1	17
Philadelphia	150	99	519	157	400	1299	33	1	19	163	2	0	1	7
Philadelphia	200	98	2041	1128	1856	3741	399	114	295	1081	58	4	33	244
Philadelphia	200	99	1711	893	1516	3285	263	61	178	788	33	1	19	163
Washington DC	As is		0	0	0	1	0	0	0	0	0	0	0	0
Washington DC	Current std		228	0	188	673	10	0	7	44	0	0	0	1
Washington DC	50	98	0	0	0	0	0	0	0	0	0	0	0	0
Washington DC	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Washington DC	100	98	93	0	71	274	3	0	1	10	0	0	0	0
Washington DC	100	99	47	0	43	143	1	0	0	4	0	0	0	0
Washington DC	150	98	896	24	970	1902	93	0	71	274	8	0	7	30
Washington DC	150	99	580	5	588	1361	47	0	43	143	3	0	1	11
Washington DC	200	98	1974	208	2439	3394	514	5	515	1230	93	0	71	274
Washington DC	200	99	1558	102	1848	2835	316	1	300	806	47	0	43	143

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99	Mean	Min	Med	p99
Atlanta	As is		1	0	0	6	0	0	0	1	0	0	0	0
Atlanta	Current std		434	3	386	1315	62	0	21	291	8	0	0	48
Atlanta	50	98	0	0	0	3	0	0	0	1	0	0	0	0
Atlanta	50	99	0	0	0	2	0	0	0	0	0	0	0	0
Atlanta	100	98	61	0	17	335	3	0	0	23	0	0	0	3
Atlanta	100	99	29	0	3	178	1	0	0	8	0	0	0	2
Atlanta	150	98	429	4	382	1517	61	0	17	335	8	0	0	56
Atlanta	150	99	266	0	178	1095	29	0	3	178	4	0	0	26
Atlanta	200	98	924	43	1015	2644	266	0	178	1095	61	0	17	335
Atlanta	200	99	727	25	763	2226	162	0	81	749	29	0	3	178
El Paso	As is		0	0	0	1	0	0	0	1	0	0	0	0
El Paso	Current std		385	106	378	847	25	6	21	65	3	0	2	12
El Paso	50	98	0	0	0	1	0	0	0	0	0	0	0	0
El Paso	50	99	0	0	0	1	0	0	0	0	0	0	0	0
El Paso	100	98	50	13	40	94	2	0	1	10	0	0	0	1
El Paso	100	99	24	6	19	49	1	0	0	6	0	0	0	1
El Paso	150	98	622	279	647	1020	50	13	40	94	7	1	4	16
El Paso	150	99	366	127	383	627	24	6	19	49	3	0	1	11
El Paso	200	98	1553	876	1692	2035	322	106	332	559	50	13	40	94
El Paso	200	99	1185	625	1262	1651	180	56	174	329	24	6	19	49
Jacksonville	As is		1	0	1	2	1	0	1	2	1	0	1	2
Jacksonville	Current std		732	723	732	741	134	90	134	177	18	7	18	29
Jacksonville	50	98	1	0	1	2	1	0	1	2	1	0	1	2
Jacksonville	50	99	1	0	1	2	1	0	1	2	1	0	1	2
Jacksonville	100	98	160	124	160	195	10	4	10	15	1	0	1	2
Jacksonville	100	99	82	55	82	108	8	3	8	12	1	0	1	2
Jacksonville	150	98	821	819	821	823	160	124	160	195	20	10	20	29
Jacksonville	150	99	585	554	585	615	82	55	82	108	10	4	10	15
Jacksonville	200	98	1770	1656	1770	1883	585	554	585	615	160	124	160	195
Jacksonville	200	99	1279	1245	1279	1312	370	335	370	404	82	55	82	108
Las Vegas	As is		0	0	0	1	0	0	0	0	0	0	0	0
Las Vegas	Current std		260	0	33	1022	10	0	1	71	0	0	0	3
Las Vegas	50	98	0	0	0	0	0	0	0	0	0	0	0	0
Las Vegas	50	99	0	0	0	0	0	0	0	0	0	0	0	0

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99	Mean	Min	Med	p99
Las Vegas	100	98	37	0	2	172	0	0	0	3	0	0	0	0
Las Vegas	100	99	15	0	1	86	0	0	0	2	0	0	0	0
Las Vegas	150	98	533	1	104	1867	37	0	2	172	1	0	0	7
Las Vegas	150	99	330	0	49	1158	15	0	1	86	1	0	0	4
Las Vegas	200	98	1152	12	389	3533	288	0	37	1022	37	0	2	172
Las Vegas	200	99	936	4	259	3036	191	0	20	688	15	0	1	86
Phoenix	As is		0	0	0	0	0	0	0	0	0	0	0	0
Phoenix	Current std		91	8	74	187	0	0	0	0	0	0	0	0
Phoenix	50	98	0	0	0	0	0	0	0	0	0	0	0	0
Phoenix	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Phoenix	100	98	66	8	91	115	0	0	0	0	0	0	0	0
Phoenix	100	99	22	4	30	39	0	0	0	0	0	0	0	0
Phoenix	150	98	1064	312	1281	1538	66	8	91	115	1	0	0	4
Phoenix	150	99	823	194	1022	1260	22	4	30	39	0	0	0	1
Phoenix	200	98	2582	1344	2672	3252	617	121	778	1007	66	8	91	115
Phoenix	200	99	2254	1068	2377	2917	455	72	588	784	22	4	30	39
Provo	As is		0	0	0	0	0	0	0	0	0	0	0	0
Provo	Current std		512	491	498	548	5	3	4	9	0	0	0	0
Provo	50	98	0	0	0	0	0	0	0	0	0	0	0	0
Provo	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Provo	100	98	175	66	206	253	1	0	0	2	0	0	0	0
Provo	100	99	87	31	109	121	0	0	0	0	0	0	0	0
Provo	150	98	2187	1709	2386	2466	175	66	206	253	5	3	4	9
Provo	150	99	1647	1176	1877	1887	87	31	109	121	1	0	0	3
Provo	200	98	3660	3154	3852	3975	1476	1017	1702	1709	175	66	206	253
Provo	200	99	3315	2806	3503	3637	1000	601	1197	1202	87	31	109	121
St. Louis	As is		0	0	0	1	0	0	0	0	0	0	0	0
St. Louis	Current std		223	45	131	540	11	0	2	51	0	0	0	1
St. Louis	50	98	0	0	0	1	0	0	0	0	0	0	0	0
St. Louis	50	99	0	0	0	1	0	0	0	0	0	0	0	0
St. Louis	100	98	82	6	32	214	2	0	0	9	0	0	0	1
St. Louis	100	99	34	1	8	107	1	0	0	3	0	0	0	1
St. Louis	150	98	798	337	643	1375	82	6	32	214	5	0	2	22
St. Louis	150	99	470	161	364	915	34	1	8	107	2	0	0	9

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99	Mean	Min	Med	p99
St. Louis	200	98	1941	1203	1747	2737	470	161	364	915	82	6	32	214
St. Louis	200	99	1469	794	1288	2195	266	63	197	588	34	1	8	107
Other MSA/CMSA	As is		0	0	0	5	0	0	0	0	0	0	0	0
Other MSA/CMSA	Current std		48	0	13	411	2	0	0	29	0	0	0	4
Other MSA/CMSA	50	98	0	0	0	0	0	0	0	0	0	0	0	0
Other MSA/CMSA	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Other MSA/CMSA	100	98	2	0	0	24	0	0	0	3	0	0	0	0
Other MSA/CMSA	100	99	1	0	0	9	0	0	0	1	0	0	0	0
Other MSA/CMSA	150	98	42	0	11	363	2	0	0	24	0	0	0	4
Other MSA/CMSA	150	99	13	0	1	150	1	0	0	9	0	0	0	2
Other MSA/CMSA	200	98	240	0	119	1550	19	0	3	219	2	0	0	24
Other MSA/CMSA	200	99	95	0	32	664	6	0	0	83	1	0	0	9
Other Not MSA	As is		1	0	0	7	0	0	0	1	0	0	0	1
Other Not MSA	Current std		121	0	24	925	14	0	0	224	3	0	0	57
Other Not MSA	50	98	1	0	0	7	0	0	0	1	0	0	0	1
Other Not MSA	50	99	0	0	0	6	0	0	0	1	0	0	0	0
Other Not MSA	100	98	9	0	0	180	1	0	0	25	1	0	0	7
Other Not MSA	100	99	4	0	0	78	1	0	0	11	0	0	0	6
Other Not MSA	150	98	77	0	11	684	9	0	0	180	2	0	0	42
Other Not MSA	150	99	32	0	2	423	4	0	0	78	1	0	0	19
Other Not MSA	200	98	284	0	81	1621	43	0	4	498	9	0	0	180
Other Not MSA	200	99	140	0	28	927	18	0	1	293	4	0	0	78

Table A-117. Estimated number of exceedances of 1-hour concentration levels (200 and 250 ppb) for monitors ≥100 m from a major road following adjustment to just meeting the current and alternative standards, 2001-2003 air quality.

Location	Scenario	Percentile	Exceedances of 250 ppb				Exceedances of 300 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99
Boston	As is		0	0	0	0	0	0	0	0
Boston	Current std		0	0	0	0	0	0	0	0
Boston	50	98	0	0	0	0	0	0	0	0
Boston	50	99	0	0	0	0	0	0	0	0
Boston	100	98	0	0	0	0	0	0	0	0
Boston	100	99	0	0	0	0	0	0	0	0
Boston	150	98	0	0	0	0	0	0	0	0
Boston	150	99	0	0	0	0	0	0	0	0
Boston	200	98	2	0	0	9	0	0	0	2
Boston	200	99	0	0	0	2	0	0	0	0
Chicago	As is		0	0	0	0	0	0	0	0
Chicago	Current std		0	0	0	0	0	0	0	0
Chicago	50	98	0	0	0	0	0	0	0	0
Chicago	50	99	0	0	0	0	0	0	0	0
Chicago	100	98	0	0	0	0	0	0	0	0
Chicago	100	99	0	0	0	0	0	0	0	0
Chicago	150	98	1	0	0	3	0	0	0	1
Chicago	150	99	0	0	0	1	0	0	0	0
Chicago	200	98	4	0	1	19	1	0	0	5
Chicago	200	99	2	0	0	7	1	0	0	3
Cleveland	As is		0	0	0	0	0	0	0	0
Cleveland	Current std		0	0	0	0	0	0	0	0
Cleveland	50	98	0	0	0	0	0	0	0	0
Cleveland	50	99	0	0	0	0	0	0	0	0
Cleveland	100	98	0	0	0	0	0	0	0	0
Cleveland	100	99	0	0	0	0	0	0	0	0
Cleveland	150	98	1	0	1	2	0	0	0	1
Cleveland	150	99	0	0	0	1	0	0	0	0
Cleveland	200	98	11	8	12	13	2	1	2	3
Cleveland	200	99	3	2	4	4	1	0	1	2
Denver	As is		0	0	0	0	0	0	0	0
Denver	Current std		1	0	1	2	1	0	1	1
Denver	50	98	0	0	0	0	0	0	0	0
Denver	50	99	0	0	0	0	0	0	0	0
Denver	100	98	0	0	0	0	0	0	0	0
Denver	100	99	0	0	0	0	0	0	0	0
Denver	150	98	1	0	1	1	1	0	1	1
Denver	150	99	1	0	1	1	0	0	0	0
Denver	200	98	5	5	5	5	2	1	2	2
Denver	200	99	3	1	3	4	1	0	1	1
Detroit	As is		1	0	0	8	1	0	0	5
Detroit	Current std		8	0	2	34	6	0	1	28
Detroit	50	98	1	0	0	7	1	0	0	5
Detroit	50	99	1	0	0	5	1	0	0	3

Location	Scenario	Percentile	Exceedances of 250 ppb				Exceedances of 300 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99
Detroit	100	98	5	0	1	25	3	0	1	15
Detroit	100	99	3	0	1	16	3	0	1	13
Detroit	150	98	12	1	4	40	8	0	3	30
Detroit	150	99	9	0	3	34	6	0	1	28
Detroit	200	98	39	5	28	91	18	1	7	47
Detroit	200	99	21	1	9	56	12	1	4	39
Los Angeles	As is		0	0	0	0	0	0	0	0
Los Angeles	Current std		0	0	0	4	0	0	0	1
Los Angeles	50	98	0	0	0	0	0	0	0	0
Los Angeles	50	99	0	0	0	0	0	0	0	0
Los Angeles	100	98	0	0	0	2	0	0	0	0
Los Angeles	100	99	0	0	0	0	0	0	0	0
Los Angeles	150	98	0	0	0	10	0	0	0	5
Los Angeles	150	99	0	0	0	6	0	0	0	4
Los Angeles	200	98	4	0	0	24	1	0	0	13
Los Angeles	200	99	1	0	0	16	0	0	0	10
Miami	As is		0	0	0	0	0	0	0	0
Miami	Current std		2	0	1	6	0	0	0	0
Miami	50	98	0	0	0	0	0	0	0	0
Miami	50	99	0	0	0	0	0	0	0	0
Miami	100	98	0	0	0	0	0	0	0	0
Miami	100	99	0	0	0	0	0	0	0	0
Miami	150	98	3	0	2	9	1	0	0	2
Miami	150	99	1	0	0	4	0	0	0	0
Miami	200	98	19	0	9	63	6	0	4	18
Miami	200	99	9	0	4	34	3	0	2	10
New York	As is		0	0	0	0	0	0	0	0
New York	Current std		0	0	0	0	0	0	0	0
New York	50	98	0	0	0	0	0	0	0	0
New York	50	99	0	0	0	0	0	0	0	0
New York	100	98	0	0	0	0	0	0	0	0
New York	100	99	0	0	0	0	0	0	0	0
New York	150	98	0	0	0	2	0	0	0	0
New York	150	99	0	0	0	1	0	0	0	0
New York	200	98	2	0	1	14	0	0	0	4
New York	200	99	1	0	0	6	0	0	0	2
Philadelphia	As is		0	0	0	1	0	0	0	0
Philadelphia	Current std		0	0	0	1	0	0	0	1
Philadelphia	50	98	0	0	0	0	0	0	0	0
Philadelphia	50	99	0	0	0	0	0	0	0	0
Philadelphia	100	98	0	0	0	1	0	0	0	1
Philadelphia	100	99	0	0	0	1	0	0	0	1
Philadelphia	150	98	1	0	1	1	0	0	0	1
Philadelphia	150	99	0	0	0	1	0	0	0	1
Philadelphia	200	98	6	0	3	43	1	0	1	3
Philadelphia	200	99	3	0	1	15	1	0	1	3
Washington DC	As is		0	0	0	0	0	0	0	0

Location	Scenario	Percentile	Exceedances of 250 ppb				Exceedances of 300 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99
Washington DC	Current std		0	0	0	0	0	0	0	0
Washington DC	50	98	0	0	0	0	0	0	0	0
Washington DC	50	99	0	0	0	0	0	0	0	0
Washington DC	100	98	0	0	0	0	0	0	0	0
Washington DC	100	99	0	0	0	0	0	0	0	0
Washington DC	150	98	1	0	0	3	0	0	0	0
Washington DC	150	99	0	0	0	1	0	0	0	0
Washington DC	200	98	14	0	12	47	3	0	1	10
Washington DC	200	99	7	0	6	25	1	0	0	4
Atlanta	As is		0	0	0	0	0	0	0	0
Atlanta	Current std		1	0	0	6	0	0	0	2
Atlanta	50	98	0	0	0	0	0	0	0	0
Atlanta	50	99	0	0	0	0	0	0	0	0
Atlanta	100	98	0	0	0	1	0	0	0	1
Atlanta	100	99	0	0	0	1	0	0	0	0
Atlanta	150	98	1	0	0	8	0	0	0	3
Atlanta	150	99	1	0	0	3	0	0	0	2
Atlanta	200	98	12	0	0	80	3	0	0	23
Atlanta	200	99	6	0	0	40	1	0	0	8
El Paso	As is		0	0	0	0	0	0	0	0
El Paso	Current std		0	0	0	3	0	0	0	1
El Paso	50	98	0	0	0	0	0	0	0	0
El Paso	50	99	0	0	0	0	0	0	0	0
El Paso	100	98	0	0	0	1	0	0	0	0
El Paso	100	99	0	0	0	1	0	0	0	0
El Paso	150	98	1	0	0	5	0	0	0	1
El Paso	150	99	0	0	0	1	0	0	0	1
El Paso	200	98	10	1	8	19	2	0	1	10
El Paso	200	99	5	1	3	15	1	0	0	6
Jacksonville	As is		1	0	1	1	0	0	0	0
Jacksonville	Current std		7	3	7	10	1	0	1	2
Jacksonville	50	98	1	0	1	2	1	0	1	1
Jacksonville	50	99	1	0	1	2	1	0	1	1
Jacksonville	100	98	1	0	1	2	1	0	1	2
Jacksonville	100	99	1	0	1	2	1	0	1	2
Jacksonville	150	98	8	3	8	12	1	0	1	2
Jacksonville	150	99	2	1	2	2	1	0	1	2
Jacksonville	200	98	35	21	35	48	10	4	10	15
Jacksonville	200	99	17	7	17	27	8	3	8	12
Las Vegas	As is		0	0	0	0	0	0	0	0
Las Vegas	Current std		0	0	0	0	0	0	0	0
Las Vegas	50	98	0	0	0	0	0	0	0	0
Las Vegas	50	99	0	0	0	0	0	0	0	0
Las Vegas	100	98	0	0	0	0	0	0	0	0
Las Vegas	100	99	0	0	0	0	0	0	0	0
Las Vegas	150	98	0	0	0	2	0	0	0	0
Las Vegas	150	99	0	0	0	1	0	0	0	0

Location	Scenario	Percentile	Exceedances of 250 ppb				Exceedances of 300 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99
Las Vegas	200	98	3	0	0	17	0	0	0	3
Las Vegas	200	99	1	0	0	6	0	0	0	2
Phoenix	As is		0	0	0	0	0	0	0	0
Phoenix	Current std		0	0	0	0	0	0	0	0
Phoenix	50	98	0	0	0	0	0	0	0	0
Phoenix	50	99	0	0	0	0	0	0	0	0
Phoenix	100	98	0	0	0	0	0	0	0	0
Phoenix	100	99	0	0	0	0	0	0	0	0
Phoenix	150	98	0	0	0	0	0	0	0	0
Phoenix	150	99	0	0	0	0	0	0	0	0
Phoenix	200	98	2	0	1	7	0	0	0	0
Phoenix	200	99	1	0	0	4	0	0	0	0
Provo	As is		0	0	0	0	0	0	0	0
Provo	Current std		0	0	0	0	0	0	0	0
Provo	50	98	0	0	0	0	0	0	0	0
Provo	50	99	0	0	0	0	0	0	0	0
Provo	100	98	0	0	0	0	0	0	0	0
Provo	100	99	0	0	0	0	0	0	0	0
Provo	150	98	0	0	0	0	0	0	0	0
Provo	150	99	0	0	0	0	0	0	0	0
Provo	200	98	17	4	17	29	1	0	0	2
Provo	200	99	5	3	4	9	0	0	0	0
St. Louis	As is		0	0	0	0	0	0	0	0
St. Louis	Current std		0	0	0	1	0	0	0	0
St. Louis	50	98	0	0	0	0	0	0	0	0
St. Louis	50	99	0	0	0	0	0	0	0	0
St. Louis	100	98	0	0	0	0	0	0	0	0
St. Louis	100	99	0	0	0	0	0	0	0	0
St. Louis	150	98	1	0	0	3	0	0	0	1
St. Louis	150	99	0	0	0	1	0	0	0	1
St. Louis	200	98	11	0	3	43	2	0	0	9
St. Louis	200	99	3	0	0	15	1	0	0	3
Other MSA/CMSA	As is		0	0	0	0	0	0	0	0
Other MSA/CMSA	Current std		0	0	0	2	0	0	0	0
Other MSA/CMSA	50	98	0	0	0	0	0	0	0	0
Other MSA/CMSA	50	99	0	0	0	0	0	0	0	0
Other MSA/CMSA	100	98	0	0	0	0	0	0	0	0
Other MSA/CMSA	100	99	0	0	0	0	0	0	0	0
Other MSA/CMSA	150	98	0	0	0	1	0	0	0	0
Other MSA/CMSA	150	99	0	0	0	0	0	0	0	0
Other MSA/CMSA	200	98	0	0	0	6	0	0	0	3
Other MSA/CMSA	200	99	0	0	0	3	0	0	0	1
Other Not MSA	As is		0	0	0	0	0	0	0	0
Other Not MSA	Current std		1	0	0	20	1	0	0	9
Other Not MSA	50	98	0	0	0	0	0	0	0	0
Other Not MSA	50	99	0	0	0	0	0	0	0	0
Other Not MSA	100	98	0	0	0	6	0	0	0	1

Location	Scenario	Percentile	Exceedances of 250 ppb				Exceedances of 300 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99
Other Not MSA	100	99	0	0	0	2	0	0	0	1
Other Not MSA	150	98	1	0	0	14	1	0	0	7
Other Not MSA	150	99	1	0	0	8	0	0	0	6
Other Not MSA	200	98	3	0	0	57	1	0	0	25
Other Not MSA	200	99	1	0	0	25	1	0	0	11

Table A-118. Estimated number of exceedances of 1-hour concentration levels (100, 150, and 200 ppb) for monitors <100 m from a major road following adjustment to just meeting the current and alternative standards, 2001-2003 air quality.

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99	Mean	Min	Med	p99
Boston	As is		0	0	0	1	0	0	0	0	0	0	0	0
Boston	Current std		119	0	65	540	4	0	0	34	0	0	0	5
Boston	50	98	0	0	0	1	0	0	0	0	0	0	0	0
Boston	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Boston	100	98	67	0	44	221	2	0	0	8	0	0	0	1
Boston	100	99	33	0	17	120	1	0	0	4	0	0	0	0
Boston	150	98	812	44	689	2524	67	0	44	221	6	0	3	22
Boston	150	99	490	8	435	1615	33	0	17	120	2	0	0	10
Boston	200	98	1863	252	1933	4698	431	6	397	1439	67	0	44	221
Boston	200	99	1544	188	1424	4145	245	1	239	821	33	0	17	120
Chicago	As is		4	0	0	36	0	0	0	0	0	0	0	0
Chicago	Current std		194	34	188	357	8	0	4	39	2	0	0	15
Chicago	50	98	1	0	0	7	0	0	0	0	0	0	0	0
Chicago	50	99	1	0	0	5	0	0	0	0	0	0	0	0
Chicago	100	98	120	20	112	267	4	0	1	37	1	0	0	7
Chicago	100	99	62	8	60	152	3	0	0	28	1	0	0	5
Chicago	150	98	1075	482	1062	1915	120	20	112	267	11	0	5	45
Chicago	150	99	732	304	736	1346	62	8	60	152	5	0	2	38
Chicago	200	98	2721	1527	2904	4067	660	255	667	1236	120	20	112	267
Chicago	200	99	2174	1131	2267	3458	440	132	436	866	62	8	60	152
Cleveland	As is		0	0	0	0	0	0	0	0	0	0	0	0
Cleveland	Current std		491	448	491	534	34	27	29	45	2	1	2	4
Cleveland	50	98	0	0	0	0	0	0	0	0	0	0	0	0
Cleveland	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Cleveland	100	98	165	127	144	224	8	5	6	12	0	0	0	0
Cleveland	100	99	84	55	69	128	2	1	2	4	0	0	0	0
Cleveland	150	98	1241	1154	1176	1394	165	127	144	224	20	9	13	37
Cleveland	150	99	908	849	856	1019	84	55	69	128	8	5	7	13
Cleveland	200	98	2865	2683	2726	3187	768	679	724	901	165	127	144	224
Cleveland	200	99	2241	2078	2126	2518	495	429	448	609	84	55	69	128
Denver	As is		19	8	19	30	1	1	1	1	0	0	0	0

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99	Mean	Min	Med	p99
Denver	Current std		152	118	152	186	16	8	16	23	4	1	4	7
Denver	50	98	5	1	5	8	0	0	0	0	0	0	0	0
Denver	50	99	1	1	1	1	0	0	0	0	0	0	0	0
Denver	100	98	171	104	171	237	17	8	17	26	5	1	5	8
Denver	100	99	79	49	79	108	11	5	11	17	1	1	1	1
Denver	150	98	1836	1647	1836	2024	171	104	171	237	26	12	26	39
Denver	150	99	1015	843	1015	1187	79	49	79	108	18	8	18	27
Denver	200	98	4161	4075	4161	4247	1015	843	1015	1187	171	104	171	237
Denver	200	99	3265	3150	3265	3379	528	377	528	678	79	49	79	108
Los Angeles	As is		13	0	5	65	0	0	0	6	0	0	0	1
Los Angeles	Current std		113	0	87	399	6	0	1	40	0	0	0	6
Los Angeles	50	98	0	0	0	3	0	0	0	1	0	0	0	0
Los Angeles	50	99	0	0	0	1	0	0	0	0	0	0	0	0
Los Angeles	100	98	40	0	25	160	1	0	0	8	0	0	0	3
Los Angeles	100	99	14	0	6	69	0	0	0	6	0	0	0	1
Los Angeles	150	98	403	0	369	1288	40	0	25	160	4	0	0	21
Los Angeles	150	99	206	0	178	702	14	0	6	69	1	0	0	8
Los Angeles	200	98	1403	0	1523	3545	225	0	199	752	40	0	25	160
Los Angeles	200	99	801	0	858	2238	100	0	83	358	14	0	6	69
Miami	As is		0	0	0	0	0	0	0	0	0	0	0	0
Miami	Current std		546	210	564	827	86	23	81	165	10	0	7	28
Miami	50	98	0	0	0	2	0	0	0	0	0	0	0	0
Miami	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Miami	100	98	103	34	81	252	4	0	1	17	0	0	0	2
Miami	100	99	56	17	44	139	1	0	0	5	0	0	0	0
Miami	150	98	566	277	456	1139	103	34	81	252	11	0	6	39
Miami	150	99	451	216	375	928	56	17	44	139	4	0	2	18
Miami	200	98	1214	567	976	2279	401	183	334	827	103	34	81	252
Miami	200	99	988	476	804	1859	280	124	227	614	56	17	44	139
New York	As is		3	0	0	21	0	0	0	0	0	0	0	0
New York	Current std		67	2	41	174	2	0	0	7	0	0	0	0
New York	50	98	0	0	0	2	0	0	0	0	0	0	0	0
New York	50	99	0	0	0	0	0	0	0	0	0	0	0	0

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99	Mean	Min	Med	p99
New York	100	98	74	4	50	277	2	0	0	18	0	0	0	2
New York	100	99	36	2	22	140	1	0	0	7	0	0	0	0
New York	150	98	999	217	845	2654	74	4	50	277	5	0	1	34
New York	150	99	655	110	538	1901	36	2	22	140	3	0	0	21
New York	200	98	2837	1159	2494	5476	589	100	484	1750	74	4	50	277
New York	200	99	2276	818	1994	4778	334	58	258	1103	36	2	22	140
Philadelphia	As is		0	0	0	1	0	0	0	0	0	0	0	0
Philadelphia	Current std		146	14	136	273	4	0	4	7	0	0	0	2
Philadelphia	50	98	0	0	0	0	0	0	0	0	0	0	0	0
Philadelphia	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Philadelphia	100	98	92	14	67	230	2	0	2	3	0	0	0	0
Philadelphia	100	99	50	5	33	132	1	0	0	2	0	0	0	0
Philadelphia	150	98	1278	500	1241	2065	92	14	67	230	5	0	5	9
Philadelphia	150	99	892	321	855	1536	50	5	33	132	3	0	4	6
Philadelphia	200	98	2873	1555	2746	4264	679	216	635	1222	92	14	67	230
Philadelphia	200	99	2469	1297	2355	3713	461	116	420	878	50	5	33	132
Washington DC	As is		0	0	0	1	0	0	0	0	0	0	0	0
Washington DC	Current std		232	10	301	400	7	0	6	18	0	0	0	1
Washington DC	50	98	0	0	0	1	0	0	0	0	0	0	0	0
Washington DC	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Washington DC	100	98	92	0	87	197	1	0	0	6	0	0	0	1
Washington DC	100	99	44	0	51	112	0	0	0	2	0	0	0	0
Washington DC	150	98	1061	152	1140	1922	92	0	87	197	5	0	4	16
Washington DC	150	99	663	70	709	1286	44	0	51	112	2	0	1	7
Washington DC	200	98	2476	847	2734	3650	589	54	636	1156	92	0	87	197
Washington DC	200	99	1915	487	2095	3037	341	14	359	700	44	0	51	112
El Paso	As is		2	0	3	3	0	0	0	0	0	0	0	0
El Paso	Current std		768	535	860	909	79	39	93	105	15	4	17	24
El Paso	50	98	0	0	0	0	0	0	0	0	0	0	0	0
El Paso	50	99	0	0	0	0	0	0	0	0	0	0	0	0
El Paso	100	98	158	117	131	226	13	5	16	17	0	0	0	0
El Paso	100	99	79	50	72	115	5	1	6	8	0	0	0	0
El Paso	150	98	1112	943	1078	1315	158	117	131	226	25	12	31	33

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99	Mean	Min	Med	p99
El Paso	150	99	757	595	743	934	79	50	72	115	14	6	18	19
El Paso	200	98	2330	2153	2188	2649	686	535	664	860	158	117	131	226
El Paso	200	99	1891	1721	1794	2158	442	325	407	594	79	50	72	115
Las Vegas	As is		0	0	0	2	0	0	0	0	0	0	0	0
Las Vegas	Current std		543	0	514	1134	22	0	13	73	2	0	0	12
Las Vegas	50	98	0	0	0	0	0	0	0	0	0	0	0	0
Las Vegas	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Las Vegas	100	98	89	0	81	196	2	0	0	12	0	0	0	0
Las Vegas	100	99	43	0	37	97	1	0	0	3	0	0	0	0
Las Vegas	150	98	1038	1	1069	2033	89	0	81	196	5	0	3	17
Las Vegas	150	99	698	0	729	1386	43	0	37	97	3	0	1	13
Las Vegas	200	98	1825	39	1904	3647	615	0	632	1244	89	0	81	196
Las Vegas	200	99	1584	17	1660	3162	410	0	413	827	43	0	37	97
Phoenix	As is		2	0	1	6	0	0	0	0	0	0	0	0
Phoenix	Current std		133	3	157	268	2	0	1	7	0	0	0	0
Phoenix	50	98	0	0	0	0	0	0	0	0	0	0	0	0
Phoenix	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Phoenix	100	98	105	1	135	201	1	0	0	3	0	0	0	0
Phoenix	100	99	46	0	55	90	0	0	0	2	0	0	0	0
Phoenix	150	98	1681	504	2064	2634	105	1	135	201	5	0	5	12
Phoenix	150	99	1318	337	1640	2117	46	0	55	90	2	0	1	7
Phoenix	200	98	3238	1460	3766	4662	996	219	1238	1653	105	1	135	201
Phoenix	200	99	2934	1247	3470	4284	713	145	860	1222	46	0	55	90
St. Louis	As is		0	0	0	1	0	0	0	0	0	0	0	0
St. Louis	Current std		141	0	87	547	6	0	1	30	1	0	0	5
St. Louis	50	98	0	0	0	1	0	0	0	0	0	0	0	0
St. Louis	50	99	0	0	0	1	0	0	0	0	0	0	0	0
St. Louis	100	98	46	0	25	202	2	0	0	11	0	0	0	1
St. Louis	100	99	18	0	8	86	1	0	0	7	0	0	0	1
St. Louis	150	98	570	50	395	1760	46	0	25	202	3	0	0	17
St. Louis	150	99	309	10	194	1127	18	0	8	86	2	0	0	11
St. Louis	200	98	1687	375	1452	3880	309	10	194	1127	46	0	25	202
St. Louis	200	99	1219	207	968	3043	167	0	97	668	18	0	8	86

Table A-119. Estimated number of exceedances of 1-hour concentration levels (250 and 300 ppb) for monitors <100 m from a major road following adjustment to just meeting the current and alternative standards, 2001-2003 air quality.

Location	Scenario	Percentile	Exceedances of 250 ppb				Exceedances of 300 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99
Boston	As is		0	0	0	0	0	0	0	0
Boston	Current std		0	0	0	0	0	0	0	0
Boston	50	98	0	0	0	0	0	0	0	0
Boston	50	99	0	0	0	0	0	0	0	0
Boston	100	98	0	0	0	0	0	0	0	0
Boston	100	99	0	0	0	0	0	0	0	0
Boston	150	98	1	0	0	3	0	0	0	1
Boston	150	99	0	0	0	2	0	0	0	0
Boston	200	98	11	0	4	39	2	0	0	8
Boston	200	99	4	0	1	16	1	0	0	4
Chicago	As is		0	0	0	0	0	0	0	0
Chicago	Current std		0	0	0	0	0	0	0	0
Chicago	50	98	0	0	0	0	0	0	0	0
Chicago	50	99	0	0	0	0	0	0	0	0
Chicago	100	98	0	0	0	0	0	0	0	0
Chicago	100	99	0	0	0	0	0	0	0	0
Chicago	150	98	3	0	0	27	1	0	0	7
Chicago	150	99	2	0	0	21	1	0	0	5
Chicago	200	98	19	1	13	62	4	0	1	37
Chicago	200	99	9	0	3	42	3	0	0	28
Cleveland	As is		0	0	0	0	0	0	0	0
Cleveland	Current std		0	0	0	0	0	0	0	0
Cleveland	50	98	0	0	0	0	0	0	0	0
Cleveland	50	99	0	0	0	0	0	0	0	0
Cleveland	100	98	0	0	0	0	0	0	0	0
Cleveland	100	99	0	0	0	0	0	0	0	0
Cleveland	150	98	2	1	2	4	0	0	0	0
Cleveland	150	99	0	0	0	0	0	0	0	0
Cleveland	200	98	32	16	26	53	8	5	6	12
Cleveland	200	99	13	7	12	21	2	1	2	4
Denver	As is		0	0	0	0	0	0	0	0
Denver	Current std		0	0	0	0	0	0	0	0
Denver	50	98	0	0	0	0	0	0	0	0
Denver	50	99	0	0	0	0	0	0	0	0
Denver	100	98	0	0	0	0	0	0	0	0
Denver	100	99	0	0	0	0	0	0	0	0
Denver	150	98	12	5	12	19	5	1	5	8
Denver	150	99	8	4	8	11	1	1	1	1
Denver	200	98	36	20	36	52	17	8	17	26
Denver	200	99	21	9	21	33	11	5	11	17
Los Angeles	As is		0	0	0	1	0	0	0	0
Los Angeles	Current std		0	0	0	1	0	0	0	1
Los Angeles	50	98	0	0	0	0	0	0	0	0

Los Angeles	50	99	0	0	0	0	0	0	0	0
Los Angeles	100	98	0	0	0	1	0	0	0	1
Los Angeles	100	99	0	0	0	1	0	0	0	0
Los Angeles	150	98	0	0	0	6	0	0	0	3
Los Angeles	150	99	0	0	0	4	0	0	0	1
Los Angeles	200	98	7	0	2	34	1	0	0	8
Los Angeles	200	99	2	0	0	13	0	0	0	6
Miami	As is		0	0	0	0	0	0	0	0
Miami	Current std		1	0	0	2	0	0	0	2
Miami	50	98	0	0	0	0	0	0	0	0
Miami	50	99	0	0	0	0	0	0	0	0
Miami	100	98	0	0	0	0	0	0	0	0
Miami	100	99	0	0	0	0	0	0	0	0
Miami	150	98	1	0	0	4	0	0	0	2
Miami	150	99	1	0	0	2	0	0	0	0
Miami	200	98	20	1	16	56	4	0	1	17
Miami	200	99	8	0	4	31	1	0	0	5
New York	As is		0	0	0	0	0	0	0	0
New York	Current std		0	0	0	0	0	0	0	0
New York	50	98	0	0	0	0	0	0	0	0
New York	50	99	0	0	0	0	0	0	0	0
New York	100	98	0	0	0	0	0	0	0	0
New York	100	99	0	0	0	0	0	0	0	0
New York	150	98	1	0	0	7	0	0	0	2
New York	150	99	0	0	0	5	0	0	0	0
New York	200	98	11	0	5	60	2	0	0	18
New York	200	99	5	0	1	31	1	0	0	7
Philadelphia	As is		0	0	0	0	0	0	0	0
Philadelphia	Current std		0	0	0	0	0	0	0	0
Philadelphia	50	98	0	0	0	0	0	0	0	0
Philadelphia	50	99	0	0	0	0	0	0	0	0
Philadelphia	100	98	0	0	0	0	0	0	0	0
Philadelphia	100	99	0	0	0	0	0	0	0	0
Philadelphia	150	98	1	0	0	2	0	0	0	0
Philadelphia	150	99	0	0	0	0	0	0	0	0
Philadelphia	200	98	9	0	7	20	2	0	2	3
Philadelphia	200	99	5	0	5	9	1	0	0	2
Washington DC	As is		0	0	0	0	0	0	0	0
Washington DC	Current std		0	0	0	0	0	0	0	0
Washington DC	50	98	0	0	0	0	0	0	0	0
Washington DC	50	99	0	0	0	0	0	0	0	0
Washington DC	100	98	0	0	0	0	0	0	0	0
Washington DC	100	99	0	0	0	0	0	0	0	0
Washington DC	150	98	0	0	0	2	0	0	0	1
Washington DC	150	99	0	0	0	1	0	0	0	0
Washington DC	200	98	11	0	11	27	1	0	0	6
Washington DC	200	99	4	0	3	13	0	0	0	2
El Paso	As is		0	0	0	0	0	0	0	0
El Paso	Current std		3	0	3	6	0	0	0	0
El Paso	50	98	0	0	0	0	0	0	0	0

El Paso	50	99	0	0	0	0	0	0	0	0
El Paso	100	98	0	0	0	0	0	0	0	0
El Paso	100	99	0	0	0	0	0	0	0	0
El Paso	150	98	5	1	5	8	0	0	0	0
El Paso	150	99	3	0	3	5	0	0	0	0
El Paso	200	98	33	20	39	40	13	5	16	17
El Paso	200	99	19	9	23	26	5	1	6	8
Las Vegas	As is		0	0	0	0	0	0	0	0
Las Vegas	Current std		0	0	0	2	0	0	0	0
Las Vegas	50	98	0	0	0	0	0	0	0	0
Las Vegas	50	99	0	0	0	0	0	0	0	0
Las Vegas	100	98	0	0	0	0	0	0	0	0
Las Vegas	100	99	0	0	0	0	0	0	0	0
Las Vegas	150	98	1	0	0	3	0	0	0	0
Las Vegas	150	99	0	0	0	2	0	0	0	0
Las Vegas	200	98	10	0	5	35	2	0	0	12
Las Vegas	200	99	4	0	3	15	1	0	0	3
Phoenix	As is		0	0	0	0	0	0	0	0
Phoenix	Current std		0	0	0	0	0	0	0	0
Phoenix	50	98	0	0	0	0	0	0	0	0
Phoenix	50	99	0	0	0	0	0	0	0	0
Phoenix	100	98	0	0	0	0	0	0	0	0
Phoenix	100	99	0	0	0	0	0	0	0	0
Phoenix	150	98	0	0	0	1	0	0	0	0
Phoenix	150	99	0	0	0	0	0	0	0	0
Phoenix	200	98	8	0	9	20	1	0	0	3
Phoenix	200	99	5	0	5	12	0	0	0	2
St. Louis	As is		0	0	0	0	0	0	0	0
St. Louis	Current std		0	0	0	1	0	0	0	1
St. Louis	50	98	0	0	0	0	0	0	0	0
St. Louis	50	99	0	0	0	0	0	0	0	0
St. Louis	100	98	0	0	0	0	0	0	0	0
St. Louis	100	99	0	0	0	0	0	0	0	0
St. Louis	150	98	1	0	0	7	0	0	0	1
St. Louis	150	99	0	0	0	3	0	0	0	1
St. Louis	200	98	6	0	1	30	2	0	0	11
St. Louis	200	99	3	0	0	16	1	0	0	7

Table A-120. Estimated number of exceedances of 1-hour concentration levels (100, 150, and 200 ppb) for monitors ≥100 m from a major road following adjustment to just meeting the current and alternative standards, 2004-2006 air quality.

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99	Mean	Min	Med	p99
Boston	As is		0	0	0	0	0	0	0	0	0	0	0	0
Boston	Current std		13	0	15	31	0	0	0	0	0	0	0	0
Boston	50	98	0	0	0	0	0	0	0	0	0	0	0	0
Boston	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Boston	100	98	5	0	2	18	0	0	0	0	0	0	0	0
Boston	100	99	0	0	0	3	0	0	0	0	0	0	0	0
Boston	150	98	169	55	156	291	5	0	2	18	0	0	0	0
Boston	150	99	101	30	85	200	0	0	0	3	0	0	0	0
Boston	200	98	512	255	498	708	83	24	68	174	5	0	2	18
Boston	200	99	400	183	374	574	42	10	38	96	0	0	0	3
Chicago	As is		0	0	0	0	0	0	0	0	0	0	0	0
Chicago	Current std		66	15	28	238	1	0	0	4	0	0	0	0
Chicago	50	98	0	0	0	0	0	0	0	0	0	0	0	0
Chicago	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Chicago	100	98	25	4	7	105	0	0	0	0	0	0	0	0
Chicago	100	99	10	0	4	46	0	0	0	0	0	0	0	0
Chicago	150	98	399	90	290	874	25	4	7	105	0	0	0	3
Chicago	150	99	247	50	149	601	10	0	4	46	0	0	0	0
Chicago	200	98	1311	584	1133	2227	218	41	123	551	25	4	7	105
Chicago	200	99	965	398	802	1742	110	24	49	330	10	0	4	46
Denver	As is		1	0	0	4	0	0	0	0	0	0	0	0
Denver	Current std		212	76	229	330	12	2	9	24	1	0	0	3
Denver	50	98	0	0	0	1	0	0	0	0	0	0	0	0
Denver	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Denver	100	98	144	66	169	196	7	1	3	16	0	0	0	1
Denver	100	99	72	23	90	103	4	0	2	9	0	0	0	0
Denver	150	98	1403	1148	1527	1533	144	66	169	196	19	6	19	31
Denver	150	99	952	780	1021	1055	72	23	90	103	10	2	7	20
Denver	200	98	2527	1957	2675	2948	851	689	906	959	144	66	169	196
Denver	200	99	2142	1683	2287	2457	505	374	549	591	72	23	90	103

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99	Mean	Min	Med	p99
Detroit	As is		0	0	0	0	0	0	0	0	0	0	0	0
Detroit	Current std		662	463	661	841	36	25	31	54	1	0	0	4
Detroit	50	98	0	0	0	0	0	0	0	0	0	0	0	0
Detroit	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Detroit	100	98	158	41	148	321	3	0	2	8	0	0	0	0
Detroit	100	99	80	9	75	184	1	0	1	4	0	0	0	0
Detroit	150	98	1088	686	1071	1597	158	41	148	321	12	0	12	31
Detroit	150	99	866	504	860	1341	80	9	75	184	4	0	2	9
Detroit	200	98	2338	1829	2271	3253	774	415	777	1226	158	41	148	321
Detroit	200	99	1966	1480	1894	2774	530	250	549	868	80	9	75	184
Los Angeles	As is		1	0	0	5	0	0	0	0	0	0	0	0
Los Angeles	Current std		55	0	38	280	1	0	0	9	0	0	0	0
Los Angeles	50	98	0	0	0	0	0	0	0	0	0	0	0	0
Los Angeles	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Los Angeles	100	98	36	0	20	176	1	0	0	7	0	0	0	0
Los Angeles	100	99	16	0	7	79	0	0	0	3	0	0	0	0
Los Angeles	150	98	430	4	388	1577	36	0	20	176	3	0	1	20
Los Angeles	150	99	271	1	240	1045	16	0	7	79	1	0	0	8
Los Angeles	200	98	1339	36	1222	3826	241	0	203	957	36	0	20	176
Los Angeles	200	99	918	19	841	2907	134	0	104	560	16	0	7	79
Miami	As is		0	0	0	0	0	0	0	0	0	0	0	0
Miami	Current std		493	167	475	854	102	11	83	231	19	0	8	62
Miami	50	98	0	0	0	1	0	0	0	0	0	0	0	0
Miami	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Miami	100	98	57	3	51	124	3	0	2	9	0	0	0	1
Miami	100	99	27	0	20	68	1	0	0	2	0	0	0	0
Miami	150	98	367	114	364	628	57	3	51	124	10	0	5	29
Miami	150	99	229	52	229	405	27	0	20	68	2	0	2	5
Miami	200	98	793	382	777	1237	229	52	229	405	57	3	51	124
Miami	200	99	578	243	560	948	136	22	126	269	27	0	20	68
New York	As is		1	0	0	3	0	0	0	0	0	0	0	0
New York	Current std		34	0	24	154	1	0	0	3	0	0	0	1
New York	50	98	0	0	0	1	0	0	0	0	0	0	0	0

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99	Mean	Min	Med	p99
New York	50	99	0	0	0	1	0	0	0	0	0	0	0	0
New York	100	98	36	0	33	92	1	0	0	5	0	0	0	1
New York	100	99	16	0	12	46	0	0	0	3	0	0	0	1
New York	150	98	521	10	582	963	36	0	33	92	2	0	1	11
New York	150	99	323	0	348	630	16	0	12	46	1	0	0	6
New York	200	98	1440	211	1583	2448	285	0	309	566	36	0	33	92
New York	200	99	1089	111	1201	1854	149	0	163	347	16	0	12	46
Philadelphia	As is		0	0	0	0	0	0	0	0	0	0	0	0
Philadelphia	Current std		222	9	105	617	8	0	3	29	0	0	0	2
Philadelphia	50	98	0	0	0	0	0	0	0	0	0	0	0	0
Philadelphia	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Philadelphia	100	98	58	3	50	163	1	0	0	7	0	0	0	0
Philadelphia	100	99	31	1	21	108	0	0	0	2	0	0	0	0
Philadelphia	150	98	734	368	660	1420	58	3	50	163	4	0	1	23
Philadelphia	150	99	572	253	519	1103	31	1	21	108	2	0	0	12
Philadelphia	200	98	1916	1300	1739	3484	435	176	413	850	58	3	50	163
Philadelphia	200	99	1595	1007	1440	2985	275	91	276	565	31	1	21	108
Washington DC	As is		0	0	0	3	0	0	0	0	0	0	0	0
Washington DC	Current std		214	0	219	683	8	0	3	39	1	0	0	6
Washington DC	50	98	0	0	0	3	0	0	0	0	0	0	0	0
Washington DC	50	99	0	0	0	1	0	0	0	0	0	0	0	0
Washington DC	100	98	75	0	64	256	2	0	0	13	0	0	0	3
Washington DC	100	99	39	0	18	165	1	0	0	8	0	0	0	1
Washington DC	150	98	714	24	649	1599	75	0	64	256	5	0	1	25
Washington DC	150	99	503	2	416	1237	39	0	18	165	3	0	1	14
Washington DC	200	98	1534	180	1632	3038	446	0	378	1120	75	0	64	256
Washington DC	200	99	1287	116	1313	2636	301	0	246	825	39	0	18	165
Atlanta	As is		0	0	0	5	0	0	0	0	0	0	0	0
Atlanta	Current std		509	1	615	1187	70	0	28	284	8	0	0	56
Atlanta	50	98	0	0	0	4	0	0	0	0	0	0	0	0
Atlanta	50	99	0	0	0	2	0	0	0	0	0	0	0	0
Atlanta	100	98	46	0	12	202	1	0	0	11	0	0	0	4
Atlanta	100	99	21	0	3	109	1	0	0	7	0	0	0	2

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99	Mean	Min	Med	p99
Atlanta	150	98	390	0	413	959	46	0	12	202	4	0	0	34
Atlanta	150	99	252	0	218	704	21	0	3	109	2	0	0	12
Atlanta	200	98	883	9	1184	1831	252	0	218	704	46	0	12	202
Atlanta	200	99	687	3	862	1487	135	0	77	454	21	0	3	109
El Paso	As is		0	0	0	0	0	0	0	0	0	0	0	0
El Paso	Current std		649	177	655	1088	64	7	54	190	8	0	7	27
El Paso	50	98	0	0	0	1	0	0	0	0	0	0	0	0
El Paso	50	99	0	0	0	0	0	0	0	0	0	0	0	0
El Paso	100	98	81	11	66	190	4	0	3	13	0	0	0	1
El Paso	100	99	47	7	37	123	1	0	1	5	0	0	0	0
El Paso	150	98	727	258	706	1317	81	11	66	190	10	0	10	28
El Paso	150	99	508	143	462	987	47	7	37	123	5	0	4	17
El Paso	200	98	1605	695	1691	2441	449	122	397	894	81	11	66	190
El Paso	200	99	1356	556	1415	2125	295	66	239	649	47	7	37	123
Jacksonville	As is		8	0	8	15	3	0	3	6	1	0	1	1
Jacksonville	Current std		816	751	816	880	161	139	161	183	43	14	43	72
Jacksonville	50	98	13	0	13	25	5	0	5	10	2	0	2	4
Jacksonville	50	99	10	0	10	19	4	0	4	7	1	0	1	2
Jacksonville	100	98	151	119	151	183	29	4	29	54	13	0	13	25
Jacksonville	100	99	66	32	66	100	21	0	21	41	10	0	10	19
Jacksonville	150	98	816	751	816	880	151	119	151	183	42	11	42	72
Jacksonville	150	99	437	418	437	455	66	32	66	100	27	3	27	51
Jacksonville	200	98	1593	1526	1593	1660	492	478	492	505	151	119	151	183
Jacksonville	200	99	1139	1065	1139	1213	254	246	254	261	66	32	66	100
Las Vegas	As is		0	0	0	0	0	0	0	0	0	0	0	0
Las Vegas	Current std		296	0	15	1209	9	0	0	43	0	0	0	1
Las Vegas	50	98	0	0	0	0	0	0	0	0	0	0	0	0
Las Vegas	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Las Vegas	100	98	42	0	1	182	0	0	0	1	0	0	0	0
Las Vegas	100	99	23	0	0	88	0	0	0	0	0	0	0	0
Las Vegas	150	98	542	4	45	2121	42	0	1	182	1	0	0	5
Las Vegas	150	99	437	1	31	1767	23	0	0	88	1	0	0	3
Las Vegas	200	98	999	13	172	3377	338	0	23	1372	42	0	1	182

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99	Mean	Min	Med	p99
Las Vegas	200	99	936	11	142	3249	257	0	11	1058	23	0	0	88
Phoenix	As is		0	0	0	1	0	0	0	0	0	0	0	0
Phoenix	Current std		102	41	62	253	1	0	0	4	0	0	0	0
Phoenix	50	98	0	0	0	0	0	0	0	0	0	0	0	0
Phoenix	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Phoenix	100	98	39	9	33	74	0	0	0	2	0	0	0	0
Phoenix	100	99	15	0	15	32	0	0	0	0	0	0	0	0
Phoenix	150	98	1113	793	1032	1453	39	9	33	74	2	0	1	7
Phoenix	150	99	804	534	681	1137	15	0	15	32	1	0	0	3
Phoenix	200	98	2726	1971	2820	3109	630	399	524	949	39	9	33	74
Phoenix	200	99	2223	1614	2304	2642	351	219	264	601	15	0	15	32
Provo	As is		202	0	0	606	13	0	0	39	0	0	0	0
Provo	Current std		790	727	778	864	259	6	115	655	176	0	1	526
Provo	50	98	0	0	0	1	0	0	0	0	0	0	0	0
Provo	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Provo	100	98	219	0	2	655	130	0	0	390	0	0	0	1
Provo	100	99	215	0	1	645	96	0	0	289	0	0	0	0
Provo	150	98	325	18	229	727	219	0	2	655	175	0	0	526
Provo	150	99	292	6	163	706	215	0	1	645	153	0	0	460
Provo	200	98	939	625	986	1206	279	1	137	698	219	0	2	655
Provo	200	99	681	345	686	1013	261	0	92	691	215	0	1	645
St. Louis	As is		0	0	0	0	0	0	0	0	0	0	0	0
St. Louis	Current std		289	31	182	762	17	0	1	66	1	0	0	2
St. Louis	50	98	0	0	0	0	0	0	0	0	0	0	0	0
St. Louis	50	99	0	0	0	0	0	0	0	0	0	0	0	0
St. Louis	100	98	44	1	33	110	0	0	0	0	0	0	0	0
St. Louis	100	99	25	0	20	60	0	0	0	0	0	0	0	0
St. Louis	150	98	584	351	533	918	44	1	33	110	1	0	1	2
St. Louis	150	99	460	259	412	757	25	0	20	60	0	0	0	1
St. Louis	200	98	1356	920	1278	1947	358	182	317	616	44	1	33	110
St. Louis	200	99	1227	841	1148	1770	269	119	230	498	25	0	20	60
Other MSA/CMSA	As is		0	0	0	3	0	0	0	0	0	0	0	0
Other MSA/CMSA	Current std		93	0	25	748	5	0	0	66	0	0	0	5

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99	Mean	Min	Med	p99
Other MSA/CMSA	50	98	0	0	0	2	0	0	0	0	0	0	0	0
Other MSA/CMSA	50	99	0	0	0	1	0	0	0	0	0	0	0	0
Other MSA/CMSA	100	98	8	0	0	123	0	0	0	5	0	0	0	2
Other MSA/CMSA	100	99	3	0	0	52	0	0	0	3	0	0	0	1
Other MSA/CMSA	150	98	136	0	56	1175	8	0	0	123	1	0	0	17
Other MSA/CMSA	150	99	77	0	23	752	3	0	0	52	0	0	0	5
Other MSA/CMSA	200	98	485	0	330	2552	66	0	17	655	8	0	0	123
Other MSA/CMSA	200	99	340	0	211	2064	31	0	6	347	3	0	0	52
Other Not MSA	As is		0	0	0	4	0	0	0	2	0	0	0	1
Other Not MSA	Current std		134	0	18	1195	19	0	0	306	3	0	0	56
Other Not MSA	50	98	0	0	0	4	0	0	0	2	0	0	0	1
Other Not MSA	50	99	0	0	0	2	0	0	0	2	0	0	0	1
Other Not MSA	100	98	10	0	0	140	1	0	0	18	0	0	0	4
Other Not MSA	100	99	6	0	0	85	1	0	0	11	0	0	0	2
Other Not MSA	150	98	93	0	8	879	10	0	0	140	2	0	0	34
Other Not MSA	150	99	63	0	4	697	6	0	0	85	1	0	0	22
Other Not MSA	200	98	258	0	55	1616	49	0	2	596	10	0	0	140
Other Not MSA	200	99	201	0	34	1364	33	0	1	437	6	0	0	85

Table A-121. Estimated number of exceedances of 1-hour concentration levels (250 and 300 ppb) for monitors ≥100 m from a major road following adjustment to just meeting the current and alternative standards, 2004-2006 air quality.

Location	Scenario	Percentile	Exceedances of 250 ppb				Exceedances of 300 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99
Boston	As is		0	0	0	0	0	0	0	0
Boston	Current std		0	0	0	0	0	0	0	0
Boston	50	98	0	0	0	0	0	0	0	0
Boston	50	99	0	0	0	0	0	0	0	0
Boston	100	98	0	0	0	0	0	0	0	0
Boston	100	99	0	0	0	0	0	0	0	0
Boston	150	98	0	0	0	0	0	0	0	0
Boston	150	99	0	0	0	0	0	0	0	0
Boston	200	98	0	0	0	0	0	0	0	0
Boston	200	99	0	0	0	0	0	0	0	0
Chicago	As is		0	0	0	0	0	0	0	0
Chicago	Current std		0	0	0	0	0	0	0	0
Chicago	50	98	0	0	0	0	0	0	0	0
Chicago	50	99	0	0	0	0	0	0	0	0
Chicago	100	98	0	0	0	0	0	0	0	0
Chicago	100	99	0	0	0	0	0	0	0	0
Chicago	150	98	0	0	0	0	0	0	0	0
Chicago	150	99	0	0	0	0	0	0	0	0
Chicago	200	98	2	0	1	11	0	0	0	0
Chicago	200	99	0	0	0	1	0	0	0	0
Denver	As is		0	0	0	0	0	0	0	0
Denver	Current std		0	0	0	0	0	0	0	0
Denver	50	98	0	0	0	0	0	0	0	0
Denver	50	99	0	0	0	0	0	0	0	0
Denver	100	98	0	0	0	0	0	0	0	0
Denver	100	99	0	0	0	0	0	0	0	0
Denver	150	98	3	0	2	7	0	0	0	1
Denver	150	99	1	0	0	4	0	0	0	0
Denver	200	98	28	6	31	48	7	1	3	16
Denver	200	99	15	4	13	28	4	0	2	9
Detroit	As is		0	0	0	0	0	0	0	0
Detroit	Current std		0	0	0	0	0	0	0	0
Detroit	50	98	0	0	0	0	0	0	0	0
Detroit	50	99	0	0	0	0	0	0	0	0
Detroit	100	98	0	0	0	0	0	0	0	0
Detroit	100	99	0	0	0	0	0	0	0	0
Detroit	150	98	1	0	1	3	0	0	0	0
Detroit	150	99	0	0	0	1	0	0	0	0
Detroit	200	98	26	1	24	67	3	0	2	8
Detroit	200	99	10	0	9	24	1	0	1	4
Los Angeles	As is		0	0	0	0	0	0	0	0
Los Angeles	Current std		0	0	0	0	0	0	0	0
Los Angeles	50	98	0	0	0	0	0	0	0	0
Los Angeles	50	99	0	0	0	0	0	0	0	0

Location	Scenario	Percentile	Exceedances of 250 ppb				Exceedances of 300 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99
Los Angeles	100	98	0	0	0	0	0	0	0	0
Los Angeles	100	99	0	0	0	0	0	0	0	0
Los Angeles	150	98	0	0	0	3	0	0	0	0
Los Angeles	150	99	0	0	0	1	0	0	0	0
Los Angeles	200	98	6	0	2	36	1	0	0	7
Los Angeles	200	99	2	0	0	15	0	0	0	3
Miami	As is		0	0	0	0	0	0	0	0
Miami	Current std		4	0	2	12	1	0	0	2
Miami	50	98	0	0	0	0	0	0	0	0
Miami	50	99	0	0	0	0	0	0	0	0
Miami	100	98	0	0	0	0	0	0	0	0
Miami	100	99	0	0	0	0	0	0	0	0
Miami	150	98	1	0	1	2	0	0	0	1
Miami	150	99	0	0	0	1	0	0	0	0
Miami	200	98	13	0	8	38	3	0	2	9
Miami	200	99	5	0	2	14	1	0	0	2
New York	As is		0	0	0	0	0	0	0	0
New York	Current std		0	0	0	1	0	0	0	0
New York	50	98	0	0	0	0	0	0	0	0
New York	50	99	0	0	0	0	0	0	0	0
New York	100	98	0	0	0	0	0	0	0	0
New York	100	99	0	0	0	0	0	0	0	0
New York	150	98	0	0	0	3	0	0	0	1
New York	150	99	0	0	0	1	0	0	0	1
New York	200	98	4	0	2	17	1	0	0	5
New York	200	99	2	0	1	10	0	0	0	3
Philadelphia	As is		0	0	0	0	0	0	0	0
Philadelphia	Current std		0	0	0	0	0	0	0	0
Philadelphia	50	98	0	0	0	0	0	0	0	0
Philadelphia	50	99	0	0	0	0	0	0	0	0
Philadelphia	100	98	0	0	0	0	0	0	0	0
Philadelphia	100	99	0	0	0	0	0	0	0	0
Philadelphia	150	98	0	0	0	2	0	0	0	0
Philadelphia	150	99	0	0	0	1	0	0	0	0
Philadelphia	200	98	8	0	3	41	1	0	0	7
Philadelphia	200	99	4	0	1	21	0	0	0	2
Washington DC	As is		0	0	0	0	0	0	0	0
Washington DC	Current std		0	0	0	2	0	0	0	1
Washington DC	50	98	0	0	0	0	0	0	0	0
Washington DC	50	99	0	0	0	0	0	0	0	0
Washington DC	100	98	0	0	0	0	0	0	0	0
Washington DC	100	99	0	0	0	0	0	0	0	0
Washington DC	150	98	1	0	0	7	0	0	0	3
Washington DC	150	99	1	0	0	5	0	0	0	1
Washington DC	200	98	11	0	2	51	2	0	0	13
Washington DC	200	99	5	0	1	25	1	0	0	8
Atlanta	As is		0	0	0	0	0	0	0	0

Location	Scenario	Percentile	Exceedances of 250 ppb				Exceedances of 300 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99
Atlanta	Current std		1	0	0	10	0	0	0	5
Atlanta	50	98	0	0	0	0	0	0	0	0
Atlanta	50	99	0	0	0	0	0	0	0	0
Atlanta	100	98	0	0	0	0	0	0	0	0
Atlanta	100	99	0	0	0	0	0	0	0	0
Atlanta	150	98	1	0	0	7	0	0	0	4
Atlanta	150	99	0	0	0	5	0	0	0	2
Atlanta	200	98	7	0	0	49	1	0	0	11
Atlanta	200	99	3	0	0	29	1	0	0	7
El Paso	As is		0	0	0	0	0	0	0	0
El Paso	Current std		1	0	0	3	0	0	0	0
El Paso	50	98	0	0	0	0	0	0	0	0
El Paso	50	99	0	0	0	0	0	0	0	0
El Paso	100	98	0	0	0	0	0	0	0	0
El Paso	100	99	0	0	0	0	0	0	0	0
El Paso	150	98	1	0	0	3	0	0	0	1
El Paso	150	99	0	0	0	2	0	0	0	0
El Paso	200	98	16	1	17	38	4	0	3	13
El Paso	200	99	8	0	9	24	1	0	1	5
Jacksonville	As is		0	0	0	0	0	0	0	0
Jacksonville	Current std		24	1	24	46	13	0	13	25
Jacksonville	50	98	1	0	1	2	0	0	0	0
Jacksonville	50	99	0	0	0	0	0	0	0	0
Jacksonville	100	98	8	0	8	16	5	0	5	10
Jacksonville	100	99	6	0	6	11	4	0	4	7
Jacksonville	150	98	23	0	23	46	13	0	13	25
Jacksonville	150	99	14	0	14	28	10	0	10	19
Jacksonville	200	98	54	22	54	85	29	4	29	54
Jacksonville	200	99	32	5	32	58	21	0	21	41
Las Vegas	As is		0	0	0	0	0	0	0	0
Las Vegas	Current std		0	0	0	0	0	0	0	0
Las Vegas	50	98	0	0	0	0	0	0	0	0
Las Vegas	50	99	0	0	0	0	0	0	0	0
Las Vegas	100	98	0	0	0	0	0	0	0	0
Las Vegas	100	99	0	0	0	0	0	0	0	0
Las Vegas	150	98	0	0	0	0	0	0	0	0
Las Vegas	150	99	0	0	0	0	0	0	0	0
Las Vegas	200	98	2	0	0	11	0	0	0	1
Las Vegas	200	99	1	0	0	6	0	0	0	0
Phoenix	As is		0	0	0	0	0	0	0	0
Phoenix	Current std		0	0	0	0	0	0	0	0
Phoenix	50	98	0	0	0	0	0	0	0	0
Phoenix	50	99	0	0	0	0	0	0	0	0
Phoenix	100	98	0	0	0	0	0	0	0	0
Phoenix	100	99	0	0	0	0	0	0	0	0
Phoenix	150	98	0	0	0	0	0	0	0	0
Phoenix	150	99	0	0	0	0	0	0	0	0

Location	Scenario	Percentile	Exceedances of 250 ppb				Exceedances of 300 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99
Phoenix	200	98	3	0	1	8	0	0	0	2
Phoenix	200	99	1	0	1	6	0	0	0	0
Provo	As is		0	0	0	0	0	0	0	0
Provo	Current std		68	0	0	205	0	0	0	1
Provo	50	98	0	0	0	0	0	0	0	0
Provo	50	99	0	0	0	0	0	0	0	0
Provo	100	98	0	0	0	0	0	0	0	0
Provo	100	99	0	0	0	0	0	0	0	0
Provo	150	98	68	0	0	205	0	0	0	1
Provo	150	99	25	0	0	75	0	0	0	0
Provo	200	98	196	0	0	589	130	0	0	390
Provo	200	99	175	0	0	526	96	0	0	289
St. Louis	As is		0	0	0	0	0	0	0	0
St. Louis	Current std		0	0	0	0	0	0	0	0
St. Louis	50	98	0	0	0	0	0	0	0	0
St. Louis	50	99	0	0	0	0	0	0	0	0
St. Louis	100	98	0	0	0	0	0	0	0	0
St. Louis	100	99	0	0	0	0	0	0	0	0
St. Louis	150	98	0	0	0	0	0	0	0	0
St. Louis	150	99	0	0	0	0	0	0	0	0
St. Louis	200	98	2	0	1	5	0	0	0	0
St. Louis	200	99	1	0	1	2	0	0	0	0
Other MSA/CMSA	As is		0	0	0	0	0	0	0	0
Other MSA/CMSA	Current std		0	0	0	2	0	0	0	1
Other MSA/CMSA	50	98	0	0	0	0	0	0	0	0
Other MSA/CMSA	50	99	0	0	0	0	0	0	0	0
Other MSA/CMSA	100	98	0	0	0	0	0	0	0	0
Other MSA/CMSA	100	99	0	0	0	0	0	0	0	0
Other MSA/CMSA	150	98	0	0	0	3	0	0	0	2
Other MSA/CMSA	150	99	0	0	0	2	0	0	0	1
Other MSA/CMSA	200	98	1	0	0	25	0	0	0	5
Other MSA/CMSA	200	99	0	0	0	9	0	0	0	3
Other Not MSA	As is		0	0	0	1	0	0	0	0
Other Not MSA	Current std		1	0	0	14	0	0	0	8
Other Not MSA	50	98	0	0	0	1	0	0	0	0
Other Not MSA	50	99	0	0	0	0	0	0	0	0
Other Not MSA	100	98	0	0	0	2	0	0	0	2
Other Not MSA	100	99	0	0	0	2	0	0	0	2
Other Not MSA	150	98	1	0	0	11	0	0	0	4
Other Not MSA	150	99	0	0	0	7	0	0	0	2
Other Not MSA	200	98	2	0	0	42	1	0	0	18
Other Not MSA	200	99	1	0	0	33	1	0	0	11

1 **Table A-122. Estimated number of exceedances of 1-hour concentration levels (100, 150, and 200 ppb) for monitors <100 m from a major road**
2 **following adjustment to just meeting the current and alternative standards, 2004-2006 air quality.**

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99	Mean	Min	Med	p99
Boston	As is		0	0	0	1	0	0	0	0	0	0	0	0
Boston	Current std		101	6	54	324	3	0	1	16	0	0	0	2
Boston	50	98	0	0	0	1	0	0	0	0	0	0	0	0
Boston	50	99	0	0	0	1	0	0	0	0	0	0	0	0
Boston	100	98	78	2	37	242	2	0	0	9	0	0	0	1
Boston	100	99	34	0	11	113	1	0	0	5	0	0	0	1
Boston	150	98	795	125	628	2015	78	2	37	242	6	0	1	29
Boston	150	99	529	64	388	1404	34	0	11	113	3	0	1	15
Boston	200	98	2028	699	1726	4268	457	49	330	1263	78	2	37	242
Boston	200	99	1646	498	1387	3617	294	25	199	837	34	0	11	113
Chicago	As is		1	0	0	5	0	0	0	0	0	0	0	0
Chicago	Current std		218	10	242	402	6	0	3	20	0	0	0	2
Chicago	50	98	0	0	0	2	0	0	0	0	0	0	0	0
Chicago	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Chicago	100	98	88	0	69	203	2	0	0	11	0	0	0	2
Chicago	100	99	40	0	36	106	1	0	0	4	0	0	0	0
Chicago	150	98	1013	256	1061	1719	88	0	69	203	5	0	2	25
Chicago	150	99	669	132	663	1203	40	0	36	106	2	0	0	11
Chicago	200	98	2594	1003	2924	3738	602	104	589	1105	88	0	69	203
Chicago	200	99	2056	691	2257	3118	337	33	329	680	40	0	36	106
Cleveland	As is		0	0	0	1	0	0	0	1	0	0	0	0
Cleveland	Current std		509	388	536	680	33	21	32	48	1	0	1	2
Cleveland	50	98	0	0	0	1	0	0	0	1	0	0	0	0
Cleveland	50	99	0	0	0	1	0	0	0	1	0	0	0	0
Cleveland	100	98	137	34	168	212	6	0	5	14	0	0	0	1
Cleveland	100	99	78	18	87	140	2	0	1	4	0	0	0	1
Cleveland	150	98	1016	534	923	1411	137	34	168	212	17	4	16	39
Cleveland	150	99	684	322	662	1011	78	18	87	140	7	0	5	18
Cleveland	200	98	2184	1310	2012	3035	632	288	622	901	137	34	168	212
Cleveland	200	99	1819	1065	1653	2501	472	189	474	688	78	18	87	140
Denver	As is		2	2	2	3	0	0	0	1	0	0	0	0

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99	Mean	Min	Med	p99
Denver	Current std		243	187	254	288	5	4	5	7	2	1	1	3
Denver	50	98	2	1	1	3	0	0	0	1	0	0	0	0
Denver	50	99	1	0	0	2	0	0	0	0	0	0	0	0
Denver	100	98	154	130	163	169	4	4	4	5	2	1	1	3
Denver	100	99	63	55	66	68	4	3	4	4	1	0	0	2
Denver	150	98	1918	1711	2000	2043	154	130	163	169	11	11	11	12
Denver	150	99	1304	1138	1382	1391	63	55	66	68	5	4	6	6
Denver	200	98	3752	3591	3766	3899	1177	1025	1245	1260	154	130	163	169
Denver	200	99	3086	2882	3153	3224	725	625	761	788	63	55	66	68
Los Angeles	As is		3	0	1	15	0	0	0	2	0	0	0	0
Los Angeles	Current std		163	0	165	419	5	0	2	22	0	0	0	5
Los Angeles	50	98	0	0	0	5	0	0	0	0	0	0	0	0
Los Angeles	50	99	0	0	0	2	0	0	0	0	0	0	0	0
Los Angeles	100	98	105	0	99	301	4	0	2	22	0	0	0	5
Los Angeles	100	99	47	0	38	162	1	0	0	10	0	0	0	2
Los Angeles	150	98	1031	19	1178	1956	105	0	99	301	10	0	5	49
Los Angeles	150	99	691	8	766	1364	47	0	38	162	5	0	2	28
Los Angeles	200	98	2571	244	2601	4079	626	6	686	1242	105	0	99	301
Los Angeles	200	99	1911	105	2066	3258	368	1	389	818	47	0	38	162
Miami	As is		3	0	0	12	1	0	0	5	1	0	0	3
Miami	Current std		691	377	709	970	195	91	201	286	36	15	30	69
Miami	50	98	5	0	0	18	1	0	0	5	1	0	0	4
Miami	50	99	3	0	0	13	1	0	0	5	1	0	0	3
Miami	100	98	117	53	114	189	6	0	1	22	5	0	0	18
Miami	100	99	53	18	54	87	5	0	0	20	3	0	0	13
Miami	150	98	557	306	549	825	117	53	114	189	15	3	12	34
Miami	150	99	377	210	368	561	53	18	54	87	6	0	1	21
Miami	200	98	1031	600	1019	1487	377	210	368	561	117	53	114	189
Miami	200	99	783	471	759	1141	239	134	237	350	53	18	54	87
New York	As is		2	0	2	6	0	0	0	1	0	0	0	0
New York	Current std		106	6	94	256	3	0	0	10	1	0	0	5
New York	50	98	0	0	0	2	0	0	0	0	0	0	0	0
New York	50	99	0	0	0	2	0	0	0	0	0	0	0	0

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99	Mean	Min	Med	p99
New York	100	98	112	8	110	245	4	0	5	10	0	0	0	2
New York	100	99	55	6	50	130	2	0	0	6	0	0	0	2
New York	150	98	1328	280	1207	2661	112	8	110	245	10	0	11	26
New York	150	99	879	127	814	1790	55	6	50	130	5	0	5	10
New York	200	98	3112	1197	2885	5534	787	106	735	1597	112	8	110	245
New York	200	99	2490	826	2291	4698	441	47	422	914	55	6	50	130
Philadelphia	As is		1	0	1	2	0	0	0	0	0	0	0	0
Philadelphia	Current std		291	96	205	768	18	5	6	78	5	0	1	25
Philadelphia	50	98	1	0	0	2	0	0	0	0	0	0	0	0
Philadelphia	50	99	1	0	0	2	0	0	0	0	0	0	0	0
Philadelphia	100	98	123	67	112	220	6	3	5	15	1	0	0	2
Philadelphia	100	99	69	35	55	128	3	2	3	7	1	0	0	2
Philadelphia	150	98	1201	686	1267	1774	123	67	112	220	11	5	9	24
Philadelphia	150	99	952	535	1006	1452	69	35	55	128	8	5	7	18
Philadelphia	200	98	2868	1704	2793	4130	747	406	798	1159	123	67	112	220
Philadelphia	200	99	2430	1429	2382	3520	514	273	556	814	69	35	55	128
Washington DC	As is		0	0	0	1	0	0	0	0	0	0	0	0
Washington DC	Current std		247	23	250	510	5	0	3	13	0	0	0	2
Washington DC	50	98	0	0	0	1	0	0	0	0	0	0	0	0
Washington DC	50	99	0	0	0	1	0	0	0	0	0	0	0	0
Washington DC	100	98	79	7	62	202	1	0	0	8	0	0	0	1
Washington DC	100	99	39	0	27	103	0	0	0	1	0	0	0	1
Washington DC	150	98	895	389	773	1700	79	7	62	202	3	0	1	14
Washington DC	150	99	629	231	567	1227	39	0	27	103	2	0	1	9
Washington DC	200	98	1974	925	1698	3326	550	186	492	1093	79	7	62	202
Washington DC	200	99	1653	761	1425	2839	363	100	308	725	39	0	27	103
El Paso	As is		0	0	0	0	0	0	0	0	0	0	0	0
El Paso	Current std		617	461	517	873	64	37	51	103	12	6	11	20
El Paso	50	98	0	0	0	0	0	0	0	0	0	0	0	0
El Paso	50	99	0	0	0	0	0	0	0	0	0	0	0	0
El Paso	100	98	85	51	66	137	8	4	9	10	0	0	0	0
El Paso	100	99	48	30	34	79	3	2	3	4	0	0	0	0
El Paso	150	98	697	461	666	963	85	51	66	137	16	7	12	28

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99	Mean	Min	Med	p99
El Paso	150	99	478	306	433	695	48	30	34	79	9	5	10	13
El Paso	200	98	1636	1263	1607	2039	425	267	384	624	85	51	66	137
El Paso	200	99	1354	1010	1340	1712	288	158	264	443	48	30	34	79
Las Vegas	As is		0	0	0	0	0	0	0	0	0	0	0	0
Las Vegas	Current std		1113	998	1113	1228	38	24	38	52	0	0	0	0
Las Vegas	50	98	0	0	0	0	0	0	0	0	0	0	0	0
Las Vegas	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Las Vegas	100	98	181	123	181	238	1	0	1	1	0	0	0	0
Las Vegas	100	99	105	58	105	152	0	0	0	0	0	0	0	0
Las Vegas	150	98	1883	1755	1883	2010	181	123	181	238	5	1	5	8
Las Vegas	150	99	1558	1443	1558	1672	105	58	105	152	3	1	3	4
Las Vegas	200	98	3169	3007	3169	3330	1258	1144	1258	1371	181	123	181	238
Las Vegas	200	99	3025	2868	3025	3181	988	878	988	1097	105	58	105	152
Phoenix	As is		2	0	0	6	0	0	0	0	0	0	0	0
Phoenix	Current std		158	0	26	562	3	0	0	13	0	0	0	1
Phoenix	50	98	0	0	0	1	0	0	0	0	0	0	0	0
Phoenix	50	99	0	0	0	0	0	0	0	0	0	0	0	0
Phoenix	100	98	74	0	11	242	2	0	0	7	0	0	0	1
Phoenix	100	99	36	0	4	110	1	0	0	4	0	0	0	0
Phoenix	150	98	1047	7	548	2326	74	0	11	242	4	0	0	14
Phoenix	150	99	799	3	380	1853	36	0	4	110	3	0	0	12
Phoenix	200	98	2236	110	1597	4452	649	0	280	1588	74	0	11	242
Phoenix	200	99	1883	50	1234	3845	410	0	143	1080	36	0	4	110
St. Louis	As is		0	0	0	1	0	0	0	0	0	0	0	0
St. Louis	Current std		241	1	114	748	9	0	2	53	0	0	0	1
St. Louis	50	98	0	0	0	1	0	0	0	0	0	0	0	0
St. Louis	50	99	0	0	0	1	0	0	0	0	0	0	0	0
St. Louis	100	98	20	0	11	173	0	0	0	2	0	0	0	1
St. Louis	100	99	11	0	3	98	0	0	0	2	0	0	0	1
St. Louis	150	98	374	33	318	1389	20	0	11	173	0	0	0	4
St. Louis	150	99	276	15	212	1112	11	0	3	98	0	0	0	2
St. Louis	200	98	1060	227	900	2989	198	5	147	871	20	0	11	173
St. Louis	200	99	934	174	809	2735	139	2	82	693	11	0	3	98

Table A-123. Estimated number of exceedances of 1-hour concentration levels (250 and 300 ppb) for monitors <100 m from a major road following adjustment to just meeting the current and alternative standards, 2004-2006 air quality.

