A Comparison of Hazardous Air Pollutant Concentrations and Emissions in El Paso, Texas and Camden, New Jersey

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ABSTRACT

Since 1984, the U.S. Environmental Protection Agency (EPA) has been measuring air pollutant concentrations at monitoring sites in urban regions around the country under the Urban Air Toxics Monitoring Program (UATMP). Of the 70 UATMP compounds measured at the participating monitoring sites, 42 are listed as hazardous air pollutants (HAPs) as defined by the Clean Air Act. EPA also initiates the compilation of a triennial HAP emission inventories for the entire country. Recently, EPA has revised the 1996 and 1999 HAP base year emission inventories.

Monitoring sites in El Paso, Texas (EPTX) and Camden, New Jersey (CANJ) participated in the 1996 and 1999 UATMPs. For both urban areas, HAP emissions inventory source data (major, area, mobile onroad, and mobile nonroad) are also available for the same years. Using statistical, geographic information systems (GIS) technology, and HAP data validation analysis, emission and concentration trends at each of these sites were developed.

INTRODUCTION

Much work has been done by the EPA in determining the atmospheric fate of air toxic compounds emitted from stationary, mobile, and biogenic emission sources[1]. Ambient air toxic monitors are strategically located around these emission sources to quantify this relationship. Monitors located upwind of an emission source are used to quantify the area of interest's background concentration without the influence of the source (typically biogenic sources); monitors located downwind of an emission source are used to quantify the source's potential contribution (typically for anthropogenic sources). However, the exact mathematical relationship between emissions and concentrations is not well defined, as various chemical and physical mechanisms, such as chemical transformation and wind and temperature parameters, may affect the downwind measured concentration.

Emission and concentration data compiled by EPA through its inventory and monitoring programs were analyzed for EPTX and CANJ for the 1996 and 1999 base years. The purpose of this paper is to: 1) provide a comparison of emissions strength and measured concentrations for each of the sites, and 2) to perform a HAP data validation analysis between the emission inventories and the ambient monitoring data.

Air Quality and Emissions Data

EPA has commissioned various studies in the past to quantify the relationship between air quality and emissions data, even going beyond this relationship to estimate human exposure to air toxic compounds. For example, the National Air Toxics Assessment (NATA) was designed to help EPA, state/local/tribal agencies, and the public to better understand the air toxics problem in the United States.

The sources of data used in NATA include an inventory of 1996 base year HAP emissions and estimates of annual air toxics concentrations. Thirty-three selected air toxic compounds were analyzed using an air dispersion model[2].

Modeled concentration data were also compared against ambient concentration data. For seven HAPs chosen for this particular comparison, only benzene was shown to have a predicted concentration close to the measured ambient air concentration. The other six compounds modeled concentrations (tetrachloroethylene, formaldehyde, acetaldehyde, lead, cadmium, and chromium) ranged from one-half to one-sixteenth actual ambient levels. One possible reason proposed by EPA for this underestimation is that emission sources may be missing in the emissions inventory[3].

EPA Emissions Data

The National Emissions Inventory (NEI) is composed of two types of pollutant groups[4]. *Criteria* pollutants are lead, particulate matter, oxides of nitrogen, volatile organic compounds (VOCs), sulfur oxides, and carbon monoxide. *HAPs* include 188 regulated air toxics that affect human health and welfare[5]. HAP compounds are organic, inorganic, or metals. There are three emission source types of criteria pollutants and HAPs: stationary (i.e., major and area) sources; mobile (i.e., onroad and nonroad) sources; and biogenic (e.g., natural) sources. This study focuses only on the anthropogenic sources (stationary and mobile sources).

EPA's initial HAP emissions inventory has a 1993 base year; emissions were allocated to the county level using national surrogate data (e.g., vehicle-miles traveled, fuel consumption). For the base year 1996 national HAP inventory, EPA compiled stationary point source emissions inventories from EPA regulatory studies, state/local/tribal agencies, and toxic release inventory (TRI) at the facility-level to enhance air toxic assessments, such as NATA. Area nonpoint, mobile onroad and nonroad, and biogenic emissions inventories remained at the county level. A subsequent emission inventory was developed for the 1999 base year.

EPA Monitoring Data

EPA also sponsors the UATMP to help state/local/tribal environmental agencies assess the composition and magnitude of urban air pollution for potentially toxics species. Urban air pollution typically contains hundreds of components, including, but not limited to, VOCs, metals, inorganic acids, and particulate matter. The 1999 UATMP focuses on a specific set of air toxic compounds, 42 of which are also included in EPA emission inventories for HAPs (Table 1). In 1996, 32 compounds were sampled in the analysis (compounds are denoted in Table 1). UATMP monitoring data have improved each year with the utilization of newer equipment and more refined sampling methods.

Although EPA sponsors the UATMP, it does not dictate the location of the monitors. Representatives from participating state/local/tribal agencies select the monitoring locations and operate the sampling equipment. Typically, monitoring stations are placed near centers of heavily-to-moderately populated cities. Occasionally, monitoring stations are placed in rural areas to provide additional information on typical background air composition in a specific area. Although over 50 urban areas have participated in this program in the last nineteen years, only two monitors, located in Camden, NJ (in the Philadelphia urban area) and El Paso, TX, participated in both the 1996 and 1999 UATMPs.

Monitoring Site Information

Site characteristics for the CANJ and EPTX monitors are listed in Table 2. Although CANJ is located in a residential setting near the New Jersey/ Pennsylvania border, numerous industrial facilities and busy roadways are located nearby (Figure 1). EPTX is located in a commercial setting in western

Texas just across the U.S./Mexico border and near the Texas/New Mexico border (Figure 2). A high number of vehicles pass by the CANJ monitor; over fifteen times the amount of traffic passing the EPTX monitor[6]. Although the U.S. population in CANJ is nearly five times that of EPTX, the total population surrounding the monitors is comparable to each other when taking into consideration Ciudad Juarez, located directly adjacent to El Paso on the Mexican side of the border. Ciudad Juarez had an estimated population of 1.2 million in 2000[7].

