Collegeville Area Air Monitoring Project
Second Report

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Commonwealth of Pennsylvania
Department of Environmental Protection

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www.dep.state.pa.us

Executive Summary

On April 1, 2004, the Pennsylvania Department of Environmental Protection (DEP) conducted ambient air monitoring in Collegeville at a soccer field located on Ursinus College property. The DEP was especially interested in the ambient air concentrations of trichloroethylene (TCE) for two reasons: historic groundwater contamination in the area due to TCE, and two nearby facilities that emit TCE into the air. During this sampling event, TCE was detected continuously between 10:30 a.m. and 11:15 a.m., with a peak concentration of 15 parts per billion at 10:37 a.m. Additional sampling was conducted in the Collegeville area from June 21 through June 24, 2004 with similar results. The DEP decided that the duration and magnitude of the TCE detected warranted further investigation.

To fully evaluate TCE concentrations, the DEP established two air monitoring sites in the Collegeville area; one in Evansburg State Park and the other at the former YMCA building in Trappe. The Department began sampling on January 4, 2005. Due to the closure of the YMCA building in 2007, the Trappe site was relocated to the roof of the Myrin Library, on the campus of Ursinus College in Collegeville. The purpose of the monitoring was to determine the concentration of TCE and other air toxics in the outdoor air, and to evaluate the risk to area residents due to exposure to these pollutants at the measured concentrations.

Air samples were collected in evacuated canisters at the Collegeville sites over a 24-hour period from midnight to midnight. Samples are collected in the same manner on the same schedule (every sixth day) at all Pennsylvania air toxics monitoring network sites. The DEP's central laboratory analyzes the samples for 55 volatile organic compounds (VOCs) based on the Environmental Protection Agency (EPA) Method TO-15. Because there are neither state nor national air quality standards for these pollutants, the DEP evaluated the health risks associated with breathing the measured concentrations using risk assessment methods approved by EPA.

The first report to the public was released on January 19, 2007. The report presented the 2005 monitoring data and associated risks. The Collegeville sites in 2005 had a higher percentage of samples detecting TCE and had higher annual average concentrations (that significantly increased the total excess lifetime cancer risk) compared to other sites in Pennsylvania. DEP held a public meeting on February 20, 2007, to discuss the report and present the plans for reducing TCE emissions from the two companies. Another meeting was held on August 8, 2007, to discuss the progress made to that point.

This second report includes an evaluation of the 2006 and 2007 sampling data. Since 2005, TCE concentrations and the associated risk have decreased at the Evansburg site due to TCE emission reduction efforts by one of the facilities. The Collegeville site in 2007 had the highest annual average concentration of TCE and associated risk to date, mainly due to a one extraordinarily high sample. However, DEP expects the ambient concentrations of TCE and the associated risk to continue to decline as both facilities fully implement their TCE emission reduction strategies.

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Introduction

Background

On April 1, 2004, the Pennsylvania Department of Environmental Protection (DEP) conducted ambient air monitoring in Collegeville at a soccer field located on Ursinus College property. The instrument, an Open–Path Fourier Transform Infrared Spectroscopy System, was capable of detecting and quantifying numerous air pollutants classified as volatile organic compounds (VOCs). The DEP was especially interested in the ambient air concentrations of trichloroethylene (TCE) because of historic groundwater contamination in the area due to TCE, and the concentration of TCE emitting sources in the area. During this sampling event, TCE was detected continuously between 10:30 a.m. and 11:15 a.m., with a peak of 15 parts per billion (ppb) at 10:37 a.m. Additional sampling was conducted in the Collegeville area from June 21 through June 24, 2004 with similar results. The DEP decided that the duration and magnitude of the TCE detected warranted further investigation.

To fully evaluate TCE concentrations, the DEP established two air monitoring sites in the Collegeville area. One is located in Evansburg State Park, the other at the former YMCA on College Avenue in Trappe (referred to as the Trappe site). Sampling began on January 4, 2005. The Trappe site was relocated in mid-2007 due to the closure of the YMCA. The sampler now resides on the roof of the Myrin Library on the campus of Ursinus College in Collegeville (referred to as the Collegeville site). The purpose of the monitoring is to determine the concentration of TCE and other air toxics in the outdoor air, and to evaluate the risk to residents associated with exposure to those pollutants at the concentrations found.

Note that there are neither state nor national air quality standards for these pollutants. Therefore, the DEP evaluated the health risks associated with breathing the measured concentrations of these pollutants using risk assessment methods approved by EPA. The DEP also compared Collegeville data to other monitoring sites in Pennsylvania where similar sampling is conducted.

Details on the monitoring equipment, sampling methods, pollutants monitored, risk assessment and the next steps for this study are described in the following sections of this report.

Monitoring

Since January 4, 2005, the DEP has collected air samples every sixth day, at both sites, in evacuated stainless steel canisters that are analyzed by the DEP laboratory for 55 VOCs. Some samples were missed due to equipment problems, and sampling stopped from September 25, 2005 to October 31, 2005 while the laboratory moved to a new building.

The specific VOCs that can be measured are determined by the analytical method and by the number of compounds in the calibration standards. The DEP Laboratory's method is based on EPA Compendium Method TO-15, Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS). EPA's National Risk Management Research Laboratory developed this "Compendium of Methods for the Determination of Toxic Organic (TO) Compounds in Ambient Air" to assist federal, state, and local regulatory personnel in developing and maintaining necessary expertise and up-to-date monitoring technology for characterizing organic pollutants in the ambient air.

The GC/MS instrument detects very low levels of pollutants, down to a few hundredths of a part per billion, by concentrating the pollutants onto a trap cooled with liquid nitrogen. The GC/MS separates the chemical compounds and then detects and identifies the compounds by matching the ion fragment patterns and retention times to known chemical standards.

The 55 target VOCs include 33 "Hazardous Air Pollutants" listed in the 1990 Clean Air Act Amendments and additional compounds emitted by industry, motor vehicles and other sources. The laboratory reports the concentration of VOCs in parts per billion volume (ppbv). Table 1 lists the target compounds, other commonly used names and each compound's Chemical Abstract Service (CAS) number that uniquely identifies the chemical.

The Collegeville monitoring site is equipped with a roof-mounted meteorological system, which measures wind speed and direction, temperature, relative humidity, precipitation and solar radiation (visible sunlight). An electronic datalogger takes a measurement every 10 seconds, and then calculates and stores 15-minute averages and one-hour averages for all parameters, except for precipitation, for which it stores the one-hour total. Wind data for 2005-2007 are summarized in a wind rose format in Appendix D.

Because there are neither state nor national ambient air quality standards for these pollutants, Collegeville data are compared in this report to data collected at the other DEP air toxics monitoring sites including Arendtsville, Chester, Erie, Lancaster, Lewisburg, Marcus Hook, Pottstown, Reading and Swarthmore. Figure 1 shows the locations of DEP air toxic monitoring sites.

Table 1. Volatile organic compounds reported by the DEP laboratory.

Compound*	Synonyms	CAS Number
1,3-Butadiene		106-99-0
1,2-Dibromoethane	Ethylene dibromide, EDB	106-93-4
cis-1,3-Dichloro-1-propene		10061-01-5
trans-1,3-Dichloro-1-propene		10061-02-6
1,2-Dichloro-1,1,2,2-tetrafluoroethane	Freon 114	76-14-2
1,2-Dichlorobenzene		95-50-1
1,3-Dichlorobenzene		541-73-1
1,4-Dichlorobenzene	Para-Dichlorobenzene	106-46-7
1,1-Dichloroethane	Ethylidene chloride	75-34-3
1,2-Dichloroethane	Ethylene chloride	107-06-2
1,1-Dichloroethene	Vinylidene chloride	75-35-4
cis-1,2-Dichloroethene		156-59-2
trans-1,2-Dichloroethene		156-60-5
1,2-Dichloropropane		78-87-5
1-Ethyl-4-methyl benzene		622-96-8
1,1,2,2-Tetrachloroethane		79-34-5
1,1,2-Trichloro-1,2,2-trifluoroethane	Freon 113	76-13-1
1,2,4-Trichlorobenzene		120-82-1
1,1,1-Trichloroethane	Methyl chloroform	71-55-6
1,1,2-Trichloroethane		79-00-5
1,2,4-Trimethylbenzene	Pseudocumene	95-63-6
1,3,5-Trimethylbenzene		108-67-8
2-Butanone	Methyl ethyl ketone, MEK	78-93-3
2-Hexanone	Methyl butyl ketone, MBK	591-78-6
2-Methoxy-2-methyl propane	Methyl-tert-butyl ether, MTBE	1634-04-4
4-Methyl-2-pentanone	MIBK	108-10-1
Acetone		67-64-1
Benzene	Benzol	71-43-2
Bromodichloromethane		75-27-4
Bromoform	Tribromomethane	75-25-2
Bromomethane		74-83-9
Carbon disulfide		75-15-0
Carbon tetrachloride	Tetrachloromethane	56-23-5
Chlorobenzene		108-90-7
Chloroethane	Ethyl chloride	75-00-3
Chloroethene	Vinyl Chloride	75-01-4
Chloroform	Trichloromethane	67-66-3

Table 1. (continued).

Compound*	Synonyms	CAS Number
Chloromethane	Methyl chloride	74-87-3
Cyclohexane		110-82-7
Dibromochloromethane		124-48-1
Dichlorodifluoromethane	Freon 12	75-71-8
Ethylbenzene		100-41-4
n-Heptane		142-82-5
Hexachloro-1,3-butadiene		87-68-3
n-Hexane		110-54-3
Methylene chloride	Dichloromethane	75-09-2
Propene	Propylene	115-07-1
Styrene		100-42-5
Tetrachloroethene	Perchloroethylene, PERC	127-18-4
Tetrahydrofuran	1,4-Epoxybutane, THF	109-99-9
Toluene	Toluol	108-88-3
Trichloroethylene	Trichloroethene, TCE	79-01-6
Trichlorofluoromethane	Freon 11	75-69-4
m & p- Xylene		108-38-3
o-Xylene		95-47-6

* Highlighted compounds are listed in the 1990 Clean Air Act Amendments as Hazardous Air Pollutants.

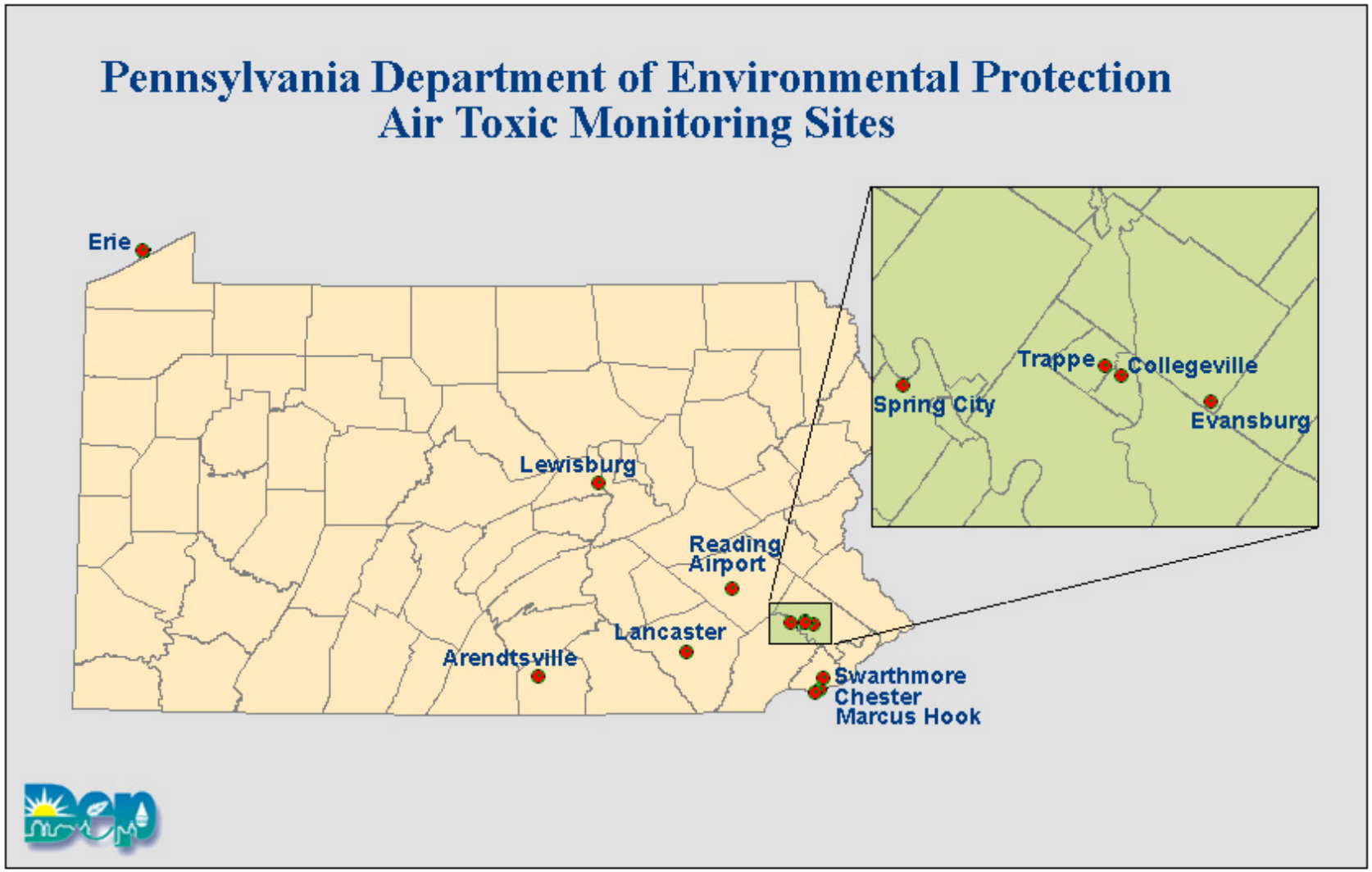


Figure 1. Map of air toxic monitoring sites in Pennsylvania referred to in this report.