Location	Scenario	Percentile	Exceedances of 250 ppb				Exceedances of 300 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99
Boston	As is		0	0	0	0	0	0	0	0
Boston	Current std		0	0	0	1	0	0	0	0
Boston	50	98	0	0	0	0	0	0	0	0
Boston	50	99	0	0	0	0	0	0	0	0
Boston	100	98	0	0	0	0	0	0	0	0
Boston	100	99	0	0	0	0	0	0	0	0
Boston	150	98	1	0	0	5	0	0	0	1
Boston	150	99	0	0	0	3	0	0	0	1
Boston	200	98	11	0	2	42	2	0	0	9
Boston	200	99	5	0	1	21	1	0	0	5
Chicago	As is		0	0	0	0	0	0	0	0
Chicago	Current std		0	0	0	0	0	0	0	0
Chicago	50	98	0	0	0	0	0	0	0	0
Chicago	50	99	0	0	0	0	0	0	0	0
Chicago	100	98	0	0	0	0	0	0	0	0
Chicago	100	99	0	0	0	0	0	0	0	0
Chicago	150	98	0	0	0	2	0	0	0	2
Chicago	150	99	0	0	0	2	0	0	0	0
Chicago	200	98	12	0	5	46	2	0	0	11
Chicago	200	99	3	0	1	17	1	0	0	4
Cleveland	As is		0	0	0	0	0	0	0	0
Cleveland	Current std		0	0	0	1	0	0	0	1
Cleveland	50	98	0	0	0	0	0	0	0	0
Cleveland	50	99	0	0	0	0	0	0	0	0
Cleveland	100	98	0	0	0	1	0	0	0	1
Cleveland	100	99	0	0	0	1	0	0	0	1
Cleveland	150	98	2	0	1	4	0	0	0	1
Cleveland	150	99	0	0	0	1	0	0	0	1
Cleveland	200	98	26	7	23	60	6	0	5	14
Cleveland	200	99	15	1	14	34	2	0	1	4
Denver	As is		0	0	0	0	0	0	0	0
Denver	Current std		0	0	0	1	0	0	0	1
Denver	50	98	0	0	0	0	0	0	0	0
Denver	50	99	0	0	0	0	0	0	0	0
Denver	100	98	0	0	0	1	0	0	0	1
Denver	100	99	0	0	0	1	0	0	0	0
Denver	150	98	4	3	4	4	2	1	1	3
Denver	150	99	2	2	2	3	1	0	0	2
Denver	200	98	16	15	16	16	4	4	4	5
Denver	200	99	8	5	10	10	4	3	4	4
Los Angeles	As is		0	0	0	0	0	0	0	0
Los Angeles	Current std		0	0	0	0	0	0	0	0
Los Angeles	50	98	0	0	0	0	0	0	0	0
Los Angeles	50	99	0	0	0	0	0	0	0	0

Location	Scenario	Percentile	Exceedances of 250 ppb				Exceedances of 300 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99
Los Angeles	100	98	0	0	0	0	0	0	0	0
Los Angeles	100	99	0	0	0	0	0	0	0	0
Los Angeles	150	98	1	0	0	10	0	0	0	5
Los Angeles	150	99	1	0	0	6	0	0	0	2
Los Angeles	200	98	16	0	10	78	4	0	2	22
Los Angeles	200	99	8	0	2	41	1	0	0	10
Miami	As is		1	0	0	3	1	0	0	3
Miami	Current std		6	0	1	23	5	0	0	19
Miami	50	98	1	0	0	3	1	0	0	3
Miami	50	99	1	0	0	3	1	0	0	3
Miami	100	98	2	0	0	8	1	0	0	5
Miami	100	99	2	0	0	6	1	0	0	5
Miami	150	98	5	0	0	20	5	0	0	18
Miami	150	99	5	0	0	18	3	0	0	13
Miami	200	98	30	10	30	52	6	0	1	22
Miami	200	99	8	0	3	25	5	0	0	20
New York	As is		0	0	0	0	0	0	0	0
New York	Current std		0	0	0	1	0	0	0	0
New York	50	98	0	0	0	0	0	0	0	0
New York	50	99	0	0	0	0	0	0	0	0
New York	100	98	0	0	0	0	0	0	0	0
New York	100	99	0	0	0	0	0	0	0	0
New York	150	98	1	0	0	6	0	0	0	2
New York	150	99	1	0	0	5	0	0	0	2
New York	200	98	17	2	14	44	4	0	5	10
New York	200	99	8	0	9	21	2	0	0	6
Philadelphia	As is		0	0	0	0	0	0	0	0
Philadelphia	Current std		1	0	0	7	0	0	0	0
Philadelphia	50	98	0	0	0	0	0	0	0	0
Philadelphia	50	99	0	0	0	0	0	0	0	0
Philadelphia	100	98	0	0	0	0	0	0	0	0
Philadelphia	100	99	0	0	0	0	0	0	0	0
Philadelphia	150	98	3	2	3	7	1	0	0	2
Philadelphia	150	99	2	0	2	3	1	0	0	2
Philadelphia	200	98	18	8	18	30	6	3	5	15
Philadelphia	200	99	10	5	8	22	3	2	3	7
Washington DC	As is		0	0	0	0	0	0	0	0
Washington DC	Current std		0	0	0	1	0	0	0	1
Washington DC	50	98	0	0	0	0	0	0	0	0
Washington DC	50	99	0	0	0	0	0	0	0	0
Washington DC	100	98	0	0	0	1	0	0	0	0
Washington DC	100	99	0	0	0	0	0	0	0	0
Washington DC	150	98	0	0	0	1	0	0	0	1
Washington DC	150	99	0	0	0	1	0	0	0	1
Washington DC	200	98	8	0	4	24	1	0	0	8
Washington DC	200	99	3	0	1	14	0	0	0	1
El Paso	As is		0	0	0	0	0	0	0	0

Location	Scenario	Percentile	Exceedances of 250 ppb				Exceedances of 300 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99
El Paso	Current std		2	1	2	3	0	0	0	0
El Paso	50	98	0	0	0	0	0	0	0	0
El Paso	50	99	0	0	0	0	0	0	0	0
El Paso	100	98	0	0	0	0	0	0	0	0
El Paso	100	99	0	0	0	0	0	0	0	0
El Paso	150	98	2	1	2	3	0	0	0	0
El Paso	150	99	1	0	1	2	0	0	0	0
El Paso	200	98	21	11	18	35	8	4	9	10
El Paso	200	99	12	6	11	20	3	2	3	4
Las Vegas	As is		0	0	0	0	0	0	0	0
Las Vegas	Current std		0	0	0	0	0	0	0	0
Las Vegas	50	98	0	0	0	0	0	0	0	0
Las Vegas	50	99	0	0	0	0	0	0	0	0
Las Vegas	100	98	0	0	0	0	0	0	0	0
Las Vegas	100	99	0	0	0	0	0	0	0	0
Las Vegas	150	98	0	0	0	0	0	0	0	0
Las Vegas	150	99	0	0	0	0	0	0	0	0
Las Vegas	200	98	13	5	13	20	1	0	1	1
Las Vegas	200	99	6	1	6	10	0	0	0	0
Phoenix	As is		0	0	0	0	0	0	0	0
Phoenix	Current std		0	0	0	0	0	0	0	0
Phoenix	50	98	0	0	0	0	0	0	0	0
Phoenix	50	99	0	0	0	0	0	0	0	0
Phoenix	100	98	0	0	0	0	0	0	0	0
Phoenix	100	99	0	0	0	0	0	0	0	0
Phoenix	150	98	1	0	0	3	0	0	0	1
Phoenix	150	99	0	0	0	2	0	0	0	0
Phoenix	200	98	8	0	0	27	2	0	0	7
Phoenix	200	99	4	0	0	13	1	0	0	4
St. Louis	As is		0	0	0	0	0	0	0	0
St. Louis	Current std		0	0	0	1	0	0	0	1
St. Louis	50	98	0	0	0	0	0	0	0	0
St. Louis	50	99	0	0	0	0	0	0	0	0
St. Louis	100	98	0	0	0	1	0	0	0	0
St. Louis	100	99	0	0	0	1	0	0	0	0
St. Louis	150	98	0	0	0	1	0	0	0	1
St. Louis	150	99	0	0	0	1	0	0	0	1
St. Louis	200	98	1	0	0	8	0	0	0	2
St. Louis	200	99	0	0	0	4	0	0	0	2

Table A-124. Estimated annual average NO_2 concentrations on-roads following adjustment to just meeting the current and alternative standards, 2001-2003 air quality.

Location	Scenario	Percentile	Site-Years	Annual Mean (ppb)			
				Mean	Min	Median	p99
Boston	As is		600	17	7	18	30
Boston	Current std		600	34	14	36	61
Boston	50	98	600	17	6	17	29
Boston	50	99	600	15	6	15	26
Boston	100	98	600	33	13	34	57
Boston	100	99	600	30	12	31	52
Boston	150	98	600	50	19	51	86
Boston	150	99	600	45	18	46	78
Boston	200	98	600	66	26	68	114
Boston	200	99	600	60	23	62	104
Chicago	As is		900	39	21	37	68
Chicago	Current std		900	65	35	62	114
Chicago	50	98	900	30	16	29	52
Chicago	50	99	900	28	15	26	48
Chicago	100	98	900	60	33	58	104
Chicago	100	99	900	56	30	53	96
Chicago	150	98	900	91	49	86	156
Chicago	150	99	900	83	45	79	143
Chicago	200	98	900	121	66	115	208
Chicago	200	99	900	111	60	106	191
Cleveland	As is		300	32	22	32	45
Cleveland	Current std		300	76	53	75	106
Cleveland	50	98	300	31	22	31	44
Cleveland	50	99	300	28	19	28	40
Cleveland	100	98	300	63	43	62	88
Cleveland	100	99	300	57	39	56	79
Cleveland	150	98	300	94	65	93	132
Cleveland	150	99	300	85	58	84	119
Cleveland	200	98	300	126	86	124	176
Cleveland	200	99	300	113	78	112	158
Denver	As is		200	42	27	40	64
Denver	Current std		200	80	48	81	129
Denver	50	98	200	31	20	30	48
Denver	50	99	200	28	18	27	43
Denver	100	98	200	63	40	60	96
Denver	100	99	200	56	36	54	85
Denver	150	98	200	94	60	90	143
Denver	150	99	200	84	54	80	128
Denver	200	98	200	125	80	120	191
Denver	200	99	200	112	72	107	171
Detroit	As is		600	37	24	36	57
Detroit	Current std		600	89	56	87	131
Detroit	50	98	600	36	23	35	55
Detroit	50	99	600	31	20	30	48
Detroit	100	98	600	72	46	69	110
Detroit	100	99	600	63	40	60	95
Detroit	150	98	600	108	68	104	164

Location	Scenario	Percentile	Site-Years	Annual Mean (ppb)			
				Mean	Min	Median	p99
Detroit	150	99	600	94	60	90	143
Detroit	200	98	600	144	91	138	219
Detroit	200	99	600	125	79	121	191
Los Angeles	As is		5100	41	6	40	82
Los Angeles	Current std		5100	56	8	55	113
Los Angeles	50	98	5100	24	4	23	48
Los Angeles	50	99	5100	21	3	20	42
Los Angeles	100	98	5100	48	7	47	96
Los Angeles	100	99	5100	41	6	41	83
Los Angeles	150	98	5100	71	11	70	144
Los Angeles	150	99	5100	62	9	61	125
Los Angeles	200	98	5100	95	14	94	191
Los Angeles	200	99	5100	83	12	81	166
Miami	As is		600	16	9	15	25
Miami	Current std		600	59	33	58	92
Miami	50	98	600	20	11	20	31
Miami	50	99	600	18	10	18	28
Miami	100	98	600	40	22	39	62
Miami	100	99	600	36	20	35	57
Miami	150	98	600	60	33	59	94
Miami	150	99	600	55	30	53	85
Miami	200	98	600	80	45	78	125
Miami	200	99	600	73	40	71	113
New York	As is		2600	36	14	34	73
New York	Current std		2600	52	18	49	103
New York	50	98	2600	26	10	25	53
New York	50	99	2600	24	9	23	48
New York	100	98	2600	52	20	49	105
New York	100	99	2600	48	18	45	96
New York	150	98	2600	78	30	74	158
New York	150	99	2600	72	28	68	144
New York	200	98	2600	105	40	98	210
New York	200	99	2600	96	37	90	192
Philadelphia	As is		1400	36	18	33	66
Philadelphia	Current std		1400	67	33	63	126
Philadelphia	50	98	1400	31	16	29	58
Philadelphia	50	99	1400	29	15	27	54
Philadelphia	100	98	1400	63	32	58	116
Philadelphia	100	99	1400	59	30	54	109
Philadelphia	150	98	1400	94	48	87	174
Philadelphia	150	99	1400	88	45	82	163
Philadelphia	200	98	1400	125	65	117	232
Philadelphia	200	99	1400	117	60	109	217
Washington DC	As is		1800	33	11	34	63
Washington DC	Current std		1800	71	24	73	133
Washington DC	50	98	1800	31	10	32	58
Washington DC	50	99	1800	28	9	29	53
Washington DC	100	98	1800	62	20	63	117
Washington DC	100	99	1800	56	19	58	107

Location	Scenario	Percentile	Site-Years	Annual Mean (ppb)			
				Mean	Min	Median	p99
Washington DC	150	98	1800	92	31	95	175
Washington DC	150	99	1800	85	28	87	160
Washington DC	200	98	1800	123	41	127	233
Washington DC	200	99	1800	113	37	116	214
Atlanta	As is		1400	22	5	24	53
Atlanta	Current std		1400	60	12	62	130
Atlanta	50	98	1400	20	4	21	46
Atlanta	50	99	1400	17	4	19	42
Atlanta	100	98	1400	39	9	42	93
Atlanta	100	99	1400	35	8	37	83
Atlanta	150	98	1400	59	13	63	139
Atlanta	150	99	1400	52	12	56	125
Atlanta	200	98	1400	78	18	83	186
Atlanta	200	99	1400	70	16	75	166
El Paso	As is		1200	27	13	27	44
El Paso	Current std		1200	69	32	68	116
El Paso	50	98	1200	25	12	25	41
El Paso	50	99	1200	23	11	23	37
El Paso	100	98	1200	51	24	50	82
El Paso	100	99	1200	46	22	45	74
El Paso	150	98	1200	76	37	75	123
El Paso	150	99	1200	69	33	68	112
El Paso	200	98	1200	102	49	100	165
El Paso	200	99	1200	92	44	90	149
Jacksonville	As is		200	26	18	26	37
Jacksonville	Current std		200	96	68	94	135
Jacksonville	50	98	200	33	23	32	47
Jacksonville	50	99	200	30	21	29	42
Jacksonville	100	98	200	66	46	65	93
Jacksonville	100	99	200	59	41	58	84
Jacksonville	150	98	200	98	69	97	140
Jacksonville	150	99	200	89	62	87	126
Jacksonville	200	98	200	131	91	129	186
Jacksonville	200	99	200	118	82	116	168
Las Vegas	As is		1600	19	3	14	51
Las Vegas	Current std		1600	46	7	33	124
Las Vegas	50	98	1600	18	3	13	47
Las Vegas	50	99	1600	16	2	12	43
Las Vegas	100	98	1600	35	5	25	94
Las Vegas	100	99	1600	32	5	23	87
Las Vegas	150	98	1600	53	8	38	141
Las Vegas	150	99	1600	49	7	35	130
Las Vegas	200	98	1600	70	10	51	188
Las Vegas	200	99	1600	65	9	47	173
Phoenix	As is		500	49	28	47	77
Phoenix	Current std		500	72	40	69	114
Phoenix	50	98	500	36	21	35	56
Phoenix	50	99	500	33	19	32	52
Phoenix	100	98	500	71	41	69	112

Location	Scenario	Percentile	Site-Years	Annual Mean (ppb)			
				Mean	Min	Median	p99
Phoenix	100	99	500	66	38	65	105
Phoenix	150	98	500	107	62	104	167
Phoenix	150	99	500	100	58	97	157
Phoenix	200	98	500	142	82	138	223
Phoenix	200	99	500	133	77	129	209
Provo	As is		300	43	28	41	64
Provo	Current std		300	96	67	93	144
Provo	50	98	300	42	28	41	64
Provo	50	99	300	39	26	38	59
Provo	100	98	300	85	55	82	127
Provo	100	99	300	78	51	76	118
Provo	150	98	300	127	83	123	191
Provo	150	99	300	117	77	114	177
Provo	200	98	300	169	110	164	255
Provo	200	99	300	157	102	152	236
St. Louis	As is		900	31	18	30	50
St. Louis	Current std		900	74	45	71	118
St. Louis	50	98	900	31	18	30	50
St. Louis	50	99	900	28	16	27	44
St. Louis	100	98	900	63	36	61	99
St. Louis	100	99	900	56	33	55	89
St. Louis	150	98	900	94	54	91	149
St. Louis	150	99	900	84	49	82	133
St. Louis	200	98	900	125	73	122	198
St. Louis	200	99	900	113	65	110	178
Other MSA/CMSA	As is		61200	23	1	22	50
Other MSA/CMSA	Current std		61200	45	1	44	99
Other MSA/CMSA	50	98	61200	15	0	15	33
Other MSA/CMSA	50	99	61200	13	0	12	28
Other MSA/CMSA	100	98	61200	30	1	29	65
Other MSA/CMSA	100	99	61200	25	1	25	55
Other MSA/CMSA	150	98	61200	44	1	44	98
Other MSA/CMSA	150	99	61200	38	1	37	83
Other MSA/CMSA	200	98	61200	59	2	58	130
Other MSA/CMSA	200	99	61200	50	1	50	111
Other Not MSA	As is		12700	12	1	11	33
Other Not MSA	Current std		12700	40	4	35	109
Other Not MSA	50	98	12700	12	1	11	33
Other Not MSA	50	99	12700	10	1	9	28
Other Not MSA	100	98	12700	24	3	21	67
Other Not MSA	100	99	12700	21	2	18	57
Other Not MSA	150	98	12700	36	4	32	100
Other Not MSA	150	99	12700	31	3	27	85
Other Not MSA	200	98	12700	48	5	42	134
Other Not MSA	200	99	12700	41	4	36	114

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2 **Table A-125. Estimated annual average NO_2 concentrations on-roads following adjustment to just meeting**
3 **the current and alternative standards, 2004-2006 air quality.**

Location	Scenario	Percentile	Site-Years	Annual Mean (ppb)			
				Mean	Min	Median	p99
Boston	As is		800	16	9	15	24
Boston	Current std		800	35	19	34	57
Boston	50	98	800	17	10	16	26
Boston	50	99	800	15	9	15	24
Boston	100	98	800	33	19	32	52
Boston	100	99	800	30	18	29	48
Boston	150	98	800	50	29	48	78
Boston	150	99	800	46	27	44	71
Boston	200	98	800	67	39	64	104
Boston	200	99	800	61	36	59	95
Chicago	As is		800	35	20	33	60
Chicago	Current std		800	63	35	59	107
Chicago	50	98	800	28	16	26	47
Chicago	50	99	800	25	14	24	43
Chicago	100	98	800	55	32	52	94
Chicago	100	99	800	50	29	48	85
Chicago	150	98	800	83	48	78	141
Chicago	150	99	800	75	43	71	128
Chicago	200	98	800	110	63	105	187
Chicago	200	99	800	100	58	95	171
Denver	As is		300	36	23	36	53
Denver	Current std		300	69	42	68	103
Denver	50	98	300	33	21	32	48
Denver	50	99	300	30	19	30	44
Denver	100	98	300	66	42	65	95
Denver	100	99	300	60	38	60	87
Denver	150	98	300	99	63	97	143
Denver	150	99	300	91	57	89	131
Denver	200	98	300	132	83	130	191
Denver	200	99	300	121	77	119	175
Detroit	As is		600	31	18	30	47
Detroit	Current std		600	90	54	88	141
Detroit	50	98	600	35	20	34	54
Detroit	50	99	600	32	19	31	49
Detroit	100	98	600	71	41	69	108
Detroit	100	99	600	64	37	62	98
Detroit	150	98	600	106	61	103	161
Detroit	150	99	600	96	56	94	147
Detroit	200	98	600	141	81	137	215
Detroit	200	99	600	129	74	125	196
Los Angeles	As is		5400	33	6	32	65
Los Angeles	Current std		5400	56	10	54	109
Los Angeles	50	98	5400	26	5	25	51
Los Angeles	50	99	5400	23	4	23	46
Los Angeles	100	98	5400	52	9	50	102

Location	Scenario	Percentile	Site-Years	Annual Mean (ppb)			
				Mean	Min	Median	p99
Los Angeles	100	99	5400	47	8	46	93
Los Angeles	150	98	5400	78	14	76	153
Los Angeles	150	99	5400	70	12	68	139
Los Angeles	200	98	5400	104	18	101	204
Los Angeles	200	99	5400	94	16	91	185
Miami	As is		400	14	9	13	20
Miami	Current std		400	55	35	53	80
Miami	50	98	400	17	11	16	24
Miami	50	99	400	14	10	14	21
Miami	100	98	400	33	22	32	47
Miami	100	99	400	29	19	28	41
Miami	150	98	400	50	33	48	71
Miami	150	99	400	43	29	42	62
Miami	200	98	400	66	44	65	94
Miami	200	99	400	58	38	56	82
New York	As is		2200	35	12	35	61
New York	Current std		2200	55	20	55	99
New York	50	98	2200	28	10	28	49
New York	50	99	2200	25	9	25	45
New York	100	98	2200	55	19	55	98
New York	100	99	2200	50	18	50	89
New York	150	98	2200	83	29	83	147
New York	150	99	2200	76	27	76	134
New York	200	98	2200	111	39	111	195
New York	200	99	2200	101	35	101	178
Philadelphia	As is		1200	31	18	30	59
Philadelphia	Current std		1200	70	37	68	123
Philadelphia	50	98	1200	30	17	29	57
Philadelphia	50	99	1200	28	16	27	53
Philadelphia	100	98	1200	61	35	58	114
Philadelphia	100	99	1200	56	32	54	106
Philadelphia	150	98	1200	91	52	87	171
Philadelphia	150	99	1200	84	48	81	159
Philadelphia	200	98	1200	121	69	116	228
Philadelphia	200	99	1200	113	64	108	212
Washington DC	As is		1700	28	9	28	52
Washington DC	Current std		1700	64	23	66	121
Washington DC	50	98	1700	27	9	28	52
Washington DC	50	99	1700	25	8	26	48
Washington DC	100	98	1700	55	17	56	104
Washington DC	100	99	1700	51	16	51	96
Washington DC	150	98	1700	82	26	83	156
Washington DC	150	99	1700	76	24	77	144
Washington DC	200	98	1700	110	34	111	208
Washington DC	200	99	1700	101	32	103	192
Atlanta	As is		1500	20	4	22	42
Atlanta	Current std		1500	62	13	68	128
Atlanta	50	98	1500	19	4	21	40
Atlanta	50	99	1500	17	4	19	36

Location	Scenario	Percentile	Site-Years	Annual Mean (ppb)			
				Mean	Min	Median	p99
Atlanta	100	98	1500	38	8	42	79
Atlanta	100	99	1500	34	7	38	71
Atlanta	150	98	1500	57	12	63	119
Atlanta	150	99	1500	52	11	57	107
Atlanta	200	98	1500	76	17	84	159
Atlanta	200	99	1500	69	15	76	143
El Paso	As is		1200	25	10	25	43
El Paso	Current std		1200	75	30	75	127
El Paso	50	98	1200	26	11	26	44
El Paso	50	99	1200	24	10	24	40
El Paso	100	98	1200	52	21	51	88
El Paso	100	99	1200	47	19	47	81
El Paso	150	98	1200	78	32	77	132
El Paso	150	99	1200	71	29	71	121
El Paso	200	98	1200	103	42	103	176
El Paso	200	99	1200	95	39	94	161
Jacksonville	As is		200	24	17	23	37
Jacksonville	Current std		200	96	67	93	145
Jacksonville	50	98	200	31	22	30	47
Jacksonville	50	99	200	27	19	26	41
Jacksonville	100	98	200	63	43	60	95
Jacksonville	100	99	200	54	37	52	81
Jacksonville	150	98	200	94	65	90	142
Jacksonville	150	99	200	80	56	77	122
Jacksonville	200	98	200	125	86	120	189
Jacksonville	200	99	200	107	74	103	162
Las Vegas	As is		1100	16	2	11	46
Las Vegas	Current std		1100	43	5	30	123
Las Vegas	50	98	1100	16	2	11	47
Las Vegas	50	99	1100	15	2	11	44
Las Vegas	100	98	1100	33	4	23	94
Las Vegas	100	99	1100	31	3	21	89
Las Vegas	150	98	1100	49	5	34	141
Las Vegas	150	99	1100	46	5	32	133
Las Vegas	200	98	1100	66	7	45	188
Las Vegas	200	99	1100	62	7	43	177
Phoenix	As is		900	43	26	42	65
Phoenix	Current std		900	73	45	71	109
Phoenix	50	98	900	34	20	33	51
Phoenix	50	99	900	31	19	30	47
Phoenix	100	98	900	67	41	65	101
Phoenix	100	99	900	62	38	61	94
Phoenix	150	98	900	101	61	98	152
Phoenix	150	99	900	93	57	91	141
Phoenix	200	98	900	134	82	131	202
Phoenix	200	99	900	125	76	122	188
Provo	As is		300	43	26	41	71
Provo	Current std		300	94	67	93	131
Provo	50	98	300	26	16	25	43

Location	Scenario	Percentile	Site-Years	Annual Mean (ppb)			
				Mean	Min	Median	p99
Provo	50	99	300	24	15	23	41
Provo	100	98	300	52	32	50	87
Provo	100	99	300	49	30	47	81
Provo	150	98	300	78	47	74	130
Provo	150	99	300	73	45	70	122
Provo	200	98	300	104	63	99	174
Provo	200	99	300	98	59	93	163
St. Louis	As is		400	27	16	26	42
St. Louis	Current std		400	68	38	66	119
St. Louis	50	98	400	27	16	26	42
St. Louis	50	99	400	25	15	25	40
St. Louis	100	98	400	54	32	52	85
St. Louis	100	99	400	51	30	49	80
St. Louis	150	98	400	81	48	78	127
St. Louis	150	99	400	76	46	74	120
St. Louis	200	98	400	108	65	105	170
St. Louis	200	99	400	102	61	98	160
Other MSA/CMSA	As is		56500	20	1	20	45
Other MSA/CMSA	Current std		56500	47	3	45	105
Other MSA/CMSA	50	98	56500	17	1	17	38
Other MSA/CMSA	50	99	56500	15	1	15	34
Other MSA/CMSA	100	98	56500	34	2	33	76
Other MSA/CMSA	100	99	56500	30	2	30	68
Other MSA/CMSA	150	98	56500	51	3	50	114
Other MSA/CMSA	150	99	56500	46	2	44	102
Other MSA/CMSA	200	98	56500	68	3	66	151
Other MSA/CMSA	200	99	56500	61	3	59	135
Other Not MSA	As is		11600	12	1	10	33
Other Not MSA	Current std		11600	39	3	34	109
Other Not MSA	50	98	11600	12	1	10	32
Other Not MSA	50	99	11600	11	1	10	30
Other Not MSA	100	98	11600	23	2	21	65
Other Not MSA	100	99	11600	21	2	19	60
Other Not MSA	150	98	11600	35	3	31	97
Other Not MSA	150	99	11600	32	3	29	90
Other Not MSA	200	98	11600	46	4	41	129
Other Not MSA	200	99	11600	43	4	38	120

Table A-126. Estimated number of exceedances of 1-hour concentration levels (100, 150, and 200 ppb) on-roads following adjustment to just meeting the current and alternative standards, 2001-2003 air quality.

			Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
Location	Scenario	Percentile	Mean	Min	Med	P99	Mean	Min	Med	p99	Mean	Min	Med	p99
Boston	As is		12	0	1	138	0	0	0	10	0	0	0	2
Boston	Current std		455	1	339	1544	79	0	16	595	12	0	1	195
Boston	50	98	8	0	0	90	0	0	0	9	0	0	0	0
Boston	50	99	4	0	0	47	0	0	0	5	0	0	0	0
Boston	100	98	411	1	302	1511	66	0	12	541	8	0	0	90
Boston	100	99	287	0	159	1244	34	0	4	301	4	0	0	47
Boston	150	98	1172	118	1135	2756	411	1	302	1511	123	0	41	764
Boston	150	99	942	63	874	2392	287	0	159	1244	73	0	15	551
Boston	200	98	1865	383	1904	3619	922	53	860	2325	411	1	302	1511
Boston	200	99	1605	289	1618	3354	713	24	632	1996	287	0	159	1244
Chicago	As is		252	0	113	1460	33	0	3	383	5	0	0	97
Chicago	Current std		1478	61	1206	4547	395	1	223	2053	110	0	30	843
Chicago	50	98	71	0	14	641	7	0	0	118	1	0	0	22
Chicago	50	99	45	0	7	431	4	0	0	74	0	0	0	10
Chicago	100	98	1197	44	951	4002	283	0	138	1564	71	0	14	641
Chicago	100	99	929	24	706	3374	196	0	80	1232	45	0	7	431
Chicago	150	98	2918	540	2670	6157	1197	44	951	4002	454	4	281	2124
Chicago	150	99	2527	384	2264	5782	929	24	706	3374	323	0	172	1689
Chicago	200	98	4311	1566	4039	7376	2362	299	2103	5533	1197	44	951	4002
Chicago	200	99	3908	1174	3635	7082	1993	179	1728	5130	929	24	706	3374
Cleveland	As is		103	0	51	429	14	0	3	89	2	0	0	23
Cleveland	Current std		2065	715	2090	3714	677	87	592	1865	222	14	148	746
Cleveland	50	98	92	0	44	393	12	0	1	85	2	0	0	19
Cleveland	50	99	54	0	18	257	7	0	1	59	1	0	0	8
Cleveland	100	98	1306	254	1224	2727	327	33	256	1003	92	0	44	393
Cleveland	100	99	983	150	909	2349	216	15	145	740	54	0	18	257
Cleveland	150	98	2996	1299	2959	4830	1306	254	1224	2727	522	54	438	1542
Cleveland	150	99	2527	997	2507	4206	983	150	909	2349	351	34	272	1068
Cleveland	200	98	4402	2519	4441	6097	2440	997	2426	4024	1306	254	1224	2727
Cleveland	200	99	3901	2051	3890	5698	2017	661	1967	3685	983	150	909	2349
Denver	As is		403	12	242	1728	51	0	6	404	6	0	1	54
Denver	Current std		2384	394	2606	3658	999	11	915	2783	382	0	283	1880

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	P99	Mean	Min	Med	p99	Mean	Min	Med	p99
Denver	50	98	92	0	19	608	6	0	1	54	0	0	0	3
Denver	50	99	49	0	6	404	2	0	1	17	0	0	0	1
Denver	100	98	1589	265	1395	3446	383	11	237	1621	92	0	19	608
Denver	100	99	1155	139	954	3025	228	2	105	1070	49	0	6	404
Denver	150	98	3064	1459	3060	4339	1589	265	1395	3446	623	32	429	2341
Denver	150	99	2716	1047	2709	4131	1155	139	954	3025	386	12	238	1621
Denver	200	98	3801	2653	3763	4959	2692	1024	2665	4131	1589	265	1395	3446
Denver	200	99	3536	2164	3485	4706	2278	631	2191	3867	1155	139	954	3025
Detroit	As is		185	1	118	752	34	0	11	194	10	0	2	51
Detroit	Current std		2779	977	2670	5049	1079	160	907	3026	391	23	272	1417
Detroit	50	98	157	1	100	629	29	0	7	162	8	0	2	45
Detroit	50	99	86	1	50	412	16	0	4	94	5	0	1	37
Detroit	100	98	1793	419	1670	3929	516	37	377	1748	157	1	100	629
Detroit	100	99	1249	224	1071	3210	296	6	197	1133	86	1	50	412
Detroit	150	98	3642	1706	3584	5876	1793	419	1670	3929	786	88	649	2351
Detroit	150	99	2990	1111	2899	5278	1249	224	1071	3210	477	28	345	1677
Detroit	200	98	4863	2972	4785	6794	3112	1111	3024	5278	1793	419	1670	3929
Detroit	200	99	4305	2372	4227	6444	2457	713	2328	4669	1249	224	1071	3210
Los Angeles	As is		414	0	211	2395	67	0	13	687	12	0	0	165
Los Angeles	Current std		1170	0	913	4433	295	0	128	1901	78	0	16	725
Los Angeles	50	98	31	0	3	374	2	0	0	36	0	0	0	6
Los Angeles	50	99	13	0	0	185	1	0	0	15	0	0	0	2
Los Angeles	100	98	701	0	450	3357	142	0	43	1145	31	0	3	374
Los Angeles	100	99	433	0	226	2518	69	0	14	690	13	0	0	185
Los Angeles	150	98	2081	1	1909	5842	701	0	450	3357	238	0	97	1641
Los Angeles	150	99	1529	0	1270	5099	433	0	226	2518	127	0	38	1041
Los Angeles	200	98	3258	25	3187	6956	1607	0	1366	5200	701	0	450	3357
Los Angeles	200	99	2698	6	2560	6487	1118	0	852	4370	433	0	226	2518
Miami	As is		21	0	4	272	1	0	0	18	0	0	0	2
Miami	Current std		1680	487	1685	2832	761	55	723	1904	334	6	263	1319
Miami	50	98	80	0	30	647	8	0	0	118	1	0	0	15
Miami	50	99	47	0	14	464	4	0	0	56	0	0	0	5
Miami	100	98	820	56	771	2054	251	1	164	1215	80	0	30	647
Miami	100	99	635	21	580	1833	176	0	102	1013	47	0	14	464

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	P99	Mean	Min	Med	p99	Mean	Min	Med	p99
Miami	150	98	1743	533	1772	2868	820	56	771	2054	372	5	289	1499
Miami	150	99	1483	360	1480	2570	635	21	580	1833	269	1	188	1246
Miami	200	98	2504	1198	2433	4193	1457	319	1448	2570	820	56	771	2054
Miami	200	99	2225	1022	2198	3697	1220	200	1193	2401	635	21	580	1833
New York	As is		205	0	83	1569	24	0	2	310	4	0	0	89
New York	Current std		900	0	639	3696	178	0	61	1461	40	0	4	494
New York	50	98	37	0	6	412	4	0	0	74	0	0	0	9
New York	50	99	23	0	2	307	2	0	0	45	0	0	0	3
New York	100	98	906	0	661	3630	171	0	65	1310	37	0	6	412
New York	100	99	665	0	438	3144	109	0	33	924	23	0	2	307
New York	150	98	2430	140	2248	5699	906	0	661	3630	301	0	144	1995
New York	150	99	2063	102	1859	5314	665	0	438	3144	195	0	79	1445
New York	200	98	3598	526	3471	6902	1944	88	1726	5190	906	0	661	3630
New York	200	99	3241	351	3106	6578	1601	33	1372	4731	665	0	438	3144
Philadelphia	As is		161	0	54	1109	17	0	1	278	2	0	0	64
Philadelphia	Current std		1788	68	1567	5152	472	0	278	2540	119	0	35	856
Philadelphia	50	98	82	0	18	706	7	0	0	153	1	0	0	33
Philadelphia	50	99	56	0	7	577	4	0	0	106	0	0	0	15
Philadelphia	100	98	1509	52	1288	4554	343	0	171	2045	82	0	18	706
Philadelphia	100	99	1219	21	965	4031	250	0	112	1521	56	0	7	577
Philadelphia	150	98	3340	879	3077	6750	1509	52	1288	4554	569	1	345	2773
Philadelphia	150	99	3036	670	2806	6336	1219	21	965	4031	423	0	232	2256
Philadelphia	200	98	4566	1958	4248	7526	2790	474	2595	6182	1509	52	1288	4554
Philadelphia	200	99	4255	1672	3932	7332	2472	314	2270	5787	1219	21	965	4031
Washington DC	As is		156	0	41	1170	17	0	0	190	2	0	0	32
Washington DC	Current std		1941	12	1963	5165	656	0	402	2992	208	0	60	1442
Washington DC	50	98	107	0	20	828	10	0	0	135	1	0	0	15
Washington DC	50	99	67	0	8	540	6	0	0	86	0	0	0	5
Washington DC	100	98	1445	1	1305	4550	401	0	183	2317	107	0	20	828
Washington DC	100	99	1154	0	941	4043	277	0	102	1789	67	0	8	540
Washington DC	150	98	3041	106	3381	6473	1445	1	1305	4550	622	0	362	3001
Washington DC	150	99	2700	52	2947	6158	1154	0	941	4043	453	0	223	2521
Washington DC	200	98	4247	458	4764	7631	2574	34	2774	5987	1445	1	1305	4550
Washington DC	200	99	3903	329	4376	7330	2211	16	2306	5699	1154	0	941	4043

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	P99	Mean	Min	Med	p99	Mean	Min	Med	p99
Atlanta	As is		98	0	11	1014	12	0	0	168	2	0	0	37
Atlanta	Current std		1572	28	1629	4537	714	1	437	2873	304	0	95	1856
Atlanta	50	98	53	0	3	624	5	0	0	91	1	0	0	17
Atlanta	50	99	29	0	0	370	2	0	0	51	0	0	0	11
Atlanta	100	98	704	0	470	3040	191	0	44	1556	53	0	3	624
Atlanta	100	99	516	0	279	2566	121	0	16	1183	29	0	0	370
Atlanta	150	98	1550	25	1609	4684	704	0	470	3040	296	0	98	1952
Atlanta	150	99	1304	8	1249	4271	516	0	279	2566	199	0	45	1577
Atlanta	200	98	2296	103	2590	5867	1275	6	1206	4194	704	0	470	3040
Atlanta	200	99	1997	67	2170	5514	1037	1	891	3749	516	0	279	2566
El Paso	As is		85	0	34	592	7	0	1	51	1	0	0	9
El Paso	Current std		2053	414	2050	3852	820	26	712	2383	277	4	177	1443
El Paso	50	98	57	0	21	403	4	0	0	34	0	0	0	7
El Paso	50	99	31	0	11	232	2	0	0	19	0	0	0	4
El Paso	100	98	1097	62	988	2693	256	2	154	1302	57	0	21	403
El Paso	100	99	819	33	697	2355	159	1	80	954	31	0	11	232
El Paso	150	98	2353	650	2417	4040	1097	62	988	2693	420	9	313	1671
El Paso	150	99	2044	472	2035	3711	819	33	697	2355	269	5	168	1328
El Paso	200	98	3215	1234	3281	5249	1993	414	1975	3658	1097	62	988	2693
El Paso	200	99	2935	1070	3002	4859	1684	246	1623	3390	819	33	697	2355
Jacksonville	As is		34	0	16	189	3	0	2	15	1	0	1	2
Jacksonville	Current std		2790	1387	2741	4492	1295	348	1238	2672	588	56	542	1540
Jacksonville	50	98	121	3	74	491	11	0	5	61	2	0	2	13
Jacksonville	50	99	68	2	34	301	5	0	2	31	1	0	2	7
Jacksonville	100	98	1374	451	1312	2842	422	25	370	1185	121	3	74	491
Jacksonville	100	99	1070	253	1046	2336	277	8	222	848	68	2	34	301
Jacksonville	150	98	2916	1544	2930	4586	1374	451	1312	2842	633	83	589	1568
Jacksonville	150	99	2479	1166	2420	4122	1070	253	1046	2336	439	31	394	1195
Jacksonville	200	98	4086	2480	4037	5972	2412	1125	2353	4122	1374	451	1312	2842
Jacksonville	200	99	3671	2103	3606	5490	1988	829	1945	3480	1070	253	1046	2336
Las Vegas	As is		88	0	6	974	10	0	0	205	1	0	0	15
Las Vegas	Current std		1347	3	627	4346	583	0	144	3276	211	0	32	1935
Las Vegas	50	98	61	0	2	687	5	0	0	132	0	0	0	11
Las Vegas	50	99	41	0	1	547	3	0	0	67	0	0	0	4

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	P99	Mean	Min	Med	p99	Mean	Min	Med	p99
Las Vegas	100	98	839	0	272	3736	232	0	37	2062	61	0	2	687
Las Vegas	100	99	686	0	197	3498	159	0	20	1557	41	0	1	547
Las Vegas	150	98	1605	5	880	4632	839	0	272	3736	362	0	70	2663
Las Vegas	150	99	1457	4	728	4470	686	0	197	3498	265	0	47	2209
Las Vegas	200	98	2143	37	1546	5259	1393	4	667	4418	839	0	272	3736
Las Vegas	200	99	1986	22	1346	5079	1229	1	534	4218	686	0	197	3498
Phoenix	As is		527	2	321	2418	57	0	4	455	5	0	0	53
Phoenix	Current std		1932	68	1830	4469	503	2	335	2311	118	0	16	951
Phoenix	50	98	100	0	11	769	4	0	0	43	0	0	0	3
Phoenix	50	99	67	0	7	533	2	0	0	27	0	0	0	0
Phoenix	100	98	1876	77	1820	4400	462	2	278	2165	100	0	11	769
Phoenix	100	99	1578	42	1468	4191	340	1	151	1789	67	0	7	533
Phoenix	150	98	3841	1127	3960	5589	1876	77	1820	4400	751	6	546	2927
Phoenix	150	99	3549	805	3699	5445	1578	42	1468	4191	583	2	382	2501
Phoenix	200	98	4880	2525	4936	6351	3300	623	3468	5329	1876	77	1820	4400
Phoenix	200	99	4683	2196	4747	6195	2994	417	3176	5198	1578	42	1468	4191
Provo	As is		241	1	88	1602	21	0	0	178	1	0	0	19
Provo	Current std		3555	1734	3628	5424	1452	142	1300	3827	435	4	199	2217
Provo	50	98	227	1	83	1512	19	0	0	178	1	0	0	19
Provo	50	99	149	0	35	1063	11	0	0	97	1	0	0	7
Provo	100	98	2950	664	2998	5067	913	19	715	3311	227	1	83	1512
Provo	100	99	2523	392	2454	4836	658	12	470	2830	149	0	35	1063
Provo	150	98	4716	2997	4712	6269	2950	664	2998	5067	1429	69	1201	3920
Provo	150	99	4456	2596	4506	6068	2523	392	2454	4836	1095	40	822	3542
Provo	200	98	5567	4162	5597	6940	4282	2251	4357	5995	2950	664	2998	5067
Provo	200	99	5365	3837	5406	6818	3986	1902	4057	5744	2523	392	2454	4836
St. Louis	As is		91	0	26	663	8	0	0	113	1	0	0	14
St. Louis	Current std		2057	409	1957	4366	683	8	545	2452	208	0	110	1225
St. Louis	50	98	91	0	26	663	8	0	0	113	1	0	0	14
St. Louis	50	99	50	0	9	388	3	0	0	59	0	0	0	7
St. Louis	100	98	1441	93	1321	3589	366	0	227	1766	91	0	26	663
St. Louis	100	99	1069	31	944	3107	230	0	117	1331	50	0	9	388
St. Louis	150	98	3129	926	3093	5295	1441	93	1321	3589	577	3	434	2210
St. Louis	150	99	2672	647	2603	4998	1069	31	944	3107	384	0	256	1777

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	P99	Mean	Min	Med	p99	Mean	Min	Med	p99
St. Louis	200	98	4483	2135	4458	6647	2627	624	2560	4998	1441	93	1321	3589
St. Louis	200	99	4005	1708	3973	6245	2144	342	2059	4417	1069	31	944	3107
Other MSA/CMSA	As is		54	0	5	637	5	0	0	102	1	0	0	12
Other MSA/CMSA	Current std		804	0	519	3700	203	0	59	1646	52	0	5	614
Other MSA/CMSA	50	98	4	0	0	89	0	0	0	4	0	0	0	0
Other MSA/CMSA	50	99	1	0	0	29	0	0	0	1	0	0	0	0
Other MSA/CMSA	100	98	188	0	52	1555	24	0	1	358	4	0	0	89
Other MSA/CMSA	100	99	90	0	14	926	9	0	0	172	1	0	0	29
Other MSA/CMSA	150	98	760	0	478	3576	188	0	52	1555	47	0	4	575
Other MSA/CMSA	150	99	473	0	233	2750	90	0	14	926	19	0	0	286
Other MSA/CMSA	200	98	1451	0	1203	4890	540	0	286	2967	188	0	52	1555
Other MSA/CMSA	200	99	1042	0	762	4194	316	0	123	2153	90	0	14	926
Other Not MSA	As is		9	0	0	154	1	0	0	27	0	0	0	7
Other Not MSA	Current std		748	0	317	3899	269	0	55	2015	97	0	9	1089
Other Not MSA	50	98	9	0	0	154	1	0	0	27	0	0	0	7
Other Not MSA	50	99	4	0	0	77	1	0	0	14	0	0	0	6
Other Not MSA	100	98	202	0	33	1700	38	0	2	564	9	0	0	154
Other Not MSA	100	99	110	0	12	1148	17	0	0	294	4	0	0	77
Other Not MSA	150	98	610	0	226	3452	202	0	33	1700	64	0	4	796
Other Not MSA	150	99	421	0	120	2674	110	0	12	1148	31	0	1	492
Other Not MSA	200	98	1078	0	583	4980	470	0	144	2886	202	0	33	1700
Other Not MSA	200	99	806	0	360	4175	301	0	67	2169	110	0	12	1148

1 **Table A-127. Estimated number of exceedances of 1-hour concentration levels (250 and 300 ppb) on-roads**
2 **following adjustment to just meeting the current and alternative standards, 2001-2003 air quality.**

			Exceedances of 250 ppb				Exceedances of 300 ppb			
Location	Scenario	Percentile	Mean	Min	Med	p99	Mean	Min	Med	p99
Boston	As is		0	0	0	0	0	0	0	0
Boston	Current std		2	0	0	30	0	0	0	8
Boston	50	98	0	0	0	0	0	0	0	0
Boston	50	99	0	0	0	0	0	0	0	0
Boston	100	98	1	0	0	21	0	0	0	9
Boston	100	99	1	0	0	12	0	0	0	5
Boston	150	98	34	0	4	301	8	0	0	90
Boston	150	99	17	0	2	189	4	0	0	47
Boston	200	98	167	0	65	927	66	0	12	541
Boston	200	99	103	0	30	684	34	0	4	301
Chicago	As is		1	0	0	29	0	0	0	7
Chicago	Current std		34	0	3	407	12	0	0	208
Chicago	50	98	0	0	0	1	0	0	0	0
Chicago	50	99	0	0	0	0	0	0	0	0
Chicago	100	98	21	0	1	291	7	0	0	118
Chicago	100	99	13	0	0	190	4	0	0	74
Chicago	150	98	175	0	68	1111	71	0	14	641
Chicago	150	99	118	0	36	845	45	0	7	431
Chicago	200	98	583	12	374	2541	283	0	138	1564
Chicago	200	99	424	3	252	2031	196	0	80	1232
Cleveland	As is		0	0	0	6	0	0	0	3
Cleveland	Current std		79	0	35	324	32	0	8	172
Cleveland	50	98	0	0	0	5	0	0	0	3
Cleveland	50	99	0	0	0	3	0	0	0	0
Cleveland	100	98	30	0	7	176	12	0	1	85
Cleveland	100	99	18	0	4	110	7	0	1	59
Cleveland	150	98	213	15	145	740	92	0	44	393
Cleveland	150	99	133	2	70	515	54	0	18	257
Cleveland	200	98	650	85	569	1715	327	33	256	1003
Cleveland	200	99	448	47	392	1278	216	15	145	740
Denver	As is		1	0	0	9	0	0	0	1
Denver	Current std		142	0	60	992	55	0	11	431
Denver	50	98	0	0	0	1	0	0	0	1
Denver	50	99	0	0	0	1	0	0	0	1
Denver	100	98	23	0	3	217	6	0	1	54
Denver	100	99	10	0	1	104	2	0	1	17
Denver	150	98	236	2	109	1104	92	0	19	608
Denver	150	99	134	1	41	792	49	0	6	404
Denver	200	98	791	69	585	2626	383	11	237	1621
Denver	200	99	520	20	340	2075	228	2	105	1070
Detroit	As is		4	0	1	34	3	0	1	28
Detroit	Current std		150	1	97	604	70	1	38	385
Detroit	50	98	4	0	1	30	3	0	1	26
Detroit	50	99	3	0	1	28	2	0	0	20
Detroit	100	98	61	1	31	312	29	0	7	162
Detroit	100	99	34	0	11	194	16	0	4	94
Detroit	150	98	340	11	230	1265	157	1	100	629

			Exceedances of 250 ppb				Exceedances of 300 ppb			
Location	Scenario	Percentile	Mean	Min	Med	p99	Mean	Min	Med	p99
Detroit	150	99	193	1	126	764	86	1	50	412
Detroit	200	98	970	142	812	2742	516	37	377	1748
Detroit	200	99	610	52	456	1940	296	6	197	1133
Los Angeles	As is		2	0	0	48	1	0	0	14
Los Angeles	Current std		22	0	1	258	7	0	0	98
Los Angeles	50	98	0	0	0	1	0	0	0	0
Los Angeles	50	99	0	0	0	0	0	0	0	0
Los Angeles	100	98	7	0	0	117	2	0	0	36
Los Angeles	100	99	3	0	0	53	1	0	0	15
Los Angeles	150	98	84	0	19	799	31	0	3	374
Los Angeles	150	99	40	0	4	466	13	0	0	185
Los Angeles	200	98	308	0	142	1967	142	0	43	1145
Los Angeles	200	99	172	0	57	1296	69	0	14	690
Miami	As is		0	0	0	0	0	0	0	0
Miami	Current std		152	0	83	860	65	0	23	509
Miami	50	98	0	0	0	3	0	0	0	0
Miami	50	99	0	0	0	1	0	0	0	0
Miami	100	98	24	0	4	291	8	0	0	118
Miami	100	99	13	0	2	186	4	0	0	56
Miami	150	98	168	0	99	953	80	0	30	647
Miami	150	99	115	0	54	787	47	0	14	464
Miami	200	98	445	7	359	1605	251	1	164	1215
Miami	200	99	332	3	254	1405	176	0	102	1013
New York	As is		1	0	0	21	0	0	0	3
New York	Current std		12	0	0	223	4	0	0	92
New York	50	98	0	0	0	0	0	0	0	0
New York	50	99	0	0	0	0	0	0	0	0
New York	100	98	11	0	0	181	4	0	0	74
New York	100	99	6	0	0	123	2	0	0	45
New York	150	98	98	0	27	841	37	0	6	412
New York	150	99	63	0	13	577	23	0	2	307
New York	200	98	391	0	213	2354	171	0	65	1310
New York	200	99	268	0	123	1838	109	0	33	924
Philadelphia	As is		0	0	0	10	0	0	0	1
Philadelphia	Current std		35	0	3	409	11	0	1	167
Philadelphia	50	98	0	0	0	1	0	0	0	1
Philadelphia	50	99	0	0	0	1	0	0	0	1
Philadelphia	100	98	23	0	1	350	7	0	0	153
Philadelphia	100	99	15	0	1	250	4	0	0	106
Philadelphia	150	98	210	0	82	1368	82	0	18	706
Philadelphia	150	99	148	0	46	1035	56	0	7	577
Philadelphia	200	98	718	5	478	3078	343	0	171	2045
Philadelphia	200	99	558	1	338	2666	250	0	112	1521
Washington DC	As is		0	0	0	2	0	0	0	0
Washington DC	Current std		69	0	8	570	25	0	0	250
Washington DC	50	98	0	0	0	1	0	0	0	0
Washington DC	50	99	0	0	0	0	0	0	0	0
Washington DC	100	98	32	0	1	297	10	0	0	135

Location	Scenario	Percentile	Exceedances of 250 ppb				Exceedances of 300 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99
Washington DC	100	99	19	0	0	208	6	0	0	86
Washington DC	150	98	254	0	92	1676	107	0	20	828
Washington DC	150	99	169	0	47	1243	67	0	8	540
Washington DC	200	98	774	0	517	3359	401	0	183	2317
Washington DC	200	99	564	0	315	2768	277	0	102	1789
Atlanta	As is		0	0	0	12	0	0	0	3
Atlanta	Current std		130	0	17	1198	56	0	4	633
Atlanta	50	98	0	0	0	3	0	0	0	1
Atlanta	50	99	0	0	0	2	0	0	0	0
Atlanta	100	98	16	0	0	225	5	0	0	91
Atlanta	100	99	8	0	0	129	2	0	0	51
Atlanta	150	98	123	0	18	1186	53	0	3	624
Atlanta	150	99	75	0	7	841	29	0	0	370
Atlanta	200	98	365	0	142	2146	191	0	44	1556
Atlanta	200	99	250	0	74	1780	121	0	16	1183
El Paso	As is		0	0	0	2	0	0	0	1
El Paso	Current std		93	0	39	791	32	0	11	257
El Paso	50	98	0	0	0	1	0	0	0	0
El Paso	50	99	0	0	0	1	0	0	0	0
El Paso	100	98	15	0	4	107	4	0	0	34
El Paso	100	99	7	0	1	52	2	0	0	19
El Paso	150	98	154	1	75	954	57	0	21	403
El Paso	150	99	91	0	37	634	31	0	11	232
El Paso	200	98	540	12	430	1929	256	2	154	1302
El Paso	200	99	366	8	263	1550	159	1	80	954
Jacksonville	As is		1	0	1	2	1	0	1	2
Jacksonville	Current std		254	5	188	789	108	3	60	490
Jacksonville	50	98	1	0	1	2	1	0	1	2
Jacksonville	50	99	1	0	1	2	1	0	1	2
Jacksonville	100	98	34	0	16	189	11	0	5	61
Jacksonville	100	99	17	0	9	112	5	0	2	31
Jacksonville	150	98	277	8	222	848	121	3	74	491
Jacksonville	150	99	175	4	119	605	68	2	34	301
Jacksonville	200	98	775	116	739	1891	422	25	370	1185
Jacksonville	200	99	550	56	503	1475	277	8	222	848
Las Vegas	As is		0	0	0	2	0	0	0	0
Las Vegas	Current std		76	0	4	857	31	0	0	455
Las Vegas	50	98	0	0	0	0	0	0	0	0
Las Vegas	50	99	0	0	0	0	0	0	0	0
Las Vegas	100	98	19	0	0	328	5	0	0	132
Las Vegas	100	99	12	0	0	233	3	0	0	67
Las Vegas	150	98	144	0	17	1451	61	0	2	687
Las Vegas	150	99	98	0	8	1033	41	0	1	547
Las Vegas	200	98	455	0	98	2955	232	0	37	2062
Las Vegas	200	99	338	0	64	2548	159	0	20	1557
Phoenix	As is		0	0	0	14	0	0	0	0
Phoenix	Current std		24	0	0	218	4	0	0	59
Phoenix	50	98	0	0	0	0	0	0	0	0

Location	Scenario	Percentile	Exceedances of 250 ppb				Exceedances of 300 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99
Phoenix	50	99	0	0	0	0	0	0	0	0
Phoenix	100	98	19	0	0	156	4	0	0	43
Phoenix	100	99	10	0	0	95	2	0	0	27
Phoenix	150	98	279	0	118	1571	100	0	11	769
Phoenix	150	99	198	0	74	1273	67	0	7	533
Phoenix	200	98	956	11	747	3353	462	2	278	2165
Phoenix	200	99	749	6	546	2927	340	1	151	1789
Provo	As is		0	0	0	2	0	0	0	0
Provo	Current std		127	0	23	831	43	0	2	303
Provo	50	98	0	0	0	2	0	0	0	0
Provo	50	99	0	0	0	0	0	0	0	0
Provo	100	98	60	0	4	401	19	0	0	178
Provo	100	99	38	0	2	273	11	0	0	97
Provo	150	98	571	5	368	2634	227	1	83	1512
Provo	150	99	402	2	210	2195	149	0	35	1063
Provo	200	98	1748	133	1564	4177	913	19	715	3311
Provo	200	99	1383	69	1123	3849	658	12	470	2830
St. Louis	As is		0	0	0	2	0	0	0	1
St. Louis	Current std		66	0	14	504	22	0	2	202
St. Louis	50	98	0	0	0	2	0	0	0	1
St. Louis	50	99	0	0	0	2	0	0	0	1
St. Louis	100	98	25	0	3	243	8	0	0	113
St. Louis	100	99	13	0	0	156	3	0	0	59
St. Louis	150	98	232	0	121	1331	91	0	26	663
St. Louis	150	99	136	0	52	894	50	0	9	388
St. Louis	200	98	740	4	603	2544	366	0	227	1766
St. Louis	200	99	500	3	360	2058	230	0	117	1331
Other MSA/CMSA	As is		0	0	0	3	0	0	0	0
Other MSA/CMSA	Current std		15	0	0	237	5	0	0	95
Other MSA/CMSA	50	98	0	0	0	0	0	0	0	0
Other MSA/CMSA	50	99	0	0	0	0	0	0	0	0
Other MSA/CMSA	100	98	1	0	0	18	0	0	0	4
Other MSA/CMSA	100	99	0	0	0	5	0	0	0	1
Other MSA/CMSA	150	98	13	0	0	218	4	0	0	89
Other MSA/CMSA	150	99	5	0	0	101	1	0	0	29
Other MSA/CMSA	200	98	67	0	8	753	24	0	1	358
Other MSA/CMSA	200	99	28	0	1	396	9	0	0	172
Other Not MSA	As is		0	0	0	3	0	0	0	1
Other Not MSA	Current std		36	0	1	530	14	0	0	250
Other Not MSA	50	98	0	0	0	3	0	0	0	1
Other Not MSA	50	99	0	0	0	1	0	0	0	1
Other Not MSA	100	98	3	0	0	59	1	0	0	27
Other Not MSA	100	99	1	0	0	30	1	0	0	14
Other Not MSA	150	98	23	0	0	380	9	0	0	154
Other Not MSA	150	99	10	0	0	176	4	0	0	77
Other Not MSA	200	98	86	0	7	997	38	0	2	564
Other Not MSA	200	99	43	0	2	597	17	0	0	294

1 **Table A-128. Estimated number of exceedances of 1-hour concentration levels (100, 150, and 200 ppb) on-roads following adjustment to just meeting**
2 **the current and alternative standards, 2004-2006 air quality.**

			Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
Location	Scenario	Percentile	Mean	Min	Med	p99	Mean	Min	Med	p99	Mean	Min	Med	p99
Boston	As is		5	0	0	75	0	0	0	1	0	0	0	0
Boston	Current std		462	13	375	1359	91	0	40	526	16	0	1	174
Boston	50	98	8	0	0	111	0	0	0	2	0	0	0	0
Boston	50	99	4	0	0	53	0	0	0	1	0	0	0	0
Boston	100	98	372	13	294	1162	64	0	20	451	8	0	0	111
Boston	100	99	267	1	196	958	36	0	8	320	4	0	0	53
Boston	150	98	1045	189	987	2192	372	13	294	1162	114	0	62	630
Boston	150	99	860	106	790	1946	267	1	196	958	71	0	27	459
Boston	200	98	1735	518	1702	3216	819	81	745	1886	372	13	294	1162
Boston	200	99	1493	371	1441	2836	644	56	564	1571	267	1	196	958
Chicago	As is		151	0	49	984	15	0	0	211	1	0	0	44
Chicago	Current std		1357	56	1146	4138	335	0	185	1754	85	0	17	673
Chicago	50	98	42	0	4	381	2	0	0	64	0	0	0	1
Chicago	50	99	24	0	1	268	1	0	0	35	0	0	0	0
Chicago	100	98	934	25	751	3211	190	0	74	1196	42	0	4	381
Chicago	100	99	688	16	506	2718	120	0	34	842	24	0	1	268
Chicago	150	98	2546	450	2312	5611	934	25	751	3211	328	0	185	1656
Chicago	150	99	2085	207	1835	5069	688	16	506	2718	209	0	84	1263
Chicago	200	98	3841	1342	3674	6844	1996	176	1762	4973	934	25	751	3211
Chicago	200	99	3417	1025	3192	6489	1603	81	1369	4496	688	16	506	2718
Denver	As is		294	2	161	1097	34	0	5	220	4	0	0	35
Denver	Current std		2163	506	2130	3718	761	19	660	2125	236	0	117	988
Denver	50	98	181	0	78	805	16	0	2	126	1	0	0	18
Denver	50	99	117	0	40	572	9	0	0	71	0	0	0	4
Denver	100	98	1971	489	1944	3540	626	18	475	1835	181	0	78	805
Denver	100	99	1650	296	1635	3172	448	7	303	1466	117	0	40	572
Denver	150	98	3235	1827	3247	4452	1971	489	1944	3540	945	56	834	2339
Denver	150	99	3014	1560	2996	4292	1650	296	1635	3172	705	22	569	1960
Denver	200	98	3842	2544	3955	4942	2922	1487	2898	4205	1971	489	1944	3540
Denver	200	99	3684	2352	3785	4758	2667	1215	2619	4014	1650	296	1635	3172
Detroit	As is		81	0	23	462	6	0	0	72	0	0	0	11
Detroit	Current std		2835	1050	2744	4917	1263	131	1187	3068	489	17	353	1744