Analysis Results

Concentration Analysis

Average mean, geometric mean, and median concentrations were calculated for both study years at each site[8]. For the average mean, a 95% confidence interval was calculated to determine if compounds significantly increased or decreased. As stated earlier, the 1999 UATMP has ten more HAPs than the 1996 UATMP. For the trends analysis, the 32 overlapping compounds will be evaluated.

At CANJ, formaldehyde had the highest sampling arithmetic mean, geometric mean, and median concentration for both study years. The next two highest concentrations at this sampling site were for toluene and acetaldehyde in 1996, but acetonitrile and *m,p*-xylene in 1999. Although numerous HAP compound concentrations computed an average decrease from 1996 to 1999 (27 of 32), only acrolein, chloroform, styrene, and 1,1,1-trichloroethane significantly decreased.

Similarly at EPTX, formaldehyde, toluene, and acetaldehyde had the three highest sampling arithmetic mean, geometric mean, and median concentration for 1996. However, acrolein measured the highest in 1999, while *m,p*-xylene and *o*-xylene measured the next two highest arithmetic means. Numerous HAP concentrations decreased from 1996 to 1999 (26 of 32), but only bromomethane (i.e., methyl bromide), propionaldehyde, and 1,1,1-trichloroethane significantly decreased.

Emissions Analysis

HAP county-level emissions for Camden County, NJ and El Paso County, TX are listed in Tables 5 and 6. For most UATMP HAPs, direct comparable emission analysis can be made to the same isomer as the ambient monitoring data, with the exception of two situations: 1) UATMP is able to distinguish between the *cis*- and *trans*- isomers of 1,3-dichloropropene, while NEI emissions were reported for total 1,3-dichloropropene; and 2) the current UATMP sampling method is unable to split *m,p*- xylene concentrations into its individual isomers. For this reason, total xylenes (*o-, m-,* and *p*-) are reported from the NEI. A total 39 HAPs are retrieved from the NEI.

Camden County emissions from stationary sources increased from 1996 to 1999 (Table 5), while emissions from mobile sources decreased during the same time period. The top three emitted compounds for both 1996 and 1999 are toluene, total xylenes, and methyl *tert*-butyl ether. Bromoform was the only UATMP HAP that was not reported to the NEI for this county. Methyl ethyl ketone, methyl isobutyl ketone, and methyl methacrylate experienced the highest overall increases (+354%, +553%, and +627%, respectively), while propionaldehyde, styrene, and total xylenes experienced the highest overall decreases (-46%, -35%, and -35%, respectively). Twenty of the thirty-nine emitted UATMP HAPs all experienced total emission decreases from 1996 to 1999 (51%). Styrene, acrolein, and 1,1,1-trichloroethane were the only HAPs that experienced significant decreases in average concentrations (Table 3) and decreases in total county-level HAP emissions.

El Paso County emissions from stationary and onroad sources decreased from 1996 to 1999 (Table 6), while emissions from nonroad sources increased during the same time period. The top three emitted compounds for both 1996 and 1999 are toluene, total xylenes, and benzene. Similar to Camden

County, bromoform was the only UATMP HAP that was not reported to the NEI for this county. Acetonitrile, 1,2,4-trichlorobenzene, and methyl ethyl ketone experienced the highest overall increases (+2388%, +1290%, and +93%, respectively), while carbon tetrachloride, methyl methacrylate, and chloroprene experienced the highest overall decreases (-96.6%, -92%, and -87%, respectively). Twenty-two of the thirty-nine emitted UATMP HAPs all experienced total emission decreases from 1996 to 1999 (56%). Propionaldehyde and 1,1,1-trichloroethane were the only HAPs that experienced significant decreases in average concentrations (Table 4) and decreases in total county-level HAP emissions. It is important to note that emission sources in Mexico were not available to be included in this analysis (Figure 2). Thus, emission sources to the south, southwest, and west have not been captured, and the total emission source picture surrounding this monitor is incomplete.

Back Trajectory Analysis

Using the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model[9], 24-hour back trajectories were constructed for all sampling days in 1996 and 1999 to trace the origins of air parcels before passing over the monitoring sites. The origins of the air parcels in relation to the monitoring site were classified by regimes using the standard 8-point compass directions. Back trajectory trends were performed for selected compounds: 1) acetaldehyde, benzene, formaldehyde, and tetrachloroethylene were HAPs of interest identified earlier from the NATA study; 2) toluene, ethybenzene, and xylenes (along with benzene) form the BTEX compounds; and 3) acetonitrile, acrolein, and trichloroethylene which all measured high concentrations at either monitoring site.

Table 7 compares the average and total CANJ HAP concentrations by the regime in which air parcels originated from twenty-four hours earlier. Total HAP concentrations were highest when air originated west of the monitor, and lowest when air originated southwest of the monitor (21.69 vs. 12.84 ppbv). As confirmed in Figure 1, several industrial facilities are located to the northeast, north, northwest, west, and southwest of the monitor while fewer industrial facilities are located to the south, southeast, and east. Tetrachloroethylene, benzene, and acetaldehyde concentrations varied little by compass regime (0.09 to 0.37 ppbv for tetrachloroethylene, 0.47 to 1.25 ppbv for benzene, and 0.91 to 1.88 ppbv for acetaldehyde). Formaldehyde concentrations were highest in the northeast, southeast, and west regimes (9.13, 8.38, and 7.07 ppbv, respectively), suggesting a close proximity of formaldehyde sources in those regimes. BTEX compounds measured highest in the west regime and lowest in the northwest regime (8.00 and 2.62 ppbv, respectively).

