

CLEVELAND AIR TOXICS STUDY



Ohio Environmental Protection Agency
DIVISION OF AIR POLLUTION CONTROL
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EXECUTIVE SUMMARY

The Ohio EPA, Division of Air Pollution Control, has completed an urban air toxic monitoring study for the Cleveland area. This report is designed to address potential concerns for health risks from multi-source, multi-pollutant interactions in the City of Cleveland. This study includes ambient air toxics monitoring results for volatile organic compounds (VOCs), heavy metals, and polycyclic aromatic hydrocarbons (PAHs). The results are briefly examined by a screening level risk assessment.

From 1989 to 1997, various sampling projects have been conducted at six different sampling locations. These sites were chosen to be representative of the Cleveland urban area as a whole, not to be dominated by a single industrial source. The majority of effort was devoted to the sampling location at 4950 Broadway Ave.

With this monitoring data, a screening level risk assessment from exposure to the chemicals of potential concern was conducted in order to translate the monitored data into a quantitative risk perspective.

Table A summarizes the calculation of excess cancer risk for each group of chemicals.

Table A: Excess Cancer Risk

Sources of Risk	Carcinogenic Risk (totaled for each class)
Volatile Organic Compounds	5.15×10^{-5}
Heavy Metals	1.21×10^{-4}
Polycyclic Aromatic Hydrocarbons	1.23×10^{-5}
Total Carcinogenic Risk	1.85×10^{-4}

The total carcinogenic risk for the Broadway monitoring site is in the range of 10^{-4} . The risk associated with exposure to heavy metals appears to be contributing the most significant portion of the total carcinogenic risk (approximately 64%). Most large urban areas in the United States exhibit aggregate or total carcinogenic risks in the 10^{-04} to 10^{-05} range. It is common for industrial or light industrial areas to have risks greater than those. Areas of higher risk characteristically may also contain large volumes of automobile traffic. While it is certainly desirable to have these aggregate risks minimized to the lowest possible level, a no-risk scenario would be impossible to achieve in a major urban area.

The calculations for non-carcinogenic risk are summarized in **Table B**. Details of the calculations are provided in the body of the report.

Table B: Non-carcinogenic Risk

Sources of Risk	Health Effects Reference Dose (Hazard Index Percentage)
Volatile Organic Compounds	63.38
Heavy Metals	0.80
Polycyclic Aromatic Hydrocarbons	1.15
Total Hazardous Index (HI) Percentage	65.33

The total hazard index (HI) percentage is below 100%. If the HI is above 100%, there may be cause for concern about potential adverse health effects due to exposure to these chemicals. For non-carcinogenic estimation of risks, the total calculated HI below 100% are generally regarded as "safe" levels of exposure. Currently, no guidance exists for determining acceptable levels of aggregate non-carcinogenic risks beyond this simple estimation.

For an accurate interpretation of the predicted risks, these risks must be placed in perspective with common daily activities. A range of "acceptable" health risk values for carcinogens has historically ranged from one in one million (1×10^{-6}) for regulation of certain individual source categories, to some sources routinely operating in the one in ten thousand (1×10^{-4}) range. For non-carcinogenic estimation of Hazard Indices, an individual calculated index below 100% is generally regarded as a "safe" level of exposure.

INTRODUCTION

The Ohio EPA, Division of Air Pollution Control (DAPC), has completed an urban air toxic monitoring study for the Cleveland area. This study was completed by the Air Toxic Unit (ATU) and Air Monitoring Section (AMS). The creation of this report is part of the Ohio EPA's Urban Air Toxic Monitoring Program, initiated by the U.S. EPA to address the potential concerns for high cancer risks from multi-source, multi-pollutant interactions in urban areas. The City of Cleveland is a large urban area with numerous industrial sources. These sources, when combined, make Cuyahoga County one of the counties generating the largest total amount of toxic air emissions released to the environment in Ohio. In this study, Ohio EPA, in conjunction with the Cleveland Department of Public Health & Welfare, has conducted ambient air toxics monitoring for volatile organic compounds (VOCs) and particulate matter collected by total suspended particulate (TSP) samplers. Some of the particulate filter samples were analyzed for a variety of heavy metals, while the remainder were analyzed for polycyclic aromatic hydrocarbons (PAHs).

From 1989 to 1997, various sampling projects have been conducted at six locations in the Cleveland area:

1. 4950 Broadway Ave. [Fire Station #13]
2. East 22nd & Woodland [St. Vincent Hospital]
3. 4150 East 56th St. [Ferro Corporation]
4. 5777 Grant Ave. [Consumer]
5. 2547 St. Tikhon [St. Theodosius Church]
6. 11 Berea Commons [Berea City Hall]

These sites were chosen to be representative of the Cleveland urban area as a whole, not to be dominated by a single industrial source. The majority of the effort was devoted to the sampling station located at 4950 Broadway Avenue. **Table 1** is a summary of the sampling site parameters collected per year. Described below is the location summary for each site.

Site Descriptions

1} Fire Station #13

Fire Station #13 is surrounded by residential areas on its southern and eastern borders, including a hospital. Approximately one quarter mile west of this site is a large industrial area which includes LTV Steel Company (the largest flat rolled steel manufacturing facility in North America). Interstate Highway 77 runs both north and south of the station approximately one city block away. Anthony Allega Asphalt Plant lies less than one mile north of Fire Station #13. This area also contains other commercial and industrial activity.

2} St. Vincent Hospital

The St. Vincent site is mainly surrounded by interstate highways and large city streets. To the north lies Interstate Highway 90 East and to the south/southwest lies Interstate Highway 90 West. Directly south and within one-half mile is LTV Steel. Approximately one-half mile northeast is the C.E.I. Coal Fired Power Generator. The area west of St. Vincent is mainly industrial and includes the Flats (the Cuyahoga River valley). A residential area overlooks the valley. The Cleveland downtown area is approximately one quarter mile north of St. Vincent. To the east of St. Vincent Hospital, there is more residential area. In addition, to the north and south of the site are some areas of undeveloped land.

3} Ferro Corporation

To the north and east of the Ferro Site are mainly highly populated residential areas including single and two family homes. There is also a mixture of business and light industry to the north. Interstate Highway 77 lies to the west of the site. Ferro Corporation is located to the north of the site.

4} Consumer

The Consumer site lies south of the Ferro Frit Plant. To the north, east and southeast lie highly populated residential areas with single and two family homes. There is also some light industry and business in this area. The Benjamin Moore Plant lies to the west of the Consumer site. Also to be noted are railroad tracks that are in use, and run directly behind this site. To the west of the Consumer site lies Interstate Highway 77.

5} St. Theodosius Church

The St. Theodosius Church monitoring site is located at the edge of the Cleveland industrial valley. Interstate 490 is located approximately 100 yards east and 50 yards south of the site. The remaining area east is the industrial valley. To the south is a residential area bordered by the valley. To the west is another residential area bordered by Interstate Highway 71 approximately half a mile from the site. The area north is moderately residential, with the industrial valley close by.