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99	Mean	Min	Med	p99
Detroit	50	98	170	0	80	860	16	0	1	141	2	0	0	30
Detroit	50	99	105	0	35	593	9	0	0	95	1	0	0	18
Detroit	100	98	1834	305	1776	3723	581	10	454	1945	170	0	80	860
Detroit	100	99	1482	179	1395	3413	406	3	279	1546	105	0	35	593
Detroit	150	98	3440	1603	3403	5488	1834	305	1776	3723	871	44	750	2531
Detroit	150	99	3074	1185	2990	5118	1482	179	1395	3413	638	13	516	2000
Detroit	200	98	4552	2776	4499	6565	2966	1162	2909	5062	1834	305	1776	3723
Detroit	200	99	4203	2311	4153	6255	2584	777	2517	4568	1482	179	1395	3413
Los Angeles	As is		177	0	64	1275	18	0	1	289	2	0	0	42
Los Angeles	Current std		1184	3	995	4030	296	0	145	1706	74	0	15	792
Los Angeles	50	98	50	0	7	553	3	0	0	62	0	0	0	6
Los Angeles	50	99	28	0	3	373	1	0	0	28	0	0	0	3
Los Angeles	100	98	984	1	774	3726	220	0	90	1466	50	0	7	553
Los Angeles	100	99	727	0	510	3141	137	0	44	1106	28	0	3	373
Los Angeles	150	98	2390	32	2185	5978	984	1	774	3726	370	0	199	2052
Los Angeles	150	99	2011	16	1826	5513	727	0	510	3141	240	0	102	1569
Los Angeles	200	98	3366	94	3232	6976	1944	13	1775	5414	984	1	774	3726
Los Angeles	200	99	3042	74	2896	6662	1582	5	1398	4876	727	0	510	3141
Miami	As is		17	0	2	158	1	0	0	14	0	0	0	1
Miami	Current std		1487	351	1544	2466	745	59	683	1788	358	3	246	1209
Miami	50	98	47	0	11	349	4	0	0	54	0	0	0	4
Miami	50	99	22	0	3	202	1	0	0	27	0	0	0	2
Miami	100	98	586	24	512	1563	170	0	85	787	47	0	11	349
Miami	100	99	417	8	334	1321	96	0	34	547	22	0	3	202
Miami	150	98	1284	295	1330	2306	586	24	512	1563	259	1	162	1019
Miami	150	99	1026	144	1023	2070	417	8	334	1321	158	0	77	787
Miami	200	98	1863	643	1955	2677	1066	175	1089	2070	586	24	512	1563
Miami	200	99	1577	463	1648	2495	823	78	797	1821	417	8	334	1321
New York	As is		168	0	69	1029	17	0	1	187	2	0	0	36
New York	Current std		1050	0	872	3687	226	0	103	1593	50	0	8	457
New York	50	98	51	0	9	387	4	0	0	65	0	0	0	7
New York	50	99	30	0	4	283	2	0	0	35	0	0	0	4
New York	100	98	1072	0	870	3498	231	0	112	1319	51	0	9	387
New York	100	99	806	0	607	2942	147	0	54	930	30	0	4	283

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99	Mean	Min	Med	p99
New York	150	98	2596	136	2635	5616	1072	0	870	3498	390	0	232	1881
New York	150	99	2237	59	2187	5196	806	0	607	2942	263	0	137	1424
New York	200	98	3774	509	3945	6796	2129	39	2079	5061	1072	0	870	3498
New York	200	99	3401	354	3532	6472	1762	17	1645	4544	806	0	607	2942
Philadelphia	As is		87	0	25	687	5	0	0	77	0	0	0	6
Philadelphia	Current std		1914	173	1881	4739	623	3	458	2456	188	0	74	1195
Philadelphia	50	98	72	0	18	580	4	0	0	64	0	0	0	4
Philadelphia	50	99	46	0	7	407	2	0	0	38	0	0	0	2
Philadelphia	100	98	1381	98	1275	4410	325	0	200	1985	72	0	18	580
Philadelphia	100	99	1126	47	972	3998	231	0	136	1474	46	0	7	407
Philadelphia	150	98	2992	972	2884	6362	1381	98	1275	4410	537	4	402	2666
Philadelphia	150	99	2697	746	2628	6108	1126	47	972	3998	396	1	265	2227
Philadelphia	200	98	4127	2047	3980	7122	2504	658	2431	5849	1381	98	1275	4410
Philadelphia	200	99	3865	1901	3733	7038	2197	414	2110	5555	1126	47	972	3998
Washington DC	As is		80	0	13	709	5	0	0	71	1	0	0	9
Washington DC	Current std		1697	25	1613	4543	587	0	341	2664	179	0	57	1250
Washington DC	50	98	75	0	12	655	5	0	0	64	0	0	0	9
Washington DC	50	99	50	0	5	474	3	0	0	35	0	0	0	6
Washington DC	100	98	1202	0	1039	3904	316	0	142	1907	75	0	12	655
Washington DC	100	99	983	0	786	3560	226	0	84	1586	50	0	5	474
Washington DC	150	98	2575	121	2738	5756	1202	0	1039	3904	506	0	291	2568
Washington DC	150	99	2307	78	2377	5427	983	0	786	3560	382	0	195	2209
Washington DC	200	98	3639	444	3880	7144	2150	41	2212	5298	1202	0	1039	3904
Washington DC	200	99	3363	312	3624	6808	1897	24	1917	4835	983	0	786	3560
Atlanta	As is		59	0	3	609	5	0	0	87	1	0	0	14
Atlanta	Current std		1665	9	1972	4187	803	0	706	2722	363	0	169	1739
Atlanta	50	98	43	0	1	486	3	0	0	63	0	0	0	9
Atlanta	50	99	23	0	0	294	2	0	0	35	0	0	0	4
Atlanta	100	98	673	0	550	2442	174	0	35	1169	43	0	1	486
Atlanta	100	99	504	0	323	2031	110	0	12	895	23	0	0	294
Atlanta	150	98	1487	3	1714	3909	673	0	550	2442	279	0	112	1518
Atlanta	150	99	1262	1	1382	3514	504	0	323	2031	187	0	44	1220
Atlanta	200	98	2200	33	2730	4963	1221	1	1322	3493	673	0	550	2442
Atlanta	200	99	1937	12	2322	4610	1013	0	1025	3050	504	0	323	2031

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99	Mean	Min	Med	p99
El Paso	As is		67	0	22	547	5	0	0	56	0	0	0	9
El Paso	Current std		2324	544	2292	4255	1114	47	980	2855	452	4	308	1871
El Paso	50	98	78	0	26	605	6	0	0	61	1	0	0	12
El Paso	50	99	48	0	16	393	3	0	0	40	0	0	0	5
El Paso	100	98	1200	67	1078	2944	317	2	184	1531	78	0	26	605
El Paso	100	99	969	36	837	2696	216	0	108	1231	48	0	16	393
El Paso	150	98	2426	597	2427	4412	1200	67	1078	2944	509	5	360	2005
El Paso	150	99	2165	425	2139	4088	969	36	837	2696	366	2	227	1669
El Paso	200	98	3214	1018	3240	5374	2069	384	2035	3955	1200	67	1078	2944
El Paso	200	99	2989	942	3023	5060	1795	290	1714	3681	969	36	837	2696
Jacksonville	As is		45	0	37	182	11	0	7	53	5	0	2	24
Jacksonville	Current std		2755	1395	2666	4892	1329	408	1290	3072	627	84	545	1943
Jacksonville	50	98	131	0	79	542	25	0	21	106	10	0	5	48
Jacksonville	50	99	68	0	48	267	15	0	11	66	7	0	3	35
Jacksonville	100	98	1280	375	1213	2873	394	25	306	1310	131	0	79	542
Jacksonville	100	99	867	162	770	2328	227	5	135	899	68	0	48	267
Jacksonville	150	98	2673	1395	2605	4495	1280	375	1213	2873	582	71	478	1736
Jacksonville	150	99	2104	978	2067	4116	867	162	770	2328	353	20	261	1275
Jacksonville	200	98	3839	2340	3798	5787	2245	1012	2149	4166	1280	375	1213	2873
Jacksonville	200	99	3231	1870	3180	5279	1685	640	1588	3451	867	162	770	2328
Las Vegas	As is		55	0	0	726	7	0	0	229	0	0	0	14
Las Vegas	Current std		1206	5	475	4215	561	0	98	3201	217	0	16	1873
Las Vegas	50	98	61	0	0	761	9	0	0	260	1	0	0	19
Las Vegas	50	99	46	0	0	681	5	0	0	181	0	0	0	10
Las Vegas	100	98	767	0	195	3573	227	0	17	2007	61	0	0	761
Las Vegas	100	99	672	0	151	3409	178	0	11	1689	46	0	0	681
Las Vegas	150	98	1416	10	676	4502	767	0	195	3573	354	0	40	2568
Las Vegas	150	99	1319	6	576	4349	672	0	151	3409	288	0	27	2246
Las Vegas	200	98	1932	40	1297	5122	1225	5	496	4215	767	0	195	3573
Las Vegas	200	99	1805	34	1124	4937	1130	4	418	4083	672	0	151	3409
Phoenix	As is		353	0	136	1794	25	0	1	184	2	0	0	18
Phoenix	Current std		2309	457	2251	4472	640	3	402	2655	146	0	23	1088
Phoenix	50	98	83	0	10	656	3	0	0	32	0	0	0	1
Phoenix	50	99	48	0	5	387	1	0	0	14	0	0	0	0

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99	Mean	Min	Med	p99
Phoenix	100	98	1909	200	1791	4162	436	0	203	2151	83	0	10	656
Phoenix	100	99	1542	87	1408	3846	298	0	96	1648	48	0	5	387
Phoenix	150	98	3807	1607	3912	5509	1909	200	1791	4162	740	4	517	2827
Phoenix	150	99	3498	1334	3573	5227	1542	87	1408	3846	524	0	284	2310
Phoenix	200	98	4812	2636	4882	6298	3305	1116	3337	5211	1909	200	1791	4162
Phoenix	200	99	4573	2410	4646	6049	2964	858	2989	4904	1542	87	1408	3846
Provo	As is		394	0	255	1237	214	0	3	706	138	0	0	662
Provo	Current std		2971	1011	2923	4766	1360	175	1173	3241	598	1	641	1990
Provo	50	98	195	0	0	694	71	0	0	624	16	0	0	309
Provo	50	99	178	0	0	686	52	0	0	579	9	0	0	195
Provo	100	98	678	0	671	1866	266	0	79	808	195	0	0	694
Provo	100	99	573	0	503	1606	246	0	30	770	178	0	0	686
Provo	150	98	1995	348	1982	3648	678	0	671	1866	325	0	175	991
Provo	150	99	1742	175	1767	3465	573	0	503	1606	293	0	131	900
Provo	200	98	3195	1802	3171	4646	1526	90	1497	3172	678	0	671	1866
Provo	200	99	2946	1445	2902	4483	1293	37	1214	2986	573	0	503	1606
St. Louis	As is		50	0	10	364	4	0	0	79	0	0	0	8
St. Louis	Current std		1785	293	1630	4265	647	1	485	2455	218	0	106	1309
St. Louis	50	98	55	0	13	397	4	0	0	88	0	0	0	12
St. Louis	50	99	39	0	7	292	2	0	0	60	0	0	0	4
St. Louis	100	98	1055	86	909	2742	249	0	161	1125	55	0	13	397
St. Louis	100	99	893	48	787	2506	190	0	109	949	39	0	7	292
St. Louis	150	98	2434	848	2271	4567	1055	86	909	2742	414	1	316	1476
St. Louis	150	99	2210	681	2034	4449	893	48	787	2506	327	0	243	1308
St. Louis	200	98	3650	1497	3499	6031	1991	557	1797	4111	1055	86	909	2742
St. Louis	200	99	3366	1354	3212	5662	1784	403	1607	3827	893	48	787	2506
Other MSA/CMSA	As is		32	0	1	430	2	0	0	46	0	0	0	5
Other MSA/CMSA	Current std		886	0	615	3726	265	0	88	1870	78	0	8	867
Other MSA/CMSA	50	98	11	0	0	194	1	0	0	14	0	0	0	1
Other MSA/CMSA	50	99	6	0	0	103	0	0	0	5	0	0	0	1
Other MSA/CMSA	100	98	359	0	159	2328	63	0	7	738	11	0	0	194
Other MSA/CMSA	100	99	240	0	80	1840	34	0	2	459	6	0	0	103
Other MSA/CMSA	150	98	1101	0	847	4238	359	0	159	2328	114	0	21	1128
Other MSA/CMSA	150	99	843	0	585	3718	240	0	80	1840	64	0	7	739

Location	Scenario	Percentile	Exceedances of 100 ppb				Exceedances of 150 ppb				Exceedances of 200 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99	Mean	Min	Med	p99
Other MSA/CMSA	200	98	1859	0	1664	5423	839	0	580	3697	359	0	159	2328
Other MSA/CMSA	200	99	1531	0	1299	4967	619	0	374	3160	240	0	80	1840
Other Not MSA	As is		10	0	0	189	1	0	0	29	0	0	0	8
Other Not MSA	Current std		737	0	299	3833	274	0	47	2075	105	0	6	1106
Other Not MSA	50	98	9	0	0	184	1	0	0	27	0	0	0	7
Other Not MSA	50	99	6	0	0	122	1	0	0	20	0	0	0	4
Other Not MSA	100	98	197	0	24	1688	41	0	1	571	9	0	0	184
Other Not MSA	100	99	157	0	14	1449	29	0	0	477	6	0	0	122
Other Not MSA	150	98	590	0	198	3357	197	0	24	1688	70	0	3	887
Other Not MSA	150	99	493	0	141	2982	157	0	14	1449	50	0	2	716
Other Not MSA	200	98	1008	0	525	4621	439	0	117	2814	197	0	24	1688
Other Not MSA	200	99	894	0	414	4343	362	0	79	2474	157	0	14	1449

1 **Table A-129. Estimated number of exceedances of 1-hour concentration levels (250 and 300 ppb) on-roads**
2 **following adjustment to just meeting the current and alternative standards, 2004-2006 air quality.**

			Exceedances of 250 ppb				Exceedances of 300 ppb			
Location	Scenario	Percentile	Mean	Min	Med	p99	Mean	Min	Med	p99
Boston	As is		0	0	0	0	0	0	0	0
Boston	Current std		3	0	0	37	0	0	0	3
Boston	50	98	0	0	0	0	0	0	0	0
Boston	50	99	0	0	0	0	0	0	0	0
Boston	100	98	1	0	0	18	0	0	0	2
Boston	100	99	0	0	0	3	0	0	0	1
Boston	150	98	34	0	5	314	8	0	0	111
Boston	150	99	18	0	1	204	4	0	0	53
Boston	200	98	155	0	100	709	64	0	20	451
Boston	200	99	103	0	52	577	36	0	8	320
Chicago	As is		0	0	0	3	0	0	0	0
Chicago	Current std		23	0	1	270	7	0	0	132
Chicago	50	98	0	0	0	0	0	0	0	0
Chicago	50	99	0	0	0	0	0	0	0	0
Chicago	100	98	10	0	0	156	2	0	0	64
Chicago	100	99	5	0	0	96	1	0	0	35
Chicago	150	98	115	0	30	842	42	0	4	381
Chicago	150	99	70	0	12	552	24	0	1	268
Chicago	200	98	419	3	267	1951	190	0	74	1196
Chicago	200	99	283	0	138	1516	120	0	34	842
Denver	As is		0	0	0	4	0	0	0	0
Denver	Current std		78	0	22	437	25	0	2	200
Denver	50	98	0	0	0	1	0	0	0	0
Denver	50	99	0	0	0	0	0	0	0	0
Denver	100	98	55	0	9	312	16	0	2	126
Denver	100	99	33	0	4	219	9	0	0	71
Denver	150	98	416	7	268	1418	181	0	78	805
Denver	150	99	281	2	149	1078	117	0	40	572
Denver	200	98	1159	107	1102	2624	626	18	475	1835
Denver	200	99	875	43	753	2196	448	7	303	1466
Detroit	As is		0	0	0	0	0	0	0	0
Detroit	Current std		183	0	86	905	65	0	17	409
Detroit	50	98	0	0	0	2	0	0	0	0
Detroit	50	99	0	0	0	0	0	0	0	0
Detroit	100	98	50	0	10	305	16	0	1	141
Detroit	100	99	28	0	3	210	9	0	0	95
Detroit	150	98	382	3	270	1512	170	0	80	860
Detroit	150	99	256	0	150	1159	105	0	35	593
Detroit	200	98	1052	76	937	2763	581	10	454	1945
Detroit	200	99	788	33	666	2339	406	3	279	1546
Los Angeles	As is		0	0	0	7	0	0	0	1
Los Angeles	Current std		20	0	1	293	5	0	0	86
Los Angeles	50	98	0	0	0	0	0	0	0	0
Los Angeles	50	99	0	0	0	0	0	0	0	0
Los Angeles	100	98	12	0	0	198	3	0	0	62
Los Angeles	100	99	6	0	0	113	1	0	0	28
Los Angeles	150	98	135	0	43	1106	50	0	7	553

Location	Scenario	Percentile	Exceedances of 250 ppb				Exceedances of 300 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99
Los Angeles	150	99	80	0	17	783	28	0	3	373
Los Angeles	200	98	465	0	279	2350	220	0	90	1466
Los Angeles	200	99	312	0	156	1858	137	0	44	1106
Miami	As is		0	0	0	0	0	0	0	0
Miami	Current std		168	0	80	792	78	0	24	536
Miami	50	98	0	0	0	1	0	0	0	0
Miami	50	99	0	0	0	1	0	0	0	0
Miami	100	98	13	0	2	137	4	0	0	54
Miami	100	99	5	0	0	76	1	0	0	27
Miami	150	98	109	0	43	595	47	0	11	349
Miami	150	99	57	0	14	387	22	0	3	202
Miami	200	98	319	3	213	1131	170	0	85	787
Miami	200	99	202	0	111	864	96	0	34	547
New York	As is		0	0	0	7	0	0	0	1
New York	Current std		13	0	0	198	4	0	0	72
New York	50	98	0	0	0	1	0	0	0	0
New York	50	99	0	0	0	1	0	0	0	0
New York	100	98	13	0	1	154	4	0	0	65
New York	100	99	7	0	0	99	2	0	0	35
New York	150	98	135	0	49	861	51	0	9	387
New York	150	99	86	0	23	606	30	0	4	283
New York	200	98	505	0	317	2227	231	0	112	1319
New York	200	99	345	0	199	1706	147	0	54	930
Philadelphia	As is		0	0	0	0	0	0	0	0
Philadelphia	Current std		55	0	9	534	17	0	1	233
Philadelphia	50	98	0	0	0	0	0	0	0	0
Philadelphia	50	99	0	0	0	0	0	0	0	0
Philadelphia	100	98	17	0	1	160	4	0	0	64
Philadelphia	100	99	10	0	0	105	2	0	0	38
Philadelphia	150	98	197	0	104	1306	72	0	18	580
Philadelphia	150	99	138	0	56	1018	46	0	7	407
Philadelphia	200	98	696	11	551	3109	325	0	200	1985
Philadelphia	200	99	521	4	389	2666	231	0	136	1474
Washington DC	As is		0	0	0	2	0	0	0	0
Washington DC	Current std		53	0	6	564	17	0	1	207
Washington DC	50	98	0	0	0	2	0	0	0	0
Washington DC	50	99	0	0	0	1	0	0	0	0
Washington DC	100	98	20	0	1	199	5	0	0	64
Washington DC	100	99	11	0	0	127	3	0	0	35
Washington DC	150	98	196	0	61	1442	75	0	12	655
Washington DC	150	99	137	0	34	1059	50	0	5	474
Washington DC	200	98	632	0	403	2810	316	0	142	1907
Washington DC	200	99	490	0	281	2421	226	0	84	1586
Atlanta	As is		0	0	0	2	0	0	0	0
Atlanta	Current std		155	0	28	1082	65	0	4	661
Atlanta	50	98	0	0	0	1	0	0	0	0
Atlanta	50	99	0	0	0	0	0	0	0	0
Atlanta	100	98	11	0	0	163	3	0	0	63

Location	Scenario	Percentile	Exceedances of 250 ppb				Exceedances of 300 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99
Atlanta	100	99	6	0	0	96	2	0	0	35
Atlanta	150	98	110	0	12	895	43	0	1	486
Atlanta	150	99	64	0	4	661	23	0	0	294
Atlanta	200	98	351	0	169	1661	174	0	35	1169
Atlanta	200	99	236	0	75	1363	110	0	12	895
El Paso	As is		0	0	0	1	0	0	0	0
El Paso	Current std		174	0	79	1065	66	0	21	519
El Paso	50	98	0	0	0	1	0	0	0	0
El Paso	50	99	0	0	0	1	0	0	0	0
El Paso	100	98	21	0	5	184	6	0	0	61
El Paso	100	99	12	0	1	122	3	0	0	40
El Paso	150	98	203	0	97	1179	78	0	26	605
El Paso	150	99	132	0	53	890	48	0	16	393
El Paso	200	98	642	9	505	2226	317	2	184	1531
El Paso	200	99	472	4	338	1874	216	0	108	1231
Jacksonville	As is		3	0	0	15	1	0	0	8
Jacksonville	Current std		293	12	202	1150	142	1	85	600
Jacksonville	50	98	6	0	2	26	4	0	1	19
Jacksonville	50	99	4	0	1	19	2	0	0	13
Jacksonville	100	98	50	0	41	199	25	0	21	106
Jacksonville	100	99	27	0	22	115	15	0	11	66
Jacksonville	150	98	274	7	169	1044	131	0	79	542
Jacksonville	150	99	148	1	89	603	68	0	48	267
Jacksonville	200	98	708	99	618	1943	394	25	306	1310
Jacksonville	200	99	441	32	352	1438	227	5	135	899
Las Vegas	As is		0	0	0	1	0	0	0	0
Las Vegas	Current std		78	0	1	862	33	0	0	630
Las Vegas	50	98	0	0	0	2	0	0	0	0
Las Vegas	50	99	0	0	0	0	0	0	0	0
Las Vegas	100	98	22	0	0	520	9	0	0	260
Las Vegas	100	99	16	0	0	431	5	0	0	181
Las Vegas	150	98	144	0	6	1399	61	0	0	761
Las Vegas	150	99	109	0	3	1133	46	0	0	681
Las Vegas	200	98	436	0	61	2813	227	0	17	2007
Las Vegas	200	99	360	0	42	2568	178	0	11	1689
Phoenix	As is		0	0	0	1	0	0	0	0
Phoenix	Current std		30	0	1	271	6	0	0	60
Phoenix	50	98	0	0	0	0	0	0	0	0
Phoenix	50	99	0	0	0	0	0	0	0	0
Phoenix	100	98	14	0	0	121	3	0	0	32
Phoenix	100	99	7	0	0	71	1	0	0	14
Phoenix	150	98	253	0	67	1395	83	0	10	656
Phoenix	150	99	167	0	29	1092	48	0	5	387
Phoenix	200	98	947	16	731	3135	436	0	203	2151
Phoenix	200	99	695	4	453	2794	298	0	96	1648
Provo	As is		66	0	0	612	26	0	0	435
Provo	Current std		330	0	220	847	225	0	68	694
Provo	50	98	0	0	0	3	0	0	0	0

Location	Scenario	Percentile	Exceedances of 250 ppb				Exceedances of 300 ppb			
			Mean	Min	Med	p99	Mean	Min	Med	p99
Provo	50	99	0	0	0	0	0	0	0	0
Provo	100	98	130	0	0	658	71	0	0	624
Provo	100	99	109	0	0	646	52	0	0	579
Provo	150	98	236	0	16	748	195	0	0	694
Provo	150	99	220	0	6	715	178	0	0	686
Provo	200	98	375	0	222	1167	266	0	79	808
Provo	200	99	330	0	175	1050	246	0	30	770
St. Louis	As is		0	0	0	0	0	0	0	0
St. Louis	Current std		71	0	14	701	26	0	0	338
St. Louis	50	98	0	0	0	0	0	0	0	0
St. Louis	50	99	0	0	0	0	0	0	0	0
St. Louis	100	98	13	0	0	155	4	0	0	88
St. Louis	100	99	9	0	0	132	2	0	0	60
St. Louis	150	98	152	0	78	801	55	0	13	397
St. Louis	150	99	111	0	44	654	39	0	7	292
St. Louis	200	98	529	5	445	1765	249	0	161	1125
St. Louis	200	99	428	1	333	1593	190	0	109	949
Other MSA/CMSA	As is		0	0	0	1	0	0	0	0
Other MSA/CMSA	Current std		23	0	0	381	7	0	0	144
Other MSA/CMSA	50	98	0	0	0	0	0	0	0	0
Other MSA/CMSA	50	99	0	0	0	0	0	0	0	0
Other MSA/CMSA	100	98	2	0	0	53	1	0	0	14
Other MSA/CMSA	100	99	1	0	0	24	0	0	0	5
Other MSA/CMSA	150	98	35	0	2	460	11	0	0	194
Other MSA/CMSA	150	99	18	0	0	277	6	0	0	103
Other MSA/CMSA	200	98	148	0	34	1330	63	0	7	738
Other MSA/CMSA	200	99	89	0	13	954	34	0	2	459
Other Not MSA	As is		0	0	0	2	0	0	0	2
Other Not MSA	Current std		42	0	1	616	17	0	0	316
Other Not MSA	50	98	0	0	0	2	0	0	0	2
Other Not MSA	50	99	0	0	0	2	0	0	0	2
Other Not MSA	100	98	2	0	0	57	1	0	0	27
Other Not MSA	100	99	2	0	0	38	1	0	0	20
Other Not MSA	150	98	26	0	0	440	9	0	0	184
Other Not MSA	150	99	17	0	0	293	6	0	0	122
Other Not MSA	200	98	89	0	4	1051	41	0	1	571
Other Not MSA	200	99	65	0	2	833	29	0	0	477

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Appendix B. Supplement to the NO_2 Exposure Assessment

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B-1 Overview

This appendix contains supplemental descriptions of the methods and data used in the NO_2 exposure assessment, as well as detailed results from the exposure analyses performed. First, a broad description of the exposure modeling approach is described, applicable to the two exposure modeling case-studies conducted to date: Philadelphia and Atlanta. This is followed with details regarding the required inputs for the model and the assumptions made for both of the case-study assessments. The primary output for each exposure assessment was the numbers of exceedances of short-term (1-hour) potential health effect benchmark levels experienced by the asthmatic population residing within each location.

The first simulation location included Philadelphia County and was summarized in the 1st draft Risk and Exposure Assessment (REA). The results from this assessment are presented here as they existed in that document and the draft Technical Support Document draft (TSD) and no adjustments were made to modeling approach used to generate the exposure results. However, additional comparative analyses are presented here to clarify certain issues raised in the review of this case-study by CASAC in May, 2008. These include additional comparisons of the AERMOD modeled air quality with the available ambient monitor data (section 3.6.2) as well as a comparison of the two on-road concentration estimation approaches used (section 3.6.3)

A second case-study was conducted in portions of the Atlanta Metropolitan Statistical Area (MSA) that includes four counties. Some of the recommendations by CASAC on the modeling approach, evaluation, and assumptions made have been incorporated in this case-study. Details on the exposure modeling approach for the Atlanta exposure case-study are provided here.

B-2 Human Exposure Modeling using APEX

The Air Pollutants Exposure model (APEX) is a personal computer (PC)-based program designed to estimate human exposure to criteria and air toxic pollutants at the local, urban, and consolidated metropolitan levels. APEX, also known as TRIM.Expo, is the human inhalation exposure module of EPA's Total Risk Integrated Methodology (TRIM) model framework (US EPA, 1999), a modeling system with multimedia capabilities for assessing human health and ecological risks from hazardous and criteria air pollutants. It is being developed to support evaluations with a scientifically sound, flexible, and user-friendly methodology. Additional information on the TRIM modeling system, as well as downloads of the APEX Model, user's guide, and other supporting documentation, can be found on EPA's Technology Transfer Network (TTN) at http://www.epa.gov/ttn/fera.

B-2.1 History

APEX was derived from the National Ambient Air Quality Standards (NAAQS) Exposure Model (NEM) series of models, developed to estimate exposure to the criteria pollutants (e.g., carbon monoxide (CO), ozone O_3). In 1979, EPA began by assembling a database of human activity patterns that could be used to estimate exposures to indoor and outdoor pollutants (Roddin et al., 1979). These data were then combined with measured outdoor concentrations in NEM to estimate exposures to CO (Biller et al., 1981; Johnson and Paul, 1983). In 1988, OAQPS began to incorporate probabilistic elements into the NEM methodology and use activity pattern data based on various human activity diary studies to create an early version of probabilistic NEM for O_3 (i.e., pNEM/O_3). In 1991, a probabilistic version of NEM was extended to CO (pNEM/CO) that included a one-compartment mass-balance model to estimate CO concentrations in indoor microenvironments. The application of this model to Denver, Colorado has been documented in Johnson et al. (1992). Additional enhancements to pNEM/O_3 in the early- to mid-1990's allowed for probabilistic exposure assessments in nine urban areas for the general population, outdoor children, and outdoor workers (Johnson et al., 1996a; 1996b; 1996c). Between 1999 and 2001, updated versions of pNEM/CO (versions 2.0 and 2.1) were developed that relied on activity diary data from EPA's Consolidated Human Activities Database (CHAD) and enhanced algorithms for simulating gas stove usage, estimating alveolar ventilation rate (a measure of human respiration), and modeling home-to-work commuting patterns.

The first version of APEX was essentially identical to pNEM/CO (version 2.0) except that it was capable of running on a PC instead of a mainframe. The next version, APEX2, was substantially different, particularly in the use of a personal profile approach (i.e., simulation of individuals) rather than a cohort simulation (i.e., groups of similar persons). APEX3 introduced a number of new features including automatic site selection from national databases, a series of new output tables providing summary exposure and dose statistics, and a thoroughly reorganized method of describing microenvironments and their parameters. Most of the spatial and temporal constraints of pNEM and APEX1 were removed or relaxed by version 3.

The version of APEX used in this exposure assessment is APEX4, described in the APEX User's Guide and the APEX Technical Support Document (US EPA, 2006a; 2006b) and referred to here as the APEX User's Guide and TSD.

B-2.2 APEX Model Overview

APEX estimates human exposure to criteria and toxic air pollutants at the local, urban, or consolidated metropolitan area levels using a stochastic, microenvironmental approach. The model randomly selects data for a sample of hypothetical individuals from an actual population database and simulates each hypothetical individual's movements through time and space (e.g., at home, in vehicles) to estimate their exposure to a pollutant. APEX simulates commuting, and thus exposures that occur at home and work locations, for individuals who work in different areas than they live.

A **microenvironment** is a three-dimensional space in which human contact with an environmental pollutant takes place and which can be treated as a well-characterized, relatively homogeneous location with respect to pollutant concentrations for a specified time period.

APEX can be conceptualized as a simulated field study that would involve selecting an actual sample of specific individuals who live in (or work and live in) a geographic area and then continuously monitoring their activities and subsequent inhalation exposure to a specific air pollutant during a specific period of time.

The main differences between APEX and an actual field study are that in APEX:

- The sample of individuals is a virtual sample, not actual persons. However, the population of individuals appropriately balanced according to various demographic variables and census data using their relative frequencies, in order to obtain a representative sample (to the extent possible) of the actual people in the study area
- The activity patterns of the sampled individuals (e.g., the specification of indoor and other microenvironments visited and the time spent in each) are assumed by the model to be comparable to individuals with similar demographic characteristics, according to activity data such as diaries compiled in EPA's Consolidated Human Activity Database (or CHAD; US EPA, 2002; McCurdy et al., 2000)
- The pollutant exposure concentrations are estimated by the model using a set of user-input ambient outdoor concentrations (either modeled or measured) and information on the behavior of the pollutant in various microenvironments;
- Variation in ambient air quality levels can be simulated by either adjusting air quality concentrations to just meet alternative ambient standards, or by reducing source emissions and obtaining resulting air quality modeling outputs that reflect these potential emission reductions, and
- The model accounts for the most significant factors contributing to inhalation exposure – the temporal and spatial distribution of people and pollutant concentrations throughout the study area and among microenvironments – while also allowing the flexibility to adjust some of these factors for alternative scenarios and sensitivity analyses.

APEX is designed to simulate human population exposure to criteria and air toxic pollutants at local, urban, and regional scales. The user specifies the geographic area to be modeled and the number of individuals to be simulated to represent this population. APEX then generates a personal profile for each simulated person that specifies various parameter values required by the model. The model next uses diary-derived time/activity data matched to each personal profile to generate an exposure event sequence (also referred to as *activity pattern* or *diary*) for the modeled individual that spans a specified time period, such as one year. Each event in the sequence specifies a start time, exposure duration, geographic location, microenvironment, and activity performed. Probabilistic algorithms are used to estimate the pollutant concentration associated with each exposure event. The estimated pollutant concentrations account for the effects of ambient (outdoor) pollutant concentration, penetration factors, air exchange rates, decay/deposition rates, and proximity to emission sources, depending on the microenvironment, available data, and estimation method selected by the user. Because the modeled individuals represent a random sample of the population of interest, the distribution of modeled individual exposures can be extrapolated to the larger population. The model simulation can be broadly described in five steps that follow:

1. **Characterize the study area**. APEX selects census tracts within a study area – and thus identifies the potentially exposed population – based on user-defined criteria and availability of air quality and meteorological data for the area.
2. **Generate simulated individuals**. APEX stochastically generates a sample of hypothetical individuals based on the census data for the study area and human profile distribution data (such as age-specific employment probabilities).
3. **Construct a sequence of activity events**. APEX constructs an exposure event sequence spanning the period of the simulation for each of the simulated individuals and based on the activity pattern data.
4. **Calculate hourly concentrations in microenvironments**. APEX users define microenvironments that people in the study area would visit by assigning location codes in the activity pattern to the user-specified microenvironments. The model then calculates hourly concentrations of a pollutant in each of these microenvironments for the period of simulation, based on the user-provided microenvironment descriptions and hourly air quality data. Microenvironmental concentrations are calculated for each of the simulated individuals.
5. **Estimate exposures**.

APEX estimates a concentration for each exposure event based on the microenvironment occupied during the event. These values can be averaged by clock hour to produce a sequence of hourly average exposures spanning the specified exposure period. These hourly values may be further aggregated to produce daily, monthly, and annual average exposure values.

B-2.2.1 Study Area Characterization

The APEX study area has traditionally been on the scale of a city or slightly larger metropolitan area, although it is now possible to model larger areas such as combined statistical areas (CSAs). In the exposure analyses performed as part of this NAAQS review, the study area is defined by either a single or a few counties. The demographic data used by the model to create personal profiles is provided at the census block level. For each block the model requires demographic information representing the distribution of age, gender, race, and work status within the study population. Each block has a location specified by latitude and longitude for some representative point (e.g., geographic center). The current release of APEX includes input files that already contain this demographic and location data for all census tracts, block groups, and blocks in the 50 United States, based on the 2000 Census. In this assessment, exposures were evaluated at the block level.

B-2.2.1.1 Air Quality Data

Air quality data can be input to the model as measured data from an ambient monitor or that generated by air quality modeling. This exposure analysis used modeled air quality data, whereas the principal emission sources included both mobile and stationary sources as well as fugitive emissions. Air quality data used for input to APEX were generated using AERMOD, a steady-state, Gaussian plume model (EPA, 2004). The following steps were performed using AERMOD.

1. **Collect and analyze general input parameters.** Meteorological data, processing methodologies used to derive input meteorological fields (e.g., temperature, wind speed, precipitation), and information on surface characteristics and land use are needed to help determine pollutant dispersion characteristics, atmospheric stability and mixing heights.
2. **Estimate emissions**. The emission sources modeled included, major stationary emission sources, on-road emissions that occur on major roadways, and fugitive emissions.
3. **Define receptor locations**. Three sets of receptors were identified for the dispersion modeling, including ambient monitoring locations, census block centroids, and links along major roadways.
4. **Estimate concentrations at receptors**. Hourly concentrations were estimated for each year of the simulation (years 2001 through 2003) by combining concentration contributions from each of the emission sources and accounting for sources not modeled.

In APEX, the ambient air quality data are assigned to geographic areas called districts. The districts are used to assign pollutant concentrations to the blocks/tracts and microenvironments being modeled. The ambient air quality data are provided by the user as hourly time series for each district. As with blocks/tracts, each district has a representative location (latitude and longitude). APEX calculates the distance from each block/tract to each district center, and assigns the block/tract to the nearest district, provided the block/tract representative location point (e.g., geographic center) is in the district. Each block/tract can be assigned to only one district. In this assessment the district was synonymous with the receptor modeled in the dispersion modeling.

B-2.2.1.2 Meteorological Data

Ambient temperatures are input to APEX for different sites (locations). As with districts, APEX calculates the distance from each block to each temperature site and assigns each block to the nearest site. Hourly temperature data are from the National Climatic Data Center Surface Airways Hourly TD-3280 dataset (NCDC Surface Weather Observations). Daily average and 1-hour maxima are computed from these hourly data.

There are two files that are used to provide meteorological data to APEX. One file, the meteorological station location file, contains the locations of meteorological data recordings expressed in latitude and longitude coordinates. This file also contains start and end dates for the data recording periods. The temperature data file contains the data from the locations in the temperature zone location file. This file contains hourly temperature readings for the period being modeled for the meteorological stations in and around the study area.

B-2.2.2 Simulated Individuals

APEX stochastically generates a user-specified number of simulated persons to represent the population in the study area. Each simulated person is represented by a personal profile, a summary of personal attributes that define the individual. APEX generates the simulated person or profile by probabilistically selecting values for a set of profile variables (Table B-1). The profile variables could include:

- Demographic variables, generated based on the census data;
- Physical variables, generated based on sets of distribution data;
- Other daily varying variables, generated based on literature-derived distribution data that change daily during the simulation period.

APEX first selects demographic and physical attributes for each specified individual, and then follows the individual over time and calculates his or her time series of exposure.

Table B-1. Examples of profile variables in APEX.

Variable Type	Profile Variables	Description
Demographic	Age	Age (years)
	Gender	Male or Female
	Home block	Block in which a simulated person lives
	Work tract	Tract in which a simulated person works
	Employment status	Indicates employment outside home
Physical	Air conditioner	Indicates presence of air conditioning at home
	Gas Stove	Indicates presence of gas stove at home

B-2.2.2.1 Population Demographics

APEX takes population characteristics into account to develop accurate representations of study area demographics. Specifically, population counts by area and employment probability estimates are used to develop representative profiles of hypothetical individuals for the simulation.

APEX is flexible in the resolution of population data provided. As long as the data are available, any resolution can be used (e.g., county, census tract, census block). For this application of the model, census block level data were used. Block-level population counts come from the 2000 Census of Population and Housing Summary File 1 (SF-1). This file contains the 100-percent data, which is the information compiled from the questions asked of all people and about every housing unit.

As part of the population demographics inputs, it is important to integrate working patterns into the assessment. In the 2000 U.S. Census, estimates of employment were developed by census information (US Census Bureau, 2007). The employment statistics are broken down by gender and age group, so that each gender/age group combination is given an employment probability fraction (ranging from 0 to 1) within each census tract. The age groupings used are: 16-19, 20-21, 22-24, 25-29, 30-34, 35-44, 45-54, 55-59, 60-61, 62-64, 65-69, 70-74, and >75. Children under 16 years of age were assumed to be not employed.

Since this analysis was conducted at the census block level, block level employment probabilities were required. It was assumed that the employment probabilities for a census tract apply uniformly to the constituent census blocks.

B-2.2.2.2 Commuting

In addition to using estimates of employment by tract, APEX also incorporates home-to-work commuting data. Commuting data were originally derived from the 2000 Census and were collected as part of the Census Transportation Planning Package (CTPP) (US DOT, 2007). The data used contain counts of individuals commuting from home to work locations at a number of geographic scales. These data were processed to calculate fractions for each tract-to-tract flow to create the national commuting data distributed with APEX. This database contains commuting data for each of the 50 states and Washington, D.C.

Commuting within the Home Tract

The APEX data set does not differentiate people that work at home from those that commute within their home tract.

Commuting Distance Cutoff

A preliminary data analysis of the home-work counts showed that a graph of log(flows) versus log(distance) had a near-constant slope out to a distance of around 120 kilometers. Beyond that distance, the relationship also had a fairly constant slope but it was flatter, meaning that flows were not as sensitive to distance. A simple interpretation of this result is that up to 120 km, the majority of the flow was due to persons traveling back and forth daily, and the numbers of such persons decrease fairly rapidly with increasing distance. Beyond 120 km, the majority of the flow is made up of persons who stay at the workplace for extended times, in which case the separation distance is not as crucial in determining the flow.

To apply the home-work data to commuting patterns in APEX, a simple rule was chosen. It was assumed that all persons in home-work flows up to 120 km are daily commuters, and no persons in more widely separated flows commute daily. This meant that the list of destinations for each home tract was restricted to only those work tracts that are within 120 km of the home tract. When the same cutoff was performed on the 1990 census data, it resulted in 4.75% of the home-work pairs in the nationwide database being eliminated, representing 1.3% of the workers. The assumption is that this 1.3% of workers do not commute from home to work on a daily basis. It is expected that the cutoff reduced the 2000 data by similar amounts.

Eliminated Records

A number of tract-to-tract pairs were eliminated from the database for various reasons. A fair number of tract-to-tract pairs represented workers who either worked outside of the U.S. (9,631 tract pairs with 107,595 workers) or worked in an unknown location (120,830 tract pairs with 8,940,163 workers). An additional 515 workers in the commuting database whose data were missing from the original files, possibly due to privacy concerns or errors, were also deleted.

Commuting outside the study area

APEX allows for some flexibility in the treatment of persons in the modeled population who commute to destinations outside the study area. By specifying "KeepLeavers = No" in the simulation control parameters file, people who work inside the study area but live outside of it are not modeled, nor are people who live in the study area but work outside of it. By specifying "KeepLeavers = Yes," these commuters are modeled. This triggers the use of two additional parameters, called LeaverMult and LeaverAdd. While a commuter is at work, if the workplace is outside the study area, then the ambient concentration is assumed to be related to the average concentration over all air districts at the same point in time, and is calculated as:

$$Ambient\ Concentration = LeaverMult \times avg(t) + LeaverAdd \qquad \text{equation (1)}$$

where:

Ambient Concentration	=	Calculated ambient air concentrations for locations outside of the study area (ppm or ppm)
LeaverMult	=	Multiplicative factor for city-wide average concentration, applied when working outside study area
avg(t)	=	Average ambient air concentration over all air districts in study area, for time *t* (ppm or ppm)
LeaverAdd	=	Additive term applied when working outside study area

All microenvironmental concentrations for locations outside of the study area are determined from this ambient concentration by the same function as applies inside the study area.

Block-level commuting

For census block simulations, APEX requires block-level commuting file. A special software preprocesser was created to generate this files for APEX on the basis of the tract-level commuting data and finely-resolved land use data. The software calculates commuting flows between census blocks for the employed population according equation (2).

$$Flow_{block} = Flow_{tract} \times F_{pop} \times F_{land} \qquad \text{equation (2)}$$

where:

$Flow_{block}$ = flow of working population between a home block and a work block.
$Flow_{tract}$ = flow of working population between a home tract and a work tract.
F_{pop} = fraction of home tract's working population residing in the home block.
F_{land} = fraction of work tract's commercial/industrial land area in the work block

Thus, it is assumed that the frequency of commuting to a workplace block within a tract is proportional to the amount of commercial and industrial land in the block.

B-2.2.2.3 Profile Functions

A *Profile Functions* file contains settings used to generate results for variables related to simulated individuals. While certain settings for individuals are generated automatically by APEX based on other input files, including demographic characteristics, others can be specified using this file. For example, the file may contain settings for determining whether the profiled individual's residence has an air conditioner, a gas stove, etc. As an example, the *Profile Functions* file contains fractions indicating the prevalence of air conditioning in the cities modeled in this assessment (Figure B-1). APEX uses these fractions to stochastically generate air conditioning status for each individual. The derivation of particular data used in specific microenvironments is provided below.

```
AC_Home
! Has air conditioning at home
TABLE
INPUT1 PROBABILITY 2     "A/C probabilities"
0.85 0.15
RESULT INTEGER 2        "Yes/No"
1 2
#
```

Figure B-1. Example of a profile function file for A/C prevalence.

B-2.2.3 Activity Pattern Sequences

Exposure models use human activity pattern data to predict and estimate exposure to pollutants. Different human activities, such as spending time outdoors, indoors, or driving, will have varying pollutant exposure concentrations. To accurately model individuals and their exposure to pollutants, it is critical to understand their daily activities.

The Consolidated Human Activity Database (CHAD) provides data for where people spend time and the activities performed. CHAD was designed to provide a basis for conducting multi-route, multi-media exposure assessments (McCurdy et al., 2000). The data contained within CHAD come from multiple activity pattern surveys with varied structures (Table B-2), however the surveys have commonality in containing daily diaries of human activities and personal attributes (e.g., age and gender).

There are four CHAD-related input files used in APEX. Two of these files can be downloaded directly from the CHADNet (http://www.epa.gov/chadnet1), and adjusted to fit into the APEX framework. These are the human activity diaries file and the personal data file, and are discussed below. A third input file contains metabolic information for different activities listed in the diary file, these are not used in this exposure analysis. The fourth input file maps five-digit location codes used in the diary file to APEX microenvironments; this file is discussed in the section describing microenvironmental calculations (Section B-2.2.4.4).

B-2.2.3.1 Personal Information file

Personal attribute data are contained in the CHAD questionnaire file that is distributed with APEX. This file also has information for each day individuals have diaries. The different variables in this file are:

- The study, person, and diary day identifiers
- Day of week
- Gender
- Employment status
- Age in years
- Maximum temperature in degrees Celsius for this diary day
- Mean temperature in degrees Celsius for this diary day
- Occupation code
- Time, in minutes, during this diary day for which no data are included in the database

B-2.2.3.2 Diary Events file

The human activity diary data are contained in the events file that is distributed with APEX. This file contains the activities for the nearly 23,000 people with intervals ranging from one minute to one hour. An individuals' diary varies in length from one to 15 days. This file contains the following variables:

- The study, person, and diary day identifiers
- Start time of this activity
- Number of minutes for this activity
- Activity code (a record of what the individual was doing)
- Location code (a record of where the individual was)

Table B-2. Summary of activity pattern studies used in CHAD.

Study Name	Location	Study time period	Ages	Persons	Person -days	Diary type /study design	Reference
Baltimore	A single building in Baltimore	01/1997-02/1997, 07/1998-08/1998	72-93	26	292	Diary	Williams et al. (2000)
California Adolescents and Adults (CARB)	California	10/1987-09/1988	12-17 18-94	181 1,552	181 1,552	Recall /Random	Robinson et al. (1989); Wiley et al. (1991a)
California Children (CARB)	California	04/1989-02/1990	0-11	1,200	1,200	Recall /Random	Wiley et al. (1991b)
Cincinnati (EPRI)	Cincinnati MSA	03/1985-04/1985, 08/1985	0-86	888	2,587	Diary /Random	Johnson (1989)
Denver (EPA)	Denver MSA	11/1982-02/1983	18-70	432	791	Diary /Random	Johnson (1984); Akland et al. (1985)
Los Angeles: Elementary School Children	Los Angeles	10/1989	10-12	17	51	Diary	Spier et al. (1992)
Los Angeles: High School Adolescents	Los Angeles	09/1990-10/1990	13-17	19	42	Diary	Spier et al. (1992)
National: NHAPS-Air	National	09/1992-10/1994	0-93	4,326	4,326	Recall /Random	Klepeis et al. (1996); Tsang and Klepeis (1996)
National: NHAPS-Water	National	09/1992-10/1994	0-93	4,332	4,332	Recall /Random	Klepeis et al. (1996); Tsang and Klepeis (1996)
Washington, D.C. (EPA)	Wash. DC MSA	11/1982-02/1983	18-98	639	639	Diary /Random	Hartwell et al. (1984); Akland et al. (1985)

B-2.2.3.3 Construction of Longitudinal Activity Sequences

Typical time-activity pattern data available for inhalation exposure modeling consist of a sequence of location/activity combinations spanning a 24-hour duration, with 1 to 3 diary-days for any single individual. Exposure modeling requires information on activity patterns over longer periods of time, e.g., a full year. For example, even for pollutant health effects with short averaging times (e.g., NO_2 1-hour average concentration) it may be desirable to know the frequency of exceedances of a concentration over a long period of time (e.g., the annual number of exceedances of a 1-hour average NO_2 concentration of 200 ppb for each simulated individual).

Long-term multi-day activity patterns can be estimated from single days by combining the daily records in various ways, and the method used for combining them will influence the variability of the long-term activity patterns across the simulated population. This in turn will influence the ability of the model to accurately represent either long-term average high-end exposures, or the number of individuals exposed multiple times to short-term high-end concentrations.

A common approach for constructing long-term activity patterns from short-term records is to re-select a daily activity pattern from the pool of data for each day, with the implicit assumption that there is no correlation between activities from day to day for the simulated individual. This approach tends to result in long-term activity patterns that are very similar across the simulated population. Thus, the resulting exposure estimates are likely to underestimate the variability across the population, and therefore, underestimate the high-end exposure concentrations or the frequency of exceedances.

A contrasting approach is to select a single activity pattern (or a single pattern for each season and/or weekday-weekend) to represent a simulated individual's activities over the duration of the exposure assessment. This approach has the implicit assumption that an individual's day-to-day activities are perfectly correlated. This approach tends to result in long-term activity patterns that are very different across the simulated population, and therefore may over-estimate the variability across the population.

Cluster-Markov Algorithm

A new algorithm has been developed and incorporated into APEX to represent the day-to-day correlation of activities for individuals. The algorithms first use cluster analysis to divide the daily activity pattern records into groups that are similar, and then select a single daily record from each group. This limited number of daily patterns is then used to construct a long-term sequence for a simulated individual, based on empirically-derived transition probabilities. This approach is intermediate between the assumption of no day-to-day correlation (i.e., re-selection for each time period) and perfect correlation (i.e., selection of a single daily record to represent all days).

The steps in the algorithm are as follows.

1. For each demographic group (age, gender, employment status), temperature range, and day-of-week combination, the associated time-activity records are partitioned into 3 groups using cluster analysis. The clustering criterion is a vector of 5 values: the time spent in each of 5 microenvironment categories (indoors – residence; indoors – other building; outdoors – near road; outdoors – away from road; in vehicle).
2. For each simulated individual, a single time-activity record is randomly selected from each cluster.
3. A Markov process determines the probability of a given time-activity pattern occurring on a given day based on the time-activity pattern of the previous day and cluster-to-cluster transition probabilities. The cluster-to-cluster transition probabilities are estimated from the available multi-day time-activity records. If insufficient multi-day time-activity records are available for a demographic group, season, day-of-week combination, then the cluster-to-cluster transition probabilities are estimated from the frequency of time-activity records in each cluster in the CHAD data base.

Details regarding the Cluster-Markov algorithm and supporting evaluations are provided in Attachment 1.

B-2.2.4 Calculating Microenvironmental Concentrations

Probabilistic algorithms are used to estimate the pollutant concentration associated with each exposure event. The estimated pollutant concentrations account for the effects of ambient (outdoor) pollutant concentration, penetration factor, air exchange rate, decay/deposition rate, and proximity to microenvironments can use the transfer factors method while the others use the mass balance emission sources, depending on the microenvironment, available data, and the estimation method selected by the user.

APEX calculates air concentrations in the various microenvironments visited by the simulated person by using the ambient air data for the relevant blocks, the user-specified estimation method, and input parameters specific to each microenvironment. APEX calculates hourly concentrations in all the microenvironments at each hour of the simulation for each of the simulated individuals using one of two methods: by mass balance or a transfer factors method.

B-2.2.4.1 Mass Balance Model

The mass balance method simulates an enclosed microenvironment as a well-mixed volume in which the air concentration is spatially uniform at any specific time. The concentration of an air pollutant in such a microenvironment is estimated using the following processes:

- Inflow of air into the microenvironment
- Outflow of air from the microenvironment
- Removal of a pollutant from the microenvironment due to deposition, filtration, and chemical degradation
- Emissions from sources of a pollutant inside the microenvironment.

Table B-3 lists the parameters required by the mass balance method to calculate concentrations in a microenvironment. A proximity factor ($f_{proximity}$) is used to account for differences in ambient concentrations between the geographic location represented by the ambient air quality data (e.g., a regional fixed-site monitor or modeled concentration) and the geographic location of the microenvironment (e.g., near a roadway). This factor could take a value either greater than or less than 1. Emission source (ES) represents the emission rate for the emission source and concentration source (CS) is the mean air concentration resulting from the source. $R_{removal}$ is defined as the removal rate of a pollutant from a microenvironment due to deposition, filtration, and chemical reaction. The air exchange rate ($R_{air\ exchange}$) is expressed in air changes per hour.

Table B-3. Mass balance model parameters.

Variable	Definition	Units	Value Range
$f_{proximity}$	Proximity factor	unitless	$f_{proximity} \geq 0$
CS	Concentration source	ppb	$CS \geq 0$
$R_{removal}$	Removal rate due to deposition, filtration, and chemical reaction	1/hr	$R_{removal} \geq 0$
$R_{air\ exchange}$	Air exchange rate	1/hr	$R_{air\ exchange} \geq 0$
V	Volume of microenvironment	m^3	$V > 0$

The mass balance equation for a pollutant in a microenvironment is described by:

$$\frac{dC_{ME}(t)}{dt} = \Delta C_{in} - \Delta C_{out} - \Delta C_{removal} + \Delta C_{source} \qquad \text{equation (3)}$$

where:

$dC_{ME}(t)$	=	Change in concentration in a microenvironment at time *t* (ppb),
ΔC_{in}	=	Rate of change in microenvironmental concentration due to influx of air (ppb/hour),
ΔC_{out}	=	Rate of change in microenvironmental concentration due to outflux of air (ppb/hour),
$\Delta C_{removal}$	=	Rate of change in microenvironmental concentration due to removal processes (ppb/hour), and
ΔC_{source}	=	Rate of change in microenvironmental concentration due to an emission source inside the microenvironment (ppb/hour).

Within the time period of an hour each of the rates of change, ΔC_{in}, ΔC_{out}, $\Delta C_{removal}$, and ΔC_{source}, is assumed to be constant. At each hour time step of the simulation period, APEX estimates the hourly equilibrium, hourly ending, and hourly mean concentrations using a series of equations that account for concentration changes expected to occur due to these physical processes. Details regarding these equations are provided in the APEX User's Guide. APEX reports hourly mean concentration as hourly concentration for a specific hour. The calculation then continues to the next hour by using the end concentration for the previous hour as the initial microenvironmental concentration. A description of the input parameters estimates used for microenvironments using the mass balance approach is provided below.

B-2.2.4.2 Factors Model

The factors method is simpler than the mass balance method. It does not calculate concentration in a microenvironment from the concentration in the previous hour and it has fewer parameters. Table B-4 lists the parameters required by the factors method to calculate concentrations in a microenvironment without emissions sources.

Table B-4. Factors model parameters.

Variable	Definition	Units	Value Range
$f_{proximity}$	Proximity factor	unitless	$f_{proximity} \geq 0$
$f_{penetration}$	Penetration factor	unitless	$0 \leq f_{penetration} \leq 1$

The factors method uses the following equation to calculate hourly mean concentration in a microenvironment from the user-provided hourly air quality data:

$$C_{ME}^{hourlymean} = C_{ambient} \; x \; f_{proximity} \; x \; f_{penetration} \qquad \text{equation (4)}$$

where:

$C_{ME}^{hourlymean}$	=	Hourly concentration in a microenvironment (ppb)
$C_{ambient}$	=	Hourly concentration in ambient environment (ppb)
$f_{proximity}$	=	Proximity factor (unitless)
$f_{penetration}$	=	Penetration factor (unitless)

The ambient NO_2 concentrations are from the air quality data input file. The proximity factor is a unitless parameter that represents the proximity of the microenvironment to a monitoring station. The penetration factor is a unitless parameter that represents the fraction of pollutant entering a microenvironment from outside the microenvironment via air exchange. The development of the specific proximity and penetration factors used in this analysis are discussed below for each microenvironment using this approach.

B-2.2.4.3 Microenvironments Modeled

In APEX, microenvironments represent the exposure locations for simulated individuals. For exposures to be estimated accurately, it is important to have realistic microenvironments that match closely to the locations where actual people spend time on a daily basis. As discussed above, the two methods available in APEX for calculating pollutant levels within microenvironments are: 1) factors and 2) mass balance. A list of microenvironments used in this study, the calculation method used, and the parameters used to calculate the microenvironment concentrations can be found in Table B-5.

Table B-5. List of microenvironments and calculation methods used.

Microenvironment		Calculation Method	Parameter Types used [1]
No.	Name		
1	Indoors – Residence	Mass balance	AER and DE
2	Indoors – Bars and restaurants	Mass balance	AER and DE
3	Indoors – Schools	Mass balance	AER and DE
4	Indoors – Day-care centers	Mass balance	AER and DE
5	Indoors – Office	Mass balance	AER and DE
6	Indoors – Shopping	Mass balance	AER and DE
7	Indoors – Other	Mass balance	AER and DE
8	Outdoors – Near road	Factors	PR
9	Outdoors – Public garage - parking lot	Factors	PR
10	Outdoors – Other	Factors	None
11	In-vehicle – Cars and Trucks	Factors	PE and PR
12	In-vehicle - Mass Transit (bus, subway, train)	Factors	PE and PR
0	Not modeled		

[1] AER=air exchange rate, DE=decay-deposition rate, PR=proximity factor, PE=penetration factor

Each of the microenvironments is designed to simulate an environment in which people spend time during the day. CHAD locations are linked to the different microenvironments in the *Microenvironment Mapping* File (see below). There are many more CHAD locations than microenvironment locations (there are 113 CHAD codes versus 12 microenvironments in this assessment), therefore most of the microenvironments have multiple CHAD locations mapped to them.

B-2.2.4.4 Mapping of APEX Microenvironments to CHAD Diaries

The *Microenvironment Mapping* file matches the APEX Microenvironments to CHAD Location codes. Table B-6 gives the mapping used for the APEX simulations.

Table B-6. Mapping of CHAD activity locations to APEX microenvironments.

CHAD Loc.	Description		APEX micro	
U	Uncertain of correct code	=	-1	Unknown
X	No data	=	-1	Unknown
30000	Residence, general	=	1	Indoors-Residence
30010	Your residence	=	1	Indoors-Residence
30020	Other residence	=	1	Indoors-Residence
30100	Residence, indoor	=	1	Indoors-Residence
30120	Your residence, indoor	=	1	Indoors-Residence
30121	..., kitchen	=	1	Indoors-Residence
30122	..., living room or family room	=	1	Indoors-Residence
30123	..., dining room	=	1	Indoors-Residence
30124	..., bathroom	=	1	Indoors-Residence
30125	..., bedroom	=	1	Indoors-Residence
30126	..., study or office	=	1	Indoors-Residence
30127	..., basement	=	1	Indoors-Residence
30128	..., utility or laundry room	=	1	Indoors-Residence
30129	..., other indoor	=	1	Indoors-Residence
30130	Other residence, indoor	=	1	Indoors-Residence
30131	..., kitchen	=	1	Indoors-Residence
30132	..., living room or family room	=	1	Indoors-Residence
30133	..., dining room	=	1	Indoors-Residence
30134	..., bathroom	=	1	Indoors-Residence
30135	..., bedroom	=	1	Indoors-Residence
30136	..., study or office	=	1	Indoors-Residence
30137	..., basement	=	1	Indoors-Residence
30138	..., utility or laundry room	=	1	Indoors-Residence
30139	..., other indoor	=	1	Indoors-Residence
30200	Residence, outdoor	=	10	Outdoors-Other
30210	Your residence, outdoor	=	10	Outdoors-Other
30211	..., pool or spa	=	10	Outdoors-Other
30219	..., other outdoor	=	10	Outdoors-Other
30220	Other residence, outdoor	=	10	Outdoors-Other
30221	..., pool or spa	=	10	Outdoors-Other
30229	..., other outdoor	=	10	Outdoors-Other
30300	Residential garage or carport	=	7	Indoors-Other
30310	..., indoor	=	7	Indoors-Other
30320	..., outdoor	=	10	Outdoors-Other
30330	Your garage or carport	=	1	Indoors-Residence
30331	..., indoor	=	1	Indoors-Residence
30332	..., outdoor	=	10	Outdoors-Other
30340	Other residential garage or carport	=	1	Indoors-Residence
30341	..., indoor	=	1	Indoors-Residence
30342	..., outdoor	=	10	Outdoors-Other
30400	Residence, none of the above	=	1	Indoors-Residence
31000	Travel, general	=	11	In Vehicle-Cars_and_Trucks
31100	Motorized travel	=	11	In Vehicle-Cars_and_Trucks
31110	Car	=	11	In Vehicle-Cars_and_Trucks
31120	Truck	=	11	In Vehicle-Cars_and_Trucks
31121	Truck (pickup or van)	=	11	In Vehicle-Cars_and_Trucks
31122	Truck (not pickup or van)	=	11	In Vehicle-Cars_and_Trucks
31130	Motorcycle or moped	=	8	Outdoors-Near_Road
31140	Bus	=	12	In Vehicle-Mass_Transit
31150	Train or subway	=	12	In Vehicle-Mass_Transit
31160	Airplane	=	0	Zero_concentration
31170	Boat	=	10	Outdoors-Other
31171	Boat, motorized	=	10	Outdoors-Other

31172	Boat, other	=	10	Outdoors-Other
31200	Non-motorized travel	=	10	Outdoors-Other
31210	Walk	=	10	Outdoors-Other
31220	Bicycle or inline skates/skateboard	=	10	Outdoors-Other
31230	In stroller or carried by adult	=	10	Outdoors-Other
31300	Waiting for travel	=	10	Outdoors-Other
31310	..., bus or train stop	=	8	Outdoors-Near_Road
31320	..., indoors	=	7	Indoors-Other
31900	Travel, other	=	11	In Vehicle-Cars_and_Trucks
31910	..., other vehicle	=	11	In Vehicle-Cars_and_Trucks
32000	Non-residence indoor, general	=	7	Indoors-Other
32100	Office building/ bank/ post office	=	5	Indoors-Office
32200	Industrial/ factory/ warehouse	=	5	Indoors-Office
32300	Grocery store/ convenience store	=	6	Indoors-Shopping
32400	Shopping mall/ non-grocery store	=	6	Indoors-Shopping
32500	Bar/ night club/ bowling alley	=	2	Indoors-Bars_and_Restaurants
32510	Bar or night club	=	2	Indoors-Bars_and_Restaurants
32520	Bowling alley	=	2	Indoors-Bars_and_Restaurants
32600	Repair shop	=	7	Indoors-Other
32610	Auto repair shop/ gas station	=	7	Indoors-Other
32620	Other repair shop	=	7	Indoors-Other
32700	Indoor gym /health club	=	7	Indoors-Other
32800	Childcare facility	=	4	Indoors-Day_Care_Centers
32810	..., house	=	1	Indoors-Residence
32820	..., commercial	=	4	Indoors-Day_Care_Centers
32900	Large public building	=	7	Indoors-Other
32910	Auditorium/ arena/ concert hall	=	7	Indoors-Other
32920	Library/ courtroom/ museum/ theater	=	7	Indoors-Other
33100	Laundromat	=	7	Indoors-Other
33200	Hospital/ medical care facility	=	7	Indoors-Other
33300	Barber/ hair dresser/ beauty parlor	=	7	Indoors-Other
33400	Indoors, moving among locations	=	7	Indoors-Other
33500	School	=	3	Indoors-Schools
33600	Restaurant	=	2	Indoors-Bars_and_Restaurants
33700	Church	=	7	Indoors-Other
33800	Hotel/ motel	=	7	Indoors-Other
33900	Dry cleaners	=	7	Indoors-Other
34100	Indoor parking garage	=	7	Indoors-Other
34200	Laboratory	=	7	Indoors-Other
34300	Indoor, none of the above	=	7	Indoors-Other
35000	Non-residence outdoor, general	=	10	Outdoors-Other
35100	Sidewalk, street	=	8	Outdoors-Near_Road
35110	Within 10 yards of street	=	8	Outdoors-Near_Road
35200	Outdoor public parking lot /garage	=	9	Outdoors-Public_Garage-Parking
35210	..., public garage	=	9	Outdoors-Public_Garage-Parking
35220	..., parking lot	=	9	Outdoors-Public_Garage-Parking
35300	Service station/ gas station	=	10	Outdoors-Other
35400	Construction site	=	10	Outdoors-Other
35500	Amusement park	=	10	Outdoors-Other
35600	Playground	=	10	Outdoors-Other
35610	..., school grounds	=	10	Outdoors-Other
35620	..., public or park	=	10	Outdoors-Other
35700	Stadium or amphitheater	=	10	Outdoors-Other
35800	Park/ golf course	=	10	Outdoors-Other
35810	Park	=	10	Outdoors-Other
35820	Golf course	=	10	Outdoors-Other
35900	Pool/ river/ lake	=	10	Outdoors-Other
36100	Outdoor restaurant/ picnic	=	10	Outdoors-Other
36200	Farm	=	10	Outdoors-Other
36300	Outdoor, none of the above	=	10	Outdoors-Other

1

B-2.2.5 Exposure Calculations

APEX calculates exposure as a time series of exposure concentrations that a simulated individual experiences during the simulation period. APEX determines the exposure using hourly ambient air concentrations, calculated concentrations in each microenvironment based on these ambient air concentrations (and indoor sources if present), and the minutes spent in a sequence of microenvironments visited according to the composite diary. The hourly exposure concentration at any clock hour during the simulation period is determined using the following equation:

$$C_i = \frac{\sum_{j=1}^{N} C_{ME(j)}^{hourlymean} \; t_{(j)}}{T} \qquad \text{equation (5)}$$

where:

C_i	=	Hourly exposure concentration at clock hour *i* of the simulation period (ppb)
N	=	Number of events (i.e., microenvironments visited) in clock hour *i* of the simulation period.
$C_{ME(j)}^{hourlymean}$	=	Hourly mean concentration in microenvironment *j* (ppm)
$t_{(j)}$	=	Time spent in microenvironment *j* (minutes)
T	=	60 minutes

From the hourly exposures, APEX calculates time series of 1-hour average exposure concentrations that a simulated individual would experience during the simulation period. APEX then statistically summarizes and tabulates the hourly (or daily, annual average) exposures. In this analysis, the exposure indicator is 1-hr exposures above selected health effect benchmark levels. From this, APEX can calculate two general types of exposure estimates: counts of the estimated number of people exposed to a specified NO_2 concentration level and the number of times per year that they are so exposed; the latter metric is in terms of person-occurrences or person-days. The former highlights the number of individuals exposed at least *one or more* times per modeling period to the health effect benchmark level of interest. APEX can also report counts of individuals with multiple exposures. This person-occurrences measure estimates the number of times per season that individuals are exposed to the exposure indicator of interest and then accumulates these estimates for the entire population residing in an area.

APEX tabulates and displays the two measures for exposures above levels ranging from 200 to 300 ppb by 50 ppb increments for 1-hour average exposures. These results are tabulated for the population and subpopulations of interest.

B-2.2.6 Exposure Model Output

All of the output files written by APEX are ASCII text files. Table B-7 lists each of the output data files written for these simulations and provides descriptions of their content. Additional output files that can produced by APEX are given in Table 5-1 of the APEX User's

Guide, and include hourly exposure, ventilation, and energy expenditures, and even detailed event-level information, if desired. The names and locations, as well as the output table levels (e.g., output percentiles, cut-points), for these output files are specified by the user in the simulation control parameters file.

Table B-7. Example of APEX output files.