Table 8 compares the average and total EPTX HAP concentrations by the regime in which air parcels originated from twenty-four hours earlier. Total HAP concentrations were highest when air originated from northwest of the monitor, and lowest when air originated southeast of the monitor (64.66 vs. 15.08 ppbv). Tetrachloroethylene and benzene concentrations did not vary much by compass regime (0.03 to 0.10 ppbv for tetrachloroethylene, 0.35 to 1.61 ppbv for benzene). Concentrations of acetaldehyde were highest from the east regime (46.52 ppbv), suggesting a close proximity of acetaldehyde sources east of EPTX. Formaldehyde was highest from the southeast, south, and west regimes (11.67, 9.47, and 9.04 ppbv, respectively), suggesting a close proximity of formaldehyde sources in those regimes. BTEX compounds measured highest in the west regime and lowest in the east regime (23.11 vs 1.69 ppbv). As noted earlier, no industrial facilities are plotted to the south, southwest, and west due to the unavailability of a Mexican HAP emissions inventory. There do appear to be significant HAP emissions sources on the Mexican side of EPTX, as south, southwest, and west compass regime HAP concentrations range between 20.53 and 42.30 ppbv.

HAP Validation Analysis

Two questions arise when comparing ambient monitoring and emissions data. First, what does it mean if the ambient monitoring data identifies a particular HAP, but the emissions inventory data does

not contain this HAP? Second, what does it mean if the emissions inventory contains emissions for a particular HAP, but it is not detected in the ambient monitoring data? Through a HAP validation analysis, the ambient monitoring and emissions data at CANJ and EPTX were analyzed for missing HAP sources and potential ambient monitoring data gaps.

Identification of Missing HAP Emissions

The emissions inventory for Camden and El Paso County included all UATMP HAPs, with the exception of bromoform. Bromoform measured at a high detection rate during the 1996 sampling season at CANJ (73%) and at a moderate rate at EPTX (59%), but was not detected at either site during the 1999 sampling season. The closest bromoform source to CANJ, according to the NEI, is located to the northeast at a landfill in New York nearly 66 miles away. Approximately 100 miles away, two more landfills are located to the southwest of this monitor in Maryland. Back trajectory analysis conducted for 1996 revealed that only eight of the twenty-four detected samples showed air flow originating 24-hours prior from the northeast and southwest of the monitor. Similarly, the closest bromoform source to EPTX is at a portland cement manufacturing facility located over 500 miles away in Ellis County, Texas. The absence of nearby bromoform sources surrounding these monitors might suggest other bromoform sources are missing in the NEI. However, the emissions inventory surrounding El Paso is incomplete, as adjacent Mexican emission sources were not included.

Identification of Unmeasured Ambient HAPs

Unmeasured ambient HAPs at CANJ and EPTX are listed in Tables 3 and 4 as non-detects (ND). At CANJ, 5 of 32 UATMP HAPs were not detected during the 1996 sampling season; in 1999, 15 of 42 were not detected. At EPTX, 8 of 32 UATMP HAPs were not detected during the 1996 sampling season; in 1999, 14 of 42 were not detected. All of the non-detect compounds in 1996 were also non-detects in 1999, with the exception of vinyl chloride at EPTX in 1999.

The number of point sources (major and area) within 50 miles of each monitor for the non-detect compounds is listed in Table 9. Interestingly, all of the non-detect compounds at CANJ, except bromoform and chloroprene, had an emitting point source within 50 miles; at EPTX, all but four compounds (bromoform, chloroprene, 1,3-dichloropropene, methyl methacrylate, and 1,1,2-trichloroethane) had an emitting point source within this range. For the non-detect compounds which didn't have an emitting point source within 50 miles, this would suggest good agreement with the ambient monitoring data. For the remaining non-detect compounds (chlorobenzene, vinyl chloride, etc.), this might raise three possible HAP validation flags: 1) the sample monitor may not be truly downwind of the emissions source; 2) the sample monitor may be too far away from emission sources for these non-detected compounds, as they may undergo chemical transformation before reaching the monitors; and/or 3) possible incorrect inclusion of a HAP in the emissions inventory.

CONCLUSIONS

Ambient concentration and emissions information data for similar HAPs were analyzed for two monitors that participated in EPA's UATMP for the 1996 and 1999 sampling season: CANJ and EPTX. A concentration trends analysis at CANJ showed that acrolein, chloroform, styrene, and 1,1,1-trichloroethane significantly decreased from 1996 to 1999. NEI data also showed a decrease in Camden County emissions for acrolein, styrene, and 1,1,1-trichlorethane, but an increase in chloroform emissions. At EPTX, bromomethane, propionaldehyde, and 1,1,1-trichloroethane concentrations significantly decreased from 1996 to 1999. NEI data also showed a decrease in El Paso County emissions for propionaldehyde and 1,1,1-trichloroethane, but an increase in bromomethane emissions.

Back trajectories were also constructed 24-hours prior to the sampling days at both monitoring sites to determine where airflow originated. Total HAP concentrations were highest when air originated to the west of CANJ and to the northwest of EPTX. The densities of stationary sources plotted within 10 miles of these monitors were high in those regimes as well.

Bromoform emission sources may be underestimated surrounding the CANJ and EPTX monitors. During the 1996 sampling season, bromoform was measured at these sites, but the nearest point sources were over 50 miles from CANJ and 500 miles from EPTX. However, the emissions inventory surrounding the EPTX monitor (close to the Mexican border) is incomplete, as emissions data from Mexico is unavailable.

HAPs that were non-detects in the ambient monitoring data, but were compiled in the emissions inventory were analyzed for possible errors. For the non-detects that have an emission point source within 50 miles of the monitor, this might raise questions as to the sampling analysis and/or the incorrect inclusion of a HAP in the emissions inventory.

