Collegeville Area Air Monitoring Project
Third Report

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Commonwealth of Pennsylvania
Department of Environmental Protection

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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 the 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 with a peak concentration of 15 parts per billion. Additional sampling was conducted in the Collegeville area in June 2004, with similar results. The DEP decided that the duration and magnitude of the TCE detected warranted further investigation.

To fully evaluate TCE concentrations in the Collegeville area, the DEP initially established two air monitoring sites in Evansburg State Park and the former YMCA building in Trappe. DEP began sampling on January 4, 2005. Air samples were collected in evacuated canisters over a 24-hour period from midnight to midnight. The DEP's central laboratory analyzed the samples for TCE and 54 additional volatile organic compounds (VOCs) based on established Environmental Protection Agency (EPA) methods.

The purpose of these monitoring sites 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. Since 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 used by EPA. A third objective was added to evaluate the impact of the TCE emission reduction measures undertaken by the two facilities in response to the initial sampling and risk assessment.

The first report to the public on the project 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.

A second report, released on March 7, 2008, included an evaluation of the sampling data collected between 2005 and 2007. A public meeting was held on March 26, 2008 to discuss the second report and progress on the TCE emission reduction efforts, which included complete elimination of TCE usage at one facility and the installation of carbon adsorbers at the other facility. Since 2005, TCE concentrations and the associated risk had decreased at the Evansburg State Park site, most likely due to TCE emission reduction efforts by the nearest facility. However the Collegeville site in 2007 had the highest annual average concentration of TCE and associated risk to date, mainly due to one extraordinarily high sample.

The scope of the project was greatly expanded when the Environmental Protection Agency (EPA) awarded DEP a Local–Scale Ambient Air Monitoring grant in 2008. Additional activities that were conducted in 2008 due to this grant include: additional sampling sites, random sampling, installation of a gas chromatograph (GC) for near-real time measurements, four additional week-long intensive sampling events, and contracting a researcher for data analysis, risk assessment and modeling.

This third report provides details on the above activities and includes all data collected between 2005 and 2008. The major findings include:

- A statistically significant decreasing trend was observed in TCE concentrations from 2007 to 2008 at both the Collegeville and Evansburg SP sites. This is most likely a result of TCE emission reduction strategies that have been implemented at both facilities.
- Intensive sampling events conducted at the perimeter of each of the two major facilities at mostly downwind locations (areas where peak ambient TCE concentrations are expected to occur) yielded concentrations well under the acute- and intermediate-term minimum risk level (MRL) set by the Agency for Toxic Substances and Disease Registry.
- Results of random sampling were comparable to that of the regularly scheduled sampling conducted at all Collegeville monitoring sites in 2008.
- Excess lifetime cancer risk to residents in the Collegeville area is comparable to the risk found at other urban sites in the state where the DEP conducts monitoring.
- Modeling of TCE concentrations around the Accellent facility show the highest concentrations occurring at the facility perimeter. The highest modeled annual average TCE concentration in the modeling region was 4.6 ppbv which corresponds to an excess lifetime cancer risk of 28 in 10,000. The average modeled annual TCE concentration in the modeling region was 0.31 ppbv which corresponds to an excess lifetime cancer risk of 1.9 in 10,000. All modeled annual average TCE concentrations are below the non-cancer benchmark, therefore chronic non-cancer health effects are not expected. The maximum modeled daily (24-hour) average TCE concentration of 25.1 ppbv is well under the acute- and intermediate-term non-cancer benchmark.

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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 the 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 sampler was located in Evansburg State Park (Evansburg SP), the other sampler was located at the former YMCA on College Avenue in Trappe (referred to as the Trappe site). Sampling began on January 4, 2005 at both sites. 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 Collegeville area 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. 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.

In 2007, to expand on the sampling activities and evaluate the effect of the TCE emission reduction efforts that were occurring, DEP applied for and was eventually awarded a federal community scale grant from the Environmental Protection Agency (EPA). The grant allowed DEP to install a background monitoring site in Spring City, execute four additional intensive sampling studies during 2008, install a continuous gas chromatograph in the Trappe area to monitor emissions on a near real-time basis, and contract with an independent researcher to compile the study data, perform the data analysis, risk analysis and emissions modeling found in this report.

Monitoring

Since January 4, 2005, the DEP has collected air samples every sixth day, at at least two sites, in evacuated stainless steel canisters that are analyzed by the DEP laboratory for 55 VOCs. In 2008, random samples were collected on a monthly basis at each operating site. At various times, samples were missed due to equipment problems. Sampling was also suspended from September 25, 2005 to October 31, 2005 while the DEP 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 laboratory 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 through 2008 are summarized in a wind rose format in Appendix C.

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 Airport and Swarthmore. Figure 1 shows the locations of the DEP air toxic monitoring sites summarized in this report.

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.

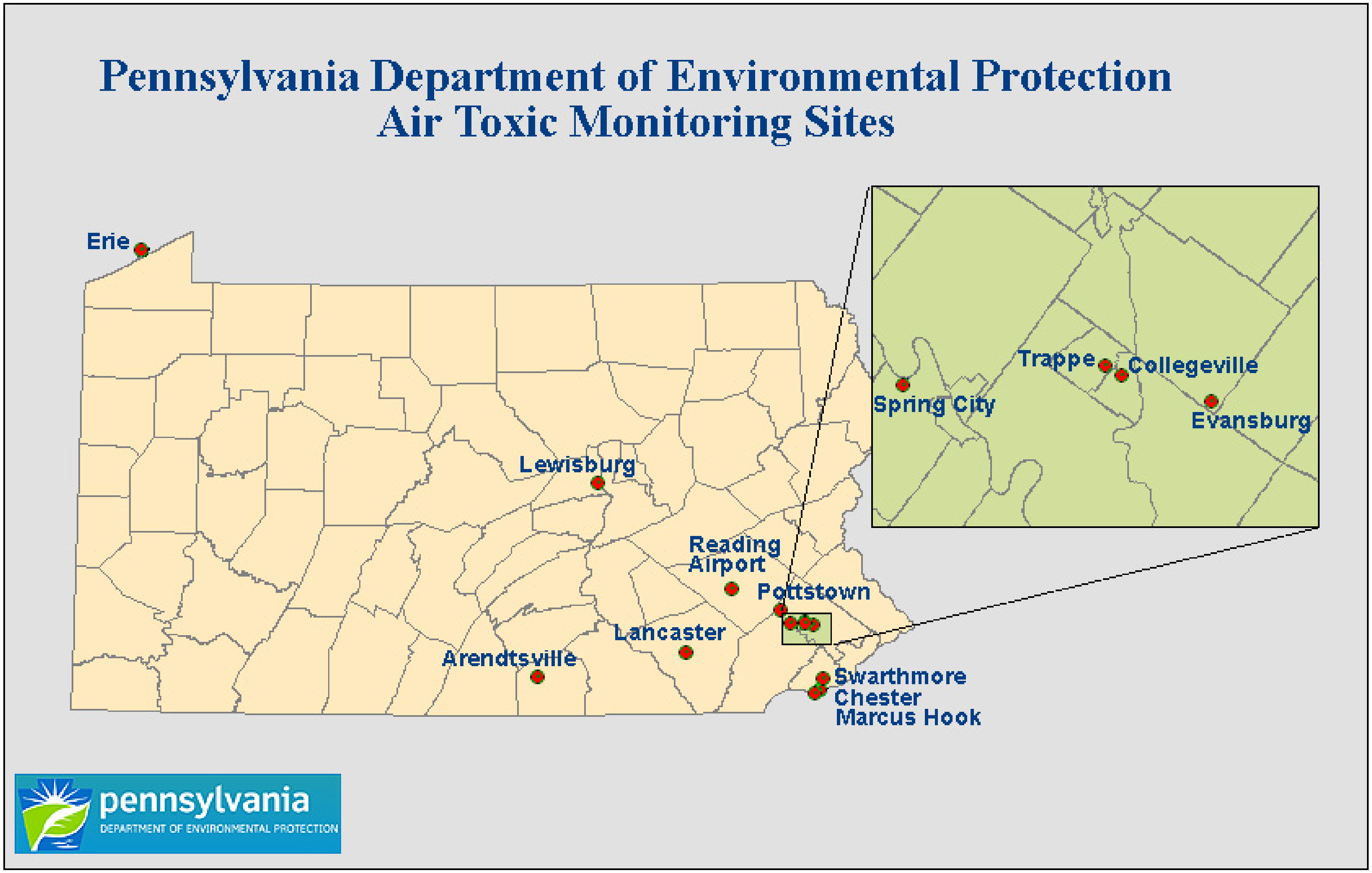

Figure 1. Map of air toxic monitoring sites in Pennsylvania referred to in this report.

Discussion of Monitoring Results

In summarizing the data, the annual average concentrations were calculated 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. (Please refer to 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 four 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 and decreased to 0.02 ppbv in 2008. Since the MDL was higher in 2007 than in other years, compounds with a large number of non-detects are likely to have a higher average in 2007 solely due to a higher MDL rather than an actual increase in the air concentration of the compound.

Tables 3a through 3d show the percent of the time each VOC was detected at each Pennsylvania air toxics site for the past four years. Thirteen VOCs were detected at all thirteen 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 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, DEP evaluated the health risks associated with breathing the measured concentrations of these pollutants using risk assessment methods used by EPA. 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 2008 for each Collegeville site and for comparison sites within the state.

Table 5 compares the Collegeville sites across sampling years in terms of mean and median TCE concentrations. In addition, a Mann-Whitney statistical test was performed to evaluate whether the TCE concentration in one year was significantly different from that of the previous year. A p-value less than 0.05, as listed in the 2008 Collegeville column (0.0009), indicates that the average TCE concentration in 2008 was significantly different from that obtained in 2007. In addition, TCE data from the Evansburg SP site was significantly different from the previous year in both 2008 and 2007. It should be noted that the average values in this table are slightly different from those presented in

Table 4 of this report. In order to perform a statistical analyses on the dataset all values below the MDL were omitted from the dataset. This was done since statistical analyses cannot be performed on data with a large number of values below the MDL.

In addition to the regularly scheduled sampling at the Collegeville site, a series of ten random samples were also collected during 2008 at each of the three Collegeville sites (Evansburg SP, Collegeville, and Spring City). The random samples are those samples that fall on these dates: 3/24/08, 4/8/08, 5/7/08, 6/10/08, 7/18/08, 8/6/08, 9/12/08, 10/2/08, 11/17/08, and 12/15/08. The results of the random sampling were comparable to that of the regularly scheduled sampling conducted in 2008 (data not shown). For example, the mean TCE concentration at the Collegeville site was 0.092 ppbv for the regular scheduled sampling and was 0.095 ppbv for the random sampling events. Similar results were obtained for the other sites.

A total of five intensive sampling efforts occurred within the Collegeville area in 2007 and 2008. These efforts involved the use of 24-hour canister sampling across three or four separate days during the months of October 2007, and February, May, August and November of 2008. A summary of the results is provided in Table 6. While all 55 VOCs were collected and quantified, only the TCE data is presented in this report. As expected, there were considerable differences between the TCE concentrations across sites and sampling periods. The average TCE concentration for the 2007 sampling effort was much higher (1.15 ppbv) than that obtained for any of the 2008 intensive sampling events (range = 0.1 to 0.29 ppbv). This is most likely due to the low number of samples collected in 2007 and an unusually high value (7.2 ppbv) obtained during this sampling period which skewed the overall average. Please note that the concentrations of TCE found during the intensives are expected to be higher than concentrations at the permanent sites due to the fact that the intensive sampling was, for the most part, conducted directly downwind. Appendix D contains maps delineating the sampling locations and summarizes the data for each of the five intensive sampling efforts.

A second sampler was collocated at the Collegeville site (Ursinus College) and began operation on March 7, 2008 operating simultaneously with the original sampler that had been installed in 2007. An analysis of the data collected from each sampler was performed to evaluate whether the measurements from each sampler were comparable. Data for a total of 17 compounds were included in this analysis. Overall, the results showed that while there was variation between the individual measurements at each site the average values for each of the 17 compounds were comparable and not found to be statistically different. Refer to Appendix E for the full technical report.

A trend analysis was conducted on the TCE data collected at the Collegeville and Evansburg SP sampling sites to determine whether there was an upward or downward trend across time. This analysis showed a statistically significant decrease in TCE concentrations over time at both sampling sites. Refer to Appendix F for the full technical report.

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

Compound*	2005 MDL (ppbv)	2006 MDL (ppbv)	2007 MDL (ppbv)	2008 MDL (ppbv)
1,3-Butadiene	0.04	0.04	0.18	0.08
1,2-Dibromoethane	0.04	0.04	0.06	0.04
cis-1,3-Dichloro-1-propene	0.02	0.04	0.04	0.04
trans-1,3-Dichloro-1-propene	0.02	0.04	0.04	0.04
1,2-Dichloro-1,1,2,2-tetrafluoroethane	0.04	0.04	0.04	0.02
1,2-Dichlorobenzene	0.16	0.04	0.04	0.02
1,3-Dichlorobenzene	0.14	0.04	0.04	0.02
1,4-Dichlorobenzene	0.14	0.04	0.04	0.02
1,1-Dichloroethane	0.04	0.04	0.04	0.02
1,2-Dichloroethane	0.04	0.04	0.06	0.02
1,1-Dichloroethene	0.04	0.04	0.06	0.04
cis-1,2-Dichloroethene	0.04	0.08	0.06	0.04
trans-1,2-Dichloroethene	0.04	0.04	0.10	0.04
1,2-Dichloropropane	0.04	0.04	0.06	0.04
1-Ethyl-4-methyl benzene	0.16	0.04	0.04	0.02
1,1,2,2-Tetrachloroethane	0.14	0.04	0.04	0.02
1,1,2-Trichloro-1,2,2-trifluoroethane	0.04	0.04	0.04	0.02
1,2,4-Trichlorobenzene	0.20	0.06	0.06	0.02
1,1,1-Trichloroethane	0.04	0.04	0.04	0.02
1,1,2-Trichloroethane	0.04	0.04	0.06	0.04
1,2,4-Trimethylbenzene	0.14	0.04	0.04	0.02
1,3,5-Trimethylbenzene	0.14	0.04	0.04	0.02
2-Butanone	0.16	0.06	0.14	0.22
2-Hexanone	0.38	0.08	0.14	0.20
2-Methoxy-2-methyl propane	0.04	0.04	0.04	0.02
4-Methyl-2-pentanone	0.88	0.04	0.18	0.22
Acetone	0.14	0.06	0.14	0.21
Benzene	0.04	0.04	0.06	0.04
Bromodichloromethane	0.04	0.04	0.06	0.04
Bromoform	0.02	0.04	0.04	0.02
Bromomethane	0.04	0.04	0.06	0.04
Carbon disulfide	0.04	0.04	0.08	0.20
Carbon tetrachloride	0.04	0.06	0.04	0.02
Chlorobenzene	0.04	0.04	0.06	0.04
Chloroethane	0.04	0.04	0.06	0.04
Chloroethene	0.04	0.04	0.06	0.04
Chloroform	0.04	0.04	0.06	0.02

Table 2. (continued).