Discussion of Monitoring Results

In summarizing the data, DEP calculated annual average concentrations for each of the 55 VOCs. In an effort to be more conservative with these averages, one-half the Method Detection Limit (MDL) was used, rather than zero, whenever a VOC was not detected in a sample. (See the definition of MDL in Appendix B.) The MDLs are determined annually by a standard laboratory quality control procedure (40 CFR Part 136, Appendix B) and can vary from year to year. Refer to Table 2 to see how the MDLs have changed over the three years of this study.

It is important to be aware of MDL changes, particularly for compounds which are less frequently detected and have a high associated cancer risk. Since a non-detect is assumed to be half its MDL for calculating an annual average and cancer risk, a higher MDL will cause the annual average and cancer risk to also be higher. Note that the MDL for TCE increased from 0.04 ppbv in 2006 to 0.06 ppbv in 2007.

Tables 3a, 3b and 3c show the percent of the time each VOC was detected at each Pennsylvania air toxics site for the past three years. Twenty one VOCs were detected at all eleven monitoring sites since the study began in 2005. The number of compounds detected at the Collegeville sites is similar to other sites in industrial or urban areas. However, different compounds are present at different sites reflecting local influences. Arendtsville is a rural background site in Adams County, and as would be expected, fewer pollutants were detected. Note that there are neither state nor national air quality standards for these pollutants. Instead, the DEP evaluated the health risks associated with breathing the measured concentrations of these pollutants using risk assessment methods approved by EPA. The DEP also compared Collegeville data to other monitoring sites in Pennsylvania where similar sampling is conducted.

Annual average concentrations are used to compare the toxic air pollutants at different sites, and to estimate the cancer and non-cancer risk from inhalation exposure to ambient air. Table 4 presents the average annual concentrations of all compounds for 2005 through 2007 for each site.

Collegeville data can be downloaded from the DEP web site. Go to www.dep.state.pa.us; click “Search”, “Toxics”, “Toxics Monitoring Sites”, and then “Collegeville”.

Table 2. The Method Detection Limits (MDL) by year for all compounds reported.

Compound*	2005 MDL (ppbv)	2006 MDL (ppbv)	2007 MDL (ppbv)
1,3-Butadiene	0.04	0.04	0.18
1,2-Dibromoethane	0.04	0.04	0.06
cis-1,3-Dichloro-1-propene	0.02	0.04	0.04
trans-1,3-Dichloro-1-propene	0.02	0.04	0.04
1,2-Dichloro-1,1,2,2-tetrafluoroethane	0.04	0.04	0.04
1,2-Dichlorobenzene	0.16	0.04	0.04
1,3-Dichlorobenzene	0.14	0.04	0.04
1,4-Dichlorobenzene	0.14	0.04	0.04
1,1-Dichloroethane	0.04	0.04	0.04
1,2-Dichloroethane	0.04	0.04	0.06
1,1-Dichloroethene	0.04	0.04	0.06
cis-1,2-Dichloroethene	0.04	0.08	0.06
trans-1,2-Dichloroethene	0.04	0.04	0.1
1,2-Dichloropropane	0.04	0.04	0.06
1-Ethyl-4-methyl benzene	0.16	0.04	0.04
1,1,2,2-Tetrachloroethane	0.14	0.04	0.04
1,1,2-Trichloro-1,2,2-trifluoroethane	0.04	0.04	0.04
1,2,4-Trichlorobenzene	0.2	0.06	0.06
1,1,1-Trichloroethane	0.04	0.04	0.04
1,1,2-Trichloroethane	0.04	0.04	0.06
1,2,4-Trimethylbenzene	0.14	0.04	0.04
1,3,5-Trimethylbenzene	0.14	0.04	0.04
2-Butanone	0.16	0.06	0.14
2-Hexanone	0.38	0.08	0.14
2-Methoxy-2-methyl propane	0.04	0.04	0.04
4-Methyl-2-pentanone	0.88	0.04	0.18
Acetone	0.14	0.06	0.14
Benzene	0.04	0.04	0.06
Bromodichloromethane	0.04	0.04	0.06
Bromoform	0.02	0.04	0.04
Bromomethane	0.04	0.04	0.06
Carbon disulfide	0.04	0.04	0.08
Carbon tetrachloride	0.04	0.06	0.04
Chlorobenzene	0.04	0.04	0.06
Chloroethane	0.04	0.04	0.06
Chloroethene	0.04	0.04	0.06
Chloroform	0.04	0.04	0.06

Table 2. (continued).

Compound*	2005 MDL (ppbv)	2006 MDL (ppbv)	2007 MDL (ppbv)
Chloromethane	0.04	0.04	0.06
Cyclohexane	0.04	0.04	0.04
Dibromochloromethane	0.04	0.04	0.06
Dichlorodifluoromethane	0.04	0.04	0.04
Ethylbenzene	0.04	0.04	0.04
n-Heptane	0.04	0.04	0.04
Hexachloro-1,3-butadiene	0.12	0.04	0.04
n-Hexane	0.04	0.04	0.04
Methylene chloride	0.04	0.04	0.08
Propene	0.16	0.04	0.06
Styrene	0.02	0.04	0.04
Tetrachloroethene	0.04	0.04	0.06
Tetrahydrofuran	0.04	0.04	0.04
Toluene	0.04	0.04	0.06
Trichloroethylene	0.04	0.04	0.06
Trichlorofluoromethane	0.04	0.04	0.04
M & p- Xylene	0.06	0.08	0.1
o-Xylene	0.04	0.04	0.04

Table 3a. Percentage of 2005 samples where compound concentrations were above the Method Detection Limit.

Compound	Arendtsville	Chester	Collegeville	Erie	Evansburg	Lancaster	Lewisburg	Marcus Hook	Pottstown	Reading Airport	Swarthmore	Trappe
1,3-Butadiene	0	0	-	0	0	0	7	0	49	-	0	5
1,2-Dibromoethane	0	0	-	0	0	0	0	0	0	-	0	0
cis-1,3-Dichloro-1-propene	0	0	-	0	0	0	0	0	0	-	0	0
trans-1,3-Dichloro-1-propene	0	0	-	0	0	0	0	0	0	-	0	0
1,2-Dichloro-1,1,2,2,tetrafluoroethane	0	0	-	0	0	0	0	0	0	-	0	0
1,2-Dichlorobenzene	0	0	-	0	0	0	0	0	0	-	0	0
1,3-Dichlorobenzene	0	0	-	0	0	0	0	0	0	-	0	0
1,4-Dichlorobenzene	0	6	-	0	0	0	0	4	0	-	0	0
1,1-Dichloroethane	0	0	-	0	0	0	0	0	0	-	0	0
1,2-Dichloroethane	0	3	-	0	0	0	0	4	0	-	0	0
1,1-Dichloroethene	0	0	-	0	0	0	0	0	0	-	0	0
cis-1,2-Dichloroethene	0	0	-	0	0	0	0	0	0	-	0	0
trans-1,2-Dichloroethene	0	0	-	0	0	0	0	0	0	-	0	0
1,2-Dichloropropane	0	0	-	0	0	0	0	0	0	-	0	0
1-Ethyl-4-methyl benzene	0	6	-	0	0	10	7	21	5	-	0	2
1,1,2,2-Tetrachloroethane	0	0	-	0	0	0	0	0	0	-	0	0
1,1,2-Trichloro-1,2,2-trifluoroethane	100	100	-	100	100	100	100	100	100	-	100	100
1,2,4-Trichlorobenzene	0	0	-	0	0	0	0	0	0	-	0	0
1,1,1-Trichloroethane	0	100	-	0	0	0	0	0	0	-	0	0
1,1,2-Trichloroethane	0	0	-	0	0	0	0	0	0	-	0	0
1,2,4-Trimethylbenzene	0	44	-	10	10	46	27	75	34	-	19	30
1,3,5-Trimethylbenzene	2	29	-	3	10	17	13	25	32	-	11	5
2-Butanone	100	100	-	97	98	98	100	100	100	-	100	100
2-Hexanone	20	3	-	0	5	0	0	4	0	-	0	3
2-Methoxy-2-methyl propane	36	97	-	0	86	49	23	100	95	-	96	91
4-Methyl-2-pentanone	10	0	-	0	4	2	0	7	2	-	4	5
Acetone	100	100	-	100	100	100	100	100	100	-	100	100
Benzene	100	100	-	100	100	100	100	100	100	-	100	100
Bromodichloromethane	0	0	-	0	0	0	0	0	0	-	0	0
Bromoform	0	0	-	0	0	0	0	0	0	-	0	0
Bromomethane	0	6	-	0	2	0	0	11	0	-	7	5
Carbon disulfide	21	29	-	10	24	15	33	29	37	-	41	39
Carbon tetrachloride	100	100	-	100	100	100	100	100	100	-	100	100
Chlorobenzene	0	0	-	0	0	100	0	4	0	-	0	0
Chloroethane	43	18	-	0	12	0	0	21	0	-	7	7
Chloroethene	0	6	-	0	2	0	0	7	2	-	0	0
Chloroform	0	0	-	3	0	5	0	0	2	-	0	0

Table 3a. (continued).

Compound	Arendtsville	Chester	Collegeville	Erie	Evansburg	Lancaster	Lewisburg	Marcus Hook	Pottstown	Reading Airport	Swarthmore	Trappe
Chloromethane	100	100	-	100	100	100	100	100	100	-	100	100
Cyclohexane	0	44	-	6	10	17	7	93	15	-	19	20
Dibromochloromethane	0	0	-	0	0	0	0	0	0	-	0	0
Dichlorodifluoromethane	100	100	-	100	100	100	100	100	100	-	100	100
Ethylbenzene	0	56	-	13	18	63	40	100	100	-	33	45
n-Heptane	26	100	-	26	84	83	73	100	93	-	89	75
Hexachloro-1,3-butadiene	0	0	-	0	0	0	0	0	0	-	0	0
n-Hexane	57	100	-	77	80	100	80	100	98	-	100	86
Methylene chloride	43	91	-	61	88	88	67	89	71	-	100	75
Propene	88	100	-	87	98	100	97	100	100	-	100	98
Styrene	0	6	-	13	0	22	23	100	100	-	4	5
Tetrachloroethene	0	35	-	6	12	12	7	32	7	-	26	25
Tetrahydrofuran	0	100	-	0	4	5	7	7	27	-	0	0
Toluene	79	100	-	97	100	98	97	100	100	-	100	98
Trichloroethylene (TCE)	0	9	-	10	76	0	7	7	32	-	22	82
Trichlorofluoromethane	100	100	-	100	100	100	100	100	100	-	100	100
m & p- Xylene	0	85	-	32	46	80	67	100	100	-	44	82
o-Xylene	0	47	-	16	28	59	47	100	98	-	33	66
Number of Compounds Detected	**19**	**33**	**-**	**24**	**29**	**28**	**27**	**34**	**30**	**-**	**27**	**30**

Table 3b. Percentage of 2006 samples where compound concentrations were above the Method Detection Limit.