6} Berea City Hall

Berea City Hall is located at 11 Berea Commons. To the north is downtown Berea, Baldwin Wallace College, and a residential area. To the east is the Cuyahoga County Fairgrounds, with another residential area. West of the site is the Berea water treatment facility. Part of the Cleveland Metroparks System and another residential area are located to the south of the site. While the Berea monitoring site collected data for this study, the results were somewhat sporadic and irregular. The wide range of values was indicative of potentially unreliable data. Therefore, the results from this site are not included in this study.

Background

For this study, Fire Station #13 was used as the main Cleveland sampling site. Samples of VOCs,

PAHs, and heavy metals were collected there. Only VOC samples were collected at the St. Vincent site. The Ferro and Consumer sites were used only for collection of heavy metal samples. Both VOC and metals samples were collected at the St. Theodosius Site.

In the past Fire Station #13 has been used as a total suspended particulate (TSP) site and is currently a monitoring site for PM-10 (particulate matter under 10 microns) and lead. The St. Vincent Church site is one of Cleveland's main PM-10 monitoring sites and has been used during previous U.S. EPA air toxics monitoring studies. The Ferro Corp. and Consumer sites are industrial lead monitoring sites. **Table 1** outlines the total data collected for each site in the Cleveland area.

Table 1: Summary of Sampling Site Parameters Collected per Year

SITE	VOCs	Semi-VOCs	Heavy Metals
Fire Station #13 AIRS: **39-035-0045	1991-1997	1991 and 1993	1990-1997
St. Vincent Hospital AIRS: 39-035-0033	1992	no samples taken	no samples taken
Ferro Corp. AIRS: 39-035-0049	no samples taken	no samples taken	1989-1997
Consumer AIRS: 39-035-0050	no samples taken	no samples taken	1989-1997
St. Theodosius AIRS: 39-035-0038	1993-1997	no samples taken	1992-1997
Berea City Hall AIRS: 39-035-2001	1992	no samples taken	no samples taken

**(AIRS), Aerometric Information and Retrieval System for ambient air quality data. Information about pollutants can be obtained by accessing the AIRS Database.

METHODS

Volatile Organic Compound Sampling and Analysis

A major component of this study consists of ambient sampling for volatile organic compounds (VOCs). These are defined as compounds that are generally found in the vapor state at normal temperatures. These compounds can be chlorinated or simple hydrocarbons. During this study, VOC samples were collected using a whole-air sampling system that pumps ambient air into an evacuated stainless steel canister. The canister acts as a storage container which allows the air sample to be maintained virtually unchanged until it is analyzed. Initially the samples were collected sporadically; however, as the sampling program became more routine, an attempt was made to collect samples twice a month over a 24 hour period. In the summary tables, each listed observation is a 24-hour sample. The specific procedures for this type of sampling can be found in the U.S. EPA document *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air* (section TO-14).

During analysis, the volatile tendency of VOC compounds allows them to be vaporized when heated (if not already in that form), and then injected into an analytical device called a gas chromatograph (GC). The typical analytical system used for this study utilized a GC with a special detector called a mass spectrometer (MS). As a sample passes through a GC column, the various compounds separate out of the sample mixture. The compounds exit the column individually, and the concentration of each is detected by the mass spectrometer. These concentrations are illustrated as peaks on a chromatogram. The area of each peak indicates the concentration of the compound in the sample. Compound identification is accomplished by comparing the retention time of the peaks on chromatogram with those from a chromatogram of a known mixture of compounds. Retention time is the time it takes for a particular compound to reach the detector. As long as the analytical conditions remain the same, a compound from one analysis to the next will have the same retention time.

The combination of a GC/MS can be used to analyze a sample by separating it into its individual components which are then broken down into mass fragments, forming a fingerprint by which a compound can be identified as described above. During the analysis, only 42 VOCs are targeted by the analytical system for identification and quantification. As the technology and method improves, additional compounds are added to the standard target list. However, if an unidentified compound of significant quantity exists in a sample, it can be identified during the MS analysis.

Tables 2-A through 2-G summarize the results of all samples collected in each year from each of the different sites in Cleveland. The detailed results for each individual sample collected are available from DAPC, AMS. The arithmetic mean (average) contains values for non-detected compounds as the 1/2 detection limit. The detection limit is the lowest measurement the procedure can accurately quantify as a true measurement of the ambient air concentration. Other options for handling values below the detection limit are available, such as using the detection limit itself for the number, or using zero for the measurement result. The ramifications of selecting each option are discussed in the Results and Discussion section of this report.

Table 2-A: VOC Sampling Results Summary for Fire Station #13*

1991

units $\mu\text{g}/\text{m}^3$

COMPOUND NAME	ARITHMETIC MEAN	MAX OBS.	MIN OBS.	SAMPLES DETECTED
dichlorodifluoromethane	5.33	19.75	2.17	8
methyl chloride	0.49	0.96	0.10	4
trichlorofluoromethane	2.08	3.53	0.28	8
dichloroethene	0.79	2.80	0.20	2
dichloromethane	2.32	6.57	0.17	6
3-chloropropene	4.00	14.90	0.16	4
1,1,2-trichloro-1,2,2- trifluoroethane	0.90	2.25	0.38	5
dichloroethane	0.39	1.02	0.20	2
trichloromethane	0.33	0.67	0.24	2
1,1,1-trichloroethane	4.90	16.70	0.27	6
benzene	3.02	6.45	0.16	6
carbon tetrachloride	0.92	2.33	0.31	4
trichloroethene	0.79	1.80	0.27	5
toluene	18.39	37.50	0.19	6
tetrachloroethene	4.02	12.80	0.34	7
chlorobenzene	0.23	0.23	0.23	0
ethylbenzene	2.18	3.73	1.16	8
m+p-xylene	5.38	13.63	0.21	6
styrene	2.05	2.98	1.01	8
o-xylene	2.56	3.93	1.64	8
4-ethyl toluene	1.75	4.38	0.25	6
1,3,5-trimethylbenzene	3.71	15.20	0.93	8
1,2,4-trimethylbenzene	3.04	5.17	0.25	7
m-dichlorobenzene	1.25	5.48	0.30	2
p-dichlorobenzene	8.17	24.30	0.30	6
o-dichlorobenzene	0.30	0.30	0.30	0
1,2,4-trichlorobenzene	1.95	8.17	0.38	2

* The sampling frequency for Fire Station #13 in 1991 was 8 (the total number of detections possible was 8).