Compound*	2005 MDL (ppbv)	2006 MDL (ppbv)	2007 MDL (ppbv)	2008 MDL (ppbv)
Chloromethane	0.04	0.04	0.06	0.04
Cyclohexane	0.04	0.04	0.04	0.02
Dibromochloromethane	0.04	0.04	0.06	0.04
Dichlorodifluoromethane	0.04	0.04	0.04	0.02
Ethylbenzene	0.04	0.04	0.04	0.04
n-Heptane	0.04	0.04	0.04	0.02
Hexachloro-1,3-butadiene	0.12	0.04	0.04	0.02
n-Hexane	0.04	0.04	0.04	0.02
Methylene chloride	0.04	0.04	0.08	0.04
Propene	0.16	0.04	0.06	0.20
Styrene	0.02	0.04	0.04	0.02
Tetrachloroethene	0.04	0.04	0.06	0.04
Tetrahydrofuran	0.04	0.04	0.04	0.02
Toluene	0.04	0.04	0.06	0.04
Trichloroethylene (TCE)	0.04	0.04	0.06	0.02
Trichlorofluoromethane	0.04	0.04	0.04	0.02
m & p- Xylene	0.06	0.08	0.10	0.06
o-Xylene	0.04	0.04	0.04	0.04

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

Compound	Collegeville	Evansburg SP	Spring City	Trappe	Arendtsville	Chester	Erie	Lancaster	Lewisburg	Marcus Hook	Pottstown	Reading Airport	Swarthmore
1,3-Butadiene	-	0	-	5	0	0	0	0	7	0	49	-	0
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	-	0	0	6	0	0	0	4	0	-	0
1,1-Dichloroethane	-	0	-	0	0	0	0	0	0	0	0	-	0
1,2-Dichloroethane	-	0	-	0	0	3	0	0	0	4	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	-	2	0	6	0	10	7	21	5	-	0
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	-	0	0	100	0	0	0	0	0	-	0
1,1,2-Trichloroethane	-	0	-	0	0	0	0	0	0	0	0	-	0
1,2,4-Trimethylbenzene	-	10	-	30	0	44	10	46	27	75	34	-	19
1,3,5-Trimethylbenzene	-	10	-	5	2	29	3	17	13	25	32	-	11
2-Butanone	-	98	-	100	100	100	97	98	100	100	100	-	100
2-Hexanone	-	5	-	3	20	3	0	0	0	4	0	-	0
2-Methoxy-2-methyl propane	-	86	-	91	36	97	0	49	23	100	95	-	96
4-Methyl-2-pentanone	-	4	-	5	10	0	0	2	0	7	2	-	4
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	-	2	-	5	0	6	0	0	0	11	0	-	7
Carbon disulfide	-	24	-	39	21	29	10	15	33	29	37	-	41
Carbon tetrachloride	-	100	-	100	100	100	100	100	100	100	100	-	100
Chlorobenzene	-	0	-	0	0	0	0	100	0	4	0	-	0
Chloroethane	-	12	-	7	43	18	0	0	0	21	0	-	7
Chloroethene	-	2	-	0	0	6	0	0	0	7	2	-	0
Chloroform	-	0	-	0	0	0	3	5	0	0	2	-	0

Table 3a. (continued).

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

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

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

Table 3b. (continued).

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

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

Compound	Collegeville	Evansburg SP	Spring City	Trappe	Arendtsville	Chester	Erie	Lancaster	Lewisburg	Marcus Hook	Pottstown	Reading Airport	Swarthmore
1,3-Butadiene	3	0	-	0	0	0	0	0	0	0	-	0	0
1,2-Dibromoethane	0	0	-	0	0	0	0	0	0	3	-	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	0	-	0	0	5	0	0	0	0	-	0	0
1,1-Dichloroethane	0	0	-	0	0	0	0	0	0	0	-	0	0
1,2-Dichloroethane	0	0	-	0	0	5	0	0	0	3	-	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	0	-	0	0	5	0	6	0	23	-	4	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	0	-	0	0	100	0	0	0	3	-	0	0
1,1,2-Trichloroethane	0	0	-	0	0	0	0	0	0	0	-	0	0
1,2,4-Trimethylbenzene	61	12	-	14	2	39	8	55	32	68	-	56	17
1,3,5-Trimethylbenzene	0	2	-	0	0	13	0	9	2	29	-	12	0
2-Butanone	100	100	-	100	100	100	97	98	100	100	-	100	100
2-Hexanone	23	17	-	5	9	11	0	6	0	16	-	12	9
2-Methoxy-2-methyl propane	3	0	-	0	0	3	0	0	0	3	-	0	0
4-Methyl-2-pentanone	26	8	-	10	5	5	0	2	0	10	-	12	6
Acetone	100	100	-	100	100	100	100	100	100	100	-	100	100
Benzene	100	100	-	100	98	100	89	100	100	100	-	96	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	0	-	0	0	3	3	0	0	6	-	0	0
Carbon disulfide	61	37	-	38	36	11	11	21	49	19	-	32	26
Carbon tetrachloride	100	100	-	100	100	97	97	98	100	100	-	100	100
Chlorobenzene	0	0	-	0	0	3	0	0	0	0	-	0	0
Chloroethane	16	13	-	24	55	24	0	0	0	10	-	0	0
Chloroethene	0	0	-	0	0	3	0	0	0	3	-	0	0
Chloroform	0	0	-	0	0	0	0	2	0	0	-	0	0

Table 3c. (continued).

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

Table 3d. Percentage of 2008 samples where compound concentrations were above the Method Detection Limit.

Compound	Collegeville	Evansburg SP	Spring City	Trappe	Arendtsville	Chester	Erie	Lancaster	Lewisburg	Marcus Hook	Pottstown	Reading Airport	Swarthmore
1,3-Butadiene	2	4	3	-	0	0	0	0	0	0	-	0	0
1,2-Dibromoethane	0	0	0	-	0	0	3	0	0	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	3	-	0	0
1,2-Dichloro-1,1,2,2,tetrafluoroethane	2	0	0	-	0	3	3	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	0	3	-	0	11	0	0	0	7	-	2	0
1,1-Dichloroethane	0	0	0	-	0	0	0	0	0	0	-	0	0
1,2-Dichloroethane	2	0	0	-	2	23	3	0	0	7	-	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	2	0	0	-	0	0	0	0	0	0	-	0	0
1,2-Dichloropropane	3	0	0	-	0	0	0	0	0	0	-	0	0
1-Ethyl-4-methyl benzene	2	4	6	-	0	11	3	4	17	23	-	4	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	4	0	0	-	0	0
1,1,1-Trichloroethane	2	0	0	-	0	94	6	0	0	0	-	0	3
1,1,2-Trichloroethane	0	0	0	-	0	0	3	0	0	0	-	0	0
1,2,4-Trimethylbenzene	17	4	44	-	0	57	3	33	60	87	-	27	24
1,3,5-Trimethylbenzene	2	2	0	-	0	11	0	11	20	10	-	2	3
2-Butanone	100	100	100	-	98	100	89	96	100	100	-	96	100
2-Hexanone	20	18	32	-	21	11	11	0	3	13	-	16	13
2-Methoxy-2-methyl propane	0	0	0	-	0	0	0	0	0	0	-	0	0
4-Methyl-2-pentanone	14	5	26	-	11	3	0	0	3	10	-	8	8
Acetone	100	100	100	-	98	100	100	100	100	100	-	100	100
Benzene	100	100	100	-	100	100	100	100	100	100	-	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	2	2	3	-	0	6	0	0	0	7	-	0	5
Carbon disulfide	8	4	3	-	7	20	3	4	3	7	-	4	0
Carbon tetrachloride	100	100	100	-	100	100	100	100	100	100	-	100	100
Chlorobenzene	0	0	0	-	2	0	8	89	3	0	-	0	0
Chloroethane	52	24	41	-	61	26	0	0	10	7	-	6	18
Chloroethene	0	0	0	-	0	0	0	0	0	3	-	0	0
Chloroform	24	36	15	-	0	43	6	26	20	37	-	18	47

Table 3d. (continued).

Compound	Collegeville	Evansburg SP	Spring City	Trappe	Arendtsville	Chester	Erie	Lancaster	Lewisburg	Marcus Hook	Pottstown	Reading Airport	Swarthmore
Chloromethane	100	100	100	-	100	100	100	100	100	100	-	100	100
Cyclohexane	29	15	9	-	2	69	3	19	10	90	-	27	53
Dibromochloromethane	0	0	0	-	0	0	3	0	0	0	-	0	0
Dichlorodifluoromethane	100	100	100	-	100	100	100	100	100	100	-	100	100
Ethylbenzene	38	15	29	-	8	74	11	44	43	83	-	45	34
n-Heptane	80	82	71	-	42	97	42	100	83	90	-	71	82
Hexachloro-1,3-butadiene	0	0	0	-	0	0	0	0	0	0	-	0	0
n-Hexane	85	89	88	-	50	94	78	100	87	90	-	90	95
Methylene chloride	89	91	91	-	46	91	61	85	90	80	-	88	97
Propene	100	95	100	-	98	94	92	100	97	93	-	96	100
Styrene	0	2	59	-	0	20	14	11	30	13	-	4	5
Tetrachloroethene	26	13	12	-	0	23	6	15	10	20	-	6	34
Tetrahydrofuran	17	35	18	-	4	91	0	0	7	33	-	0	16
Toluene	100	100	100	-	76	100	92	100	97	100	-	100	100
Trichloroethylene (TCE)	77	38	41	-	3	34	8	11	50	7	-	35	16
Trichlorofluoromethane	100	100	100	-	100	100	100	100	100	100	-	100	100
m & p- Xylene	61	55	65	-	31	94	31	70	87	100	-	65	63
o-Xylene	44	27	38	-	8	66	11	52	47	90	-	43	39
Number of Compounds Detected	**35**	**31**	**31**	**-**	**25**	**34**	**32**	**27**	**30**	**34**	**-**	**29**	**29**

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

	Collegeville				Evansburg SP				Spring City			
	Annual Avg (ppbv)[1]				Annual Avg (ppbv)[1]				Annual Avg (ppbv)[1]			
Compound	**2005**	**2006**	**2007**	**2008**	**2005**	**2006**	**2007**	**2008**	**2005**	**2006**	**2007**	**2008**
1,3-Butadiene	-	-	0.09	0.04	0.02	0.02	0.09	0.05	-	-	-	0.04
1,2-Dibromoethane	-	-	0.03	0.02	0.02	0.02	0.03	0.02	-	-	-	0.02
cis-1,3-Dichloro-1-propene	-	-	0.02	0.02	0.01	0.02	0.02	0.02	-	-	-	0.02
trans-1,3-Dichloro-1-propene	-	-	0.02	0.02	0.01	0.02	0.02	0.02	-	-	-	0.02
1,2-Dichloro-1,1,2,2-tetrafluoroethane	-	-	0.02	0.01	0.02	0.02	0.02	0.01	-	-	-	0.01
1,2-Dichlorobenzene	-	-	0.02	0.01	0.08	0.02	0.02	0.01	-	-	-	0.01
1,3-Dichlorobenzene	-	-	0.02	0.01	0.07	0.02	0.02	0.01	-	-	-	0.01
1,4-Dichlorobenzene	-	-	0.02	0.01	0.07	0.02	0.02	0.01	-	-	-	0.01
1,1-Dichloroethane	-	-	0.02	0.01	0.02	0.02	0.02	0.01	-	-	-	0.01
1,2-Dichloroethane	-	-	0.03	0.01	0.02	0.02	0.03	0.01	-	-	-	0.01
1,1-Dichloroethene	-	-	0.03	0.02	0.02	0.02	0.03	0.02	-	-	-	0.02
cis-1,2-Dichloroethene	-	-	0.03	0.02	0.02	0.04	0.03	0.02	-	-	-	0.02
trans-1,2-Dichloroethene	-	-	0.05	0.02	0.02	0.02	0.05	0.02	-	-	-	0.02
1,2-Dichloropropane	-	-	0.03	0.02	0.02	0.02	0.03	0.02	-	-	-	0.02
1-Ethyl-4-methyl benzene	-	-	0.02	0.01	0.08	0.02	0.02	0.01	-	-	-	0.01
1,1,2,2-Tetrachloroethane	-	-	0.02	0.01	0.07	0.02	0.02	0.01	-	-	-	0.01
1,1,2-Trichloro-1,2,2-trifluoroethane	-	-	0.07	0.07	0.06	0.06	0.06	0.07	-	-	-	0.07
1,2,4-Trichlorobenzene	-	-	0.03	0.01	0.10	0.03	0.03	0.01	-	-	-	0.01
1,1,1-Trichloroethane	-	-	0.02	0.01	0.02	0.02	0.02	0.01	-	-	-	0.01
1,1,2-Trichloroethane	-	-	0.03	0.02	0.02	0.02	0.03	0.02	-	-	-	0.02
1,2,4-Trimethylbenzene	-	-	0.04	0.02	0.07	0.02	0.02	0.01	-	-	-	0.03
1,3,5-Trimethylbenzene	-	-	0.02	0.01	0.07	0.02	0.02	0.01	-	-	-	0.01
2-Butanone	-	-	1.57	1.46	1.16	1.06	1.08	1.34	-	-	-	1.59
2-Hexanone	-	-	0.19	0.26	0.20	0.10	0.16	0.23	-	-	-	0.47
2-Methoxy-2-methyl propane	-	-	0.02	0.01	0.21	0.07	0.02	0.01	-	-	-	0.01
4-Methyl-2-pentanone	-	-	0.13	0.14	0.44	0.03	0.10	0.14	-	-	-	0.19
Acetone	-	-	9.27	10.53	5.96	6.23	6.05	9.09	-	-	-	12.11
Benzene	-	-	0.19	0.17	0.18	0.15	0.16	0.16	-	-	-	0.18
Bromodichloromethane	-	-	0.03	0.02	0.02	0.02	0.03	0.02	-	-	-	0.02
Bromoform	-	-	0.02	0.01	0.01	0.02	0.02	0.01	-	-	-	0.01
Bromomethane	-	-	0.03	0.02	0.02	0.02	0.03	0.02	-	-	-	0.02
Carbon disulfide	-	-	0.19	0.14	0.04	0.22	0.13	0.11	-	-	-	0.11
Carbon tetrachloride	-	-	0.08	0.08	0.09	0.08	0.09	0.09	-	-	-	0.08
Chlorobenzene	-	-	0.03	0.02	0.02	0.02	0.03	0.02	-	-	-	0.02
Chloroethane	-	-	0.04	0.05	0.03	0.02	0.04	0.03	-	-	-	0.04
Chloroethene	-	-	0.03	0.02	0.02	0.02	0.03	0.02	-	-	-	0.02
Chloroform	-	-	0.03	0.01	0.02	0.02	0.03	0.02	-	-	-	0.01

Table 4. (continued).