Output File Type	Description
Log	The *Log* file contains the record of the APEX model simulation as it progresses. If the simulation completes successfully, the log file indicates the input files and parameter settings used for the simulation and reports on a number of different factors. If the simulation ends prematurely, the log file contains error messages describing the critical errors that caused the simulation to end.
Profile Summary	The *Profile Summary* file provides a summary of each individual modeled in the simulation.
Microenvironment Summary	The *Microenvironment Summary* file provides a summary of the time and exposure by microenvironment for each individual modeled in the simulation.
Sites	The *Sites* file lists the tracts, districts, and zones in the study area, and identifies the mapping between them.
Output Tables	The *Output Tables* file contains a series of tables summarizing the results of the simulation. The percentiles and cut-off points used in these tables are defined in the simulation control parameters file.

B-3 Philadelphia Exposure Assessment Case-Study

This section documents detailed methodology and input data used in the Philadelphia inhalation exposure assessment for NO_2 conducted in support of the current review of the NO_2 primary NAAQS. Two important components of the analysis include the approach for estimating temporally and spatially variable NO_2 concentrations and simulating contact of humans with these pollutant concentrations. A combined air quality and exposure modeling approach has been used here to generate estimates of 1-hour NO_2 exposures within Philadelphia. Details on the approaches used are provided below and include the following:

- Description of the area assessed and populations considered
- Summary of the air quality modeling methodology and associated input data
- Description of the inhalation exposure model and associated input data
- Evaluation of estimated NO_2 exposures using modeling methodology

B-3.1 Study Area Selection and Description

The selection of areas to include in the exposure analysis takes into consideration the location of field and epidemiology studies, the availability of ambient monitoring and other input data, the desire to represent a range of geographic areas, population demographics, general climatology, and results of the ambient air quality characterization.

Philadelphia was selected as a location of interest through a similar statistical analysis of the ambient NO_2 air quality data described in Appendix A for each monitoring site within a location. Criteria were established for selecting sites with high annual means and/or high numbers of exceedances of potential health effect benchmark concentrations. The analysis considered all data combined, as well as the more recent air quality data (2001-2006) separately.

The 90^{th} percentile served as the point of reference for the annual means, and across all complete site-years for 2001-2006, this value was 23.5 ppb. Seventeen locations contained one or more site-years with an annual average concentration at or above the 90^{th} percentile. When combined with the number of 1-hour NO_2 concentrations at or above 200 ppb, only two locations fit these criteria, Philadelphia and Los Angeles. In comparing the size of the potential modeling domains and the anticipated complexity in modeling influence of roadway exposures, Philadelphia was determined to be a more manageable case-study.

Philadelphia County is comprised of 17,315 blocks containing a population of 1,517,550 persons. For this analysis the population studied was limited those residents of Philadelphia County residing in census blocks that were either within 400 meters of a major roadway or within 10 km of a major emission source (see section B-3.5 for definition). This was done to maintain balance between the representation of the study area/objectives and the computational load regarding file size and processing time. There were 16,857 such blocks containing a population of 1,475,651.

B-3.2 Exposure Period of Analysis

The exposure periods modeled were 2001 through 2003 to envelop the most recent year of travel demand modeling (TDM) data available for the respective study locations (i.e., 2002) and to include a 3 years of meteorological data to achieve a degree of stability in the dispersion and exposure model estimates.

B-3.3 Populations Analyzed

A detailed consideration of the population residing in each modeled area was included where the exposure modeling was performed. The assessment includes the general population (All Persons) residing in each modeled area and considered susceptible and vulnerable populations as identified in the ISA. These include population subgroups defined from either an exposure or health perspective. The population subgroups identified by the ISA (US EPA, 2007a) that were included and that can be modeled in the exposure assessment include:

- Children (ages 5-18)
- Asthmatic children (ages 5-18)
- All persons (all ages)
- All Asthmatics (all ages)

In addition to these population subgroups, individuals anticipated to be exposed more frequently to NO_2 were considered, including those commuting on roadways and persons residing near major roadways. To date, this document provides a summary of the subpopulations of interest (all asthmatics and asthmatic children), supplemented with additional exposure and risk results for the total population where appropriate.

B-3.4 Simulated Individuals

Due to the large size of the air quality input files, the modeled area was separated into three sections. The number of simulated persons in each model run (3 sections per 3 years) was set to 50,000, yielding a total of 150,000 persons simulated for each year. The parameters controlling the location and size of the simulated area were set to include the county(s) in the selected study area. The settings that allow for replacement of CHAD data that are missing gender, employment or age values were all set to preclude replacing missing data. The width of the age window was set to 20 percent to increase the pool of diaries available for selection. The variable that controls the use of additional ages outside the target age window was set to 0.1 to further enhance variability in diary selection. See the APEX User's Guide for further explanation of these parameters. The total population simulated for Philadelphia County was approximately 1.48 million persons, of which there a total simulated population of 163,000 asthmatics. The model simulated approximately 281,000 children, of which there were about 48,000 asthmatics. Due to random sampling, the actual number of specific subpopulations modeled varied slightly by year.

B-3.4.1 Asthma Prevalence Rates

One of the important population subgroups for the exposure assessment is asthmatic children. Evaluation of the exposure of this group with APEX requires the estimation of children's asthma prevalence rates. The proportion of the population of children characterized as being asthmatic was estimated by statistics on asthma prevalence rates recently used in the NAAQS review for O_3 (US EPA, 2007d; 2007e). Specifically, the analysis generated age and gender specific asthma prevalence rates for children ages 0-17 using data provided in the National Health Interview Survey (NHIS) for 2003 (CDC, 2007). These asthma rates were characterized by geographic regions, namely Midwest, Northeast, South, and West. Adult asthma prevalence rates for Philadelphia County were obtained from the Behavioral Risk Factor Surveillance System (BRFSS) survey information (PA DOH, 2008). The average rates for adult males and females in Philadelphia for 2001-2003 were 7% and 12%, respectively. These rates were assumed to apply to all adults uniformly. Table B-8 provides a summary of the prevalence rates used in the exposure analysis by age and gender.

Table B-8. Asthma prevalence rates by age and gender used for Philadelphia.

Region (Study Area)	Age	Females				Males			
		Prevalence	se	L95	U95	Prevalence	se	L95	U95
Northeast (Philadelphia)	0	0.068	0.066	0.007	0.442	0.048	0.033	0.010	0.200
	1	0.072	0.038	0.021	0.221	0.046	0.018	0.019	0.108
	2	0.075	0.022	0.038	0.145	0.052	0.015	0.027	0.097
	3	0.077	0.020	0.042	0.138	0.068	0.018	0.037	0.120
	4	0.082	0.023	0.043	0.151	0.100	0.023	0.059	0.164
	5	0.116	0.030	0.063	0.205	0.149	0.029	0.094	0.226
	6	0.161	0.037	0.092	0.266	0.207	0.042	0.129	0.316
	7	0.185	0.041	0.108	0.298	0.228	0.045	0.143	0.343
	8	0.171	0.040	0.096	0.284	0.222	0.043	0.142	0.332
	9	0.145	0.035	0.080	0.246	0.212	0.041	0.136	0.316
	10	0.135	0.031	0.078	0.223	0.177	0.037	0.108	0.275
	11	0.141	0.031	0.084	0.227	0.166	0.035	0.102	0.259
	12	0.166	0.034	0.102	0.259	0.183	0.036	0.116	0.276
	13	0.174	0.034	0.109	0.266	0.171	0.031	0.113	0.250
	14	0.151	0.029	0.095	0.232	0.170	0.029	0.115	0.244
	15	0.146	0.028	0.093	0.221	0.182	0.029	0.127	0.254
	16	0.146	0.031	0.088	0.232	0.204	0.032	0.142	0.284
	17	0.157	0.054	0.068	0.322	0.242	0.061	0.133	0.399
	18+	0.070		0.040	0.140	0.120		0.090	0.150

Notes:
se – Standard error
L95 – Lower limit on 95th confidence interval
U95 – Upper limit on 95th confidence interval

B-3.5 Air Quality Data Generated by AERMOD

Air quality data input to the model were generated by air quality modeling using AERMOD. Principal emission sources included both mobile and stationary sources as well as fugitive emissions. The methodology is described below.

B-3.5.1 Meteorological Inputs

All meteorological data used for the AERMOD dispersion model simulations were processed with the AERMET meteorological preprocessor, version 06341. This section describes the input data and processing methodologies used to derive input meteorological fields for each of the five regions of interest.

B-3.5.1.1 Data Selection

Raw surface meteorological data for the 2001 to 2003 period were obtained from the Integrated Surface Hourly (ISH) Database,[1] maintained by the National Climatic Data Center (NCDC). The ISH data used for this study consists of typical hourly surface parameters (including air and dew point temperature, atmospheric pressure, wind speed and direction, precipitation amount, and cloud cover) from hourly Automated Surface Observing System (ASOS) stations. No on-site observations were used.

The surface meteorological station used for this analysis is located at Philadelphia International (KPHL) airport. The selection of surface meteorological stations minimized the distance from the station to city center, minimized missing data, and maximized land-use representativeness of the station site compared to the city center.

The total number of surface observations and the percentage of those observations accepted by AERMET (i.e., those observations that were both not missing and within the expected ranges of values), are shown by Table B-9. Note that instances of calm winds are not rejected by the AERMET processor, but are later treated as calms in the dispersion analysis. There were 1,772 hours in Philadelphia (7%) with calm winds (see Table B-10).

Table B-9. Number of AERMET raw hourly surface meteorology observations, percent acceptance rate, 2001-2003.

Surface Variable	Philadelphia (KPHL) n=26,268
	% Accepted [a]
Precipitation	100
Station Pressure	99
Cloud Height	99
Sky Cover	95
Horizontal Visibility	99
Temperature	99 *
Dew Point Temperature	99
Relative Humidity	99
Wind Direction	97
Wind Speed	99

Notes:
[a] Percentages are rounded down to the nearest integer.
* The majority of unaccepted records are due to values being out of range.

[1] http://www1.ncdc.noaa.gov/pub/data/techrpts/tr200101/tr2001-01.pdf

Table B-10. Number of calms reported by AERMET by year for Philadelphia.

Year	Number of Calms
2001	610
2002	470
2003	692
Total	**1772**

Mandatory and significant levels of upper-air data were obtained from the NOAA Radiosonde Database.[2] Upper air observations show less spatial variation than do surface observations; thus they are both representative of larger areas and measured with less spatial frequency than are surface observations. The selection of upper-air station locations for each city minimized both the proximity of the station to city center and the amount of missing data in the records. The selected stations for Philadelphia was Washington Dulles Airport (KIAD). The total number of upper-air observations per station per height interval, and the percentage of those observations accepted by AERMET, are shown in Table B-11.

Table B-11. Number and AERMET acceptance rate of upper-air observations 2001-2003.

Height Level	Variable	Philadelphia (KIAD)	
		n	% Accepted
Surface	Pressure	2152	100
	Height	2152	100
	Temperature	2152	100
	DewPoint Temperature	2152	100
	WindDirection	2152	100
	WindSpeed	2152	85 *
0-500m	Pressure	4320	100
	Height	4320	100
	Temperature	4320	100
	DewPoint Temperature	4320	99
	WindDirection	4320	63
	WindSpeed	4320	62
500-1000m	Pressure	3702	100
	Height	3702	100
	Temperature	3702	100
	DewPointTemperature	3702	99 *
	WindDirection	3702	73
	WindSpeed	3702	73
1000-1500m	Pressure	4204	100
	Height	4204	100
	Temperature	4204	100
	DewPointTemperature	4204	97 *
	WindDirection	4204	71
	WindSpeed	4204	71
1500-2000m	Pressure	3354	100
	Height	3354	100
	Temperature	3354	100
	DewPointTemperature	3354	95 *
	WindDirection	3354	50
	WindSpeed	3354	50

[2] http://raob.fsl.noaa.gov/

Height Level	Variable	Philadelphia (KIAD)	
		n	% Accepted
2000-2500m	Pressure	3246	100
	Height	3246	100
	Temperature	3246	100
	DewPointTemperature	3246	93 *
	WindDirection	3246	50
	WindSpeed	3246	50
2500-3000m	Pressure	3736	100
	Height	3736	100
	Temperature	3736	100
	DewPointTemperature	3736	90 *
	WindDirection	3736	64
	WindSpeed	3736	64
3000-3500m	Pressure	3614	100
	Height	3614	100
	Temperature	3614	100
	DewPointTemperature	3614	90 *
	WindDirection	3614	65
	WindSpeed	3614	65
3500-4000m	Pressure	2830	100
	Height	2830	100
	Temperature	2830	100
	DewPointTemperature	2830	87 *
	WindDirection	2830	50
	WindSpeed	2830	50
>4000 m	Pressure	7619	88 *
	Height	7619	71 *
	Temperature	7619	99 *
	DewPointTemperature	7619	79 *
	WindDirection	7619	55
	WindSpeed	7619	55

Notes:
[a] Percentages are rounded down to the nearest integer.
* The majority of unaccepted records are due to values being out of range.
Shading:
≤95 of observations were accepted.
≤75 of observations were accepted.
≤50 of observations were accepted.

B-3.5.2 Surface Characteristics and Land Use Analysis

In addition to the standard meteorological observations of wind, temperature, and cloud cover, AERMET analyzes three principal variables to help determine atmospheric stability and mixing heights: the Bowen ratio[3], surface albedo[4] as a function of the solar angle, and surface roughness. [5]

[3] For any moist surface, the Bowen Ratio is the ratio of heat energy used for sensible heating (conduction and convection) to the heat energy used for latent heating (evaporation of water or sublimation of snow). The Bowen ratio ranges from about 0.1 for the ocean surface to more than 2.0 for deserts. Bowen ratio values tend to decrease with increasing surface moisture for most land-use types.

The January 2008 version of AERSURFACE was used to estimate land-use patterns and calculate the Bowen ratio, surface albedo, and surface roughness as part of the AERMET processing. AERSURFACE uses the US Geological Survey (USGS) National Land Cover Data 1992 archives (NLCD92).[6] Three to four land-use sectors were manually identified around the surface meteorological station using this land-use data. These land-use sectors are used to identify the Bowen ratio and surface albedo, which are assumed to represent an area around the station of radius 10 km, and to calculate surface roughness by wind direction.

A monthly temporal resolution was used for the Bowen ratio, albedo, and surface roughness at the meteorological site. Because the site was located at an airport, a lower surface roughness was calculated for the 'Commercial/Industrial/Transportation' land-use type to reflect the dominance of transportation land cover rather than commercial buildings. Philadelphia has at least one winter month of continuous snow cover, which tends to increase albedo, decrease Bowen ratio, and decrease surface roughness for most land-use types during the winter months compared to a snow-free area. Seasons were assigned based on 1971-2000 NCDC 30-year climatic normals and on input from the state climatologist (Table B-12).

Table B-12. Seasonal definitions and specifications for Philadelphia.

Location	Winter (continuous snow)	Winter (no snow)	Spring	Summer	Fall
Philadelphia	Dec, Jan, Feb		Mar, Apr, May	Jun, Jul, Aug	Sep, Oct, Nov

Season definitions provided by the AERSURFACE manual as follows:

Winter (continuous snow):	Winter with continuous snow on ground
Winter (no snow):	Late autumn after frost and harvest, or winter with no snow
Spring:	Transitional spring with partial green coverage or short annuals
Summer:	Midsummer with lush vegetation
Fall:	Autumn with unharvested cropland

Figure B-2 illustrates show the manually created land-use sectors around the application site; a 1.9 mile (3 km) radius circle was used. Data are from the NLCD92 database. Prior to the release of AERSURFACE, the user was required to manually pull values of Bowen ratio (β_0), albedo (α), and surface roughness (z_0) per season and per land-use sector from look-up tables in the *AERMET User's Guide*. Using the look-up tables, values of these three surface characteristics vary by the four seasons and by eight basic land-use categories. Furthermore, the *AERMOD Implementation Guide* was somewhat ambiguous about whether Bowen ratio values should also vary with wind direction sector, as does the surface roughness. AERSURFACE resolves these issues by providing a uniform methodology for calculation of surface effects on dispersion; it also only varies surface roughness by wind direction.

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[4] The ratio of the amount of electromagnetic radiation reflected by the earth's surface to the amount incident upon it. Value varies with surface composition. For example, snow and ice vary from 80% to 85% and bare ground from 10% to 20%.
[5] The presence of buildings, trees, and other irregular land topography that is associated with its efficiency as a momentum sink for turbulent air flow, due to the generation of drag forces and increased vertical wind shear.
[6] http://seamless.usgs.gov/

Before AERSURFACE, without an automated algorithm to determine land-use patterns, it was simplest for the user to visually estimate land usage by sector. With AERSURFACE, the land-use is automatically determined. The proximity of the meteorological site to an airport and whether the site was located in an arid region were previously not explicitly accounted for as they now are in AERSURFACE. Snow cover, too, is critical for determination of α, but was largely left to user's discretion regarding its presence. With AERSURFACE, the lookup tables have separate columns for winter without much snow and for winter with abundant snow. The user determines if winter at a particular location contains at least one month of continuous snow cover, and AERSURFACE will pull values of the surface characteristics from the appropriate winter column.

We conducted a sensitivity test to evaluate the impacts of using this new tool on the present analysis. Figure B-3 shows a sample comparison of surface roughness values at the Philadelphia site with and without the use of AERSURFACE. In the Figure, estimated surface roughness values using visual land-use estimations and look-up table values are shown in muted shades and AERSURFACE values in dark shades. Monthly season definitions are the same in both cases. However, in the AERSURFACE case, winter was specified as having a one-month period of snow cover. Also, in the AERSURFACE case the site was specified as being at an airport.

In this case, z_0 values are much lower with AERSURFACE than with a visual estimation of land-use. In the AERSURFACE tool, Philadelphia was noted as being at an airport, tending to represent the lower building heights in the region and the inverse distance weighting implemented in the tool. Thus, lower z_0 values were obtained over most developed-area sectors in this scenario. The indication that at least one month of continuous snow cover is present also tends to lower wintertime z_0 values. In addition to these systematic differences, the automated AERSURFACE land-use analysis for Philadelphia tended to identify less urban coverage and more water coverage, lowering roughness values, but it also tended to identify more forest cover and less cultivated land cover than our visual analysis, increasing some z_0 values.

β_0 and α also varied significantly between the scenarios. However, this was largely due to two practical matters: First, the independence of these variables of wind direction in the AERSURFACE case and secondly the use of monthly-varying moisture conditions in one test case and not another. Thus we have not presented those results

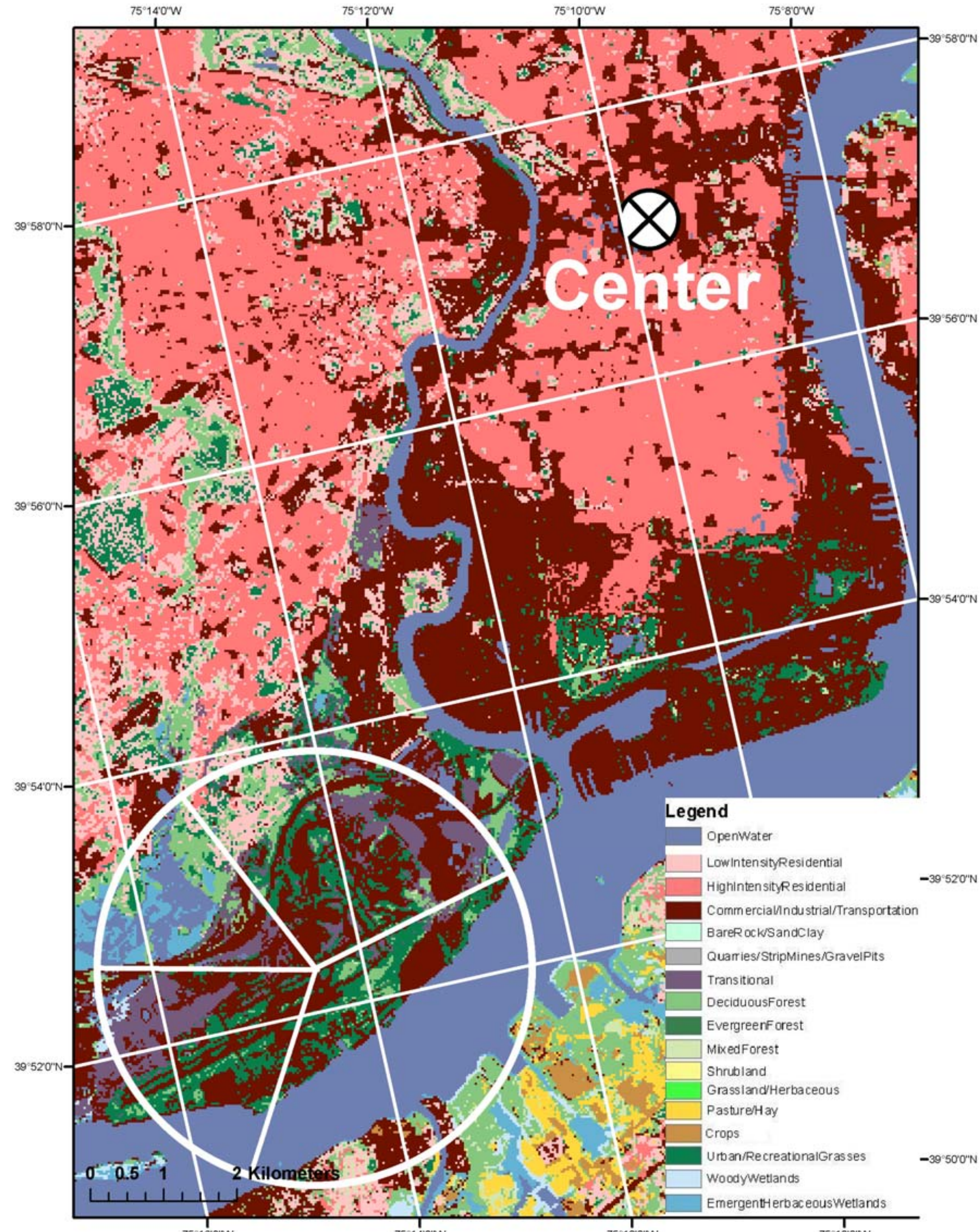

Figure B-2. Land-use and sectors around the Philadelphia-area surface meteorological station (KPHL). Sector borders are 80, 184, 262, and 312 degrees from geographic North. Philadelphia city center is labeled.

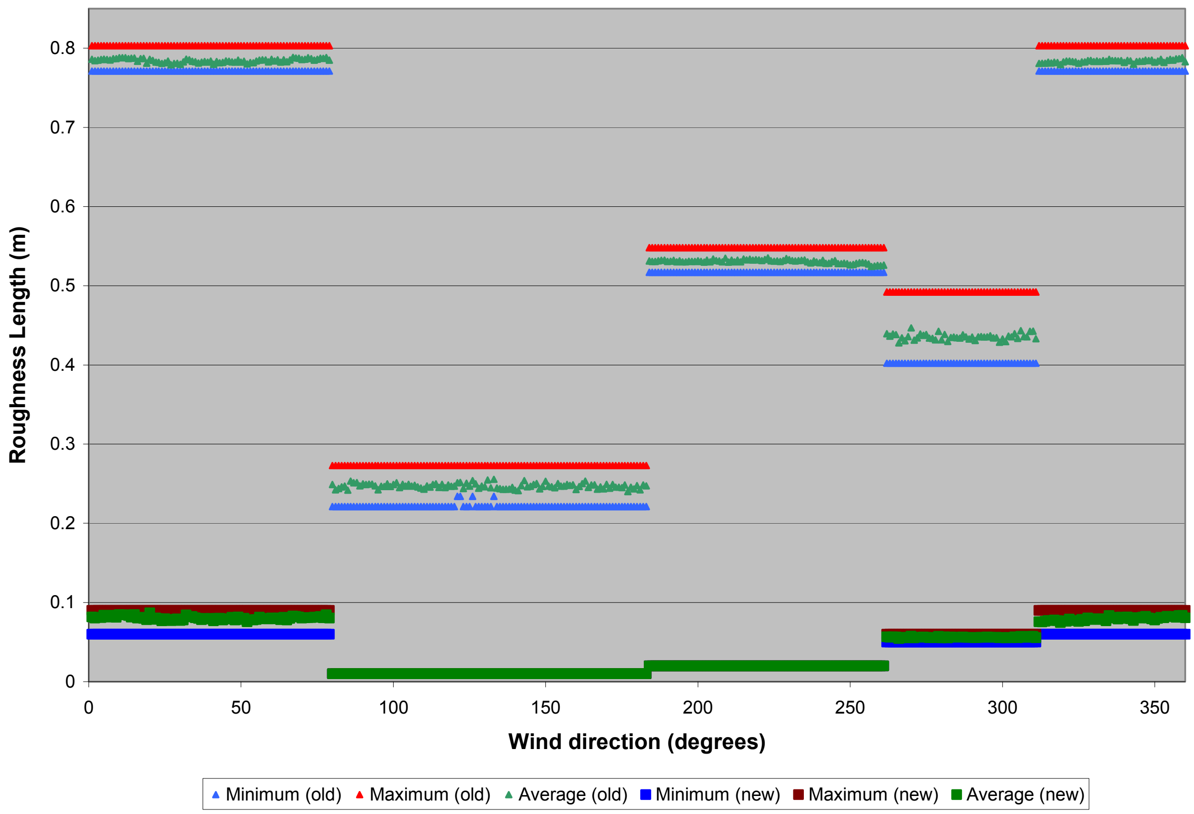

Figure B-3. Estimated z_0 values for the Philadelphia case-study analysis using visual and AERSURFACE land-use estimations.

B-3.5.3 Meteorological Data Analysis

The AERMET application location and elevation were taken as the center of the modeled city, estimated using Google Earth version 4.2.0198.2451 (beta) and defined as 39.952 °N, 75.164 °W, 12 m. The 2001-2003 AERSURFACE processing was run three times – once assuming the entire period was drier than normal, once assuming the entire period was wetter than normal, and once assuming the entire period was of average precipitation accumulation. These precipitation assumptions influence the Bowen ratio, discussed above.

To create meteorological input records that best represent the city for each of the three years, the resulting surface output files for each site were then pieced together on a month-by-month basis, with selection based on the relative amount of precipitation in each month. Any month where the actual precipitation amount received was at least twice the 1971-2000 NCDC 30-year climatic normal monthly precipitation amount was considered wetter than normal, while any month that received less than half the normal amount of precipitation amount was considered drier than normal; all other months were considered to have average surface moisture conditions. Table B-13 indicates the surface moisture condition for each month evaluated in this Philadelphia case-study.

Table B-13. Monthly precipitation compared to NCDC 30-year climatic normal for Philadelphia, 2001-2003.

Year	Jan	Feb	Mar	Apr	May	Jun
2001	74.8%	103.6%	144.2%	43.9%	102.9%	180.1%
	Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
	29.9%	26.0%	67.1%	30.6%	17.9%	64.6%
2002	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**
	69.9%	17.7%	96.4%	52.7%	89.2%	93.9%
	Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
	51.0%	59.0%	89.1%	202.7%	94.2%	117.9%
2003	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**
	53.2%	165.0%	102.7%	62.0%	108.5%	246.2%
	Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
	46.5%	86.1%	120.8%	162.8%	92.9%	158.6%

Shading:	
(light shading)	Less than or equal to half the normal monthly precipitation amount
(no shading)	Less than twice the normal precipitation level and greater than half the normal amount
(dark shading)	At least twice the normal precipitation level

B-3.5.4 On-Road Emissions Preparation

Information on traffic data in the Philadelphia area was obtained from the Delaware Valley Regional Planning Council (DVRPC[7]) via their most recent, baseline travel demand modeling (TDM) simulation – that is, the most recent simulation calibrated to match observed traffic data. DVRPC provided the following files.

- Shapefiles of TDM outputs for the 2002 baseline year for all links in their network.
- Input files for the MOBILE6.2 emissions model that characterize local inputs that differ from national defaults, including fleet registration distribution information.
- Postprocessing codes they employ for analysis of TDM outputs into emission inventory data, to ensure as much consistency as possible between the methodology used for this study and that of DVRPC. These include DVRPC's versions of the local SVMT.DEF, HVMT.DEF, and FVMT.DEF MOBILE6.2 input files describing the vehicle miles traveled (VMT) by speed, hour, and facility, respectively, by county in the Delaware Valley area.
- A lookup table used to translate average annual daily traffic (AADT) generated by the TDM into hourly values.

Although considerable effort was expended to maintain consistency between the DVRPC approach to analysis of TDM data and that employed in this analysis, including several personal communications with agency staff on data interpretation, complete consistency was not possible due to the differing analysis objectives. The DVRPC creates countywide emission inventories. This study created spatially and temporally resolved emission strengths for dispersion modeling.

B-3.5.4.1 Emission Sources and Locations

[7] http://www.dvrpc.org/

The TDM simulation's shapefile outputs include annual average daily traffic (AADT) volumes and a description of the loaded highway network. The description of the network consists of a series of nodes joining individual model links (i.e., roadway segments) to which the traffic volumes are assigned, and the characteristics of those links, such as endpoint location, number of lanes, link distance, and TDM-defined link daily capacity.[8]

To reduce the scope of the analysis, the full set of links in the DVRPC network was first filtered to include only those roadway types considered *major* (i.e., freeway, parkway, major arterial, ramp), and that had AADT values greater than 15,000 vehicles per day (one direction).

However, the locations of links in the model do not necessarily agree well with the roads they are attempting to represent. While the exact locations of the links may not be mandatory for DVRPC's travel demand modeling, the impacts of on-road emissions on fixed receptors is crucially linked to the distance between the roadways and receptors. Hence, it was necessary to modify the link locations from the TDM to the best known locations of the actual roadways. The correction of link locations was done based on the locations of the nodes that define the end points of links with a GIS analysis, as follows.

A procedure was developed to relocate TDM nodes to more realistic locations. The nodes in the TDM represent the endpoints of links in the transportation planning network and are specified in model coordinates. The model coordinate system is a Transverse Mercator projection of the TranPlan Coordinate System with a false easting of 31068.5, false northing of -200000.0, central meridian: -75.00000000, origin latitude of 0.0, scale factor of 99.96, and in units of miles. The procedure moved the node locations to the true road locations and translated to dispersion model coordinates. The Pennsylvania Department of Transportation (PA DOT) road network database[9] was used as the specification of the true road locations. The nodes were moved to coincide with the nearest major road of the corresponding roadway type using a built-in function of ArcGIS. Once the nodes had been placed in the corrected locations, a line was drawn connecting each node pair to represent a link of the adjusted planning network.

To determine hourly traffic on each link, the AADT volumes were converted to hourly values by applying DVRPC's seasonal and hourly scaling factors. To determine hourly traffic on each link, the AADT volumes were converted to hourly values by applying DVRPC's seasonal and hourly scaling factors. The heavy-duty vehicle fraction – which is assumed by DVRPC to be about 6% in all locations and times – was also applied.[10] Another important

[8] The TDM capacity specifications are not the same as those defined by the Highway Capacity Manual (HCM). Following consultation with DVRPC, the HCM definition of capacity was used in later calculations discussed below.

[9] http://www.pasda.psu.edu/

[10] As shown by Figure B-4 NO_x emissions from HDVs tend to be higher than their LDV counterparts by about a factor of 10. However, the HDV fraction is less than 10% of the total VMT in most circumstances, mitigating their influence on composite emission factors, although this mitigating effect is less pronounced at some times than others. For example, nighttimes on freeways tend to show a smaller reduction in HDV volume than in total volume, and thus an increased HDV fraction. This effect is not captured in most TDMs or emission postprocessors and – both to maintain consistency with the local MPO's vehicle characterizations and emissions modeling and due to lack of other relevant data – was also not included here. The net result of this is likely to be slightly underestimated emissions from major freeways during late-night times.

variable, the number of traffic signals occurring on a given link, was taken from the TDM link-description information.

Several of these parameters are shown in the following set of tables.

- Table B-14 hourly scaling factors
- Table B-15 seasonal scaling factors
- Table B-16 number of signals per roadway mile
- Table B-17 statistical summaries of AADT volumes for links included in the study.

Table B-14. Hourly scaling factors (in percents) applied to Philadelphia County AADT volumes.

Road Type	Region	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00
Freeway	CBD	1.23	0.86	0.74	0.84	1.23	2.50	4.87	6.52	6.47	5.75	4.99	5.02
	Fringe	1.23	0.86	0.74	0.84	1.23	2.50	4.87	6.52	6.47	5.75	4.99	5.02
	Urban	1.23	0.86	0.74	0.84	1.23	2.50	4.87	6.52	6.47	5.75	4.99	5.02
	Suburban	0.96	0.64	0.54	0.61	0.90	2.16	5.39	7.33	6.85	5.52	4.90	4.94
	Rural	0.71	0.48	0.38	0.48	0.95	2.54	6.05	7.77	6.79	5.22	4.64	4.78
Arterial	CBD	1.43	0.96	0.61	0.50	0.58	1.17	2.89	5.50	6.87	5.87	5.37	5.17
	Fringe	1.53	0.97	0.62	0.47	0.54	1.10	2.99	5.77	6.53	5.60	5.14	4.86
	Urban	1.13	0.68	0.52	0.45	0.63	1.68	4.26	6.68	6.86	5.47	5.09	5.17
	Suburban	0.70	0.40	0.32	0.33	0.55	1.71	4.51	7.04	6.84	5.37	4.95	5.36
	Rural	0.60	0.36	0.34	0.41	0.77	2.29	5.47	7.37	6.62	5.36	5.09	5.35
Local	CBD	1.11	0.71	0.45	0.37	0.41	0.97	2.39	4.82	6.72	6.50	4.60	4.93
	Fringe	1.00	0.55	0.37	0.21	0.39	0.98	1.98	5.31	5.91	5.78	5.14	5.19
	Urban	1.19	0.74	0.53	0.43	0.54	1.32	3.37	6.54	6.86	5.09	4.65	4.95
	Suburban	0.53	0.29	0.21	0.20	0.37	1.25	3.94	7.51	7.50	5.24	4.66	5.22
	Rural	0.55	0.32	0.25	0.30	0.57	1.89	5.26	7.93	6.84	4.94	4.57	4.89
Ramp	CBD	1.23	0.86	0.74	0.84	1.23	2.50	4.87	6.52	6.47	5.75	4.99	5.02
	Fringe	1.23	0.86	0.74	0.84	1.23	2.50	4.87	6.52	6.47	5.75	4.99	5.02
	Urban	1.23	0.86	0.74	0.84	1.23	2.50	4.87	6.52	6.47	5.75	4.99	5.02
	Suburban	0.96	0.64	0.54	0.61	0.90	2.16	5.39	7.33	6.85	5.52	4.90	4.94
	Rural	0.71	0.48	0.38	0.48	0.95	2.54	6.05	7.77	6.79	5.22	4.64	4.78

Road Type	Region	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Freeway	CBD	4.97	5.77	6.40	6.60	7.02	6.76	6.27	4.20	3.52	3.06	2.50	1.92
	Fringe	4.97	5.77	6.40	6.60	7.02	6.76	6.27	4.20	3.52	3.06	2.50	1.92
	Urban	4.97	5.77	6.40	6.60	7.02	6.76	6.27	4.20	3.52	3.06	2.50	1.92
	Suburban	5.05	5.19	5.90	6.80	7.58	7.67	6.51	4.27	3.34	2.97	2.32	1.66
	Rural	4.92	5.01	5.75	7.12	7.88	8.18	6.27	4.31	3.45	2.97	2.10	1.27
Arterial	CBD	5.27	5.57	5.95	6.63	7.39	7.81	6.36	4.78	4.05	3.74	3.18	2.36
	Fringe	5.52	5.40	6.08	6.88	7.36	8.08	6.24	4.98	4.21	3.82	3.13	2.19
	Urban	5.42	5.54	6.16	7.04	7.39	7.42	6.08	4.74	3.77	3.31	2.61	1.93
	Suburban	5.75	5.71	6.12	7.05	7.66	7.98	6.42	4.81	3.83	3.13	2.15	1.34
	Rural	5.55	5.50	6.00	7.11	7.82	7.98	6.26	4.48	3.50	2.80	1.88	1.11
Local	CBD	6.26	6.74	6.88	6.78	7.64	8.10	6.57	4.96	3.96	3.02	2.88	2.25
	Fringe	6.31	5.64	6.64	7.32	7.85	9.52	6.25	5.50	5.29	2.87	2.46	1.56
	Urban	5.25	5.40	6.44	7.35	7.80	7.85	6.41	5.02	4.04	3.46	2.79	2.01

	Suburban	5.78	5.57	6.01	7.11	8.20	8.98	6.83	5.02	3.83	2.90	1.82	1.05
	Rural	5.20	5.11	5.89	7.41	8.53	8.93	6.75	4.82	3.64	2.70	1.73	0.99
Ramp	CBD	4.97	5.77	6.40	6.60	7.02	6.76	6.27	4.20	3.52	3.06	2.50	1.92
	Fringe	4.97	5.77	6.40	6.60	7.02	6.76	6.27	4.20	3.52	3.06	2.50	1.92
	Urban	4.97	5.77	6.40	6.60	7.02	6.76	6.27	4.20	3.52	3.06	2.50	1.92
	Suburban	5.05	5.19	5.90	6.80	7.58	7.67	6.51	4.27	3.34	2.97	2.32	1.66
	Rural	4.92	5.01	5.75	7.12	7.88	8.18	6.27	4.31	3.45	2.97	2.10	1.27

Table B-15. Seasonal scaling factors applied to Philadelphia County AADT volumes.

Season	Road Type	Factor
Winter	Freeway	0.945
Spring	Freeway	1.006
Summer	Freeway	1.041
Autumn	Freeway	1.009
Winter	Arterial	0.942
Spring	Arterial	1.004
Summer	Arterial	1.041
Autumn	Arterial	1.013
Winter	Local	0.933
Spring	Local	1.012
Summer	Local	1.05
Autumn	Local	1.004
Winter	Ramp	0.944
Spring	Ramp	1.005
Summer	Ramp	1.041
Autumn	Ramp	1.011

Table B-16. Signals per mile, by link type, applied to Philadelphia County AADT volumes.

Functional Class	Region Type				
	CBD	Fringe	Rural	Suburban	Urban
Freeway	0	0	0	0	0
Local	8	6	1.5	3	5
Major Arterial	8	6	1	2	4
Minor Arterial	8	6	1.3	2	4
Parkway	4	2	0.5	1	1.5
Ramp	0	0	0	0	0

Table B-17. Statistical summary of AADT volumes (one direction) for Philadelphia County AERMOD simulations.

Statistic	Road Type	CBD	Fringe	Suburban	Urban
Count	Arterial	186	58	210	580
	Freeway	11	10	107	98
	Ramp	0	4	3	1
Minimum AADT	Arterial	15088	15282	15010	15003
	Freeway	15100	18259	15102	15100
	Ramp		16796	15679	16337
Maximum AADT	Arterial	44986	44020	48401	44749
	Freeway	39025	56013	68661	68661

	Ramp		40538	24743	16337
Average AADT	Arterial	21063	21196	20736	22368
	Freeway	25897	40168	33979	31294
	Ramp		24468	18814	16337

B-3.5.4.2 Emission Source Strength

On-road mobile emission factors were derived from the MOBILE6.2 emissions model as follows. The DVRPC-provided external data files describing the vehicle miles traveled (VMT) distribution by speed, functional class, and hour, as well as the registration distribution and *Post-1994 Light Duty Gasoline Implementation* for Philadelphia County were all used in the model runs without modification. To further maintain consistency with the recent DVRPC inventory simulations and maximize temporal resolution, the DVRPC's seasonal particulate matter (PM) MOBILE6 input control files were also used. These files include county-specific data describing the vehicle emissions inspection and maintenance (I/M) programs, on-board diagnostics (OBD) start dates, VMT mix, vehicle age distributions, default diesel fractions, and representative minimum and maximum temperatures, humidity, and fuel parameters. The simulations are designed to calculate average running NO_x emission factors.[11]

These input files were modified for the current project to produce running NOx emissions in grams per mile for a specific functional class (Freeway, Arterial, or Ramp) and speed. Iterative MOBILE6.2 simulations were conducted to create tables of average Philadelphia County emission factors resolved by speed (2.5 to 65 mph), functional class, season, and year (2001, 2002, or 2003) for each of the eight combined MOBILE vehicle classes (LDGV, LDGT12, LDGT34, HDGV, LDDV, LDDT, HDDV, and MC)[12]. The resulting tables were then consolidated into speed, functional class, and seasonal values for combined light- and heavy-duty vehicles. Figure B-4 shows an example of the calculated emission factors for Autumn, 2001.

[11] Basing the present emissions model input files on MPO-provided PM, rather than NO_x input files should not cause confusion. MPO-provided PM files were used because they contain quarterly rather than annual or biannual information. In all cases the output species were modified to produce gaseous emissions. Further, many of the specified input parameters do not affect PM emissions, but were included by the local MPO to best represent local conditions, which were preserved in the present calculations of NO_x emissions. This usage is consistent with the overall approach of preserving local information wherever possible.

[12] HDDV - Heavy-Duty Diesel Vehicle, HDGV - Heavy-Duty Gasoline Vehicle, LDDT - Light-Duty Diesel Truck, LDDV - Light-Duty Diesel Vehicle, LDGT12 - Light-Duty Gasoline Truck with gross vehicle weight rating ≤ 6,000 lbs and a loaded vehicle weight of ≤ 5,750 lbs, LDGT 34 - Light-Duty Gasoline Truck with gross vehicle weight rating between 6,001 - 8,500 and a loaded vehicle weight of ≤ 5,750 lbs, LDGV - Light-Duty Gasoline Vehicle, MC - Motorcycles.

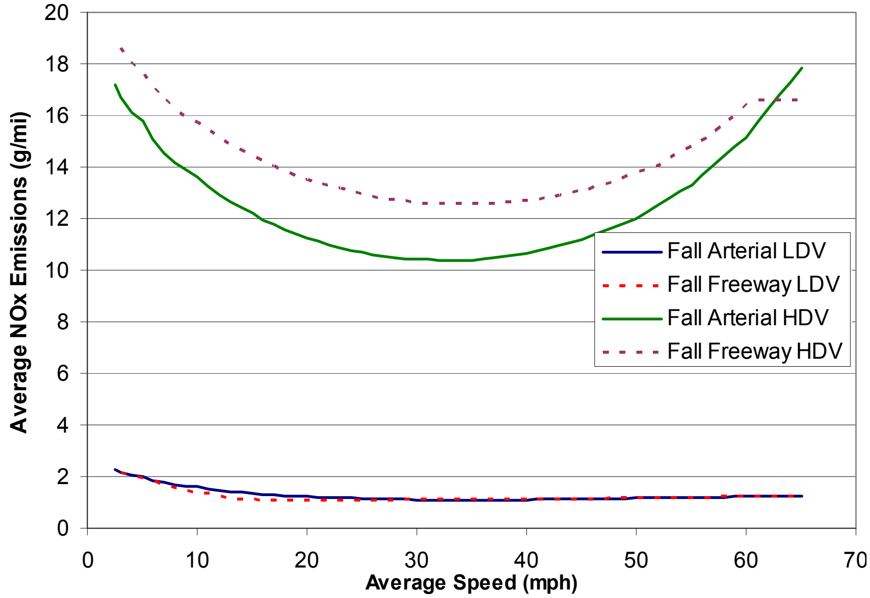

Figure B-4. Example of Light- and heavy-duty vehicle NOx emissions grams/mile (g/mi) for arterial and freeway functional classes, 2001.

To determine the emission strengths for each link for each hour of the year, the Philadelphia County average MOBILE6.2 speed-resolved emissions factor tables were merged with the TDM link data, which had been processed to determine time-resolved speeds. The speed calculations were made as follows.

The spatial-mean speed of each link at each time was calculated following the methodology of the Highway Capacity Manual.[13] Generally, the spatial-mean speed calculation is a function of the time-resolved volume-to-capacity ratio, with capacity the limiting factor. In the case of freeway calculations, this is determined by the HDV fraction, posted speed, and the general hilliness of the terrain, which was assumed to be uniformly flat for this region. The case of arterials without intersections is similar, but also considers urban effects. The case of arterials with intersections further considers the number of signals and length of each link and signalization parameters. It was assumed that all signals are identical, operating with a 120-second cycle and a protected left turn phase. Each link's speed is calculated independently. For example, a series of adjacent arterial links could show very different spatial-mean speeds if one link contains one or more intersections. That is, no up- or down-stream impacts are considered on individual link speeds. Speeds were assumed to be equal for light- and heavy-duty vehicles.

Table B-18 shows the resulting average speed for each functional class within each TDM region. Several values are shown as N/A, due to the focus only on major links as discussed above.

Table B-18. Average calculated speed by link type.

	Average Speed (mph)				
	CBD	Fringe	Suburban	Urban	Rural

[13] As defined in Chapter 9 of Recommended Procedure for Long-Range Transporation Planning and Sketch Planning, NCHRP Report 387, National Academy Press, 1997. 151 pp., ISBN No: 0-309-060-58-3.

Ramp	N/A	35	35	35	N/A
Arterial	34	31	44	32	N/A
Freeway	51	62	66	62	N/A

The resulting emission factors were then coupled with the TDM-based activity estimates to calculate emissions from each of the 1,268 major roadway links. However, many of the links were two sides of the same roadway segment. To speed model execution time, those links that could be combined into a single emission source were merged together. This was done only for the 628 links (314 pairs) where opposing links were paired in space and exhibited similar activity levels within 20% of each other.

B-3.5.4.3 Other Emission Parameters

Each roadway link is characterized as a rectangular area source with the width given by the number of lanes and an assumed universal lane width of 12 ft (3.66 m). The length and orientation of each link is determined as the distance and angle between end nodes from the adjusted TDM locations. In cases where the distance is such that the aspect ratio is greater than 100:1, the links were disaggregated into sequential links, each with a ratio less than that threshold. There were 27 links that exceeded this ratio and were converted to 55 segmented sources. Thus, the total number of area sources included in the dispersion simulations is 982. Table B-19 shows the distribution of on-road area source sizes. Note that there are some road segments whose length was zero after GIS adjustment of node location. This is assumed to be compensated by adjacent links whose length will have been expanded by a corresponding amount.

Table B-19. On-road area source sizes.

	Segment Width (m)	Lanes	Segment Length (m)
Minimum	3.7	1.0	0.0
Median	11.0	3.0	220.6
Average	13.7	3.8	300.2
1-σ Deviation	7.7	2.1	259.5
Maximum	43.9	12.0	1340.2

Resulting daily emission estimates were temporally allocated to hour of the day and season using MOBILE6.2 emission factors, coupled with calculated hourly speeds from the postprocessed TDM and allocated into SEASHR emission profiles for the AERMOD dispersion model. That is, 96 emissions factors are attributed to each roadway link to describe the emission strengths for 24 hours of each day of each of four seasons and written to the AERMOD input control file.

The release height of each source was determined as the average of the light- and heavy-duty vehicle fractions, with an assumed light- and heavy-duty emission release heights of 1.0 ft (0.3048 m) and 13.1 ft (4.0 m), respectively.[14] Because AERMOD only accepts a single release height for each source, the 24-hour average of the composite release heights is used in the modeling. Since surface-based mobile emissions are anticipated to be terrain following, no

[14] 4.0 m includes plume rise from truck exhaust stacks. See Diesel Particulate Matter Exposure Assessment Study for the Ports of Los Angeles and Long Beach, State of California Air Resources Board, Final Report, April 2006.

elevated or complex terrain was included in the modeling. That is, all sources are assumed to lie in a flat plane.

B-3.5.5 Stationary Sources Emissions Preparation

Data for the parameterization of major point sources in Philadelphia comes primarily from two sources: the 2002 National Emissions Inventory (NEI; US EPA, 2007b) and Clean Air Markets Division (CAMD) Unit Level Emissions Database (US EPA, 2007c). These two databases have complimentary information.

The NEI database contains stack locations, emissions release parameters (i.e., height, diameter, exit temperature, exit velocity), and annual emissions for 707 NO_x-emitting stacks (206 of which are considered fugitive release points) in Philadelphia County. The CAMD database, on the other hand, has information on hourly NO_x emission rates for all the units in the US, where the units are the boilers or equivalent, each of which can have multiple stacks. The alignment of facilities between the two databases is not exact, however. Some facilities listed in the NEI, are not included in the CAMD database. Of those facilities that do match, in many cases there is no clear pairing between the individual stacks assigned within the databases.

B-3.5.5.1 Data Source Alignment

To align the information between the two databases and extract the useful portion of each for dispersion modeling, the following methodology was used.

1. Attention was limited stacks within the NEI data base that (a) lie within Philadelphia County and (b) were part of a facility with total emissions from all stacks exceeding 100 tpy NO_x.
2. Individual stacks that had identical stack physical parameters and were co-located within about 10 m were combined to be simulated as a single stack with their emissions summed.
3. All fugitive releases were removed from the list, to be analyzed as a separate source group.

The resulting 19 distinct, combined stacks from the NEI are shown in Table B-20.

The CAMD database was then queried for facilities that matched the facilities identified from the NEI database. Facility matching was done on the facility name, Office of Regulatory Information Systems (ORIS) identification code (when provided) and facility total emissions to ensure a best match between the facilities. Once facilities were paired, individual units and stacks in the data bases were paired, based on annual emission totals. Table B-21 shows the matching scheme for the seven major facilities in Philadelphia County.[15]

[15] Note that Jefferson Smurfit does not exist in the CAMD database. The matching here was based on facility types as follows. Smurfit in PA was taken as a packaging/recycling facility, and the stack assumed to be a Cogen facility, based on information in the NEEDS database (http://www.epa.gov/interstateairquality/pdfs/NEEDS-NODA.xls). The best matched cogen plant in Philadelphia County in both the NEEDS and CAMD database is the Gray's Ferry Cogen Partnership (ORIS 54785), which was a reasonable match for Smurfit's total emissions. It was assumed that the hourly emission profile also matches well.

In Table B-21, there are sometimes multiple CAMD units that pair with a single NEI combined stack. In these cases the hourly emission rates from the matching CAMD units are summed for each hour. For example, in the case of stack 859 for "Sunoco, Inc – Philadelphia" five CAMD hourly records are summed into a single hourly record. Then each resulting hourly value is scaled by a factor of 1032.8 / 938.9 = 1.10, so that the annual total matches the NEI annual total.

Similarly, there are sometimes multiple combined stacks that pair with single units. In this case the CAMD values are disaggregated according to NEI-defined stack contributions. For example, "Sunoco, Inc – Philadelphia" stack 855's profile is determined by taking the hourly profile from CAMD unit number 52106-150101, and scaling each value by a factor of 26.2 tpy / 48.2 tpy total = 0.54. Then each resulting hourly value is scaled by a factor of 48.2/162.1 = 0.3 so that the sum of the annual totals for the 4 stacks corresponding to unit number 52106-150101 matches the NEI total. For consistency, in each case the 2001 and 2003 hourly emission profiles were determined using the same scaling factors, but applied to the respective CAMD emission profile.

It is clear from Table B-21 that most facilities agree well in total annual NO_x emissions between the two databases. However, in the case of the "Sunoco Chemicals (Former Allied Signal)" facility, nearly half of the NEI emissions (without fugitives) do not appear in the CAMD database. The reason for this is unknown and no information was readily available on the relative accuracy of the two databases.

Figure B-5 illustrates the discrepancy versus fraction of hours with positive emissions, according to the CAMD data base. The figure suggests that the discrepancies are not primarily the result of facilities with episodic emissions (i.e., "peak load" facilities). Although there is good agreement on facility-wide emissions between the two data bases, there are larger discrepancies between CAMD unit emissions and NEI stack emissions. This is to be expected given the discrepancy in resolution between the two data bases.

Table B-20. Combined stacks parameters for stationary NOx emission sources in Philadelphia County.

Stack No	NEI Site ID	Facility Name	SIC Code	NAICS Code	ORIS Facility Code	Stack Emissions (tpy)	Stack X (deg)	Stack Y (deg)	Stack Ht (m)	Exit Temp (K)	Stack Diam (m)	Exit Velocity (m/s)	Facility Emission with Fugitive (tpy)
817	NEIPA2218	EXELON GENERATION CO - DELAWARE STATION	4911	221112	3160	4.82	-75.1358	39.96769	49	515	4.2	0	297.8
818	NEIPA2218	EXELON GENERATION CO - DELAWARE STATION	4911	221112	3160	287.8	-75.1358	39.96769	64	386	3.7	17	297.8
819	NEI40720	JEFFERSON SMURFIT CORPORATION (U S)	2631	32213		0.148	-75.2391	40.03329	16	477	0.4	19	228.4
820	NEI40720	JEFFERSON SMURFIT CORPORATION (U S)	2631	32213		113.8	-75.2391	40.03329	53	427	2.4	10	228.4
821	NEI40720	JEFFERSON SMURFIT CORPORATION (U S)	2631	32213		114.46	-75.2391	40.03329	53	477	2.4	12	228.4
855	NEI40723	Sunoco Inc. - Philadelphia	2911	32411		26.2	-75.2027	39.92535	24	450	2.1	9	3112.2
856	NEI40723	Sunoco Inc. - Philadelphia	2911	32411		1.3	-75.2003	39.91379	24	644	1.5	22	3112.2
857	NEI40723	Sunoco Inc. - Philadelphia	2911	32411		1.4	-75.203	39.92539	25	511	1.9	10	3112.2
858	NEI40723	Sunoco Inc. - Philadelphia	2911	32411		19.3	-75.2027	39.92535	25	527	1.9	11	3112.2
859	NEI40723	Sunoco Inc. - Philadelphia	2911	32411		1032.8	-75.2124	39.90239	61	489	5.8	11	3112.2
860	NEI7330	SUNOCO CHEMICALS (FORMER ALLIED SIGNAL)	2869	325998		0.033	-75.0715	40.00649	5	476	0.5	7	160.9
861	NEI7330	SUNOCO CHEMICALS (FORMER ALLIED SIGNAL)	2869	325998		49.1	-75.0715	40.00649	41	422	1.4	22	160.9
862	NEI7330	SUNOCO CHEMICALS (FORMER ALLIED SIGNAL)	2869	325998		34.6	-75.0715	40.00649	42	422	1.6	17	160.9
863	NEI7330	SUNOCO CHEMICALS (FORMER ALLIED SIGNAL)	2869	325998		77.2	-75.0715	40.00649	42	422	1.6	22	160.9
864	NEIPA101353	TRIGEN - SCHUYLKILL	4961	22		128.6	-75.1873	39.94239	69	450	4.9	6	190.1
865	NEIPA101353	TRIGEN - SCHUYLKILL	4961	22		61.5	-75.1873	39.94239	78	450	7.3	2	190.1
866	NEIPA101356	GRAYS FERRY COGENERATION PARTNERS	4911	22	54785	143.2	-75.1873	39.94239	78	396	5.5	20	233.5
867	NEIPA101356	GRAYS FERRY COGENERATION PARTNERS	4911	22	54785	90.3	-75.1873	39.94239	85	443	3.2	21	233.5
868	NEIPA2222	TRIGEN - EDISON	4961	62		130.5	-75.1569	39.94604	78	589	3.7	9	130.5

Table B-21. Matched stacks between the CAMD and NEI database.

NEI Facility Name	NEI *Comb. Stack* Number	NEI *Comb. Stack* Emiss (tpy)	NEI Unit Emiss (tpy)	NEI Facility Emiss (tpy, w/out Fugitive)	CAMD Facility Name	CAMD Units *	CAMD Unit Emiss (tpy) *	CAMD Comb. Unit Totals (tpy)	CAMD Facility Totals (tpy)	Stack δ (%, relative to CAMD value)	Stack δ (tpy)	Facility δ (% relative to CAMD value)	Facility δ (tpy)
Exelon Generation Co - Delaware Station	817	4.8	4.8	**292.6**	Delaware	3160-9	1.542	1.542	**289.3**	213%	3.3	**1%**	**3.3**
	818	287.8	287.8			3160-71	123.8	287.8		0%	0.0		
						3160-81	164						
Sunoco Inc. - Philadelphia	855	26.2	48.2	**1081.0**	Philadelphia Refinery	52106-150101	162.1	162.1	**1101.0**	-70%	-113.9	**-2%**	**-20.3**
	856	1.3											
	857	1.4											
	858	19.3											
	859	1032.8	1032.8			52106-150137	194.2	938.9		10%	93.9		
						52106-150110	162.1						
						52106-150138	194.2						
						52106-150139	194.2						
						52106-150140	194.2						
Sunoco Chemicals (Former Allied Signal)	860	0.0	160.9	**160.9**	Sunoco Chemicals Frankford Plant	880007-52	84.5	84.5	**84.5**	90%	76.4	**90%**	**76.4**
	861	49.1											
	862	34.6											
	863	77.2											
Trigen - Schuylkill	864	128.6	128.6	**190.1**	Trigen Energy - Schuylkill	50607-23	163.1	163.1	**178.7**	-21%	-34.5	**6%**	**11.4**
	865	61.5	61.5			50607-24	2.9	15.6		293%	45.9		

NEI Facility Name	NEI *Comb. Stack* Number	NEI *Comb. Stack* Emiss (tpy)	NEI Unit Emiss (tpy)	NEI Facility Emiss (tpy, w/out Fugitive)	CAMD Facility Name	CAMD Units *	CAMD Unit Emiss (tpy) *	CAMD Comb. Unit Totals (tpy)	CAMD Facility Totals (tpy)	Stack δ (%, relative to CAMD value)	Stack δ (tpy)	Facility δ (% relative to CAMD value)	Facility δ (tpy)
						50607-26	12.7						
Grays Ferry Cogeneration Partners	866	143.2	143.2	**233.5**	Grays Ferry Cogen Partnership	54785-2	143.2	143.2	**233.5**	0%	0.0	**0%**	**0.0**
	867	90.3	90.3			54785-25	90.3	90.3		0%	0.0		
Trigen - Edison	868	130.5	130.5	**130.5**	Trigen Energy Corporation-Edison St	880006-1	19.8	111	**111.0**	18%	19.4	**18%**	**19.4**
						880006-2	17.3						
						880006-3	36.1						
						880006-4	37.8						
Jefferson Smurfit Corporation (U S) ***	819	0.1	228.4	**228.4**		54785-2	143.2	233.5	**233.5**	-2%	-5.1	**-2%**	**-5.1**
	820	113.8				54785-25	90.3						
	821	114.5											

Notes:
* In the format "ORIS ID - UNIT ID"
** All CAMD values are for 2002
*** Jefferson Smurfit not in CAMD; will use Grays Ferry as surrogate

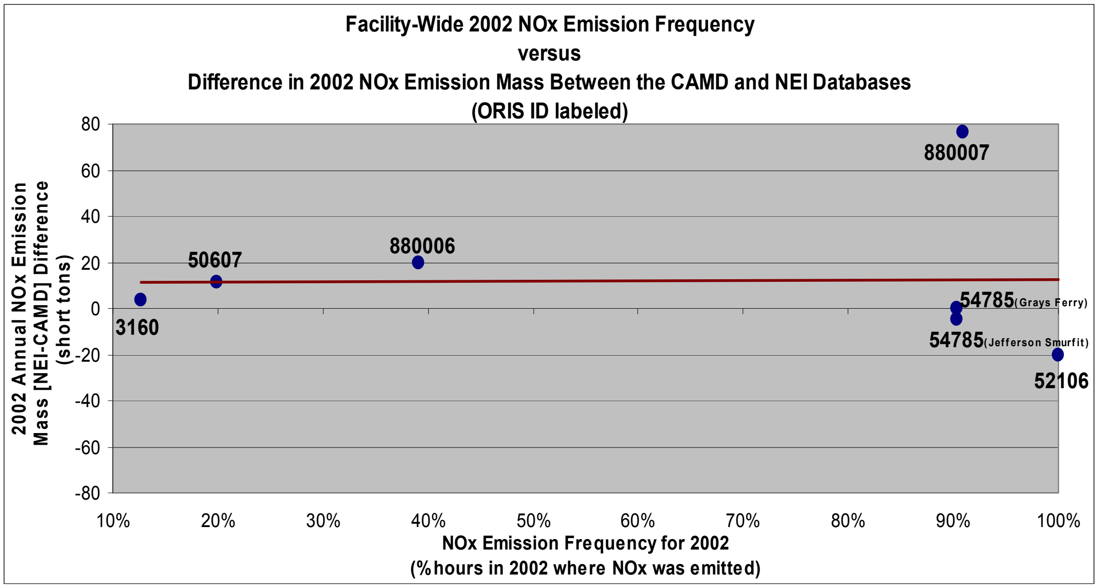

Figure B-5. Differences in facility-wide annual NOx emission totals between NEI and CAMD data bases for Philadelphia County 2002.

B-3.5.6 Fugitive and Airport Emissions Preparation

Fugitive emission releases in Philadelphia County, as totaled in the NEI database, were modeled as area sources with the profile of these releases determined by the overall facility profile of emissions. In addition, emissions associated with the Philadelphia International Airport were estimated.

B-3.5.6.1 Fugitive Releases

Thirty five *combined stacks* were identified during the point source analysis (see previous section) that were associated with facilities considered major emitters, but where the emissions from the stacks are labeled *Fugitive* in the NEI. These stacks have zero stack diameter, zero emission velocity, and exit temperature equal to average ambient conditions (295 K). Thus, we determined it was not appropriate to include these in the point source group simulation.

These 35 stacks occur at only two facilities in the County: Exelon Generation Co – Delaware Station (NEI Site ID: NEIPA2218) and Sunoco Inc. – Philadelphia (NEI Site ID: NEI40723). Consequently, they were grouped by facility. The Sunoco emissions further fall into two distinct categories based on release heights. Thus, to accommodate all these sources most efficiently, we created three area source groups: one for Sunoco emissions at 3.0 m, one for Sunoco emissions greater than 23.0 m, and one for Exelon. The "stacks" within the NEI and their parameters comprising each of these sources are shown in Table B-22 along with their groupings and the resulting combined area source parameters.

Table B-22. Emission parameters for the three Philadelphia County fugitive NOx area emission sources.

Grp. No.	NEI Site ID	Facility Name	NEI 2002 Emissions (tpy)	Stack X	Stack Y	Stack Height (m)	Stacks Used for Emission Profile [1]	Scaled Emissions (tpy) [2]		
								2001	2002	2003

Grp. No.	NEI Site ID	Facility Name	NEI 2002 Emissions (tpy)	Stack X	Stack Y	Stack Height (m)	Stacks Used for Emission Profile [1]	Scaled Emissions (tpy) [2]		
								2001	2002	2003
	NEIPA 2218	EXELON GENERATION CO - DELAWARE STATION	0.1	-75.13582	39.96769	5				
			5.1	-75.12528	39.96680	8				
1			**5.2**			**6.5**	**817+818**	**4.8**	**5.2**	**6.4**
	NEI40 723	Sunoco Inc. - Philadelphia	65.3	-75.21408	39.90811	3				
			350.9	-75.21300	39.90878	3				
			12.7	-75.20972	39.90467	3				
			355.7	-75.20945	39.90778	3				
			31.1	-75.20876	39.90185	3				
			6.2	-75.20845	39.90708	3				
			182.4	-75.20809	39.91580	3				
			1.1	-75.20707	39.90946	3				
			7.5	-75.20651	39.90988	3				
			1.0	-75.20301	39.91362	3				
			2.0	-75.20114	39.91273	3				
			49.4	-75.20090	39.91621	3				
			106.3	-75.20079	39.91615	3				
			188.5	-75.20047	39.91366	3				
			87.8	-75.20043	39.91377	3				
			36.1	-75.20024	39.91406	3				
			9.7	-75.20020	39.91410	3				
			61.2	-75.19995	39.91596	3				
			13.6	-75.19766	39.91696	3				
			17.0	-75.19751	39.91696	3				
			17.2	-75.19735	39.91590	3				
			12.2	-75.19723	39.91597	3				
			12.6	-75.19720	39.91698	3				
			23.7	-75.19713	39.91596	3				
			19.2	-75.19699	39.91599	3				
			10.0	-75.19644	39.91493	3				
2			**1,680.4**			**3.0**	**855+856+857+858+859**	**1,873.8**	**1,681.4**	**2,202.4**
	NEI40 723	Sunoco Inc. - Philadelphia	79.5	-75.21322	39.90899	23				
			13.1	-75.20833	39.90278	26				
			15.3	-75.20850	39.90246	27				
			2.5	-75.20844	39.90239	27				
			10.2	-75.20838	39.90231	27				
			19.0	-75.20828	39.90237	27				
			211.2	-75.20889	39.90279	30				
3			**350.8**			**26.7**	**855+856+857+858+859**	**391.2**	**351.0**	**459.8**

[1] See Table B-20 for stack definitions.

[2] Scaled emissions are determined by summing the scaled, hourly values from the CAMD database, as used in the dispersion modeling.

In the case of the Sunoco emissions, the vertices of the area sources were determined by a convex hull encapsulating all the points. In the case of Excelon, only two points are provided, which is insufficient information to form a closed polygon. Instead, the boundary of the facility was digitized into a 20-sided polygon. Figure B-6 shows the locations of these polygons.

Emission profiles for the fugitive releases were determined from the CAMD hourly emission database in a method similar to that for the point sources. We determined scaling factors based on the ratio of the 2002 fugitive releases described by the NEI to the total, non-fugitive point source releases from the same facility. All stacks within that facility were combined on an hourly basis for each year and the fugitive to non-fugitive scaling factor applied, ensuring that the same temporal emission profile was used for fugitives as for other releases from the facility, since the origins of the emissions should be parallel. We created external hourly emissions files for each of the three fugitive area sources with appropriate units (grams per second per square meter).

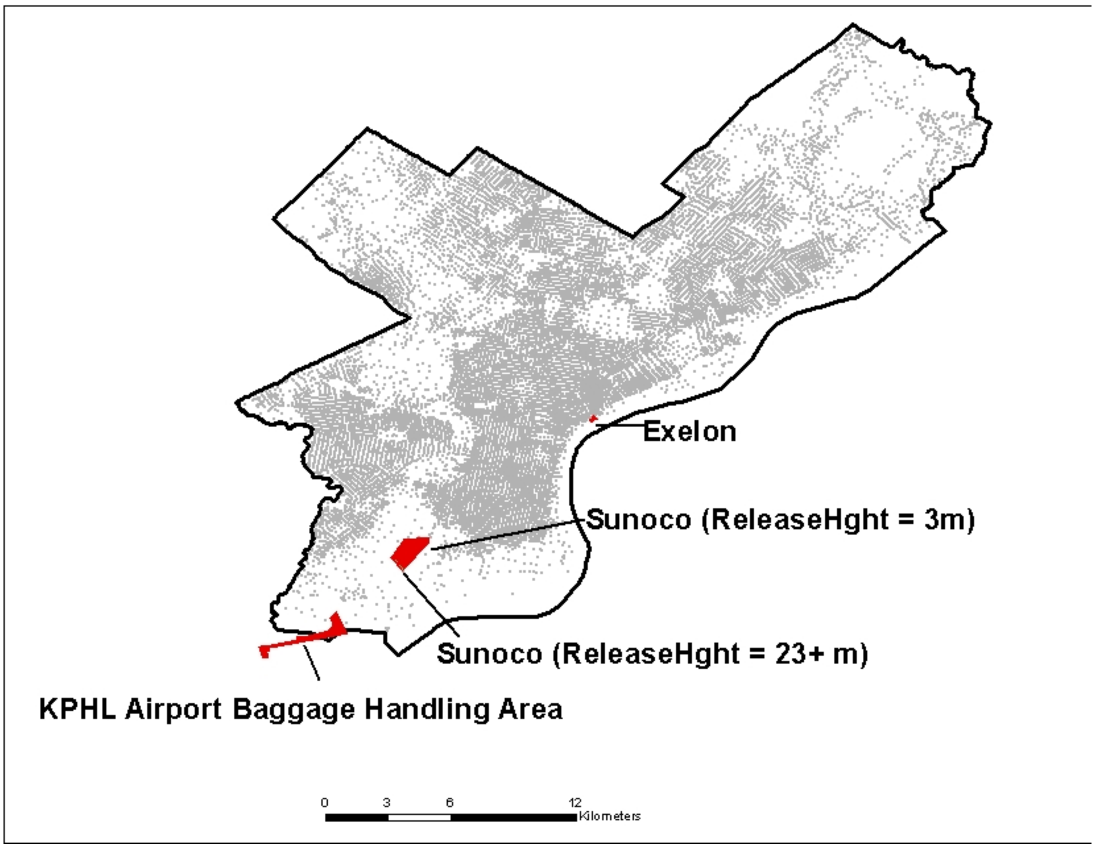

Figure B-6. Locations of the four ancillary area sources. Also shown are centroid receptor locations.

B-3.5.6.2 Philadelphia International Airport Emissions

Another significant source of NOx emissions in Philadelphia County not captured in the earlier simulations is from operation of the Philadelphia International Airport (PHL). PHL is the only major commercial airport in the County and is the largest airport in the Delaware Valley.