**Table 2-B: VOC Sampling Results Summary for Fire Station #13, and
St. Vincent Hospital***

1992

units $\mu\text{g}/\text{m}^3$

COMPOUND NAME:	ARITHMETIC MEAN	MAX OBS.	MIN OBS.	SAMPLES DETECTED
dichlorodifluoromethane	3.36	7.71	0.99	18
methyl chloride	0.78	1.85	0.10	17
trichlorofluoromethane	2.77	6.16	0.79	18
1,1-dichloroethene	0.20	0.20	0.20	0
dichloromethane	6.77	36.90	0.50	18
3-chloropropene	0.27	1.53	0.16	3
1,1,2-trichloro-1,2,2-trifluoroethane	0.94	2.26	0.38	14
dichloroethane	0.20	0.20	0.20	0
trichloromethane	0.33	0.52	0.24	6
1,1,1-trichloroethane	3.48	7.68	1.11	18
benzene	3.68	6.92	1.84	18
carbon tetrachloride	0.70	0.94	0.31	17
trichloroethene	1.35	4.29	0.27	16
toluene	9.58	22.20	3.91	18
tetrachloroethene	2.30	7.47	0.68	18
chlorobenzene	0.23	0.23	0.23	0
ethylbenzene	1.92	3.92	0.91	18
m+p-xylene	6.53	16.00	2.29	18
styrene	0.99	5.95	0.22	12
o-xylene	2.33	4.82	0.96	18
4-ethyl toluene	1.41	4.42	0.25	14
1,3,5-trimethylbenzene	0.72	1.65	0.25	13
1,2,4-trimethylbenzene	2.55	4.42	0.87	18
m-dichlorobenzene	0.30	0.30	0.30	0
p-dichlorobenzene	0.35	0.76	0.30	2
o-dichlorobenzene	0.30	0.30	0.30	0
1,2,4-trichlorobenzene	0.34	0.74	0.25	4

* The sampling frequency in 1992 for Fire Station #13 was 14. The sampling for St. Vincent Hospital was 4 (the total number of detections possible was 18).

**Table 2-C: VOC Sampling Results Summary for Fire Station #13 and
St. Theodosius Church***

1993

units $\mu\text{g}/\text{m}^3$

COMPOUND NAME:	ARITHMETIC MEAN	MAX OBS.	MIN OBS.	SAMPLES DETECTED
dichlorodifluoromethane	2.49	9.57	0.78	29
methyl chloride	0.35	1.06	0.10	16
trichlorofluoromethane	2.54	4.15	1.83	29
1,1-dichloroethene	0.22	0.57	0.20	2
dichloromethane	2.84	19.70	0.41	29
3-chloropropene	0.16	0.16	0.16	0
1,1,2-trichloro-1,2,2-trifluoroethane	0.92	1.85	0.38	25
dichloroethane	0.21	0.42	0.20	1
trichloromethane	0.24	0.24	0.24	0
1,1,1-trichloroethane	2.85	8.76	1.03	29
benzene	3.95	17.00	1.13	29
carbon tetrachloride	0.86	1.80	0.31	28
trichloroethene	0.60	1.89	0.27	13
toluene	8.13	23.80	1.74	29
tetrachloroethene	1.45	3.88	0.34	20
chlorobenzene	0.30	1.40	0.23	2
ethylbenzene	2.07	4.12	0.75	29
m+p-xylene	5.62	14.70	1.10	29
styrene	0.95	8.13	0.22	10
o-xylene	1.83	3.97	0.21	28
4-ethyl toluene	1.03	3.29	0.25	22
1,3,5-trimethylbenzene	0.54	1.76	0.25	15
1,2,4-trimethylbenzene	2.09	5.63	0.61	29
m-dichlorobenzene	0.32	0.78	0.30	1
p-dichlorobenzene	0.54	4.13	0.30	6
o-dichlorobenzene	0.32	0.65	0.30	1
1,2,4-trichlorobenzene	0.38	0.38	0.38	0

* The sampling frequency in 1993 for Fire Station #13 was 14. The sampling frequency for St. Theodosius was 15 (the total number of detections possible was 29).

**Table 2-D: VOC Sampling Results Summary for Fire Station #13 and
St. Theodosius Church***

1994

units $\mu\text{g}/\text{m}^3$

COMPOUND NAME:	ARITHMETIC MEAN	MAX OBS.	MIN OBS.	SAMPLES DETECTED
dichlorodifluoromethane	2.07	4.91	0.67	29
methyl chloride	0.54	1.08	0.21	29
trichlorofluoromethane	12.58	161.00	1.39	29
1,1-dichloroethene	0.20	0.20	0.20	0
dichloromethane	2.08	11.20	0.33	29
3-chloropropene	0.16	0.16	0.16	0
1,1,2-trichloro-1,2,2- trifluoroethane	0.54	1.11	0.38	11
dichloroethane	0.20	0.20	0.20	0
trichloromethane	0.29	0.92	0.24	3
1,1,1-trichloroethane	2.68	12.50	0.52	29
benzene	3.34	16.70	0.59	29
carbon tetrachloride	0.73	1.31	0.31	24
trichloroethene	0.65	2.41	0.27	15
toluene	5.76	17.50	1.45	29
tetrachloroethene	1.14	5.47	0.34	21
chlorobenzene	0.23	0.23	0.23	0
ethylbenzene	1.31	4.98	0.22	28
m+p-xylene	3.09	8.13	0.84	29
styrene	0.36	1.02	0.22	13
o-xylene	1.08	2.96	0.21	27
4-ethyl toluene	0.39	1.15	0.25	9
1,3,5-trimethylbenzene	0.35	1.05	0.25	6
1,2,4-trimethylbenzene	1.20	3.25	0.25	27
m-dichlorobenzene	0.30	0.30	0.30	0
p-dichlorobenzene	0.30	0.30	0.30	0
o-dichlorobenzene	0.30	0.30	0.30	0
1,2,4-trichlorobenzene	0.38	0.38	0.38	0

* The sampling frequency in 1994 for Fire Station #13 was 14. The sampling frequency in 1994 for St. Theodosius was 15 (the total number of detections possible was 29).

**Table 2-E: VOC Sampling Results Summary for Fire Station #13 and
St. Theodosius Church***

1995

units $\mu\text{g}/\text{m}^3$

COMPOUND NAME:	ARITHMETIC MEAN	MAX OBS.	MIN OBS.	SAMPLES DETECTED
dichlorodifluoromethane	1.78	3.38	0.35	44
methyl chloride	0.67	1.46	0.25	44
trichlorofluoromethane	3.34	47.30	1.24	44
1,1-dichloroethene	0.21	0.87	0.20	1
dichloromethane	2.17	13.70	0.17	40
3-chloropropene	0.16	0.16	0.16	0
1,1,2-trichloro-1,2,2-trifluoroethane	0.42	0.83	0.38	5
dichloroethane	0.20	0.20	0.20	0
trichloromethane	0.30	1.18	0.24	4
1,1,1-trichloroethane	1.93	5.71	0.53	44
benzene	5.49	62.20	0.59	44
carbon tetrachloride	0.57	0.87	0.31	29
trichloroethene	0.46	3.23	0.27	12
toluene	6.79	28.10	1.10	44
tetrachloroethene	0.71	3.83	0.34	16
chlorobenzene	0.23	0.23	0.23	0
ethylbenzene	0.94	5.51	0.22	39
m+p-xylene	3.28	18.30	0.57	44
styrene	0.28	1.03	0.22	6
o-xylene	1.34	6.08	0.21	43
4-ethyl toluene	0.42	1.86	0.25	16
1,3,5-trimethylbenzene	0.45	1.90	0.25	11
1,2,4-trimethylbenzene	1.10	5.80	0.25	39
m-dichlorobenzene	0.30	0.30	0.30	0
p-dichlorobenzene	0.31	0.60	0.30	1
o-dichlorobenzene	0.30	0.30	0.30	0
1,2,4-trichlorobenzene	0.38	0.38	0.38	0

* The sampling frequency in 1995 for Fire Station #13 was 24. The sampling frequency in 1995 for St. Theodosius was 20 (the total number of detections possible was 44).