Compound	Collegeville				Evansburg SP				Spring City			
	Annual Avg (ppbv)[1]				Annual Avg (ppbv)[1]				Annual Avg (ppbv)[1]			
	2005	2006	2007	2008	2005	2006	2007	2008	2005	2006	2007	2008
Chloromethane	-	-	0.44	0.49	0.48	0.43	0.46	0.51	-	-	-	0.49
Cyclohexane	-	-	0.03	0.02	0.02	0.02	0.02	0.01	-	-	-	0.01
Dibromochloromethane	-	-	0.03	0.02	0.02	0.02	0.03	0.02	-	-	-	0.02
Dichlorodifluoromethane	-	-	0.43	0.46	0.43	0.43	0.44	0.47	-	-	-	0.45
Ethylbenzene	-	-	0.04	0.03	0.03	0.03	0.02	0.03	-	-	-	0.03
n-Heptane	-	-	0.09	0.08	0.07	0.05	0.08	0.06	-	-	-	0.05
Hexachloro-1,3-butadiene	-	-	0.02	0.01	0.06	0.02	0.02	0.01	-	-	-	0.01
n-Hexane	-	-	0.13	0.13	0.11	0.08	0.09	0.09	-	-	-	0.10
Methylene chloride	-	-	0.09	0.09	0.07	0.08	0.16	0.14	-	-	-	0.08
Propene	-	-	1.16	1.03	1.01	0.96	0.99	0.93	-	-	-	1.18
Styrene	-	-	0.02	0.01	0.01	0.02	0.02	0.01	-	-	-	0.06
Tetrachloroethene	-	-	0.03	0.04	0.02	0.02	0.03	0.02	-	-	-	0.02
Tetrahydrofuran	-	-	0.02	0.03	0.02	0.02	0.05	0.04	-	-	-	0.02
Toluene	-	-	0.29	0.29	0.34	0.29	0.28	0.28	-	-	-	0.26
Trichloroethylene (TCE)	-	-	0.75	0.09	0.14	0.12	0.07	0.03	-	-	-	0.03
Trichlorofluoromethane	-	-	0.34	0.32	0.21	0.21	0.25	0.25	-	-	-	0.24
m & p- Xylene	-	-	0.12	0.09	0.07	0.06	0.07	0.07	-	-	-	0.09
o-Xylene	-	-	0.05	0.04	0.03	0.03	0.02	0.03	-	-	-	0.04

Table 4. (continued).

Compound	Trappe				Arendtsville				Chester			
	Annual Avg (ppbv)[1]				Annual Avg (ppbv)[1]				Annual Avg (ppbv)[1]			
	2005	2006	2007	2008	2005	2006	2007	2008	2005	2006	2007	2008
1,3-Butadiene	0.03	0.03	0.09	-	0.02	0.02	0.09	0.04	0.02	0.02	0.09	0.04
1,2-Dibromoethane	0.02	0.02	0.03	-	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02
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	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	0.02
1,2-Dichloro-1,1,2,2-tetrafluoroethane	0.02	0.02	0.02	-	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.01
1,2-Dichlorobenzene	0.08	0.02	0.02	-	0.08	0.02	0.02	0.01	0.08	0.02	0.02	0.01
1,3-Dichlorobenzene	0.07	0.02	0.02	-	0.07	0.02	0.02	0.01	0.07	0.02	0.02	0.01
1,4-Dichlorobenzene	0.07	0.02	0.02	-	0.07	0.02	0.02	0.01	0.07	0.02	0.02	0.01
1,1-Dichloroethane	0.02	0.02	0.02	-	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.01
1,2-Dichloroethane	0.02	0.02	0.03	-	0.02	0.02	0.03	0.01	0.02	0.02	0.05	0.08
1,1-Dichloroethene	0.02	0.02	0.03	-	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02
cis-1,2-Dichloroethene	0.02	0.04	0.03	-	0.02	0.04	0.03	0.02	0.02	0.04	0.03	0.02
trans-1,2-Dichloroethene	0.02	0.02	0.05	-	0.02	0.02	0.05	0.02	0.02	0.02	0.05	0.02
1,2-Dichloropropane	0.02	0.02	0.03	-	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02
1-Ethyl-4-methyl benzene	0.08	0.02	0.02	-	0.08	0.02	0.02	0.01	0.08	0.02	0.02	0.01
1,1,2,2-Tetrachloroethane	0.07	0.02	0.02	-	0.07	0.02	0.02	0.01	0.07	0.02	0.02	0.01
1,1,2-Trichloro-1,2,2-trifluoroethane	0.06	0.06	0.06	-	0.06	0.07	0.07	0.07	0.08	0.08	0.08	0.12
1,2,4-Trichlorobenzene	0.10	0.03	0.03	-	0.10	0.03	0.03	0.01	0.10	0.03	0.03	0.01
1,1,1-Trichloroethane	0.02	0.02	0.02	-	0.02	0.02	0.02	0.01	0.10	0.11	0.15	0.37
1,1,2-Trichloroethane	0.02	0.02	0.03	-	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02
1,2,4-Trimethylbenzene	0.08	0.02	0.02	-	0.07	0.02	0.02	0.01	0.07	0.04	0.04	0.04
1,3,5-Trimethylbenzene	0.07	0.02	0.02	-	0.07	0.02	0.02	0.01	0.07	0.03	0.03	0.02
2-Butanone	0.99	0.73	1.12	-	1.28	0.91	1.06	1.69	2.02	1.85	2.11	3.82
2-Hexanone	0.19	0.05	0.13	-	0.27	0.05	0.12	0.30	0.19	0.04	0.11	0.15
2-Methoxy-2-methyl propane	0.27	0.10	0.02	-	0.04	0.03	0.02	0.01	0.55	0.21	0.02	0.01
4-Methyl-2-pentanone	0.44	0.02	0.10	-	0.44	0.04	0.10	0.16	0.44	0.02	0.11	0.12
Acetone	7.05	7.46	6.31	-	7.89	7.33	7.73	12.69	5.54	5.32	6.22	10.27
Benzene	0.23	0.20	0.19	-	0.14	0.13	0.14	0.15	0.27	0.23	0.28	0.25
Bromodichloromethane	0.02	0.02	0.03	-	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02
Bromoform	0.01	0.02	0.02	-	0.01	0.02	0.02	0.01	0.01	0.02	0.02	0.01
Bromomethane	0.02	0.02	0.03	-	0.02	0.02	0.03	0.02	0.04	0.02	0.04	0.02
Carbon disulfide	0.05	0.13	0.28	-	0.04	0.41	0.11	0.12	0.04	0.08	0.07	0.14
Carbon tetrachloride	0.09	0.08	0.11	-	0.08	0.08	0.09	0.09	0.07	0.08	0.09	0.08
Chlorobenzene	0.02	0.02	0.03	-	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02
Chloroethane	0.02	0.03	0.04	-	0.04	0.05	0.08	0.07	0.03	0.05	0.06	0.07
Chloroethene	0.02	0.02	0.03	-	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02
Chloroform	0.02	0.02	0.03	-	0.02	0.02	0.03	0.01	0.02	0.02	0.03	0.02

Table 4. (continued).

	Trappe				Arendtsville				Chester			
	Annual Avg (ppbv)[1]				Annual Avg (ppbv)[1]				Annual Avg (ppbv)[1]			
Compound	**2005**	**2006**	**2007**	**2008**	**2005**	**2006**	**2007**	**2008**	**2005**	**2006**	**2007**	**2008**
Chloromethane	0.47	0.45	0.48	-	0.54	0.46	0.46	0.50	0.48	0.46	0.47	0.50
Cyclohexane	0.03	0.03	0.02	-	0.02	0.02	0.02	0.01	0.05	0.08	0.05	0.03
Dibromochloromethane	0.02	0.02	0.03	-	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02
Dichlorodifluoromethane	0.43	0.44	0.44	-	0.43	0.43	0.43	0.46	0.43	0.43	0.43	0.46
Ethylbenzene	0.04	0.04	0.03	-	0.02	0.02	0.02	0.03	0.05	0.05	0.04	0.05
n-Heptane	0.07	0.08	0.06	-	0.03	0.04	0.07	0.06	0.16	0.18	0.20	0.13
Hexachloro-1,3-butadiene	0.06	0.02	0.02	-	0.06	0.02	0.02	0.01	0.06	0.02	0.02	0.01
n-Hexane	0.14	0.10	0.10	-	0.05	0.04	0.06	0.09	0.21	0.25	0.26	0.19
Methylene chloride	0.06	0.08	0.07	-	0.03	0.04	0.04	0.04	0.08	0.07	0.06	0.07
Propene	1.13	1.29	1.18	-	0.68	0.61	0.72	1.09	3.23	2.76	2.46	2.78
Styrene	0.01	0.02	0.02	-	0.01	0.02	0.02	0.01	0.01	0.02	0.02	0.02
Tetrachloroethene	0.03	0.03	0.03	-	0.02	0.02	0.03	0.02	0.04	0.04	0.03	0.03
Tetrahydrofuran	0.02	0.02	0.02	-	0.02	0.02	0.02	0.01	0.90	0.80	1.10	2.12
Toluene	0.37	0.30	0.21	-	0.09	0.12	0.12	0.11	0.51	0.69	0.63	0.58
Trichloroethylene (TCE)	0.26	0.22	0.25	-	0.02	0.02	0.03	0.01	0.03	0.03	0.06	0.04
Trichlorofluoromethane	0.22	0.21	0.27	-	0.21	0.21	0.25	0.24	0.22	0.22	0.25	0.25
m & p- Xylene	0.15	0.13	0.07	-	0.03	0.04	0.05	0.08	0.16	0.14	0.12	0.15
o-Xylene	0.07	0.06	0.03	-	0.02	0.02	0.02	0.03	0.05	0.05	0.04	0.05

Table 4. (continued).

Compound	Erie				Lancaster				Lewisburg			
	Annual Avg (ppbv)[1]				Annual Avg (ppbv)[1]				Annual Avg (ppbv)[1]			
	2005	2006	2007	2008	2005	2006	2007	2008	2005	2006	2007	2008
1,3-Butadiene	0.02	0.02	0.09	0.04	0.02	0.02	0.09	0.04	0.03	0.04	0.09	0.04
1,2-Dibromoethane	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02
cis-1,3-Dichloro-1-propene	0.01	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.01	0.02	0.02	0.02
trans-1,3-Dichloro-1-propene	0.01	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.01	0.02	0.02	0.02
1,2-Dichloro-1,1,2,2-tetrafluoroethane	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.01
1,2-Dichlorobenzene	0.08	0.02	0.02	0.01	0.08	0.02	0.02	0.01	0.08	0.02	0.02	0.01
1,3-Dichlorobenzene	0.07	0.02	0.02	0.01	0.07	0.02	0.02	0.01	0.07	0.02	0.02	0.01
1,4-Dichlorobenzene	0.07	0.02	0.02	0.01	0.07	0.02	0.02	0.01	0.07	0.02	0.02	0.01
1,1-Dichloroethane	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.01
1,2-Dichloroethane	0.02	0.02	0.03	0.01	0.02	0.02	0.03	0.01	0.02	0.02	0.03	0.01
1,1-Dichloroethene	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02
cis-1,2-Dichloroethene	0.02	0.04	0.03	0.02	0.02	0.04	0.03	0.02	0.02	0.04	0.03	0.02
trans-1,2-Dichloroethene	0.02	0.02	0.05	0.02	0.02	0.02	0.05	0.02	0.02	0.02	0.05	0.02
1,2-Dichloropropane	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02
1-Ethyl-4-methyl benzene	0.08	0.02	0.02	0.01	0.09	0.02	0.02	0.01	0.08	0.03	0.02	0.02
1,1,2,2-Tetrachloroethane	0.07	0.02	0.02	0.01	0.07	0.02	0.02	0.01	0.07	0.02	0.02	0.01
1,1,2-Trichloro-1,2,2-trifluoroethane	0.06	0.06	0.06	0.07	0.06	0.06	0.06	0.07	0.06	0.06	0.06	0.09
1,2,4-Trichlorobenzene	0.10	0.03	0.03	0.01	0.10	0.03	0.03	0.01	0.10	0.03	0.03	0.01
1,1,1-Trichloroethane	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.01
1,1,2-Trichloroethane	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02
1,2,4-Trimethylbenzene	0.07	0.02	0.02	0.01	0.12	0.04	0.05	0.03	0.07	0.08	0.03	0.06
1,3,5-Trimethylbenzene	0.07	0.02	0.02	0.01	0.08	0.02	0.03	0.02	0.07	0.04	0.02	0.04
2-Butanone	0.41	0.36	0.46	0.50	0.40	0.40	0.55	0.65	0.78	0.78	0.66	0.97
2-Hexanone	0.19	0.04	0.07	0.12	0.19	0.04	0.08	0.10	0.19	0.04	0.07	0.14
2-Methoxy-2-methyl propane	0.02	0.02	0.02	0.01	0.06	0.03	0.02	0.01	0.03	0.03	0.02	0.01
4-Methyl-2-pentanone	0.44	0.02	0.09	0.11	0.44	0.02	0.09	0.11	0.44	0.05	0.09	0.12
Acetone	2.72	2.87	3.21	3.54	2.65	3.09	4.09	4.36	5.27	7.11	5.50	7.81
Benzene	0.18	0.16	0.19	0.20	0.30	0.27	0.26	0.27	0.24	0.19	0.16	0.20
Bromodichloromethane	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02
Bromoform	0.01	0.02	0.02	0.01	0.01	0.02	0.02	0.01	0.01	0.02	0.02	0.01
Bromomethane	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02
Carbon disulfide	0.02	0.05	0.08	0.11	0.03	0.09	0.09	0.10	0.04	0.39	0.20	0.10
Carbon tetrachloride	0.08	0.08	0.09	0.08	0.09	0.08	0.08	0.08	0.09	0.08	0.08	0.09
Chlorobenzene	0.02	0.02	0.03	0.03	0.08	0.06	0.03	0.06	0.02	0.02	0.03	0.02
Chloroethane	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02
Chloroethene	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02
Chloroform	0.02	0.02	0.03	0.01	0.02	0.02	0.03	0.01	0.02	0.02	0.03	0.01

Table 4. (continued).