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KEYWORDS

Emission Inventories
Air Toxics
Back Trajectory
Ambient Monitoring
Validation Techniques

TABLES

Table 1. UATMP HAP compounds

Acetaldehyde	*Dibromoethane, 1,2-	*Methyl-*tert*-Butyl Ether
*Acetonitrile	Dichlorobenzene, *p*-	Methylene Chloride
Acrolein	Dichloroethane, 1,1-	Propionaldehyde
*Acrylonitrile	Dichloroethane, 1,2-	Styrene
Benzene	Dichloropropane, 1,2-	Tetrachloroethane, 1,1,2,2-
Bromoform	Dichloropropene, *cis*-1,3-	Tetrachloroethylene
Bromomethane	Dichloropropene, *trans*-1,3-	Toluene
Butadiene, 1,3-	*Ethyl Acrylate	*Trichlorobenzene, 1,2,4-
Carbon Tetrachloride	Ethylbenzene	Trichloroethane, 1,1,1-
Chlorobenzene	Formaldehyde	Trichloroethane, 1,1,2-
Chloroethane	*Hexachloro-1,3-Butadiene	Trichloroethylene
Chloroform	*Methyl Ethyl Ketone	Vinyl Chloride
Chloromethane	*Methyl Isobutyl Ketone	Xylene, *m,p*-
Chloroprene	*Methyl Methacrylate	Xylene, *o*-

* = Compound not measured in 1996

Table 2. Site characteristics for Camden, New Jersey and El Paso, Texas monitors.

Comparison Parameter		Camden, NJ	El Paso, TX
UATMP[a] Code		CANJ	EPTX
AIRS[b] Site Code		34-007-0003	48-141-0055
Universal Transverse Mercator (UTM) Monitor Coordinates	Zone	18	13
	Easting (m)	491,692	367,128
	Northing (m)	4,419,012	3,513,025
Zip Code for Monitor		08104	79901
County for Monitor		Camden County	El Paso County
Location Setting of Monitor		Residential	Commercial
Land Use Classification for Monitor		Suburban	Urban
Traffic Count at Monitor		62,000[c]	3,790[d]
Closest National Weather Service Observation Station		Philadelphia NE (WBAN#94732)	El Paso International (WBAN#23044)
Population within 10 miles of Monitor[e]		2,113,778	423,488[f]
Stationary HAP County Emissions[g]		1,071	1,947
Onroad HAP County Emissions[g]		2,680	2,730
Nonroad HAP County Emissions[g]		445	505

[a] = UATMP: Urban Air Toxics Monitoring Program
[b] = AIRS: Aerometric Information Retrieval System
[c] = 1986 estimate provided to AIRS
[d] = 1992 estimate provided to AIRS
[e] = U.S. Population only using zip codes. Website address: http://link-usa.com/zipcode/pop.htm
[f] = This monitor, located in El Paso, is near the U.S.-Mexico border; The population in Ciudad Juarez, located on the Mexican side of the border, is estimated to be 1.2 million.
[g] = Total emissions (in tons per year) from the 1999 National Emissions Inventory (NEI) for Hazardous Air Pollutants (HAPs), revised October 2002

Table 3. UATMP HAP compound concentrations in Camden, New Jersey.

Compound	1996				1999			
	A	B	C	D[a]	A	B	C	D[b]
Acetaldehyde	1.260 ± 0.525	0.634	0.658	100	1.807 ± 0.276	1.680	1.624	100
Acetonitrile	NS				2.450 ± 1.845	1.474	1.775	25
Acrolein	0.082 ± 0.045	0.059	0.058	30	0.025 ± 0.006	0.022	0.024	54
Acrylonitrile	NS				0.919 ± 0.152	0.894	0.940	29
Benzene	0.798 ± 0.398	0.561	0.470	94	0.568 ± 0.072	0.539	0.562	100
Bromoform	0.120 ± 0.035	0.092	0.115	73	ND			
Bromomethane	0.114 ± 0.042	0.087	0.095	61	0.075 ± 0.042	0.059	0.050	29
Butadiene, 1,3-	0.103 ± 0.031	0.077	0.070	64	0.110 ± 0.038	0.081	0.087	83
Carbon Tetrachloride	0.103 ± 0.017	0.095	0.085	88	0.086 ± 0.008	0.083	0.091	96
Chlorobenzene	0.070 ± 0.040	0.056	0.090	9	ND			
Chloroethane	0.130 ± 0.028	0.128	0.130	6	0.072 ± 0.053	0.060	0.072	8
Chloroform	0.050 ± 0.007	0.046	0.050	73	0.019 ± 0.013	0.017	0.019	8
Chloromethane	0.746 ± 0.110	0.699	0.617	88	0.830 ± 0.082	0.804	0.839	100
Chloroprene	ND				ND			
Dibromoethane, 1,2-	NS				ND			
Dichlorobenzene, *p*-	0.084 ± 0.023	0.063	0.060	76	0.056 ± 0.012	0.051	0.060	63
Dichloroethane, 1,1-	0.070[c]	0.070	0.070	3	ND			
Dichloroethane, 1,2-	ND				ND			
Dichloropropane, 1,2-	ND				ND			
Dichloropropene, *cis*-1,3-	ND				ND			
Dichloropropene, *trans*-1,3-	ND				ND			
Ethyl Acrylate	NS				ND			
Ethylbenzene	0.217 ± 0.054	0.176	0.180	94	0.191 ± 0.030	0.176	0.179	100
Formaldehyde	5.380 ± 2.046	2.394	1.910	100	3.994 ± 0.712	3.650	3.686	100
Hexachloro-1,3-Butadiene	NS				0.120	0.120	0.120	4
Methyl Ethyl Ketone	NS				0.821 ± 0.169	0.685	0.715	100
Methyl Isobutyl Ketone	NS				0.094 ± 0.036	0.084	0.080	25
Methyl Methacrylate	NS				ND			
Methyl-*tert*-Butyl Ether	NS				0.969 ± 0.209	0.821	0.980	100
Methylene Chloride	0.233 ± 0.043	0.207	0.250	70	0.173 ± 0.035	0.154	0.162	100
Propionaldehyde	0.559 ± 0.486	0.230	0.160	36	0.359 ± 0.071	0.308	0.366	100
Styrene	0.231 ± 0.120	0.114	0.080	91	0.083 ± 0.015	0.075	0.070	100
Tetrachloroethane, 1,1,2,2-	0.020 ± 0.016	0.016	0.010	9	ND			
Tetrachloroethylene	0.101 ± 0.023	0.087	0.081	83	0.169 ± 0.130	0.083	0.070	88
Toluene	1.469 ± 0.360	1.202	1.120	94	1.155 ± 0.200	1.040	1.160	100
Trichlorobenzene, 1,2,4-	NS				0.040 ± 0.042	0.026	0.040	8
Trichloroethane, 1,1,1-	0.235 ± 0.053	0.204	0.190	94	0.064 ± 0.006	0.062	0.068	100
Trichloroethane, 1,1,2-	0.110[c]	0.110	0.110	3	ND			
Trichloroethylene	0.041 ± 0.017	0.031	0.030	39	0.051 ± 0.015	0.047	0.060	25
Vinyl Chloride	0.130[c]	0.130	0.130	3	ND			
Xylene, *m,p*-	0.913 ± 0.220	0.774	0.783	94	2.021 ± 2.919	0.537	0.483	100
Xylene, *o*-	0.328 ± 0.073	0.279	0.288	94	0.246 ± 0.041	0.025	0.246	100