**Table 2-F: VOC Sampling Results Summary for Fire Station #13 and
St. Theodosius Church***

1996

units $\mu\text{g}/\text{m}^3$

COMPOUND NAME:	ARITHMETIC MEAN	MAX OBS.	MIN OBS.	SAMPLES DETECTED
dichlorodifluoromethane	2.31	4.60	0.25	52
methyl chloride	0.87	1.70	0.10	47
trichlorofluoromethane	2.65	46.80	0.90	53
1,1-dichloroethene	0.20	0.20	0.20	0
dichloromethane	1.00	5.80	0.17	35
3-chloropropene	0.16	0.17	0.16	1
1,1,2-trichloro-1,2,2-trifluoroethane	0.38	0.38	0.38	0
dichloroethane	0.21	0.60	0.20	1
trichloromethane	0.26	0.66	0.24	2
1,1,1-trichloroethane	1.32	4.19	0.27	40
benzene	2.60	10.50	0.78	53
carbon tetrachloride	0.35	0.74	0.31	6
trichloroethene	0.39	2.80	0.27	8
toluene	5.75	17.70	1.01	53
tetrachloroethene	0.77	7.60	0.34	11
chlorobenzene	0.23	0.23	0.23	0
ethylbenzene	0.63	1.75	0.22	40
m+p-xylene	5.78	21.60	0.43	53
styrene	0.22	0.49	0.22	1
o-xylene	0.75	1.90	0.21	43
4-ethyl toluene	0.30	0.84	0.25	7
1,3,5-trimethylbenzene	0.27	0.60	0.25	4
1,2,4-trimethylbenzene	1.05	11.00	0.25	43
m-dichlorobenzene	0.30	0.30	0.30	0
p-dichlorobenzene	0.30	0.30	0.30	0
o-dichlorobenzene	0.30	0.30	0.30	0
1,2,4-trichlorobenzene	0.38	0.38	0.38	0

* The sampling frequency in 1996 for Fire Station #13 was 27. The sampling frequency in 1996 for St. Theodosius was 26 (the total number of detections possible was 53).

**Table 2-G: VOC Sampling Results Summary for Fire Station #13 and
St. Theodosius Church***

1997

units $\mu\text{g}/\text{m}^3$

COMPOUND NAME:	ARITHMETIC MEAN	MAX OBS.	MIN OBS.	SAMPLES DETECTED
dichlorodifluoromethane	2.56	4.50	1.00	43
methyl chloride	0.76	4.80	0.10	22
trichlorofluoromethane	2.08	11.30	0.80	43
1,1-dichloroethene	0.20	0.20	0.20	0
dichloromethane	0.71	6.00	0.17	11
3-chloropropene	0.16	0.16	0.16	0
1,1,2-trichloro-1,2,2-trifluoroethane	0.38	0.38	0.38	0
dichloroethane	0.20	0.20	0.20	0
trichloromethane	0.24	0.24	0.24	0
1,1,1-trichloroethane	1.36	6.60	0.27	23
benzene	4.54	47.10	0.50	43
carbon tetrachloride	0.33	0.70	0.31	2
trichloroethene	0.38	1.70	0.27	6
toluene	5.61	25.40	1.80	43
tetrachloroethene	0.45	2.10	0.34	5
chlorobenzene	0.23	0.23	0.23	0
ethylbenzene	0.73	2.90	0.22	29
m+p-xylene	5.16	21.70	1.40	43
styrene	0.33	2.30	0.21	6
o-xylene	0.88	3.40	0.22	37
4-ethyl toluene	0.25	0.25	0.25	0
1,3,5-trimethylbenzene	0.33	1.40	0.25	6
1,2,4-trimethylbenzene	1.00	3.80	0.25	36
m-dichlorobenzene	0.30	0.30	0.30	0
p-dichlorobenzene	0.31	0.60	0.30	1
o-dichlorobenzene	0.30	0.30	0.30	0
1,2,4-trichlorobenzene	0.38	0.38	0.38	0

* The sampling frequency in 1996 for Fire Station #13 was 21. The sampling frequency in 1996 for St. Theodosius was 22 (the total number of detections possible was 43).

Heavy Metals Sampling and Analysis

Ambient air toxic monitoring for heavy metals in the Cleveland area was initiated in December 1988, and has remained in continuous operation since. Sampling for heavy metals is conducted using a high volume total suspended particulate (TSP) sampler. With this sampler, particulate matter in the air is collected on a pre-weighed glass fiber filter. Sampling is done intermittently with 24-hour samples collected once every six days. The operating procedures can be found in the *Code of Federal Regulations, 40 CFR, Part 50, Appendix B - Reference Method for Determination of Suspended Particulate Matter in the Atmosphere*. For lead, 40 CFR Part 50, Appendix G is used.

Filters collected at each site were analyzed as a monthly composite. The acid-extracted samples are analyzed by atomic absorption (AA) spectroscopy. When an element is heated in the flame of this instrument, it absorbs light at a characteristic wavelength. By measuring the amount of light absorbed at a particular wavelength, the concentration of the element being analyzed can be determined.

Tables 3-A through 3-I summarize the heavy metal results from the various sampling sites for each year. The complete monthly results from each site are available from the DAPC, AMS.

**Table 3-A: Heavy Metal Sampling Results Summary for
Ferro Corporation and Consumer***

1989

units $\mu\text{g}/\text{m}^3$

ELEMENT	ARITHMETIC MEAN	MAXIMUM OBSERVATION	MINIMUM OBSERVATION	SAMPLES DETECTED
Arsenic	0.00306	0.00466	0.00146	26
Cadmium	0.01008	0.03100	0.00218	26
Chromium	0.00435	0.00907	0.00411	13
Lead	0.16410	0.41400	0.05070	25
Nickel	0.03051	0.19900	0.00733	23
Zinc	0.19569	0.36800	0.03050	26
Beryllium	0.00014	0.00024	0.00006	15

* The sampling frequency in December 1988-89 for Ferro Corporation and Consumer was 13 for each site (the total number of detections possible was 26), with the exception for beryllium which was not measured after July 1989 due to extremely small amounts previously measured.