	Erie				Lancaster				Lewisburg			
	Annual Avg (ppbv)[1]				Annual Avg (ppbv)[1]				Annual Avg (ppbv)[1]			
Compound	**2005**	**2006**	**2007**	**2008**	**2005**	**2006**	**2007**	**2008**	**2005**	**2006**	**2007**	**2008**
Chloromethane	0.48	0.45	0.46	0.50	0.49	0.48	0.48	0.49	0.44	0.45	0.47	0.49
Cyclohexane	0.02	0.02	0.02	0.01	0.03	0.02	0.03	0.02	0.03	0.02	0.02	0.01
Dibromochloromethane	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02
Dichlorodifluoromethane	0.43	0.43	0.44	0.46	0.43	0.44	0.44	0.45	0.44	0.46	0.45	0.48
Ethylbenzene	0.03	0.02	0.02	0.03	0.06	0.06	0.05	0.05	0.06	0.04	0.03	0.04
n-Heptane	0.03	0.02	0.03	0.02	0.07	0.06	0.08	0.09	0.06	0.08	0.06	0.08
Hexachloro-1,3-butadiene	0.06	0.02	0.02	0.01	0.06	0.02	0.02	0.01	0.06	0.02	0.02	0.01
n-Hexane	0.09	0.05	0.07	0.09	0.15	0.14	0.14	0.15	0.09	0.08	0.07	0.08
Methylene chloride	0.04	0.04	0.07	0.05	0.08	0.09	0.10	0.09	0.06	0.06	0.05	0.09
Propene	0.43	0.35	0.52	0.45	1.13	1.13	1.00	1.10	0.87	0.91	0.77	0.95
Styrene	0.01	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.09	0.05	0.04	0.03
Tetrachloroethene	0.05	0.02	0.03	0.02	0.02	0.02	0.03	0.03	0.02	0.02	0.03	0.02
Tetrahydrofuran	0.02	0.02	0.02	0.01	0.08	0.02	0.02	0.01	0.06	0.04	0.02	0.01
Toluene	0.19	0.13	0.13	0.12	0.58	0.69	0.69	0.60	0.33	0.34	0.31	0.26
Trichloroethylene (TCE)	0.02	0.02	0.03	0.01	0.02	0.02	0.03	0.02	0.02	0.03	0.04	0.03
Trichlorofluoromethane	0.21	0.21	0.25	0.24	0.22	0.23	0.29	0.26	0.22	0.22	0.26	0.25
m & p- Xylene	0.07	0.05	0.06	0.05	0.20	0.19	0.17	0.14	0.22	0.14	0.10	0.13
o-Xylene	0.03	0.02	0.02	0.02	0.07	0.07	0.06	0.05	0.07	0.05	0.03	0.04

Table 4. (continued).

	Marcus Hook				Pottstown				Reading Airport				Swarthmore			
	Annual Avg (ppbv)[1]				Annual Avg (ppbv)[1]				Annual Avg (ppbv)[1]				Annual Avg (ppbv)[1]			
Compound	**2005**	**2006**	**2007**	**2008**	**2005**	**2006**	**2007**	**2008**	**2005**	**2006**	**2007**	**2008**	**2005**	**2006**	**2007**	**2008**
1,3-Butadiene	0.02	0.02	0.09	0.04	0.19	0.12	-	-	-	-	0.09	0.04	0.02	0.02	0.09	0.04
1,2-Dibromoethane	0.02	0.02	0.03	0.02	0.02	0.02	-	-	-	-	0.03	0.02	0.02	0.02	0.03	0.02
cis-1,3-Dichloro-1-propene	0.01	0.02	0.02	0.02	0.01	0.02	-	-	-	-	0.02	0.02	0.01	0.02	0.02	0.02
trans-1,3-Dichloro-1-propene	0.01	0.02	0.02	0.02	0.01	0.02	-	-	-	-	0.02	0.02	0.01	0.02	0.02	0.02
1,2-Dichloro-1,1,2,2-tetrafluoroethane	0.02	0.02	0.02	0.01	0.02	0.02	-	-	-	-	0.02	0.01	0.02	0.02	0.02	0.01
1,2-Dichlorobenzene	0.08	0.02	0.02	0.01	0.08	0.02	-	-	-	-	0.02	0.01	0.08	0.02	0.02	0.01
1,3-Dichlorobenzene	0.07	0.02	0.02	0.01	0.07	0.02	-	-	-	-	0.02	0.01	0.07	0.02	0.02	0.01
1,4-Dichlorobenzene	0.07	0.02	0.02	0.01	0.07	0.02	-	-	-	-	0.02	0.01	0.07	0.02	0.02	0.01
1,1-Dichloroethane	0.02	0.02	0.02	0.01	0.02	0.02	-	-	-	-	0.02	0.01	0.02	0.02	0.02	0.01
1,2-Dichloroethane	0.02	0.02	0.03	0.01	0.02	0.02	-	-	-	-	0.03	0.01	0.02	0.02	0.03	0.01
1,1-Dichloroethene	0.02	0.02	0.03	0.02	0.02	0.02	-	-	-	-	0.03	0.02	0.02	0.02	0.03	0.02
cis-1,2-Dichloroethene	0.02	0.04	0.03	0.02	0.02	0.04	-	-	-	-	0.03	0.02	0.02	0.04	0.03	0.02
trans-1,2-Dichloroethene	0.02	0.02	0.05	0.02	0.02	0.02	-	-	-	-	0.05	0.02	0.02	0.02	0.05	0.02
1,2-Dichloropropane	0.02	0.02	0.03	0.02	0.02	0.02	-	-	-	-	0.03	0.02	0.02	0.02	0.03	0.02
1-Ethyl-4-methyl benzene	0.08	0.02	0.03	0.03	0.08	0.02	-	-	-	-	0.02	0.01	0.08	0.02	0.02	0.01
1,1,2,2-Tetrachloroethane	0.07	0.02	0.02	0.01	0.07	0.02	-	-	-	-	0.02	0.01	0.07	0.02	0.02	0.01
1,1,2-Trichloro-1,2,2-trifluoroethane	0.06	0.07	0.07	0.07	0.07	0.06	-	-	-	-	0.07	0.07	0.07	0.07	0.07	0.07
1,2,4-Trichlorobenzene	0.10	0.03	0.03	0.01	0.10	0.03	-	-	-	-	0.03	0.01	0.10	0.03	0.03	0.01
1,1,1-Trichloroethane	0.02	0.02	0.02	0.01	0.02	0.02	-	-	-	-	0.02	0.01	0.02	0.02	0.02	0.01
1,1,2-Trichloroethane	0.02	0.02	0.03	0.02	0.02	0.02	-	-	-	-	0.03	0.02	0.02	0.02	0.03	0.02
1,2,4-Trimethylbenzene	0.09	0.06	0.08	0.08	0.07	0.02	-	-	-	-	0.04	0.02	0.07	0.03	0.03	0.02
1,3,5-Trimethylbenzene	0.08	0.02	0.06	0.02	0.07	0.02	-	-	-	-	0.03	0.01	0.08	0.02	0.02	0.01
2-Butanone	0.77	0.58	0.87	1.30	0.58	0.55	-	-	-	-	1.05	1.10	0.56	0.65	0.82	1.10
2-Hexanone	0.19	0.04	0.11	0.21	0.19	0.04	-	-	-	-	0.12	0.17	0.19	0.04	0.11	0.17
2-Methoxy-2-methyl propane	0.73	1.68	0.02	0.01	0.28	0.11	-	-	-	-	0.02	0.01	0.28	0.11	0.02	0.01
4-Methyl-2-pentanone	0.44	0.03	0.11	0.14	0.44	0.02	-	-	-	-	0.11	0.13	0.44	0.02	0.10	0.13
Acetone	18.98	4.97	6.47	8.50	6.07	6.76	-	-	-	-	6.86	6.77	4.62	6.00	5.41	8.03
Benzene	0.72	0.56	0.48	0.42	0.32	0.25	-	-	-	-	0.20	0.18	0.26	0.20	0.21	0.23
Bromodichloromethane	0.02	0.02	0.03	0.02	0.02	0.02	-	-	-	-	0.03	0.02	0.02	0.02	0.03	0.02
Bromoform	0.01	0.02	0.02	0.01	0.01	0.02	-	-	-	-	0.02	0.01	0.01	0.02	0.02	0.01
Bromomethane	0.06	0.03	0.05	0.03	0.02	0.02	-	-	-	-	0.03	0.02	0.02	0.03	0.03	0.02
Carbon disulfide	0.06	0.10	0.08	0.10	0.04	0.07	-	-	-	-	0.12	0.10	0.06	0.17	0.09	0.10
Carbon tetrachloride	0.08	0.08	0.09	0.09	0.09	0.08	-	-	-	-	0.08	0.09	0.08	0.08	0.08	0.09
Chlorobenzene	0.02	0.02	0.03	0.02	0.02	0.02	-	-	-	-	0.03	0.02	0.02	0.02	0.03	0.02
Chloroethane	0.06	0.04	0.04	0.02	0.02	0.02	-	-	-	-	0.03	0.02	0.02	0.03	0.03	0.03
Chloroethene	0.02	0.02	0.03	0.02	0.02	0.02	-	-	-	-	0.03	0.02	0.02	0.02	0.03	0.02
Chloroform	0.02	0.02	0.03	0.02	0.02	0.02	-	-	-	-	0.03	0.01	0.02	0.02	0.03	0.02

Table 4. (continued).

Compound	Marcus Hook Annual Avg (ppbv)[1]				Pottstown Annual Avg (ppbv)[1]				Reading Airport Annual Avg (ppbv)[1]				Swarthmore Annual Avg (ppbv)[1]			
	2005	2006	2007	2008	2005	2006	2007	2008	2005	2006	2007	2008	2005	2006	2007	2008
Chloromethane	0.53	0.48	0.50	0.50	0.50	0.45	-	-	-	-	0.45	0.50	0.52	0.50	0.51	0.54
Cyclohexane	0.20	0.18	0.20	0.20	0.03	0.03	-	-	-	-	0.02	0.02	0.03	0.03	0.03	0.03
Dibromochloromethane	0.02	0.02	0.03	0.02	0.02	0.02	-	-	-	-	0.03	0.02	0.02	0.02	0.03	0.02
Dichlorodifluoromethane	0.45	0.44	0.45	0.47	0.44	0.43	-	-	-	-	0.44	0.47	0.44	0.44	0.44	0.46
Ethylbenzene	0.20	0.10	0.08	0.07	0.21	0.25	-	-	-	-	0.04	0.04	0.04	0.03	0.03	0.03
n-Heptane	0.36	0.26	0.35	0.34	0.09	0.07	-	-	-	-	0.09	0.06	0.13	0.10	0.11	0.10
Hexachloro-1,3-butadiene	0.06	0.02	0.02	0.01	0.06	0.02	-	-	-	-	0.02	0.01	0.06	0.02	0.02	0.01
n-Hexane	0.56	0.55	0.66	0.58	0.17	0.12	-	-	-	-	0.11	0.10	0.15	0.15	0.16	0.21
Methylene chloride	0.13	0.06	0.07	0.08	0.08	0.09	-	-	-	-	0.07	0.09	0.11	0.14	0.08	0.11
Propene	6.20	7.58	6.34	4.76	1.76	1.53	-	-	-	-	1.16	0.99	1.18	1.44	1.23	1.31
Styrene	0.20	0.02	0.02	0.01	0.33	0.43	-	-	-	-	0.02	0.01	0.01	0.02	0.02	0.01
Tetrachloroethene	0.04	0.03	0.03	0.03	0.02	0.02	-	-	-	-	0.03	0.02	0.03	0.03	0.03	0.03
Tetrahydrofuran	0.02	0.02	0.02	0.07	0.04	0.03	-	-	-	-	0.02	0.01	0.02	0.02	0.02	0.04
Toluene	1.14	0.78	0.94	1.23	0.58	0.51	-	-	-	-	0.48	0.35	0.51	0.31	0.27	0.29
Trichloroethylene (TCE)	0.03	0.02	0.04	0.01	0.04	0.05	-	-	-	-	0.05	0.03	0.03	0.03	0.03	0.01
Trichlorofluoromethane	0.22	0.22	0.27	0.25	0.22	0.21	-	-	-	-	0.25	0.25	0.35	0.31	0.34	0.42
m & p- Xylene	0.57	0.35	0.28	0.25	0.38	0.36	-	-	-	-	0.13	0.12	0.10	0.08	0.07	0.09
o-Xylene	0.22	0.11	0.10	0.09	0.13	0.14	-	-	-	-	0.05	0.04	0.04	0.03	0.03	0.03

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

Table 5. Statistical comparison of TCE concentrations by year at Collegeville area sites.

Site	2005		2006			2007			2008		
	Avg[1] (ppbv)	Median (ppbv)	Avg[1] (ppbv)	Median (ppbv)	p-Value[2]	Avg[1] (ppbv)	Median (ppbv)	p-Value[2]	Avg[1] (ppbv)	Median (ppbv)	p-Value[2]
Collegeville	-	-	-	-	-	0.79	0.17	-	0.11	0.89	**0.0009**
Evansburg SP	0.14	0.11	0.16	0.13	0.17	0.09	0.081	**0.008**	0.03	0.02	**0.0001**
Trappe	0.31	0.23	0.27	0.22	0.98	0.29	0.21	0.620	-	-	-

[1] Averages were calculated without substituting ½ the MDL for non-detects in order to perform statistical analysis.
[2] p-Values in bold indicate a significant difference in TCE concentrations from the previous year.

Table 6. Summary of 24-hour intensive sampling results for TCE.

Intensive Sampling Effort	Sampling Dates	Year	Average[1] TCE Concentration (ppbv)	Median TCE Concentration (ppbv)	Number of Samples (N)
1	10/15 -10/17	2007	1.13	0.18	9
2	2/19 – 2/21	2008	0.10	0.04	12
3	5/13 – 5/15	2008	0.26	0.08	15
4	8/18 – 8/20, 8/22	2008	0.29	0.03	16
5	11/17 – 11/19	2008	0.28	0.05	20
2007			**1.13**	**0.18**	**9**
2008			**0.24**	**0.04**	**63**
TOTAL			**0.35**	**0.05**	**72**

[1] Average 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 effects 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 had to be referenced. Table 7 lists the URFs and RfCs, and summarizes their sources. A total of 47 of the targeted VOCs had data for either the URF or the RfC.

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 8 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 compared to the national average. In the United States, on average, slightly less than 1 in 2 in men, and slightly more than 1 in 3 in women will get cancer during their lifetime.