The majority of NOx emissions in the NEI[16] database attributable to airports in Philadelphia County are from non-road mobile sources, specifically ground support equipment. There is another airport in the County: Northeast Philadelphia Airport. However, because it serves general aviation, is generally much smaller in operations than PHL, and has little ground support equipment activity – which is associated primarily with commercial aviation – all airport emissions in the County were attributed to PHL. The PHL emissions were taken from the non-road section of the 2002 NEI, and are shown by Table B-23.

Table B-23. Philadelphia International airport (PHL) NO_x emissions.

State and County	SCC	NOx (tpy)	SCC Level 1 Description	SCC Level 3 Description	SCC Level 6 Description	SCC Level 8 Description
Philadelphia, PA	2265008005	4.6	Mobile Sources	Off-highway Vehicle Gasoline, 4-Stroke	Airport Ground Support Equipment	Airport Ground Support Equipment
	2267008005	5.1	Mobile Sources	LPG	Airport Ground Support Equipment	Airport Ground Support Equipment
	2270008005	196.2	Mobile Sources	Off-highway Vehicle Diesel	Airport Ground Support Equipment	Airport Ground Support Equipment
	2275020000	0.01	Mobile Sources	Aircraft	Commercial Aircraft	Total: All Types
	2275050000	2.5	Mobile Sources	Aircraft	General Aviation	Total
PHL Total		**208.4**				

As with the fugitive sources discussed above, the airport emissions are best parameterized as area sources. The boundary of the area source was taken as the region of operation of baggage handling equipment, including the terminal building and the region surrounding the gates. This region was digitized into an 18-sided polygon of size 1,326,000 m^2, and included in the AERMOD input control file.

The activity profile for PHL was taken to have seasonal and hourly variation (SEASHR), based on values from the EMS-HAP model.[17] These factors are disaggregated in the EMS-HAP model database based on source classification codes (SCCs), which were linked to those from the NEI database. The EMS-HAP values provide hourly activity factors by season, day type, and hour; to compress to simple SEASHR modeling, the hourly values from the three individual day types were averaged together. The total emissions for each SCC were then disaggregated into seasonal and hourly components and the resulting components summed to create total PHL emissions for each hour of the four annual seasons. These parameterized emissions were then normalized to the total cargo handling operational area, to produce emission factors in units of grams per second per square meter and included in the AERMOD input file. Figure B-6 also illustrates the location of the PHL area source.

[16] http://www.epa.gov/ttn/chief/net/2002inventory.html
[17] EPA 2004, User's Guide for the Emissions Modeling System for Hazardous Air Pollutants (EMS-HAP) Version 3.0, EPA-454/B-03-006.

B-3.5.7 Receptor Locations

Three sets of receptors were chosen to represent the locations of interest. First, all NOx monitor locations, shown by Table B-24, within the Philadelphia county were included as receptor locations. Although all receptors are assumed to be on a flat plane, they are placed at the standard breathing height of 5.9 ft (1.8 m).

Table B-24. Philadelphia County NOx monitors.

Site ID	Latitude	Longitude
421010004	40.0089	-75.0978
421010029	39.9572	-75.1731
421010047	39.9447	-75.1661

The second receptor locations were selected to represent the locations of census block centroids near major NO_x sources. GIS analysis was used to determine all block centroids in Philadelphia County that lie within a 0.25 mile (400 m) of the roadway segments and also all block centroids that lie within 6.2 miles (10 km) of any major point source. 12,982 block centroids were selected due to their proximity to major roadways; 16,298 centroids were selected due to their proximity to major sources. The union of these sets produced 16,857 unique block centroid receptor locations, each of which was assigned a height of 5.9 ft (1.8 m). The locations of centroids that met either distance criteria – and were thus included in the modeling – is shown by Figure B-7.

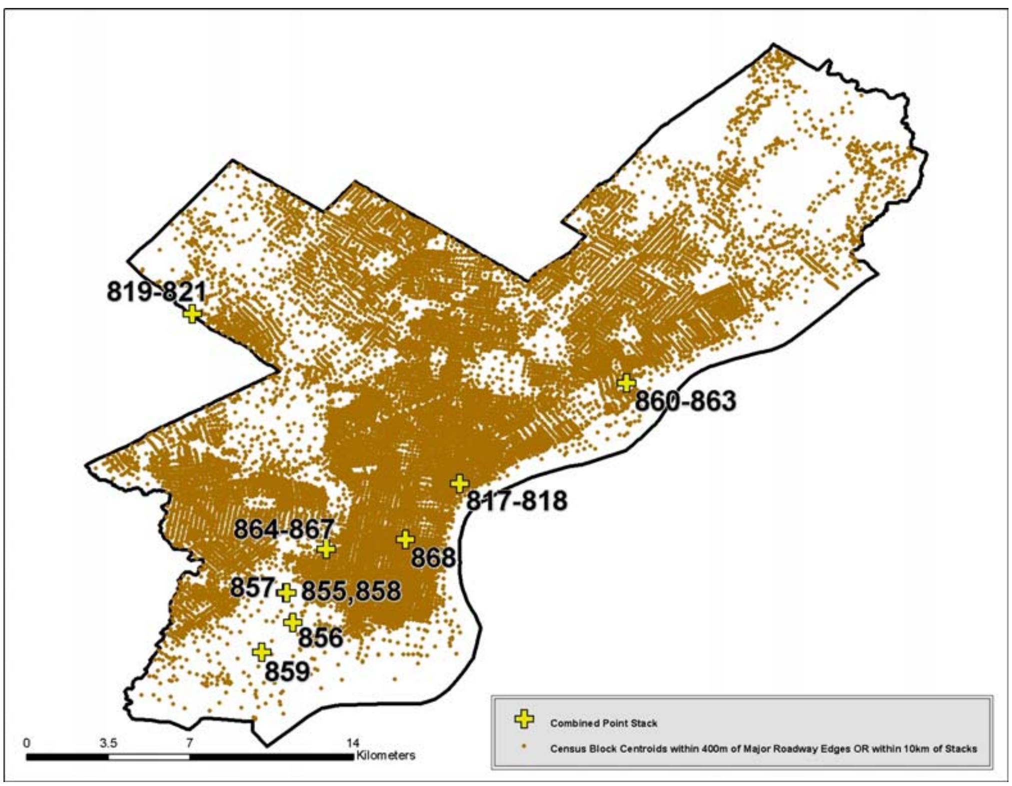

Figure B-7. Centroid locations within fixed distances to major point and mobile sources in Philadelphia county.

The third set of receptors was chosen to represent the on-road microenvironment. For this set, one receptor was placed at the center of each of the 982 sources.

The distance relationship between the road segments and block centroids can be estimated by looking at the distance between the road-centered and the block centroid receptors. Figure B-8 shows the histogram of the shortest distance between each centroid receptor and its nearest roadway-centered receptor.

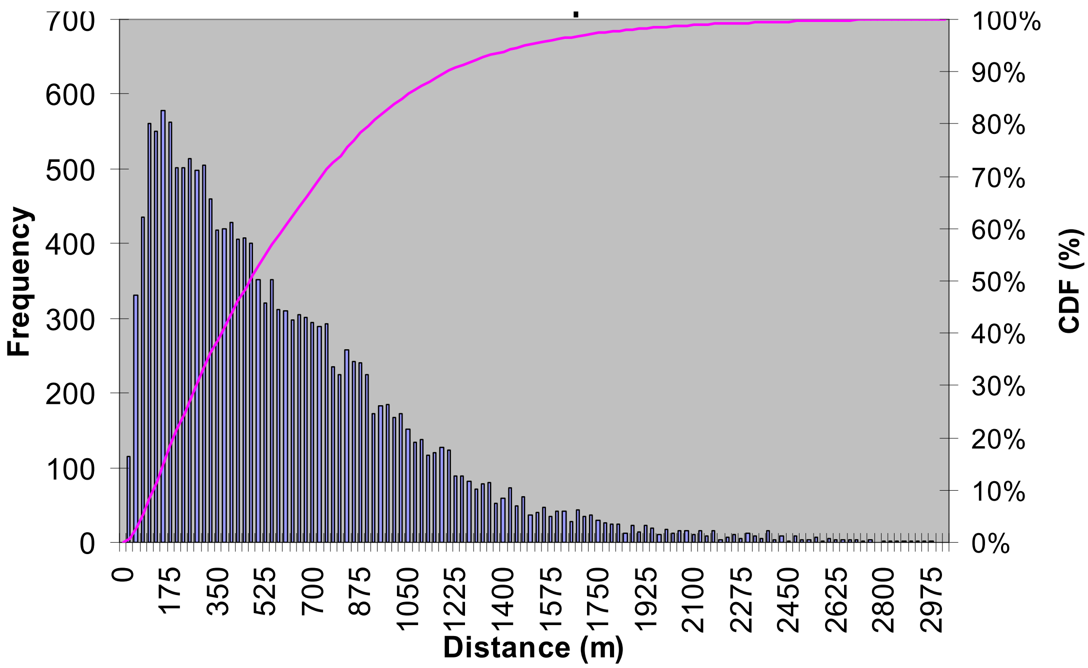

Figure B-8. Frequency distribution of distance between each Census receptor and its nearest road-centered receptor in Philadelphia County.

The block centroids selected were those within 10 km of any major point source or 400 m from any receptor edge, so the distances to the nearest major road segment can be significantly greater than 400 m. The mode of the distribution is about 150 m and the median distance to the closest roadway segment center is about 450 m. However, these values represent the distances of the block centroids to road centers instead of road edges, so that they overestimate the actual distances to the zone most influenced by roadway by an average of 14 m and a range of 4 m to 44 m (see Table B-19 above).

B-3.5.8 Other AERMOD Specifications

Since each of the case-study locations were MSA/CMSAs, all emission sources were characterized as urban. The AERMOD *toxics* enhancements were also employed to speed calculations from area sources. NO_x chemistry was applied to all sources to determine NO_2 concentrations. For the each of the roadway, fugitive, and airport emission sources, the ozone limiting method (OLM) was used, with plumes considered ungrouped. Because an initial NO_2 fraction of NO_x is anticipated to be about 10% or less (Finlayson-Pitts and Pitts, 2000; Yao et al., 2005), a conservative value of 10% for all sources was selected. For all point source simulations the Plume Volume Molar Ratio Method (PVMRM) was used to estimate the conversion of NO_x to NO_2, with the following settings:

1. Hourly series of O_3 concentrations were taken from EPA's AQS database[18]. The complete national hourly record of monitored O_3 concentrations were filtered for the four monitors within Philadelphia County (stations 421010004, 421010014, 421010024, and 421010136). The hourly records of these stations were then averaged together to provide an average Philadelphia County concentrations of O_3 for each hour of 2001-2003.
2. The equilibrium value for the NO_2:NO_x ratio was taken as 75%, the national average ambient ratio.[19]
3. The initial NO_2 fraction of NO_x is anticipated to be about 10% or less. A default value of 10% was used for all stacks (Finlayson-Pitts and Pitts, 2000).

B-3.5.9 Air Quality Concentration Adjustment

The hourly concentrations estimated from each of the three source categories were combined at each receptor. Then a local concentration, reflecting the concentration contribution from emission sources not included in the simulation, was added to the sum of the concentration contributions from each of these sources at each receptor. The local concentration was estimated from the difference between the model predictions at the local NO_2 monitors and the observed values. It should be noted that this local concentration may also include any model error present in estimating concentration at the local monitoring sites. Table B-25 presents a summary of the estimated local concentration added to the AERMOD hourly concentration data.

Table B-25. Comparison of ambient monitoring and AERMOD predicted NO_2 concentrations in Philadelphia.

Year and Monitor ID	Annual Average NO_2 concentration (ppb)			
	Monitor	AERMOD Initial	Difference[1]	AERMOD Final[2]
2001				
4210100043	26	7	18	19
4210100292	28	22	6	33
4210100471	30	20	10	32
mean			11	
2002				
4210100043	24	7	17	18
4210100292	28	21	7	32
4210100471	29	19	10	31
mean			11	
2003				
4210100043	24	7	17	13
4210100292	25	22	3	28
4210100471*	25	26	-1	32

[18] http://www.epa.gov/ttn/airs/airsaqs/detaildata/downloadaqsdata.htm
[19] Appendix W to CFR 51, page 466. http://www.epa.gov/scram001/guidance/guide/appw_03.pdf.

mean		6	

[1] the difference represents concentrations attributed to sources not modeled by AERMOD and model error.
[2] the mean difference between measured and modeled was added uniformly at each receptor hourly concentration to generate the AERMOD final concentrations.
* monitor did not meet completeness criteria used in the air quality characterization.

B-3.5.10 Meteorological Data Used By APEX

APEX used the same meteorological data that was used for the AERMOD modeling, the station located at Philadelphia International (KPHL) airport.

B-3.5.11 Microenvironment Descriptions

B-3.5.11.1 Microenvironment 1: Indoor-Residence

The Indoors-Residence microenvironment uses several variables that affect NO_2 exposure: whether or not air conditioning is present, the average outdoor temperature, the NO_2 removal rate, and an indoor concentration source. The first two of these variables affect the air exchange rate.

Since the selection of an air exchange rate distribution is conditioned on the presence or absence of an air-conditioner, for each modeled area the air conditioning status of the residential microenvironments is simulated randomly using the probability that a residence has an air conditioner. For this study, location-specific air conditioning prevalence was taken from the American Housing Survey of 2003 (AHS, 2003a; 2003b). Previous analyses (US EPA, 2007d) detail the specification of uncertainty estimates in the form of confidence intervals for the air conditioner prevalence using the following:

$$\text{Standard Error}\,(P) = \sqrt{\frac{3850\,P\,(1-P)}{N}},$$

$$\text{Confidence Interval}\,(P) = P \pm 1.96 \times \text{Standard Error}\,(P)$$

where P is the estimated percentage and N is the estimated total number of housing units. Table B-26 contains the values for air conditioning prevalence used for each modeled location.

Table B-26. Air conditioning prevalence estimates with 95% confidence intervals.

AHS Survey	Housing Units	A/C Prevalence (%)	se	L95	U95
Philadelphia	1,943,492	90.6	1.3	88.1	93.2

Notes:
se – Standard error
L95 – Lower limit on 95th confidence interval
U95 – Upper limit on 95th confidence interval

Air exchange rate data for the indoor residential microenvironment were obtained from US EPA (2007d). Briefly, residential air exchange rate (AER) data were obtained from several studies (Avol et al., 1998; Williams et al., 2003a, 2003b; Meng et al., 2004; Weisel et al., 2004; Chillrud at al, 2004; Kinney et al., 2002; Sax et al., 2004; Wilson et al., 1986, 1996; Colome et al., 1993, 1994; Murray and Burmaster, 1995). Influential characteristics (e.g., temperature, air conditioning), where reported in the study, were also compiled for use in statistical analyses. Descriptive statistics were generated for each location/variable type and evaluated using statistical comparison testing (e.g., ANOVA). Based on the summary statistics and the statistical comparisons, different AER distributions were fit for each combination of A/C type, city, and temperature. In general, lognormal distributions provided the best fit, and are defined by a geometric mean (GM) and standard deviation (GSD). To avoid unusually extreme simulated AER values, bounds of 0.1 and 10 were selected for minimum and maximum AER, respectively.

For Philadelphia, a distribution was selected from a location thought to have similar characteristics to the city to be modeled, qualitatively considering factors that might influence AERs. These factors include the age composition of housing stock, construction methods, and other meteorological variables not explicitly treated in the analysis, such as humidity and wind speed patterns. The distributions used for Philadelphia are provided in Table B-27.

Table B-27. Geometric means (GM) and standard deviations (GSD) for air exchange rates by city, A/C type, and temperature range.

Area Modeled	Study City	A/C Type	Temp (ºC)	N	GM	GSD
Philadelphia	New York City	Central or Room A/C	<=10	20	0.7108	2.0184
			10-25	42	1.1392	2.6773
			>25	19	1.2435	2.1768
		No A/C	<=10	48	1.0165	2.1382
			10-20	59	0.7909	2.0417
			>20	32	1.6062	2.1189

For this analysis, the same NO_2 removal rate distribution was used for all microenvironments that use the mass balance method. This removal rate is based on data provided by Spicer et al. (1993). A total of 6 experiments, under variable source emission characteristics including operation of gas stove, were conducted in an unoccupied test house. A distribution could not be described with the limited data set, therefore a uniform distribution was approximated by the bounds of the 6 values, a minimum of 1.02 and a maximum of 1.45 h^{-1}.

An excerpt from the APEX input file describing the indoor residential microenvironment is provided in Figure B-9. The first section of the input file excerpt specifies the air exchange rate distributions for the microenvironment. Average temperature and air conditioning presence, which are city-specific, were coded into air exchange rate *conditional variables, C1* and *C2*, respectively. Average temperatures were separated into five categories (variable *C1*, numbered 1-5): 50 º F, 50-68 º F, 68-77 º F, 77-86 º F, and 86 º F and above. For variable *C2*, air conditioning status can range from *1* to *2* (*1* for having air conditioning, *2* for not having it). The air exchange rate estimates generated previously in the form of lognormal distributions were entered into the appropriate temperature and A/C category for each location for a total of ten distributions (i.e., 5 temperature distributions by 2 air conditioning distributions). In the input file example however, there are actually four AER distributions for homes with an air conditioner and three for those without; the last few distributions for each air conditioning setting were the same due to the available data to populate the field. The parameter estimates for the removal factor (DE) is also shown following the AER data.

```
Micro number     = 1        !    Indoors - residence - AIR EXCHANGE RATES
Parameter Type    = AER
Condition # 1     = AvgTempCat
Condition # 2     = AC_Home
ResampHours      = NO
ResampDays       = YES
ResampWork       = YES
Block DType Season Area C1  C2  C3   Shape      Par1     Par2  Par3 Par4  LTrunc UTrunc
1     1     1      1    1   1   1   Lognormal  0.711   2.018   0    .      0.1    10
1     1     1      1    2   1   1   Lognormal  1.139   2.677   0    .      0.1    10
1     1     1      1    3   1   1   Lognormal  1.139   2.677   0    .      0.1    10
1     1     1      1    4   1   1   Lognormal  1.244   2.177   0    .      0.1    10
1     1     1      1    5   1   1   Lognormal  1.244   2.177   0    .      0.1    10
1     1     1      1    1   2   1   Lognormal  1.016   2.138   0    .      0.1    10
1     1     1      1    2   2   1   Lognormal  0.791   2.042   0    .      0.1    10
1     1     1      1    3   2   1   Lognormal  1.606   2.119   0    .      0.1    10
1     1     1      1    4   2   1   Lognormal  1.606   2.119   0    .      0.1    10
1     1     1      1    5   2   1   Lognormal  1.606   2.119   0    .      0.1    10

Micro number     = 1              !   DECAY RATES
Pollutant = 1
Parameter Type    = DE
ResampHours      = NO
ResampDays       = NO
ResampWork       = YES
Block DType Season Area C1  C2  C3   Shape      Par1   Par2  Par3 Par4  LTrunc UTrunc
1     1     1      1    1   1   1   Uniform     1.02   1.45   .    .     1.02   1.45
```

Figure B-9. Example input file from APEX for Indoors-residence microenvironment.

Indoor source contributions

A number of studies, as described in the NO_x ISA, have noted the importance of gas cooking appliances as sources of NO_2 emissions. An indoor emission source term was included in the APEX simulations to estimate exposure to indoor sources of NO_2. Three types of data were used to implement this factor:

- The fraction of households in the Philadelphia MSA that use gas for cooking fuel
- The range of contributions to indoor NO_2 concentrations that occur from cooking with gas
- The diurnal pattern of cooking in households.

The fraction of households in Philadelphia County that use gas cooking fuel (i.e., 55%) was taken from the *US Census Bureau's American Housing Survey for the Philadelphia Metropolitan Area: 2003.*

Data used for estimating the contribution to indoor NO_2 concentrations that occur during cooking with gas fuel were derived from a study sponsored by the California Air Resources Board (CARB, 2001). For this study a test house was set up for continuous measurements of NO_2 indoors and outdoors, among several other parameters, and conducted under several different cooking procedures and stove operating conditions. A uniform distribution of concentration contributions for input to APEX was estimated as follows.

- The concurrent outdoor NO_2 concentration measurement was subtracted from each indoor concentration measurement, to yield net indoor concentrations
- Net indoor concentrations for duplicate cooking tests (same food cooked the same way) were averaged for each indoor room, to yield average net indoor concentrations
- The minimum and maximum average net indoor concentrations for any test in any room were used as the lower and upper bounds of a uniform distribution

This resulted in a minimum average net indoor concentration of 4 ppb and a maximum net average indoor concentration of 188 ppb.

An analysis by Johnson et al (1999) of survey data on gas stove usage collected by Koontz et al (1992) showed an average number of meals prepared each day with a gas stove of 1.4. The diurnal allocation of these cooking events was estimated as follows.

- Food preparation time obtained from CHAD diaries was stratified by hour of the day, and summed for each hour, and summed for total preparation time.
- The fraction of food preparation occurring in each hour of the day was calculated as the total number of minutes for that hour divided by the overall total preparation time. The result was a measure of the probability of food preparation taking place during any hour, given one food preparation event per day.
- Each hourly fraction was multiplied by 1.4, to normalize the expected value of daily food preparation events to 1.4.

The estimated probabilities of cooking by hour of the day are presented in Table B-28. For this analysis it was assumed that the probability that food preparation would include stove usage was the same for each hour of the day, so that the diurnal allocation of food preparation events would be the same as the diurnal allocation of gas stove usage. It was also assumed that each cooking event lasts for exactly 1 hour, implying that the average total daily gas stove usage is 1.4 hours.

Table B-28. Probability of gas stove cooking by hour of the day.

Hour of Day	Probability of Cooking (%)[1]
0	0
1	0
2	0
3	0
4	0
5	5
6	10
7	10
8	10
9	5

Hour of Day	Probability of Cooking (%)[1]
10	5
11	5
12	10
13	5
14	5
15	5
16	15
17	20
18	15
19	10
20	5
21	5
22	0
23	0
[1] Values rounded to the nearest 5%. Data sum to 145% due to rounding and scaling to 1.4 cooking events/day.	

B-3.5.11.2 *Microenvironments 2-7: All other indoor microenvironments*

The remaining five indoor microenvironments, which represent Bars and Restaurants, Schools, Day Care Centers, Office, Shopping, and Other environments, are all modeled using the same data and functions (Figure B-10). As with the Indoor-Residence microenvironment, these microenvironments use both air exchange rates and removal rates to calculate exposures within the microenvironment. The air exchange rate distribution (GM = 1.109, GSD = 3.015, Min = 0.07, Max = 13.8) was developed based on an indoor air quality study (Persily et al, 2005; see US EPA, 2007d for details in derivation). The decay rate is the same as used in the Indoor-Residence microenvironment discussed previously. The Bars and Restaurants microenvironment included an estimated contribution from indoor sources as was described for the Indoor-Residence, only there was an assumed 100% prevalence rate and the cooking with the gas appliance occurred at any hour of the day.

```
Micro number     = 2       !    Bars & restaurants     - AIR EXCHANGE RATES
Parameter Type   = AER
ResampHours      = NO
ResampDays       = YES
ResampWork       = YES
Block DType Season Area C1  C2  C3   Shape       Par1   Par2  Par3 Par4  LTrunc UTrunc
1     1     1      1    1   1   1    LogNormal   1.109  3.015  0    .     0.07   13.8

Micro number     = 2               !   DECAY RATES
Pollutant = 1
Parameter Type   = DE
ResampHours      = NO
ResampDays       = YES
ResampWork       = YES
Block DType Season Area C1  C2  C3   Shape      Par1   Par2  Par3 Par4  LTrunc UTrunc
1     1     1      1    1   1   1    Uniform    1.02   1.45   .    .     1.02   1.45
```

Figure B-10. Example input file from APEX for all Indoors microenvironments (non-residence).

Microenvironments 8 and 9: Outdoor microenvironments

Two outdoor microenvironments, the Near Road and Public Garage/Parking Lot, used the factors method to calculate pollutant exposure. Penetration factors are not applicable to outdoor environments (effectively, PEN=1). Proximity factors were developed from the AERMOD concentration predictions, i.e., the block-centroid-to-nearest-roadway concentration ratios. Based on the resulting sets of ratio values, the ratio distributions were stratified by hour of the day into 3 groups as indicated by the "hours-block" specification in the example file in Figure B-11. The lower and upper bounds for sampling were specified as the 5th and 95th percentile values, respectively, of each distribution.

```
Micro number     = 8       !    Outdoor near road      PROXIMITY FACTOR
Pollutant = 1
Parameter Type   = PR
Hours - Block     =      1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 3 3 3 1 1
ResampHours      = YES
ResampDays       = YES
ResampWork       = YES
Block DType Season Area C1  C2  C3   Shape      Par1   Par2  Par3 Par4  LTrunc UTrunc  ResampOut
1     1     1      1    1   1   1  LogNormal  1.251  1.478  0.    .    0.86  2.92    Y
2     1     1      1    1   1   1  LogNormal  1.555  1.739  0.    .    0.83  4.50    Y
3     1     1      1    1   1   1  LogNormal  1.397  1.716  0.    .    0.73  4.17    Y
```

Figure B-11. Example input file from APEX for outdoor near road microenvironment.

B-3.5.11.3 Microenvironment 10: Outdoors-General.

The general outdoor environment concentrations are well represented by the modeled concentrations. Therefore, both the penetration factor and proximity factor for this microenvironment were set to 1.

B-3.5.11.4 Microenvironments 11 and 12: In Vehicle- Cars and Trucks, and Mass Transit

Penetration factors were developed from data provided in Chan and Chung (2003). Inside-vehicle and outdoor NO_2 concentrations were measured with for three ventilation conditions, air-recirculation, fresh air intake, and with windows opened. Since major roads were the focus of this assessment, reported indoor/outdoor ratios for highway and urban streets were used here. Mean values range from about 0.6 to just over 1.0, with higher values associated with increased ventilation (i.e., window open). A uniform distribution was selected for the penetration factor for Inside-Cars/Trucks (ranging from 0.6 to 1.0) due to the limited data available to describe a more formal distribution and the lack of data available to reasonably assign potentially influential characteristics such as use of vehicle ventilation systems for each location. Mass transit systems, due to the frequent opening and closing of doors, was assigned a uniform distribution ranging from 0.8 to 1.0 based on the reported mean values for fresh air intake and open windows. Proximity factors were developed as described above for Microenvironments 8 and 9.

B-3.5.12 Adjustment for Just Meeting the Current Standard

To simulate just meeting the current standard, dispersion modeled concentration were not rolled-up as was done for the monitor concentrations used in the air quality characterization. A proportional approach was used as done in the Air Quality Characterization, but to reduce computer processing time, the health effect benchmark levels were proportionally reduced by the similar factors described for each specific location and simulated year. Since it is a proportional adjustment, the end effect of adjusting concentrations upwards versus adjusting benchmark levels downward within the model is the same. The difference in the exposure and risk modeling was that the modeled air quality concentrations were used to generate the adjustment factors. Table B-29 provides the adjustment factors used and the adjusted potential health effect benchmark concentrations to simulate just meeting the current standard. When modeling indoor sources, the indoor concentration contributions needed to be scaled downward by the same proportions.

Table B-29. Adjustment factors and potential health effect benchmark levels used by APEX to simulate just meeting the current standard.

Simulated Year (factor)	Potential Health Effect Benchmark Level (ppb)	
	Actual	Adjusted
2001 (1.59)	150	94
	200	126
	250	157
	300	189
2002 (1.63)	150	92
	200	122
	250	153
	300	184
2003 (1.64)	150	91
	200	122
	250	152
	300	183

When considering the indoor sources, an additional scaling was performed so as not to affect their estimated concentrations while adjusting the benchmark levels downward. To clarify how this was done, exposure concentrations an individual experiences are first defined as the sum of the contribution from ambient concentrations and from indoor sources (if present) and this concentration can be either above or below a selected concentration level of interest:

$$C_{esposure} = A \times C_{ambient} + B \times C_{indoor} > C_{threshold} \qquad \text{equation (6)}$$

where,

$C_{exposure}$ = individual exposure concentration
A = proportion of exposure concentration from ambient
$C_{ambient}$ = ambient concentration in the absence of indoor sources

B = proportion of exposure concentration from indoor
C_{indoor} = indoor source concentration contribution
$C_{threshold}$ = an exposure concentration of interest

It follows that if we are interested in adjusting the ambient concentrations upwards by some proportional factor F, this can be described with the following:

$$F \times A \times C_{ambient} + B \times C_{indoor} > C_{threshold} \qquad \text{equation (7)}$$

This is equivalent to

$$A \times C_{ambient} + B \times (C_{indoor} / F) > (C_{threshold} / F) \qquad \text{equation (8)}$$

Therefore, if the potential health effect benchmark level and the indoor concentrations are both proportionally scaled downward by the same adjustment factor, the contribution of both sources of exposure (i.e., ambient and indoor) are maintained and the same number of estimated exceedances would be obtained as if the ambient concentration were proportionally adjusted upwards by factor F.

B-3.6 Philadelphia Exposure Modeling Results

B-3.6.1 Overview

The results of the exposure and risk characterization are presented here for Philadelphia County. Several scenarios were considered for the exposure assessment, including two averaging time for NO_2 concentrations (annual and 1-hour), inclusion of indoor sources, and for evaluating just meeting the current standard. To date, year 2002 served as the base year for all scenarios, years 2001 and 2003 were only evaluated for a limited number of scenarios. Exposures were simulated for four groups; children and all persons, and the asthmatic population within each of these.

The exposure results summarized below focus on the population group where exposure estimations are of greatest interest, namely asthmatic individuals. The complete results for each of these two population subgroups are provided in section B-3.6.7. However, due to certain limitations in the data summaries output from the current version of APEX, some exposure data could only be output for the entire population modeled (i.e., all persons - includes asthmatics and healthy persons of all ages). The summary data for the entire population (e.g., annual average exposure concentrations, time spent in microenvironments at or above a potential health effect benchmark level) can be representative of the asthmatic population since the asthmatic population does not have its microenvironmental concentrations and activities estimated any differently from those of the total population.

B-3.6.2 Evaluation of Modeled NO_2 Air Quality Concentrations (as is)

Since the current NO_2 standard is 0.053 ppm annual average, the predicted air quality concentrations were first summarized by calculating annual average concentration. The distribution for the AERMOD predicted NO_2 concentrations at each of the 16,857 receptors for years 2001 through 2003 are illustrated in Figure B-12. Variable concentrations were estimated by the dispersion model over the three year period (2001-2003). The NO_2 concentration distribution was similar for years 2001 and 2002, with mean annual average concentrations of about 21 ppb and a COV of just over 30%. On average, NO_2 annual average concentrations were lowest during simulated year 2003 (mean annual average concentration was about 16 ppb), largely a result of the comparably lower local concentration added (Table B-28). While the mean annual average concentrations were lower than those estimated for 2001 and 2002, a greater number of annual average concentrations were estimated above 53 ppb for year 2003. In addition, year 2003 also contained greater variability in annual average concentrations as indicated by a COV of 53%.

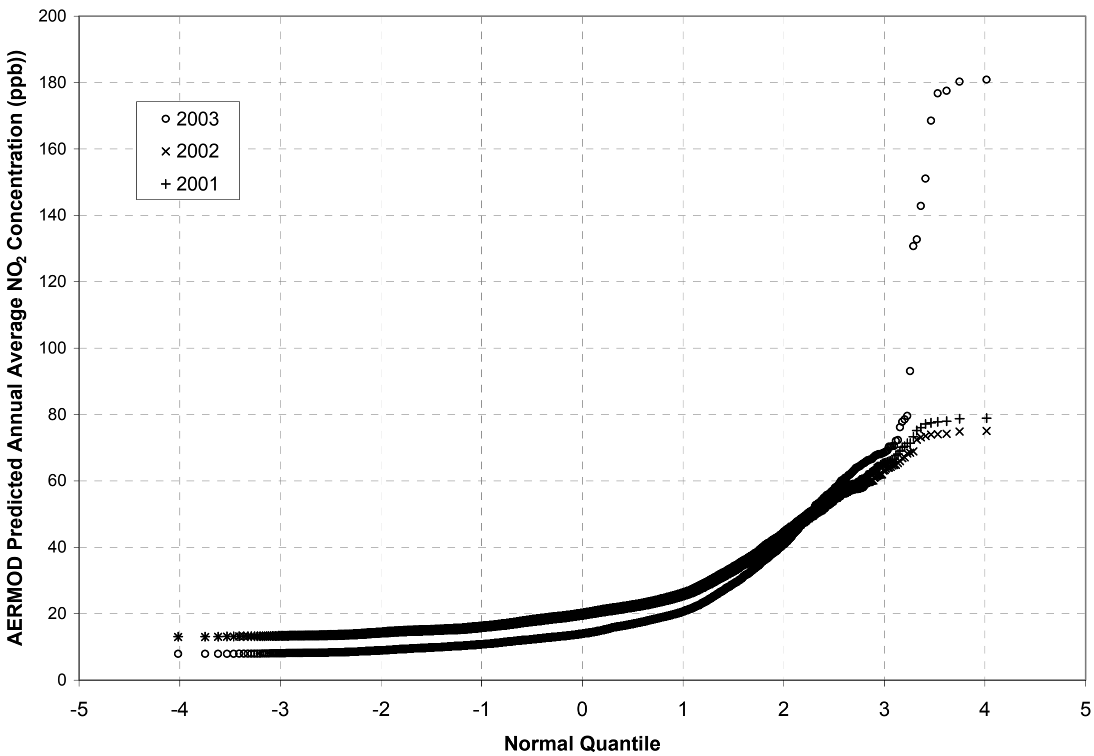

Figure B-12 . Distribution of AERMOD estimated annual average NO_2 concentrations at each of the 16,857 receptors in Philadelphia County for years 2001-2003.

Diurnal variability in NO_2 concentrations was evaluated by comparing the modeled concentrations at the monitor receptors with the measured concentrations at the ambient monitors. Figure B-13 presents the annual average NO_2 concentration at each hour of the day for the three monitors located in Philadelphia County. The diurnal distributions among the modeled versus measured concentrations are similar at all of the monitors, with peak NO_2 concentrations generally coinciding with the typical peak commute times of 6:00-9:00 AM and 5:00-8:00 PM. The pattern is represented best at monitor 4210100043 (top graph in Figure B-13), however the AERMOD concentrations are approximately 8 ppb lower at the earlier times of the day following the adjustment for sources not modeled (section B-3.5.9). There is greater variability in the modeled NO_2 concentrations at the other two monitors when compared with the measured data (middle and bottom graphs of Figure B-13), although the patterns are still similar. The greatest difference in NO_2 concentrations occurs during the later commute period, most notable at monitor 4210100292. Given the concentration adjustment to correct for sources not modeled was applied to all receptors equally across the entire modeling domain, it is not surprising that the modeled concentrations are higher in some instances while others not. The pattern in the concentrations is the important feature to replicate, of which AERMOD does reasonably, and based on these three receptors, may slightly overestimate peak concentrations more times than underestimate them.

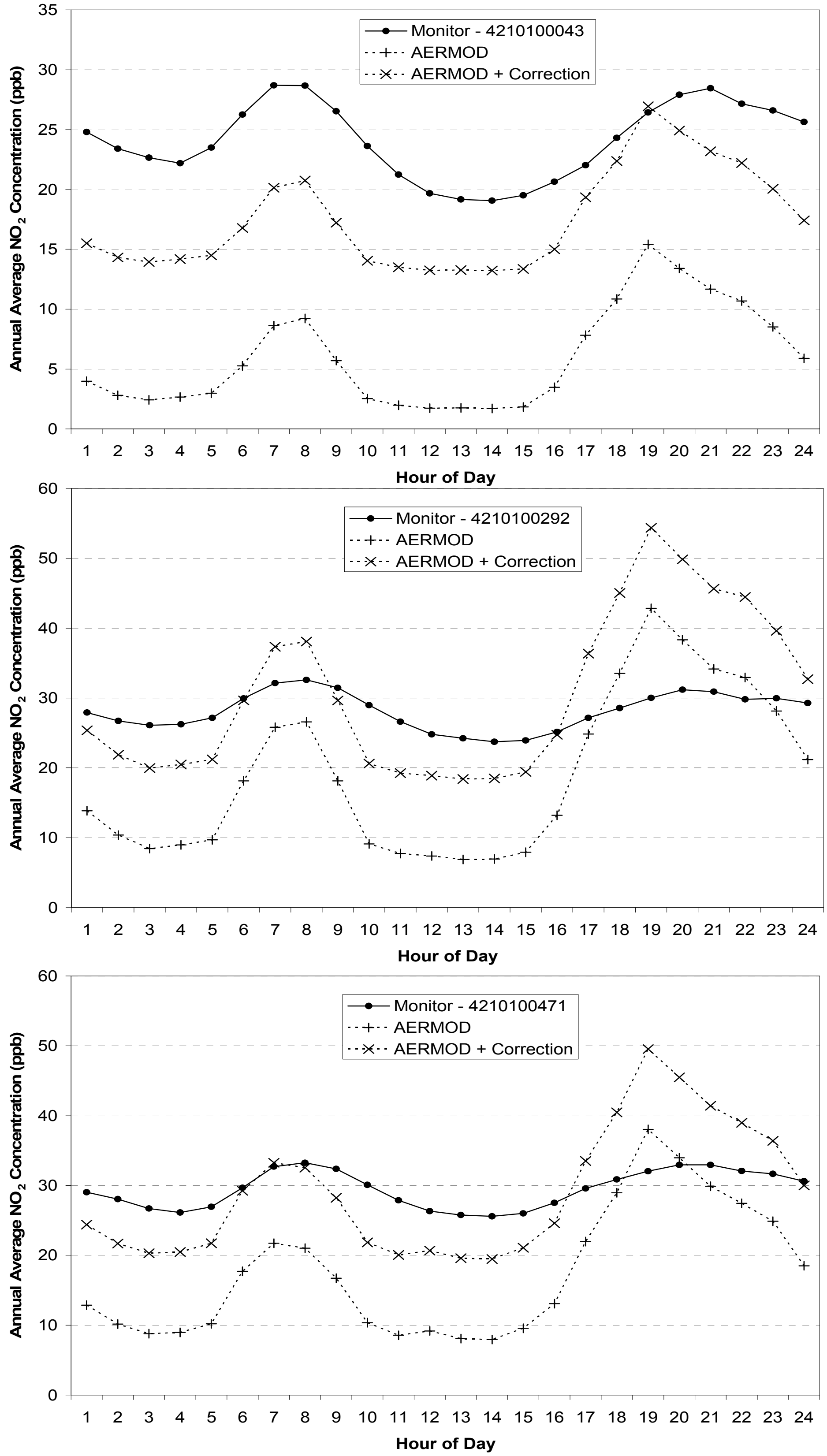

Figure B-13. Measured and modeled diurnal pattern of NO_2 concentrations at three ambient monitor sites.

B-3.6.3 Comparison of estimated on-road NO_2 concentrations

The two independent approaches used to estimate on-road NO_2 concentrations, one using ambient monitor data combined with an on-road simulation factor (section A-8) and the other using the AERMOD dispersion model (section B-3.5), were compared to one another. There are no on-road NO_2 concentration measurements in Philadelphia for the modeled data to be compared with, although it should be noted that the data used to estimate the simulation factors and applied to the monitor data are measurement based.

First a comparison can be made between the factor used for estimating on-road concentrations in the air quality analysis and similar factors calculated using AERMOD estimated concentrations. As described in section A-8, an empirical distribution of on-road simulation factors was derived from on-road and near-road NO_2 concentration measurements published in the extant literature. The derived empirical distribution was separated into two components, one for application to summertime ambient concentrations, and the second for all other seasons. The two empirical distributions are presented in Figure B-14, and represent the factors multiplied by the ambient monitor concentration (> 100 m from a major road) and used to estimate the on-road concentration in the air quality characterization. The one-hour NO_2 concentrations estimated at every AERMOD receptor in Philadelphia were compared with the concentrations estimated at their closest on-road receptor to generate a similar ratio (i.e., on-road/non-road concentrations). These ratios were also stratified into two seasonal categories, one containing the summer ratios (June, July, and August) and the other for all other times of the year. The AERMOD on-road factor distributions in semi-empirical form are also presented in Figure B-14. There are similarities in comparing each of the AERMOD with the measurement study derived distributions, most importantly at the upper percentiles. Intersection of the two approaches occurs at about the 70^{th} percentile and continues through the 90^{th} percentile. While the two seasonal distributions for AERMOD are very similar to one another, they diverge at the upper percentiles, with the summer ratios containing greater values at the same percentiles. This is similar to what was observed in the measurement derived distribution, although the summer ratio distribution consistently contained greater values at all percentiles compared with the non-summer distribution.

There are differences that exist when comparing the two approaches at the mid to lower percentiles, with the AERMOD ratios consistently lower than the empirically derived factors. This is likely due to the differences in the population of samples used to generate each type of distribution. The measurement study derived distribution used data from on-road concentration measurements and from monitoring sites located at a distance from the road, sites that by design of the algorithm and the factor selection criteria are likely not under the influence of non-road NO_2 emission sources. Thus, the measurement study derived ratios never fall below a value of one, there are no on-road concentrations less than any corresponding non-road influenced concentrations. This was, by design, a reasonable assumption for estimating the on-road concentrations for the air quality characterization. The AERMOD receptors however, include all types of emission sources such that there are possibilities for concentrations at non-road receptors that are greater than on-road, a more realistic depiction of the actual relationship between on-road and non-road receptors. Furthermore, the AERMOD distribution extends beyond the range of values offered by the measurement study derived ratios at the very upper percentiles. This could indicate that the AERMOD approach is better accounting for locally high NO_2 concentrations than those reported by the limited measurement studies.

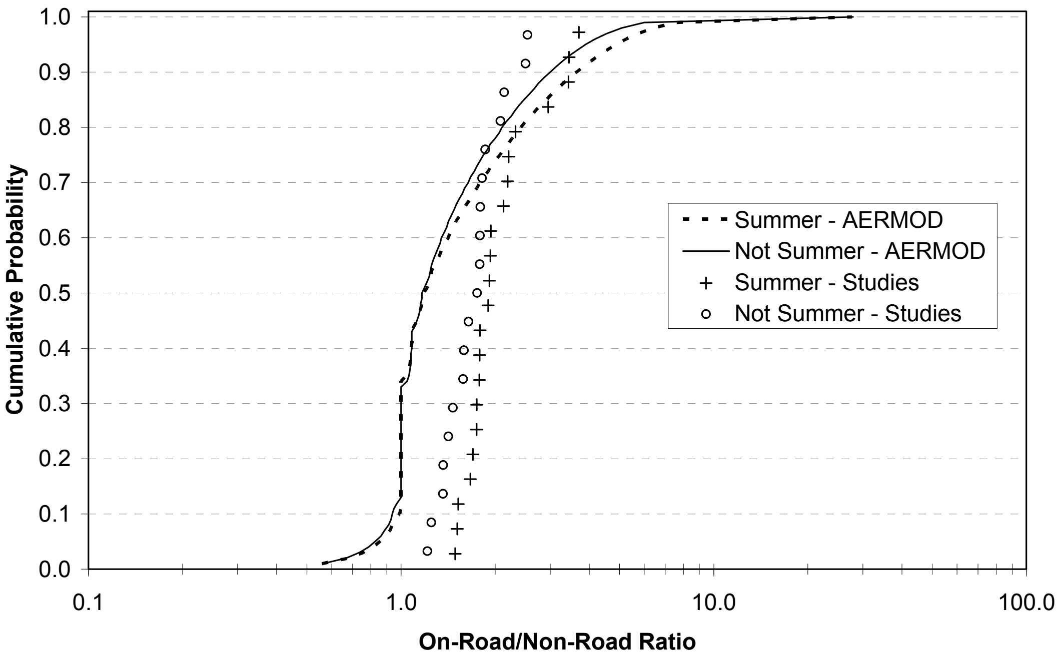

Figure B-14. Comparison of on-road factors developed from AERMOD concentration estimates and those derived from published NO_2 measurement studies.

Briefly for the second comparison, hourly on-road NO_2 concentrations were estimated using AERMOD for 979 on-road receptors in Philadelphia for the year 2002. The 24 hourly values modeled for each day at each receptor were rounded to the nearest 1 ppb and then adjusted for sources not modeled using the ambient monitor data (Table B-25). The second set of estimated on-road NO_2 concentrations was generated as part of the Air Quality Characterization by applying randomly selected on-road factors to the ambient monitor concentrations in the Philadelphia CMSA.

Table B-30 compares the summary statistics of the hourly concentrations and the number of exceedances of the potential health effect benchmark levels. The AERMOD predicted and ambient monitor simulated concentration distributions have very similar means and percentiles. However the variance of the modeled values is about 60 % higher than the variance of the simulated on-road monitor concentrations. This variance difference is largely a function of differences in the extreme upper tails of the distributions and most notable when comparing the numbers of exceedances of the potential health effect benchmark levels. The AERMOD on-road receptors consistently have a greater number of exceedances of potential health effect benchmark levels than that estimated using the on-road monitor simulation. For example, the AERMOD receptors had an average of 35 exceedances of 200 ppb per site-year while the simulated on-road monitors had an average of 2 exceedances per year. The maximum number of exceedances per site-year was 530 for the AERMOD modeled data and 59 for the simulated on-road monitor data.

The apparent contradiction between the similarity of the hourly concentration distributions and the large differences in the exceedance distributions can be explained by the fact that 200 ppb is the 99.605th percentile of the AERMOD hourly concentrations and is the 99.974th percentile of the simulated on-road monitor concentrations. Thus on average, 0.395 % of hourly AERMOD values exceed 200 ppb per year and 0.026 % of hourly simulated on-road monitored values exceed 200 ppb per year. These differences could be due to the greater number of receptors modeled by AERMOD (n=979) compared with the on-road monitor simulation (n=5). Again, the AERMOD generated data could include locations greatly influenced by roadway emissions that are not captured by the simplified approach conducted in the Air Quality Characterization.

Table B-30. Summary statistics of on-road hourly NO_2 concentrations (ppb) and the numbers of potential health effect benchmark levels using AERMOD and the on-road ambient monitor simulation approaches in Philadelphia.

	1-hour NO_2 concentrations		Exceedances of 150 ppb		Exceedances of 200 ppb		Exceedances of 250 ppb	
Statistic	AERMOD	Monitor Simulation	AERMOD	Monitor Simulation	AERMOD	Monitor Simulation	AERMOD	Monitor Simulation
N	8,576,040	4,183,900	979	500	979	500	979	500
Mean	36.2	35.4	113	18	35	2	12	0.6
Stdev	32.1	24.9	142	47	61	8	30	1.6
Variance	1,030	620	20,171	2,187	3,751	61	900	2.6
p0	12	0	0	0	0	0	0	0
p5	12	5	2	0	0	0	0	0
p10	12	9	8	0	0	0	0	0
p15	13	11	13	0	1	0	0	0
p20	14	14	21	0	2	0	0	0
p25	15	16	27	1	3	0	0	0
p30	17	19	32	1	4	0	0	0
p35	18	22	39	1	6	0	1	0
p40	20	25	45	1	8	0	1	0
p45	22	27	56	1	10	0	2	0
p50	25	30	65	1	13	0	2	0
p55	28	34	73	1	15	0	3	0
p60	31	38	86	2	20	1	4	0
p65	35	41	106	3	24	1	5	0
p70	40	45	122	6	31	1	7	0
p75	45	49	143	8	39	1	10	1
p80	52	54	176	15	56	1	15	1
p85	61	60	216	24	72	1	21	1
p90	75	68	267	63	95	4	31	1
p95	98	81	390	92	148	11	58	1
p100	707	681	1,072	278	530	59	299	11

B-3.6.4 Annual Average Exposure Concentrations (as is)

The hourly NO_2 concentrations output from AERMOD were input into the exposure model, providing a range of estimated exposures output by APEX. Figure B-15 illustrates the annual average exposure concentrations for the entire simulated population (both asthmatics and healthy individual of all ages), for each of the years analyzed and where indoor sources were modeled. While years 2001 and 2002 contained very similar population exposure concentration distributions, the modeled year 2003 contained about 20% lower annual average concentrations. The lower exposure concentrations for year 2003 are similar to what was observed for the predicted air quality (Figure B-12), however, all persons were estimated to contain exposures below an annual average concentration of 53 ppb, even considering indoor source concentration contributions. Again, while Figure B-15 summarizes the entire population, the data are representative of what would be observed for the population of asthmatics or asthmatic children.

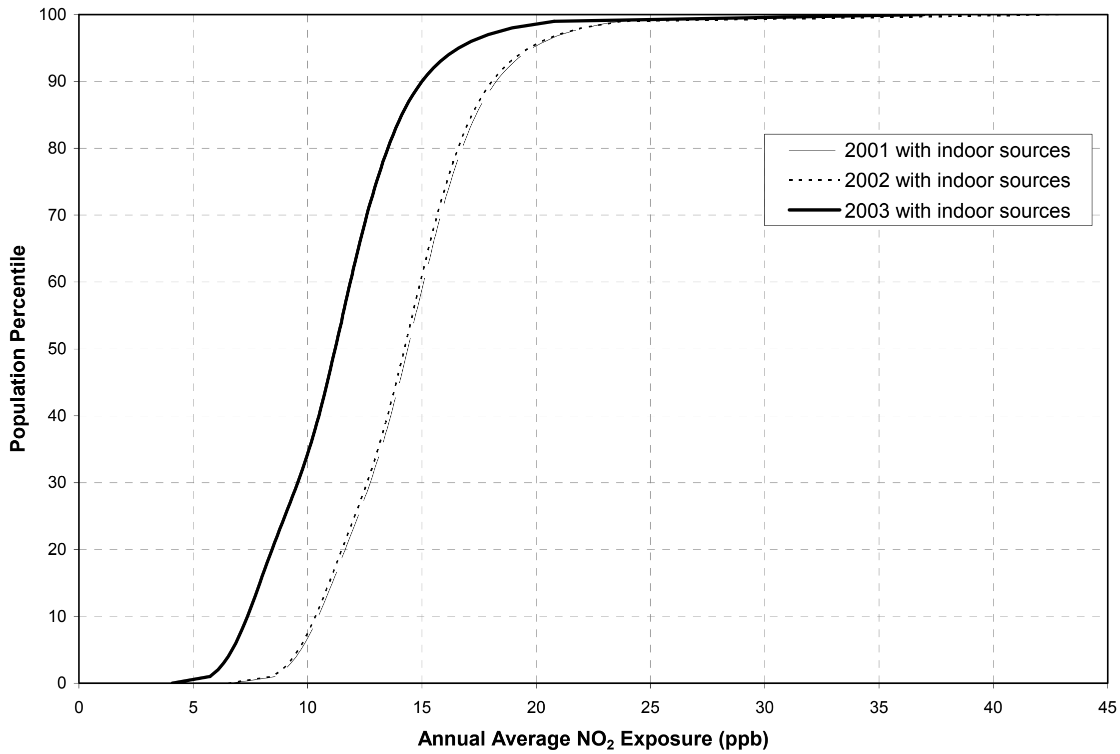

Figure B-15. Estimated annual average total NO_2 exposure concentrations for all simulated persons in Philadelphia County, using modeled 2001-2003 air quality (as is), with modeled indoor sources.

The AERMOD predicted air quality and the estimated exposures for year 2002 were compared using their respective annual average NO_2 concentrations (Figure B-16). As a point of reference, the annual average concentration for 2002 ambient monitors ranged from 24 ppb to 29 ppb. Many of the AERMOD predicted annual average concentrations were below that of the lowest ambient monitoring concentration of 24 ppb, although a few of the receptors contained concentrations above the highest measured annual average concentration. Estimated exposure concentrations were below that of both the modeled and measured air quality. For example, exposure concentrations were about 5 ppb less than the modeled air quality when the exposure estimation included indoor sources, and about 10 ppb less for when exposures were estimated without indoor sources. In comparing the estimated exposures with and without indoor sources, indoor sources were estimated to contribute between 1 and 5 ppb to the total annual average exposures.

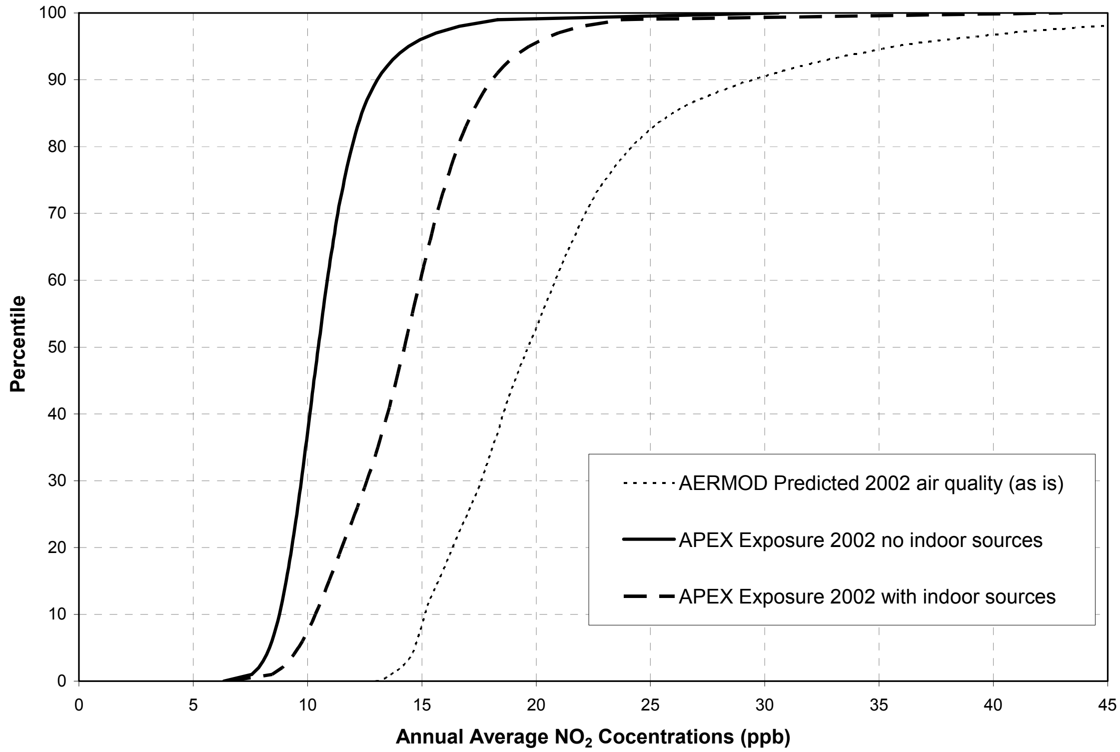

Figure B-16. Comparison of AERMOD predicted and ambient monitoring annual average NO_2 concentrations (as is) and APEX exposure concentrations (with and without modeled indoor sources) in Philadelphia County for year 2002.

B-3.6.5 One-Hour Exposures (as is)

Since there is interest in short-term exposures, a few analyses were performed using the APEX estimated exposure concentrations. As part of the standard analysis, APEX reports the maximum exposure concentration for each simulated individual in the simulated population. This can provide insight into the proportion of the population experiencing any NO_2 exposure concentration level of interest. In addition, exposures are estimated for each of the selected potential health effect benchmark levels (200, 250, and 300 ppb, 1-hour average). An exceedance was recorded when the maximum exposure concentration observed for the individual was above the selected level in a day (therefore, the maximum number of exceedances is 365 for a single person). Estimates of repeated exposures are also recorded, that is where 1-hour exposure concentrations were above a selected level in a day added together across multiple days (therefore, the maximum number of multiple exceedances is also 365). Persons of interest in this exposure analysis are those with particular susceptibility to NO_2 exposure, namely individuals with asthma. The health effect benchmark levels are appropriate for estimating the potential risk of adverse health effects for asthmatics. The majority of the results presented in this section are for the simulated asthmatic population. However, the exposure analysis was performed for the total population to assess numbers of persons exposed to these levels and to provide additional information relevant to the asthmatic population (such as time spent in particular microenvironments).

B-3.6.5.1 Maximum Estimated Exposure Concentrations

A greater variability was observed in maximum exposure concentrations for the 2003 year simulation compared with years 2001 and 2002 (Figure B-17). While annual average exposure concentrations for the total population were the lowest of the 3-year simulation, year 2003 contained a greater number of individual maximum exposures at and above the lowest potential health effect benchmark level. When indoor sources are not modeled however, over 90% of the simulated persons do not have an occurrence of a 1-hour exposure above 200 ppb in a year.

B-3.6.5.2 Number of Estimated Exposures above Selected Levels

When considering the total asthmatic population simulated in Philadelphia County and using current air quality of 2001-2003, nearly 50,000 persons were estimated to be exposed at least one time to a one-hour concentration of 200 ppb in a year (Figure B-18). These exposures include both the NO_2 of ambient origin and that contributed by indoor sources. The number of asthmatics exposed to greater concentrations (e.g., 250 or 300 ppb) drops dramatically and is estimated to be somewhere between 1,000 – 15,000 depending on the 1-hour concentration level and the year of air quality data used. Exposures simulated for year 2003 contained the greatest number of asthmatics exposed in a year consistently for all potential health effect benchmark levels, while year 2002 contained the lowest number of asthmatics. Similar trends across the benchmark levels and the simulation years were observed for asthmatic children, albeit with lower numbers of asthmatic children with exposures at or above the potential health effect benchmark levels.

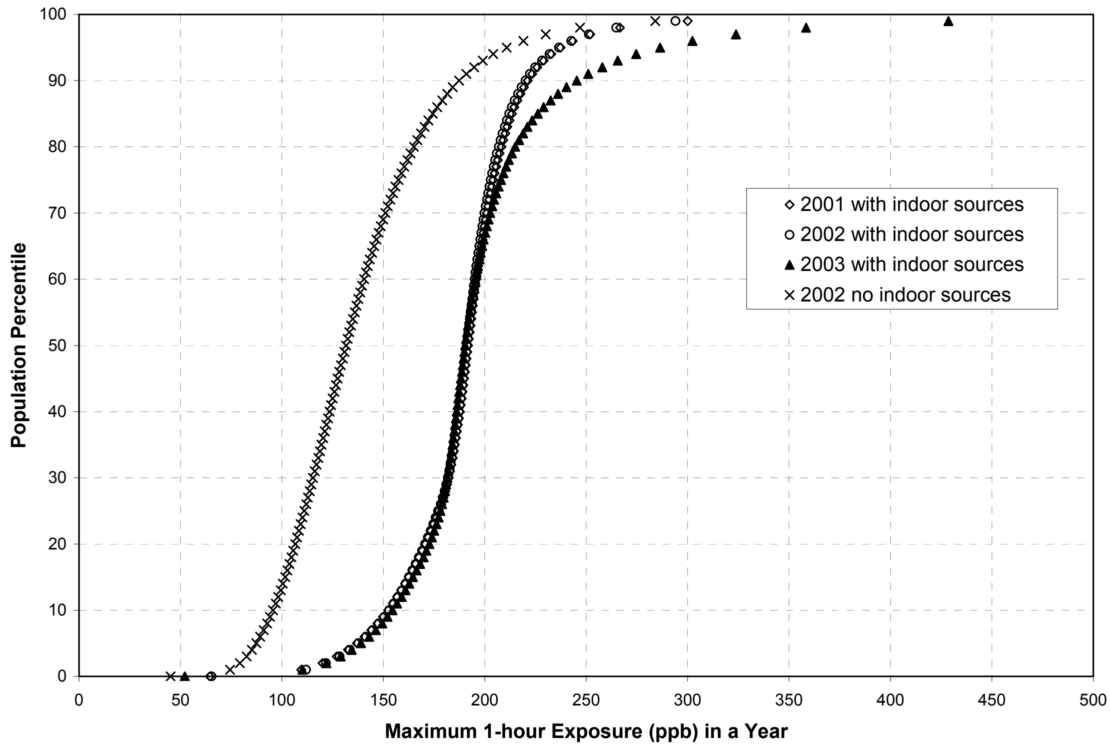

Figure B-17. Estimated maximum NO_2 exposure concentration for all simulated persons in Philadelphia County, using modeled 2001-2003 air quality (as is), with and without modeled indoor sources. Values above the 99th percentile are not shown.

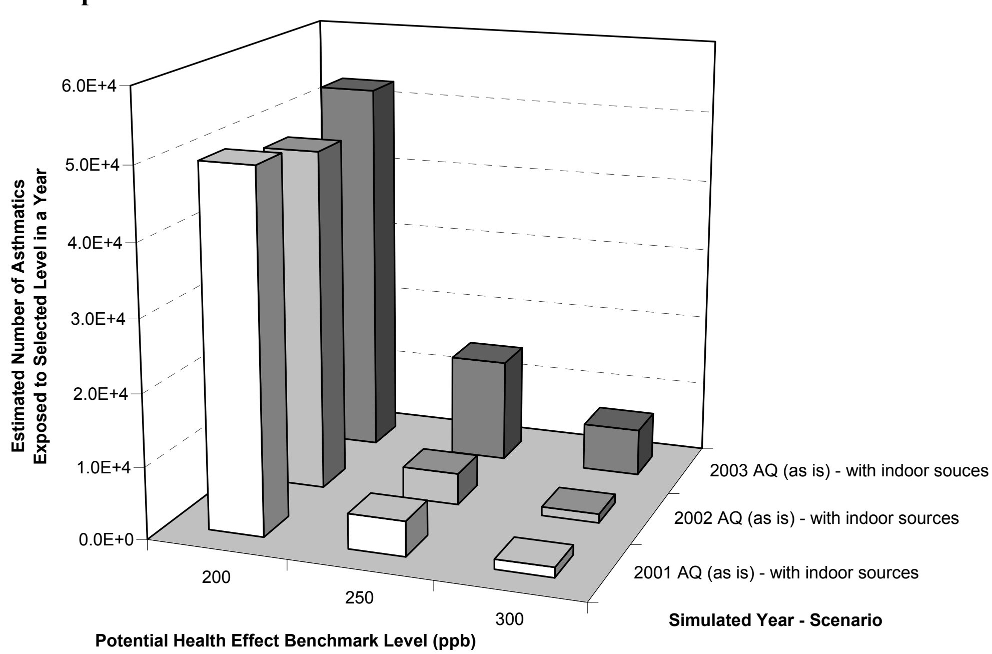

Figure B-18. Estimated number of all simulated asthmatics in Philadelphia County with at least one NO_2 exposure at or above the potential health effect benchmark levels, using modeled 2001-2003 air quality (as is), with modeled indoor sources.

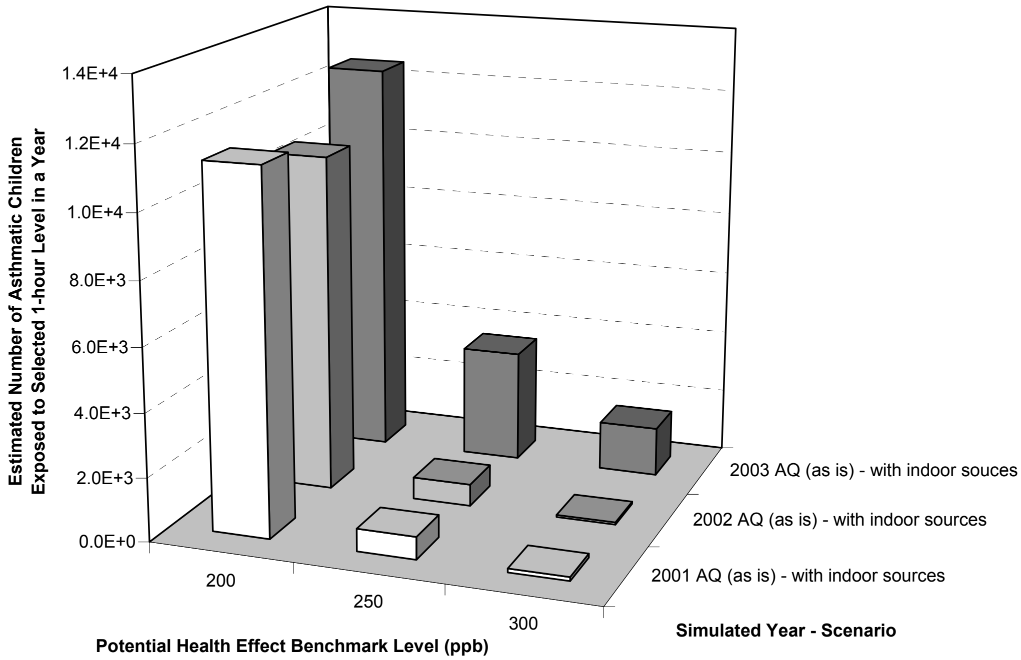

Figure B-19. Estimated number of simulated asthmatic children in Philadelphia County with at least one NO_2 exposure at or above the potential health effect benchmark levels, using modeled 2001-2003 air quality (as is), with modeled indoor sources.

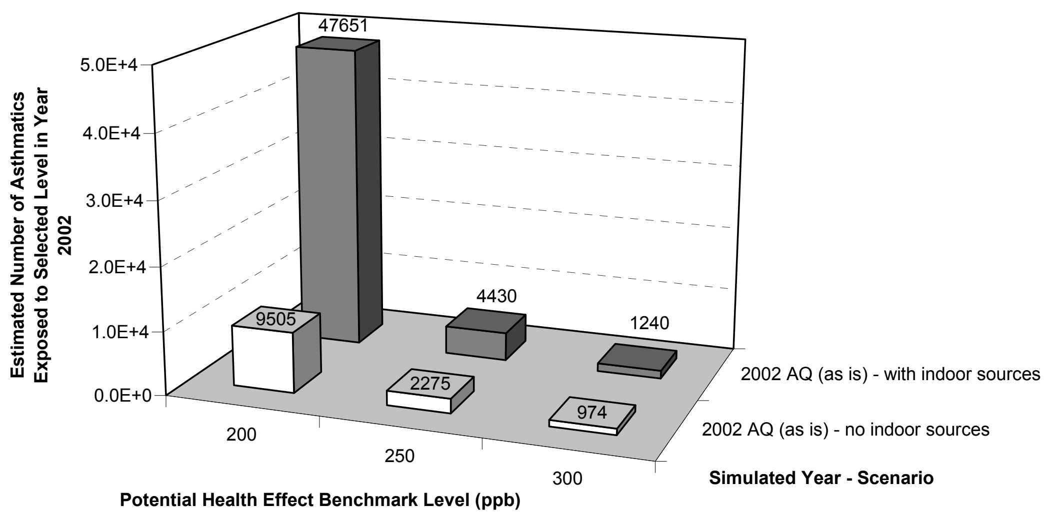

Figure B-20. Comparison of the estimated number of all simulated asthmatics in Philadelphia County with at least one NO_2 exposure at or above potential health effect benchmark levels, using modeled 2002 air quality (as is) , with and without modeled indoor sources.

For example, nearly 12,000 were estimated to be exposed to at least a one-hour NO_2 concentration of 200 ppb in a year (Figure B-19). Additional exposure estimates were generated using the modeled 2002 air quality (as is) and where the contribution from indoor sources was not included in the exposure concentrations. APEX allows for the same persons to be simulated, i.e., demographics of the population were conserved, as well as using the same individual time-location-activity profiles generated for each person. Figure B-20 compares the estimated number of asthmatics experiencing exposures above the potential health effect benchmarks, both with indoor sources and without indoor sources included in the model runs. The number of asthmatics at or above the selected concentrations is reduced by between 50-80%, depending on benchmark level, when not including indoor source (i.e., gas cooking) concentration contributions.

An evaluation of the time spent in the 12 microenvironments was performed to estimate where simulated individuals are exposed to concentrations above the potential health effect benchmark levels. Currently, the output generated by APEX is limited to compiling the microenvironmental time for the total population (includes both asthmatic individuals and healthy persons) and is summarized to the total time spent above the selected potential health effect benchmark levels. As mentioned above, the data still provide a reasonable approximation for each of the population subgroups (e.g., asthmatics or asthmatic children) since their microenvironmental concentrations and activities are not estimated any differently from those of the total population by APEX.

As an example, Figure B-21 (a, b, c) summarizes the percent of total time spent in each microenvironment for simulation year 2002 that was associated with estimated exposure concentrations at or above 200, 250, and 300 ppb (results for years 2001 and 2003 were similar). Estimated exposures included the contribution from one major category of indoor sources (i.e., gas cooking). The time spent in the indoor residence and bars/restaurants were the most important for concentrations ≥200 ppb, contributing to approximately 75% of the time persons were exposed (Figure B-21a). This is likely a result of the indoor source concentration contribution to each individual's exposure concentrations. The importance of the particular microenvironment however changes with differing potential health effect benchmark levels. This is evident when considering the in-vehicle and outdoor near-road microenvironments, progressing from about 19% of the time exposures were at the lowest potential health effect benchmark level (200 ppb) to a high of 64% of the time exposures were at the highest benchmark level (300 ppb, Figure B-21c).