**Table 3-B: Heavy Metal Sampling Results Summary for Ferro Corporation,
Consumer, and Fire Station #13***

1990

units $\mu\text{g}/\text{m}^3$

ELEMENT	ARITHMETIC MEAN	MAXIMUM OBSERVATION	MINIMUM OBSERVATION	SAMPLES DETECTED
Arsenic	0.00325	0.00642	0.00136	36
Cadmium	0.01053	0.07900	0.00126	36
Chromium	0.01092	0.08910	0.00285	35
Lead	0.21721	1.34000	0.06260	35
Nickel	0.03247	0.12500	0.00421	30
Zinc	0.21419	0.49000	0.06100	36

*The sampling frequency in 1990 for the three mentioned sites was 12 for each site (the total number of detections possible was 36).

**Table 3-C: Heavy Metal Sampling Results Summary for Ferro Corporation,
Consumer, and Fire Station #13***

1991

units $\mu\text{g}/\text{m}^3$

ELEMENT	ARITHMETIC MEAN	MAXIMUM OBSERVATION	MINIMUM OBSERVATION	SAMPLES DETECTED
Arsenic	0.00295	0.00848	0.00100	36
Cadmium	0.00854	0.04750	0.00132	36
Chromium	0.00961	0.01670	0.00373	35
Lead	0.14583	0.51300	0.01050	31
Nickel	0.03483	0.24500	0.00722	31
Zinc	0.24717	0.55900	0.10400	36

* The sampling frequency in 1991 for the three mentioned sites was 12 for each site (the total number of detections possible was 36).

Table 3-D: Heavy Metal Sampling Results Summary for Ferro Corporation, Consumer, Fire Station #13, and St. Theodosius Church*

1992

units $\mu\text{g}/\text{m}^3$

ELEMENT	ARITHMETIC MEAN	MAXIMUM OBSERVATION	MINIMUM OBSERVATION	SAMPLES DETECTED
Arsenic	0.00294	0.00618	0.00106	37
Cadmium	0.00832	0.07880	0.00111	37
Chromium	0.01144	0.01640	0.00698	37
Lead	0.17805	0.75200	0.05410	37
Nickel	0.03461	0.19100	0.00455	37
Zinc	0.28030	0.72500	0.03910	37

* The sampling frequency in 1992 for Ferro Corporation and Fire Station #13 was 12 for each site. The sampling frequency for Consumer was 7 (no data available from May-September). The sampling frequency for St. Theodosius was 6 (no data available from January-June)(the total number of detections possible was 37).

Table 3-E: Heavy Metal Sampling Results Summary for Ferro Corporation, Consumer, Fire Station #13, and St. Theodosius Church*

1993

units $\mu\text{g}/\text{m}^3$

ELEMENT	ARITHMETIC MEAN	MAXIMUM OBSERVATION	MINIMUM OBSERVATION	SAMPLES DETECTED
Arsenic	0.00311	0.03300	0.00023	47
Cadmium	0.00393	0.01330	0.00069	48
Chromium	0.01219	0.02010	0.00562	46
Lead	0.15152	1.04000	0.04100	41
Nickel	0.02335	0.10001	0.00409	31
Zinc	0.16584	0.40600	0.05870	48

* The sampling frequency in 1993 for Ferro Corporation, Consumer, Fire Station #13, and St. Theodosius was

12 for each site (the total number of detections possible was 48).

Table 3-F: Heavy Metal Sampling Results Summary for Ferro Corporation, Consumer, Fire Station #13, and St. Theodosius Church*

1994

units $\mu\text{g}/\text{m}^3$

ELEMENT	ARITHMETIC MEAN	MAXIMUM OBSERVATION	MINIMUM OBSERVATION	SAMPLES DETECTED
Arsenic	0.00341	0.0248	0.00011	45
Cadmium	0.02108	0.5760	0.00078	46
Chromium	0.00588	0.0173	0.00159	35
Lead	0.09148	0.4980	0.02570	25
Nickel	0.04640	0.3540	0.00213	31
Zinc	0.17828	0.3800	0.05930	46

* The sampling frequency in 1994 for Fire Station #13, Consumer, and St. Theodosius was 12 for each site. The sampling frequency for Ferro Corporation was 11 (the total number of detections possible was 47).

Table 3-G: Heavy Metal Sampling Results Summary for Ferro Corporation, Consumer, Fire Station #13, and St. Theodosius Church*

1995

units $\mu\text{g}/\text{m}^3$

ELEMENT	ARITHMETIC MEAN	MAXIMUM OBSERVATION	MINIMUM OBSERVATION	SAMPLES DETECTED
Arsenic	0.00219	0.0041	0.00102	48
Cadmium	0.00388	0.0419	0.00070	48
Chromium	0.00494	0.0123	0.00162	28
Lead	0.07848	0.5210	0.02355	22
Nickel	0.02090	0.1610	0.00223	29
Zinc	0.14732	0.3440	0.04510	48

* The sampling frequency in 1995 for Ferro Corporation, Consumer, Fire Station #13, and St. Theodosius was 12 for each site (the total number of detections possible was 48).

**Table 3-H: Heavy Metal Sampling Results Summary for Ferro Corporation,
Consumer, Fire Station #13, and St. Theodosius Church***

1996

units $\mu\text{g}/\text{m}^3$

ELEMENT	ARITHMETIC MEAN	MAXIMUM OBSERVATION	MINIMUM OBSERVATION	SAMPLES DETECTED
Arsenic	0.00212	0.0041	0.00096	48
Cadmium	0.00338	0.0584	0.00046	48
Chromium	0.00529	0.0106	0.00167	38
Lead	0.04372	0.3710	0.02425	4
Nickel	0.01694	0.0853	0.00194	25
Zinc	0.17260	0.5690	0.05090	48

* The sampling frequency in 1996 for Ferro Corporation, Consumer, Fire Station #13, and St. Theodosius was 12 for each site (the total number of detections possible was 48).

**Table 3-I: Heavy Metal Sampling Results Summary for Ferro Corporation,
Consumer, Fire Station #13, and St. Theodosius Church***

1997

units $\mu\text{g}/\text{m}^3$

ELEMENT	ARITHMETIC MEAN	MAXIMUM OBSERVATION	MINIMUM OBSERVATION	SAMPLES DETECTED
Arsenic	0.00179	0.00754	0.00070	48
Cadmium	0.00159	0.00897	0.00034	48
Chromium	0.00759	0.01320	0.00368	48
Lead	0.05046	0.08490	0.02550	25
Nickel	0.02501	0.11600	0.00412	30
Zinc	0.15529	0.29800	0.06830	48

* The sampling frequency in 1997 for Ferro Corporation, Consumer, Fire Station #13, and St. Theodosius was 12 for each site (the total number of detections possible was 48).

Semi-Volatile Organic Compound Sampling and Analysis

This study examined different groups of organic compounds. The first section focused on VOCs, while this section focuses on semi-volatile organic compounds. These compounds are found in either the vapor state or attached to particulate matter at normal atmospheric temperatures. Sampling for these types of compounds requires a sampling device that collects both the vapor and particulate phases of a compound simultaneously in the sampled air stream. This is accomplished in a modified TSP sampler operating at a lower flow rate. The particulate matter is trapped on a quartz fiber filter, while the vapor portion is captured on an adsorbent cartridge made up of a sandwich of poly-urethane foam (PUF) and a chemical resin. During this study, all of the samples were collected over a 48-hour sampling period to obtain an adequate sample concentration and to improve the minimum detection limits. The specific operation procedure is found in the U.S. EPA document *Compendium of the Methods for the Determination of Toxic Organic Compound in Ambient Air* (section TO-4).