BOLD = significant difference (α =0.05) between 1996 and 1999 measurements

A = average concentration (ppbv) ± confidence interval, α=0.05 (ppbv)

B = geometric mean (ppbv)

C = median (ppbv)

D = percentage detected rounded to nearest whole number (%)

NS = Not sampled during the 1996 UATMP

ND = Not Detected

[a] = 33 total samples

[b] = 24 total samples

[c] = only one sample was collected for this compound; no confidence interval calculation was computed.

Table 4. UATMP HAP compound concentrations in El Paso, Texas.

Compound	1996				1999			
	A	B	C	D[a]	A	B	C	D[b]
Acetaldehyde	5.368 ± 3.113	3.290	2.858	97	2.077 ± 0.698	1.581	1.234	100
Acetonitrile	NS				13.02 ± 13.84	4.913	8.132	19
Acrolein	0.177 ± 0.100	0.118	0.100	45	0.177 ± 0.132	0.056	0.023	54
Acrylonitrile	NS				0.811 ± 0.088	0.800	0.840	31
Benzene	1.242 ± 0.259	1.031	1.140	100	1.389 ± 0.208	1.291	1.350	100
Bromoform	0.143 ± 0.070	0.090	0.080	59	ND			
Bromomethane	0.240 ± 0.086	0.170	0.225	41	0.062 ± 0.035	0.055	0.047	12
Butadiene, 1,3-	0.216 ± 0.048	0.182	0.200	83	0.263 ± 0.059	0.226	0.200	96
Carbon Tetrachloride	0.090 ± 0.011	0.087	0.081	93	0.080 ± 0.010	0.074	0.080	100
Chlorobenzene	0.010[c]	0.010	0.010	3	ND			
Chloroethane	ND				ND			
Chloroform	0.073 ± 0.020	0.064	0.057	48	ND			
Chloromethane	0.760 ± 0.069	0.740	0.716	93	0.861 ± 0.058	0.848	0.875	100
Chloroprene	ND				ND			
Dibromoethane, 1,2-	NS				ND			
Dichlorobenzene, *p*-	0.097 ± 0.041	0.060	0.050	93	0.057 ± 0.017	0.045	0.040	81
Dichloroethane, 1,1-	ND				ND			
Dichloroethane, 1,2-	ND				ND			
Dichloropropane, 1,2-	ND				ND			
Dichloropropene, *cis*-1,3-	0.040[c]	0.040	0.040	3	ND			
Dichloropropene, *trans*-1,3-	ND				ND			
Ethyl Acrylate	NS				0.125 ± 0.089	0.107	0.125	8
Ethylbenzene	0.443 ± 0.096	0.358	0.370	100	1.557 ± 2.056	0.524	0.450	100
Formaldehyde	8.517 ± 1.545	7.329	8.059	97	6.629 ± 2.935	4.537	3.574	100
Hexachloro-1,3-Butadiene	NS				0.107 ± 0.115	0.069	0.107	8
Methyl Ethyl Ketone	NS				1.137 ± 0.263	0.976	0.855	100
Methyl Isobutyl Ketone	NS				0.179 ± 0.084	0.149	0.140	19
Methyl Methacrylate	NS				ND			
Methyl-*tert*-Butyl Ether	NS				0.410 ± 0.138	0.297	0.342	69
Methylene Chloride	0.353 ± 0.322	0.166	0.169	83	0.602 ± 0.090	0.528	0.676	100
Propionaldehyde	0.563 ± 0.188	0.407	0.514	90	0.174 ± 0.028	0.159	0.157	100
Styrene	0.361 ± 0.120	0.188	0.165	90	0.211 ± 0.131	0.102	0.080	100
Tetrachloroethane, 1,1,2,2-	0.010[c]	0.010	0.010	3	ND			
Tetrachloroethylene	0.076 ± 0.050	0.047	0.041	59	0.039 ± 0.010	0.034	0.039	54
Toluene	2.923 ± 0.697	2.268	2.336	100	3.227 ± 0.650	2.756	2.685	100
Trichlorobenzene, 1,2,4-	NS				0.078 ± 0.082	0.051	0.029	12
Trichloroethane, 1,1,1-	0.195 ± 0.048	0.172	0.150	100	0.067 ± 0.009	0.009	0.063	100
Trichloroethane, 1,1,2-	ND				ND			
Trichloroethylene	0.440 ± 0.656	0.065	0.040	59	0.075 ± 0.029	0.063	0.060	23
Vinyl Chloride	ND				0.087[c]	0.087	0.087	4
Xylene, *m,p*-	1.712 ± 0.376	1.405	1.510	100	5.084 ± 7.206	1.428	1.255	100
Xylene, *o*-	0.650 ± 0.140	0.533	0.594	100	2.334 ± 3.264	0.682	0.584	100

BOLD = significant difference (α =0.05) between 1996 and 1999 measurements
A = average concentration (ppbv) ± confidence interval, α=0.05 (ppbv)
B = geometric mean (ppbv)
C = median (ppbv)
D = percentage detected rounded to nearest whole number (%)
NS = Not sampled during the 1996 UATMP
ND = Not Detected
[a] = 29 total samples
[b] = 26 total samples
[c] = only one sample was collected for this compound; no confidence interval calculation was computed.