The microenvironments where higher exposure concentrations occur were also evaluated for the exposure estimates generated without indoor source contributions. Figure B-22 illustrates that the time spent in the indoor microenvironments contributes little to the estimated exposures above the selected benchmark levels. The contribution of these microenvironments varied only slightly with increasing benchmark concentration, ranging from about 2-5%. Most of the time associated with high exposures was associated with the transportation microenvironments (In-Vehicle or In-Public Transport) or outdoors (Out-Near Road, Out-Parking Lot, Out-Other). The importance of time spent outdoors near roadways exhibited the greatest change in contribution with increased health benchmark level, increasing from around 30 to 44% of time associated with concentrations of 200 and 300 ppb, respectively. While more persons are likely to spend time inside a vehicle than outdoors near roads, there is attenuation of the on-road concentration that penetrates the in-vehicle microenvironment, leading to lowered concentrations, occurring less frequently above 300 ppb than outdoors near roads.

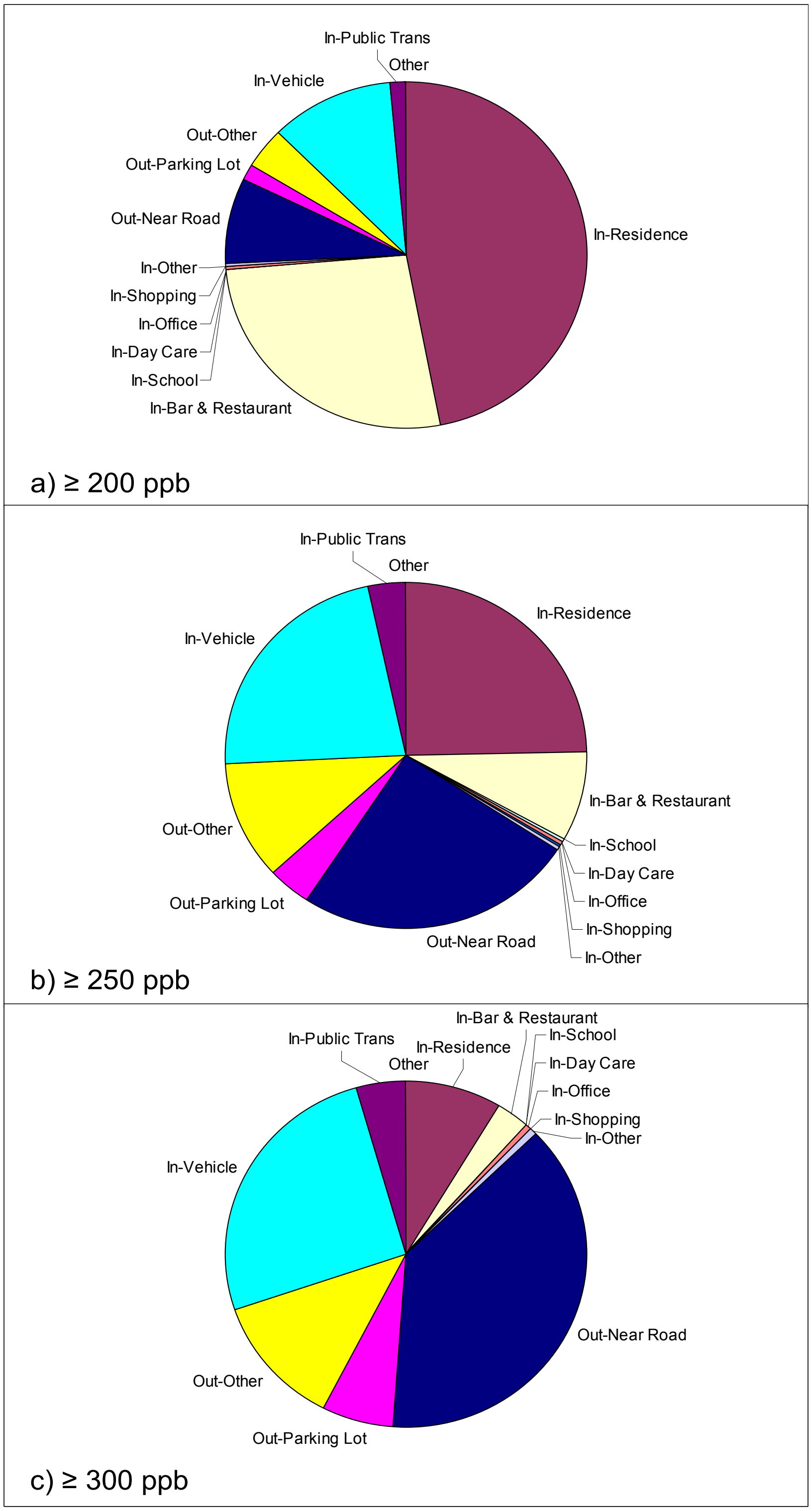

Figure B-21. Fraction of time all simulated persons in Philadelphia County spend in the twelve microenvironments associated with the potential NO_2 health effect benchmark levels, a) ≥ 200 ppb, b) ≥ 250 ppb, and c) ≥ 300 ppb, year 2002 simulation with indoor sources.

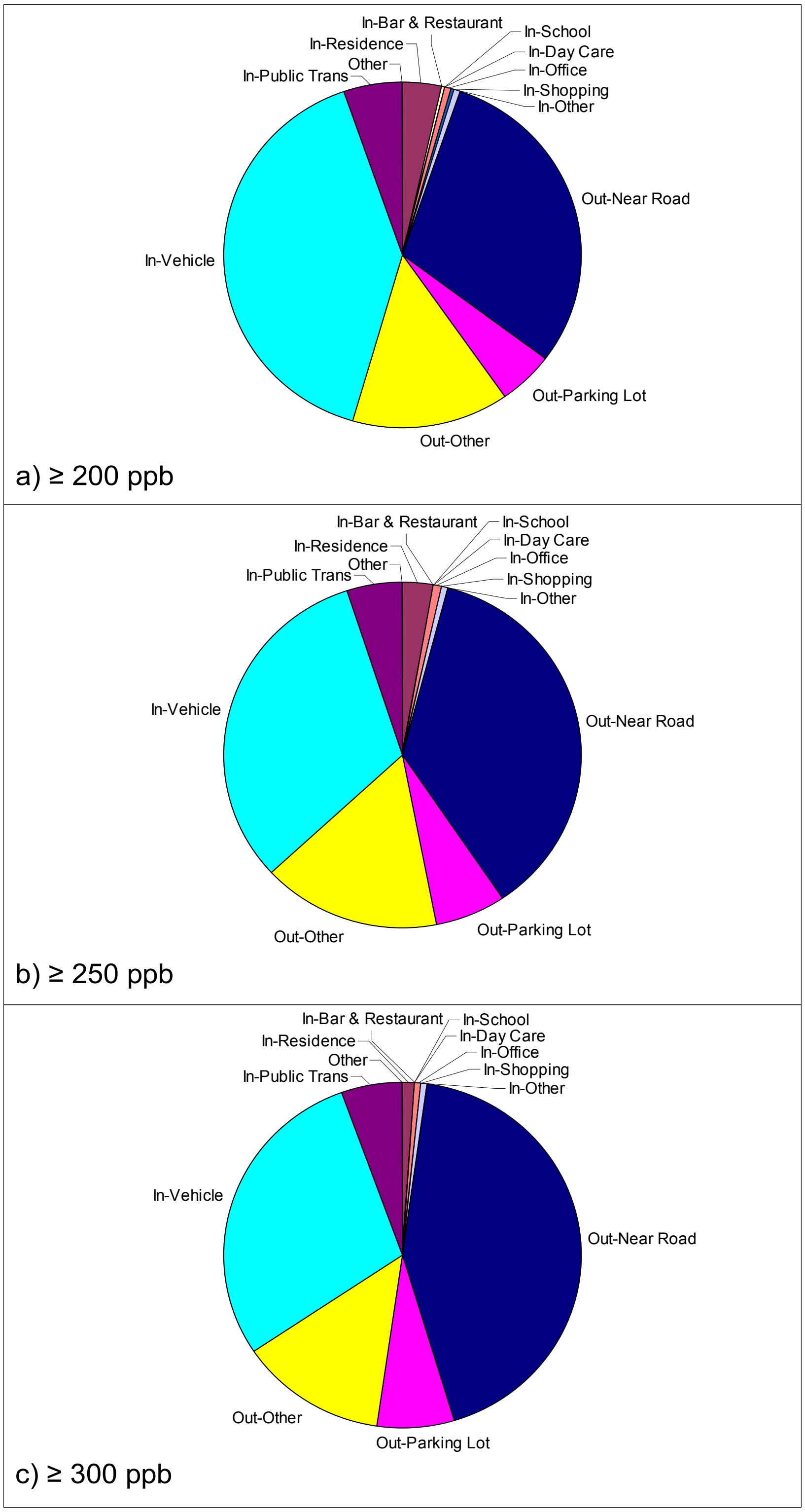

Figure B-22. Fraction of time all simulated persons in Philadelphia County spend in the twelve microenvironments associated with the potential NO_2 health effect benchmark levels, a) ≥ 200 ppb, b) ≥ 250 ppb, and c) ≥ 300 ppb, year 2002 simulation without indoor sources.

B-3.6.5.3 Number of Repeated Exposures Above Selected Levels

In the analysis of persons exposed, the results show the number or percent of those with at least one exposure at or above the selected potential health effect benchmark level. Given that the benchmark is for a small averaging time (i.e., one-hour) it may be possible that individuals are exposed to concentrations at or above the potential health effect benchmark levels more than once in a given year. Since APEX simulates the longitudinal diary profile for each individual, the number of times above a selected level is retained for each person. Figure B-23 presents such an analysis for the year 2003, the year containing the greatest number of exposure concentrations at or above the selected benchmarks. Estimated exposures include both those resulting from exposures to NO_2 of ambient origin and those resulting from indoor source NO_2 contributions. While a large fraction of individuals experience at least one exposure to 200 ppb or greater over a 1-hour time period in a year (about 32 percent), only around 14 percent were estimated to contain at least 2 exposures. Multiple exposures at or above the selected benchmarks greater than or equal to 3 or more times per year are even less frequent, with around 5 percent or less of asthmatics exposed to 1-hour concentrations greater than or equal to 200 ppb 3 or more times in a year.

Exposure estimates for year 2002 are presented to provide an additional perspective, including a lower bound of repeated exposures for this population subgroup and for exposure estimates generated with and without modeled indoor sources (Figure B-24). Most asthmatics exposed to a 200 ppb concentration are exposed once per year and only around 11 percent would experience 2 or more exposures at or above 200 ppb when including indoor source contributions. The percent of asthmatics experiencing multiple exposures a and abovet 250 and 300 ppb is much lower, typically less than 1 percent of all asthmatics are exposed at the higher potential benchmark levels. Also provided in Figure B-24 are the percent of asthmatics exposed to selected levels in the absence of indoor sources. Again, without the indoor source contribution, there are reduced occurrences of multiple exposures at all of the potential health effect benchmark levels compared with when indoor sources were modeled.

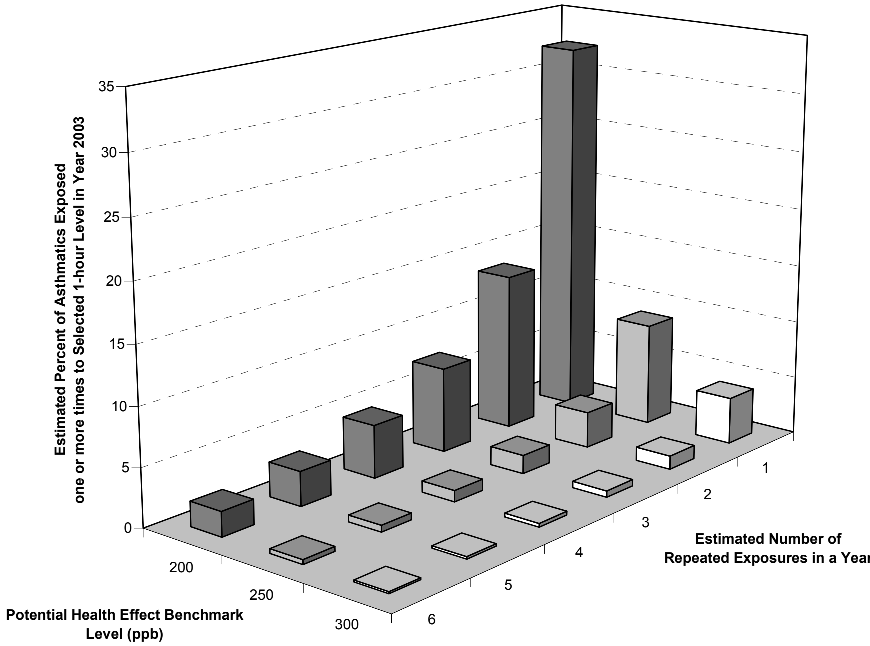

Figure B-23. Estimated percent of all asthmatics in Philadelphia County with repeated NO_2 exposures above potential health effect benchmark levels, using 2003 modeled air quality (as is), with modeled indoor sources.

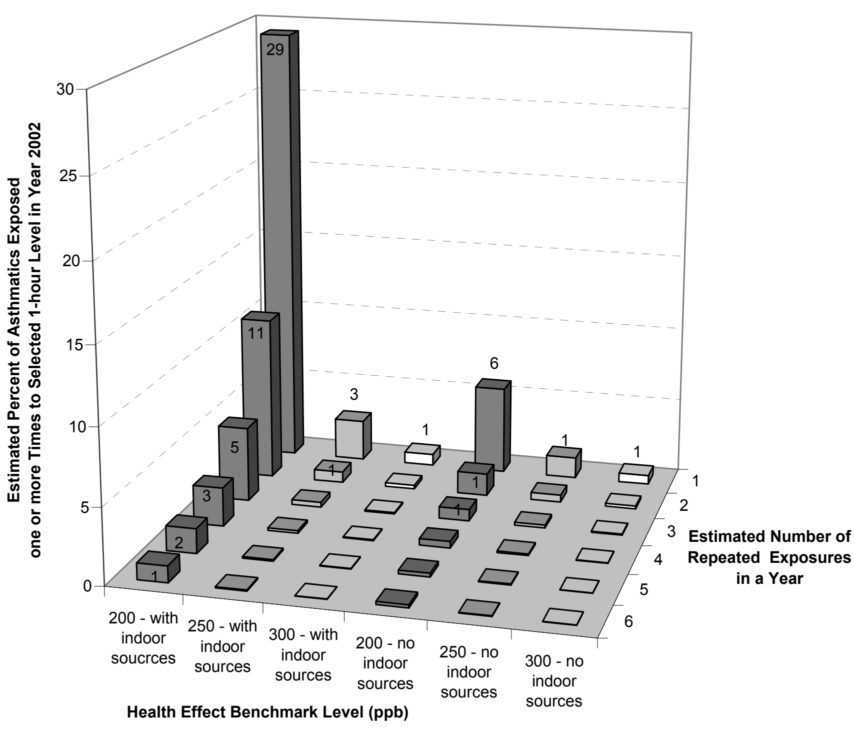

Figure B-24. Estimated percent of all asthmatics in Philadelphia County with repeated NO_2 exposures above potential health effect benchmark levels, using modeled 2002 air quality (as is), with and without indoor sources.

B-3.6.6 One-Hour Exposures Associated with Just Meeting the Current Standard

To simulate just meeting the current NO_2 standard, the potential health effect benchmark level was adjusted in the exposure model, rather than adjusting all of the hourly concentrations for each receptor and year simulated. Similar estimates of short-term exposures (i.e., 1-hour) were generated for the total population and population subgroups of interest (i.e., asthmatics and asthmatic children).

B-3.6.6.1 Number of Estimated Exposures above Selected Levels

In considering exposures estimated to occur associated with air quality simulated to just meet the current annual average NO_2 standard, the number of persons experiencing concentrations at or above the potential health effect benchmarks increased. To allow for reasonable comparison, the number of persons affected considering each scenario is expressed as the percent of the subpopulation of interest. Figure B-25 illustrates the percent of asthmatics estimated to experience at least one exposure at or above the selected potential health effect benchmark concentrations, with just meeting the current standard and including indoor source contributions. While it was estimated that about 30% percent of asthmatics would be exposed to 200 ppb (1-hour average) at least once in a year for as is air quality, it was estimated that around 80 percent of asthmatics would experience at least one concentration above the lowest potential health effect benchmark level in a year representing just meeting the current standard. Again, estimates for asthmatic children exhibited a similar trend, with between 75 to 80 percent exposed to a concentration at or above the lowest potential health effect benchmark level at least once per year for a year just meeting the current standard (data not shown). The percent of all asthmatics experiencing the higher benchmark levels is reduced to between 31 and 45 percent for the 250 ppb, 1-hour benchmark, and between 10 and 24 percent for the 300 ppb, 1-hour benchmark level associated with air quality representing just meeting the current annual average standard.

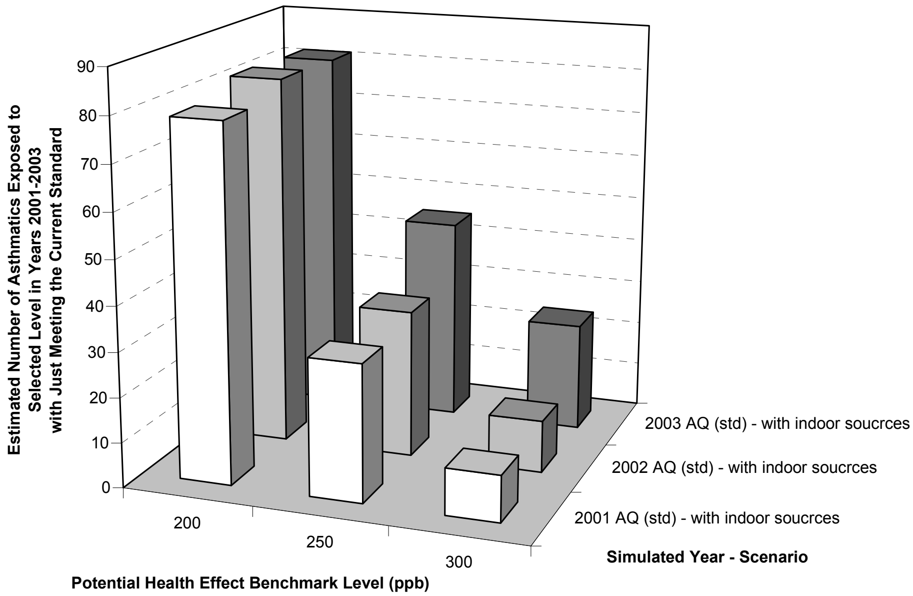

Figure B-25. Estimated percent of all asthmatics in Philadelphia with at least one exposure at or above the potential health effect benchmark level, using modeled 2001-2003 air quality just meeting the current standard, with modeled indoor sources.

In evaluating the influence of indoor source contribution for the scenario just meeting the current standard, the numbers of individuals exposed at selected levels are reduced without indoor sources, ranging from about 26 percent lower for the 200 ppb level to around 11 percent for the 300 ppb level when compared with exposure estimates that accounted for indoor sources (Figure B-26).

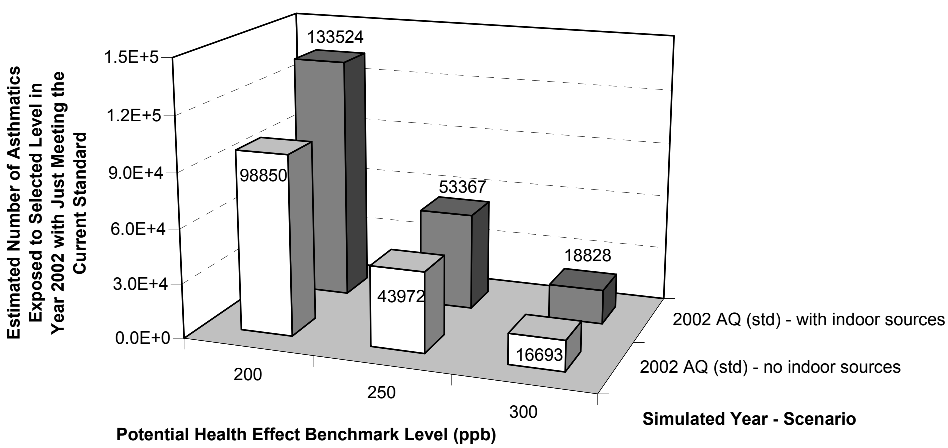

Figure B-26. Estimated number of all asthmatics in Philadelphia with at least one exposure at or above the potential health effect benchmark level, using modeled 2002 air quality just meeting the current standard, with and without modeled indoor sources.

B-3.6.6.2 Number of Repeated Exposures Above Selected Levels

For air quality simulated to just meet the current standard, repeated exposures at the selected potential health effect benchmarks are more frequent than that estimated for the modeled as is air quality. Figure B-27 illustrates this using the simulated asthmatic population for year 2002 data as an example. Many asthmatics that are exposed at or above the selected levels are exposed more than one time. Repeated exposures above the potential health effect benchmark levels are reduced however, when not including the contribution from indoor sources. The percent of asthmatics exposed drops with increasing benchmark level, with progressively fewer persons experiencing multiple exposures for each benchmark level.

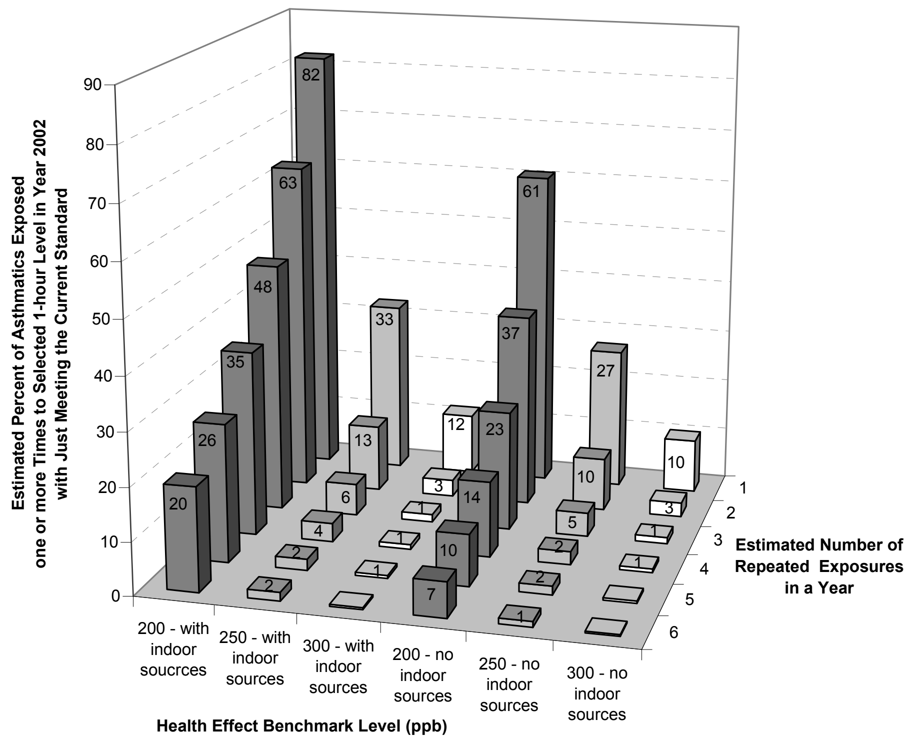

Figure B-27. Estimated percent of asthmatics in Philadelphia County with repeated exposures above health effect benchmark levels, using modeled 2002 air quality just meeting the current standard, with and without modeled indoor sources.

B-3.6.7 Additional Exposure Results

This section provides supplemental exposure and risk characterization results for two subpopulations, all asthmatics and asthmatic children. The data are presented in series of summary tables and figures across each of the scenarios investigated (i.e. with modeled air quality as is and simulating just meeting the current standard), with and without modeled indoor sources (i.e., gas stoves), for each of the potential health effect benchmark levels (i.e., 200, 250, 300 ppb 1-hour), and across three years of modeled air quality (i.e., 2001 to 2003). Repeated exposures are presented only for the lowest potential health effect benchmark level (i.e., 200 ppb 1-hour).

B-3.6.7.1 All Asthmatics

Table B-31. Estimated number of asthmatics in Philadelphia County exposed at or above potential health effect benchmark levels (1 to 6 times per year), using modeled air quality (as is) and with just meeting the current standard (std), and with and without indoor sources.

Year (AQ)	Indoor Source	Level (ppb)	Persons with Number of Repeated Exposures					
			1	2	3	4	5	6
2001 (as is)	Yes	200	49796	19544	8959	4516	2666	1732
		250	4867	1414	658	381	265	157
		300	1388	404	157	108	59	39
	No	200	10544	2577	1230	795	520	422
		250	2584	765	413	295	186	118
		300	1013	344	177	98	39	29
2001 (std)	Yes	200	128147	96119	70079	50253	35965	26167
		250	49632	18322	8523	4808	3095	2152
		300	16805	4480	1828	1219	866	638
	No	200	90211	51600	31720	19805	12899	8938
		250	40466	14362	6155	3225	2141	1414
		300	15100	3590	1595	1003	755	569
2002 (as is)	Yes	200	47652	17720	8056	4170	2662	1765
		250	4430	1173	530	274	166	127
		300	1240	393	147	88	69	49
	No	200	9505	2411	1240	706	401	323
		250	2276	778	332	185	117	88
		300	975	304	137	59	49	49
2002 (std)	Yes	200	133524	102861	77512	57152	42473	31800
		250	53367	20737	9855	5784	3489	2623
		300	18828	5220	2324	1447	925	648
	No	200	98849	60056	36913	23238	15850	10875
		250	43972	16367	7370	4066	2680	1734
		300	16693	4389	1950	1131	766	510
2003 (as is)	Yes	200	52639	22084	11950	7441	4863	3457
		250	14407	5040	2599	1577	935	650
		300	6568	1892	887	512	335	245
	No	200	26120	10007	5857	3783	2609	1842
		250	11142	3927	2040	1261	777	550
		300	5605	1627	778	462	285	206
2003 (std)	Yes	200	132640	102034	76909	58857	44719	34990
		250	73387	38505	22953	15416	11101	8499
		300	39283	16213	9280	6175	4374	3259
	No	200	109726	73489	51133	36551	27509	21181
		250	65437	33096	18948	12710	8964	6862
		300	35948	14502	8474	5654	4098	2935

Table B-32. Estimated percent of asthmatics in Philadelphia County exposed at or above potential health effect benchmark levels (1 to 6 times per year), using modeled air quality (as is) and with just meeting the current standard (std), and with and without indoor sources.

Year (AQ)	Indoor Source	Level (ppb)	Percent (%) of Persons With Repeated Exposures					
			1	2	3	4	5	6
2001 (as is)	Yes	200	31	12	6	3	2	1
		250	3	1	0	0	0	0
		300	1	0	0	0	0	0
	No	200	6	2	1	0	0	0
		250	2	0	0	0	0	0
		300	1	0	0	0	0	0
2001 (std)	Yes	200	79	59	43	31	22	16
		250	31	11	5	3	2	1
		300	10	3	1	1	1	0
	No	200	55	32	20	12	8	5
		250	25	9	4	2	1	1
		300	9	2	1	1	0	0
2002 (as is)	Yes	200	29	11	5	3	2	1
		250	3	1	0	0	0	0
		300	1	0	0	0	0	0
	No	200	6	1	1	0	0	0
		250	1	0	0	0	0	0
		300	1	0	0	0	0	0
2002 (std)	Yes	200	82	63	48	35	26	20
		250	33	13	6	4	2	2
		300	12	3	1	1	1	0
	No	200	61	37	23	14	10	7
		250	27	10	5	2	2	1
		300	10	3	1	1	0	0
2003 (as is)	Yes	200	32	14	7	5	3	2
		250	9	3	2	1	1	0
		300	4	1	1	0	0	0
	No	200	16	6	4	2	2	1
		250	7	2	1	1	0	0
		300	3	1	0	0	0	0
2003 (std)	Yes	200	81	63	47	36	27	21
		250	45	24	14	9	7	5
		300	24	10	6	4	3	2
	No	200	67	45	31	22	17	13
		250	40	20	12	8	6	4
		300	22	9	5	3	3	2

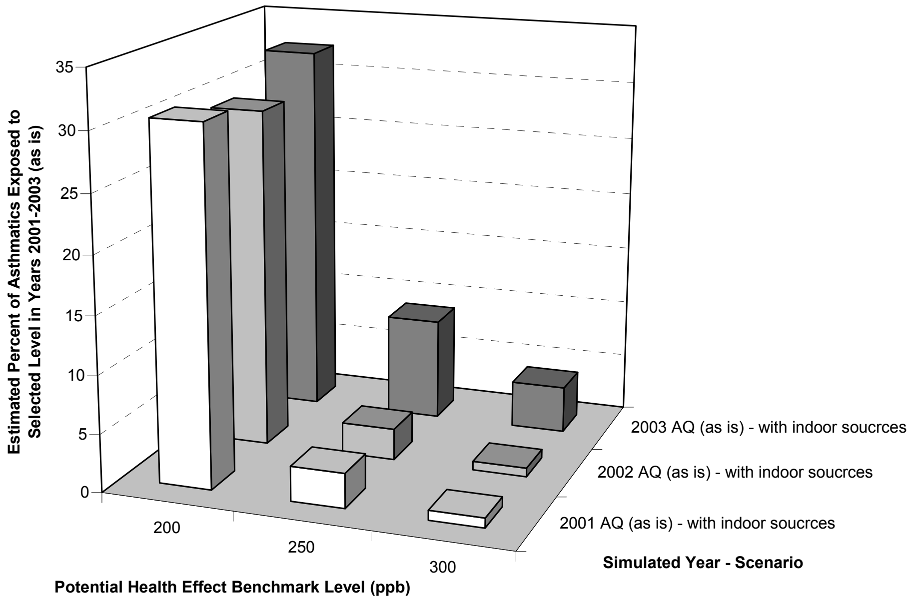

Figure B-28. Estimated percent of all asthmatics in Philadelphia County with at least one NO_2 exposure at or above potential health effect benchmark level, using 2001-2003 modeled air quality (as is), with modeled indoor sources.

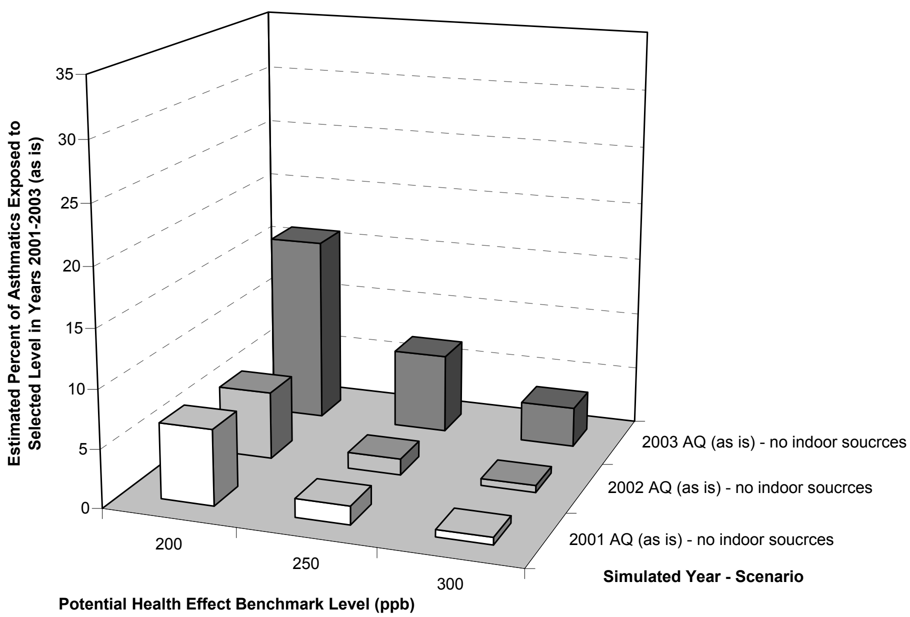

Figure B-29. Estimated percent of all asthmatics in Philadelphia County with at least one NO_2 exposure at or above potential health effect benchmark level, using 2001-2003 modeled air quality (as is), with no indoor sources.

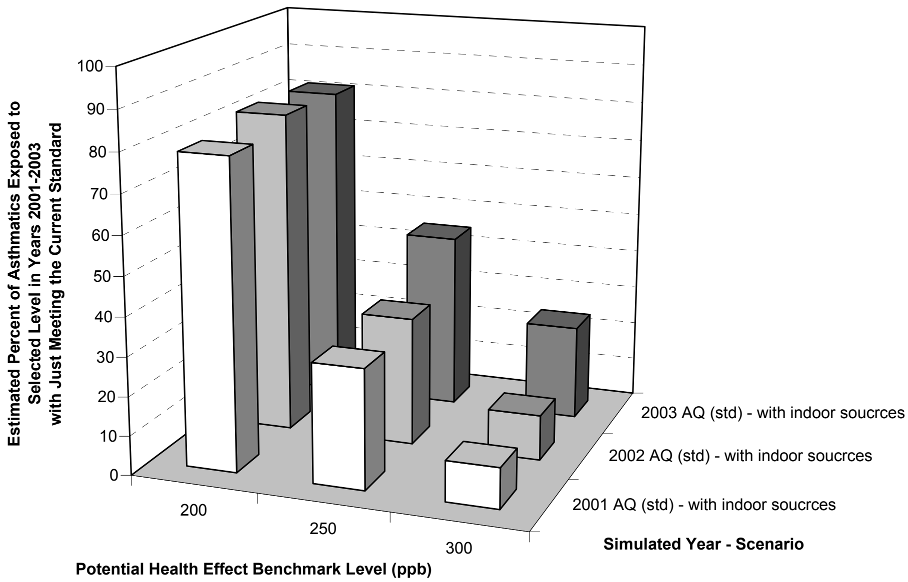

Figure B-30. Estimated percent of all asthmatics in Philadelphia County with at least one NO_2 exposure at or above potential health effect benchmark level, using 2001-2003 modeled air quality just meeting the current standard (std), with modeled indoor sources.

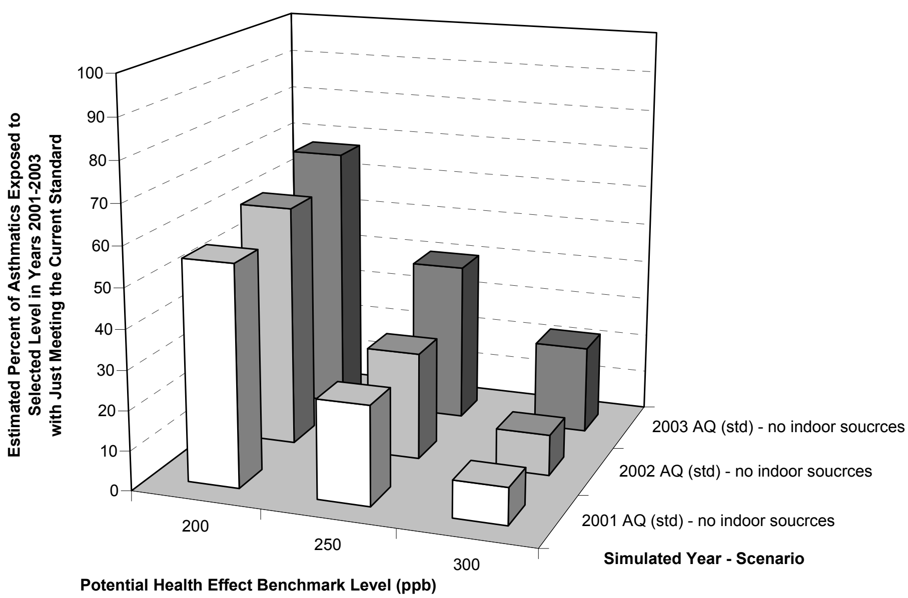

Figure B-31. Estimated percent of all asthmatics in Philadelphia County with at least one NO_2 exposure at or above potential health effect benchmark level, using 2001-2003 modeled air quality just meeting the current standard (std), with no indoor sources.

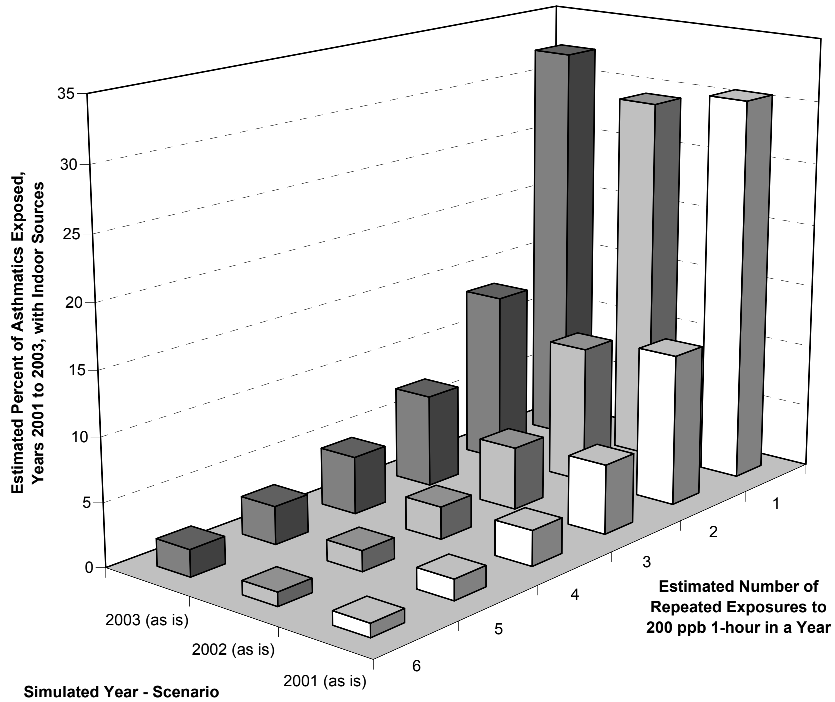

Figure B-32. Estimated percent of all asthmatics in Philadelphia County with repeated NO_2 exposures at or above 200 ppb 1-hr, using 2001-2003 modeled air quality (as is), with modeled indoor sources.

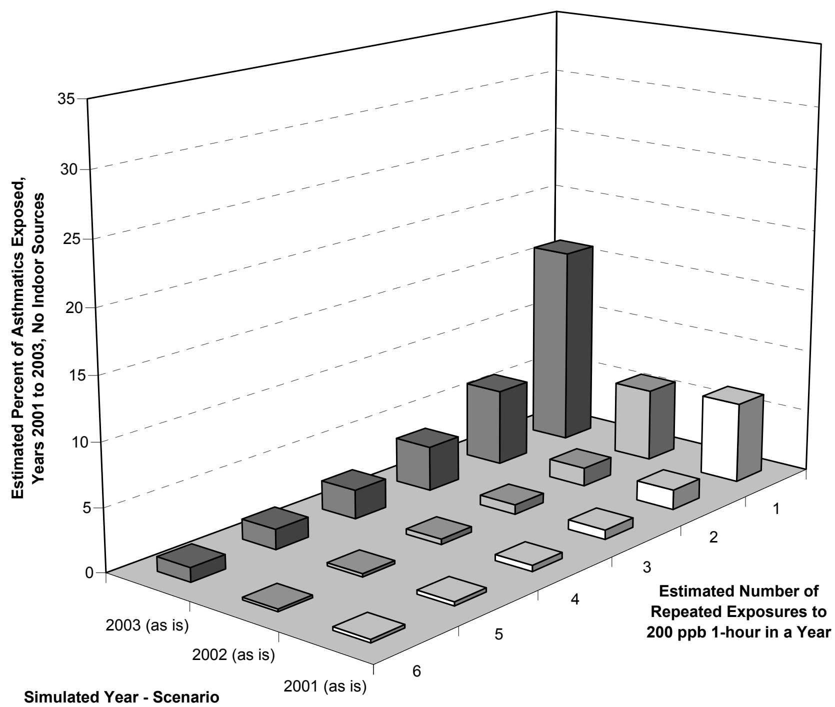

Figure B-33. Estimated percent of all asthmatics in Philadelphia County with repeated NO2 exposures at or above 200 ppb 1-hr, using 2001-2003 modeled air quality (as is), without indoor sources.

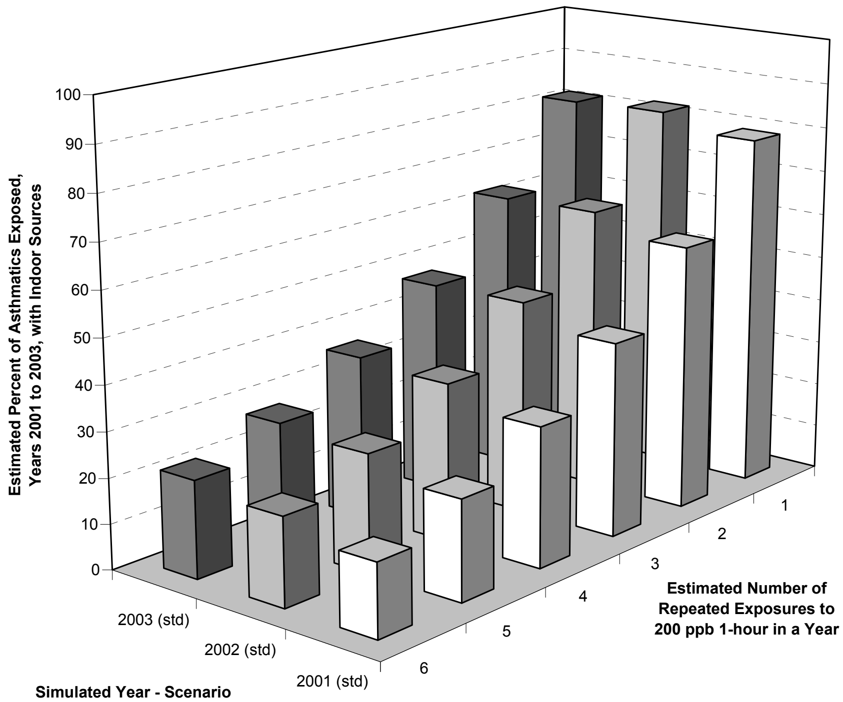

Figure B-34. Estimated percent of all asthmatics in Philadelphia County with repeated NO_2 exposures at or above 200 ppb 1-hour, using 2001-2003 modeled air quality just meeting the current standard (std), with modeled indoor sources.

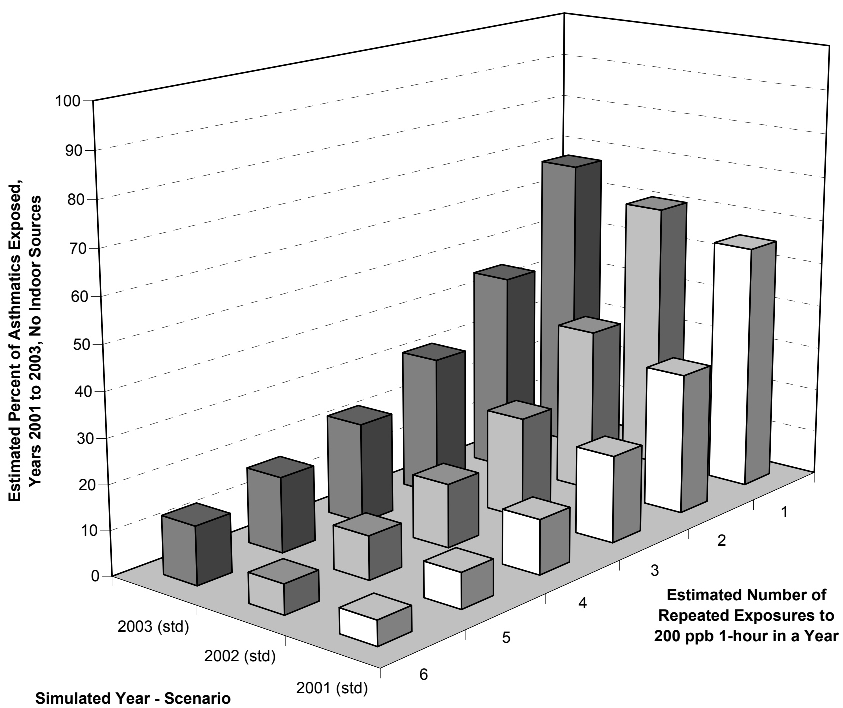

Figure B-35. Estimated percent of all asthmatics in Philadelphia County with repeated NO_2 exposures at or above 200 ppb 1-hour, using 2001-2003 modeled air quality just meeting the current standard (std), with no indoor sources.

B-3.6.7.2 Asthmatic Children

Table B-33. Estimated number of asthmatic children in Philadelphia County exposed at or above potential health effect benchmark levels (1 to 6 times per year), using modeled air quality (as is) and with just meeting the current standard (std), and with and without indoor sources.

Year (AQ)	Indoor Source	Level (ppb)	Persons With Number of Repeated Exposures					
			1	2	3	4	5	6
2001 (as is)	Yes	200	11351	3649	1418	709	424	267
		250	709	167	68	49	20	10
		300	128	49	10	10	0	0
	No	200	2329	401	147	98	58	58
		250	393	97	39	20	0	0
		300	97	29	10	10	0	0
2001 (std)	Yes	200	36656	26353	18272	12133	8271	5783
		250	13543	4530	1877	926	533	295
		300	3909	768	236	187	128	88
	No	200	27511	16067	9890	6094	3757	2430
		250	11282	3735	1413	500	333	197
		300	3440	638	187	128	109	79
2002 (as is)	Yes	200	10636	3338	1439	800	494	346
		250	692	139	49	30	0	0
		300	70	10	0	0	0	0
	No	200	1771	315	158	79	10	0
		250	158	49	20	10	0	0
		300	30	10	0	0	0	0
2002 (std)	Yes	200	38834	28678	20840	14308	10063	6996
		250	14855	4887	1978	1086	652	514
		300	4203	947	336	228	119	79
	No	200	30548	18685	11394	7063	4336	2782
		250	12487	3775	1288	738	493	365
		300	3736	670	276	158	99	39
2003 (as is)	Yes	200	12525	4693	2736	1712	1100	797
		250	3541	1240	678	423	247	178
		300	1545	423	237	138	89	39
	No	200	6724	2526	1515	984	708	492
		250	2784	1032	531	335	188	128
		300	1368	355	208	119	69	39
2003 (std)	Yes	200	37931	28305	20344	15230	11013	8483
		250	20044	9893	6016	4088	2888	2253
		300	10562	4100	2381	1643	1211	906
	No	200	32066	21662	14938	10326	7647	6018
		250	18770	8897	4974	3371	2388	1859
		300	9547	3704	2223	1496	1072	817

Table B-34. Estimated percent of asthmatic children in Philadelphia County exposed at or above potential health effect benchmark levels (1 to 6 times per year), using modeled air quality (as is) and with just meeting the current standard (std), and with and without indoor sources.

Year (AQ)	Indoor Source	Level (ppb)	Percent (%) of Persons With Repeated Exposures					
			1	2	3	4	5	6
2001 (as is)	Yes	200	23	8	3	1	1	1
		250	1	0	0	0	0	0
		300	0	0	0	0	0	0
	No	200	5	1	0	0	0	0
		250	1	0	0	0	0	0
		300	0	0	0	0	0	0
2001 (std)	Yes	200	75	54	38	25	17	12
		250	28	9	4	2	1	1
		300	8	2	0	0	0	0
	No	200	57	33	20	13	8	5
		250	23	8	3	1	1	0
		300	7	1	0	0	0	0
2002 (as is)	Yes	200	22	7	3	2	1	1
		250	1	0	0	0	0	0
		300	0	0	0	0	0	0
	No	200	4	1	0	0	0	0
		250	0	0	0	0	0	0
		300	0	0	0	0	0	0
2002 (std)	Yes	200	81	60	43	30	21	15
		250	31	10	4	2	1	1
		300	9	2	1	0	0	0
	No	200	64	39	24	15	9	6
		250	26	8	3	2	1	1
		300	8	1	1	0	0	0
2003 (as is)	Yes	200	26	10	6	4	2	2
		250	7	3	1	1	1	0
		300	3	1	0	0	0	0
	No	200	14	5	3	2	1	1
		250	6	2	1	1	0	0
		300	3	1	0	0	0	0
2003 (std)	Yes	200	79	59	43	32	23	18
		250	42	21	13	9	6	5
		300	22	9	5	3	3	2
	No	200	67	45	31	22	16	13
		250	39	19	10	7	5	4
		300	20	8	5	3	2	2

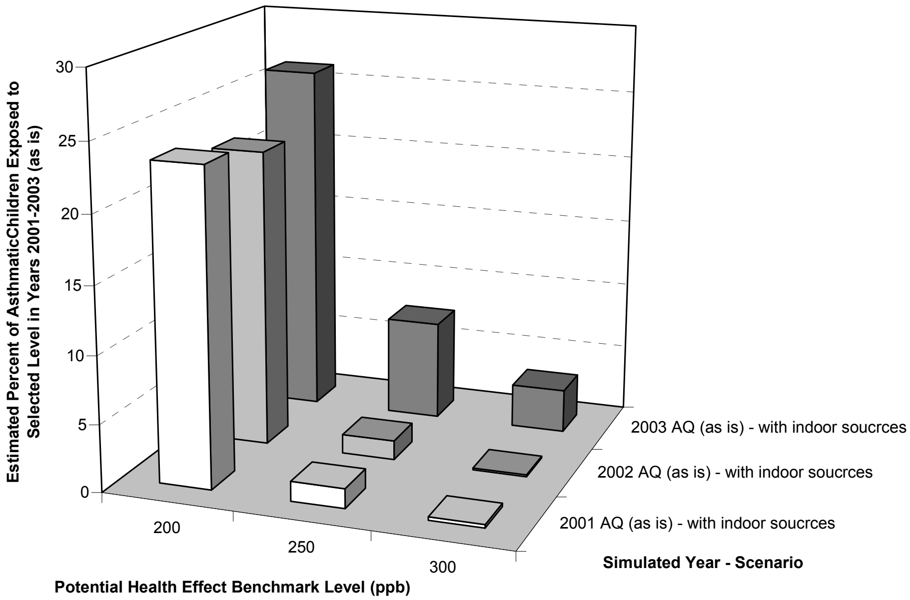

Figure B-36. Estimated percent of asthmatic children in Philadelphia County with at least one NO_2 exposure at or above potential health effect benchmark level, using 2001-2003 modeled air quality (as is), with modeled indoor sources.

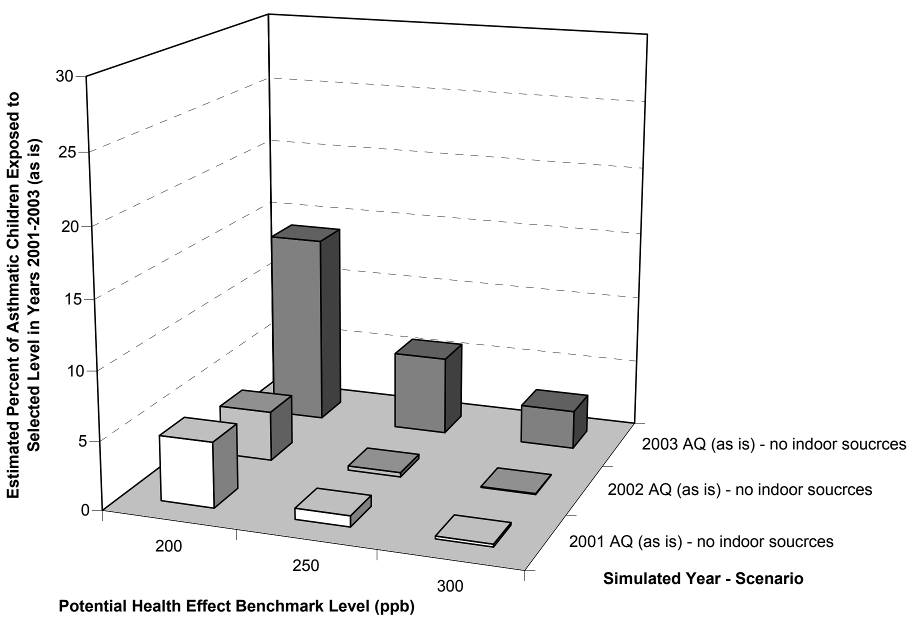

Figure B-37. Estimated percent of asthmatic children in Philadelphia County with at least one NO_2 exposure at or above potential health effect benchmark level, using 2001-2003 modeled air quality (as is), with no indoor sources.

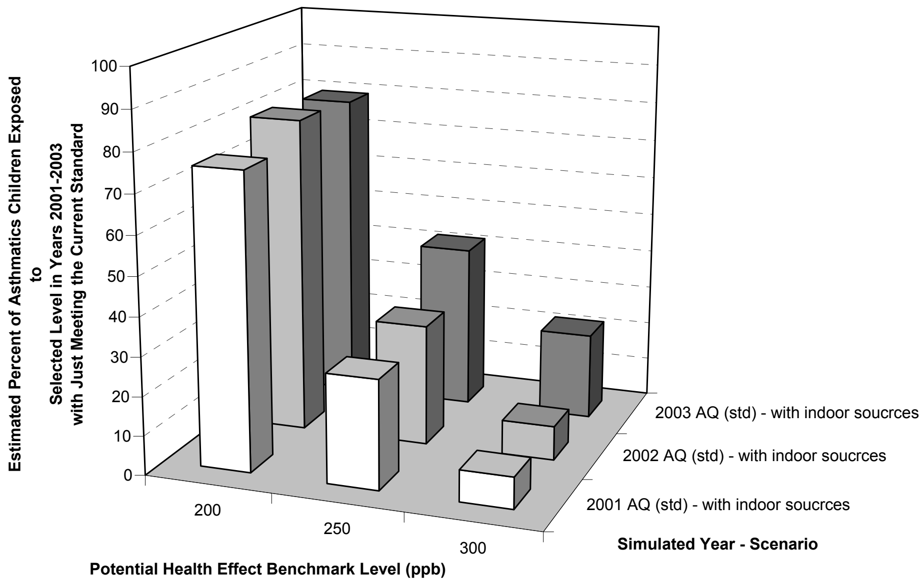

Figure B-38. Estimated percent of asthmatic children in Philadelphia County with at least one NO_2 exposure at or above potential health effect benchmark level, using 2001-2003 modeled air quality just meeting the current standard (std), with modeled indoor sources.

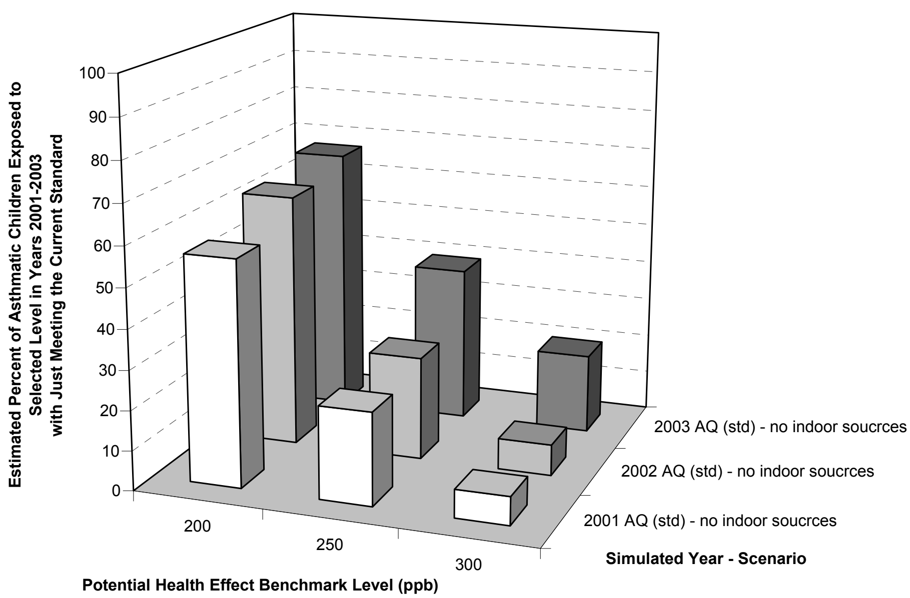

Figure B-39. Estimated percent of asthmatic children in Philadelphia County with at least one NO_2 exposure at or above potential health effect benchmark level, using 2001-2003 modeled air quality just meeting the current standard (std), with no indoor sources.

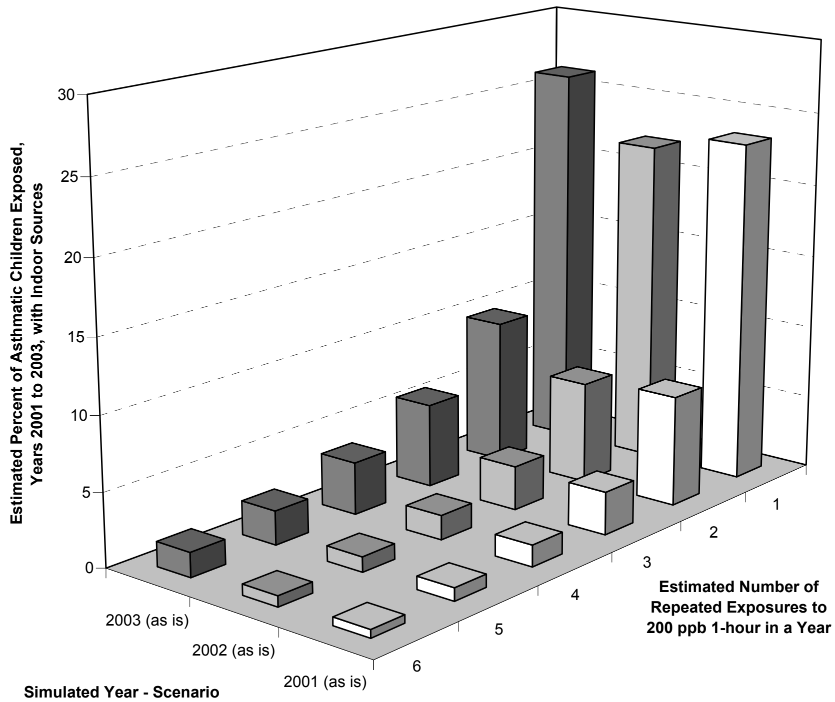

Figure B-40. Estimated percent of asthmatic children in Philadelphia County with repeated NO_2 exposures at or above 200 ppb 1-hr, using 2001-2003 modeled air quality (as is), with modeled indoor sources.

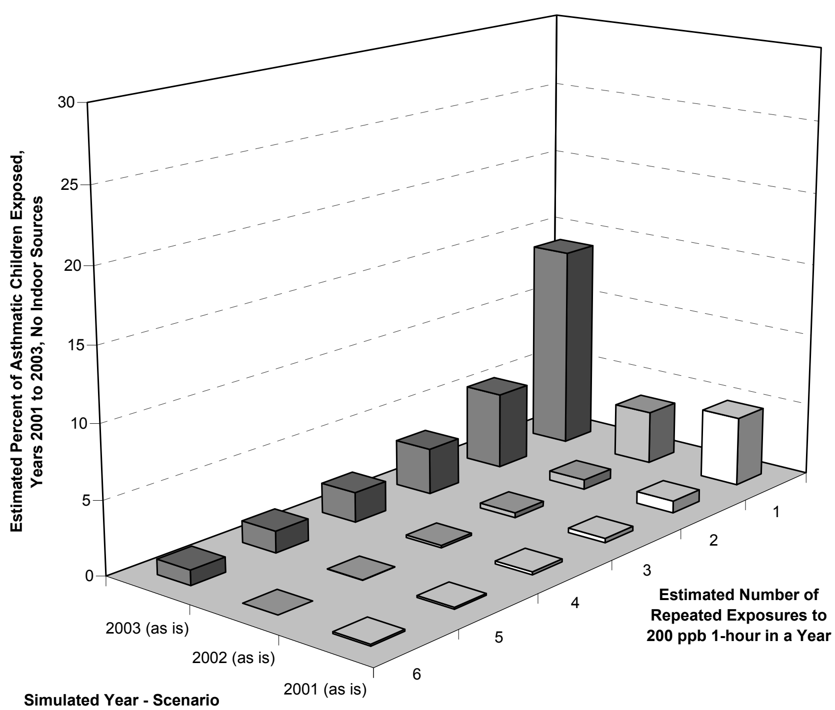

Figure B-41. Estimated percent of asthmatic children in Philadelphia County with repeated NO_2 exposures at or above 200 ppb 1-hr, using 2001-2003 modeled air quality (as is), with no indoor sources.

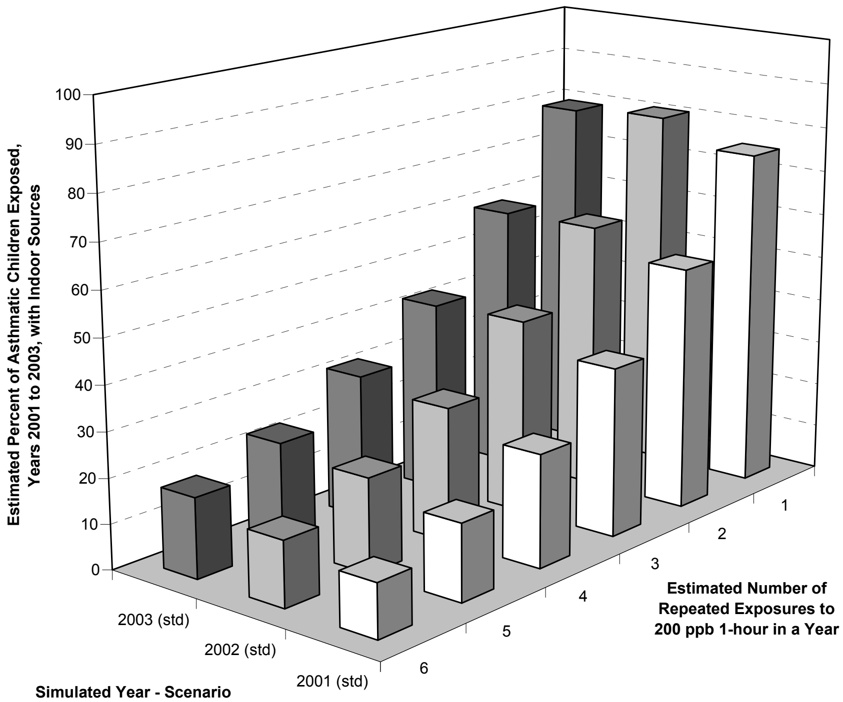

Figure B-42. Estimated percent of asthmatic children in Philadelphia County with repeated NO_2 exposures at or above 200 ppb 1-hr, using 2001-2003 modeled air quality meeting the current standard (std), with modeled indoor sources.

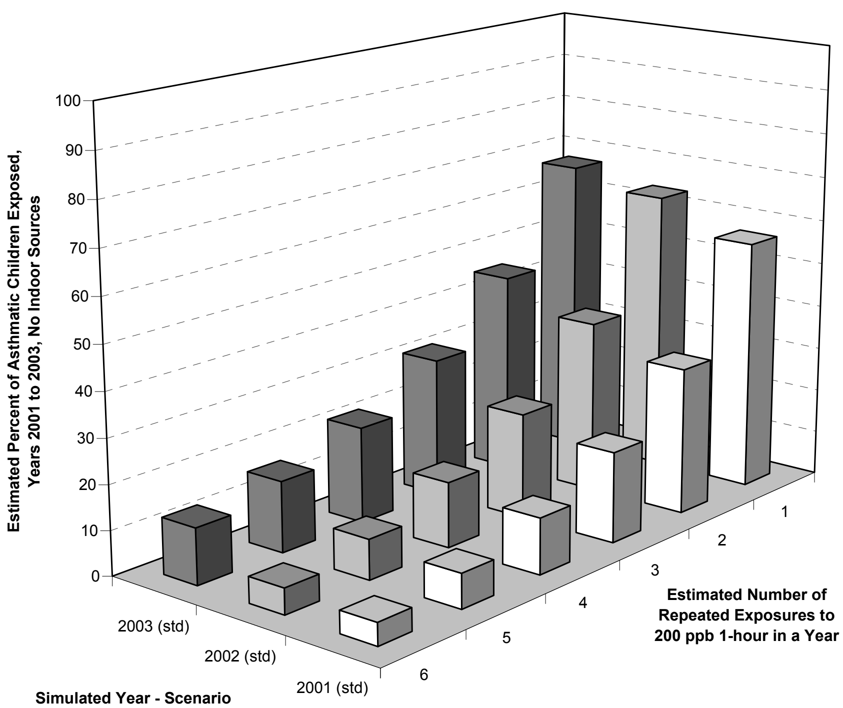

Figure B-43. Estimated percent of asthmatic children in Philadelphia County with repeated NO_2 exposures at or above 200 ppb 1-hr, using 2001-2003 modeled air quality meeting the current standard (std), with no indoor sources.

B-4 Atlanta Exposure Assessment Case-Study

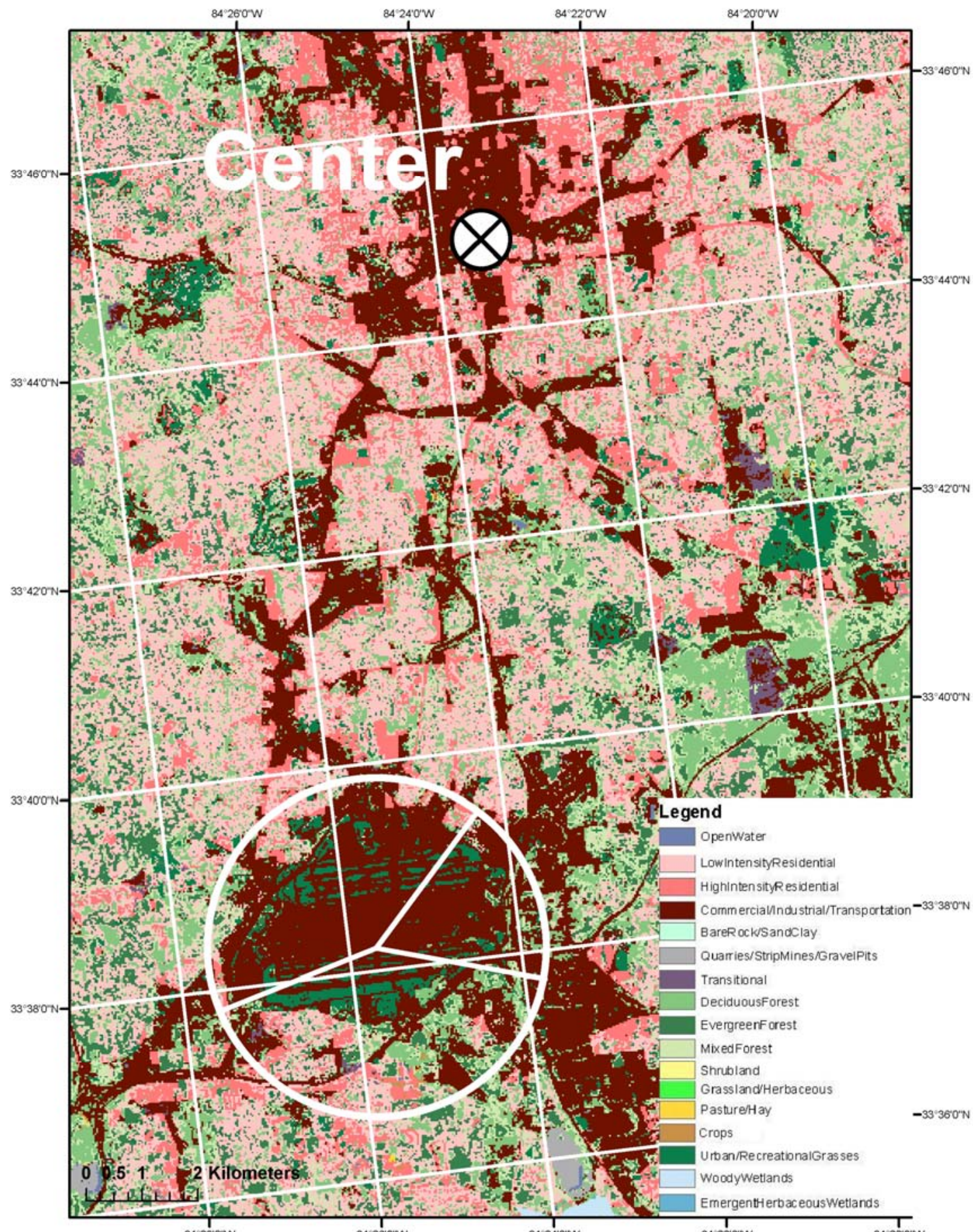

Figure B-44. Land-use and sectors around the Atlanta-area surface meteorological station (KATL). Sector borders are 43, 104, and 255 degrees from geographic North. Atlanta city center is labeled.

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Attachment 1: Technical Memorandum on Longitudinal Diary Construction Approach

ICF INTERNATIONAL

TECHNICAL MEMORANDUM

TO: Stephen Graham and John Langstaff, US EPA

FROM: Arlene Rosenbaum

DATE: February 29, 2008

SUBJECT: The Cluster-Markov algorithm in APEX

Background

The goals of population exposure assessment generally include an accurate estimate of both the average exposure concentration and the high end of the exposure distribution. One of the factors influencing the number of exposures at the high end of the concentration distribution is time-activity patterns that differ from the average, e.g., a disproportionate amount of time spent near roadways. Whether a model represents these exposure scenarios well depends on whether the treatment of activity pattern data accurately characterizes differences among individuals.