Compound	Arendtsville	Chester	Collegeville	Erie	Evansburg	Lancaster	Lewisburg	Marcus Hook	Pottstown	Reading Airport	Swarthmore	Trappe
1,3-Butadiene	0	0	-	0	2	0	15	0	47	-	0	11
1,2-Dibromoethane	0	0	-	0	0	0	0	0	0	-	0	0
cis-1,3-Dichloro-1-propene	0	0	-	0	0	0	0	0	0	-	0	0
trans-1,3-Dichloro-1-propene	0	0	-	0	0	0	0	0	0	-	0	0
1,2-Dichloro-1,1,2,2,tetrafluoroethane	0	0	-	0	0	0	0	0	0	-	0	0
1,2-Dichlorobenzene	0	0	-	0	0	0	0	0	0	-	0	0
1,3-Dichlorobenzene	0	0	-	0	0	0	0	0	0	-	0	0
1,4-Dichlorobenzene	0	7	-	0	0	0	0	0	0	-	0	0
1,1-Dichloroethane	0	0	-	0	0	0	0	0	0	-	0	0
1,2-Dichloroethane	0	5	-	0	0	0	0	0	0	-	0	0
1,1-Dichloroethene	0	0	-	0	0	0	0	0	0	-	0	0
cis-1,2-Dichloroethene	0	0	-	0	0	2	0	0	0	-	0	0
trans-1,2-Dichloroethene	0	0	-	0	0	0	0	0	0	-	0	0
1,2-Dichloropropane	0	0	-	0	0	0	0	0	0	-	0	0
1-Ethyl-4-methyl benzene	0	2	-	0	0	2	4	0	0	-	0	0
1,1,2,2-Tetrachloroethane	0	0	-	0	0	0	0	0	0	-	0	0
1,1,2-Trichloro-1,2,2-trifluoroethane	88	89	-	87	87	90	87	92	86	-	88	86
1,2,4-Trichlorobenzene	0	0	-	0	0	0	0	0	0	-	0	0
1,1,1-Trichloroethane	0	95	-	0	0	0	0	0	0	-	0	0
1,1,2-Trichloroethane	0	0	-	0	0	0	0	0	0	-	0	0
1,2,4-Trimethylbenzene	2	20	-	0	3	15	15	32	14	-	6	7
1,3,5-Trimethylbenzene	0	11	-	0	2	2	4	11	8	-	3	2
2-Butanone	100	100	-	92	100	96	100	97	98	-	100	98
2-Hexanone	2	0	-	0	7	0	0	0	0	-	0	2
2-Methoxy-2-methyl propane	14	55	-	0	34	19	9	58	61	-	41	47
4-Methyl-2-pentanone	17	0	-	0	5	0	17	16	7	-	3	7
Acetone	100	100	-	100	100	100	100	100	100	-	100	100
Benzene	92	98	-	95	100	100	100	100	100	-	100	100
Bromodichloromethane	0	0	-	0	0	0	0	0	0	-	0	0
Bromoform	0	0	-	0	0	0	0	0	0	-	0	0
Bromomethane	2	0	-	0	3	2	2	5	0	-	9	5
Carbon disulfide	56	34	-	21	46	40	83	45	32	-	47	49
Carbon tetrachloride	92	89	-	84	85	88	94	92	88	-	97	88
Chlorobenzene	0	2	-	0	0	77	0	0	0	-	0	0
Chloroethane	42	23	-	3	7	0	0	29	0	-	22	18
Chloroethene	0	0	-	0	0	0	0	3	0	-	3	0
Chloroform	0	2	-	0	0	4	0	0	2	-	3	0

Table 3b. (continued).

Compound	Arendtsville	Chester	Collegeville	Erie	Evansburg	Lancaster	Lewisburg	Marcus Hook	Pottstown	Reading Airport	Swarthmore	Trappe
Chloromethane	100	100	-	100	100	100	100	100	100	-	100	100
Cyclohexane	0	32	-	0	7	17	0	82	14	-	19	12
Dibromochloromethane	0	0	-	0	0	0	0	0	0	-	0	0
Dichlorodifluoromethane	100	100	-	100	100	100	100	100	100	-	100	100
Ethylbenzene	2	41	-	5	11	63	45	79	98	-	28	37
n-Heptane	54	93	-	5	66	60	72	100	73	-	81	75
Hexachloro-1,3-butadiene	0	0	-	0	0	0	0	0	0	-	0	0
n-Hexane	42	91	-	53	66	92	68	97	85	-	88	74
Methylene chloride	49	75	-	45	80	85	85	79	86	-	88	82
Propene	92	100	-	76	100	100	100	100	100	-	100	100
Styrene	0	0	-	8	0	19	17	5	100	-	3	0
Tetrachloroethene	2	43	-	0	7	8	6	13	8	-	13	23
Tetrahydrofuran	0	100	-	0	0	0	21	0	15	-	0	0
Toluene	90	100	-	89	100	100	100	100	100	-	100	100
Trichloroethylene (TCE)	0	20	-	11	70	2	19	0	61	-	38	77
Trichlorofluoromethane	100	100	-	100	100	100	100	100	100	-	100	100
m & p- Xylene	5	73	-	11	21	73	72	100	98	-	47	61
o-Xylene	3	41	-	3	13	63	57	89	98	-	22	58
Number of Compounds Detected	**24**	**31**	**-**	**20**	**28**	**29**	**28**	**27**	**28**	**-**	**29**	**28**

Table 3c. Percentage of 2007 samples where compound concentrations were above the Method Detection Limit.

Compound	Arendtsville	Chester	Collegeville	Erie	Evansburg	Lancaster	Lewisburg	Marcus Hook	Pottstown	Reading Airport	Swarthmore	Trappe
1,3-Butadiene	0	0	3	0	0	0	0	0	-	0	0	0
1,2-Dibromoethane	0	0	0	0	0	0	0	3	-	0	0	0
cis-1,3-Dichloro-1-propene	0	0	0	0	0	0	0	0	-	0	0	0
trans-1,3-Dichloro-1-propene	0	0	0	0	0	0	0	0	-	0	0	0
1,2-Dichloro-1,1,2,2,tetrafluoroethane	0	0	0	0	0	0	0	0	-	0	0	0
1,2-Dichlorobenzene	0	0	0	0	0	0	0	0	-	0	0	0
1,3-Dichlorobenzene	0	0	0	0	0	0	0	0	-	0	0	0
1,4-Dichlorobenzene	0	5	0	0	0	0	0	0	-	0	0	0
1,1-Dichloroethane	0	0	0	0	0	0	0	0	-	0	0	0
1,2-Dichloroethane	0	5	0	0	0	0	0	3	-	0	0	0
1,1-Dichloroethene	0	0	0	0	0	0	0	0	-	0	0	0
cis-1,2-Dichloroethene	0	0	0	0	0	0	0	0	-	0	0	0
trans-1,2-Dichloroethene	0	0	0	0	0	0	0	0	-	0	0	0
1,2-Dichloropropane	0	0	0	0	0	0	0	0	-	0	0	0
1-Ethyl-4-methyl benzene	0	5	0	0	0	6	0	23	-	4	0	0
1,1,2,2-Tetrachloroethane	0	0	0	0	0	0	0	0	-	0	0	0
1,1,2-Trichloro-1,2,2-trifluoroethane	100	100	100	100	100	100	100	100	-	100	100	100
1,2,4-Trichlorobenzene	0	0	0	0	0	0	0	0	-	0	0	0
1,1,1-Trichloroethane	0	100	0	0	0	0	0	3	-	0	0	0
1,1,2-Trichloroethane	0	0	0	0	0	0	0	0	-	0	0	0
1,2,4-Trimethylbenzene	2	39	61	8	12	55	32	68	-	56	17	14
1,3,5-Trimethylbenzene	0	13	0	0	2	9	2	29	-	12	0	0
2-Butanone	100	100	100	97	100	98	100	100	-	100	100	100
2-Hexanone	9	11	23	0	17	6	0	16	-	12	9	5
2-Methoxy-2-methyl propane	0	3	3	0	0	0	0	3	-	0	0	0
4-Methyl-2-pentanone	5	5	26	0	8	2	0	10	-	12	6	10
Acetone	100	100	100	100	100	100	100	100	-	100	100	100
Benzene	98	100	100	89	100	100	100	100	-	96	100	100
Bromodichloromethane	0	0	0	0	0	0	0	0	-	0	0	0
Bromoform	0	0	0	0	0	0	0	0	-	0	0	0
Bromomethane	0	3	0	3	0	0	0	6	-	0	0	0
Carbon disulfide	36	11	61	11	37	21	49	19	-	32	26	38
Carbon tetrachloride	100	97	100	97	100	98	100	100	-	100	100	100
Chlorobenzene	0	3	0	0	0	0	0	0	-	0	0	0
Chloroethane	55	24	16	0	13	0	0	10	-	0	0	24
Chloroethene	0	3	0	0	0	0	0	3	-	0	0	0
Chloroform	0	0	0	0	0	2	0	0	-	0	0	0

Table 3c. (continued).

Compound	Arendtsville	Chester	Collegeville	Erie	Evansburg	Lancaster	Lewisburg	Marcus Hook	Pottstown	Reading Airport	Swarthmore	Trappe
Chloromethane	100	100	100	97	100	100	100	100	-	100	100	100
Cyclohexane	0	39	13	0	6	9	0	94	-	4	20	0
Dibromochloromethane	0	0	0	0	0	0	0	0	-	0	0	0
Dichlorodifluoromethane	100	100	100	100	100	100	100	100	-	100	100	100
Ethylbenzene	5	53	48	11	12	57	24	87	-	60	23	19
n-Heptane	79	97	97	29	85	81	71	97	-	88	94	62
Hexachloro-1,3-butadiene	0	0	0	0	0	0	0	0	-	0	0	0
n-Hexane	66	92	87	68	83	94	83	100	-	88	100	71
Methylene chloride	3	26	29	8	87	43	15	42	-	36	66	43
Propene	100	100	100	97	100	100	100	100	-	100	100	100
Styrene	0	0	0	5	0	4	17	3	-	8	0	0
Tetrachloroethene	0	3	3	0	0	0	0	6	-	4	0	0
Tetrahydrofuran	0	100	0	0	25	0	0	6	-	0	6	0
Toluene	86	100	100	74	98	100	100	100	-	100	97	86
Trichloroethylene (TCE)	5	8	81	0	40	2	22	3	-	24	0	71
Trichlorofluoromethane	100	100	100	100	100	100	100	100	-	100	100	100
m & p- Xylene	3	61	65	11	21	70	39	97	-	68	26	24
o-Xylene	3	53	77	11	13	68	32	94	-	64	29	24
Number of Compounds Detected	**22**	**34**	**26**	**20**	**25**	**26**	**21**	**34**	**-**	**26**	**22**	**22**

Table 4. Summary of annual average concentrations of targeted VOCs across all Pennsylvania monitoring sites.

	Arendtsville			Chester			Collegeville			Erie		
	Annual Avg (ppbv)[1]			Annual Avg (ppbv)[1]			Annual Avg (ppbv)[1]			Annual Avg (ppbv)[1]		
Compound	2005	2006	2007	2005	2006	2007	2005	2006	2007	2005	2006	2007
1,3-Butadiene	0.02	0.02	0.09	0.02	0.02	0.09	-	-	0.09	0.02	0.02	0.09
1,2-Dibromoethane	0.02	0.02	0.03	0.02	0.02	0.03	-	-	0.03	0.02	0.02	0.03
cis-1,3-Dichloro-1-propene	0.01	0.02	0.02	0.01	0.02	0.02	-	-	0.02	0.01	0.02	0.02
trans-1,3-Dichloro-1-propene	0.01	0.02	0.02	0.01	0.02	0.02	-	-	0.02	0.01	0.02	0.02
1,2-Dichloro-1,1,2,2-tetrafluoroethane	0.02	0.02	0.02	0.02	0.02	0.02	-	-	0.02	0.02	0.02	0.02
1,2-Dichlorobenzene	0.08	0.02	0.02	0.08	0.02	0.02	-	-	0.02	0.08	0.02	0.02
1,3-Dichlorobenzene	0.07	0.02	0.02	0.07	0.02	0.02	-	-	0.02	0.07	0.02	0.02
1,4-Dichlorobenzene	0.07	0.02	0.02	0.07	0.02	0.02	-	-	0.02	0.07	0.02	0.02
1,1-Dichloroethane	0.02	0.02	0.02	0.02	0.02	0.02	-	-	0.02	0.02	0.02	0.02
1,2-Dichloroethane	0.02	0.02	0.03	0.02	0.02	0.05	-	-	0.03	0.02	0.02	0.03
1,1-Dichloroethene	0.02	0.02	0.03	0.02	0.02	0.03	-	-	0.03	0.02	0.02	0.03
cis-1,2-Dichloroethene	0.02	0.04	0.03	0.02	0.04	0.03	-	-	0.03	0.02	0.04	0.03
trans-1,2-Dichloroethene	0.02	0.02	0.05	0.02	0.02	0.05	-	-	0.05	0.02	0.02	0.05
1,2-Dichloropropane	0.02	0.02	0.03	0.02	0.02	0.03	-	-	0.03	0.02	0.02	0.03
1-Ethyl-4-methyl benzene	0.08	0.02	0.02	0.08	0.02	0.02	-	-	0.02	0.08	0.02	0.02
1,1,2,2-Tetrachloroethane	0.07	0.02	0.02	0.07	0.02	0.02	-	-	0.02	0.07	0.02	0.02
1,1,2-Trichloro-1,2,2-trifluoroethane	0.06	0.07	0.07	0.08	0.08	0.08	-	-	0.07	0.06	0.06	0.06
1,2,4-Trichlorobenzene	0.10	0.03	0.03	0.10	0.03	0.03	-	-	0.03	0.10	0.03	0.03
1,1,1-Trichloroethane	0.02	0.02	0.02	0.10	0.11	0.15	-	-	0.02	0.02	0.02	0.02
1,1,2-Trichloroethane	0.02	0.02	0.03	0.02	0.02	0.03	-	-	0.03	0.02	0.02	0.03
1,2,4-Trimethylbenzene	0.07	0.02	0.02	0.07	0.04	0.04	-	-	0.04	0.07	0.02	0.02
1,3,5-Trimethylbenzene	0.07	0.02	0.02	0.07	0.03	0.03	-	-	0.02	0.07	0.02	0.02
2-Butanone	1.28	0.91	1.06	2.02	1.85	2.11	-	-	1.57	0.41	0.36	0.46
2-Hexanone	0.27	0.05	0.12	0.19	0.04	0.11	-	-	0.19	0.19	0.04	0.07
2-Methoxy-2-methyl propane	0.04	0.03	0.02	0.55	0.21	0.02	-	-	0.02	0.02	0.02	0.02
4-Methyl-2-pentanone	0.44	0.04	0.10	0.44	0.02	0.11	-	-	0.13	0.44	0.02	0.09
Acetone	7.89	7.33	7.73	5.54	5.32	6.22	-	-	9.27	2.72	2.87	3.21
Benzene	0.14	0.13	0.14	0.27	0.23	0.28	-	-	0.19	0.18	0.16	0.19
Bromodichloromethane	0.02	0.02	0.03	0.02	0.02	0.03	-	-	0.03	0.02	0.02	0.03
Bromoform	0.01	0.02	0.02	0.01	0.02	0.02	-	-	0.02	0.01	0.02	0.02
Bromomethane	0.02	0.02	0.03	0.04	0.02	0.04	-	-	0.03	0.02	0.02	0.03
Carbon disulfide	0.04	0.41	0.11	0.04	0.08	0.07	-	-	0.19	0.02	0.05	0.08
Carbon tetrachloride	0.08	0.08	0.09	0.07	0.08	0.09	-	-	0.08	0.08	0.08	0.09
Chlorobenzene	0.02	0.02	0.03	0.02	0.02	0.03	-	-	0.03	0.02	0.02	0.03
Chloroethane	0.04	0.05	0.08	0.03	0.05	0.06	-	-	0.04	0.02	0.02	0.03
Chloroethene	0.02	0.02	0.03	0.02	0.02	0.03	-	-	0.03	0.02	0.02	0.03
Chloroform	0.02	0.02	0.03	0.02	0.02	0.03	-	-	0.03	0.02	0.02	0.03

Table 4. (continued).