Table 5. Emissions analysis for UATMP HAPs in Camden County, New Jersey.

Compound	1996				1999				%
	Major	Area	Mobile[a]	Total	Major	Area	Mobile[a]	Total	Change
Acetaldehyde	0	2.15	113.7	115.85	0	5.49	109.51	115	-0.7
Acetonitrile	0	0.08	0	0.08	0	0.09	0	0.09	+14.4
Acrolein	0	7.4	23.55	30.95	0	10.00	14.29	25.29	-21.5
Acrylonitrile	0.33	0.10	0	0.43	0	0.48	0	0.48	+9.8
Benzene	2.54	18.12	651.49	672.15	1.67	20.15	554.72	576.54	-14.2
Bromoform	NA								
Bromomethane	0	112.07	0	112.07	0	111.70	0	111.70	-0.3
Butadiene, 1,3-	0.24	1.68	89.77	91.69	0.24	4.89	88.38	93.51	+2.0
Carbon Tetrachloride	6.1E-4	0.35	0	0.35	0	0.31	0	0.31	-12.9
Chlorobenzene	0.03	36.27	0	36.30	0	36.20	0	36.20	-0.3
Chloroethane	0.08	4.14	0	4.22	0	4.44	0	4.44	+5.0
Chloroform	3.6E-3	21.83	0	21.83	0	23.43	0	23.43	+7.3
Chloromethane	0	3.97	0	3.97	0	5.25	0	5.25	+32.2
Chloroprene	0	8.9E-3	0	8.9E-3	0	9.0E-3	0	9.0E-3	+1.6
Dibromoethane, 1,2-	1.9E-4	9.9E-5	0	2.9E-4	0	3.1E-4	0	3.1E-4	+7.8
Dichlorobenzene, *p*-	0.03	41.99	0	42.02	0	39.26	0	39.26	-6.6
Dichloroethane, 1,1-	0.23	0	0	0.23	0	0.26	0	0.26	+12.0
Dichloroethane, 1,2-	0.04	4.9E-3	0	0.04	0	0.05	0	0.05	+10.0
Dichloropropane, 1,2-	0.02	4.1E-3	0	0.02	0	0.03	0	0.03	+10.2
Dichloropropene, 1,3-	0	80.76	0	80.76	0	80.49	0	80.49	-0.3
Ethyl Acrylate	0	9.8E-4	0	9.8E-4	0	1.0E-3	0	1.0E-3	+2.3
Ethylbenzene	0.49	52.61	391.83	444.93	1.50	49.06	252.87	303.43	-31.8
Formaldehyde	32.46	17.67	363.50	413.63	55.78	39.22	342.77	437.77	+5.8
Hexachloro-1,3-Butadiene	0	1.9E-4	0	1.9E-4	0	1.8E-4	0	1.8E-4	-3.1
Methyl Ethyl Ketone	0.51	138.43	0	138.94	0	630.23	0	630.23	+354
Methyl Isobutyl Ketone	0.19	27.34	0	27.53	0	179.82	0	179.82	+553
Methyl Methacrylate	0	0.30	0	0.30	0	2.19	0	2.19	+627
Methyl-*tert*-Butyl Ether	0	20.41	919.35	939.76	0	13.40	861.79	875.19	-6.9
Methylene Chloride	1.21	161.28	0	162.49	0	144.42	0	144.42	-11.7
Propionaldehyde	0	2.2E-3	37.21	37.21	0	2.0E-3	19.95	19.95	-46.4
Styrene	17.78	2.24	67.27	87.29	17.78	0.80	38.42	57.00	-34.7
Tetrachloroethane, 1,1,2,2-	0.19	4.6E-4	0	0.19	0	0.21	0	0.21	+12.0
Tetrachloroethylene	0.62	118.93	0	119.55	0	82.22	0	82.22	-31.2
Toluene	15.15	406.69	2371.9	2793.7	24.75	391.80	1443.45	1860	-33.4
Trichlorobenzene, 1,2,4-	0	2.0E-2	0	2.0E-2	0	2.3E-2	0	2.3E-2	+14.9
Trichloroethane, 1,1,1-	0.06	229.53	0	229.59	0	221.01	0	221.01	-3.7
Trichloroethane, 1,1,2-	0	9.9E-4	0	9.9E-4	0	9.8E-4	0	9.8E-4	-0.9
Trichloroethylene	0.37	24.43	0	24.80	0	16.69	0	16.69	-32.7
Vinyl Chloride	0.46	5.3E-3	0	0.47	0	0.52	0	0.52	+11.8
Xylene, *o,m,p*-	1.28	298.03	1517.35	1816.7	10.25	204.66	974.23	1189.1	-34.5
Total	**74.31**	**1829.8**	**6546.8**	**8450.9**	**111.96**	**2318.8**	**4700.4**	**7131.2**	**-15.6**

[a] = Mobile emissions include onroad and nonroad sources

Table 6. Emissions analysis (tpy) for UATMP HAPs in El Paso, Texas.