Human time-activity data for population exposure models are generally derived from demographic surveys of individuals' daily activities, the amount of time spent engaged in those activities, and the ME locations where the activities occur. Typical time-activity pattern data available for inhalation exposure modeling consist of a sequence of location/activity combinations spanning a 24-hour duration, with 1 to 3 records for any single individual. But modeling assessments of exposure to air pollutants typically require information on activity patterns over long periods of time, e.g., a full year. For example, even for pollutant health effects with short averaging times (e.g., ozone 8-hour average) it may be desirable to know the frequency of exceedances of a threshold concentration over a long period of time (e.g., the annual number of exceedances of an 8-hour average ozone concentration of 0.07 ppm for each simulated individual).

Long-term activity patterns can be estimated from daily ones by combining the daily records in various ways, and the method used for combining them will influence the variability of the long-term activity patterns across the simulated population. This in turn will influence the ability of the model to accurately represent either long-term average high-end exposures, or the number of individuals exposed multiple times to short-term high-end concentrations.

A common approach for constructing long-term activity patterns from short-term records is to re-select a daily activity pattern from the pool of data for each day, with the implicit assumption that there is no correlation between activities from day to day for the simulated individual. This approach tends to result in long-term activity patterns that are very similar across the simulated population. Thus, the resulting exposure estimates are likely to underestimate the variability across the population, and therefore, underestimate the high-end concentrations.

A contrasting approach is to select a single activity pattern (or a single pattern for each season and/or weekday-weekend) to represent a simulated individual's activities over the modeling period. This approach has the implicit assumption that an individual's day to day activities are perfectly correlated. This approach tends to result in long-term activity patterns that are very different across the simulated population, and therefore may over-estimate the variability across the population.

The Cluster-Markov Algorithm

Recently, a new algorithm has been developed and incorporated into APEX that attempts to more realistically represent the day-to-day correlation of activities for individuals. The algorithms first use cluster analysis to divide the daily activity pattern records into groups that are similar, and then select a single daily record from each group. This limited number of daily patterns is then used to construct a long-term sequence for a simulated individual, based on empirically-derived transition probabilities. This approach is intermediate between the assumption of no day-to-day correlation (i.e., re-selection for each time period) and perfect correlation (i.e., selection of a single daily record to represent all days).

The steps in the algorithm are as follows.

- For each demographic group (age, gender, employment status), temperature range, and day-of-week combination, the associated time-activity records are partitioned into 3 groups using cluster analysis. The clustering criterion is a vector of 5 values: the time spent in each of 5 microenvironment categories (indoors – residence; indoors – other building; outdoors – near road; outdoors – away from road; in vehicle).
- For each simulated individual, a single time-activity record is randomly selected from each cluster.
- Next the Markov process determines the probability of a given time-activity pattern occurring on a given day based on the time-activity pattern of the previous day and cluster-to-cluster transition probabilities. The cluster-to-cluster transition probabilities are estimated from the available multi-day time-activity records. (If insufficient multi-day time-activity records are available for a demographic group, season, day-of-week combination, then the cluster-to-cluster transition probabilities are estimated from the frequency of time-activity records in each cluster in the CHAD data base.).

Figure 1 illustrates the Cluster-Markov algorithm in flow chart format.

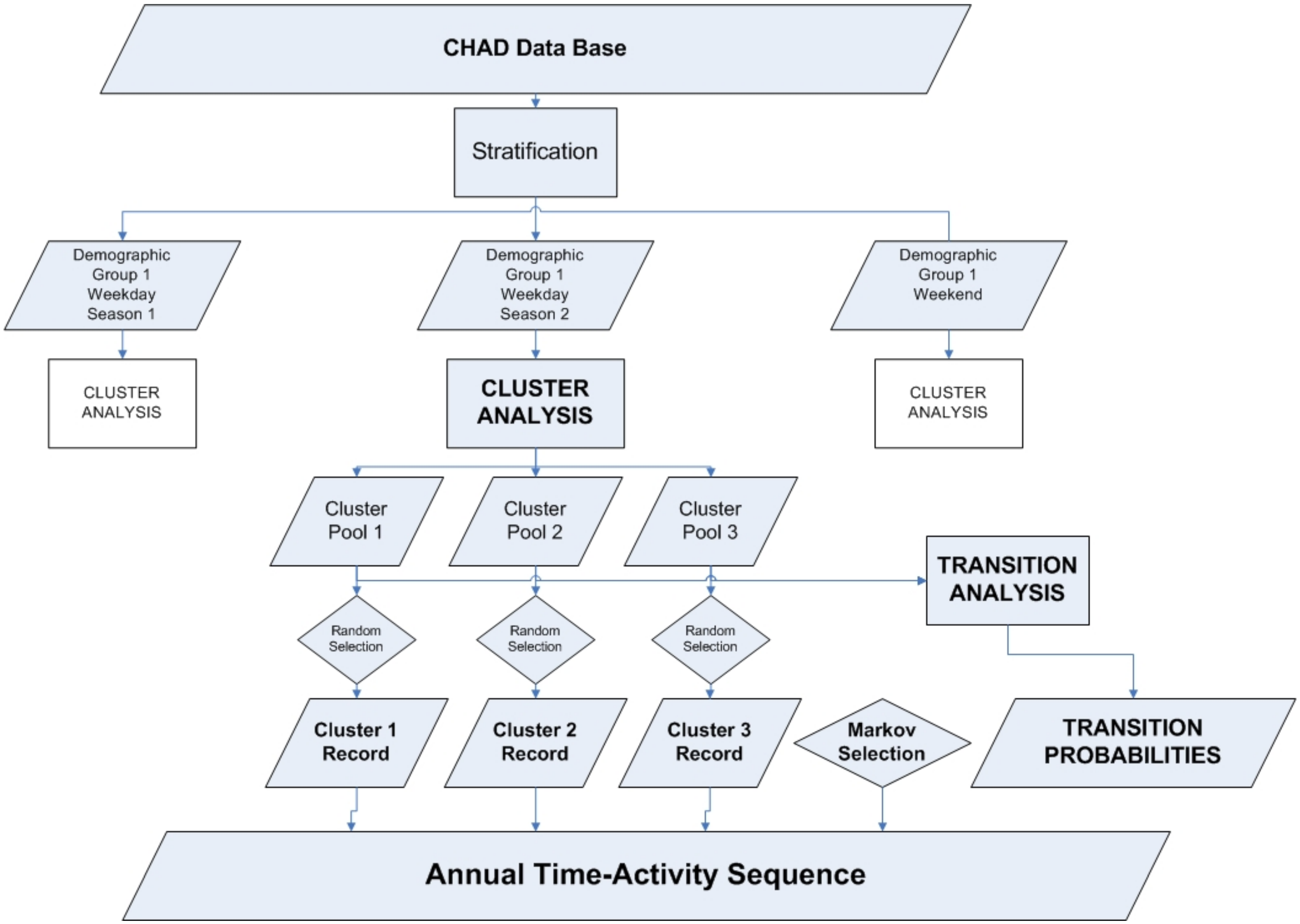

Figure 1. Flow chart of Cluster-Markov algorithm used for constructing longitudinal time-activity diaries.

Evaluation of modeled diary profiles versus observed diary profiles

The Cluster-Markov algorithm is also incorporated into the Hazardous Air Pollutant Exposure Model (HAPEM). Rosebaum and Cohen (2004) incorporated the algorithm in HAPEM and tested modeled longitudinal profiles with multi-day diary data sets collected as part of the Harvard Southern California Chronic Ozone Exposure Study (Xue et al. 2005, Geyh et al. 2000). In this study, 224 children in ages between 7 and 12 yr were followed for 1 year from June 1995 to May 1996, for 6 consecutive days each month. The subjects resided in two separate areas of San Bernardino County: urban Upland CA, and the small mountain towns of Lake Arrowhead, Crestline, and Running Springs, CA.

For purposes of clustering the activity pattern records were characterized according to time spent in each of 5 aggregate microenvironments: indoors-home, indoors-school, indoors-other, outdoors, and in-transit. For purposes of defining diary pools and for clustering and calculating transition probabilities the activity pattern records were divided by day type (i.e., weekday, weekend), season (i.e., summer or ozone season, non-summer or non-ozone season), age (7-10 and 11-12), and gender.

Week-long sequences (Wednesday through Tuesday) for each of 100 people in each age/gender group for each season were simulated. To evaluate the algorithm the following statistics were calculated for the predicted multi-day activity patterns and compared them with the actual multi-day diary data.

- For each age/gender group for each season, the average time in each microenvironment
- For each simulated person-week and microenvironment, the average of the within-person variance across all simulated persons. (The within-person variance was defined as the variance of the total time per day spent in the microenvironment across the week.)
- For each simulated person-week the variance across persons of the mean time spent in each microenvironment.

In each case the predicted statistic for the stratum was compared to the statistic for the corresponding stratum in the actual diary data. The mean normalized bias for the statistic, which is a common performance measure used in dispersion model performance and was also calculated as follows.

$$NBIAS = \frac{100}{N}\sum_{1}^{N}\frac{(predicted - observed)}{observed}$$

The predicted time-in-microenvironment averages matched well with the observed values. For combinations of microenvironment/age/gender/season the normalized bias ranges from –35% to +41%. Sixty percent of the predicted averages have bias between –9% and +9%, and the mean bias across any microenvironment ranges from -9% to +4%. Fourteen predictions have positive bias and 23 have negative bias.

For the variance across persons for the average time spent in each microenvironment, the bias ranged from –40% to +120% for any microenvironment/age/gender/season. Sixty-five percent of the predicted variances had bias between –22% and +24%. The mean normalized bias across any microenvironment ranged from –10% to +28%. Eighteen predictions had positive bias and 20 had negative bias.

For the within-person variance for time spent in each microenvironment, the bias ranged from –47% to +150% for any microenvironment/age/gender/season. Seventy percent of the predicted variances had bias between –25% and +30%. The mean normalized bias across any microenvironment ranged from –11% to +47%. Twenty-eight predictions had positive bias and 12 had negative bias, suggesting some tendency for overprediction of this variance measure.

The overall conclusion was that the proposed algorithm appeared to be able to replicate the observed data reasonably well. Although some discrepancies were rather large for some of the "variance across persons" and "within-person variance" subsets, about two-thirds of the predictions for each case were within 30% of the observed value. A detailed description of the evaluation using HAPEM is presented in Attachment 1.

Comparison of Cluster-Markov approach with other algorithms

As part of the application of APEX in support of US EPA's recent review of the ozone NAAQS several sensitivity analyses were conducted (US EPA, 2007). One of these was to make parallel simulations using each of the three algorithms for constructing multi-day time-activity sequences that are incorporated into APEX.

Table 1 presents the results for the number of persons in Atlanta population groups with moderate exertion exposed to 8-hour average concentrations exceeding 0.07 ppm. The results show that the predictions made with alternative algorithm Cluster-Markov algorithm are substantially different from those made with simple re-sampling or with the Diversity-Autocorrelation algorithm ("base case"). Note that for the cluster algorithm approximately 30% of the individuals with 1 or more exposure have 3 or more exposures. The corresponding values for the other algorithms range from about 13% to 21%.

Table 2 presents the results for the mean and standard deviation of number of days/person with 8-hour average exposures exceeding 0.07 ppm with moderate or greater exertion. The results show that although the mean for the Cluster-Markov algorithm is similar to the other approaches, the standard deviation is substantially higher, i.e., the Cluster-Markov algorithm results in substantially higher inter-individual variability.

Table 1. Sensitivity to longitudinal diary algorithm: 2002 simulated counts of Atlanta general population and children (ages 5-18) with any or three or more 8-hour ozone exposures above 0.07 ppm concomitant with moderate or greater exertion (after US EPA 2007).

Population Group	One or more exposures			Three or more exposures		
	Simple re-sampling	Diversity-Autocorrelation	Cluster-Markov	Simple re-sampling	Diversity-Autocorrelation	Cluster-Markov
General Population	979,533	939,663 (-4%)	668,004 (-32%)	124,687	144,470 (+16%)	188,509 (+51%)
Children (5-18)	411,429	389,372 (-5%)	295,004 (-28%)	71,174	83,377 (+17%)	94,216 (+32%)

Table 2. Sensitivity to longitudinal diary algorithm: 2002 days per person with 8-hour ozone exposures above 0.07 ppm concomitant with moderate or greater exertion for Atlanta general population and children (ages 5-18) (after US EPA 2007).

Population Group	Mean Days/Person			Standard Deviation		
	Simple re-sampling	Base case	Cluster-Markov	Simple re-sampling	Base case	Cluster-Markov
General Population	0.332	0.335 (+1%)	0.342 (+3%)	0.757	0.802 (+6%)	1.197 (+58%)
Children (5-18)	0.746	0.755 (+1%)	0.758 (+2%)	1.077	1.171 (+9%)	1.652 (+53%)

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Attachment 2: Detailed Evaluation Cluster-Markov Algorithm

TECHNICAL MEMORANDUM

TO: Ted Palma, US EPA

FROM: Arlene Rosenbaum and Jonathan Cohen, ICF Consulting

DATE: November 4, 2004

SUBJECT: Evaluation of a multi-day activity pattern algorithm for creating longitudinal activity patterns.

BACKGROUND

In previous work ICF reviewed the HAPEM4 modeling approach for developing annual average activity patterns from the CHAD database and recommended an approach to improve the model's pattern selection process to better represent the variability among individuals. This section summarizes the recommended approach. (For details see Attachment 2)

Using cluster analysis, first the CHAD daily activity patterns are grouped into either two or three categories of similar patterns for each of the 30 combinations of day type (summer weekday, non-summer weekday, and weekend) and demographic group (males or females; age groups: 0-4, 5-11, 12-17, 18-64, 65+). Next, for each combination of day type and demographic group, category-to-category transition probabilities are defined by the relative frequencies of each second-day category associated with each given first-day category, where the same individual was observed for two consecutive days. (Consecutive day activity pattern records for a single individual constitute a small subset of the CHAD data.)

To implement the proposed algorithm, for each day type and demographic group, one daily activity pattern per category is randomly selected from the corresponding CHAD data to represent that category. That is, if there are 3 cluster categories for each of 3 day types, 9 unique activity patterns are selected to be averaged together to create an annual average activity pattern to represent an individual in a given demographic group and census tract.

The weighting for each of the 9 activity patterns used in the averaging process is determined by the product of two factors. The first is the relative frequency of its day type, i.e., 0.18 for summer weekdays, 0.54 for non-summer weekdays, and 0.28 for weekends.

The second factor in the weighting for the selected activity pattern is determined by simulating a sequence of category-types as a one-stage Markov chain process using the transition probabilities. The category for the first day is selected according to the relative frequencies of each category. The category for the second day is selected according to the category-to-category transition probabilities for the category selected for the first day. The category for the third day is selected according to the transition probabilities for the category selected for the second day. This is repeated for all days in the day type (65 for summer weekdays, 195 for non-summer weekdays, 104 for weekends), producing a sequence of daily categories. The relative frequency of the category-type in the sequence associated with the selected activity pattern is the second factor in the weighting.

PROPOSED ALGORITHM STEPS

The proposed algorithm is summarized in Figure 1. Each step is explained in this section.

Data Preparation

Step 1: Each daily activity pattern in the CHAD data base is summarized by the total minutes in each of five micro-environments: indoors – residence; indoors – other building; outdoors – near road; outdoors – away from road; in vehicle. These five numbers are assumed to represent the most important features of the activity pattern for their exposure impact.

Step 2: All CHAD activity patterns for a given day-type and demographic group are subjected to cluster analysis, resulting in 2 or 3 cluster categories. Each daily activity pattern is tagged with a cluster category.

Step 3: For each day-type and demographic group, the relative frequency of each day-type in the CHAD data base is determined.

Step 4: All CHAD activity patterns for a given day-type and demographic group that are consecutive days for a single individual, are analyzed to determine the category-to-category transition frequencies in the CHAD data base. These transition frequencies are used to calculate category-to-category transition probabilities.

For example, if there are 2 categories, A and B, then

P_{AA} = the probability that a type A pattern is followed by a type A pattern,

P_{AB} = the probability that a type A pattern is followed by a type B pattern ($P_{AB} = 1 - P_{AA}$),

P_{BB} = the probability that a type B pattern is followed by a type B pattern, and

P_{BA} = the probability that a type B pattern is followed by a type A pattern ($P_{BA} = 1 - P_{BB}$).

Activity Pattern Selection

For each day-type and demographic group in each census tract:

Step 5: One activity pattern is randomly selected from each cluster category group (i.e., 2 to 3 activity patterns)

Creating Weights for Day-type Averaging

For each day-type and demographic group in each census tract:

Step 6: A cluster category is selected for the first day of the day-type sequence, according to the relative frequency of the cluster category days in the CHAD data set.

Step 7: A cluster category is selected for each subsequent day in the day-type sequence day by day using the category-to-category transition probabilities.

Step 8: The relative frequency of each cluster category in the day-type sequence is determined.

Step 9: The activity patterns selected for each cluster category (Step 5) are averaged together using the cluster category frequencies (Step 8) as weights, to create a day-type average activity pattern.

Creating Annual Average Activity Patterns

For each demographic group in each census tract:

Step 10: The day-type average activity patterns are averaged together using the relative frequency of day-types as weights, to create an annual average activity pattern.

Creating Replicates

For each demographic group in each census tract:

Step 11: Steps 5 through 10 are repeated 29 times to create 30 annual average activity patterns.

EVALUATING THE ALGORITHM

The purpose of this study is to evaluate how well the proposed one-stage Markov chain algorithm can reproduce observed multi-day activity patterns with respect to demographic group means and inter-individual variability, while using one-day selection.

In order to accomplish this we propose to apply the algorithm to observed multi-day activity patterns provided by the WAM, and compare the means and variances of the predicted multi-day patterns with the observed patterns.

Current APEX Algorithm

Because the algorithm is being considered for incorporation into APEX, we would like the evaluation to be consistent with the approach taken in APEX for selection of activity patterns for creating multi-day sequences. The APEX approach for creating multi-day activity sequences is as follows.

Step1: A profile for a simulated individual is generated by selection of gender, race (not implemented?), age group, and home sector from a given set of distributions consistent with the population of the study area.

Step 2: A specific age within the age group is selected from a uniform distribution.

Step 3: The employment status is simulated as a function of the age.

Step 4: For each simulated day, the user defines an initial pool of possible diary days based on a user-specified function of the day type (e.g., weekday/weekend) and temperature.

Step 5: The pool is further restricted to match the target gender and employment status exactly and the age within 2A years for some parameter A. The diary days within the pool are assigned a weight of 1 if the age is within A years of the target age and a weight of w (user-defined parameter) if the age difference is between A and 2A years. For each simulated day, the probability of selecting a given diary day is equal to the age weight divided by the total of the age weights for all diary days in the pool for that day.

Approach to Incorporation of Day-to-Day Dependence into APEX Algorithm

If we were going to incorporate day-to-day dependence of activity patterns into the APEX model, we would propose preparing the data with cluster analysis and transition probabilities as described in Steps 1-4 for the proposed HAPEM 5 algorithm, with the following modifications.

- For Step 2 the activity patterns would be divided into groups based on day-type (weekday, weekend), temperature, gender, employment status, and age, with cluster analysis applied to each group. However, because the day-to-day transitions in the APEX activity selection algorithm can cross temperature bins, we would propose to use broad temperature bins for the clustering and transition probability calculations so that the cluster definitions would be fairly uniform across temperature bins. Thus we would probably define the bins according to season (e.g., summer, non-summer).
- In contrast to HAPEM, the sequence of activity patterns may be important in APEX. Therefore, for Step 4 transition probabilities would be specified for transitions between days with the same day-type and season, as in HAPEM, and also between days with different day-types and/or seasons. For example, transition probabilities would be specified for transitions between summer weekdays of each category and summer weekends of each category.

Another issue for dividing the CHAD activity records for the purposes of clustering and calculating transition probabilities is that the diary pools specified for the APEX activity selection algorithm use varying and overlapping age ranges. One way to address this problem would be to simply not include consideration of age in the clustering process, under the assumption that cluster categories are similar across age groups, even if the frequency of each cluster category varies by age group. This assumption could be tested by examination of the cluster categories stratified by age group that were developed for HAPEM5. If the assumption is found to be valid, then the cluster categories could be pre-determined for input to APEX, while the transition probabilities could be calculated within APEX during the simulation for each age range specified for dairy pools.

If the assumption is found to be invalid, then an alternative approach could be implemented that would create overlapping age groups for purposes of clustering as follows.

APEX age group ranges and age window percentages would be constrained to some maximum values. Then a set of overlapping age ranges that would be at least as large as the largest possible dairy pool age ranges would be defined for the purposes of cluster analysis and transition probability calculation. The resulting sets of cluster categories and transition probabilities would be pre-determined for input into APEX and the appropriate set used by APEX for each diary pool used during the simulation.

The actual activity pattern sequence selection would be implemented as follows. The activity pattern for first day in the year would be selected exactly as is currently done in APEX, as described above. For the selecting the second day's activity pattern, each age weight would be multiplied by the transition probability P_{AB} where A is the cluster for the first day's activity pattern and B is the cluster for a given activity pattern in the available pool of diary days for day 2. (Note that day 2 may be a different day-type and/or season than day 1). The probability of selecting a given diary day on day 2 is equal to the age weight times P_{AB} divided by the total of the products of age weight and P_{AB} for all diary days in the pool for day 2. Similarly, for the transitions from day 2 to day 3, day 3 to day 4, etc.

Testing the Approach with the Multi-day Data set

We tested this approach using the available multi-day data set. For purposes of clustering we characterized the activity pattern records according to time spent in each of 5 microenvironments: indoors-home, indoors-school, indoors-other, outdoors (aggregate of the 3 outdoor microenvironments), and in-transit.

For purposes of defining diary pools and for clustering and calculating transition probabilities we divided the activity pattern records by day type (i.e., weekday, weekend), season (i.e., summer or ozone season, non-summer or non-ozone season), age (6-10 and 11-12), and gender. Since all the subjects are 6-12 years of age and all are presumably unemployed, we need not account for differences in employment status. For each day type, season, age, and gender, we found that the activity patterns appeared to group in three clusters.

In this case, we simulated week-long sequences (Wednesday through Tuesday) for each of 100 people in each age/gender group for each season, using the transition probabilities. To evaluate the algorithm we calculated the following statistics for the predicted multi-day activity patterns for comparison with the actual multi-day diary data.

- For each age/gender group for each season, the average time in each microenvironment
- For each age/gender group, season, and microenvironment, the average of the within-person variance across all simulated persons (We defined the within-person variance as the variance of the total time per day spent in the microenvironment across the week.)
- For each age/gender group, season, and microenvironment, the variance across persons of the mean time spent in that microenvironment

In each case we compared the predicted statistic for the stratum to the statistic for the corresponding stratum in the actual diary data.[20]

We also calculated the mean normalized bias for the statistic, which is a common performance measure used in dispersion model performance and which is calculated as follows.

$$NBIAS = \frac{100}{N}\sum_{1}^{N}\frac{(predicted - observed)}{observed} \quad \%$$

RESULTS

Comparisons of simulated and observed data for time in each of the 5 microenvironments are presented in Tables 1 – 3 and Figures 2-5.

Average Time in Microenvironment

Table 1 and Figure 2 show the comparisons for the average time spent in each of the 5 microenvironments for each age/gender group and season. Figure 3 shows the comparison for all the microenvironments except indoor, home in order to highlight the lower values.

Table 1 and the figures show that the predicted time-in-microenvironment averages match well with the observed values. For combinations of microenvironment/age/gender/season the normalized bias ranges from –35% to +41%. Sixty percent of the predicted averages have bias between –9% and +9%, and the mean bias across any microenvironment ranges from -9% to +4%. Fourteen predictions have positive bias and 23 have negative bias. A Wilcoxon signed rank test that the median bias across the 40 combinations = 0 % was not significant (p-value = 0.40) supporting the conclusion of no overall bias.

Variance Across Persons

Table 2 and Figure 4 show the comparisons for the variance across persons for the average time spent in each microenvironment. In this case the bias ranges from –40% to +120% for any microenvironment/age/gender/season. Sixty-five percent of the predicted variances have bias between –22% and +24%. The mean normalized bias across any microenvironment ranges from –10% to +28%. Eighteen predictions have positive bias and 20 have negative bias. Figure 4 suggests a reasonably good match of predicted to observed variance in spite of 2 or 3 outliers. A Wilcoxon signed rank test that the median bias across the 40 combinations = 0 % was not significant (p-value = 0.93) supporting the conclusion of no overall bias.

Within-Person Variance for Persons

[20] For the diary data, because the number of days per person varies, the average of the within-person variances was calculated as a weighted average, where the weight is the degrees of freedom, i.e., one less than the number of days simulated. Similarly, the variance across persons of the mean time was appropriately adjusted for the different degrees of freedom using analysis of variance.

Table 3 and Figure 5 show the comparisons for the within-person variance for time spent in each microenvironment. In this case the bias ranges from –47% to +150% for any microenvironment/age/gender/season. Seventy percent of the predicted variances have bias between –25% and +30%. The mean normalized bias across any microenvironment ranges from –11% to +47%. Twenty-eight predictions have positive bias and 12 have negative bias, suggesting some tendency for overprediction of this variance measure. And indeed a Wilcoxon signed rank test that the median bias across the 40 combinations = 0 % was very significant (p-value = 0.01) showing that the within-person variance was significantly overpredicted. Still, Figure 4 suggests a reasonably good match of predicted to observed variance in most cases, with a few overpredicting outliers at the higher end of the distribution. So although the positive bias is significant in a statistical sense (i.e., the variance is more likely to be overpredicted than underpredicted), it is not clear whether the bias is large enough to be important.

CONCLUSIONS

The proposed algorithm appears to be able to replicate the observed data reasonably well, although the within-person variance is somewhat overpredicted.

It would be informative to compare this algorithm with the earlier alternative approaches in order to gain perspective on the degree of improvement, if any, afforded by this approach.

Two earlier approaches were:

1. Select a single activity pattern for each day-type/season combination from the appropriate set, and use that pattern for every day in the multi-day sequence that corresponds to that day-type and season.
2. Re-select an activity pattern for each day in the multi-day sequence from the appropriate set for the corresponding day-type and season.

Goodness-of-fit statistics could be developed to compare the three approaches and find which model best fits the data for a given stratum.

Table 1. Average time spent in each microenvironment: comparison of predicted and observed.

Microenvironment	Demographic Group	Season	Observed (hours/day)	Predicted (hours/day)	Normalized Bias
Indoor, home	Girls, 6-10	Summer	15.5	16.5	6%
		Not Summer	15.8	15.5	-2%
	Boys, 6-10	Summer	15.7	15.2	-3%
		Not Summer	15.8	16.4	4%
	Girls, 11-12	Summer	16.2	15.3	-5%
		Not Summer	16.5	16.5	0%
	Boys, 11-12	Summer	16.0	15.6	-3%
		Not Summer	16.2	16.1	-1%
	MEAN				-1%
Indoor, school	Girls, 6-10	Summer	0.7	0.7	-9%
		Not Summer	2.3	2.5	7%
	Boys, 6-10	Summer	0.8	0.5	-34%
		Not Summer	2.2	2.2	0%
	Girls, 11-12	Summer	0.7	0.7	6%
		Not Summer	2.1	2.4	13%
	Boys, 11-12	Summer	0.6	0.9	38%
		Not Summer	2.4	2.7	11%
	MEAN				4%
Indoor, other	Girls, 6-10	Summer	2.9	2.4	-14%
		Not Summer	2.4	2.7	13%
	Boys, 6-10	Summer	2.2	2.7	21%
		Not Summer	1.9	1.8	-3%
	Girls, 11-12	Summer	2.2	1.6	-25%
		Not Summer	2.2	2.1	-2%
	Boys, 11-12	Summer	2.3	2.2	-5%
		Not Summer	1.9	2.0	4%
	MEAN				-2%
Outdoors	Girls, 6-10	Summer	3.7	3.5	-6%
		Not Summer	2.5	2.5	0%
	Boys, 6-10	Summer	4.1	4.3	4%
		Not Summer	3.1	2.7	-12%
	Girls, 11-12	Summer	3.7	5.2	41%
		Not Summer	2.3	2.1	-5%
	Boys, 11-12	Summer	3.9	4.3	9%
		Not Summer	2.6	2.4	-7%
	MEAN				3%
In-vehicle	Girls, 6-10	Summer	1.1	0.9	-20%
		Not Summer	1.0	0.9	-13%
	Boys, 6-10	Summer	1.1	1.3	13%
		Not Summer	1.0	0.9	-16%
	Girls, 11-12	Summer	1.2	1.1	-12%
		Not Summer	0.9	0.8	-15%
	Boys, 11-12	Summer	1.1	1.0	-5%
		Not Summer	0.9	0.8	-7%
	MEAN				-9%

Table 2. Variance across persons for time spent in each microenvironment: comparison of predicted and observed.

Microenvironment	Demographic Group	Season	Observed $(hours/day)^2$	Predicted $(hours/day)^2$	Normalized Bias
Indoor, home	Girls, 6-10	Summer	70	42	-40%
		Not Summer	67	60	-9%
	Boys, 6-10	Summer	54	49	-9%
		Not Summer	35	30	-12%
	Girls, 11-12	Summer	56	47	-17%
		Not Summer	42	38	-10%
	Boys, 11-12	Summer	57	63	12%
		Not Summer	39	42	8%
	MEAN				-10%
Indoor, school	Girls, 6-10	Summer	6.0	5.2	-13%
		Not Summer	9.5	5.9	-38%
	Boys, 6-10	Summer	5.6	3.8	-32%
		Not Summer	5.3	8.2	53%
	Girls, 11-12	Summer	4.9	5.5	11%
		Not Summer	5.4	5.3	-1%
	Boys, 11-12	Summer	5.6	6.0	6%
		Not Summer	9.2	11	23%
	MEAN				1%
Indoor, other	Girls, 6-10	Summer	46	32	-30%
		Not Summer	44	46.	6%
	Boys, 6-10	Summer	34	33	-4%
		Not Summer	23	16	-27%
	Girls, 11-12	Summer	21	18	-15%
		Not Summer	28	22	-22%
	Boys, 11-12	Summer	33	31	-6%
		Not Summer	30	30	0%
	MEAN				-12%
Outdoors	Girls, 6-10	Summer	17	23	37%
		Not Summer	9.3	6.8	-27%
	Boys, 6-10	Summer	17	18	3%
		Not Summer	8.3	7.6	-8%
	Girls, 11-12	Summer	22	22	0%
		Not Summer	9.0	9.1	1%
	Boys, 11-12	Summer	13	29	120%
		Not Summer	10	11	8%
	MEAN				17%
In-vehicle	Girls, 6-10	Summer	1.9	2.3	24%
		Not Summer	1.8	1.6	-11%
	Boys, 6-10	Summer	2.5	4.7	93%
		Not Summer	1.5	1.6	9%
	Girls, 11-12	Summer	3.5	4.7	34%
		Not Summer	2.8	2.0	-28%
	Boys, 11-12	Summer	3.2	5.4	69%
		Not Summer	1.3	1.7	35%
	MEAN				28%

Table 3. Average within person variance for time spent in each microenvironment: comparison of predicted and observed.

Microenvironment	Demographic Group	Season	Observed $(hours/day)^2$	Predicted $(hours/day)^2$	Normalized Bias
Indoor, home	Girls, 6-10	Summer	20	29	49%
		Not Summer	18	23	25%
	Boys, 6-10	Summer	17	30	75%
		Not Summer	15	24	64%
	Girls, 11-12	Summer	22	42	93%
		Not Summer	22	25	13%
	Boys, 11-12	Summer	21	24	16%
		Not Summer	17	24	38%
	MEAN				47%
Indoor, school	Girls, 6-10	Summer	2.3	2.4	5%
		Not Summer	7.3	6.4	-12%
	Boys, 6-10	Summer	2.0	1.5	-25%
		Not Summer	6.7	5.8	-14%
	Girls, 11-12	Summer	1.7	2.1	29%
		Not Summer	7.4	7.6	3%
	Boys, 11-12	Summer	1.4	2.9	101%
		Not Summer	7.3	7.8	6%
	MEAN				12%
Indoor, other	Girls, 6-10	Summer	14	14	-4%
		Not Summer	14	18	30%
	Boys, 6-10	Summer	12	17	42%
		Not Summer	10	13	26%
	Girls, 11-12	Summer	10	10	1%
		Not Summer	14	15	7%
	Boys, 11-12	Summer	11	14	26%
		Not Summer	12	13	7%
	MEAN				17%
Outdoors	Girls, 6-10	Summer	8.4	9.5	13%
		Not Summer	3.4	3.2	-3%
	Boys, 8-10	Summer	6.7	9.5	42%
		Not Summer	3.4	4.4	28%
	Girls, 11-12	Summer	10	25	150%
		Not Summer	4.0	4.5	11%
	Boys, 11-12	Summer	9.2	7.4	-20%
		Not Summer	4.3	3.7	-15%
	MEAN				26%
In-vehicle	Girls, 6-10	Summer	1.0	0.90	-13%
		Not Summer	0.90	0.48	-47%
	Boys, 6-10	Summer	1.1	1.4	31%
		Not Summer	0.81	0.71	-12%
	Girls, 11-12	Summer	1.3	1.3	4%
		Not Summer	1.3	1.1	-16%
	Boys, 11-12	Summer	2.4	1.6	-34%
		Not Summer	0.85	0.85	1%
	MEAN				-11%

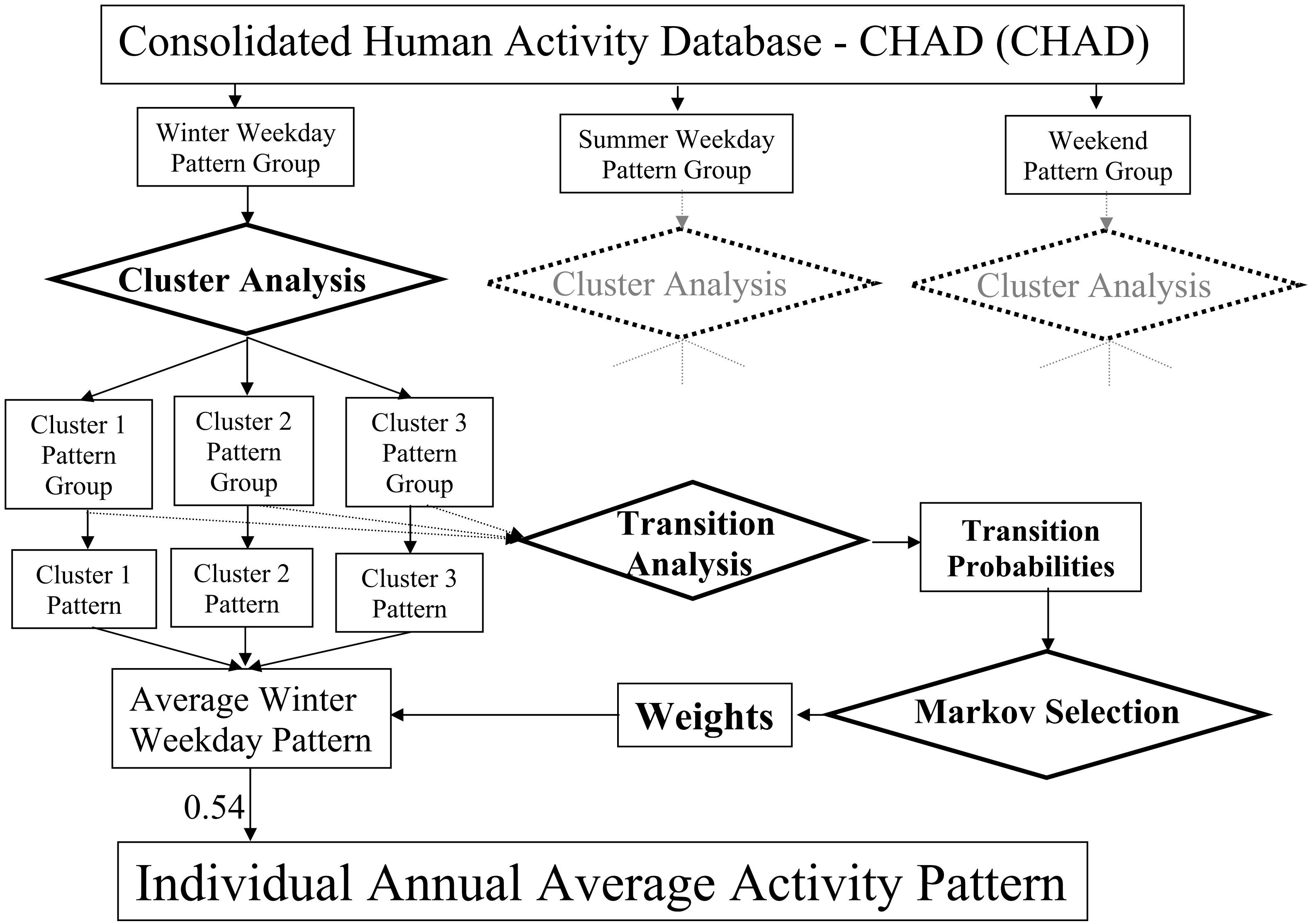

Figure 1. Flow diagram of proposed algorithm for creating annual average activity patterns for HAPEM5.

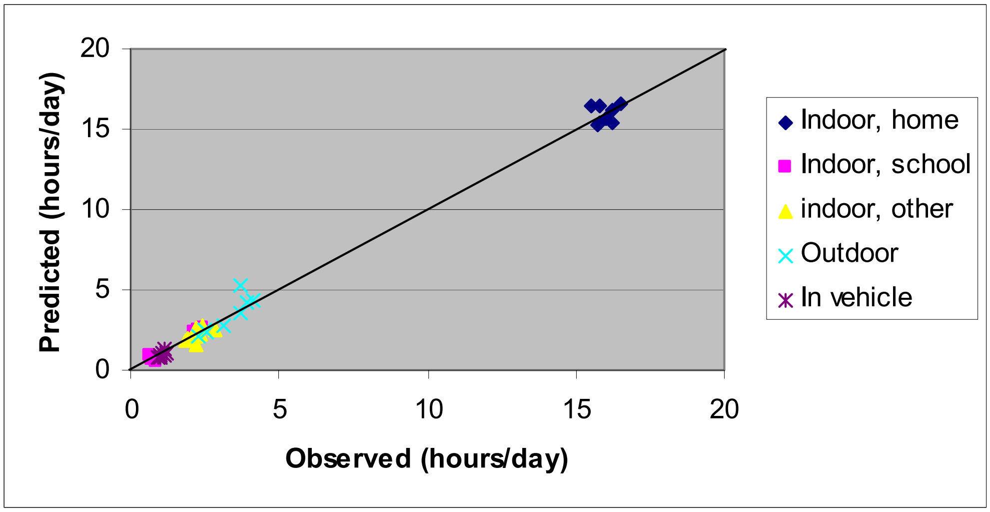

Figure 2. Comparison of predicted and observed average time in each of 5 microenvironments for age/gender groups and seasons.

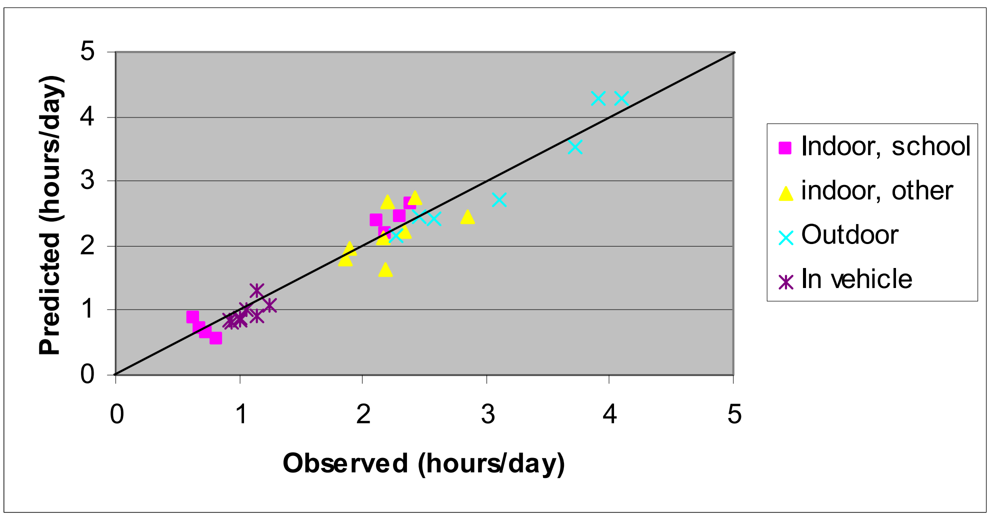

Figure 3. Comparison of predicted and observed average time in each of 4 microenvironments for age/gender groups and seasons.

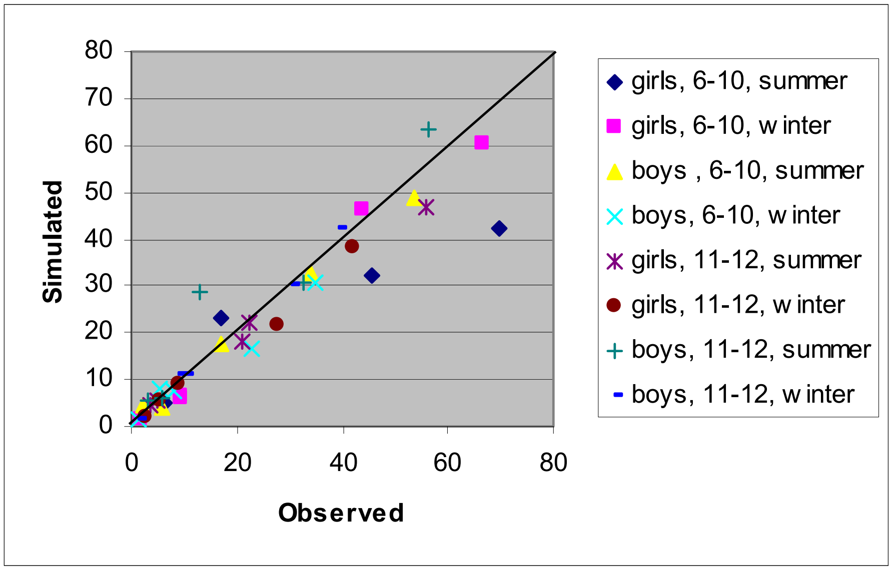

Figure 4. Comparison of predicted and observed variance across persons for time spent in each of 5 microenvironments for age/gender groups and seasons.

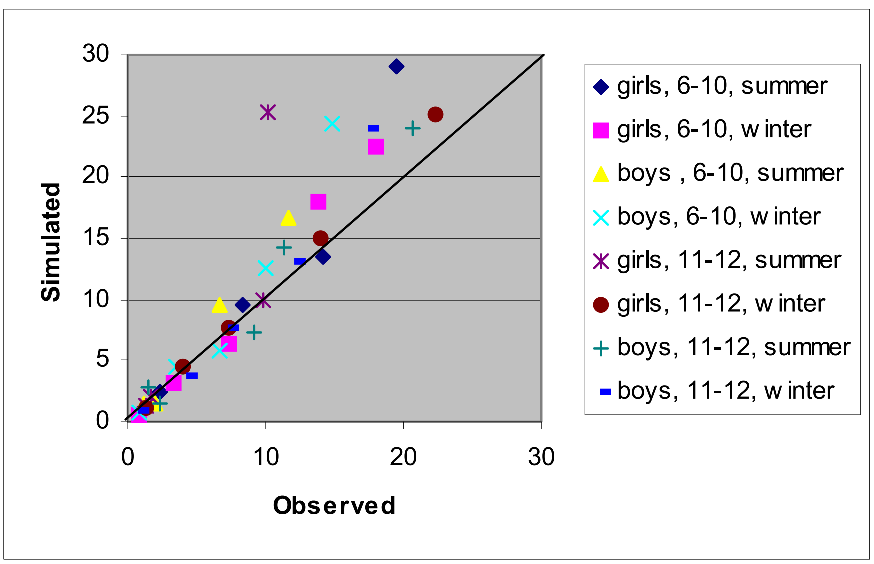

Figure 5. Comparison of predicted and observed the average within-person variance for time spent in each of 5 microenvironments by age/gender groups and seasons.

Appendix C

Nitrogen Dioxide Health Risk Assessment for Atlanta, GA

Draft Report

August 2008

Prepared for
Office of Air Quality Planning and Standards
U.S. Environmental Protection Agency
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Nitrogen Dioxide Health Risk Assessment for Atlanta, GA

1 INTRODUCTION

The U.S. Environmental Protection Agency (EPA) is presently conducting a review of the national ambient air quality standards (NAAQS) for nitrogen dioxide (NO_2). Sections 108 and 109 of the Clean Air Act (Act) govern the establishment and periodic review of the NAAQS. These standards are established for pollutants that may reasonably be anticipated to endanger public health and welfare, and whose presence in the ambient air results from numerous or diverse mobile or stationary sources. The NAAQS are to be based on air quality criteria, which are to accurately reflect the latest scientific knowledge useful in indicating the kind and extent of identifiable effects on public health or welfare that may be expected from the presence of the pollutant in ambient air. The EPA Administrator is to promulgate and periodically review, at five-year intervals, "primary" (health-based) and "secondary" (welfare-based) NAAQS for such pollutants.[1] Based on periodic reviews of the air quality criteria and standards, the Administrator is to make revisions in the criteria and standards, and promulgate any new standards, as may be appropriate. The Act also requires that an independent scientific review committee advise the Administrator as part of this NAAQS review process, a function performed by the Clean Air Scientific Advisory Committee (CASAC).

EPA's plan and schedule for this NO_2 NAAQS review is presented in the "Integrated Review Plan for the Primary National Ambient Air Quality Standard for Nitrogen Dioxide" (U.S. EPA, 2007a). The plan discusses the preparation of two key components in the NAAQS review process: an Integrated Science Assessment (ISA) and risk/exposure assessments. The ISA critically evaluates and integrates scientific information on the health effects associated with exposure to oxides of nitrogen (NOx) in the ambient air. The risk/exposure assessments develop qualitative characterization and quantitative estimates, where judged appropriate, of human exposure and health risk and related variability and uncertainties, drawing upon the information summarized in the ISA.

In early March 2008, EPA's National Center for Environmental Assessment released a second draft of the "Integrated Science Assessment for Oxides of Nitrogen – Health Criteria (Second External Review Draft)," henceforth referred to as the draft ISA (U.S. EPA, 2008a). EPA's Office of Air Quality Planning and Standards (OAQPS) in early April released a first draft of its "Risk and Exposure Assessment to Support the Review of the NO_2 Primary National Ambient Air Quality Standard," henceforth referred to as the 1st draft REA (U.S. EPA, 2008b). Both of these documents were reviewed by the CASAC NO_2 Panel on May 1-2, 2008.

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[1]Section 109(b)(1) [42 U.S.C. 7409] of the Act defines a primary standard as one "the attainment and maintenance of which in the judgment of the Administrator, based on such criteria and allowing an adequate margin of safety, are requisite to protect the public health."

As a result of the May 2008 CASAC NO_2 Panel review and in response to advice offered by the CASAC Panel, OAQPS decided to expand the health risk assessment to include a quantitative assessment of respiratory-related emergency department (ED) visits estimated to be associated with exposures to NO_2 for the Atlanta metropolitan statistical area (MSA).

NO_2 is one of a group of substances known as nitrogen oxides (NO_x), which include multiple gaseous (e.g., NO_2, NO) and particulate (e.g., nitrate) species. As in past NAAQS reviews, NO_2 is considered as the surrogate for the gaseous NO_x species for the purpose of this assessment, with particulate species addressed as part of the particulate matter (PM) NAAQS review.

Previous reviews of the NO_2 primary NAAQS completed in 1985 and 1994 did not include quantitative health risk assessments. Thus, the risk assessment described in this document builds upon the methodology and lessons learned from the risk assessment work conducted for the recently concluded PM and O_3 NAAQS reviews (Abt Associates, 2005; Abt Associates, 2007a). Many of the same methodological issues are present for each of these criteria air pollutants where epidemiological studies provided the basis for the concentration-response (C-R) relationships used in the quantitative risk assessment.

In July 2008, EPA issued the final ISA, "Integrated Science Assessment for Oxides of Nitrogen – Health Criteria (Final Report), henceforth referred to as the final ISA (U.S. EPA, 2008c). The risk assessment described in this document is also based on the information and evaluation contained in the final ISA. In August 2008, EPA is releasing its 2nd draft REA, henceforth referred to as the draft REA (U.S. EPA, 2008d).

The NO_2 health risk assessment described in this document estimates the incidence of respiratory-related ED visits associated with short-term exposures to NO_2 under recent ("as is") air quality levels and upon just meeting the current NO_2 standard of 0.053 ppm annual average and several alternative NO_2 primary NAAQS in the Atlanta MSA.[2] The alternative standards considered are daily maximum 1-hour standards, with levels of 0.05, 0.10, 0.15, and 0.20 ppm, using a 98th percentile form and also using a 99th percentile form, using a three-year period.[3] The risk assessment is intended as a tool that, together with other information on this health endpoint and other health effects evaluated in the final ISA, can aid the Administrator in judging whether the current primary standard protects public health with an adequate margin of safety, or whether revisions to the standard are appropriate.

[2] The current NO_2 standard refers to a two-year period and requires that the annual average NO_2 level be less than or equal to 0.053 ppm in each of the two years.
[3] For the alternative standards using, say, the 98th percentile form, the standard is met when the average of the three annual 98th percentile daily maximum 1-hr concentrations for the 3-year period is at or below the specified standard level.

Preliminary considerations and the basic structure of the risk assessment are described in section 2. Section 3 describes the methods used, and section 4 presents the results of the risk assessment.

2 PRELIMINARY CONSIDERATIONS

The health risk assessment described in this document estimates the incidence of respiratory-related ED visits associated with NO_2 exposures for recent ("as is") NO_2 levels, based on 2005, 2006, and 2007 air quality data, as well as the risks associated with just meeting the current standard and the reduced risks associated with just meeting each of several alternative NO_2 NAAQS.[4] In this section we address preliminary considerations. Section 2.1 briefly discusses the broad empirical basis for a relationship between NO_2 exposures and adverse health effects. Section 2.2 describes the basic structure of the risk assessment. Finally, section 2.3 addresses air quality considerations.

2.1 The Broad Empirical Basis for a Relationship Between NO_2 and Adverse Health Effects

The final ISA concludes that there is a broad empirical basis supporting the inference of a likely causal relationship between short-term NO_2 exposure and respiratory effects:

> Taken together, the findings of epidemiologic, human clinical, and animal toxicological studies provided evidence that is sufficient to infer a likely causal relationship for respiratory effects with short-term NO_2 exposure. The body of evidence from epidemiologic studies has grown substantially since the 1993 AQCD and provided scientific evidence that short-term exposure to NO_2 is associated with a broad range of respiratory morbidity effects, including altered lung host defense, inflammation, airway hyperresponsiveness, respiratory symptoms, lung function decrements, and ED visits and hospital admissions for respiratory diseases (final ISA, section 3.1.7, p. 3-41).

2.2 Basic Structure of the Risk Assessment

The general approach used in this risk assessment, as in the risk assessment that was part of the recent PM NAAQS review, relies upon C-R functions that have been estimated in epidemiological studies. Since these studies estimate C-R functions using ambient air quality data from fixed-site, population-oriented monitors, the appropriate application of these functions in a NO_2 risk assessment similarly requires the use of ambient air quality data at fixed-site, population-oriented monitors. The NO_2 health risk model combines information about NO_2 air quality for a specific urban area with C-R functions derived from an epidemiological study and baseline health incidence data for a specific health endpoint to derive estimates of the annual incidence of the specified health effect attributable to ambient NO_2 concentrations. The analyses have been conducted for both "as is" air quality and for air quality simulated to reflect attainment of the current and alternative NO_2 ambient standards.

[4] The current NO_2 standard is met in all locations in the United States. The risks associated with just meeting the current standard are therefore *greater* than the risks associated with "as is" NO_2 concentrations, which are *lower* than NO_2 concentrations simulated to just meet the current standard.

As described more fully below, a risk assessment based on epidemiological studies requires baseline incidence data or baseline incidence rates and population data for the risk assessment locations.

The characteristics that are relevant to carrying out a risk assessment based on epidemiology studies can be summarized as follows:

- A risk assessment based on epidemiology studies uses C-R functions, and therefore requires as input (monitored) ambient NO_2 concentrations.

- Epidemiological studies are carried out in specific real world locations (e.g., specific urban areas). A risk assessment focused on locations in which the epidemiologic studies providing the C-R functions were carried out will minimize uncertainties.

- A risk assessment based on epidemiological studies requires baseline incidences or baseline incidence rates and population data for the risk assessment locations.

The methods for the NO_2 risk assessment are discussed in section 3 below. The risk assessment was implemented within a new probabilistic version of TRIM.Risk, the component of EPA's Total Risk Integrated Methodology (TRIM) model that estimates human health risks.[5]

2.3 Air Quality Considerations

The risk assessment includes risk estimates for three recent years of air quality ("as is" air quality) and for air quality adjusted so that it simulates just meeting the current or alternative NO_2 standards based on that recent three-year period (2005-2007). This period was selected to represent the most recent air quality for which complete data were available.

In order to estimate health risks associated with just meeting the current and alternative NO_2 standards, it is necessary to estimate the distribution of hourly NO_2 concentrations that would occur under any given standard. Since all locations in the United States are in attainment of the current NO_2 standard, and since compliance with the current NO_2 standard is based on examining a 2-year period, air quality data from 2006 to 2007 were used to determine the amount of *increase* in NO_2 concentrations that would occur if the current standard were just met in the risk assessment location. Estimated design values were used to determine the (upward) adjustment necessary to just meet the current NO_2 standard. The adjustment was then applied to each year of data (2006 and 2007) to estimate risks in each of these individual years. For alternative 1-hour daily maximum standards, staff specified the form as being the 3-year average of the 98th (or 99th) percentile of the daily maximum 1-hour concentrations. Thus, the three-year period including 2005 to 2007 was used for analyses involving alternative 1-hour standards. Estimated design values were used to determine the

[5] TRIM.Risk was most recently applied to EPA's O_3 health risk assessment. A User's Guide for the Application of TRIM.Risk to the O_3 health risk assessment (Abt Associates, 2007b) is available online at: http://epa.gov/ttn/fera/data/trim/trimrisk_ozone_ra_userguide_8-6-07.pdf.

upward (or downward) adjustments necessary to just meet alternative NO_2 standards, and the adjustments were then applied to each year of data to estimate risks in each of these individual years.

As described in section 6.2.1 of the draft REA, EPA concluded that the proportional (linear) air quality adjustment procedure adequately represented the pattern of reductions across the NO_2 air quality distribution observed over recent years. The proportional air quality adjustment procedure was applied in the Atlanta MSA to the filled in 2006 and 2007 NO_2 monitoring data, based on the 2-year period (2006-2007) NO_2 design value for the current standard, to generate new time series of hourly NO_2 concentrations for 2006 and 2007 that simulate air quality levels that just meet the current NO_2 standard of 0.053 ppm annual average. Because every location across the U.S. meets the current NO_2 standard (see U.S. EPA, 2007b, Figure 1), simulation of just meeting the current standard required rolling *up* air quality.

The proportional air quality adjustment procedure was similarly applied in the Atlanta MSA to the filled in 2005, 2006, and 2007 NO_2 monitoring data, based on the 3-year period (2005-2007) NO_2 design values for the alternative 1-hour standards, to generate new time series of hourly NO_2 concentrations for 2005, 2006, and 2007 that simulate air quality levels that just meet each of the alternative NO_2 standards considered in the risk assessment over this three year period.

Because compliance with the alternative 1-hour daily maximum standards is based on the 3-year average of the values for the chosen metric, the air quality distribution in each of the 3 years can and generally does vary. As a result, the risk estimates associated with air quality just meeting a standard also will vary depending on the year chosen for the analysis. The risk assessment for the alternative 1-hour standards includes risk estimates involving adjustment of 2005, 2006, and 2007 air quality data to illustrate the magnitude of this year-to-year variability in the estimates.

The risk estimates developed for the recently concluded PM and O_3 NAAQS reviews represented risks associated with PM and O_3 levels in excess of estimated policy-relevant background (PRB) levels in the U.S. PRB levels of NO_2 are defined as the distribution of NO_2 concentrations that would be observed in the U.S. in the absence of anthropogenic (man-made) emissions of NO_2 precursors in the U.S., Canada, and Mexico. Estimates of NO_2 PRB are reported in section 2.4.6 of the final ISA, and for most of the continental U.S. the PRB is estimated to be less than 300 parts per trillion (ppt). In the Northeastern U.S., where present-day NO_2 concentrations are highest, this amounts to a contribution of about 1% percent of the total observed ambient NO_2 concentration (final ISA, p. 2-28). Since this is well below concentrations that might be considered to cause a potential health effect, there was no adjustment made for risks associated with PRB concentrations in the current NO_2 health risk assessment.

3 METHODS

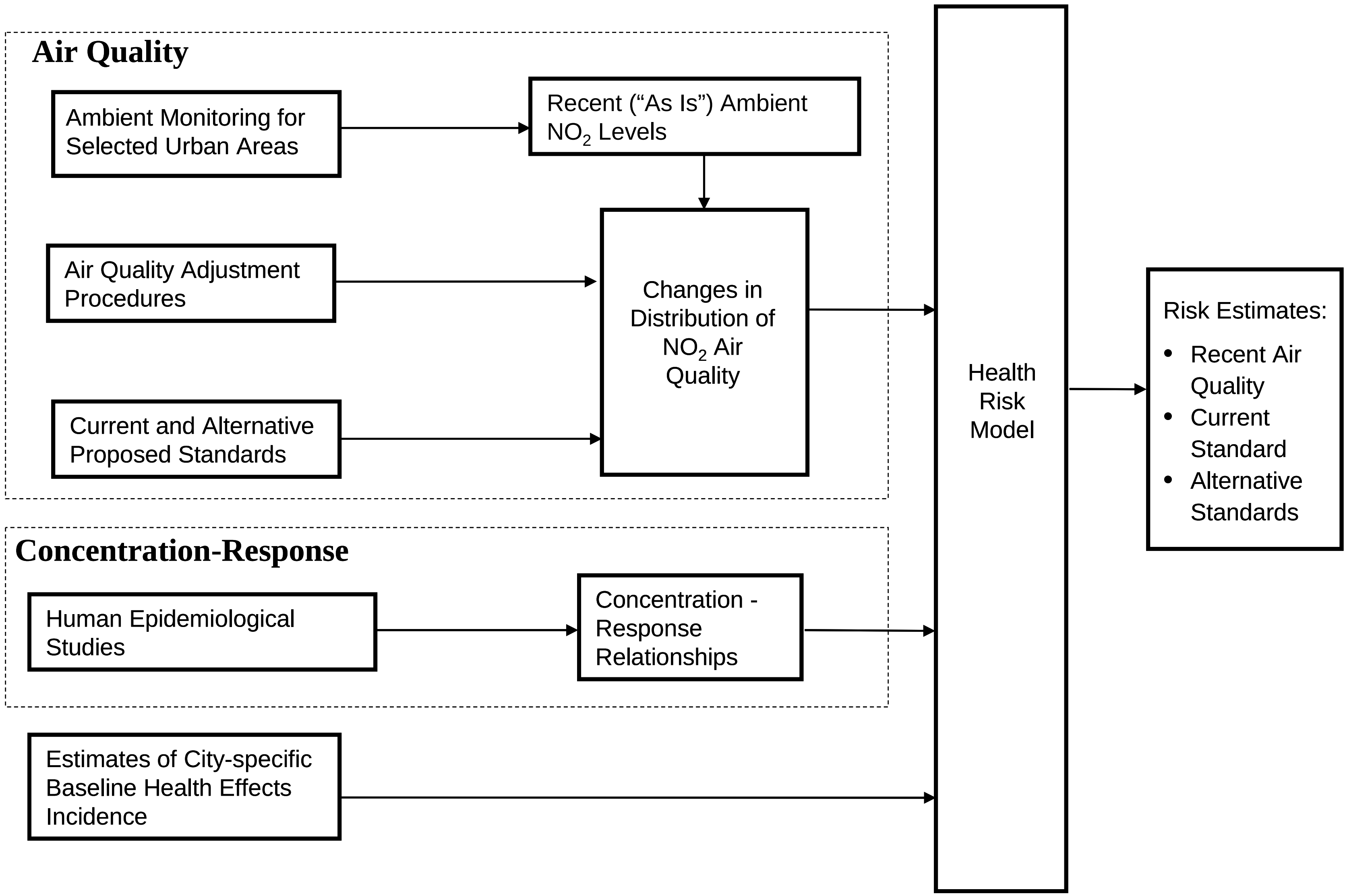
The major components of the NO_2 health risk assessment are illustrated in Figure 3-1. The air quality component that is integral to the health risk assessment is discussed in chapters 2 and 6 of the draft REA. As described in the final ISA and the draft REA, recent studies, when taken together, provide scientific evidence that NO_2 is associated with a range of respiratory effects. The evidence is judged to be sufficient to infer a likely causal relationship between short-term NO_2 exposure and adverse effects on the respiratory system. This finding is supported by a large body of epidemiologic evidence, in combination with findings from human and animal experimental studies (final ISA, sections 3.1.6 and 3.1.7).

3.1 General approach

As in the PM risk assessment (Abt Associates, 2005) and part of the recently completed O_3 risk assessment (Abt Associates, 2007a), the general approach used in the NO_2 risk assessment relies upon C-R functions which have been estimated in epidemiological studies. Since these studies estimate C-R functions using ambient air quality data from fixed-site, population-oriented monitors, the appropriate application of these functions in a risk assessment similarly requires the use of ambient air quality data at fixed-site, ambient monitors. The NO_2 health risk model combines information about NO_2 air quality for a specific urban area with C-R functions derived from epidemiological studies and baseline incidence data for a specific health endpoint to derive estimates of the incidence of the health endpoint attributable to ambient NO_2 concentrations during the period examined.

In the first part of the risk assessment, we estimate health effects incidence associated with “as is” NO_2 levels. In the second part, we estimate the (increased) health effects incidence associated with NO_2 concentrations simulated to just meet the current NO_2 annual standard and the health effects incidence associated with NO_2 concentrations simulated to just meet alternative 1-hour daily maximum NO_2 standards in the assessment location. In both parts, we consider the incidence of health effects associated with NO_2 concentrations in excess of 0 ppm (as opposed to in excess of PRB, as explained in section 2.3).

Figure 3-1. Major Components of NO_2 Health Risk Assessment Based on Epidemiology Studies



Both parts of the risk assessment may be viewed as assessing the change in incidence of the health effect associated with a change in NO_2 concentrations from some upper levels to specified (lower) levels – in the NO_2 risk assessment, the lower level is 0 ppm in both cases. The important operational difference between the two parts is in the upper NO_2 levels. In the first part, the upper NO_2 levels are "as is" concentrations. In contrast, the upper NO_2 levels in the second part are the estimated NO_2 levels that would occur when the current NO_2 standard of 0.053 ppm annual average is just met in the assessment location or when one of several alternative 1-hour daily maximum NO_2 standards is just met in this location. The second part therefore requires that a method be developed to simulate just meeting the current or alternative standards. This method is described in chapter 6 of the draft REA.

To estimate the incidence of a given health effect associated with "as is" ambient NO_2 concentrations or NO_2 concentrations that just meet the current or an alternative standard in an assessment location, the following analysis inputs are necessary:

- **Air quality information** including: (1) "as is" air quality data for NO_2 from ambient monitors in the assessment location, and (2) "as is" concentrations adjusted to simulate just meeting the specified standard. (These air quality inputs are discussed in more detail in chapter 2 of this report and in chapter 6 of the draft REA.)

- **Concentration-response function(s),** which provide an estimate of the relationship between the health endpoint of interest and NO_2 concentrations.

- **Baseline health effects incidence**. The baseline incidence of the health effect in the assessment location in the target year is the incidence corresponding to "as is" NO_2 levels in that location in that year. The baseline incidence can be calculated as the product of the incidence rate (e.g., number of cases per 10,000 population) and the affected population (divided by 10,000, if the rate is per 10,000 population). Alternatively, if an estimate of the incidence in the location of interest is available, that can be used instead.

These inputs are combined to estimate health effect incidence changes associated with specified changes in NO_2 levels. Although some epidemiological studies have estimated linear or logistic C-R functions, by far the most common form (and the form used in the models selected for the NO_2 risk assessment) is the exponential (or log-linear) form:

$$y = Be^{\beta x}, \tag{3-1}$$

where x is the ambient NO_2 level, y is the incidence of the health endpoint of interest at NO_2 level x, β is the coefficient of ambient NO_2 concentration (describing the extent of change in y with a unit change in x), and B is the incidence at x=0, i.e., when there is no ambient NO_2. The relationship between a specified ambient NO_2 level, x_0, for example, and the incidence of a given health endpoint associated with that level (denoted as y_0) is then

$$y_0 = Be^{\beta x_0}. \tag{3-2}$$

Because the log-linear form of C-R function (equation (3-1)) is by far the most common form, we use this form to illustrate the "health impact function" used in the risk assessment.

If we let x_0 denote the baseline (upper) NO_2 level, and x_1 denote the lower NO_2 level, and y_0 and y_1 denote the corresponding incidences of the health effect, we can derive the following relationship between the change in x, $\Delta x = (x_0 - x_1)$, and the corresponding change in y, Δy, from equation (3-1)[6]:

$$\Delta y = (y_0 - y_1) = y_0[1 - e^{-\beta \Delta x}]. \tag{3-3}$$

Alternatively, the difference in health effects incidence can be calculated indirectly using relative risk. Relative risk (RR) is a measure commonly used by epidemiologists to characterize the comparative health effects associated with a particular air quality comparison. The risk of ED visits for respiratory illness at ambient NO_2 level x_0 relative to the risk of ED visits for respiratory illness at ambient NO_2 level x_1, for example, may be characterized by the ratio of the two rates: the rate of ED visits for respiratory illness among individuals when the ambient NO_2 level is x_0 and the rate of ED visits for respiratory illness among (otherwise identical) individuals when the ambient NO_2 level is x_1. This is the RR for ED visits for respiratory illness associated with the difference between the two ambient NO_2 levels, x_0 and x_1. Given a C-R function of the form shown in equation (3-1) and a particular difference in ambient NO_2 levels, Δx, the RR associated with that difference in ambient NO_2, denoted as $RR_{\Delta x}$, is equal to $e^{\beta \Delta x}$. The difference in health effects incidence, Δy, corresponding to a given difference in ambient NO_2 levels, Δx, can then be calculated based on this $RR_{\Delta x}$ as

$$\Delta y = (y_0 - y_1) = y_0[1 - (1/RR_{\Delta x})]. \tag{3-4}$$

Equations (3-3) and (3-4) are simply alternative ways of expressing the relationship between a given difference in ambient NO_2 levels, $\Delta x > 0$, and the corresponding difference in health effects incidence, Δy. These health impact equations are the key equations that combine air quality information, C-R function information, and baseline health effects incidence information to estimate health risks related to changes in ambient NO_2 concentrations.

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[6] If $\Delta x < 0$ – i.e., if $\Delta x = (x_1 - x_0)$ – then the relationship between Δx and Δy can be shown to be $\Delta y = (y_1 - y_0) = y_0[e^{\beta \Delta x} - 1]$. If $\Delta x < 0$, Δy will similarly be negative. However, the *magnitude* of Δy will be the same whether $\Delta x > 0$ or $\Delta x < 0$ – i.e., the absolute value of Δy does not depend on which equation is used.

3.2 Selection of health endpoint(s)

As discussed in section 3.1.6 of the final ISA, many studies have observed positive associations between ambient NO_2 concentrations and ED visits and hospitalizations for all respiratory diseases and asthma, and these associations appear to be generally robust and independent of the effects of ambient particles or gaseous copollutants. Noting that exposure to NO_2 has been found to result in host defense and immune system changes, airway inflammation, and airway responsiveness, the final ISA concludes that "while not providing specific mechanistic data linking exposure to ambient NO_2 and respiratory hospitalization or ED visits for asthma, these findings provide plausibility and coherence for such a relationship" (section 3.1.6.5, p. 3-41).

In summarizing the evidence for a relationship between short-term exposure to NO_2 and respiratory health effects, the final ISA notes that "the body of evidence from epidemiologic studies has grown substantially since the 1993 AQCD and provided scientific evidence that short-term exposure to NO_2 is associated with a broad range of respiratory morbidity effects, including altered lung host defense, inflammation, airway hyperresponsiveness, respiratory symptoms, lung function decrements, and ED visits and hospital admissions for respiratory diseases" (section 3.1.7, p. 3-41). For this risk assessment, we are focusing on respiratory ED visits.