When the sample is returned from the field it is extracted and then concentrated, followed by silica gel clean-up, using column chromatography to remove potential interferences prior to analysis. The analysis is performed by GC/MS. For semi-volatile organic compounds, there are three separate groups of measured pollutants: polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and pesticides. From the samples collected during this study, only PAH compounds were detected, as shown in **Table 4**.

Table 4: PAH Sampling Results Summary for Fire Station #13

1991 and 1993

units $\mu\text{g}/\text{m}^3$

COMPOUND	11-04-91	11-18-91	06-22-93	07-07-93	09-07-93	09-27-93
Naphthalene	0.4350	0.1380	0.1258	0.2388	0.3210	2.4671
Acenaphthylene	0.0160		0.0020	0.0400	0.0700	0.0460
Acenaphthene	0.0390		0.0217	0.0600	0.0342	0.0958
Fluorene	0.0470	0.0100	0.0237	0.0530	0.0312	0.0562
Phenanthrene	0.1050	0.0280	0.0512	0.1246	0.0679	0.0800
Anthracene	0.0180		0.0013	0.0062	0.0047	0.0140
Fluoranthene	0.0430		0.0068	0.0315	0.0315	0.0224
Pyrene	0.0210		0.0160	0.0312	0.0174	0.0090
Chrysene			0.0054	0.0004	0.0022	0.0021
Dibenz(a,h) anthracene			0.0042	0.0020	0.0007	0.0036
Indeno[1,2,3cd] pyrene			0.0014	0.0000	0.0003	0.0009
Benzo-						
(a)anthracene			0.0050	0.0115	0.0051	0.0024
(a)pyrene			0.0013	0.0019	0.0014	0.0006
(b)fluoranthene			0.0020	0.0007	0.0011	0.0007
(k)fluoranthene			0.0011	0.0007	0.0003	0.0003
(g,h,i)perylene			0.0033	0.0006	0.0007	0.0050

RESULTS AND DISCUSSION

Human Health Risk Assessment

Risk assessment is a process which uses current available toxicological information as a basis for estimating the health effects that individuals or populations may experience as a result of prolonged exposure to hazardous substances. Following the risk assessment guidelines provided by the National Academy of Science (NAS) and the U.S. EPA, Ohio EPA conducted a screening level risk assessment with the Cleveland air toxic monitoring data. The risk assessment process consists of four steps: hazard identification, toxicity assessment, exposure assessment, and risk characterization. These steps, when combined, produce a numerical prediction of the probability of an adverse health effect, such as carcinogenicity and/or systematic toxicity, which may occur as a result of constant exposure to a single, or multiple toxic compounds for a long period of time.

For the purpose of this study, it is assumed that a hypothetical individual is exposed constantly for 24 hours per day and 365 days per year to the average measured airborne concentrations of pollutants. Exposure is through the inhalation pathway. This assumption creates a theoretical person known as the “maximally exposed individual” (MEI). Health risks for the MEI, through the inhalation exposure pathway only, are estimated in this study. This scenario provides the largest safety buffer in evaluating potential health risks. The MEI exposure assumptions are very conservative. It is believed that the actual risks will be no greater than the estimated inhalation risk, in fact the actual risks will most likely be less than those estimated in this study. The health effects quantified in this study are the result of breathing air contaminated with a combination of specific volatile organic compounds (VOCs), heavy metals, and polycyclic aromatic hydrocarbons (PAHs) found in the monitoring data at Fire Station #13, St. Vincent Hospital, and St. Theodosius Church. The results are a quantitative, chemically-oriented analysis of the statistical probability that an adverse health effect from inhalation of these compounds could occur.

Selection of Chemicals for Risk Evaluation

Heavy metals, VOCs, and PAHs data from the Fire Station #13, St. Vincent Hospital, and St. Theodosius Church were used for the following risk evaluation. These sites yield a more representative result from the ambient air sampling in the Cleveland area. This decision was based upon the number and type of samples collected. Some VOCs, such as benzene, carbon tetrachloride, and trichloromethane, are classified as hazardous because they have been implicated as potential carcinogens. Others, such as styrene, toluene, p-dichlorobenzene and 1,1,1-trichloroethane, are believed to potentially cause non-carcinogenic adverse health effects such as developmental, reproductive, neurobehavioral, or cardio-vascular health implications. The heavy metals of zinc compounds, nickel compounds, beryllium, arsenic, cadmium and chromium (VI) are classified as human carcinogens. Polycyclic aromatic hydrocarbons (PAHs) are products of incomplete organic matter combustion and are typically found adsorbed to airborne particles such as soot and smoke. PAHs include benzo(a)pyrene, pyrene, chrysene, diethylphthalate, fluoranthene, etc. U.S. EPA has classified benzo(a)pyrene as a probable human carcinogen and other PAH's carcinogenic potentials are estimated by using the toxic equivalent factors (TEQs). TEQs use benzo(a)pyrene as the reference compound for assigning ranked toxicity to other

compounds in the same class.

For the risk assessment portion of this study, the mean (average) concentration for long-term exposure estimation contains values of 1/2 the detection limit for non-detects (results below the detection limit). The detection limit is the lowest measurement the procedure can accurately quantify as a true measurement of the ambient air concentration, which can be included in the risk assessment means as either the detection limit itself, 1/2 the detection limit, or a value of zero. Using the detection limit will tend to yield an over-estimation of the true result, as many of the values will be below the detection limit, perhaps even zero. Using a value of zero, however, will tend to underestimate the true average, as many values could be well below the detection limit, but greater than zero. Using the value of 1/2 the detection limit is a reasonable compromise between over- or under-estimation of the true ambient air concentration of these compounds.

Toxicity Information for Selected Chemicals

In order to reference the toxicity of the chemicals detected and measured, Ohio EPA used the reference doses/reference concentrations (RfDs/RfCs) and the unit risk factors (URFs) for carcinogenic compounds data from IRIS (U.S. EPA's Integrated Risk Information System database). Chronic RfDs/RfCs are estimates of daily exposure levels to which the human population, including sensitive subpopulations, may be exposed constantly for long periods, without an appreciable risk of deleterious health effects. Chronic RfDs/RfCs are especially developed to be protective for long-term exposures to the compounds. These numbers are used for non-carcinogenic chemicals only. URFs are used to assess health risks from carcinogenic compounds. The URF is a toxicity value that defines quantitatively the relationship between dose and response. Multiplying the URF by the average daily long-term dose will produce the probability of developing a cancer as a result of chronic exposure.