Table 7. List of Unit Risk Factors (URFs) and Reference Air Concentrations (RfCs).

Compound[1]	URF ($m^3/\mu g$)	RfC ($\mu g/m^3$)	Molecular Weight	Source[2]	
				URF	RFC
1,3-Butadiene	3.00E-05	2.0E+00	54.1	IRIS	IRIS
1,2-Dibromoethane	6.00E-04	9.0E+00	187.9	IRIS	IRIS
cis-1,3-Dichloro-1-propene	4.00E-06	2.0E+01	111.0	IRIS	IRIS
trans-1,3-Dichloro-1-propene	4.00E-06	2.0E+01	111.0	IRIS	IRIS
1,2-Dichlorobenzene	-	2.0E+02	147.0	-	O
1,4-Dichlorobenzene	1.10E-05	8.0E+02	147.0	O	IRIS
1,1-Dichloroethane	1.60E-06	5.0E+02	99.0	O	O
1,2-Dichloroethane	2.60E-05	2.4E+03	99.0	IRIS	O
1,1-Dichloroethene	-	2.0E+02	97.0	-	IRIS
trans-1,2-Dichloroethene	-	6.0E+01	97.0	-	O
1,2-Dichloropropane	1.00E-05	4.0E+00	113.0	O	IRIS
1,1,2,2-Tetrachloroethane	5.80E-05	-	167.9	IRIS	-
1,1,2-Trichloro-1,2,2-trifluoroethane	-	3.0E+04	187.4	-	O
1,2,4-Trichlorobenzene	-	4.0E+00	181.4	-	O
1,1,1-Trichloroethane	-	5.0E+03	133.4	-	IRIS
1,1,2-Trichloroethane	1.60E-05	-	133.4	IRIS	-
1,2,4-Trimethylbenzene	-	7.0E+00	120.2	-	O
1,3,5-Trimethylbenzene	-	6.0E+00	120.2	-	O
2-Butanone (MEK)	-	5.0E+03	72.1	-	IRIS
2-Methoxy-2-methylpropane (MTBE)	2.60E-07	3.0E+03	88.2	O	IRIS
4-Methyl-2-pentanone (MIBK)	.	3.0E+03	100.2	-	IRIS
Benzene	7.80E-06	3.0E+01	78.1	IRIS	IRIS
Bromodichloromethane	3.70E-05	-	163.8	O	-
Bromoform	1.10E-06	-	252.7	IRIS	-
Bromomethane	-	5.0E+00	94.9	-	IRIS
Carbon disulfide	-	7.0E+02	76.1	-	IRIS
Carbon tetrachloride	1.50E-05	4.0E+01	153.8	IRIS	O
Chlorobenzene	-	5.0E+01	112.6	-	O
Chloroethane	-	1.0E+04	64.5	-	IRIS
Chloroethene	8.80E-06	1.0E+02	62.5	IRIS	IRIS
Chloroform	2.30E-05	3.0E+02	119.4	IRIS	O
Chloromethane	1.80E-06	9.0E+01	50.5	O	IRIS
Cyclohexane	-	6.0E+03	84.2	-	IRIS
Dibromochloromethane	2.70E-05	-	208.3	O	-
Dichlorodifluoromethane	-	2.0E+02	120.9	-	O
Ethylbenzene	2.50E-06	1.0E+03	106.2	O	IRIS
Hexachloro-1,3-butadiene	2.20E-05	-	260.8	IRIS	-
n-Hexane	-	7.0E+02	86.2	-	IRIS
Methylene chloride	4.70E-07	4.0E+02	84.9	IRIS	O
Propene	-	3.0E+03	42.1	-	O
Styrene	-	1.0E+03	104.2	-	IRIS
Tetrachloroethene (PERC)	5.90E-06	6.0E+02	165.8	O	O
Toluene	-	5.0E+03	92.1	-	IRIS
Trichloroethylene (TCE)	1.14E-04	4.0E+01	131.4	O	O
Trichlorofluoromethane	-	7.0E+02	137.4	-	O
m&p-Xylene	-	1.0E+02	106.2	-	IRIS
o-Xylene	-	1.0E+02	106.2	-	IRIS

[1] Highlighted compounds have different URFs and RfCs from the second (March 7, 2008) Collegeville report.
[2] IRIS – EPA Integrated Risk Information System, O - Other sources

Table 8. 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 risk is based on an adult weight of 70 kg (154 lbs), breathing rate of 20 m^3 (706 ft^3) and a lifetime exposure of 70 years;
- The only excess risk considered in this report is due to inhalation;
- The cancer unit risk 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 are 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 effects.

Table 9 shows the excess lifetime cancer risks for inhalation exposure calculated using annual average VOC concentrations measured at the permanent sampling sites. 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 including these non-detected compounds in the aggregate risk at concentrations of one-half the MDL, the risks listed in Table 9 tend to be conservative.

The risk values for 2005 through 2007 in Table 9 may vary from the risk values found in Tables 3 and 6 from the first two Collegeville reports. This is due to using the latest available and additional URF and RfC values which were applied to 2005 through 2007 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 of VOCs for 2008 were significantly lower at the Collegeville area sites (Collegeville, Evansburg SP and Spring City) compared to previous years (Table 10). The lower risk was mainly driven by the reduction in TCE concentrations within the Collegeville area due to the reduction in TCE usage by the two facilities in the area. Annual average TCE concentrations in 2008 ranged between 0.03 and 0.09 ppbv at the Collegeville, Evansburg SP and Spring City sites (Table 4). This range compares to annual average concentrations ranging from 0.07 to 0.75 ppbv at the Collegeville, Evansburg SP and Trappe sites in 2007.

At the Collegeville site, the excess lifetime cancer risk due to TCE in 2008 was 0.55 per population of 10,000 (Table 11). This risk value is considerably lower than the value calculated in 2007 which was 4.6 in 10,000. It should be noted that the high annual risk value calculated in 2007 was skewed by one sample of 18.0 ppbv collected on June 29, 2007. The next highest concentration found at the Collegeville site during this period was 0.48 ppbv with values typically in 0 to 0.30 ppbv range. If the June 29, 2007 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 SP site, the excess lifetime cancer risk due to TCE dropped from a high of 0.86 in 10,000 in 2005 to a low of 0.18 in 10,000 in 2008 (Table 11).

At the Trappe site, the excess lifetime cancer risk due to TCE was 1.6 in 10,000 in 2005, 1.3 in 10,000 in 2006 and 1.5 in 10,000 in 2007 (Table 11). 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. Also note that sampling at this site ended before TCE emission reductions were made at the facility primarily impacting this site.

The laboratory MDLs for VOCs in 2007 were higher than MDLs in 2005, 2006 and 2008 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, 2006 and 2008.

Table 9. Summary of excess lifetime cancer risks from inhalation of targeted VOCs across all Pennsylvania monitoring sites.

	Collegeville				Evansburg SP				Spring City			
	Cancer Risk				Cancer Risk				Cancer Risk			
Compound	**2005**	**2006**	**2007**	**2008**	**2005**	**2006**	**2007**	**2008**	**2005**	**2006**	**2007**	**2008**
1,3-Butadiene	-	-	6.0E-06	2.7E-06	1.3E-06	1.3E-06	6.0E-06	3.3E-06	-	-	-	2.7E-06
1,2-Dibromoethane	-	-	1.4E-04	9.2E-05	9.2E-05	9.2E-05	1.4E-04	9.2E-05	-	-	-	9.2E-05
cis-1,3-Dichloro-1-propene	-	-	3.6E-07	3.6E-07	1.8E-07	3.6E-07	3.6E-07	3.6E-07	-	-	-	3.6E-07
trans-1,3-Dichloro-1-propene	-	-	3.6E-07	3.6E-07	1.8E-07	3.6E-07	3.6E-07	3.6E-07	-	-	-	3.6E-07
1,2-Dichlorobenzene	-	-	-	-	-	-	-	-	-	-	-	-
1,4-Dichlorobenzene	-	-	1.3E-06	6.6E-07	4.6E-06	1.3E-06	1.3E-06	6.6E-07	-	-	-	6.6E-07
1,1-Dichloroethane	-	-	1.3E-07	6.5E-08	1.3E-07	1.3E-07	1.3E-07	6.5E-08	-	-	-	6.5E-08
1,2-Dichloroethane	-	-	3.2E-06	1.1E-06	2.1E-06	2.1E-06	3.2E-06	1.1E-06	-	-	-	1.1E-06
1,1-Dichloroethene	-	-	-	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	-	-	-	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	-	-	1.4E-06	9.2E-07	9.2E-07	9.2E-07	1.4E-06	9.2E-07	-	-	-	9.2E-07
1,1,2,2-Tetrachloroethane	-	-	8.0E-06	4.0E-06	2.8E-05	8.0E-06	8.0E-06	4.0E-06	-	-	-	4.0E-06
1,1,2-Trichloro-1,2,2-trifluoroethane	-	-	-	-	-	-	-	-	-	-	-	-
1,2,4-Trichlorobenzene	-	-	-	-	-	-	-	-	-	-	-	-
1,1,1-Trichloroethane	-	-	-	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	-	-	2.6E-06	1.7E-06	1.7E-06	1.7E-06	2.6E-06	1.7E-06	-	-	-	1.7E-06
1,2,4-Trimethylbenzene	-	-	-	-	-	-	-	-	-	-	-	-
1,3,5-Trimethylbenzene	-	-	-	-	-	-	-	-	-	-	-	-
2-Butanone	-	-	-	-	-	-	-	-	-	-	-	-
2-Methoxy-2-methyl propane	-	-	1.9E-08	9.4E-09	2.0E-07	6.6E-08	1.9E-08	9.4E-09	-	-	-	9.4E-09
4-Methyl-2-pentanone	-	-	-	-	-	-	-	-	-	-	-	-
Benzene	-	-	4.7E-06	4.2E-06	4.5E-06	3.7E-06	4.0E-06	4.0E-06	-	-	-	4.5E-06
Bromodichloromethane	-	-	7.4E-06	5.0E-06	5.0E-06	5.0E-06	7.4E-06	5.0E-06	-	-	-	5.0E-06
Bromoform	-	-	2.3E-07	1.1E-07	1.1E-07	2.3E-07	2.3E-07	1.1E-07	-	-	-	1.1E-07
Bromomethane	-	-	-	-	-	-	-	-	-	-	-	-
Carbon disulfide	-	-	-	-	-	-	-	-	-	-	-	-
Carbon tetrachloride	-	-	7.5E-06	7.5E-06	8.5E-06	7.5E-06	8.5E-06	8.5E-06	-	-	-	7.5E-06
Chlorobenzene	-	-	-	-	-	-	-	-	-	-	-	-
Chloroethane	-	-	-	-	-	-	-	-	-	-	-	-
Chloroethene	-	-	6.7E-07	4.5E-07	4.5E-07	4.5E-07	6.7E-07	4.5E-07	-	-	-	4.5E-07
Chloroform	-	-	3.4E-06	1.1E-06	2.2E-06	2.2E-06	3.4E-06	2.2E-06	-	-	-	1.1E-06
Chloromethane	-	-	1.6E-06	1.8E-06	1.8E-06	1.6E-06	1.7E-06	1.9E-06	-	-	-	1.8E-06
Cyclohexane	-	-	-	-	-	-	-	-	-	-	-	-
Dibromochloromethane	-	-	6.9E-06	4.6E-06	4.6E-06	4.6E-06	6.9E-06	4.6E-06	-	-	-	4.6E-06
Dichlorodifluoromethane	-	-	-	-	-	-	-	-	-	-	-	-
Ethylbenzene	-	-	4.3E-07	3.3E-07	3.3E-07	3.3E-07	2.2E-07	3.3E-07	-	-	-	3.3E-07
Hexachloro-1,3-butadiene	-	-	4.7E-06	2.3E-06	1.4E-05	4.7E-06	4.7E-06	2.3E-06	-	-	-	2.3E-06
n-Hexane	-	-	-	-	-	-	-	-	-	-	-	-
Methylene chloride	-	-	1.5E-07	1.5E-07	1.1E-07	1.3E-07	2.6E-07	2.3E-07	-	-	-	1.3E-07
Propene	-	-	-	-	-	-	-	-	-	-	-	-
Styrene	-	-	-	-	-	-	-	-	-	-	-	-
Tetrachloroethene	-	-	1.2E-06	1.6E-06	8.0E-07	8.0E-07	1.2E-06	8.0E-07	-	-	-	8.0E-07
Toluene	-	-	-	-	-	-	-	-	-	-	-	-
Trichloroethylene (TCE)	-	-	4.6E-04	5.5E-05	8.6E-05	7.3E-05	4.3E-05	1.8E-05	-	-	-	1.8E-05
Trichlorofluoromethane	-	-	-	-	-	-	-	-	-	-	-	-
m & p- Xylene	-	-	-	-	-	-	-	-	-	-	-	-
o-Xylene	-	-	-	-	-	-	-	-	-	-	-	-
Total Risk	**-**	**-**	**6.6E-04**	**1.9E-04**	**2.6E-04**	**2.1E-04**	**2.4E-04**	**1.5E-04**	**-**	**-**	**-**	**1.5E-04**

Table 9. (continued).