3.3 Selection of urban area(s) and epidemiological studies

Several objectives were considered in selecting potential urban areas for which to conduct the risk assessment. An urban area was considered if:

- it had sufficient air quality data for the 3-year period under consideration;
- it was a location where at least one C-R function for the selected health endpoint had been estimated by a study that satisfied the study selection criteria; and
- it had available relatively recent location-specific baseline incidence data, specific to International Classification of Disease (ICD) codes, or an equivalent illness classification system.

C-R functions for respiratory ED visits have been estimated in two urban areas in the United States – Atlanta and New York City. The selection of an urban area to include in the risk assessment depends in part on the decision of which epidemiological studies to use. An epidemiological study was considered if:

- it was a published, peer-reviewed study that had been evaluated in the final ISA for the pollutant of interest and judged adequate by EPA staff for purposes of inclusion in the risk assessment based on that evaluation;

- it directly measured, rather than estimated, the pollutant of interest on a reasonable proportion of the days in the study; and

- it either did not rely on Generalized Additive Models (GAMs) using the S-Plus software to estimate C-R functions or it appropriately re-estimated these functions using revised methods.[7]

- it preferably included both single- and multi-pollutant models.

Six U.S. studies focused on ED visits and/or hospital admissions. Three of these (Peel et al., 2005 and Tolbert et al., 2007 in Atlanta; Ito et al., 2007 in New York City) evaluated associations with NO_2 using multi-pollutant models as well as single-pollutant models. Tolbert et al. (2007), which updated Peel et al. (2005), evaluated ED visits among all ages in Atlanta, GA during the period of 1993 to 2004. Using single pollutant models, the authors reported a 2% (95% CI: 1%, 2.9%) increase in respiratory ED visits associated with a 23-ppb increase in 1-h maximum NO_2 levels. In a two-pollutant model with CO, NO_2 was positive and still statistically significant (RR = 1.017, 95% CI =1.006, 1.029). In two-pollutant models with PM_{10} and O_3, and in a three-pollutant model with both PM_{10} and O_3, NO_2 was still positively associated with respiratory ED visits albeit no longer statistically significant (RR = 1.007, 95% CI = 0.996, 1.018 in the model with PM_{10}; RR = 1.010, 95% CI = 0.999, 1.020 in the model with O_3; and RR = 1.004, 95% CI = 0.992, 1.015 in the model with both PM_{10} and O_3) (Tolbert, 2008).

The Atlanta study (Peel et al., 2005 and Tolbert et al., 2007) spanned 12 years, and collected NO_2 monitor data on 4,351 out of a possible 4,384 days – over 99 percent of the days. It satisfies all of the criteria listed above for study selection.

In the study by Ito and colleagues, investigators evaluated ED visits for asthma in New York City during the years 1999 to 2002. The authors found a 12 % (95% CI: 7%, 15%) increase in risk per 20 ppb increase in 24-hour ambient NO_2. Risk estimates were robust and remained statistically significant in multi-pollutant models that included $PM_{2.5}$, O_3, CO, and SO_2.

Due to time and resource constraints, EPA staff selected the Atlanta area and the study by Tolbert et al. to conduct a focused risk assessment for ED visits. Considerations that influenced this choice were the longer time period and more comprehensive coverage of emergency departments in the Tolbert et al. study, the ready availability of baseline incidence data from the authors of this study, and the EPA staff's objective of conducting the risk assessment for the same urban area selected for the population exposure analysis.

[7] The GAM S-Plus problem was discovered prior to the recent final PM risk assessment carried out as part of the PM NAAQS review. It is discussed in the PM Criteria Document (EPA, 2004), PM Staff Paper (EPA, 2005), and PM Health Risk Assessment Technical Support Document (Abt Associates, 2005).

3.4 Selection of concentration-response functions

Studies often report more than one estimated C-R function for the same location and health endpoint. Sometimes models including different sets of co-pollutants are estimated in a study; sometimes different lags are estimated.

Tolbert et al. (2007) estimated C-R functions in which NO_2 was the only pollutant entered into the health effects model (i.e., single pollutant models) as well as other C-R functions in which NO_2 and one or two co-pollutants (PM_{10}, O_3, CO) were entered into the health effects model (i.e., multi-pollutant models). To the extent that any of the co-pollutants present in the ambient air may have contributed to the health effects attributed to NO_2 in single pollutant models, risks attributed to NO_2 might be overestimated where C-R functions are based on single pollutant models. However, if co-pollutants are highly correlated with NO_2, their inclusion in an NO_2 health effects model can lead to misleading conclusions in identifying a specific causal pollutant. When collinearity exists, inclusion of multiple pollutants in models often produces unstable and statistically insignificant effect estimates for both NO_2 and the co-pollutants. Given that single and multi-pollutant models each have both potential advantages and disadvantages, with neither type clearly preferable over the other in all cases, we report risk estimates based on both single- and multi-pollutant models.

All of the models in Tolbert et al. (2007) used a 3-day moving average of pollution levels (i.e., the average of 0-, 1-, and 2-day lags), so the issue of which of several different lag structures to select does not arise. The issue of how well a given lag structure captures the actual relationship between the pollutant and the health effect, however, is still relevant. Models in which the pollutant-related incidence on a given day depends only on same-day or previous-day pollutant concentration (or some variant of those, such as a two- or three-day average concentration) necessarily assume that the longer pattern of pollutant levels preceding the pollutant concentration on a given day does not affect incidence of the health effect on that day. To the extent that a pollutant -related health effect on a given day is affected by pollutant concentrations over a longer period of time, then these models would be mis-specified, and this mis-specification would affect the predictions of daily incidence based on the model. The extent to which short-term NO_2 exposure studies may not capture the possible impact of long-term exposures to NO_2 is not known. A number of epidemiologic studies have examined the effects of long-term exposure to NO_2 and observed associations with decrements in lung function and partially irreversible decrements in lung function growth. The final ISA concludes, however, that "overall, the epidemiological evidence was suggestive but not sufficient to infer a causal relationship between long-term NO_2 exposure and respiratory morbidity" (section 3.4). Currently, there is insufficient information to adequately adjust for the potential impact of longer-term exposure on respiratory ED visits associated with NO_2 exposures, if any, and this uncertainty should be kept in mind as one considers the results from the short-term exposure NO_2 risk assessment.

3.5 Air quality considerations

Air quality considerations are discussed briefly in section 2 of this document and in chapter 6 of the draft REA. Here we describe those air quality considerations that are directly relevant to the estimation of health risks in the NO_2 risk assessment.

In the first part of the risk assessment, we estimate the incidence of the health effect associated with "as is" levels of NO_2 (or equivalently, the change in health effect incidence, Δy, associated with a change in NO_2 concentrations from "as is" levels of NO_2 to 0 ppm). In the second part, we estimate the incidence of the health effect associated with NO_2 concentrations simulated to just meet a standard (i.e., the current NO_2 standard of 0.053 ppm annual average as well as each of several alternative 1-hour daily maximum standards).

To estimate the incidence of a health effect associated with "as is" NO_2 levels in a location, we need a time series of hourly "as is" NO_2 concentrations for that location. We use monitor data from the Georgia Tech monitor (monitor id =131210048), the monitor that was used in Tolbert et al. (2007), the epidemiology study from which we obtained C-R functions (see section 3.3 above).

For the Georgia Tech monitor site, complete hourly data were available on over 93 percent of the days – 348 days in 2005, 345 days in 2006, and 340 days in 2007. Missing air quality data were estimated by the following procedure. Where there were consecutive strings of missing values (data gaps of less than 6 hours), missing values were estimated by linear interpolation between the valid values at the ends of the gap. Remaining missing values at a monitor were estimated by fitting linear regression models for each hour of the day, with each of the other monitors, and choosing the model which maximizes R^2 for each hour of the day, subject to the constraints that R^2 be greater than 0.5 and the number of regression data values is at least 50. If there were any remaining missing values at this point, for gaps of less than 9 hours, missing values were estimated by linear interpolation between the valid values at the ends of the gap. Any remaining missing values were replaced with the regional mean for that hour. The annual mean, and the 98th and 99th percentiles of daily 1-hr maximum concentrations are shown in Table 3-1, separately for 2005, 2006, and 2007.

Table 3-1. Mean and 98th and 99th Percentiles of the Distributions of 1-Hour Daily Maximum NO_2 Concentrations (in ppm) at the Georgia Tech Monitor: 2005, 2006, and 2007

Year	Mean	98th Percentile	99th Percentile
2005	0.0351	0.0764	0.0794
2006	0.0364	0.0660	0.0694
2007	0.0327	0.0684	0.0780

Because Tolbert et al. (2007) estimated a relationship between daily respiratory-related ED visits and the 3-day moving average (i.e., NO_2 levels on the same day, the previous day, and the day before that) of daily 1-hour maximum NO_2 concentrations, we calculated daily 1-hour maximum NO_2 concentrations at the monitor. Because our lower bound NO_2 concentration is 0 ppm in all cases, for each day Δx in equation (3-3) equals the 3-day moving average of the 1-hour maximum "as is" NO_2 concentration for that day at the Georgia Tech monitor.

The calculations for the second part of the risk assessment, in which we estimated risks associated with NO_2 levels simulated to just meet the current and alternative standards were done analogously, using the monitor-specific series of adjusted hourly concentrations rather than the monitor-specific series of "as is" hourly concentrations.

3.6 Baseline health effects incidence

The most common epidemiologically-based health risk model expresses the reduction in health risk (Δy) associated with a given reduction in NO_2 concentrations (Δx) as a percentage of the baseline incidence (y). To accurately assess the impact of changes in NO_2 air quality on health risk in the selected urban area, information on the baseline incidence of the health effect (i.e., the incidence under "as is" air quality conditions) in the selected location is therefore needed.

We obtained an estimate of the baseline incidence of respiratory ED visits in Atlanta, GA (Tolbert, 2008). The study notes that there are 42 hospitals with EDs in the 20-county Atlanta MSA. Of these, 41 were able to provide incidence data for at least part of the study period (1993 – 2004). For purposes of the NO_2 risk assessment, we need incidences for the years of the risk assessment (2005 – 2007). Assuming that baseline incidence of respiratory ED visits does not change appreciably in the span of a few years, we used the incidence of respiratory ED visits for the most recent year in the Tolbert study, 2004 – 121,818 respiratory ED visits (Tolbert, 2008).[8] Because this baseline incidence estimate is based on 36 hospitals, rather than the total 42 hospitals with EDs in Atlanta, this is an underestimate of baseline incidence. This is thus a source of downward bias in our estimates of NO_2-related risk.

The specific definition of "respiratory-related" ED visits used in Tolbert et al. (2007) included ED visits with the following respiratory illnesses as the primary diagnosis (specified by ICD-9 diagnostic codes): asthma (493, 786.07, and 786.09), COPD (491, 492, and 496), upper respiratory illness (460 – 465, 460.0, and 477), pneumonia (480 – 486), and bronchiolitis (466.1, 466.11, and 466.19). The baseline incidence given above – 121,818 – is thus a count of all ED visits with one of these ICD-9 codes as the primary diagnosis at the 36 hospitals in the Atlanta MSA that contributed 2004 baseline incidence data to the Tolbert study.

[8] 2004 was not only the most recent year for which a baseline incidence estimate was available from the study, but it also had the most hospitals reporting – 36 out of 42 hospitals.

3.7 Summary of determinants of the NO_2 risk assessment

The determinants of the NO_2 risk assessment can be summarized as follows:

- Health endpoint: respiratory ED visits among all ages
- Assessment location: Atlanta MSA
- Epidemiological study: Tolbert et al. (2007)
- C-R functions:
    - a single-pollutant C-R function,
    - two-pollutant C-R functions (with CO, PM_{10}, and O_3), and
    - a three-pollutant C-R function (with both PM_{10} and O_3).

  In all C-R functions the count of ED visits on a given day is related to a 3-day moving average of NO_2 1-hour maxima (i.e., NO_2 1-hour maxima on the same day, the previous day, and the day before that).
- Air quality data: 1-hour maximum "as is" NO_2 concentration for each day calculated from hourly air quality data at the Georgia Tech monitor (site id =131210048), the monitor used in the epidemiology study from which we obtained C-R functions. Complete hourly data were available on over 93 percent of the days of the three-year period.
- Baseline incidence: an estimate of the baseline incidence of respiratory ED visits in Atlanta, GA in 2004 (the most recent year in the study) was obtained (Tolbert, 2008). The estimate, 121,818 respiratory ED visits in 2004, was based on 36 (out of 42) hospitals that reported data.

3.8 Addressing uncertainty and variability

Any estimation of risk associated with "as is" NO_2 concentrations, with just meeting the current NO_2 standard, or with just meeting alternative NO_2 standards should address both the variability and uncertainty that generally underlie such an analysis. *Uncertainty* refers to the lack of knowledge regarding the actual values of model input variables (parameter uncertainty) and of physical systems or relationships (model uncertainty – e.g., the shapes of C-R functions). The goal of the analyst is to reduce uncertainty to the maximum extent possible. Uncertainty can be reduced by improved measurement and improved model formulation. In a health risk assessment, however, significant uncertainty often remains. The degree of uncertainty can be characterized, sometimes quantitatively. For example, the statistical uncertainty surrounding the estimated NO_2 coefficients in the C-R functions is reflected in confidence intervals provided for the risk estimates.

Variability refers to the heterogeneity in a population or parameter. Even if there is no uncertainty surrounding inputs to the analysis, there may still be variability. For example, there may be variability among C-R functions describing the relationship between NO_2 and respiratory ED visits across urban areas. This variability does not imply uncertainty about the C-R function in any of the urban areas, but only that these functions are different in the different locations, reflecting differences in the populations and/or other factors that may affect the relationship between NO_2 and respiratory ED visits. In general, it is possible to have uncertainty but no variability (if, for instance, there is a single parameter whose value is uncertain) or variability but little or no uncertainty (for example, people's heights vary considerably but can be accurately measured with little uncertainty).

The NO_2 risk assessment addresses variability-related concerns by using location-specific inputs (i.e., location-specific C-R function, baseline incidence data and air quality data). Because the NO_2 risk assessment focuses on only a single urban area, it does not attempt to portray a larger picture of risk than is relevant to the selected assessment area.

Temporal variability is more difficult to address, because the risk assessment focuses on some unspecified time in the future. To minimize the degree to which values of inputs to the analysis may be different from the values of those inputs at that unspecified time, we used recent input data – for example, year 2005 through 2007 air quality data and recent (2004) baseline incidence data. However, future changes in inputs have not been predicted (e.g., future baseline incidences). To address the impact of variability in NO_2 concentrations from one year to another, we carried out the risk assessment for the years in the three-year period under consideration – 2005, 2006, and 2007 – separately.

A number of important sources of uncertainty in the NO_2 risk assessment are addressed where possible. The following are among the major sources of uncertainty:

- Uncertainties related to estimating the C-R functions, including
  - uncertainty about the extent to which the association between NO_2 and the health endpoint actually reflects a causal relationship.
  - uncertainty surrounding estimates of NO_2 coefficients in the C-R functions used in the analyses.
  - uncertainty about the specification of the model (including the shape of the C-R relationship), particularly whether or not there is a threshold below which no response occurs.
  - uncertainty related to the transferability of NO_2 C-R functions from the study time period to the time period selected for the risk assessment.[9] A C-R function in a study time period may not provide an accurate representation of the C-R relationship in the analysis time period because of

[9] Uncertainty about transferability of C-R functions often results not only from differences between the study and risk assessment time periods, but also between the study and risk assessment locations. Because the NO_2 risk assessment is being conducted in the same location as the study from which the C-R functions were obtained, this is not a problem here.

- the possible role of associated co-pollutants, which may vary over time, in influencing NO_2 risk,
- temporal variation in the relationship of total ambient exposure (both outdoor and ambient contributions to indoor exposure) to ambient monitoring (e.g., due to changes in air conditioning usage over time),
- changes in population characteristics (e.g., the proportions of members of sensitive subpopulations) and population behavior patterns over time.

- Uncertainties related to the air quality data, including the adjustment procedure that was used to simulate just meeting the current and alternative NO_2 standards.

- Uncertainties associated with use of baseline health effects incidence information – e.g., the extent to which the baseline incidence estimate is downward biased by the lack of data for 6 of the 42 hospitals in the Atlanta MSA.

The specific sources of uncertainty in the NO_2 risk assessment are described in detail below and are summarized in Table 3-2.

Table 3-2. Key Uncertainties in the NO_2 Risk Assessment

Uncertainty	Comments
Causality	Statistical association does not prove causation. However, the risk assessment considers only a health endpoint for which the overall weight of the evidence supports the assumption that NO_2 is likely causally related based on the totality of the health effects evidence.
Empirically estimated C-R relations	Because C-R functions are empirically estimated, there is uncertainty surrounding these estimates. Omitted confounding variables could cause bias in the estimated NO_2 coefficients. However, including potential confounding variables that are highly correlated with one another can lead to unstable estimators. Because both single- and multi-pollutant models were available, both were used.
Functional form of C-R relation	Statistical significance of coefficients in an estimated C-R function does not necessarily mean that the mathematical form of the function is the best model of the true C-R relation.
Lag structure of C-R relation	The actual lag structure for short-term NO_2 exposures is uncertain. Omitted lags could cause an underestimation in the predicted incidence associated with a given reduction in NO_2 concentrations.
Transferability of C-R relations	C-R functions may not provide an adequate representation of the C-R relationship in times and places other than those in which they were estimated. For example, populations in the assessment location/time period may have more or fewer members of sensitive subgroups than the location/time period in which functions were derived, which would introduce additional uncertainty related to the use of a given C-R function in the analysis. This problem was minimized in the NO_2 risk assessment, however, because it relies on C-R functions estimated in a recent study conducted in the assessment location.
Extrapolation of C-R relations beyond the range of observed NO_2 data	A C-R relationship estimated by an epidemiological study may not be valid at concentrations outside the range of concentrations observed during the study. This problem should be minimal in the NO_2 risk assessment, however, because the NO_2 concentrations observed in the study from which C-R functions were obtained covered a wide range – from 1 ppb to 181 ppb.
Adequacy of ambient NO_2 monitors as surrogate for population exposure	Possible differences in how the spatial variation in ambient NO_2 levels across an urban area are characterized in the original epidemiological study compared to the more recent ambient NO_2 data used to characterize current air quality would contribute to uncertainty in the health risk estimates. The NO_2 risk assessment uses the same monitor used in the epidemiological study from which the C-R functions were obtained, which should minimize this source of uncertainty.

Uncertainty	Comments
Adjustment of air quality distributions to simulate just meeting current and alternative NO_2 standards.	The pattern and extent of daily reductions in NO_2 concentrations that would result if the current NO_2 standard or alternative NO_2 standards were just met is not known. There remains uncertainty about the shape of the air quality distribution of hourly levels upon just meeting an NO_2 standard that will depend on future air quality control strategies.
Baseline health effects data	Data on baseline incidence may be uncertain for a variety of reasons. For example, location- and age-group-specific baseline rates may not be available in all cases. Baseline incidence may change over time for reasons unrelated to NO_2. This source of uncertainty is relatively minor in the NO_2 risk assessment, however, because a baseline incidence estimate has been obtained from the study authors for the assessment area. There is a known downward bias to this estimate, however, because it is based on an incomplete set of hospitals providing ED data (36 out of 42) in the Atlanta MSA.

We handled uncertainties in the risk assessment as follows:

- Limitations and assumptions in estimating risks and reduced risks are clearly stated and explained.

- The uncertainty resulting from the statistical uncertainty associated with the estimate of the NO_2 coefficient in a C-R function was characterized by confidence intervals around the corresponding point estimate of risk. Confidence intervals express the range within which the true risk is likely to fall if the uncertainty surrounding the NO_2 coefficient estimate were the only uncertainty in the analysis. They do not, for example, reflect the uncertainty concerning whether the NO_2 coefficients in the study period and the assessment period are the same.

Not all health effects that may result from NO_2 exposure were included. We focused on respiratory ED visits because it was judged that there was sufficient epidemiological and other evidence to support the hypothesis of a causal relationship. Other health effects reported to be associated with exposure to NO_2 (e.g., increased respiratory illnesses and symptoms) are considered qualitatively in the draft REA. Thus, it is important to recognize that the NO_2 risk assessment represents only a portion of the health risks associated with NO_2 exposures.

3.8.1 Concentration-response functions

The C-R function is a key element of the NO_2 risk assessment. The quality of the risk assessment depends, in part, on (1) whether the C-R functions used in the risk assessment are good estimates of the relationship between the population health response and ambient NO_2 concentration in the study location (which, in this case, is the same as the assessment location), (2) how applicable these functions are to the analysis period, and (3) the extent to which these relationships apply beyond the range of the NO_2 concentrations from which they were estimated. These issues are discussed in the subsections below.

3.8.1.1 Uncertainty associated with the appropriate model form

The relationship between a health endpoint and NO_2 can be characterized in terms of the form of the function describing the relationship – e.g., linear, log-linear, or logistic – and the value of the NO_2 coefficient in that function. Although most epidemiological studies estimated NO_2 coefficients in log-linear models, there is still substantial uncertainty about the correct functional form of the relationship between NO_2 and respiratory ED visits – especially at the low end of the range of NO_2 values, where data are generally too sparse to discern possible thresholds. While there are likely biological thresholds in individuals for specific health responses, the available epidemiological studies generally have not supported or refuted the existence of thresholds at the population level for NO_2 exposures within the range of air quality observed in the studies.

3.8.1.2 Uncertainty associated with the estimated concentration-response functions in the study location

The uncertainty associated with an estimate of the NO_2 coefficient in a C-R function reported by a study depends on the sample size and the study design. The final ISA has evaluated the substantial body of NO_2 epidemiological studies. In general, critical considerations in evaluating the design of an epidemiological study include the adequacy of the measurement of ambient NO_2, the adequacy of the health effects incidence data, and the consideration of potentially important health determinants and potential confounders and effect modifiers such as:

- other pollutants;
- weather variables (e.g., temperature extremes);
- exposure to other health risks, such as smoking and occupational exposure; and
- demographic characteristics, including age, sex, socioeconomic status, and access to medical care.

The possible confounding effects of copollutants, including other criteria air pollutants, has often been noted as a problem in air pollutant risk assessments, particularly when these other pollutants are highly correlated with the pollutant of interest. NO_2 was only moderately correlated with the other pollutants considered in the models that produced the C-R functions that are used in the risk assessment (see Tolbert et al., 2007, Table 3), although it was fairly highly correlated (corr.=0.7) with CO. The issue of possible confounding by copollutants is discussed in more detail in the final ISA.

One of the criteria for selecting studies addresses the adequacy of the measurement of ambient NO_2. This criterion was that NO_2 was directly measured, rather than estimated, on a reasonable proportion of the days in the study. This criterion was designed to minimize error in the estimated NO_2 coefficients in the C-R functions used in the risk assessment. NO_2 was measured in the Tolbert study on over 93 percent of the days of the study period, so this criterion was well satisfied.

Ambient concentrations at central monitors, however, may not provide a good representation of personal exposures. The final ISA identifies the following three components to exposure measurement error: (1) the use of average population rather than individual exposure data; (2) the difference between average personal ambient exposure and ambient concentrations at central monitoring sites; and (3) the difference between true and measured ambient concentrations (final ISA, section 1.3.2, p. 1-5). While a C-R function may understate the effect of personal exposures to NO_2 on the incidence of a health effect, however, it will give an unbiased estimate of the effect of ambient concentrations on the incidence of the health effect, if the ambient concentrations at monitoring stations provide an unbiased estimate of the ambient concentrations to which the population is exposed. In this case, if NO_2 is actually the causal agent, the understatement of the impact of personal exposures isn't an issue (since EPA regulates ambient concentrations rather than personal exposures). If NO_2 is not the causal agent, however, then there is a problem of confounding copollutants or other factors, so that reducing ambient NO_2 concentrations might not result in the expected reductions in the health effect. A more comprehensive discussion of exposure measurement error and its potential impact on the NO_2 C-R relationships reported in community epidemiological studies is given in section 2.5.8 of the ISA and in the ISA Annex section AX6.1.

To the extent that a study did not address all relevant factors (i.e., all factors that affect the health endpoint), there is uncertainty associated with the C-R function estimated in that study, beyond that reflected in the confidence or credible interval. It may result in either over- or underestimates of risk associated with ambient NO_2 concentrations in the location in which the study was carried out. Techniques for addressing the problem of confounding factors and other study design issues have improved over the years, however, and the epidemiological studies currently available for use in the NO_2 risk assessment provide a higher level of confidence in study quality than ever before.

When a study is conducted in a single location, the problem of possible confounding co-pollutants may be particularly difficult, if co-pollutants are highly correlated in the study location. Single-pollutant models, which omit co-pollutants, may produce overestimates of the NO_2 effect, if some of the effects of other pollutants (omitted from the model) are falsely attributed to NO_2. Statistical estimates of an NO_2 effect based on a multi-pollutant model can be more uncertain, and even statistically insignificant, if the co-pollutants included in the model are highly correlated with NO_2. As a result of these considerations, we report risk estimates based on both the single-pollutant and multi-pollutant models from Tolbert et al. (2007).

3.8.1.3 Applicability of concentration-response functions in different locations and/or time periods

The relationship between ambient NO_2 concentration and the incidence of a given health endpoint in the population (the population health response) depends on (1) the relationship between ambient NO_2 concentration and personal exposure to ambient generated NO_2 and (2) the relationship between personal exposure to ambient-generated NO_2 and the population health response. Both of these are likely to vary to some degree from one location and/or time period to another. The relationship between ambient NO_2 concentration and personal exposure to ambient-generated NO_2 will depend on patterns of behavior, such as the amount of time spent outdoors, as well as on factors affecting the extent to which ambient-generated NO_2 infiltrates into indoor environments. The relationship between personal exposure to ambient-generated NO_2 and the population health response will depend on the population exposed. Exposed populations may differ from one location and/or time period to another in characteristics that are likely to affect their susceptibility to NO_2 air pollution. For instance, people with preexisting conditions such as asthma are probably more susceptible to the adverse effects of exposure to NO_2, and populations may vary from one location and/or time period to another in the prevalence of specific diseases. Also, some age groups may be more susceptible than others, and population age distributions may also vary both spatially and temporally. In the NO_2 risk assessment we avoid the uncertainty associated with inter-locational differences, however, by using C-R functions that were estimated in the assessment area. In addition, although we cannot completely eliminate possible temporal changes, we minimize the uncertainty associated with such changes by using relatively recent baseline incidence data.

3.8.1.4 Extrapolation beyond observed air quality levels

Although a C-R function describes the relationship between ambient NO_2 and a given health endpoint for all possible NO_2 levels (potentially down to zero), the estimation of a C-R function is based on real ambient NO_2 values that are limited to the range of NO_2 concentrations in the location in which the study was conducted. Thus, uncertainty in the shape of the estimated C-R function increases considerably outside the range of NO_2 concentrations observed in the study.

Because we are interested in the effects of NO_2 down to 0 ppm, the NO_2 risk assessment assumes that the estimated C-R functions adequately represent the true C-R relationship down to 0 ppm in the assessment location. However, although the observed NO_2 concentrations in Tolbert et al. (2007) did not go down to 0 ppm, the study authors reported the minimum 1-hour NO_2 level observed in their study to be 1 ppb (or 0.001 ppm) (and the maximum to be 181 ppb), so the uncertainty resulting from extrapolation to levels below those air quality levels observed in the study should be minimal.

The C-R relationship may also be less certain towards the upper end of the concentration range being considered in a risk assessment, particularly if the NO_2 concentrations in the assessment location/time period exceed the NO_2 concentrations observed in the study location/time period. Even though it may be reasonable to model the C-R relationship as log-linear over the ranges of NO_2 concentrations typically observed in epidemiological studies, it may not be log-linear over the entire range of NO_2 levels at the location considered in the NO_2 risk assessment. However, because the study was carried out in the risk assessment location and is relatively recent, the uncertainty resulting from extrapolation to levels above those air quality levels observed in the study should similarly be minimal.

3.8.2 The air quality data

3.8.2.1 Adequacy of NO_2 air quality data

Ideally, the measurement of average hourly ambient NO_2 concentrations in the study location is unbiased. In this case, unbiased risk predictions in the assessment location depend, in part, on an unbiased measurement of average hourly ambient NO_2 concentrations in the assessment location as well. If, however, the measurement of average hourly ambient NO_2 concentrations in the study location is biased, unbiased risk predictions in the assessment location are still possible if the measurement of average hourly ambient NO_2 concentrations in the assessment location incorporates the same bias as exists in the study location measurements. Because the NO_2 risk assessment is using the same NO_2 monitor as was used in Tolbert et al. (2007), the estimates of risk should avoid any bias as a result of the monitor estimates of average hourly ambient NO_2 concentrations in the risk assessment location.

Another potential source of uncertainty is missing air quality data. Although NO_2 concentrations were not available for all hours of the 3-year period chosen for the NO_2 risk assessment in the assessment location, they were available for all hours on most days. In particular, complete hourly data were available on over 93 percent of the days – 348 days in 2005, 345 days in 2006, and 340 days in 2007. Missing NO_2 concentrations were filled in, as described above in section 3.5.

The results of the risk assessment are generalizable to other years only to the extent that ambient NO_2 levels in the available data are similar to ambient NO_2 levels in those other years. A substantial difference between NO_2 levels in the years used in the risk assessment and NO_2 levels in the other years could imply a substantial difference in predicted incidences of health effects.

3.8.2.2 Simulation of reductions in NO_2 concentrations to just meet the current or an alternative standard

The pattern of hourly NO_2 concentrations that would result if the current NO_2 standard or an alternative standard were just met in the assessment location is, of course, not known. This therefore adds uncertainty to estimates of risk when NO_2 concentrations just meet a specified standard.

Although the health risk assessment uses air quality data from three years, 2005, 2006, and 2007, it simulates just attaining a standard in each year separately, since we are estimating annual reduced health risks. Design values based on the most recent three-year period available are used to determine the amount of adjustment to apply to each of these years. As can be seen in Table 3-1, the distributions of NO_2 concentrations in the three years are similar**.**

3.8.3 Baseline health effects incidence

The C-R functions used in the NO_2 risk assessment are log-linear (see equation 3-1 in section 3.1). Given this functional form, the percent change in incidence of a health effect corresponding to a change in NO_2 depends only on the change in NO_2 levels (and not the actual value of either the initial or final NO_2 concentration). This percent change is multiplied by a baseline incidence, y_0, in order to determine the change in health effects incidence, as shown in equation (3-3) in section 3.1:

$$\Delta y = y_0[1 - e^{-\beta \Delta x}] \quad .$$

Predicted changes in incidence therefore depend on the baseline incidence of the health effect.

3.8.3.1 Quality of incidence data

As noted in section 3.7 above, we obtained an estimate of the baseline incidence of respiratory ED visits in Atlanta, GA (Tolbert, 2008). There are 42 hospitals with EDs in the 20-county Atlanta MSA, but not all 42 contributed incidence data in all of the years of the Tolbert study (1993 – 2004). The most recent year of the study (2004) had an estimate of baseline incidence of respiratory ED visits in Atlanta based on data from 36 hospitals. Although this was the largest number of hospitals reporting in any single year of the study, it is still not the entire 42 hospitals with EDs in the study (and risk assessment) area. The estimate of baseline incidence in 2004, which is used as the estimate of baseline incidence in the NO_2 risk assessment for 2005 - 2007, is thus an underestimate. This underestimate of baseline incidence is therefore a source of downward bias in the estimates of NO_2-related respiratory ED visits.

A minor uncertainty surrounding hospital or ED visit baseline incidence estimates sometimes arises if these estimates are based on the reporting of hospitals within an assessment area. Hospitals report the numbers of ICD code-specific discharges in a given year. If people from outside the assessment area use these hospitals or EDs, and/or if residents of the assessment area use hospitals or EDs outside the assessment area, these rates will not accurately reflect the numbers of residents of the assessment area who were admitted to the hospital or ED for specific illnesses during the year, the rates that are desired for the risk assessment. This problem is partially avoided in Tolbert et al. (2007) because only residents of the Atlanta MSA, determined by residential zip code at the time of the ED visit, were included in the study. To the extent that residents of the Atlanta MSA visited EDs outside the Atlanta MSA, this would tend to downward bias the estimates of NO_2-related risk of respiratory-related ED visits. However, this is likely to be a very minor problem because emergency visits are likely to be made to the closest ED available, which, for residents of the Atlanta MSA are likely to be within that MSA.

Regardless of the data source, if actual incidences are higher than the incidences used, risks will be underestimated. If actual incidences are lower than the incidences rates used, then risks will be overestimated.

Both morbidity and mortality rates change over time for various reasons. One of the most important of these is that population age distributions change over time. The old and the extremely young are more susceptible to many health problems than is the population as a whole. The most recent available data were used in the NO_2 risk assessment. However, the average age of the population in the assessment location will increase as post-World War II children age. Alternatively, if Atlanta experiences rapid in-migration, as is currently occurring in much of the South and West, it may tend to have a decreasing mean population age and corresponding changes in incidence rates and risk. Consequently, to the extent that respiratory-related ED visits are age-related, the baseline incidence rate may change over time. However, recent data were used in all cases, so temporal changes are not expected to be a large source of uncertainty.

3.8.3.2 Lack of daily health effects incidences

Both ambient NO_2 levels and the daily health effects incidence rates corresponding to ambient NO_2 levels vary somewhat from day to day. Those analyses based on C-R functions estimated by short-term exposure studies calculate daily changes in incidence and sum them over the days of the year to predict a total change in health effect incidence during the year. However, only annual baseline incidence is available. Average daily baseline incidences, necessary for short-term daily C-R functions, were calculated by dividing the annual incidence by the number of days in the year for which the baseline incidences were obtained. To the extent that NO_2 affects health, however, actual incidence rates would be expected to be somewhat higher than average on days with high NO_2 concentrations; using an average daily incidence would therefore result in underestimating the changes in incidence on such days. Similarly, actual incidence rates would be expected to be somewhat lower than average on days with low NO_2 concentrations; using an average daily incidence would therefore result in overestimating the changes in incidence on low NO_2 days. Both effects would be expected to be small, however, and should largely cancel one another out.

4 RESULTS

Results are expressed as (1) incidence of respiratory-related ED visits, (2) incidence of respiratory-related ED visits per 100,000 population, and (3) percent of total incidence of respiratory-related ED visits. Each form of result is shown in three tables, one for each of the three years (2005, 2006, and 2007) of air quality data used in the analysis. As noted in section 2.3, because the current annual average standard is based on two years, the adjustment to simulate just meeting the current standard was applied only to two years, 2006 and 2007. Therefore, results tables for 2005 do not include results associated with just meeting the current standard. The alternative 1-hour daily maximum standards, in contrast, have the form of the 3-year average of the 98^{th} (or 99^{th}) percentile of the daily maximum 1-hour concentrations. Thus, the adjustment to simulate just meeting these alternative 1-hour daily maximum standards was applied to each of the three years, 2005, 2006 and 2007. Therefore, results tables for 2006 and 2007 include results associated with just meeting the alternative 1-hour daily maximum standards as well as results associated with just meeting the current standard. All results tables include results associated with “as is” NO_2 concentrations.

Tables 4-1 through 4-3 show results expressed as incidence of respiratory-related ED visits for 2005, 2006, and 2007, respectively. Tables 4-4 through 4-6 show results expressed as incidence of respiratory-related ED visits per 100,000 population for each of the three years; and Tables 4-7 through 4-9 show results expressed as percent of total incidence of respiratory-related ED visits for each of the three years. Figure 4-1 shows the trends over both years and air quality scenarios, based on the single-pollutant model.

Table 4-1. Estimated Incidence of Respiratory Emergency Department Visits Associated with "As Is" NO_2 Concentrations and NO_2 Concentrations that Just Meet Alternative Standards in Atlanta, GA, Based on Adjusting 2005 NO_2 Concentrations*

Other Pollutants in Model	Incidence of Respiratory Emergency Department Visits Associated with "As is" NO_2 Concentrations and NO_2 Concentrations that Just Meet Alternative Standards**								
	"as is"	Atternative 98th percentile 1-hr daily maximum standards (ppm)				Alternative 99th percentile 1-hr daily maximum standards (ppm)			
		0.05***	0.1	0.15	0.2	0.05	0.1	0.15	0.2
none	3600 (1900 - 5300)	2600 (1400 - 3800)	5100 (2700 - 7400)	7500 (4100 - 10900)	9900 (5400 - 14300)	2400 (1300 - 3500)	4700 (2500 - 6900)	7000 (3800 - 10200)	9300 (5000 - 13300)
CO	3100 (1000 - 5100)	2200 (700 - 3600)	4300 (1500 - 7200)	6400 (2200 - 10500)	8500 (2900 - 13800)	2000 (700 - 3400)	4000 (1400 - 6700)	6000 (2000 - 9800)	7900 (2700 - 12900)
O_3	1800 (-100 - 3700)	1300 (-100 - 2600)	2600 (-100 - 5200)	3900 (-200 - 7700)	5100 (-200 - 10200)	1200 (-100 - 2500)	2400 (-100 - 4900)	3600 (-200 - 7200)	4800 (-200 - 9500)
PM_{10}	1300 (-700 - 3300)	900 (-500 - 2300)	1800 (-1000 - 4600)	2700 (-1600 - 6800)	3600 (-2100 - 9000)	800 (-500 - 2200)	1700 (-1000 - 4300)	2500 (-1500 - 6400)	3400 (-1900 - 8400)
PM_{10}, O_3	700 (-1400 - 2800)	500 (-1000 - 2000)	1000 (-2000 - 4000)	1600 (-3000 - 5900)	2100 (-4000 - 7800)	500 (-900 - 1900)	1000 (-1800 - 3700)	1500 (-2800 - 5500)	1900 (-3700 - 7300)

*Estimated incidences of respiratory emergency department visits are based on the concentration-response functions estimated in Tolbert et al. (2007) [results corresponding to Figure 2 in Tolbert et al. (2007) were obtained via personal communication with P. Tolbert]. All models use a 3-day moving average of the daily 1-hr. maximum NO_2 concentration and apply to all ages.

**Incidence was quantified down to 0 ppb. Incidences are rounded to the nearest 100.

***Alternative 1-hr daily maximum standards are characterized by a concentration of m ppm and an nth percentile, requiring that the average of the 3 annual nth percentile 1-hr daily maxima over a 3-year period be at or below m ppm.
Note: Numbers in parentheses are 95% confidence intervals based on statistical uncertainty surrounding the NO_2 coefficient.

Table 4-2. Estimated Incidence of Respiratory Emergency Department Visits Associated with "As Is" NO_2 Concentrations and NO_2 Concentrations that Just Meet the Current and Alternative Standards in Atlanta, GA, Based on Adjusting 2006 NO_2 Concentrations*

Other Pollutants in Model	Incidence of Respiratory Emergency Department Visits Associated with "As is" NO_2 Concentrations and NO_2 Concentrations that Just Meet the Current and Alternative Standards**									
	"as is"	current annual standard	Alternative 98th percentile 1-hr daily maximum standards (ppm)				Alternative 99th percentile 1-hr daily maximum standards (ppm)			
			0.05***	0.1	0.15	0.2	0.05	0.1	0.15	0.2
none	3800 (2000 - 5500)	10900 (5900 - 15700)	2700 (1400 - 3900)	5300 (2800 - 7700)	7800 (4200 - 11300)	10300 (5600 - 14800)	2500 (1300 - 3600)	4900 (2600 - 7200)	7300 (3900 - 10600)	9600 (5200 - 13900)
CO	3200 (1100 - 5300)	9400 (3200 - 15200)	2300 (800 - 3800)	4500 (1500 - 7400)	6700 (2300 - 11000)	8800 (3000 - 14400)	2100 (700 - 3500)	4200 (1400 - 6900)	6200 (2100 - 10200)	8200 (2800 - 13400)
O_3	1900 (-100 - 3900)	5600 (-300 - 11200)	1400 (-100 - 2700)	2700 (-100 - 5400)	4000 (-200 - 8000)	5300 (-200 - 10600)	1300 (-100 - 2600)	2500 (-100 - 5100)	3700 (-200 - 7500)	4900 (-200 - 9900)
PM_{10}	1300 (-800 - 3400)	4000 (-2300 - 9900)	900 (-500 - 2400)	1900 (-1100 - 4800)	2800 (-1600 - 7100)	3700 (-2200 - 9400)	900 (-500 - 2300)	1800 (-1000 - 4500)	2600 (-1500 - 6600)	3500 (-2000 - 8700)
PM_{10}, O_3	800 (-1500 - 2900)	2300 (-4400 - 8600)	500 (-1000 - 2100)	1100 (-2100 - 4100)	1600 (-3100 - 6200)	2200 (-4200 - 8100)	500 (-1000 - 1900)	1000 (-1900 - 3900)	1500 (-2900 - 5700)	2000 (-3900 - 7600)

*Estimated incidences of respiratory emergency department visits are based on the concentration-response functions estimated in Tolbert et al. (2007) [results corresponding to Figure 2 in Tolbert et al. (2007) were obtained via personal communication with P. Tolbert]. All models use a 3-day moving average of the daily 1-hr. maximum NO_2 concentration and apply to all ages.

**Incidence was quantified down to 0 ppb. Incidences are rounded to the nearest 100.

***Alternative 1-hr daily maximum standards are characterized by a concentration of m ppm and an nth percentile, requiring that the average of the 3 annual nth percentile 1-hr daily maxima over a 3-year period be at or below m ppm.

Note: Numbers in parentheses are 95% confidence intervals based on statistical uncertainty surrounding the NO_2 coefficient.

Table 4-3. Estimated Incidence of Respiratory Emergency Department Visits Associated with "As Is" NO_2 Concentrations and NO_2 Concentrations that Just Meet the Current and Alternative Standards in Atlanta, GA, Based on Adjusting 2007 NO_2 Concentrations*

Other Pollutants in Model	Incidence of Respiratory Emergency Department Visits Associated with "As is" NO_2 Concentrations and NO_2 Concentrations that Just Meet the Current and Alternative Standards**									
	"as is"	current annual standard	Alternative 98th percentile 1-hr daily maximum standards (ppm)				Alternative 99th percentile 1-hr daily maximum standards (ppm)			
			0.05***	0.1	0.15	0.2	0.05	0.1	0.15	0.2
none	3400 (1800 - 4900)	9800 (5300 - 14200)	2400 (1300 - 3500)	4700 (2500 - 6900)	7000 (3800 - 10200)	9300 (5000 - 13400)	2200 (1200 - 3300)	4400 (2400 - 6400)	6500 (3500 - 9500)	8600 (4700 - 12500)
CO	2900 (1000 - 4800)	8400 (2900 - 13700)	2000 (700 - 3400)	4000 (1300 - 6700)	6000 (2000 - 9900)	7900 (2700 - 12900)	1900 (600 - 3200)	3800 (1300 - 6200)	5600 (1900 - 9200)	7400 (2500 - 12100)
O_3	1700 (-100 - 3500)	5100 (-200 - 10100)	1200 (-100 - 2500)	2400 (-100 - 4900)	3600 (-200 - 7200)	4800 (-200 - 9500)	1100 (-100 - 2300)	2200 (-100 - 4500)	3300 (-200 - 6700)	4400 (-200 - 8900)
PM_{10}	1200 (-700 - 3000)	3600 (-2100 - 8900)	800 (-500 - 2200)	1700 (-1000 - 4300)	2500 (-1500 - 6400)	3400 (-1900 - 8400)	800 (-400 - 2000)	1600 (-900 - 4000)	2400 (-1400 - 5900)	3100 (-1800 - 7800)
PM_{10}, O_3	700 (-1300 - 2600)	2100 (-4000 - 7800)	500 (-900 - 1900)	1000 (-1800 - 3700)	1500 (-2800 - 5500)	1900 (-3700 - 7300)	500 (-900 - 1700)	900 (-1700 - 3500)	1400 (-2600 - 5100)	1800 (-3400 - 6800)

*Estimated incidences of respiratory emergency department visits are based on the concentration-response functions estimated in Tolbert et al. (2007) [results corresponding to Figure 2 in Tolbert et al. (2007) were obtained via personal communication with P. Tolbert]. All models use a 3-day moving average of the daily 1-hr. maximum NO_2 concentration and apply to all ages.

**Incidence was quantified down to 0 ppb. Incidences are rounded to the nearest 100.

***Alternative 1-hr daily maximum standards are characterized by a concentration of m ppm and an nth percentile, requiring that the average of the 3 annual nth percentile 1-hr daily maxima over a 3-year period be at or below m ppm.
Note: Numbers in parentheses are 95% confidence intervals based on statistical uncertainty surrounding the NO_2 coefficient.

Table 4-4. Estimated Incidence of Respiratory Emergency Department Visits per 100,000 Population Associated with "As Is" NO_2 Concentrations and NO_2 Concentrations that Just Meet Alternative Standards in Atlanta, GA, Based on Adjusting 2005 NO_2 Concentrations*

Other Pollutants in Model	Incidence of Respiratory Emergency Department Visits per 100,000 Population Associated with "As is" NO_2 Concentrations and NO_2 Concentrations that Just Meet Alternative Standards**								
	"as is"	Alternative 98th percentile 1-hr daily maximum standards (ppm)				Alternative 99th percentile 1-hr daily maximum standards (ppm)			
		0.05***	**0.1**	**0.15**	**0.2**	**0.05**	**0.1**	**0.15**	**0.2**
none	240 (130 - 360)	170 (90 - 250)	340 (180 - 500)	510 (270 - 730)	670 (360 - 960)	160 (90 - 240)	320 (170 - 460)	470 (250 - 690)	620 (340 - 900)
CO	210 (70 - 340)	150 (50 - 250)	290 (100 - 480)	440 (150 - 710)	570 (190 - 930)	140 (50 - 230)	270 (90 - 450)	410 (140 - 660)	540 (180 - 870)
O_3	120 (-10 - 250)	90 (0 - 180)	170 (-10 - 350)	260 (-10 - 520)	340 (-20 - 690)	80 (0 - 170)	160 (-10 - 330)	240 (-10 - 490)	320 (-10 - 640)
PM_{10}	90 (-50 - 220)	60 (-40 - 160)	120 (-70 - 310)	180 (-110 - 460)	240 (-140 - 610)	60 (-30 - 150)	110 (-70 - 290)	170 (-100 - 430)	230 (-130 - 570)
PM_{10}, O_3	50 (-90 - 190)	40 (-70 - 140)	70 (-130 - 270)	110 (-200 - 400)	140 (-270 - 530)	30 (-60 - 130)	70 (-120 - 250)	100 (-190 - 370)	130 (-250 - 490)

*Estimated incidences of respiratory emergency department visits are based on the concentration-response functions estimated in Tolbert et al. (2007) [results corresponding to Figure 2 in Tolbert et al. (2007) were obtained via personal communication with P. Tolbert]. All models use a 3-day moving average of the daily 1-hr. maximum NO_2 concentration and apply to all ages.

**Incidence was quantified down to 0 ppb. Incidences per 100,000 population are rounded to the nearest ten.

***Alternative 1-hr daily maximum standards are characterized by a concentration of m ppm and an nth percentile, requiring that the average of the 3 annual nth percentile 1-hr daily maxima over a 3-year period be at or below m ppm.

Note: Numbers in parentheses are 95% confidence intervals based on statistical uncertainty surrounding the NO_2 coefficient.

Table 4-5. Estimated Incidence of Respiratory Emergency Department Visits per 100,000 Population Associated with "As Is" NO_2 Concentrations and NO_2 Concentrations that Just Meet the Current and Alternative Standards in Atlanta, GA, Based on Adjusting 2006 NO_2 Concentrations*

Other Pollutants in Model	Incidence of Respiratory Emergency Department Visits per 100,000 Population Associated with "As is" NO_2 Concentrations and NO_2 Concentrations that Just Meet the Current and Alternative Standards**									
	"as is"	current annual standard	Alternative 98th percentile 1-hr daily maximum standards (ppm)				Alternative 99th percentile 1-hr daily maximum standards (ppm)			
			0.05***	0.1	0.15	0.2	0.05	0.1	0.15	0.2
none	250 (140 - 370)	740 (400 - 1060)	180 (100 - 260)	360 (190 - 520)	530 (280 - 760)	700 (380 - 1000)	170 (90 - 250)	330 (180 - 480)	490 (260 - 710)	650 (350 - 940)
CO	220 (70 - 360)	630 (210 - 1030)	150 (50 - 260)	300 (100 - 500)	450 (150 - 740)	600 (200 - 970)	140 (50 - 240)	280 (90 - 470)	420 (140 - 690)	560 (190 - 910)
O_3	130 (-10 - 260)	380 (-20 - 760)	90 (0 - 190)	180 (-10 - 370)	270 (-10 - 540)	360 (-20 - 710)	80 (0 - 170)	170 (-10 - 340)	250 (-10 - 510)	330 (-20 - 670)
PM_{10}	90 (-50 - 230)	270 (-160 - 670)	60 (-40 - 160)	130 (-70 - 320)	190 (-110 - 480)	250 (-150 - 630)	60 (-30 - 150)	120 (-70 - 300)	180 (-100 - 450)	240 (-140 - 590)
PM_{10}, O_3	50 (-100 - 200)	150 (-300 - 580)	40 (-70 - 140)	70 (-140 - 280)	110 (-210 - 420)	150 (-280 - 550)	30 (-60 - 130)	70 (-130 - 260)	100 (-190 - 390)	140 (-260 - 510)

*Estimated incidences of respiratory emergency department visits are based on the concentration-response functions estimated in Tolbert et al. (2007) [results corresponding to Figure 2 in Tolbert et al. (2007) were obtained via personal communication with P. Tolbert]. All models use a 3-day moving average of the daily 1-hr. maximum NO_2 concentration and apply to all ages.

**Incidence was quantified down to 0 ppb. Incidences per 100,000 population are rounded to the nearest ten.

***Alternative 1-hr daily maximum standards are characterized by a concentration of m ppm and an nth percentile, requiring that the average of the 3 annual nth percentile 1-hr daily maxima over a 3-year period be at or below m ppm.

Note: Numbers in parentheses are 95% confidence intervals based on statistical uncertainty surrounding the NO_2 coefficient.

Table 4-6. Estimated Incidence of Respiratory Emergency Department Visits per 100,000 Population Associated with "As Is" NO_2 Concentrations and NO_2 Concentrations that Just Meet the Current and Alternative Standards in Atlanta, GA, Based on Adjusting 2007 NO_2 Concentrations*

Other Pollutants in Model	Incidence of Respiratory Emergency Department Visits per 100,000 Population Associated with "As is" NO_2 Concentrations and NO_2 Concentrations that Just Meet the Current and Alternative Standards**									
	"as is"	current annual standard	Alternative 98th percentile 1-hr daily maximum standards (ppm)				Alternative 99th percentile 1-hr daily maximum standards (ppm)			
			0.05***	0.1	0.15	0.2	0.05	0.1	0.15	0.2
none	230 (120 - 330)	660 (360 - 960)	160 (90 - 240)	320 (170 - 470)	470 (260 - 690)	630 (340 - 900)	150 (80 - 220)	300 (160 - 430)	440 (240 - 640)	580 (310 - 840)
CO	190 (60 - 320)	570 (190 - 930)	140 (50 - 230)	270 (90 - 450)	410 (140 - 670)	540 (180 - 870)	130 (40 - 210)	250 (80 - 420)	380 (130 - 620)	500 (170 - 820)
O_3	120 (-10 - 230)	340 (-20 - 680)	80 (0 - 170)	160 (-10 - 330)	240 (-10 - 490)	320 (-10 - 640)	80 (0 - 150)	150 (-10 - 310)	230 (-10 - 450)	300 (-10 - 600)
PM_{10}	80 (-50 - 210)	240 (-140 - 600)	60 (-30 - 150)	110 (-70 - 290)	170 (-100 - 430)	230 (-130 - 570)	50 (-30 - 140)	110 (-60 - 270)	160 (-90 - 400)	210 (-120 - 530)
PM_{10}, O_3	50 (-90 - 180)	140 (-270 - 520)	30 (-60 - 130)	70 (-120 - 250)	100 (-190 - 370)	130 (-250 - 490)	30 (-60 - 120)	60 (-120 - 230)	90 (-170 - 350)	120 (-230 - 460)

*Estimated incidences of respiratory emergency department visits are based on the concentration-response functions estimated in Tolbert et al. (2007) [results corresponding to Figure 2 in Tolbert et al. (2007) were obtained via personal communication with P. Tolbert]. All models use a 3-day moving average of the daily 1-hr. maximum NO_2 concentration and apply to all ages.

**Incidence was quantified down to 0 ppb. Incidences per 100,000 population are rounded to the nearest ten.

***Alternative 1-hr daily maximum standards are characterized by a concentration of m ppm and an nth percentile, requiring that the average of the 3 annual nth percentile 1-hr daily maxima over a 3-year period be at or below m ppm.

Note: Numbers in parentheses are 95% confidence intervals based on statistical uncertainty surrounding the NO_2 coefficient.

Table 4-7. Estimated Percent of Total Incidence of Respiratory Emergency Department Visits Associated with "As Is" NO_2 Concentrations and NO_2 Concentrations that Just Meet Alternative Standards in Atlanta, GA, Based on Adjusting 2005 NO_2 Concentrations*

Other Pollutants in Model	Percent of Total Incidence of Respiratory Emergency Department Visits Associated with "As is" NO_2 Concentrations and NO_2 Concentrations that Just Meet Alternative Standards**								
	"as is"	Atternative 98th percentile 1-hr daily maximum standards (ppm)				Alternative 99th percentile 1-hr daily maximum standards (ppm)			
		0.05***	0.1	0.15	0.2	0.05	0.1	0.15	0.2
none	3% (1.6% - 4.3%)	2.1% (1.1% - 3.1%)	4.2% (2.2% - 6.1%)	6.2% (3.3% - 8.9%)	8.1% (4.4% - 11.7%)	2% (1% - 2.9%)	3.9% (2.1% - 5.7%)	5.8% (3.1% - 8.3%)	7.6% (4.1% - 10.9%)
CO	2.5% (0.8% - 4.2%)	1.8% (0.6% - 3%)	3.6% (1.2% - 5.9%)	5.3% (1.8% - 8.7%)	7% (2.4% - 11.3%)	1.7% (0.6% - 2.8%)	3.3% (1.1% - 5.5%)	4.9% (1.7% - 8.1%)	6.5% (2.2% - 10.6%)
O_3	1.5% (-0.1% - 3.1%)	1.1% (0% - 2.2%)	2.1% (-0.1% - 4.3%)	3.2% (-0.1% - 6.3%)	4.2% (-0.2% - 8.4%)	1% (0% - 2%)	2% (-0.1% - 4%)	2.9% (-0.1% - 5.9%)	3.9% (-0.2% - 7.8%)
PM_{10}	1.1% (-0.6% - 2.7%)	0.8% (-0.4% - 1.9%)	1.5% (-0.9% - 3.8%)	2.2% (-1.3% - 5.6%)	3% (-1.7% - 7.4%)	0.7% (-0.4% - 1.8%)	1.4% (-0.8% - 3.5%)	2.1% (-1.2% - 5.2%)	2.8% (-1.6% - 6.9%)
PM_{10}, O_3	0.6% (-1.1% - 2.3%)	0.4% (-0.8% - 1.7%)	0.9% (-1.6% - 3.3%)	1.3% (-2.5% - 4.9%)	1.7% (-3.3% - 6.4%)	0.4% (-0.8% - 1.5%)	0.8% (-1.5% - 3%)	1.2% (-2.3% - 4.5%)	1.6% (-3.1% - 6%)

*Estimated incidences of respiratory emergency department visits are based on the concentration-response functions estimated in Tolbert et al. (2007) [results corresponding to Figure 2 in Tolbert et al. (2007) were obtained via personal communication with P. Tolbert]. All models use a 3-day moving average of the daily 1-hr. maximum NO_2 concentration and apply to all ages.

**Incidence was quantified down to 0 ppb. Percents are rounded to the nearest tenth.

***Alternative 1-hr daily maximum standards are characterized by a concentration of m ppm and an nth percentile, requiring that the average of the 3 annual nth percentile 1-hr daily maxima over a 3-year period be at or below m ppm.

Note: Numbers in parentheses are 95% confidence intervals based on statistical uncertainty surrounding the NO_2 coefficient.

Table 4-8. Estimated Percent of Total Incidence of Respiratory Emergency Department Visits Associated with "As Is" NO_2 Concentrations and NO_2 Concentrations that Just Meet the Current and Alternative Standards in Atlanta, GA, Based on Adjusting 2006 NO_2 Concentrations*

Other Pollutants in Model	Percent of Total Incidence of Respiratory Emergency Department Visits Associated with "As is" NO_2 Concentrations and NO_2 Concentrations that Just Meet the Current and Alternative Standards**									
	"as is"	current annual standard	Alternative 98th percentile 1-hr daily maximum standards (ppm)				Alternative 99th percentile 1-hr daily maximum standards (ppm)			
			0.05***	0.1	0.15	0.2	0.05	0.1	0.15	0.2
none	3.1% (1.6% - 4.5%)	9% (4.9% - 12.9%)	2.2% (1.2% - 3.2%)	4.3% (2.3% - 6.3%)	6.4% (3.5% - 9.3%)	8.5% (4.6% - 12.2%)	2% (1.1% - 3%)	4% (2.2% - 5.9%)	6% (3.2% - 8.7%)	7.9% (4.3% - 11.4%)
CO	2.6% (0.9% - 4.4%)	7.7% (2.6% - 12.5%)	1.9% (0.6% - 3.1%)	3.7% (1.2% - 6.1%)	5.5% (1.8% - 9%)	7.3% (2.5% - 11.8%)	1.7% (0.6% - 2.9%)	3.4% (1.2% - 5.7%)	5.1% (1.7% - 8.4%)	6.8% (2.3% - 11%)
O_3	1.6% (-0.1% - 3.2%)	4.6% (-0.2% - 9.2%)	1.1% (-0.1% - 2.3%)	2.2% (-0.1% - 4.5%)	3.3% (-0.2% - 6.6%)	4.4% (-0.2% - 8.7%)	1% (0% - 2.1%)	2.1% (-0.1% - 4.1%)	3.1% (-0.1% - 6.2%)	4.1% (-0.2% - 8.1%)
PM_{10}	1.1% (-0.6% - 2.8%)	3.3% (-1.9% - 8.2%)	0.8% (-0.4% - 2%)	1.6% (-0.9% - 3.9%)	2.3% (-1.3% - 5.8%)	3.1% (-1.8% - 7.7%)	0.7% (-0.4% - 1.8%)	1.4% (-0.8% - 3.7%)	2.2% (-1.2% - 5.4%)	2.9% (-1.7% - 7.2%)
PM_{10}, O_3	0.6% (-1.2% - 2.4%)	1.9% (-3.6% - 7.1%)	0.4% (-0.8% - 1.7%)	0.9% (-1.7% - 3.4%)	1.3% (-2.5% - 5.1%)	1.8% (-3.4% - 6.7%)	0.4% (-0.8% - 1.6%)	0.8% (-1.6% - 3.2%)	1.2% (-2.4% - 4.7%)	1.6% (-3.2% - 6.2%)

*Estimated incidences of respiratory emergency department visits are based on the concentration-response functions estimated in Tolbert et al. (2007) [results corresponding to Figure 2 in Tolbert et al. (2007) were obtained via personal communication with P. Tolbert]. All models use a 3-day moving average of the daily 1-hr. maximum NO_2 concentration and apply to all ages.

**Incidence was quantified down to 0 ppb. Percents are rounded to the nearest tenth.

***Alternative 1-hr daily maximum standards are characterized by a concentration of m ppm and an nth percentile, requiring that the average of the 3 annual nth percentile 1-hr daily maxima over a 3-year period be at or below m ppm.

Note: Numbers in parentheses are 95% confidence intervals based on statistical uncertainty surrounding the NO_2 coefficient.

Table 4-9. Estimated Percent of Total Incidence of Respiratory Emergency Department Visits Associated with "As Is" NO_2 Concentrations and NO_2 Concentrations that Just Meet the Current and Alternative Standards in Atlanta, GA, Based on Adjusting 2007 NO_2 Concentrations*

Other Pollutants in Model	Percent of Total Incidence of Respiratory Emergency Department Visits Associated with "As is" NO_2 Concentrations and NO_2 Concentrations that Just Meet the Current and Alternative Standards**									
	"as is"	current annual standard	Alternative 98th percentile 1-hr daily maximum standards (ppm)				Alternative 99th percentile 1-hr daily maximum standards (ppm)			
			0.05***	0.1	0.15	0.2	0.05	0.1	0.15	0.2
none	2.8% (1.5% - 4%)	8.1% (4.4% - 11.6%)	2% (1% - 2.9%)	3.9% (2.1% - 5.7%)	5.8% (3.1% - 8.4%)	7.6% (4.1% - 11%)	1.8% (1% - 2.7%)	3.6% (1.9% - 5.3%)	5.4% (2.9% - 7.8%)	7.1% (3.8% - 10.2%)
CO	2.4% (0.8% - 3.9%)	6.9% (2.3% - 11.3%)	1.7% (0.6% - 2.8%)	3.3% (1.1% - 5.5%)	4.9% (1.7% - 8.1%)	6.5% (2.2% - 10.6%)	1.6% (0.5% - 2.6%)	3.1% (1% - 5.1%)	4.6% (1.5% - 7.5%)	6.1% (2% - 9.9%)
O_3	1.4% (-0.1% - 2.8%)	4.1% (-0.2% - 8.3%)	1% (0% - 2%)	2% (-0.1% - 4%)	2.9% (-0.1% - 5.9%)	3.9% (-0.2% - 7.8%)	0.9% (0% - 1.9%)	1.8% (-0.1% - 3.7%)	2.7% (-0.1% - 5.5%)	3.6% (-0.2% - 7.3%)
PM_{10}	1% (-0.6% - 2.5%)	2.9% (-1.7% - 7.3%)	0.7% (-0.4% - 1.8%)	1.4% (-0.8% - 3.5%)	2.1% (-1.2% - 5.2%)	2.8% (-1.6% - 6.9%)	0.6% (-0.4% - 1.7%)	1.3% (-0.7% - 3.3%)	1.9% (-1.1% - 4.9%)	2.6% (-1.5% - 6.4%)
PM_{10}, O_3	0.6% (-1.1% - 2.2%)	1.7% (-3.2% - 6.4%)	0.4% (-0.8% - 1.5%)	0.8% (-1.5% - 3%)	1.2% (-2.3% - 4.5%)	1.6% (-3% - 6%)	0.4% (-0.7% - 1.4%)	0.7% (-1.4% - 2.8%)	1.1% (-2.1% - 4.2%)	1.5% (-2.8% - 5.6%)

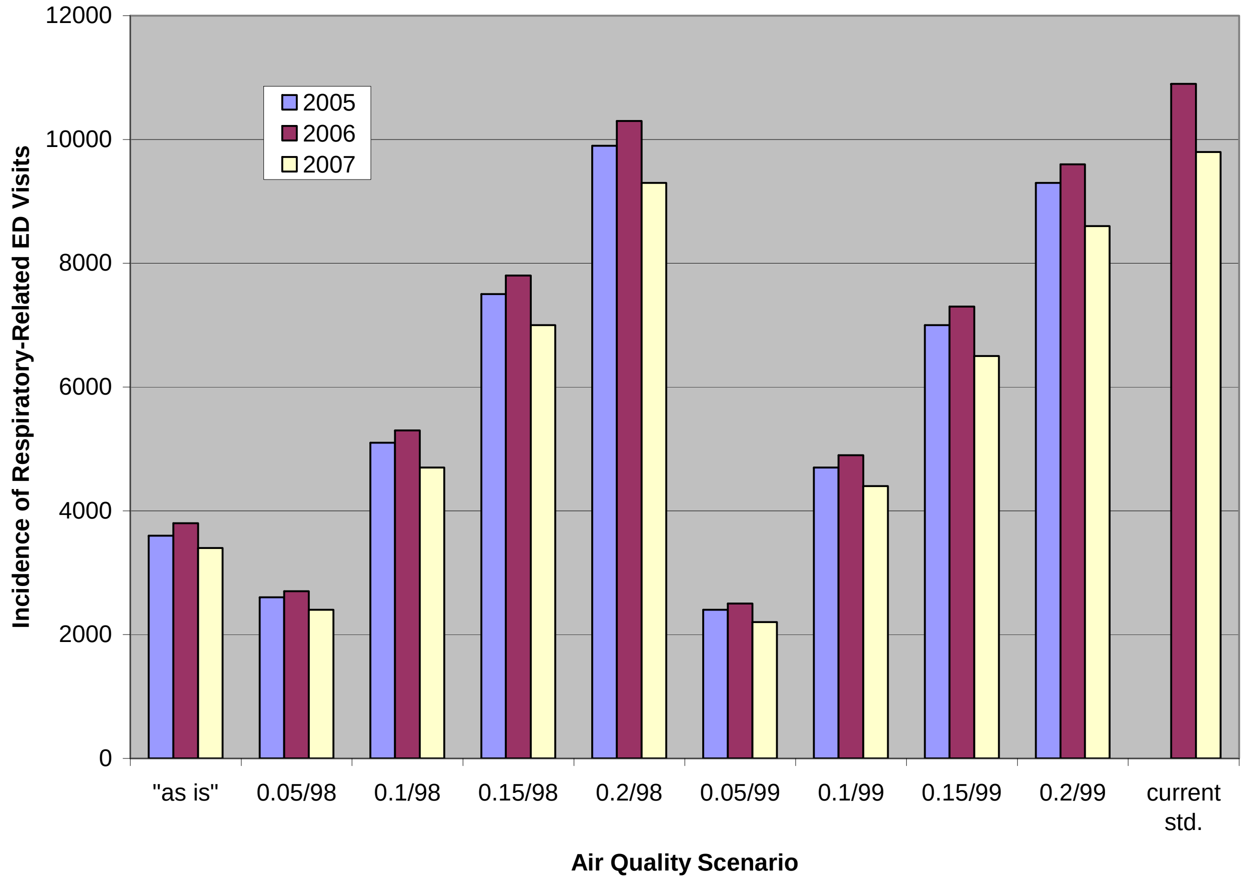
*Estimated incidences of respiratory emergency department visits are based on the concentration-response functions estimated in Tolbert et al. (2007) [results corresponding to Figure 2 in Tolbert et al. (2007) were obtained via personal communication with P. Tolbert]. All models use a 3-day moving average of the daily 1-hr. maximum NO_2 concentration and apply to all ages.

**Incidence was quantified down to 0 ppb. Percents are rounded to the nearest tenth.

***Alternative 1-hr daily maximum standards are characterized by a concentration of m ppm and an nth percentile, requiring that the average of the 3 annual nth percentile 1-hr daily maxima over a 3-year period be at or below m ppm.

Note: Numbers in parentheses are 95% confidence intervals based on statistical uncertainty surrounding the NO_2 coefficient.

Figure 4-1. Incidence of Respiratory-Related Emergency Department Visits in Atlanta, GA Under Different Air Quality Scenarios, Based on Adjusting 2005, 2006, and 2007 NO_2 Concentrations*



*The current standard is an annual average standard of 0.053 ppm. Alternative 1-hour maximum daily standards are denoted m/n, where m (in ppm) is the standard level and n is the percentile. So, for example, 0.05/98 denotes a 98th percentile standard of 0.05 ppm. See section 1 for more detail. All results shown are based on the single-pollutant model in Tolbert et al. (2007).

As can be seen in Figure 4-1, the greatest incidence of respiratory-related ED visits in Atlanta is estimated to occur if the current annual standard were just met – almost three times as high as the incidence associated with “as is” NO_2 concentrations in both 2006 (10,900 vs. 3,800, based on the single-pollutant model) and 2007 (9,800 vs. 3,400). The only alternative standards that are estimated to reduce the incidence of respiratory-related ED visits from the estimated levels associated with “as is” NO_2 concentrations are the two 1-hour daily maximum standards based on 0.05 ppm. The 98th percentile 0.05 ppm standard is estimated to reduce the incidence of respiratory-related ED visits by from 28 percent (in 2005) to 29 percent (in 2007); the 99th percentile 0.05 ppm standard is estimated to reduce the incidence of respiratory-related ED visits by 33 to 35 percent.

In general, the impact of changing the level of the alternative 1-hour daily maximum standards is substantially greater than the impact of changing from a 98th to a 99th percentile standard. For example, changing from a 98th percentile 1-hour daily maximum standard based on 0.05 ppm to one based on 0.1 ppm reduces the estimated incidence of respiratory-related ED visits in Atlanta by about 49 percent in 2007 (from 4700 to 2400); however, changing from a 98th percentile 1-hour daily maximum standard based on 0.05 ppm to a 99th percentile 1-hour daily maximum standard based on 0.05 ppm reduces the incidence in 2007 by only about 8 percent (from 2400 to 2200). The corresponding results for 2006 and 2005 are similar.

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