Compound	Arendtsville			Chester			Collegeville			Erie		
	Annual Avg (ppbv)[1]			Annual Avg (ppbv)[1]			Annual Avg (ppbv)[1]			Annual Avg (ppbv)[1]		
	2005	2006	2007	2005	2006	2007	2005	2006	2007	2005	2006	2007
Chloromethane	0.54	0.46	0.46	0.48	0.46	0.47	-	-	0.44	0.48	0.45	0.46
Cyclohexane	0.02	0.02	0.02	0.05	0.08	0.05	-	-	0.03	0.02	0.02	0.02
Dibromochloromethane	0.02	0.02	0.03	0.02	0.02	0.03	-	-	0.03	0.02	0.02	0.03
Dichlorodifluoromethane	0.43	0.43	0.43	0.43	0.43	0.43	-	-	0.43	0.43	0.43	0.44
Ethylbenzene	0.02	0.02	0.02	0.05	0.05	0.04	-	-	0.04	0.03	0.02	0.02
n-Heptane	0.03	0.04	0.07	0.16	0.18	0.20	-	-	0.09	0.03	0.02	0.03
Hexachloro-1,3-butadiene	0.06	0.02	0.02	0.06	0.02	0.02	-	-	0.02	0.06	0.02	0.02
n-Hexane	0.05	0.04	0.06	0.21	0.25	0.26	-	-	0.13	0.09	0.05	0.07
Methylene chloride	0.03	0.04	0.04	0.08	0.07	0.06	-	-	0.09	0.04	0.04	0.07
Propene	0.68	0.61	0.72	3.23	2.76	2.46	-	-	1.16	0.43	0.35	0.52
Styrene	0.01	0.02	0.02	0.01	0.02	0.02	-	-	0.02	0.01	0.02	0.02
Tetrachloroethene	0.02	0.02	0.03	0.04	0.04	0.03	-	-	0.03	0.05	0.02	0.03
Tetrahydrofuran	0.02	0.02	0.02	0.90	0.80	1.10	-	-	0.02	0.02	0.02	0.02
Toluene	0.09	0.12	0.12	0.51	0.69	0.63	-	-	0.29	0.19	0.13	0.13
Trichloroethylene (TCE)	0.02	0.02	0.03	0.03	0.03	0.06	-	-	0.75	0.02	0.02	0.03
Trichlorofluoromethane	0.21	0.21	0.25	0.22	0.22	0.25	-	-	0.34	0.21	0.21	0.25
m & p- Xylene	0.03	0.04	0.05	0.16	0.14	0.12	-	-	0.12	0.07	0.05	0.06
o-Xylene	0.02	0.02	0.02	0.05	0.05	0.04	-	-	0.05	0.03	0.02	0.02

Table 4. (continued).

Compound	Evansburg			Lancaster			Lewisburg			Marcus Hook		
	Annual Avg (ppbv)[1]			Annual Avg (ppbv)[1]			Annual Avg (ppbv)[1]			Annual Avg (ppbv)[1]		
	2005	2006	2007	2005	2006	2007	2005	2006	2007	2005	2006	2007
1,3-Butadiene	0.02	0.02	0.09	0.02	0.02	0.09	0.03	0.04	0.09	0.02	0.02	0.09
1,2-Dibromoethane	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.03
cis-1,3-Dichloro-1-propene	0.01	0.02	0.02	0.01	0.02	0.02	0.01	0.02	0.02	0.01	0.02	0.02
trans-1,3-Dichloro-1-propene	0.01	0.02	0.02	0.01	0.02	0.02	0.01	0.02	0.02	0.01	0.02	0.02
1,2-Dichloro-1,1,2,2-tetrafluoroethane	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
1,2-Dichlorobenzene	0.08	0.02	0.02	0.08	0.02	0.02	0.08	0.02	0.02	0.08	0.02	0.02
1,3-Dichlorobenzene	0.07	0.02	0.02	0.07	0.02	0.02	0.07	0.02	0.02	0.07	0.02	0.02
1,4-Dichlorobenzene	0.07	0.02	0.02	0.07	0.02	0.02	0.07	0.02	0.02	0.07	0.02	0.02
1,1-Dichloroethane	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
1,2-Dichloroethane	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.03
1,1-Dichloroethene	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.03
cis-1,2-Dichloroethene	0.02	0.04	0.03	0.02	0.04	0.03	0.02	0.04	0.03	0.02	0.04	0.03
trans-1,2-Dichloroethene	0.02	0.02	0.05	0.02	0.02	0.05	0.02	0.02	0.05	0.02	0.02	0.05
1,2-Dichloropropane	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.03
1-Ethyl-4-methyl benzene	0.08	0.02	0.02	0.09	0.02	0.02	0.08	0.03	0.02	0.08	0.02	0.03
1,1,2,2-Tetrachloroethane	0.07	0.02	0.02	0.07	0.02	0.02	0.07	0.02	0.02	0.07	0.02	0.02
1,1,2-Trichloro-1,2,2-trifluoroethane	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.07
1,2,4-Trichlorobenzene	0.10	0.03	0.03	0.10	0.03	0.03	0.10	0.03	0.03	0.10	0.03	0.03
1,1,1-Trichloroethane	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
1,1,2-Trichloroethane	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.03
1,2,4-Trimethylbenzene	0.07	0.02	0.02	0.12	0.04	0.05	0.07	0.08	0.03	0.09	0.06	0.08
1,3,5-Trimethylbenzene	0.07	0.02	0.02	0.08	0.02	0.03	0.07	0.04	0.02	0.08	0.02	0.06
2-Butanone	1.16	1.06	1.08	0.40	0.40	0.55	0.78	0.78	0.66	0.77	0.58	0.87
2-Hexanone	0.20	0.10	0.16	0.19	0.04	0.08	0.19	0.04	0.07	0.19	0.04	0.11
2-Methoxy-2-methyl propane	0.21	0.07	0.02	0.06	0.03	0.02	0.03	0.03	0.02	0.73	1.68	0.02
4-Methyl-2-pentanone	0.44	0.03	0.10	0.44	0.02	0.09	0.44	0.05	0.09	0.44	0.03	0.11
Acetone	5.96	6.23	6.05	2.65	3.09	4.09	5.27	7.11	5.50	18.98	4.97	6.47
Benzene	0.18	0.15	0.16	0.30	0.27	0.26	0.24	0.19	0.16	0.72	0.56	0.48
Bromodichloromethane	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.03
Bromoform	0.01	0.02	0.02	0.01	0.02	0.02	0.01	0.02	0.02	0.01	0.02	0.02
Bromomethane	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.03	0.06	0.03	0.05
Carbon disulfide	0.04	0.22	0.13	0.03	0.09	0.09	0.04	0.39	0.20	0.06	0.10	0.08
Carbon tetrachloride	0.09	0.08	0.09	0.09	0.08	0.08	0.09	0.08	0.08	0.08	0.08	0.09
Chlorobenzene	0.02	0.02	0.03	0.08	0.06	0.03	0.02	0.02	0.03	0.02	0.02	0.03
Chloroethane	0.03	0.02	0.04	0.02	0.02	0.03	0.02	0.02	0.03	0.06	0.04	0.04
Chloroethene	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.03
Chloroform	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.03

Table 4. (continued).

Compound	Evansburg			Lancaster			Lewisburg			Marcus Hook		
	Annual Avg (ppbv)[1]			Annual Avg (ppbv)[1]			Annual Avg (ppbv)[1]			Annual Avg (ppbv)[1]		
	2005	2006	2007	2005	2006	2007	2005	2006	2007	2005	2006	2007
Chloromethane	0.48	0.43	0.46	0.49	0.48	0.48	0.44	0.45	0.47	0.53	0.48	0.50
Cyclohexane	0.02	0.02	0.02	0.03	0.02	0.03	0.03	0.02	0.02	0.20	0.18	0.20
Dibromochloromethane	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.03
Dichlorodifluoromethane	0.43	0.43	0.44	0.43	0.44	0.44	0.44	0.46	0.45	0.45	0.44	0.45
Ethylbenzene	0.03	0.03	0.02	0.06	0.06	0.05	0.06	0.04	0.03	0.20	0.10	0.08
n-Heptane	0.07	0.05	0.08	0.07	0.06	0.08	0.06	0.08	0.06	0.36	0.26	0.35
Hexachloro-1,3-butadiene	0.06	0.02	0.02	0.06	0.02	0.02	0.06	0.02	0.02	0.06	0.02	0.02
n-Hexane	0.11	0.08	0.09	0.15	0.14	0.14	0.09	0.08	0.07	0.56	0.55	0.66
Methylene chloride	0.07	0.08	0.16	0.08	0.09	0.10	0.06	0.06	0.05	0.13	0.06	0.07
Propene	1.01	0.96	0.99	1.13	1.13	1.00	0.87	0.91	0.77	6.20	7.58	6.34
Styrene	0.01	0.02	0.02	0.02	0.03	0.02	0.09	0.05	0.04	0.20	0.02	0.02
Tetrachloroethene	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.03	0.04	0.03	0.03
Tetrahydrofuran	0.02	0.02	0.05	0.08	0.02	0.02	0.06	0.04	0.02	0.02	0.02	0.02
Toluene	0.34	0.29	0.28	0.58	0.69	0.69	0.33	0.34	0.31	1.14	0.78	0.94
Trichloroethylene (TCE)	0.14	0.12	0.07	0.02	0.02	0.03	0.02	0.03	0.04	0.03	0.02	0.04
Trichlorofluoromethane	0.21	0.21	0.25	0.22	0.23	0.29	0.22	0.22	0.26	0.22	0.22	0.27
m & p- Xylene	0.07	0.06	0.07	0.20	0.19	0.17	0.22	0.14	0.10	0.57	0.35	0.28
o-Xylene	0.03	0.03	0.02	0.07	0.07	0.06	0.07	0.05	0.03	0.22	0.11	0.10

Table 4. (continued).