Estimation of Risk

For carcinogens, the excess lifetime cancer risk resulting from the inhalation of toxic compounds is calculated by multiplying the monitored average ambient air concentrations by the U.S. EPA's URFs. The resulting products are added to estimate the total risk for the site. This summation is based upon the principle that the addition of each risk produces a combined total risk estimate. This is the method recommended by the *U.S. EPA Risk Assessment Guidelines of 1986*, in the absence of additional information. It has been suggested in scientific literature that exposure to combinations of pollutants may cause greater or lesser risk than can be explained by merely the summation of the risks resulting from exposure to the substances individually. U.S. EPA does not currently have any guidance on quantifying these effects from exposure to mixtures of compounds measured in this study. Until further guidance is formulated, Ohio EPA will continue to add the risks associated with the compounds measured in a linear fashion. This is potentially an extremely conservative method of assessing risk.

Table 5 summarizes the calculation of excess cancer risk for each group of chemicals. The URFs from the IRIS database as of July 1998 were used in the calculations. For chemicals for which carcinogenicity is currently under review by U.S. EPA, values provided in the Health Effect

Assessment Summary Table (HEAST) were used. For PAH risk calculation, benzo(a)pyrene is used as the reference compound and the toxicity equivalent factors (TEFs) suggested by Clement International Corporation are used. More advanced risk estimates will be made in the future as new and updated study results are available.

The calculation of total carcinogenic risk is presented in Table 5. As shown in the table, the total carcinogenic risk for the combined Cleveland area sites appears to be in the range of 10^{-4} . The risk associated with exposure to heavy metals appears to be contributing the most significant portion of the total carcinogenic risk (approximately 64%). It should be noted that the chromium measured is total chromium, and the chromium cancer risk is calculated by using the cancer slope factor of Chromium VI. Chromium III is known as a non-carcinogenic chemical. Due to this the carcinogenic risk may be overestimated. Currently no methods are available to estimate the correct proportion of Chromium III versus VI in the atmosphere.

For non-carcinogenic adverse health effects, the risks are evaluated by the use of a Hazard Index (HI) which is a summation of the ratio of the average daily concentrations compared to the Reference Concentrations (RfC) for each compound. If the HI exceeds 100% for a compound, there may be cause for concern about potential health effects as a result of exposure to the compound. This is the method included in the *U.S. EPA Risk Assessment Guidelines of 1986*. As can be noted in the tables, occasionally one compound can be unusually high for a period of time, which does not necessarily define the long-term average (for example the data for 3-chloropropene in the 1991 data).

Table 6 summarizes the calculation of HIs for each group of chemicals, from 1990-1997 for all Cleveland area sites. For VOCs, RfCs available in IRIS as of July 1998 were used in the calculations. Presently IRIS has many RfCs that are under review. Therefore, for chemicals which do not have RfCs in IRIS, values provided in the HEAST are used. Also, route to route extrapolation was conducted to estimate RfCs from RfDs. The Total Health Effects Percentage is below the recommended 100% ceiling, indicating that adverse non-cancer human health effects are not expected to occur due to inhalation exposure.

Table 5: Carcinogenic Effects

COMPOUND	CARCINOGENIC UNIT RISK ($\mu\text{g}/\text{m}^3$) ⁻¹	SOURCE	AVERAGE CONCENTRATION ($\mu\text{g}/\text{m}^3$)	CARCINOGENIC RISK
VOCs				
Methyl Chloride	1.8 E-06	HEAST	0.68	1.22 E-06
Dichloromethane	4.7 E-07	IRIS	2.06	9.70 E-07
Trichloromethane	2.3 E-05	IRIS	0.27	6.29 E-06
Benzene	8.3 E-06	IRIS	3.91	3.25 E-05
Carbon tetrachloride	1.5 E-05	IRIS	0.55	8.30 E-06
Trichloroethene	1.7 E-06	HEAST	0.55	9.42 E-07
Tetrachloroethene	9.5 E-07	HEAST	1.07	1.02 E-06
Styrene	5.7 E-07	HEAST	0.49	2.81 E-07
SUM				5.15 E-05
HEAVY METALS				
Arsenic	4.30 E-03	IRIS	0.00271	1.17 E-05
Cadmium	1.80 E-03	IRIS	0.00765	1.38 E-05
Chromium(total)**	1.20 E-02	IRIS	0.00800	9.60 E-05
SUM				1.21 E-04
PAHs				
Benzo(a)pyrene***	2.10 E-03	1	0.006	1.26 E-06
Benzo(a)anthracene	2.10 E-04	0.1	0.0048	1.01 E-06
Benzo(b)fluoranthene	2.10 E-04	0.1	0.0023	4.83 E-07
Benzo(k)fluoranthene	2.10 E-04	0.1	0.0007	1.47 E-07
Chrysene	2.10 E-05	0.01	0.0047	9.87 E-08
Dibenz(a,h)anthracene	2.10 E-03	1	0.0041	8.61 E-06
Indeno[1,2,3-cd]pyrene	2.10 E-04	0.1	0.0031	6.51 E-07
SUM				1.23 E-05
TOTAL CARCINOGENIC RISK				1.85 E-04

** Estimation based on slope factor of Chromium VI.

*** Estimation based on slope factor of oral route.

Table 6: Non-carcinogenic Effects

COMPOUND	REFERENCE CONC (µg/m ³)	SOURCE	AVERAGE CONC. (µg/m ³)	HAZARD PERCENT INDEX (HI)
VOCs				
Dichlorodifluoromethane	7.00 E+02	IRIS**	2.44	0.35
Trichlorofluoromethane	1.05 E+03	IRIS**	3.94	0.37
Dichloromethane	2.10 E+02	IRIS**	2.06	0.98
3-chloropropene	1.00 E+00	IRIS(RfC)	0.31	30.60
1,1,2-trichloro-1,2,2-trifluoroethane	1.05 E+05	IRIS**	0.54	5.16 E-04
Trichloromethane	3.50 E+01	IRIS**	0.27	0.78
1,1,1-trichloroethane	1.00 E+03	HEAST	2.12	0.21
Carbon tetrachloride	2.45 E+00	IRIS**	0.55	22.57
Toluene	4.00 E+01	IRIS(RfC)	7.00	1.75
Tetrachloroethene	3.50 E+01	IRIS**	1.07	3.06
Ethylbenzene	1.00 E+03	IRIS(RfC)	1.17	0.12
m+p-xylene	7.00 E+02	HEAST	4.85	0.69
Styrene	1.00 E+03	IRIS(RfC)	0.49	0.05
o-xylene	7.00 E+02	HEAST	1.27	0.18
1,2,4-trichlorobenzene	3.50 E+01	IRIS**	0.55	1.58
p-dichlorobenzene	8.00 E+02	IRIS(RfC)	0.62	0.08
SUM				63.38
PAHs				
Naphthalene	1.40 E+01	HEAST	0.152	1.08
Acenaphthene	2.10 E+02	IRIS**	0.027	0.01
Fluorene	1.40 E+02	IRIS**	0.028	0.02
Anthracene	1.05 E+03	IRIS**	0.004	0.00
Fluoranthene	1.40 E+02	IRIS**	0.025	0.02
Pyrene	1.05 E+02	IRIS**	0.017	0.02
SUM				1.15
HEAVY METALS				
Arsenic	1.05 E+00	IRIS**	0.0027	0.26
Cadmium	1.75 E+00	IRIS**	0.0077	0.44
Chromium(total)***	1.75 E+01	IRIS**	0.008	0.05
Nickel and compounds	7.00 E+01	IRIS**	0.0289	0.04
Zinc and compounds	1.05 E+03	IRIS**	0.1904	0.02
SUM				.80
TOTAL HEALTH EFFECTS PERCENTAGE				65.33

** Estimation based on route to route extrapolation from RfD.

*** Estimation based on RfD of Chromium VI.

Continued monitoring efforts will enable Ohio EPA to further evaluate the carcinogenic risks and non-carcinogenic adverse health effects associated with air toxics concentrations measured in the Cleveland area.