Compound	1996				1999				%
	Major	Area	Mobile[a]	Total	Major	Area	Mobile[a]	Total	Change
Acetaldehyde	0.30	3.04	165.31	168.65	0.34	14.04	190.36	204.74	+21.4
Acetonitrile	0	0.20	0	0.20	0	2.78	0	2.78	+1290
Acrolein	0	7.82	28.19	36.01	0.01	4.59	28.77	33.37	-7.3
Acrylonitrile	0	0.47	0	0.47	0	0.42	0	0.42	-8.8
Benzene	184.42	42.79	908.59	1135.8	134.55	54.59	860.58	1049.7	-7.6
Bromoform	NA								
Bromomethane	0	152.08	0	152.08	0.02	154.61	0	154.63	+1.7
Butadiene, 1,3-	0.09	0.20	142.79	143.08	3.87	1.85	94.62	100.34	-29.9
Carbon Tetrachloride	0	0.49	0	0.49	0	0.02	0	0.02	-96.6
Chlorobenzene	0	49.25	0	49.25	0	49.90	0	49.90	+1.3
Chloroethane	0	5.70	0	5.70	0	6.11	0	6.11	+7.2
Chloroform	0	16.35	0	16.35	0	15.14	0	15.14	-7.4
Chloromethane	0	4.73	0	4.73	0	6.93	0	6.93	+46.4
Chloroprene	0	9.6E-3	0	9.6E-3	0	1.3E-3	0	1.3E-3	-86.5
Dibromoethane, 1,2-	0	2.4E-4	0	2.4E-4	0	2.8E-4	0	2.8E-4	+18.3
Dichlorobenzene, *p*-	0	57.02	0	57.02	0	54.24	0	54.24	-4.9
Dichloroethane, 1,1-	0	0.24	0	0.24	0	0.29	0	0.29	+22.6
Dichloroethane, 1,2-	0	0.05	0	0.05	0	0.07	0	0.07	+44.7
Dichloropropane, 1,2-	0	2.5E-2	0	2.5E-2	0	2.6E-2	0	2.6E-2	+2.6
Dichloropropene, 1,3-	0	109.60	0	109.60	0	111.39	0	111.39	+1.6
Ethyl Acrylate	0	8.5E-4	0	8.5E-4	0	2.4E-4	0	2.4E-4	-72
Ethylbenzene	36.49	69.65	410.7	516.84	21.59	71.36	384.66	477.61	-7.6
Formaldehyde	5.80	37.73	455.97	499.5	5.27	30.85	423.02	459.14	-8.1
Hexachloro-1,3-Butadiene	0	2.6E-4	0	2.6E-4	0	2.6E-4	0	2.6E-4	-0.4
Methyl Ethyl Ketone	0.5	167.77	0	168.27	33.98	290.15	0	324.13	+92.6
Methyl Isobutyl Ketone	10.34	32.10	0	42.44	0	63.00	0	63.00	+48.4
Methyl Methacrylate	0	0.46	0	0.46	0	0.03	0	0.03	-92.4
Methyl-*tert*-Butyl Ether	35.71	44.72	46.27	126.70	26.01	33.37	89.32	148.70	+17.4
Methylene Chloride	0	200.33	0	200.33	0.07	180.78	0	180.85	-9.7
Propionaldehyde	0	7.3E-3	34.06	34.07	0	0.29	26.20	26.49	-22.2
Styrene	129.09	12.03	70.56	202.68	122.20	19.21	50.90	192.31	-9.1
Tetrachloroethane, 1,1,2,2-	0	0.19	0	0.19	0	0.23	0	0.23	+22.2
Tetrachloroethylene	0	158.33	0	158.33	0.75	116.87	0	117.62	-25.7
Toluene	200.64	569.36	2536.16	3306.2	108.69	568.01	2065	2741.7	-17.1
Trichlorobenzene, 1,2,4-	0	0.02	0	0.02	0	0.5	0	0.50	+2388
Trichloroethane, 1,1,1-	0	289.53	0	289.53	0	283.70	0	283.70	-2.0
Trichloroethane, 1,1,2-	0	7.2E-4	0	7.2E-4	0	7.2E-4	0	7.2E-4	-0.2
Trichloroethylene	23.89	37.63	0	61.52	0	44.89	0	44.89	-27.0
Vinyl Chloride	0	0.59	0	0.59	0	0.70	0	0.70	+17.4
Xylene, *o,m,p*-	148.89	352.24	1572.19	2073.3	89.66	234.87	1285.02	1609.6	-22.4
Total	**776.15**	**2422.8**	**6370.9**	**9569.9**	**547.00**	**2415.8**	**5498.1**	**8460.9**	**-11.6**

[a] = Mobile emissions include onroad and nonroad sources

Table 7. Average CANJ UATMP HAP concentrations (ppbv) by origin regime (selected HAPs).

Compound	HAP Concentration in Relation to Origin of Air Parcel by Compass Regime							
	North	Northeast	East	Southeast	South	Southwest	West	Northwest
Acetaldehyde	1.63	1.92	1.16	1.57	1.54	1.22	1.95	1.14
Acetonitrile	4.86	ND	3.08	ND	0.73	ND	0.27	0.90
Acrolein	0.03	ND	ND	0.24	0.04	0.03	0.05	0.06
Benzene	0.47	0.53	0.54	0.65	0.55	0.65	1.25	0.52
Ethylbenzene	0.16	0.22	0.20	0.34	0.20	0.18	0.27	0.17
Formaldehyde	4.66	9.13	2.77	8.38	3.81	3.18	7.07	3.92
Tetrachloroethylene	0.15	0.10	0.12	0.09	0.37	0.09	0.11	0.09
Toluene	0.91	1.32	1.67	1.88	1.10	1.33	1.79	1.09
Trichloroethylene	0.02	0.03	0.04	0.02	0.03	0.04	0.06	0.06
Xylene, *m,p-*	0.47	0.80	0.73	1.42	0.71	0.68	4.32	0.59
Xylene, *o-*	0.21	0.29	0.29	0.49	0.28	0.29	0.37	0.25
Other HAPs	2.22	3.26	4.88	2.36	5.25	5.15	4.18	5.05
BTEX[a] Compounds	5.06	3.16	3.43	4.78	2.84	3.13	8.00	2.62
Sum of Avg Concentrations	**18.63**	**17.87**	**15.48**	**17.44**	**14.61**	**12.84**	**21.69**	**13.84**

[a] = BTEX: benzene, toluene, ethylbenzene, and xylenes

Table 8. Average EPTX UATMP HAP concentrations (ppbv) by origin regime (selected HAPs).