	Trappe				Arendtsville				Chester			
	Cancer Risk				Cancer Risk				Cancer Risk			
Compound	**2005**	**2006**	**2007**	**2008**	**2005**	**2006**	**2007**	**2008**	**2005**	**2006**	**2007**	**2008**
1,3-Butadiene	2.0E-06	2.0E-06	6.0E-06	-	1.3E-06	1.3E-06	6.0E-06	2.7E-06	1.3E-06	1.3E-06	6.0E-06	2.7E-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	9.2E-05	1.4E-04	9.2E-05
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	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	3.6E-07
1,2-Dichlorobenzene	-	-	-	-	-	-	-	-	-	-	-	-
1,4-Dichlorobenzene	4.6E-06	1.3E-06	1.3E-06	-	4.6E-06	1.3E-06	1.3E-06	6.6E-07	4.6E-06	1.3E-06	1.3E-06	6.6E-07
1,1-Dichloroethane	1.3E-07	1.3E-07	1.3E-07	-	1.3E-07	1.3E-07	1.3E-07	6.5E-08	1.3E-07	1.3E-07	1.3E-07	6.5E-08
1,2-Dichloroethane	2.1E-06	2.1E-06	3.2E-06	-	2.1E-06	2.1E-06	3.2E-06	1.1E-06	2.1E-06	2.1E-06	5.3E-06	8.4E-06
1,1-Dichloroethene	-	-	-	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	-	-	-	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	9.2E-07	9.2E-07	1.4E-06	-	9.2E-07	9.2E-07	1.4E-06	9.2E-07	9.2E-07	9.2E-07	1.4E-06	9.2E-07
1,1,2,2-Tetrachloroethane	2.8E-05	8.0E-06	8.0E-06	-	2.8E-05	8.0E-06	8.0E-06	4.0E-06	2.8E-05	8.0E-06	8.0E-06	4.0E-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	1.7E-06	2.6E-06	1.7E-06
1,2,4-Trimethylbenzene	-	-	-	-	-	-	-	-	-	-	-	-
1,3,5-Trimethylbenzene	-	-	-	-	-	-	-	-	-	-	-	-
2-Butanone	-	-	-	-	-	-	-	-	-	-	-	-
2-Methoxy-2-methyl propane	2.5E-07	9.4E-08	1.9E-08	-	3.7E-08	2.8E-08	1.9E-08	9.4E-09	5.2E-07	2.0E-07	1.9E-08	9.4E-09
4-Methyl-2-pentanone	-	-	-	-	-	-	-	-	-	-	-	-
Benzene	5.7E-06	5.0E-06	4.7E-06	-	3.5E-06	3.2E-06	3.5E-06	3.7E-06	6.7E-06	5.7E-06	7.0E-06	6.2E-06
Bromodichloromethane	5.0E-06	5.0E-06	7.4E-06	-	5.0E-06	5.0E-06	7.4E-06	5.0E-06	5.0E-06	5.0E-06	7.4E-06	5.0E-06
Bromoform	1.1E-07	2.3E-07	2.3E-07	-	1.1E-07	2.3E-07	2.3E-07	1.1E-07	1.1E-07	2.3E-07	2.3E-07	1.1E-07
Bromomethane	-	-	-	-	-	-	-	-	-	-	-	-
Carbon disulfide	-	-	-	-	-	-	-	-	-	-	-	-
Carbon tetrachloride	8.5E-06	7.5E-06	1.0E-05	-	7.5E-06	7.5E-06	8.5E-06	8.5E-06	6.6E-06	7.5E-06	8.5E-06	7.5E-06
Chlorobenzene	-	-	-	-	-	-	-	-	-	-	-	-
Chloroethane	-	-	-	-	-	-	-	-	-	-	-	-
Chloroethene	4.5E-07	4.5E-07	6.7E-07	-	4.5E-07	4.5E-07	6.7E-07	4.5E-07	4.5E-07	4.5E-07	6.7E-07	4.5E-07
Chloroform	2.2E-06	2.2E-06	3.4E-06	-	2.2E-06	2.2E-06	3.4E-06	1.1E-06	2.2E-06	2.2E-06	3.4E-06	2.2E-06
Chloromethane	1.7E-06	1.7E-06	1.8E-06	-	2.0E-06	1.7E-06	1.7E-06	1.9E-06	1.8E-06	1.7E-06	1.7E-06	1.9E-06
Cyclohexane	-	-	-	-	-	-	-	-	-	-	-	-
Dibromochloromethane	4.6E-06	4.6E-06	6.9E-06	-	4.6E-06	4.6E-06	6.9E-06	4.6E-06	4.6E-06	4.6E-06	6.9E-06	4.6E-06
Dichlorodifluoromethane	-	-	-	-	-	-	-	-	-	-	-	-
Ethylbenzene	4.3E-07	4.3E-07	3.3E-07	-	2.2E-07	2.2E-07	2.2E-07	3.3E-07	5.4E-07	5.4E-07	4.3E-07	5.4E-07
Hexachloro-1,3-butadiene	1.4E-05	4.7E-06	4.7E-06	-	1.4E-05	4.7E-06	4.7E-06	2.3E-06	1.4E-05	4.7E-06	4.7E-06	2.3E-06
n-Hexane	-	-	-	-	-	-	-	-	-	-	-	-
Methylene chloride	9.8E-08	1.3E-07	1.1E-07	-	4.9E-08	6.5E-08	6.5E-08	6.5E-08	1.3E-07	1.1E-07	9.8E-08	1.1E-07
Propene	-	-	-	-	-	-	-	-	-	-	-	-
Styrene	-	-	-	-	-	-	-	-	-	-	-	-
Tetrachloroethene	1.2E-06	1.2E-06	1.2E-06	-	8.0E-07	8.0E-07	1.2E-06	8.0E-07	1.6E-06	1.6E-06	1.2E-06	1.2E-06
Toluene	-	-	-	-	-	-	-	-	-	-	-	-
Trichloroethylene (TCE)	1.6E-04	1.3E-04	1.5E-04	-	1.2E-05	1.2E-05	1.8E-05	6.1E-06	1.8E-05	1.8E-05	3.7E-05	2.4E-05
Trichlorofluoromethane	-	-	-	-	-	-	-	-	-	-	-	-
m & p- Xylene	-	-	-	-	-	-	-	-	-	-	-	-
o-Xylene	-	-	-	-	-	-	-	-	-	-	-	-
Total Risk	**3.4E-04**	**2.8E-04**	**3.6E-04**	**-**	**1.8E-04**	**1.5E-04**	**2.2E-04**	**1.4E-04**	**1.9E-04**	**1.6E-04**	**2.4E-04**	**1.7E-04**

Table 9. (continued).

	Erie				Lancaster				Lewisburg			
	Cancer Risk				Cancer Risk				Cancer Risk			
Compound	2005	2006	2007	2008	2005	2006	2007	2008	2005	2006	2007	2008
1,3-Butadiene	1.3E-06	1.3E-06	6.0E-06	2.7E-06	1.3E-06	1.3E-06	6.0E-06	2.7E-06	2.0E-06	2.7E-06	6.0E-06	2.7E-06
1,2-Dibromoethane	9.2E-05	9.2E-05	1.4E-04	9.2E-05	9.2E-05	9.2E-05	1.4E-04	9.2E-05	9.2E-05	9.2E-05	1.4E-04	9.2E-05
cis-1,3-Dichloro-1-propene	1.8E-07	3.6E-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	3.6E-07
trans-1,3-Dichloro-1-propene	1.8E-07	3.6E-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	3.6E-07
1,2-Dichlorobenzene	-	-	-	-	-	-	-	-	-	-	-	-
1,4-Dichlorobenzene	4.6E-06	1.3E-06	1.3E-06	6.6E-07	4.6E-06	1.3E-06	1.3E-06	6.6E-07	4.6E-06	1.3E-06	1.3E-06	6.6E-07
1,1-Dichloroethane	1.3E-07	1.3E-07	1.3E-07	6.5E-08	1.3E-07	1.3E-07	1.3E-07	6.5E-08	1.3E-07	1.3E-07	1.3E-07	6.5E-08
1,2-Dichloroethane	2.1E-06	2.1E-06	3.2E-06	1.1E-06	2.1E-06	2.1E-06	3.2E-06	1.1E-06	2.1E-06	2.1E-06	3.2E-06	1.1E-06
1,1-Dichloroethene	-	-	-	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	-	-	-	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	9.2E-07	9.2E-07	1.4E-06	9.2E-07	9.2E-07	9.2E-07	1.4E-06	9.2E-07	9.2E-07	9.2E-07	1.4E-06	9.2E-07
1,1,2,2-Tetrachloroethane	2.8E-05	8.0E-06	8.0E-06	4.0E-06	2.8E-05	8.0E-06	8.0E-06	4.0E-06	2.8E-05	8.0E-06	8.0E-06	4.0E-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	1.7E-06	2.6E-06	1.7E-06	1.7E-06	1.7E-06	2.6E-06	1.7E-06
1,2,4-Trimethylbenzene	-	-	-	-	-	-	-	-	-	-	-	-
1,3,5-Trimethylbenzene	-	-	-	-	-	-	-	-	-	-	-	-
2-Butanone	-	-	-	-	-	-	-	-	-	-	-	-
2-Methoxy-2-methyl propane	1.9E-08	1.9E-08	1.9E-08	9.4E-09	5.6E-08	2.8E-08	1.9E-08	9.4E-09	2.8E-08	2.8E-08	1.9E-08	9.4E-09
4-Methyl-2-pentanone	-	-	-	-	-	-	-	-	-	-	-	-
Benzene	4.5E-06	4.0E-06	4.7E-06	5.0E-06	7.5E-06	6.7E-06	6.5E-06	6.7E-06	6.0E-06	4.7E-06	4.0E-06	5.0E-06
Bromodichloromethane	5.0E-06	5.0E-06	7.4E-06	5.0E-06	5.0E-06	5.0E-06	7.4E-06	5.0E-06	5.0E-06	5.0E-06	7.4E-06	5.0E-06
Bromoform	1.1E-07	2.3E-07	2.3E-07	1.1E-07	1.1E-07	2.3E-07	2.3E-07	1.1E-07	1.1E-07	2.3E-07	2.3E-07	1.1E-07
Bromomethane	-	-	-	-	-	-	-	-	-	-	-	-
Carbon disulfide	-	-	-	-	-	-	-	-	-	-	-	-
Carbon tetrachloride	7.5E-06	7.5E-06	8.5E-06	7.5E-06	8.5E-06	7.5E-06	7.5E-06	7.5E-06	8.5E-06	7.5E-06	7.5E-06	8.5E-06
Chlorobenzene	-	-	-	-	-	-	-	-	-	-	-	-
Chloroethane	-	-	-	-	-	-	-	-	-	-	-	-
Chloroethene	4.5E-07	4.5E-07	6.7E-07	4.5E-07	4.5E-07	4.5E-07	6.7E-07	4.5E-07	4.5E-07	4.5E-07	6.7E-07	4.5E-07
Chloroform	2.2E-06	2.2E-06	3.4E-06	1.1E-06	2.2E-06	2.2E-06	3.4E-06	1.1E-06	2.2E-06	2.2E-06	3.4E-06	1.1E-06
Chloromethane	1.8E-06	1.7E-06	1.7E-06	1.9E-06	1.8E-06	1.8E-06	1.8E-06	1.8E-06	1.6E-06	1.7E-06	1.7E-06	1.8E-06
Cyclohexane	-	-	-	-	-	-	-	-	-	-	-	-
Dibromochloromethane	4.6E-06	4.6E-06	6.9E-06	4.6E-06	4.6E-06	4.6E-06	6.9E-06	4.6E-06	4.6E-06	4.6E-06	6.9E-06	4.6E-06
Dichlorodifluoromethane	-	-	-	-	-	-	-	-	-	-	-	-
Ethylbenzene	3.3E-07	2.2E-07	2.2E-07	3.3E-07	6.5E-07	6.5E-07	5.4E-07	5.4E-07	6.5E-07	4.3E-07	3.3E-07	4.3E-07
Hexachloro-1,3-butadiene	1.4E-05	4.7E-06	4.7E-06	2.3E-06	1.4E-05	4.7E-06	4.7E-06	2.3E-06	1.4E-05	4.7E-06	4.7E-06	2.3E-06
n-Hexane	-	-	-	-	-	-	-	-	-	-	-	-
Methylene chloride	6.5E-08	6.5E-08	1.1E-07	8.2E-08	1.3E-07	1.5E-07	1.6E-07	1.5E-07	9.8E-08	9.8E-08	8.2E-08	1.5E-07
Propene	-	-	-	-	-	-	-	-	-	-	-	-
Styrene	-	-	-	-	-	-	-	-	-	-	-	-
Tetrachloroethene	2.0E-06	8.0E-07	1.2E-06	8.0E-07	8.0E-07	8.0E-07	1.2E-06	1.2E-06	8.0E-07	8.0E-07	1.2E-06	8.0E-07
Toluene	-	-	-	-	-	-	-	-	-	-	-	-
Trichloroethylene (TCE)	1.2E-05	1.2E-05	1.8E-05	6.1E-06	1.2E-05	1.2E-05	1.8E-05	1.2E-05	1.2E-05	1.8E-05	2.4E-05	1.8E-05
Trichlorofluoromethane	-	-	-	-	-	-	-	-	-	-	-	-
m & p- Xylene	-	-	-	-	-	-	-	-	-	-	-	-
o-Xylene	-	-	-	-	-	-	-	-	-	-	-	-
Total Risk	**1.9E-04**	**1.5E-04**	**2.2E-04**	**1.4E-04**	**1.9E-04**	**1.6E-04**	**2.2E-04**	**1.5E-04**	**1.9E-04**	**1.6E-04**	**2.2E-04**	**1.5E-04**

Table 9. (continued).