Compound	Pottstown			Reading Airport			Swarthmore			Trappe		
	Annual Avg (ppbv)[1]			Annual Avg (ppbv)[1]			Annual Avg (ppbv)[1]			Annual Avg (ppbv)[1]		
	2005	2006	2007	2005	2006	2007	2005	2006	2007	2005	2006	2007
1,3-Butadiene	0.19	0.12	-	-	-	0.09	0.02	0.02	0.09	0.03	0.03	0.09
1,2-Dibromoethane	0.02	0.02	-	-	-	0.03	0.02	0.02	0.03	0.02	0.02	0.03
cis-1,3-Dichloro-1-propene	0.01	0.02	-	-	-	0.02	0.01	0.02	0.02	0.01	0.02	0.02
trans-1,3-Dichloro-1-propene	0.01	0.02	-	-	-	0.02	0.01	0.02	0.02	0.01	0.02	0.02
1,2-Dichloro-1,1,2,2-tetrafluoroethane	0.02	0.02	-	-	-	0.02	0.02	0.02	0.02	0.02	0.02	0.02
1,2-Dichlorobenzene	0.08	0.02	-	-	-	0.02	0.08	0.02	0.02	0.08	0.02	0.02
1,3-Dichlorobenzene	0.07	0.02	-	-	-	0.02	0.07	0.02	0.02	0.07	0.02	0.02
1,4-Dichlorobenzene	0.07	0.02	-	-	-	0.02	0.07	0.02	0.02	0.07	0.02	0.02
1,1-Dichloroethane	0.02	0.02	-	-	-	0.02	0.02	0.02	0.02	0.02	0.02	0.02
1,2-Dichloroethane	0.02	0.02	-	-	-	0.03	0.02	0.02	0.03	0.02	0.02	0.03
1,1-Dichloroethene	0.02	0.02	-	-	-	0.03	0.02	0.02	0.03	0.02	0.02	0.03
cis-1,2-Dichloroethene	0.02	0.04	-	-	-	0.03	0.02	0.04	0.03	0.02	0.04	0.03
trans-1,2-Dichloroethene	0.02	0.02	-	-	-	0.05	0.02	0.02	0.05	0.02	0.02	0.05
1,2-Dichloropropane	0.02	0.02	-	-	-	0.03	0.02	0.02	0.03	0.02	0.02	0.03
1-Ethyl-4-methyl benzene	0.08	0.02	-	-	-	0.02	0.08	0.02	0.02	0.08	0.02	0.02
1,1,2,2-Tetrachloroethane	0.07	0.02	-	-	-	0.02	0.07	0.02	0.02	0.07	0.02	0.02
1,1,2-Trichloro-1,2,2-trifluoroethane	0.07	0.06	-	-	-	0.07	0.07	0.07	0.07	0.06	0.06	0.06
1,2,4-Trichlorobenzene	0.10	0.03	-	-	-	0.03	0.10	0.03	0.03	0.10	0.03	0.03
1,1,1-Trichloroethane	0.02	0.02	-	-	-	0.02	0.02	0.02	0.02	0.02	0.02	0.02
1,1,2-Trichloroethane	0.02	0.02	-	-	-	0.03	0.02	0.02	0.03	0.02	0.02	0.03
1,2,4-Trimethylbenzene	0.07	0.02	-	-	-	0.04	0.07	0.03	0.03	0.08	0.02	0.02
1,3,5-Trimethylbenzene	0.07	0.02	-	-	-	0.03	0.08	0.02	0.02	0.07	0.02	0.02
2-Butanone	0.58	0.55	-	-	-	1.05	0.56	0.65	0.82	0.99	0.73	1.12
2-Hexanone	0.19	0.04	-	-	-	0.12	0.19	0.04	0.11	0.19	0.05	0.13
2-Methoxy-2-methyl propane	0.28	0.11	-	-	-	0.02	0.28	0.11	0.02	0.27	0.10	0.02
4-Methyl-2-pentanone	0.44	0.02	-	-	-	0.11	0.44	0.02	0.10	0.44	0.02	0.10
Acetone	6.07	6.76	-	-	-	6.86	4.62	6.00	5.41	7.05	7.46	6.31
Benzene	0.32	0.25	-	-	-	0.20	0.26	0.20	0.21	0.23	0.20	0.19
Bromodichloromethane	0.02	0.02	-	-	-	0.03	0.02	0.02	0.03	0.02	0.02	0.03
Bromoform	0.01	0.02	-	-	-	0.02	0.01	0.02	0.02	0.01	0.02	0.02
Bromomethane	0.02	0.02	-	-	-	0.03	0.02	0.03	0.03	0.02	0.02	0.03
Carbon disulfide	0.04	0.07	-	-	-	0.12	0.06	0.17	0.09	0.05	0.13	0.28
Carbon tetrachloride	0.09	0.08	-	-	-	0.08	0.08	0.08	0.08	0.09	0.08	0.11
Chlorobenzene	0.02	0.02	-	-	-	0.03	0.02	0.02	0.03	0.02	0.02	0.03
Chloroethane	0.02	0.02	-	-	-	0.03	0.02	0.03	0.03	0.02	0.03	0.04
Chloroethene	0.02	0.02	-	-	-	0.03	0.02	0.02	0.03	0.02	0.02	0.03
Chloroform	0.02	0.02	-	-	-	0.03	0.02	0.02	0.03	0.02	0.02	0.03

Table 4. (continued).

Compound	Pottstown			Reading Airport			Swarthmore			Trappe		
	Annual Avg (ppbv)[1]			Annual Avg (ppbv)[1]			Annual Avg (ppbv)[1]			Annual Avg (ppbv)[1]		
	2005	2006	2007	2005	2006	2007	2005	2006	2007	2005	2006	2007
Chloromethane	0.50	0.45	-	-	-	0.45	0.52	0.50	0.51	0.47	0.45	0.48
Cyclohexane	0.03	0.03	-	-	-	0.02	0.03	0.03	0.03	0.03	0.03	0.02
Dibromochloromethane	0.02	0.02	-	-	-	0.03	0.02	0.02	0.03	0.02	0.02	0.03
Dichlorodifluoromethane	0.44	0.43	-	-	-	0.44	0.44	0.44	0.44	0.43	0.44	0.44
Ethylbenzene	0.21	0.25	-	-	-	0.04	0.04	0.03	0.03	0.04	0.04	0.03
n-Heptane	0.09	0.07	-	-	-	0.09	0.13	0.10	0.11	0.07	0.08	0.06
Hexachloro-1,3-butadiene	0.06	0.02	-	-	-	0.02	0.06	0.02	0.02	0.06	0.02	0.02
n-Hexane	0.17	0.12	-	-	-	0.11	0.15	0.15	0.16	0.14	0.10	0.10
Methylene chloride	0.08	0.09	-	-	-	0.07	0.11	0.14	0.08	0.06	0.08	0.07
Propene	1.76	1.53	-	-	-	1.16	1.18	1.44	1.23	1.13	1.29	1.18
Styrene	0.33	0.43	-	-	-	0.02	0.01	0.02	0.02	0.01	0.02	0.02
Tetrachloroethene	0.02	0.02	-	-	-	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Tetrahydrofuran	0.04	0.03	-	-	-	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Toluene	0.58	0.51	-	-	-	0.48	0.51	0.31	0.27	0.37	0.30	0.21
Trichloroethylene (TCE)	0.04	0.05	-	-	-	0.05	0.03	0.03	0.03	0.26	0.22	0.25
Trichlorofluoromethane	0.22	0.21	-	-	-	0.25	0.35	0.31	0.34	0.22	0.21	0.27
m & p- Xylene	0.38	0.36	-	-	-	0.13	0.10	0.08	0.07	0.15	0.13	0.07
o-Xylene	0.13	0.14	-	-	-	0.05	0.04	0.03	0.03	0.07	0.06	0.03

[1] Annual Avg is the arithmetic mean of valid samples with 1/2 the MDL substituted for non-detects.

Risk Characterization

Overview of Risk Factors and Reference Doses

The excess lifetime cancer risk for each of the chemical compounds was calculated using unit risk factors (URFs), and the risk for non-cancer health effects was calculated using reference air concentrations (RfCs). The URF is a measure of the probability of developing cancer from exposure over a lifetime to a specified concentration of a given chemical. The RfC is the concentration below which no (non-cancer) adverse health affects are expected to occur over a lifetime of continuous exposure. The EPA Integrated Risk Information System (IRIS) database was the primary source for the risk factors. In some cases, there were no inhalation risk data for a chemical in the IRIS database, so other sources, such as the EPA Region III Superfund Technical Support Section's risk-based concentration (RBC) table had to be referenced. Table 9 in Appendix C lists the URFs and RfCs, and summarizes their sources. A total of 41 of the targeted VOCs had data for either the inhalation reference dose or inhalation cancer slope factor (from which the RfC and URF are derived).

The URF and RfC are derived by assuming an adult weighing 70 kilograms (154 pounds) will breathe 20 m^3 (706 ft^3) of air each day for 365 days a year, over a 70-year lifetime of exposure. (For more details on these calculations, see Appendix C.) The excess lifetime cancer risk is calculated for each chemical by multiplying its URF by the average concentration of all the valid air samples collected during the year. The individual risks for each chemical are added to get the total excess lifetime cancer risk at that site.

The excess lifetime cancer risk numbers are written in an exponential format (e.g. 1.0E-04). Table 5 should be referred to when interpreting these numbers. For example, an excess lifetime cancer risk of 1.9E-04 means that 1.9 more people in a population of 10,000 are likely to develop cancer. This is above and beyond the national lifetime cancer risk of slightly less than 1 in 2 in men, and slightly more than 1 in 3 in women.

Table 5. Interpreting the risk numbers.

Risk	Exponential	Decimal	Read as…
1.0E-08	$1x10^{-8}$	0.00000001	1 in 100 million
1.0E-07	$1x10^{-7}$	0.0000001	1 in 10 million
1.0E-06	$1x10^{-6}$	0.000001	1 in 1 million
1.0E-05	$1x10^{-5}$	0.00001	1 in 100,000
1.0E-04	$1x10^{-4}$	0.0001	1 in 10,000
1.0E-03	$1x10^{-3}$	0.001	1 in 1,000
1.0E-02	$1x10^{-2}$	0.01	1 in 100
1.0E-01	$1x10^{-1}$	0.1	1 in 10

Any risk estimate is based on a number of assumptions and some of the assumptions made for this study include:

- The measured annual average concentration is the concentration that the individual will be exposed to over a lifetime;
- The concentrations measured at the sampling site are representative of exposures to the population in the area;
- The effects from exposure to multiple chemicals are additive;
- The exposure is based on a typical adult;
- The only excess risk considered in this report is due to inhalation;
- The cancer slope factor for each compound is assumed to be correct although reliability ratings vary greatly from compound to compound. Some are based on many well-controlled studies, while others are based on limited data and listed as provisional values.

The non-cancer risk associated with each of the relevant compounds is calculated by simply dividing the measured air concentration by the compound's respective RfC. If this value is less than one, and inhalation is the only source of exposure, then that chemical is not likely to cause adverse non-cancer health affects.

Table 6 shows the excess lifetime cancer risks for inhalation exposure calculated using annual average VOC concentrations. The total risk for each site includes compounds that were not detected. As explained earlier, it is accepted practice to include non-detected compounds in risk calculations by substituting a concentration defined as one-half the MDL. Thus, by conservatively including these non-detected compounds in the aggregate risk at concentrations of one-half the MDL, the risks in Table 8 are a "worst-case-scenario" risk calculation.

The risk values for 2005 in Table 6 may vary from the risk values found in Table 3 from the first Collegeville report. This is due to using the latest available and additional URF values which were applied to 2005 average annual concentrations. Please note that the URF value for TCE did not change since the first Collegeville report.

Excess Lifetime Cancer Risk

The total excess lifetime cancer risks for inhalation, based on the annual average concentration of VOCs, were significantly higher at the Collegeville sites than other monitoring sites across Pennsylvania in 2005 and 2006 (Table 7). In 2007, this was also true for the Collegeville and Trappe sites. This was mainly driven by higher concentrations of TCE in the Collegeville area, a chemical primarily used to clean and degrease metals. Annual average TCE concentrations from the Collegeville, Evansburg and Trappe sites ranged from 0.07 to 0.75 ppbv. In comparison, the annual TCE averages for most other Pennsylvania sites were near or below the method detection limits of 0.04 (in 2005 and 2006) and 0.06 ppbv (in 2007).

At the Collegeville site, the excess lifetime cancer risk due to TCE in 2007 was 4.6 in 10,000 (Table 8). This is the highest annual risk value of all three Collegeville sites for all three years of monitoring. The 2007 annual average TCE concentration of 0.75 ppbv (used to calculate the 2007 risk value) is skewed by one sample of 18.0 ppbv collected on 6/29/07. The next highest concentration found at the Collegeville site was 0.48 ppbv and values are typically in the 0 to 0.30 ppbv range. If the 6/29/07 sample is omitted, the Collegeville annual average TCE concentration for 2007 drops to 0.18 ppbv and the corresponding excess lifetime cancer risk due to TCE drops to 1.1 in 10,000.

At the Evansburg site, the excess lifetime cancer risk due to TCE dropped from 0.88 in 10,000 in 2005, to 0.45 in 10,000 in 2007 (Table 8). This mirrors the reduction in emissions from one of the TCE emitting facilities located 1.3 miles to the west.

At the Trappe site, the excess lifetime cancer risk due to TCE was 1.60 in 10,000 in 2005, 1.3 in 10,000 in 2006 and 1.5 in 10,000 in 2007 (Table 8). Note that at the Trappe site, as well as the Collegeville site, TCE (one compound) is accounting for close to one-half the excess lifetime cancer risk.

It is important to note that the laboratory MDLs for VOCs in 2007 were higher than MDLs in 2005 and 2006 due to changes in the GC/MS analytical equipment. Because any compound that was not detected was given a value of one-half the MDL for excess lifetime cancer risk calculations (as explained in the previous section), the calculated risks across all sites are greater in 2007 than in 2005 and 2006.

Non-Cancer Health Effects

There were no VOCs with annual average concentrations (Table 4) above their respective RfC (Table 11). Consequently, non-cancer health effects are not expected from breathing the air in the Collegeville area.

Table 6. Summary of excess lifetime cancer risks from inhalation of targeted VOCs across all Pennsylvania monitoring sites.