Risk Estimates in Perspective

For an accurate interpretation of the predicted risks, these risks must be placed in perspective with common daily activities. A range of "acceptable" health risk values for carcinogens has been historically proposed by U.S. EPA. Acceptability ranges from one in one million (1×10^{-6}) for regulation of certain source categories of individual toxic air pollutants, to some source categories routinely operating in the one in ten thousand (1×10^{-4}) range. For non-carcinogenic estimation of Hazard Indexes, an individual calculated index below one (100%) is generally regarded as a "safe" level of exposure.

Most large urban areas in the United States exhibit aggregate or total carcinogenic risks in the 10^{-4} to 10^{-5} range. It is common for industrial or light industrial areas to have risks greater than those. Conversely, some smaller suburban and rural areas have combined carcinogenic risks in the 10^{-6} to 10^{-8} range. Areas of higher risk characteristically may also contain large volumes of congested automobile traffic. Workers in such areas routinely are exposed only during working hours, and return to residential areas of decreased exposure concentrations during non-working hours. While it is certainly desirable to have these aggregate risks minimized to the lowest possible level, a no-risk scenario would be impossible to achieve in a major urban area.

Cuyahoga County Toxic Release Inventory (TRI)

For additional information, a summation of the toxic chemical release inventory data for Cuyahoga County is presented in **Table 7**. This information is based upon the Toxic Release Inventory (TRI) database prepared by Ohio EPA. TRI is a publicly available database that contains specific toxic chemical release and transfer information from manufacturing facilities. This inventory is established to provide information under the Emergency Planning and Community Right to Know Act of 1986 (EPCRA), which Congress passed to provide information to the public about the presence and release of toxic and hazardous chemicals in the community. Facilities which manufactured or processed a reportable toxic chemical in quantities exceeding the thresholds established by U.S. EPA for that calendar year, or otherwise used 10,000 pounds or more of the reportable toxic chemical that calendar year, are required to report release and transfer amounts each year. The threshold amounts for manufacturing and processing a toxic chemical are:

Calendar year 1987	75,000 pounds
Calendar year 1988	50,000 pounds
Calendar year 1989	
& subsequent years	25,000 pounds

The reported information is managed by Ohio EPA as a database to provide the public with information on the releases of listed toxic chemicals in their communities and to provide the Agency with information in determining the need for future regulations.

TRI data is emission data at a specific location, rather than ambient air concentration data. TRI data cannot be directly translated into accurate human exposure data. It is important to note that TRI requires reporting of the disposition of toxic materials even if the means of disposition makes human exposure or release to the environment unlikely. Emissions data are an important contributing factor to ambient air concentration data but other factors such as meteorology, topography, fate of the released chemical, and other background concentrations also contribute significantly to ambient air concentrations.

Ohio has an active pollution prevention program whose goals include reduction of toxic releases. Pollution prevention is aimed at stopping the creation of pollutants, rather than managing them after they already exist.

The "Ohio Prevention First" program was initiated in 1993 when Governor George Voinovich challenged the "Top 100" companies that reported the most emissions on the TRI report (1991 data) and asked them to voluntarily prepare and implement comprehensive pollution prevention plans. Eighty-six of the 100 companies agreed and 81 others asked to take part as well. Altogether, they have successfully reduced 135 million pounds of toxics, and project reducing approximately 422 million additional pounds of pollution. The result has been a cost savings in excess of \$15 million.

**TABLE 7: SUMMATION OF THE TOXIC CHEMICAL RELEASE INVENTORY
DATA FOR CUYAHOGA COUNTY**

	1991	1992	1993	1994	1995	1996
County Rank in State	3	3	3	3	4	4
Number of Reporting Facilities	235	249	249	242	230	221

Release Summary (lbs/yr)	1991	1992	1993	1994	1995	1996
Air	6,559,555	5,357,397	4,449,096	3,818,383	3,178,575	3,485,465
Surface Water	20,892	10,929	5,861	6,000	3,575	8,251
Deepwell injection	0	0	0	0	0	0
Land On-Site	2,016,192	2,123,665	1,874,552	2,029,499	2,537,212	799,854
POTW*	1,485,950	1,390,935	1,155,931	227,076	185,722	163,252
Off-Site Transfers	6,203,082	5,745,981	6,151,505	5,911,501	6,468,167	5,648,572
Total Releases & Transfers	16,285,671	14,628,907	13,636,945	11,992,459	12,373,251	10,105,394

Top 5 Facilities in County (Based on Air Releases)	State Rank	Air Releases (lbs/1996)	Top 5 Facilities in County (Based on Total Releases & Transfers)	State Rank	Total Releases (lbs/1996)
1) CLEVELAND LAMINATING CORP.	20	696,000	1) FORD MOTOR CO. CASTING PLANT	12	2,186,355
2) FORD MOTOR CO. CASTING PLANT	27	537,730	2) LTV STEEL CO. INC. CLEVE WORKS	13	2,075,812
3) PPG INDUSTRIES CLEVELAND.	68	221,670	3) CLEVELAND LAMINATING CORP	44	790,000
4) PARK OHIO IND. PARK DROP FORGE DIV.	79	180,000	4) GE CHEMICAL PRODS. PLANT	64	505,945
5) LINDERME TUBE CO.	84	165,000	5) PPG INDUSTRIES CLEVELAND	70	419,013

Top 5 Chemicals in County (Based on Air Releases)	Air Releases (lbs/1996)	Top 5 Chemicals in County (Based on Total Releases & Transfers)	Total Releases (lbs/1996)
1) DICHLOROMETHANE	867,378	1) MANGANESE & COMPOUNDS	2,126,753
2) XYLENE (MIXED ISOMERS)	340,511	2) ZINC & COMPOUNDS	1,663,704
3) METHYL ETHYL KETONE	334,097	3) DICHLOROMETHANE	1,004,157
4) TETRACHLOROETHYLENE	328,829	4) CHROMIUM & COMPOUNDS	495,561
5) TOLUENE	217,053	5) TETRACHLOROETHYLENE	494,115

* All Releases & Transfers are in pounds per year

* POTW = Publicly Owned Treatment Works or Public Sewage Systems

* County Rank in State is based on Total Releases & Transfers

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