Compound	HAP Concentration in Relation to Origin of Air Parcel by Compass Regime							
	North	Northeast	East	Southeast	South	Southwest	West	Northwest
Acetaldehyde	1.88	2.01	46.52	4.28	3.33	1.53	3.14	2.08
Acetonitrile	11.63	ND	ND	4.33	ND	ND	1.33	43.48
Acrolein	ND	ND	ND	0.28	0.27	0.04	0.19	0.02
Benzene	1.61	1.20	0.35	1.41	1.00	0.99	1.42	1.55
Ethylbenzene	0.45	0.57	0.10	0.52	0.35	0.32	3.02	0.54
Formaldehyde	4.61	3.15	7.04	9.47	11.67	3.81	9.04	5.27
Tetrachloroethylene	0.04	0.03	ND	0.07	0.03	0.04	0.05	0.10
Toluene	2.72	2.72	0.75	3.32	2.22	2.39	3.41	3.73
Trichloroethylene	0.03	0.2	ND	0.06	0.06	5.94	0.13	0.21
Xylene, *m,p-*	1.67	2.39	0.37	1.68	1.17	0.99	10.53	1.83
Xylene, *o-*	0.59	0.83	0.12	0.70	0.46	0.43	4.73	0.78
Other HAPs	5.85	1.98	3.18	6.30	4.36	4.05	5.31	5.07
BTEX[a] Compounds	7.04	7.71	1.69	7.63	5.20	5.12	23.11	8.43
Sum of Avg Concentrations	**31.08**	**15.08**	**58.43**	**32.42**	**24.92**	**20.53**	**42.30**	**64.66**

[a] = BTEX: benzene, toluene, ethylbenzene, and xylenes

Table 9. Number of NEI point source facilities reporting non-detected HAPs (within 50 miles).

Non-Detected Compound	CANJ	EPTX
Bromoform	0	0
Chlorobenzene	55	5
Chloroethane	Not Applicable	4
Chloroform	Not Applicable	5
Chloroprene	0	0
Dibromoethane, 1,2-	38	4
Dichloroethane, 1,1-	38	4
Dichloroethane, 1,2-	59	5
Dichloropropane, 1,2-	40	4
Dichloropropene, 1,3-	2	0
Ethyl Acrylate	7	Not Applicable
Methyl Methacrylate	15	0
Tetrachloroethane, 1,1,2,2-	39	4
Trichloroethane, 1,1,2-	2	0
Vinyl Chloride	51	5

FIGURES

Figure 1. 1999 NEI facilities within 10 miles of the UATMP site in Camden, New Jersey.

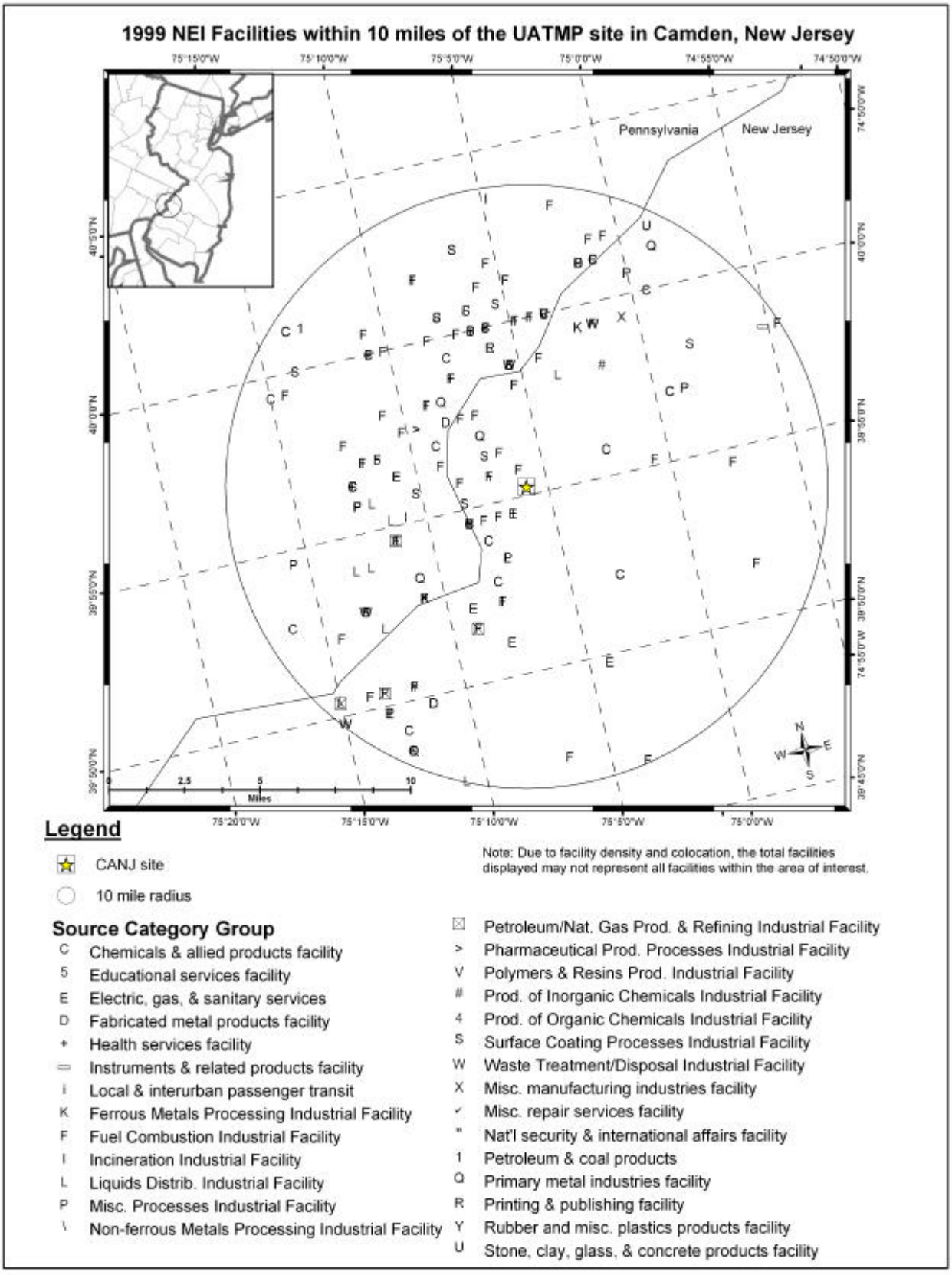

Figure 2 – 1999 NEI Facilities within 10 miles of the UATMP site in El Paso, Texas