	Arendtsville			Chester			Collegeville			Erie		
	Cancer Risk			Cancer Risk			Cancer Risk			Cancer Risk		
Compound	2005	2006	2007	2005	2006	2007	2005	2006	2007	2005	2006	2007
1,3-Butadiene	1.3E-06	1.3E-06	6.0E-06	1.3E-06	1.3E-06	6.0E-06	-	-	6.2E-06	1.3E-06	1.3E-06	6.0E-06
1,2-Dibromoethane	9.2E-05	9.2E-05	1.4E-04	9.2E-05	9.2E-05	1.4E-04	-	-	1.4E-04	9.2E-05	9.2E-05	1.4E-04
cis-1,3-Dichloro-1-propene	1.8E-07	3.6E-07	3.6E-07	1.8E-07	3.6E-07	3.6E-07	-	-	3.6E-07	1.8E-07	3.6E-07	3.6E-07
trans-1,3-Dichloro-1-propene	1.8E-07	3.6E-07	3.6E-07	1.8E-07	3.6E-07	3.6E-07	-	-	3.6E-07	1.8E-07	3.6E-07	3.6E-07
1,2-Dichlorobenzene	-	-	-	-	-	-	-	-	-	-	-	-
1,4-Dichlorobenzene	4.8E-06	1.4E-06	1.4E-06	4.8E-06	1.5E-06	1.5E-06	-	-	1.4E-06	4.8E-06	1.4E-06	1.4E-06
1,1-Dichloroethane	1.3E-07	1.3E-07	1.3E-07	1.3E-07	1.3E-07	1.3E-07	-	-	1.3E-07	1.3E-07	1.3E-07	1.3E-07
1,2-Dichloroethane	2.1E-06	2.1E-06	3.2E-06	2.2E-06	2.4E-06	5.2E-06	-	-	3.2E-06	2.1E-06	2.1E-06	3.2E-06
1,1-Dichloroethene	-	-	-	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	-	-	-	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	9.5E-07	9.5E-07	1.4E-06	9.5E-07	9.5E-07	1.4E-06	-	-	1.4E-06	9.5E-07	9.5E-07	1.4E-06
1,1,2,2-Tetrachloroethane	2.8E-05	8.0E-06	8.0E-06	2.8E-05	8.0E-06	8.0E-06	-	-	8.0E-06	2.8E-05	8.0E-06	8.0E-06
1,1,2-Trichloro-1,2,2-trifluoroethane	-	-	-	-	-	-	-	-	-	-	-	-
1,2,4-Trichlorobenzene	-	-	-	-	-	-	-	-	-	-	-	-
1,1,1-Trichloroethane	-	-	-	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	1.7E-06	1.7E-06	2.6E-06	1.7E-06	1.7E-06	2.6E-06	-	-	2.6E-06	1.7E-06	1.7E-06	2.6E-06
2-Methoxy-2-methyl propane	-	-	-	-	-	-	-	-	-	-	-	-
4-Methyl-2-pentanone	-	-	-	-	-	-	-	-	-	-	-	-
Benzene	3.5E-06	3.2E-06	3.5E-06	6.7E-06	5.8E-06	6.9E-06	-	-	4.8E-06	4.4E-06	3.9E-06	4.6E-06
Bromoform	1.1E-07	2.3E-07	2.3E-07	1.1E-07	2.3E-07	2.3E-07	-	-	2.3E-07	1.1E-07	2.3E-07	2.3E-07
Bromomethane	-	-	-	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	7.6E-06	7.5E-06	8.6E-06	6.8E-06	7.4E-06	8.6E-06	-	-	7.6E-06	7.8E-06	7.2E-06	8.5E-06
Chlorobenzene	-	-	-	-	-	-	-	-	-	-	-	-
Chloroethane	-	-	-	-	-	-	-	-	-	-	-	-
Chloroethene	4.5E-07	4.5E-07	6.7E-07	4.9E-07	4.5E-07	7.1E-07	-	-	6.7E-07	4.5E-07	4.5E-07	6.7E-07
Chloroform	2.2E-06	2.2E-06	3.4E-06	2.2E-06	2.3E-06	3.4E-06	-	-	3.4E-06	2.8E-06	2.2E-06	3.4E-06
Chloromethane	-	-	-	-	-	-	-	-	-	-	-	-
Cyclohexane	-	-	-	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	-	-	-	-	-	-	-	-	-	-	-	-
Ethylbenzene	-	-	-	-	-	-	-	-	-	-	-	-
Hexachloro-1,3-butadiene	1.4E-05	4.7E-06	4.7E-06	1.4E-05	4.7E-06	4.7E-06	-	-	4.7E-06	1.4E-05	4.7E-06	4.7E-06
n-Hexane	-	-	-	-	-	-	-	-	-	-	-	-
Methylene Chloride	5.6E-08	5.9E-08	6.8E-08	1.2E-07	1.2E-07	9.4E-08	-	-	1.5E-07	6.9E-08	5.7E-08	1.1E-07
Styrene	-	-	-	-	-	-	-	-	-	-	-	-
Tetrachloroethylene	7.7E-07	7.9E-07	1.2E-06	1.7E-06	1.6E-06	1.2E-06	-	-	1.2E-06	1.9E-06	7.7E-07	1.2E-06
Tetrahydrofuran	1.1E-07	1.1E-07	1.1E-07	5.2E-06	4.5E-06	6.3E-06	-	-	1.1E-07	1.1E-07	1.1E-07	1.1E-07
Toluene	-	-	-	-	-	-	-	-	-	-	-	-
Trichloroethylene (TCE)	1.2E-05	1.2E-05	2.0E-05	1.7E-05	1.8E-05	3.6E-05	-	-	4.6E-04	1.4E-05	1.5E-05	1.8E-05
Trichlorofluoromethane	-	-	-	-	-	-	-	-	-	-	-	-
m,p-Xylene	-	-	-	-	-	-	-	-	-	-	-	-
o-Xylene	-	-	-	-	-	-	-	-	-	-	-	-
Total Risk	1.7E-04	1.4E-04	2.0E-04	1.9E-04	1.5E-04	2.3E-04	-	-	6.4E-04	1.8E-04	1.4E-04	2.0E-04

Table 6. (continued).

Compound	Evansburg			Lancaster			Lewisburg			Marcus Hook		
	Cancer Risk			Cancer Risk			Cancer Risk			Cancer Risk		
	2005	2006	2007	2005	2006	2007	2005	2006	2007	2005	2006	2007
1,3-Butadiene	1.3E-06	1.5E-06	6.0E-06	1.3E-06	1.3E-06	6.0E-06	2.2E-06	2.5E-06	6.0E-06	1.3E-06	1.3E-06	6.0E-06
1,2-Dibromoethane	9.2E-05	9.2E-05	1.4E-04	9.2E-05	9.2E-05	1.4E-04	9.2E-05	9.2E-05	1.4E-04	9.2E-05	9.2E-05	1.4E-04
cis-1,3-Dichloro-1-propene	1.8E-07	3.6E-07	3.6E-07	1.8E-07	3.6E-07	3.6E-07	1.8E-07	3.6E-07	3.6E-07	1.8E-07	3.6E-07	3.6E-07
trans-1,3-Dichloro-1-propene	1.8E-07	3.6E-07	3.6E-07	1.8E-07	3.6E-07	3.6E-07	1.8E-07	3.6E-07	3.6E-07	1.8E-07	3.6E-07	3.6E-07
1,2-Dichlorobenzene	-	-	-	-	-	-	-	-	-	-	-	-
1,4-Dichlorobenzene	4.8E-06	1.4E-06	1.4E-06	4.8E-06	1.4E-06	1.4E-06	4.8E-06	1.4E-06	1.4E-06	4.8E-06	1.4E-06	1.4E-06
1,1-Dichloroethane	1.3E-07	1.3E-07	1.3E-07	1.3E-07	1.3E-07	1.3E-07	1.3E-07	1.3E-07	1.3E-07	1.3E-07	1.3E-07	1.3E-07
1,2-Dichloroethane	2.1E-06	2.1E-06	3.2E-06	2.1E-06	2.1E-06	3.2E-06	2.1E-06	2.1E-06	3.2E-06	2.2E-06	2.1E-06	3.3E-06
1,1-Dichloroethene	-	-	-	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	-	-	-	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	9.5E-07	9.5E-07	1.4E-06	9.5E-07	9.5E-07	1.4E-06	9.5E-07	9.5E-07	1.4E-06	9.5E-07	9.5E-07	1.4E-06
1,1,2,2-Tetrachloroethane	2.8E-05	8.0E-06	8.0E-06	2.8E-05	8.0E-06	8.0E-06	2.8E-05	8.0E-06	8.0E-06	2.8E-05	8.0E-06	8.0E-06
1,1,2-Trichloro-1,2,2-trifluoroethane	-	-	-	-	-	-	-	-	-	-	-	-
1,2,4-Trichlorobenzene	-	-	-	-	-	-	-	-	-	-	-	-
1,1,1-Trichloroethane	-	-	-	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	1.7E-06	1.7E-06	2.6E-06	1.7E-06	1.7E-06	2.6E-06	1.7E-06	1.7E-06	2.6E-06	1.7E-06	1.7E-06	2.6E-06
2-Methoxy-2-methyl propane	-	-	-	-	-	-	-	-	-	-	-	-
4-Methyl-2-pentanone	-	-	-	-	-	-	-	-	-	-	-	-
Benzene	4.5E-06	3.7E-06	4.0E-06	7.4E-06	6.8E-06	6.4E-06	6.0E-06	4.6E-06	4.0E-06	1.8E-05	1.4E-05	1.2E-05
Bromoform	1.1E-07	2.3E-07	2.3E-07	1.1E-07	2.3E-07	2.3E-07	1.1E-07	2.3E-07	2.3E-07	1.1E-07	2.3E-07	2.3E-07
Bromomethane	-	-	-	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	8.2E-06	7.2E-06	8.1E-06	8.4E-06	7.5E-06	8.0E-06	8.4E-06	7.6E-06	7.7E-06	7.6E-06	7.5E-06	8.4E-06
Chlorobenzene	-	-	-	-	-	-	-	-	-	-	-	-
Chloroethane	-	-	-	-	-	-	-	-	-	-	-	-
Chloroethene	4.6E-07	4.5E-07	6.7E-07	4.5E-07	4.5E-07	6.7E-07	4.5E-07	4.5E-07	6.7E-07	5.1E-07	4.7E-07	7.0E-07
Chloroform	2.2E-06	2.2E-06	3.4E-06	2.4E-06	2.6E-06	3.4E-06	2.2E-06	2.2E-06	3.4E-06	2.2E-06	2.2E-06	3.4E-06
Chloromethane	-	-	-	-	-	-	-	-	-	-	-	-
Cyclohexane	-	-	-	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	-	-	-	-	-	-	-	-	-	-	-	-
Ethylbenzene	-	-	-	-	-	-	-	-	-	-	-	-
Hexachloro-1,3-butadiene	1.4E-05	4.7E-06	4.7E-06	1.4E-05	4.7E-06	4.7E-06	1.4E-05	4.7E-06	4.7E-06	1.4E-05	4.7E-06	4.7E-06
n-Hexane	-	-	-	-	-	-	-	-	-	-	-	-
Methylene Chloride	1.2E-07	1.3E-07	2.7E-07	1.3E-07	1.5E-07	1.6E-07	9.1E-08	1.1E-07	7.9E-08	2.1E-07	9.3E-08	1.1E-07
Styrene	-	-	-	-	-	-	-	-	-	-	-	-
Tetrachloroethylene	9.4E-07	8.6E-07	1.2E-06	9.4E-07	9.0E-07	1.2E-06	8.4E-07	8.4E-07	1.2E-06	1.4E-06	1.0E-06	1.3E-06
Tetrahydrofuran	1.4E-07	1.1E-07	2.7E-07	4.4E-07	1.1E-07	1.1E-07	3.6E-07	2.4E-07	1.1E-07	1.4E-07	1.1E-07	1.4E-07
Toluene	-	-	-	-	-	-	-	-	-	-	-	-
Trichloroethylene (TCE)	8.8E-05	7.3E-05	4.5E-05	1.2E-05	1.3E-05	1.9E-05	1.5E-05	1.6E-05	2.5E-05	1.6E-05	1.2E-05	2.4E-05
Trichlorofluoromethane	-	-	-	-	-	-	-	-	-	-	-	-
m,p-Xylene	-	-	-	-	-	-	-	-	-	-	-	-
o-Xylene	-	-	-	-	-	-	-	-	-	-	-	-
Total Risk	2.5E-04	2.0E-04	2.3E-04	1.8E-04	1.4E-04	2.1E-04	1.8E-04	1.5E-04	2.1E-04	1.9E-04	1.5E-04	2.2E-04

Table 6. (continued).