Compound	Marcus Hook Cancer Risk				Pottstown Cancer Risk				Reading Airport Cancer Risk			
	2005	2006	2007	2008	2005	2006	2007	2008	2005	2006	2007	2008
1,3-Butadiene	1.3E-06	1.3E-06	6.0E-06	2.7E-06	1.3E-05	8.0E-06	-	-	-	-	6.0E-06	2.7E-06
1,2-Dibromoethane	9.2E-05	9.2E-05	1.4E-04	9.2E-05	9.2E-05	9.2E-05	-	-	-	-	1.4E-04	9.2E-05
cis-1,3-Dichloro-1-propene	1.8E-07	3.6E-07	3.6E-07	3.6E-07	1.8E-07	3.6E-07	-	-	-	-	3.6E-07	3.6E-07
trans-1,3-Dichloro-1-propene	1.8E-07	3.6E-07	3.6E-07	3.6E-07	1.8E-07	3.6E-07	-	-	-	-	3.6E-07	3.6E-07
1,2-Dichlorobenzene	-	-	-	-	-	-	-	-	-	-	-	-
1,4-Dichlorobenzene	4.6E-06	1.3E-06	1.3E-06	6.6E-07	4.6E-06	1.3E-06	-	-	-	-	1.3E-06	6.6E-07
1,1-Dichloroethane	1.3E-07	1.3E-07	1.3E-07	6.5E-08	1.3E-07	1.3E-07	-	-	-	-	1.3E-07	6.5E-08
1,2-Dichloroethane	2.1E-06	2.1E-06	3.2E-06	1.1E-06	2.1E-06	2.1E-06	-	-	-	-	3.2E-06	1.1E-06
1,1-Dichloroethene	-	-	-	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	-	-	-	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	9.2E-07	9.2E-07	1.4E-06	9.2E-07	9.2E-07	9.2E-07	-	-	-	-	1.4E-06	9.2E-07
1,1,2,2-Tetrachloroethane	2.8E-05	8.0E-06	8.0E-06	4.0E-06	2.8E-05	8.0E-06	-	-	-	-	8.0E-06	4.0E-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	1.7E-06	-	-	-	-	2.6E-06	1.7E-06
1,2,4-Trimethylbenzene	-	-	-	-	-	-	-	-	-	-	-	-
1,3,5-Trimethylbenzene	-	-	-	-	-	-	-	-	-	-	-	-
2-Butanone	-	-	-	-	-	-	-	-	-	-	-	-
2-Methoxy-2-methyl propane	6.8E-07	1.6E-06	1.9E-08	9.4E-09	2.6E-07	1.0E-07	-	-	-	-	1.9E-08	9.4E-09
4-Methyl-2-pentanone	-	-	-	-	-	-	-	-	-	-	-	-
Benzene	1.8E-05	1.4E-05	1.2E-05	1.0E-05	8.0E-06	6.2E-06	-	-	-	-	5.0E-06	4.5E-06
Bromodichloromethane	5.0E-06	5.0E-06	7.4E-06	5.0E-06	5.0E-06	5.0E-06	-	-	-	-	7.4E-06	5.0E-06
Bromoform	1.1E-07	2.3E-07	2.3E-07	1.1E-07	1.1E-07	2.3E-07	-	-	-	-	2.3E-07	1.1E-07
Bromomethane	-	-	-	-	-	-	-	-	-	-	-	-
Carbon disulfide	-	-	-	-	-	-	-	-	-	-	-	-
Carbon tetrachloride	7.5E-06	7.5E-06	8.5E-06	8.5E-06	8.5E-06	7.5E-06	-	-	-	-	7.5E-06	8.5E-06
Chlorobenzene	-	-	-	-	-	-	-	-	-	-	-	-
Chloroethane	-	-	-	-	-	-	-	-	-	-	-	-
Chloroethene	4.5E-07	4.5E-07	6.7E-07	4.5E-07	4.5E-07	4.5E-07	-	-	-	-	6.7E-07	4.5E-07
Chloroform	2.2E-06	2.2E-06	3.4E-06	2.2E-06	2.2E-06	2.2E-06	-	-	-	-	3.4E-06	1.1E-06
Chloromethane	2.0E-06	1.8E-06	1.9E-06	1.9E-06	1.9E-06	1.7E-06	-	-	-	-	1.7E-06	1.9E-06
Cyclohexane	-	-	-	-	-	-	-	-	-	-	-	-
Dibromochloromethane	4.6E-06	4.6E-06	6.9E-06	4.6E-06	4.6E-06	4.6E-06	-	-	-	-	6.9E-06	4.6E-06
Dichlorodifluoromethane	-	-	-	-	-	-	-	-	-	-	-	-
Ethylbenzene	2.2E-06	1.1E-06	8.7E-07	7.6E-07	2.3E-06	2.7E-06	-	-	-	-	4.3E-07	4.3E-07
Hexachloro-1,3-butadiene	1.4E-05	4.7E-06	4.7E-06	2.3E-06	1.4E-05	4.7E-06	-	-	-	-	4.7E-06	2.3E-06
n-Hexane	-	-	-	-	-	-	-	-	-	-	-	-
Methylene chloride	2.1E-07	9.8E-08	1.1E-07	1.3E-07	1.3E-07	1.5E-07	-	-	-	-	1.1E-07	1.5E-07
Propene	-	-	-	-	-	-	-	-	-	-	-	-
Styrene	-	-	-	-	-	-	-	-	-	-	-	-
Tetrachloroethene	1.6E-06	1.2E-06	1.2E-06	1.2E-06	8.0E-07	8.0E-07	-	-	-	-	1.2E-06	8.0E-07
Toluene	-	-	-	-	-	-	-	-	-	-	-	-
Trichloroethylene (TCE)	1.8E-05	1.2E-05	2.4E-05	6.1E-06	2.4E-05	3.1E-05	-	-	-	-	3.1E-05	1.8E-05
Trichlorofluoromethane	-	-	-	-	-	-	-	-	-	-	-	-
m & p- Xylene	-	-	-	-	-	-	-	-	-	-	-	-
o-Xylene	-	-	-	-	-	-	-	-	-	-	-	-
Total Risk	**2.1E-04**	**1.7E-04**	**2.3E-04**	**1.5E-04**	**2.2E-04**	**1.8E-04**			**-**	**-**	**2.3E-04**	**1.5E-04**

Table 9. (continued).

	Swarthmore			
	Cancer Risk			
Compound	**2005**	**2006**	**2007**	**2008**
1,3-Butadiene	1.3E-06	1.3E-06	6.0E-06	2.7E-06
1,2-Dibromoethane	9.2E-05	9.2E-05	1.4E-04	9.2E-05
cis-1,3-Dichloro-1-propene	1.8E-07	3.6E-07	3.6E-07	3.6E-07
trans-1,3-Dichloro-1-propene	1.8E-07	3.6E-07	3.6E-07	3.6E-07
1,2-Dichlorobenzene	-	-	-	-
1,4-Dichlorobenzene	4.6E-06	1.3E-06	1.3E-06	6.6E-07
1,1-Dichloroethane	1.3E-07	1.3E-07	1.3E-07	6.5E-08
1,2-Dichloroethane	2.1E-06	2.1E-06	3.2E-06	1.1E-06
1,1-Dichloroethene	-	-	-	-
trans-1,2-Dichloroethene	-	-	-	-
1,2-Dichloropropane	9.2E-07	9.2E-07	1.4E-06	9.2E-07
1,1,2,2-Tetrachloroethane	2.8E-05	8.0E-06	8.0E-06	4.0E-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
1,2,4-Trimethylbenzene	-	-	-	-
1,3,5-Trimethylbenzene	-	-	-	-
2-Butanone	-	-	-	-
2-Methoxy-2-methyl propane	2.6E-07	1.0E-07	1.9E-08	9.4E-09
4-Methyl-2-pentanone	-	-	-	-
Benzene	6.5E-06	5.0E-06	5.2E-06	5.7E-06
Bromodichloromethane	5.0E-06	5.0E-06	7.4E-06	5.0E-06
Bromoform	1.1E-07	2.3E-07	2.3E-07	1.1E-07
Bromomethane	-	-	-	-
Carbon disulfide	-	-	-	-
Carbon tetrachloride	7.5E-06	7.5E-06	7.5E-06	8.5E-06
Chlorobenzene	-	-	-	-
Chloroethane	-	-	-	-
Chloroethene	4.5E-07	4.5E-07	6.7E-07	4.5E-07
Chloroform	2.2E-06	2.2E-06	3.4E-06	2.2E-06
Chloromethane	1.9E-06	1.9E-06	1.9E-06	2.0E-06
Cyclohexane	-	-	-	-
Dibromochloromethane	4.6E-06	4.6E-06	6.9E-06	4.6E-06
Dichlorodifluoromethane	-	-	-	-
Ethylbenzene	4.3E-07	3.3E-07	3.3E-07	3.3E-07
Hexachloro-1,3-butadiene	1.4E-05	4.7E-06	4.7E-06	2.3E-06
n-Hexane	-	-	-	-
Methylene chloride	1.8E-07	2.3E-07	1.3E-07	1.8E-07
Propene	-	-	-	-
Styrene	-	-	-	-
Tetrachloroethene	1.2E-06	1.2E-06	1.2E-06	1.2E-06
Toluene	-	-	-	-
Trichloroethylene (TCE)	1.8E-05	1.8E-05	1.8E-05	6.1E-06
Trichlorofluoromethane	-	-	-	-
m & p- Xylene	-	-	-	-
o-Xylene	-	-	-	-
Total Risk	**1.9E-04**	**1.6E-04**	**2.2E-04**	**1.4E-04**

Table 10. 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**	**2008**
Collegeville	-	-	6.6	1.9
Evansburg SP	2.6	2.1	2.4	1.5
Spring City	-	-	-	1.5
Trappe	3.4	2.8	3.6	-
Arendtsville	1.8	1.5	2.2	1.4
Chester	1.9	1.6	2.4	1.7
Erie	1.9	1.5	2.2	1.4
Lancaster	1.9	1.6	2.2	1.5
Lewisburg	1.9	1.6	2.2	1.5
Marcus Hook	2.1	1.7	2.3	1.5
Pottstown	2.2	1.8	-	-
Reading Airport	-	-	2.3	1.5
Swarthmore	1.9	1.6	2.2	1.4

Table 11. 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**	**2008**
Collegeville	-	-	4.6	0.55
Evansburg SP	0.86	0.73	0.43	0.18
Spring City	-	-	-	0.18
Trappe	1.6	1.3	1.5	-
Arendtsville	0.12	0.12	0.18	0.06
Chester	0.18	0.18	0.37	0.24
Erie	0.12	0.12	0.18	0.06
Lancaster	0.12	0.12	0.18	0.12
Lewisburg	0.12	0.18	0.24	0.18
Marcus Hook	0.18	0.12	0.24	0.06
Pottstown	0.24	0.31	-	-
Reading Airport	-	-	0.31	0.18
Swarthmore	0.18	0.18	0.18	0.06

Non-Cancer Health Effects

There were no VOCs measured at the permanent Collegeville sampling sites with annual average concentrations (Table 4) above their respective RfC (Table 7). Consequently, chronic non-cancer health effects are not expected from breathing the air within the Collegeville area.

Table 12 summarizes the individual and average TCE concentrations measured during each of the five intensive sampling events. The purpose of the intensive sampling events was to measure TCE in downwind locations close to emission sources. These locations were chosen to represent areas that are likely to have the highest concentrations of TCE and would be appropriate for estimating the maximum likelihood of acute non-cancer health risks. A detailed account of the intensive sampling locations is provided in Appendix D.

In order to evaluate the acute health risks due to inhalation exposure to TCE, the measured concentrations can be compared with the minimal risk level (MRL) for TCE as defined by the Agency for Toxic Substances and Disease Registry. The MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse, non-cancer health effects over a specified duration of exposure. ATSDR defines both an acute and an intermediate exposure MRL. An acute exposure refers to a short-term exposure over a period of 1 to 14 days while an intermediate exposure refers to an exposure spanning a period of 15 to 364 days. The MRL for acute exposure to TCE is 2,000 ppbv and the MRL for intermediate exposure is 100 ppbv.

The TCE concentrations measured during the intensive sampling events were much lower than either the acute or intermediate MRL (refer to Table 12). This indicates that inhalation exposure to TCE within Collegeville is not likely to result in acute non-cancer health effects.

Table 12. Summary of measured TCE concentrations for intensive sampling events within the Collegeville area.

Intensive 1		Intensive 2		Intensive 3		Intensive 4		Intensive 5	
Sampling date	**TCE (ppbv)**	**Sampling date**	**TCE (ppbv)**	**Sampling date**	**TCE (ppbv)**	**Sampling date**	**TCE (ppbv)**	**Sampling date**	**TCE (ppbv)**
10/15/07	0.07	2/19/08	0.04	5/13/08	0.12	8/18/08	0.01	11/17/08	0.03
10/15/07	0.07	2/19/08	0.04	5/13/08	0.06	8/18/08	0.04	11/17/08	0.06
10/15/07	0.07	2/20/08	0.05	5/13/08	0.13	8/18/08	0.02	11/17/08	<0.02
10/15/07	0.14	2/20/08	0.04	5/13/08	1.50	8/18/08	0.01	11/17/08	0.49
10/16/07	<0.06	2/20/08	0.05	5/14/08	0.81	8/18/08	2.20	11/17/08	3.10
10/16/07	0.18	2/20/08	0.39	5/14/08	<0.02	8/19/08	0.02	11/17/08	<0.02
10/16/07	7.20	2/20/08	0.04	5/14/08	0.13	8/19/08	0.01	11/17/08	<0.02
10/16/07	0.18	2/20/08	0.03	5/14/08	0.90	8/19/08	0.01	11/18/08	<0.02
10/17/07	1.50	2/20/08	<0.02	5/14/08	0.02	8/19/08	0.20	11/18/08	<0.02
-	-	2/21/08	<0.02	5/14/08	0.08	8/19/08	0.01	11/18/08	0.08
-	-	2/21/08	<0.02	5/15/08	0.09	8/20/08	0.04	11/18/08	0.74
-	-	2/21/08	0.04	5/15/08	<0.02	8/20/08	0.10	11/18/08	<0.02
-	-	-	-	5/15/08	0.06	8/20/08	0.45	11/19/08	0.03
-	-	-	-	5/15/08	<0.02	8/20/08	1.40	11/19/08	0.04
-	-	-	-	5/15/08	0.04	8/22/08	0.01	11/19/08	<0.02
-	-	-	-	-	-	8/22/08	0.03	11/19/08	0.56
-	-	-	-	-	-	-	-	11/19/08	0.13
-	-	-	-	-	-	-	-	11/20/08	<0.02
-	-	-	-	-	-	-	-	11/20/08	0.09
-	-	-	-	-	-	-	-	11/20/08	0.08
Average[1]	**1.13**	**Average[1]**	**0.10**	**Average[1]**	**0.26**	**Average[1]**	**0.29**	**Average[1]**	**0.28**

[1] ½ the MDL was substituted for values that were non-detect.

Air Dispersion Modeling

Air dispersion modeling was carried out using AERMOD View, a commercially available software package that integrates the various components of EPA-sponsored AERMOD software. Air dispersion modeling uses mathematical formulas to characterize the processes that disperse a pollutant emitted by a source or multiple sources. This allows one to predict the spatial distribution of pollutants from the source taking into consideration emission source number and characteristics, meteorological information, terrain details and building downwash potential. This information can then be used to estimate the non-cancer and cancer health risks for a particular area.

For this effort, 2009 TCE emission data for January 1 through June 30, 2009 were included for the Accellent, Inc. facility, one of the TCE emitting facilities. This represents the time period after which TCE emission reduction efforts were fully implemented at the facility. Superior Tube, the other facility, eliminated the use of TCE in 2008 and their reported TCE emissions (approximately 15 pounds per month) were considered negligible and were not included in the model. A detailed technical discussion of the model inputs, assumptions and results is provided in Appendix G.

The model was utilized to evaluate the spatial distribution of TCE concentrations and the associated short- and long-term health risks for residents within the Collegeville area. Acute or short-term health risks were evaluated by modeling the maximum daily (24-hour) TCE concentrations. The maximum predicted concentration was then compared with short-term exposure guidelines (minimal risk level or MRL). Chronic or long-term health risks were evaluated by modeling TCE concentrations averaged across an annual basis. These results were subsequently compared to reference concentrations and cancer risk factors using the methodology previously described.

The highest annual TCE concentration was 4.6 ppbv and occurred at a location at the plant perimeter (refer to Figure 7 in Appendix G). As expected, the average annual TCE concentration drops precipitously the farther one moves from the plant perimeter. The minimum concentration in the modeling region was 0.02 ppbv found at locations 1.5 kilometers and greater from the facility.

These minimum and maximum TCE values correspond to an excess lifetime cancer risk of 0.1 to 28 per 10,000 population. The average TCE concentration across the entire modeling domain was estimated to be 0.31 ppbv which corresponds to an excess lifetime cancer risk of 1.9 per 10,000.