Compound	Pottstown			Swarthmore			Trappe		
	Cancer Risk			Cancer Risk			Cancer Risk		
	2005	2006	2007	2005	2006	2007	2005	2006	2007
1,3-Butadiene	1.3E-05	8.1E-06	-	1.3E-06	1.3E-06	6.0E-06	1.8E-06	2.1E-06	6.0E-06
1,2-Dibromoethane	9.2E-05	9.2E-05	-	9.2E-05	9.2E-05	1.4E-04	9.2E-05	9.2E-05	1.4E-04
cis-1,3-Dichloro-1-propene	1.8E-07	3.6E-07	-	1.8E-07	3.6E-07	3.6E-07	1.8E-07	3.6E-07	3.6E-07
trans-1,3-Dichloro-1-propene	1.8E-07	3.6E-07	-	1.8E-07	3.6E-07	3.6E-07	1.8E-07	3.6E-07	3.6E-07
1,2-Dichlorobenzene	-	-	-	-	-	-	-	-	-
1,4-Dichlorobenzene	4.8E-06	1.4E-06	-	4.8E-06	1.4E-06	1.4E-06	4.8E-06	1.4E-06	1.4E-06
1,1-Dichloroethane	1.3E-07	1.3E-07	-	1.3E-07	1.3E-07	1.3E-07	1.3E-07	1.3E-07	1.3E-07
1,2-Dichloroethane	2.1E-06	2.1E-06	-	2.1E-06	2.1E-06	3.2E-06	2.1E-06	2.1E-06	3.2E-06
1,1-Dichloroethene	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	9.5E-07	9.5E-07	-	9.5E-07	9.5E-07	1.4E-06	9.5E-07	9.5E-07	1.4E-06
1,1,2,2-Tetrachloroethane	2.8E-05	8.0E-06	-	2.8E-05	8.0E-06	8.0E-06	2.8E-05	8.0E-06	8.0E-06
1,1,2-Trichloro-1,2,2-trifluoroethane	-	-	-	-	-	-	-	-	-
1,2,4-Trichlorobenzene	-	-	-	-	-	-	-	-	-
1,1,1-Trichloroethane	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	1.7E-06	1.7E-06	-	1.7E-06	1.7E-06	2.6E-06	1.7E-06	1.7E-06	2.6E-06
2-Methoxy-2-methyl propane	-	-	-	-	-	-	-	-	-
4-Methyl-2-pentanone	-	-	-	-	-	-	-	-	-
Benzene	7.9E-06	6.2E-06	-	6.4E-06	4.9E-06	5.3E-06	5.8E-06	4.9E-06	4.7E-06
Bromoform	1.1E-07	2.3E-07	-	1.1E-07	2.3E-07	2.3E-07	1.1E-07	2.3E-07	2.3E-07
Bromomethane	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	8.7E-06	7.3E-06	-	7.3E-06	7.2E-06	8.0E-06	8.8E-06	7.6E-06	9.9E-06
Chlorobenzene	-	-	-	-	-	-	-	-	-
Chloroethane	-	-	-	-	-	-	-	-	-
Chloroethene	4.9E-07	4.5E-07	-	4.5E-07	4.6E-07	6.7E-07	4.5E-07	4.5E-07	6.7E-07
Chloroform	2.4E-06	2.3E-06	-	2.2E-06	2.3E-06	3.4E-06	2.2E-06	2.2E-06	3.4E-06
Chloromethane	-	-	-	-	-	-	-	-	-
Cyclohexane	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	-	-	-	-	-	-	-	-	-
Ethylbenzene	-	-	-	-	-	-	-	-	-
Hexachloro-1,3-butadiene	1.4E-05	4.7E-06	-	1.4E-05	4.7E-06	4.7E-06	1.4E-05	4.7E-06	4.7E-06
n-Hexane	-	-	-	-	-	-	-	-	-
Methylene Chloride	1.3E-07	1.5E-07	-	1.8E-07	2.3E-07	1.3E-07	1.0E-07	1.2E-07	1.1E-07
Styrene	-	-	-	-	-	-	-	-	-
Tetrachloroethylene	9.6E-07	8.6E-07	-	1.3E-06	1.0E-06	1.2E-06	1.3E-06	1.2E-06	1.2E-06
Tetrahydrofuran	2.0E-07	1.5E-07	-	1.1E-07	1.1E-07	1.3E-07	1.1E-07	1.1E-07	1.1E-07
Toluene	-	-	-	-	-	-	-	-	-
Trichloroethylene (TCE)	2.3E-05	3.3E-05	-	1.9E-05	2.1E-05	1.8E-05	1.6E-04	1.3E-04	1.5E-04
Trichlorofluoromethane	-	-	-	-	-	-	-	-	-
m,p-Xylene	-	-	-	-	-	-	-	-	-
o-Xylene	-	-	-	-	-	-	-	-	-
Total Risk	2.0E-04	1.7E-04	-	1.8E-04	1.5E-04	2.0E-04	3.2E-04	2.6E-04	3.4E-04

Table 7. Excess lifetime cancer risk for inhalation of ambient VOC concentrations per population of 10,000.

Site	Excess Lifetime Cancer Risk per 10,000 (Total VOC)		
	2005	2006	2007
Arendtsville	1.7	1.4	2.0
Chester	1.9	1.5	2.3
Collegeville	-	-	6.4
Erie	1.8	1.4	2.0
Evansburg	2.5	2.0	2.3
Lancaster	1.8	1.4	2.1
Lewisburg	1.8	1.5	2.1
Marcus Hook	1.9	1.5	2.2
Pottstown	2.0	1.7	-
Swarthmore	1.8	1.5	2.0
Trappe	3.2	2.6	3.4

Table 8. Excess lifetime cancer risk for inhalation of ambient trichloroethylene (TCE) concentrations per population of 10,000.

Site	Excess Lifetime Cancer Risk per 10,000 (TCE)		
	2005	2006	2007
Arendtsville	0.12	0.12	0.20
Chester	0.17	0.18	0.36
Collegeville	-	-	4.6
Erie	0.14	0.15	0.18
Evansburg	0.88	0.73	0.45
Lancaster	0.12	0.13	0.19
Lewisburg	0.15	0.16	0.25
Marcus Hook	0.16	0.12	0.24
Pottstown	0.23	0.33	-
Swarthmore	0.19	0.21	0.18
Trappe	1.6	1.3	1.5

Next Steps

DEP will continue to work with the owners and operators of two large facilities on their TCE emission reduction plans. Full implementation at both facilities is expected by May 1, 2008.

In 2007, DEP applied for and was awarded, a federal community scale grant from EPA to expand sampling in the Collegeville area. The grant will allow DEP to incorporate several new initiatives and expand on current activities. One initiative, that already has occurred, is the installation of a background monitoring site in the Spring City area. This site will allow DEP to evaluate pollutant levels that are transported into the Collegeville area. The second initiative will be to conduct four intensive sampling studies over the course of 2008. These intensive sampling studies will include expanded canister sampling at the established stations in Trappe, Evansburg and Spring City, as well as incorporating the Mobile Analytical Unit and its equipment. The third initiative is the installation of a continuous gas chromatograph in the Trappe area to monitor emissions on a near real-time basis. Lastly, the grant will allow DEP to contract with an independent researcher to compile all study data, perform data analysis, risk analysis and emissions modeling, and deliver the results in a report to DEP by mid-2009.

The DEP will also begin to analyze some of its canister samples for a new compound, 1-bromo-propane, also known as n-propyl bromide. This solvent is used as a replacement for TCE and is part of the TCE reduction strategy employed by one of the Collegeville area facilities. This solvent is an EPA approved solvent for metal cleaning. It is a VOC, but not classified as an air toxic. It is not known to have carcinogenic effects.

Detailed descriptions of TCE emission reduction plans, enhanced monitoring under the EPA grant, and other related information are available on DEP's website at www.dep.state.pa.us, keyword Collegeville.

Appendix

A. Monitoring

Equipment

Canister Sampler - Andersen Instruments, Inc. AVOCS

Canisters - Six-liter, SUMMA-polished from various suppliers

Wind Sensors - Climatronics model F460 low-threshold anemometer and tail vane, 10-meter tower height, wind direction referenced to True North

Temperature and Relative Humidity - Vaisala model HMP-45

Solar Radiation: Silicon Cell, Matrix, Inc. model Mk 1-G

Precipitation - Texas Electronics, Inc. model TE-525 tipping bucket, 0.01 inches per tip, unheated, rain only

Datalogger: Campbell Scientific model CR-10X, 10-second measurement interval, calculates 15-minute averages, 15-minute sigma theta (standard deviation of horizontal wind direction), 1-hour averages and 1-hour total precipitation

Canister Analysis - Entech 7000 or 7100A sample concentrator, Agilent 6890 gas chromatograph, 5973 quadrupole mass spectrometer

Samples were collected over a 24-hour period once every six days. This same schedule is used at other toxic monitoring sites across the state to allow for comparison between sites.

The automated Andersen sampler pumps air into an evacuated stainless steel canister, at a constant flow rate, over a 24-hour sampling period. The filled canister is returned the DEP laboratory for analysis.

Calibration and Analysis

The laboratory GC/MS system is calibrated using working standards prepared from a 500 ppbv, 60-component commercial gas cylinder standard (Spectra Gases, Inc.) diluted with humidified nitrogen. In addition, a 15-component primary standard (National Institute of Standards and Technology, NIST SRM-1800) is analyzed to verify the calibration. Each run consists of standards, blanks and continuing calibration standards after every ten samples.

After analysis, canisters are cleaned and evacuated by the laboratory. After each batch is cleaned, at least one canister is filled and retested as a blank to verify they are clean. Canisters are not dedicated to a specific site, so canisters used at the Collegeville sites may be cleaned and sent to other ambient monitoring sites.

B. Definitions

Blank – Sampling materials and chemicals analyzed without collecting a sample to test for contaminants that might interfere with the analysis. The analytical protocol specifies acceptable blank levels and how these values are used.

Chronic — Occurs over a long period of time. Cancer is the primary health effect considered when evaluating the risk from chronic exposure to a chemical compound.

Excess Lifetime Cancer Risk — The increased risk of developing cancer above the normal background rate of slightly less than 1 in 2 in men, and slightly more than 1 in 3 in women.

Mean — The arithmetic average. For example: (2.2 +2.6 +4.8)/3 = 3.2

Method Detection Limit (MDL) — The definition of MDL is "the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte". When concentrations are below the MDL, the result cannot be distinguished with statistical confidence from the background noise of the instrument. The MDLs are determined by a standard laboratory quality control procedure (40 CFR Part 136, Appendix B).

Microgram — A microgram is one millionth of a gram weight. (The symbol µg is commonly used for microgram). Ambient air concentrations are commonly expressed in micrograms per cubic meter of air ($\mu g/m^3$). Because air expands and contracts with changes in temperature and pressure, the cubic meter volume must be referenced to a specific temperature and pressure. Standard conditions for ambient air measurements are 25° C (77° F) and one atmosphere (29.92 inches of mercury).

ppbv — Parts per billion by volume – The concentration units commonly used for gaseous pollutants in ambient air. These units are not used for non-gaseous pollutants.

Reference Air Concentration (RfC) — The concentration of a specific chemical in the air below which no (non-cancer) adverse health affects are expected to occur over a lifetime of continuous exposure.

Reporting Limit (RL) — The RL of a compound is approximately ten times its MDL. Concentrations at or above the RL are considered quantifiably accurate. If data is between the RL and the MDL, there is confidence that the compound is actually present, but less certainty in the accuracy of the reported concentration.

Unit Risk Factor (URF) — A measure of the probability of an individual developing cancer as a result of exposure to a specified unit concentration of a specific chemical. In air, the unit concentration is 1.0 µg/m^3. For example, an inhalation URF of 3.0E-04 implies that if 10,000 people breathe that chemical for 70 years at a concentration of 1.0 µg/m^3, three of the 10,000 may develop cancer as a result of the exposure.

Volatile Organic Chemical (VOC) — A chemical compound containing carbon that can be present in the atmosphere as a vapor at normal temperatures. Generally, chemicals with vapor pressures greater than 0.1 mmHg at 20° C (0.0001316 atmospheres at 68° F) are classified as volatile, and chemicals with measurable vapor pressures that are less than 0.1 mmHg are classified as semi-volatile.

C. Risk Calculation

The excess lifetime cancer risk for each of the chemical compounds was calculated using unit risk factors (URFs), and the risk for non-cancer health effects was calculated using reference air concentrations (RfCs) (Table 9). The EPA Integrated Risk Information System (IRIS) database was the primary source for the risk factors. In some cases, there were no inhalation risk data for a chemical in the IRIS database, so other sources, such as the EPA Region III Superfund Technical Support Section's risk-based concentration (RBC) table had to be referenced.

IRIS lists the URFs and RfCs directly. The RBC table lists four different chronic toxicological constants from which the URFs and RfCs can be derived: 1) Oral Reference Dose (RfDo), 2) Inhalation Reference Dose (RfDi), 3) Oral Cancer Slope Factor (CSFo), and 4) Inhalation Cancer Slope Factor (CSFi). For this study, only the RfDi and CSFi were used.

The URF and the RfC are derived from the CSFi and RfDi, respectively, by assuming that an adult weighing 70 kilograms (154 pounds) will breathe 20 m^3 (706 ft^3) of air a day for 365 days a year, over a 70-year lifetime of exposure. From this standard 70-year exposure scenario for an adult, excess lifetime cancer risk is calculated for each chemical by multiplying the measured air concentrations by their respective URFs. The individual risks for each chemical are added to get the total excess lifetime cancer risk at that site. The non-cancer risk associated with each of the relevant chemicals is calculated by simply dividing the measured air concentration by the chemical's respective RfC. If the result is less than 1, non-cancer health effects are not expected.

The conversion from CSFi to URF is carried out as follows:

$$(\text{kg-day})/\text{mg} \times (1/70\ \text{kg}) \times (20\ m^3/\text{day}) \times (\text{mg}/1000\ \mu\text{g}) = m^3/\mu\text{g}$$

The conversion from RfDi to RfC is carried out as follows:

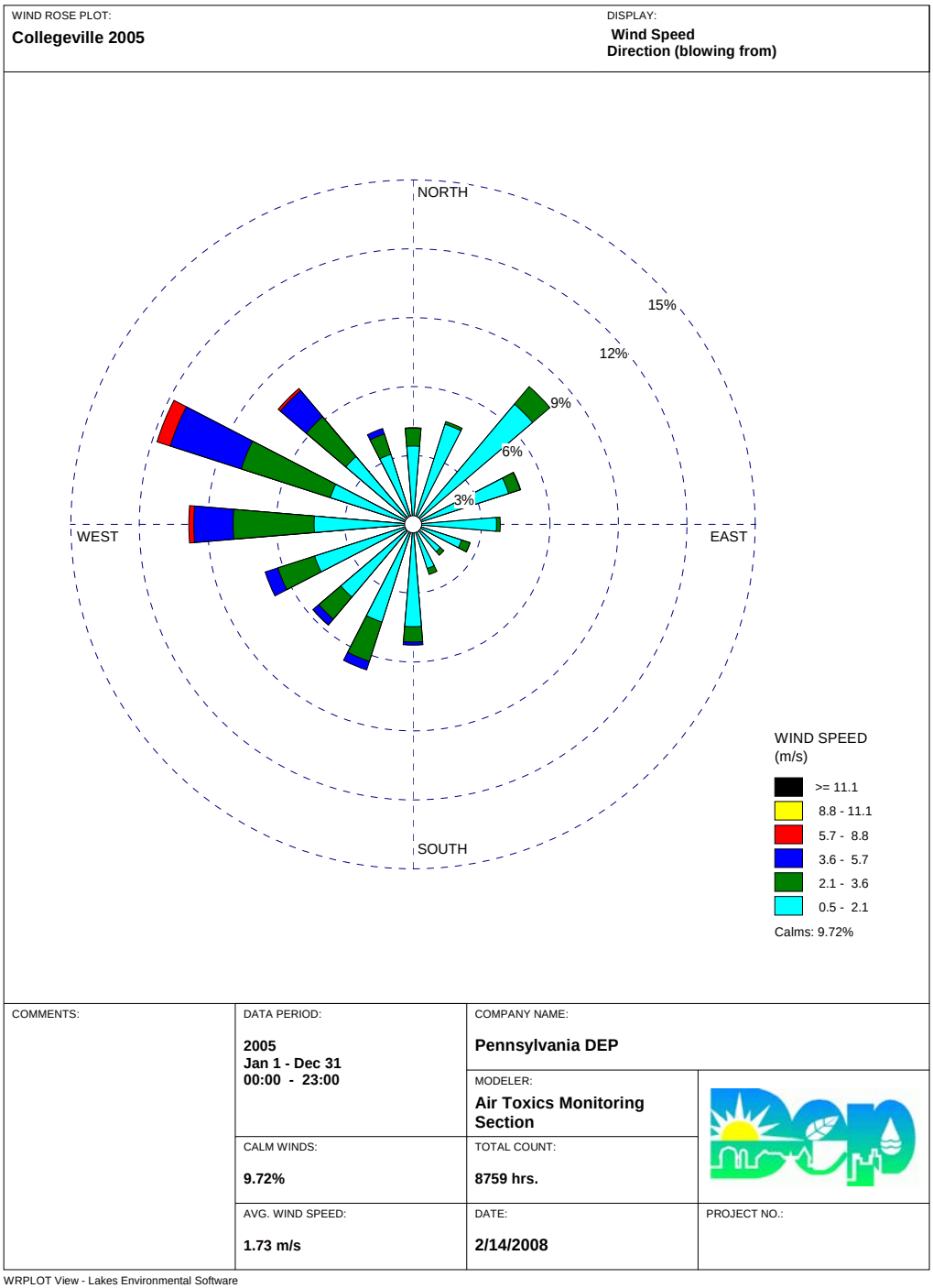
$$\text{mg}/(\text{kg-day}) \times (70\ \text{kg}) \times (\text{day}/20\ m^3) \times (1000\ \mu\text{g}/\text{mg}) = \mu\text{g}/m^3$$

Table 9. Cancer Unit Risk Factors (URFs) and Reference Air Concentrations (RfCs) used in this report.

Compound[1]	Unit Risk Factor $m^3/\mu g$	Reference Air Concentration $\mu g/m^3$	Molecular Weight	Source[2]	
				URF	RfC
1,3-Butadiene	3.00E-05	2.00E+00	54.1	IRIS	IRIS
1,2-Dibromoethane	6.00E-04	9.00E+00	187.9	IRIS	IRIS
cis-1,3-Dichloro-1-propene	4.00E-06	2.00E+01	111.0	IRIS	IRIS
trans-1,3-Dichloro-1-propene	4.00E-06	2.00E+01	111.0	IRIS	IRIS
1,2-Dichlorobenzene	-	1.40E+02	147.0	-	RBC
1,4-Dichlorobenzene	1.14E-05	8.00E+02	147.0	RBC	IRIS
1,1-Dichloroethane	1.60E-06	4.90E+02	99.0	O	RBC
1,2-Dichloroethane	2.60E-05	2.45E+03	99.0	IRIS	RBC
1,1-Dichloroethene	-	2.00E+02	97.0	-	IRIS
trans-1,2-Dichloroethene	-	5.95E+01	97.0	-	RBC
1,2-Dichloropropane	1.03E-05	4.00E+00	113.0	RBC	IRIS
1,1,2,2-Tetrachloroethane	5.80E-05	-	167.9	IRIS	-
1,1,2-Trichloro-1,2,2-trifluoroethane	-	3.01E+04	187.4	-	RBC
1,2,4-Trichlorobenzene	-	3.50E+00	181.4	-	O
1,1,1-Trichloroethane	-	5.00E+03	133.4	-	IRIS
1,1,2-Trichloroethane	1.60E-05	-	133.4	IRIS	-
2-Methoxy-2-methyl propane	-	3.00E+03	88.2	-	IRIS
4-Methyl-2-pentanone	-	3.00E+03	100.2	-	IRIS
Benzene	7.80E-06	3.00E+01	78.1	IRIS	IRIS
Bromoform	1.10E-06	-	252.8	IRIS	-
Bromomethane	-	4.90E+00	95.0	-	RBC
Carbon Tetrachloride	1.50E-05	1.75E+02	153.8	IRIS	RBC
Chlorobenzene	-	4.90E+01	112.6	-	RBC
Chloroethane	-	1.00E+04	64.5	-	IRIS
Chloroethene	8.80E-06	1.00E+02	62.5	IRIS	IRIS
Chloroform	2.30E-05	4.90E+01	119.4	IRIS	RBC
Chloromethane	-	9.00E+01	50.5	-	IRIS
Cyclohexane	-	6.00E+03	84.2	-	IRIS
Dichlorodifluoromethane	-	1.75E+02	120.9	-	RBC
Ethylbenzene	-	1.00E+03	106.2	-	IRIS
Hexachloro-1,3-butadiene	2.20E-05	-	260.7	IRIS	-
n-Hexane	-	7.00E+02	86.2	-	IRIS
Methylene Chloride	4.70E-07	1.05E+03	84.9	IRIS	RBC
Styrene	-	1.00E+03	104.2	-	IRIS
Tetrachloroethene	5.71E-06	2.80E+02	165.8	RBC	RBC
Tetrahydrofuran	1.94E-06	3.01E+02	72.1	RBC	RBC
Toluene	-	5.00E+03	92.1	-	IRIS
Trichloroethylene (TCE)	1.14E-04	3.50E+01	131.4	RBC	RBC
Trichlorofluoromethane	-	7.00E+02	137.4	-	RBC
m & p-Xylene	-	1.00E+02	106.2	-	IRIS
o-Xylene	-	1.00E+02	106.2	-	IRIS

[1] Highlighted compounds have different URF's and RfC's from first Collegeville report.
[2] IRIS – EPA Integrated Risk Information System
RBC – EPA Region III Risk-Based Concentrations
O - Other sources

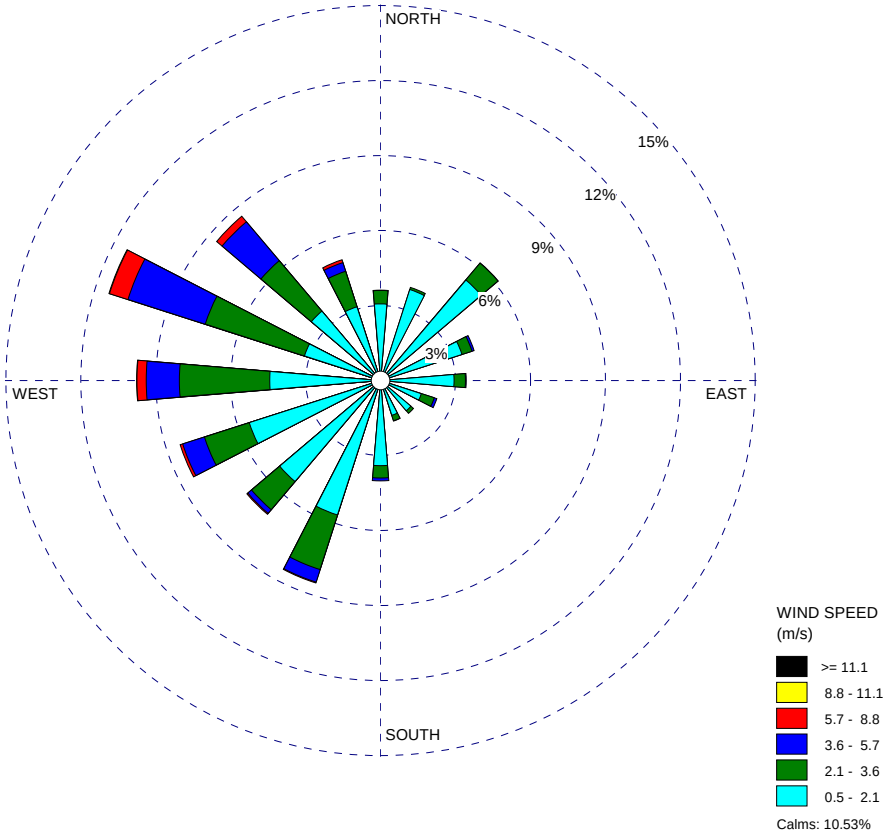
D. Yearly Wind Roses



Pennsylvania Department of Environmental Protection
Collegeville Area Air Monitoring Project
March 7, 2008

WIND ROSE PLOT:
Collegeville 2006

DISPLAY:
Wind Speed
Direction (blowing from)



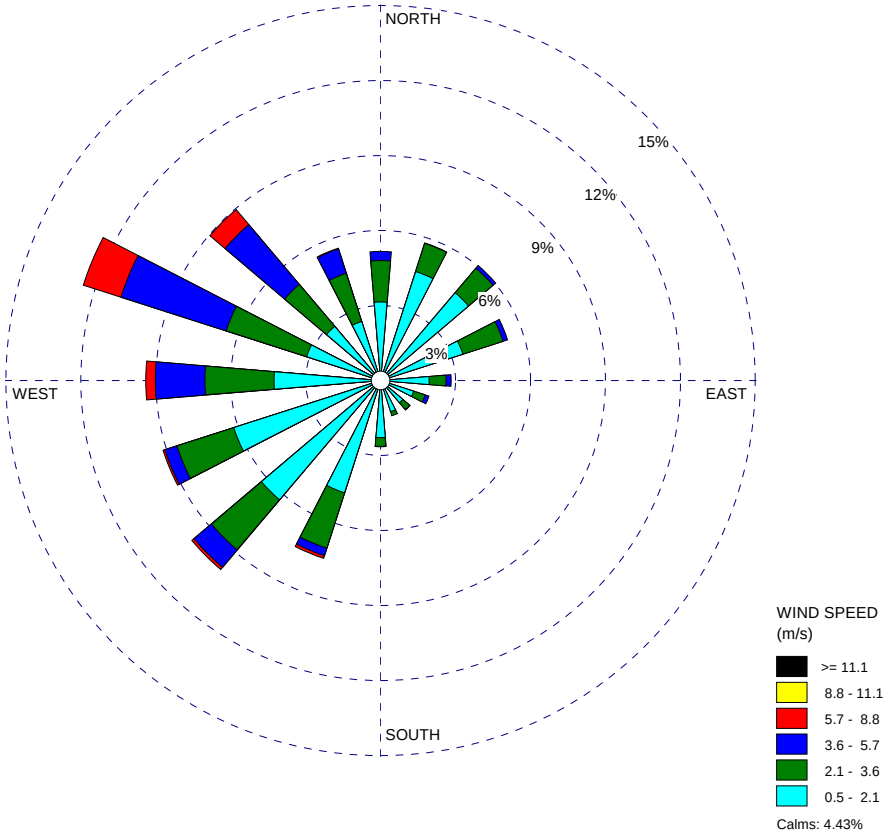
COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2006 **Jan 1 - Dec 31** **00:00 - 23:00**	**Pennsylvania DEP**	
		MODELER: **Air Toxics Monitoring Section**	
	CALM WINDS: **10.53%**	TOTAL COUNT: **8759 hrs.**	
	AVG. WIND SPEED: **1.84 m/s**	DATE: **2/14/2008**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

Pennsylvania Department of Environmental Protection
Collegeville Area Air Monitoring Project
March 7, 2008

WIND ROSE PLOT:
Collegeville 2007

DISPLAY:
Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD: **2007** **Jan 1 - Dec 31** **00:00 - 23:00**	COMPANY NAME: **Pennsylvania DEP**	
		MODELER: **Air Toxics Monitoring Section**	
	CALM WINDS: **4.43%**	TOTAL COUNT: **6346 hrs.**	
	AVG. WIND SPEED: **2.20 m/s**	DATE: **2/14/2008**	PROJECT NO.:

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