All of the maximum annual TCE concentrations (4.6 ppbv or less) were lower than the reference concentration for TCE (40 $\mu g/m^3$ or 7.5 ppbv). Therefore, the model did not predict TCE concentrations within the modeling region that are likely to result in chronic non-cancer health risks.

The maximum daily (24-hour) TCE concentration predicted by the model was 25.1 ppbv located at the plant perimeter. All maximum daily TCE concentrations calculated by the model were lower than either the acute (2000 ppbv) or intermediate minimal risk level (100 ppbv). Therefore, the model did not predict any levels showing a concern for short-term non-cancer health risks.

Next Steps

Accellent and Superior Tube, the owners and operators of the two large facilities in the Collegeville area completed their TCE emission reduction plans early in the second quarter of 2008. DEP amended the Operating Permits for both facilities to make the TCE emission reductions enforceable.

DEP is analyzing all canister samples for an additional compound, 1-bromopropane, also known as n-propyl bromide. This solvent is being used as a replacement for TCE at

Superior Tube. This solvent is an EPA approved solvent for metal cleaning. It is a VOC, but not designated as a hazardous air pollutant by the EPA. It is not known to have carcinogenic effects.

In January 2009, the DEP relocated the Evansburg State Park sampling site to a location closer to Superior Tube to a property off the Germantown Pike. This was necessary due to the fact that TCE is no longer being used by the facility and there have been fewer samples at the State Park site containing TCE. DEP plans to continue sampling at this site at least through 2009.

DEP discontinued sampling at the Spring City sampling site at the end of 2008. The sampler has been moved to a site on West 5th Avenue in Trappe where DEP is operating a continuous gas chromatograph (GC) to monitor ambient concentrations of TCE on a near real-time basis. The canister sampler, operating on a 1-in-12-day schedule, will provide a comparison to the GC results.

Due to problems during the initial installation and testing, near real-time data on TCE and n-propyl bromide concentrations from the GC were not available in 2008. DEP plans to operate the GC (and canister sampler) through 2009 to collect this information to better assess daily variations in these pollutant levels.

The air monitoring and risk assessment objectives under the EPA grant have been completed and are discussed in this report. The DEP plans to continue with the above initiatives through 2009 to fully ensure the TCE reductions at the two large facilities remain effective in reducing ambient levels of TCE. If the current trend continues, DEP may discontinue sampling in 2010. Detailed descriptions of TCE emission reduction plans, enhanced monitoring under the EPA grant, and other related information are available on the DEP website at www.depweb.state.pa.us, keyword Collegeville.

Appendix

A. Monitoring

Equipment

Canister Samplers - Andersen Instruments, Inc. AVOCS, Entech TM1100P

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 and Entech sampler regulate 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 1000 ppbv, 65-component commercial gas cylinder standard (Scott Specialty Gases) diluted with humidified nitrogen. In addition, a 4-component internal standard is used 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 effects 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 $\mu g/m^3$. 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 $\mu g/m^3$, 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.

Pennsylvania Department of Environmental Protection
Collegeville Area Air Monitoring Project
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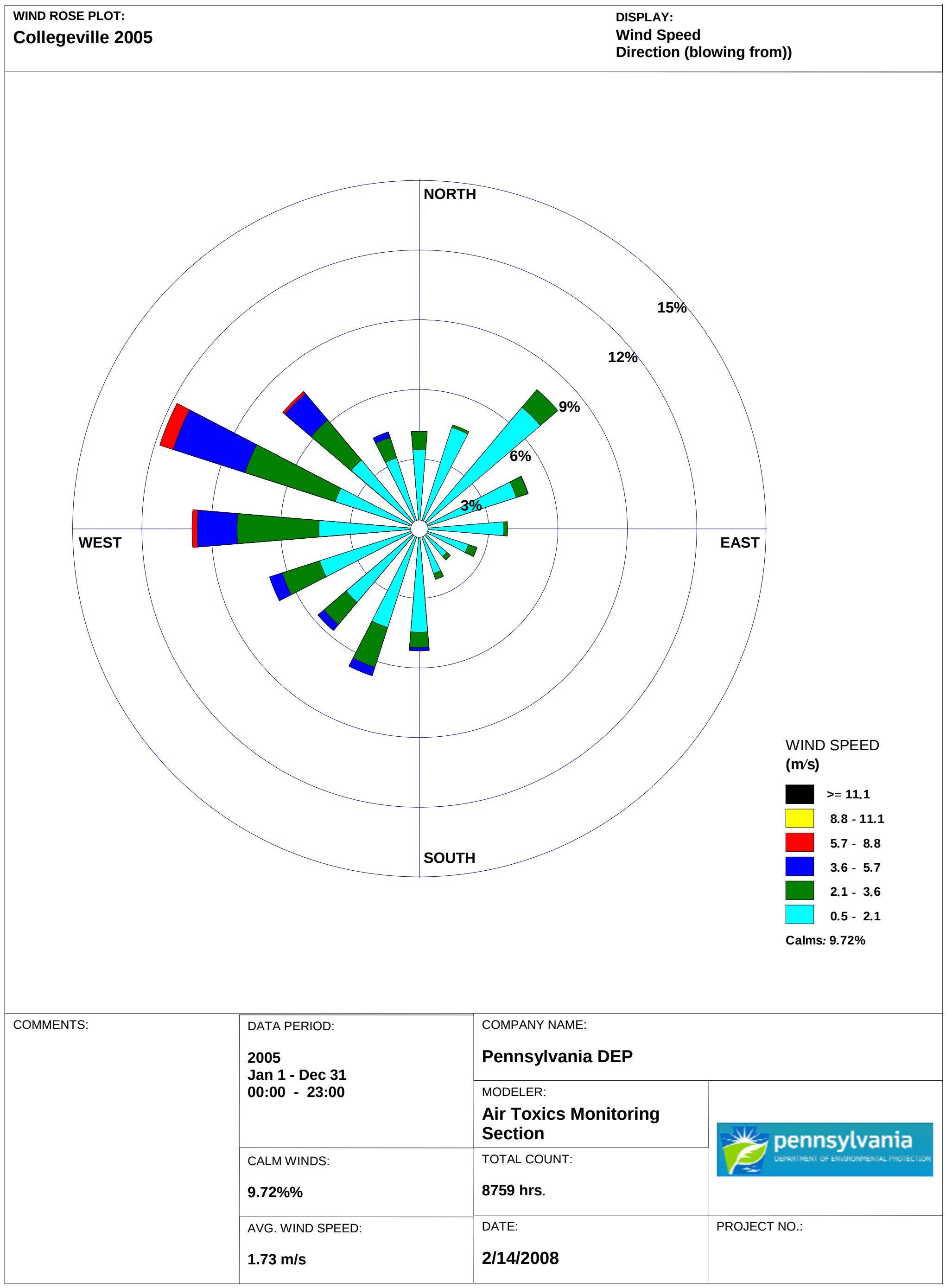
C. Yearly Wind Roses

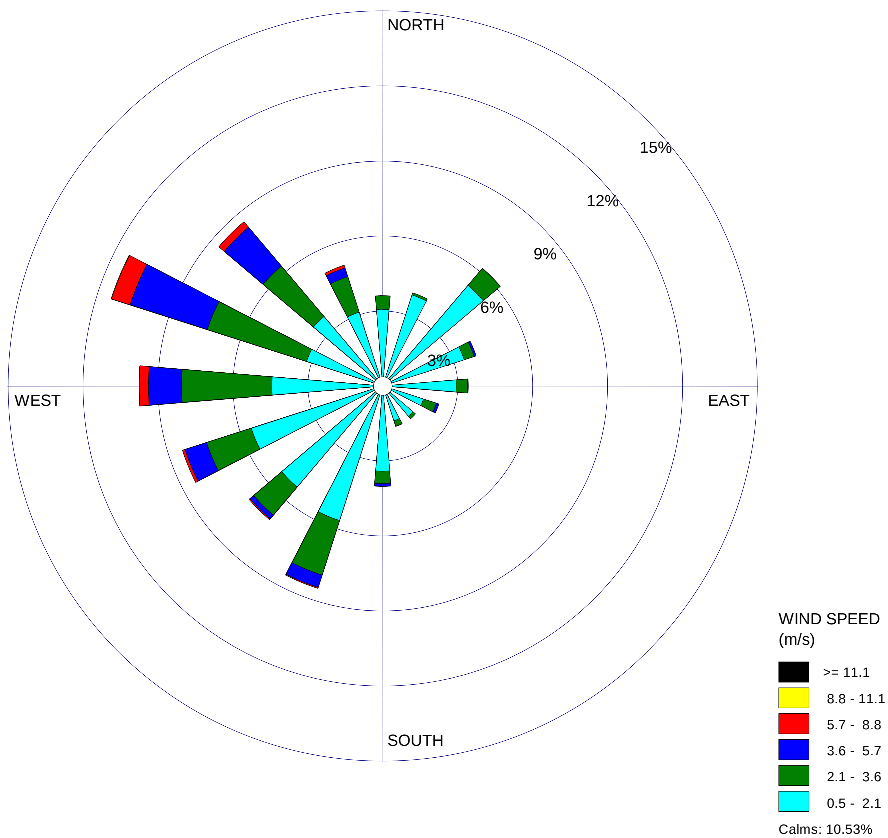


WRPLOT View - Lakes Environmental Software

Pennsylvania Department of Environmental Protection
Collegeville Area Air Monitoring Project
November 17, 2009

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

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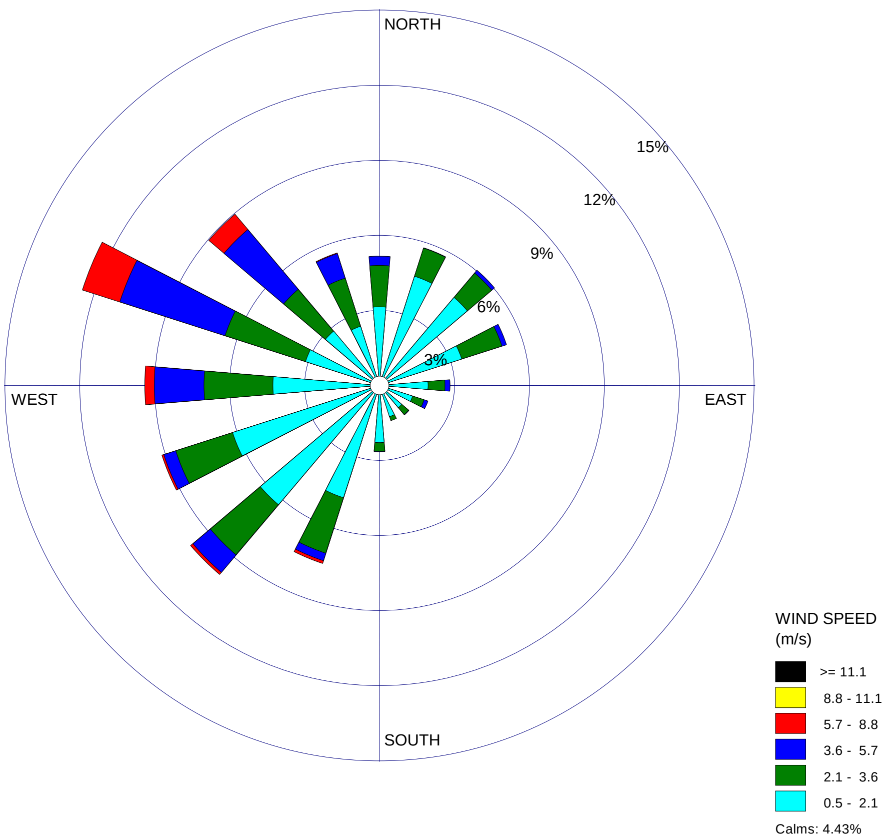
WIND ROSE PLOT:	DISPLAY:
Collegeville 2007	**Wind Speed** **Direction (blowing from)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2007 **Jan 1 - Dec 31** **00:00 - 23:00**	**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.:

WRPLOT View - Lakes Environmental Software

Pennsylvania Department of Environmental Protection
Collegeville Area Air Monitoring Project
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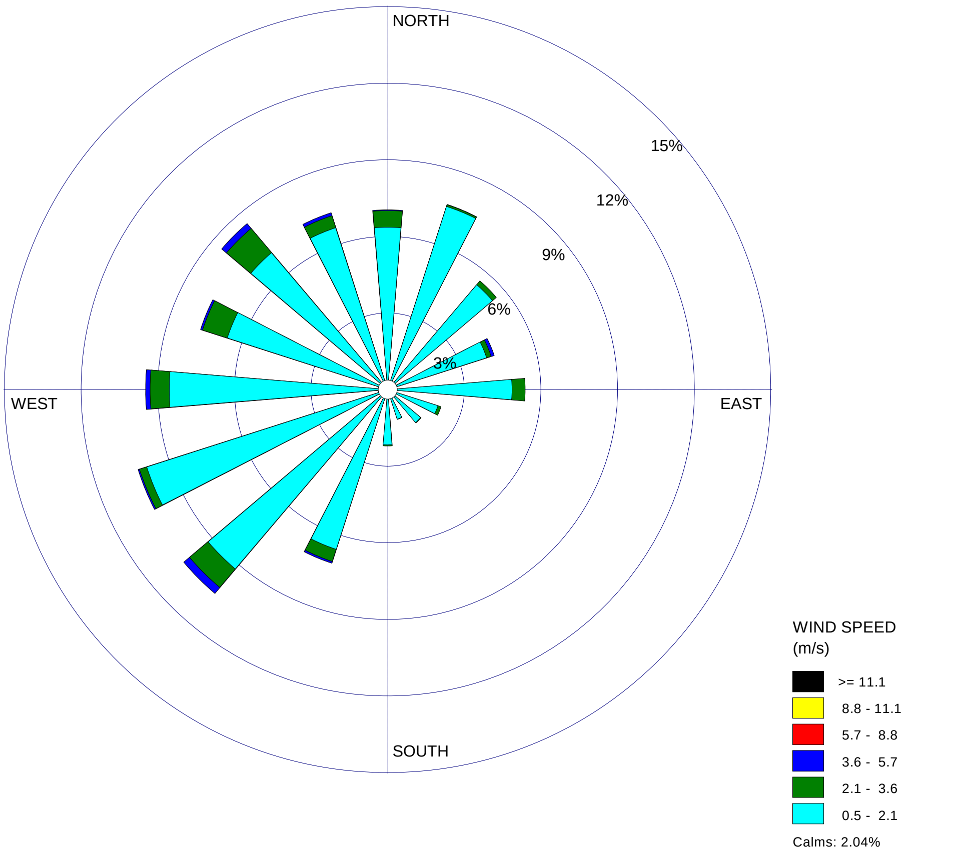
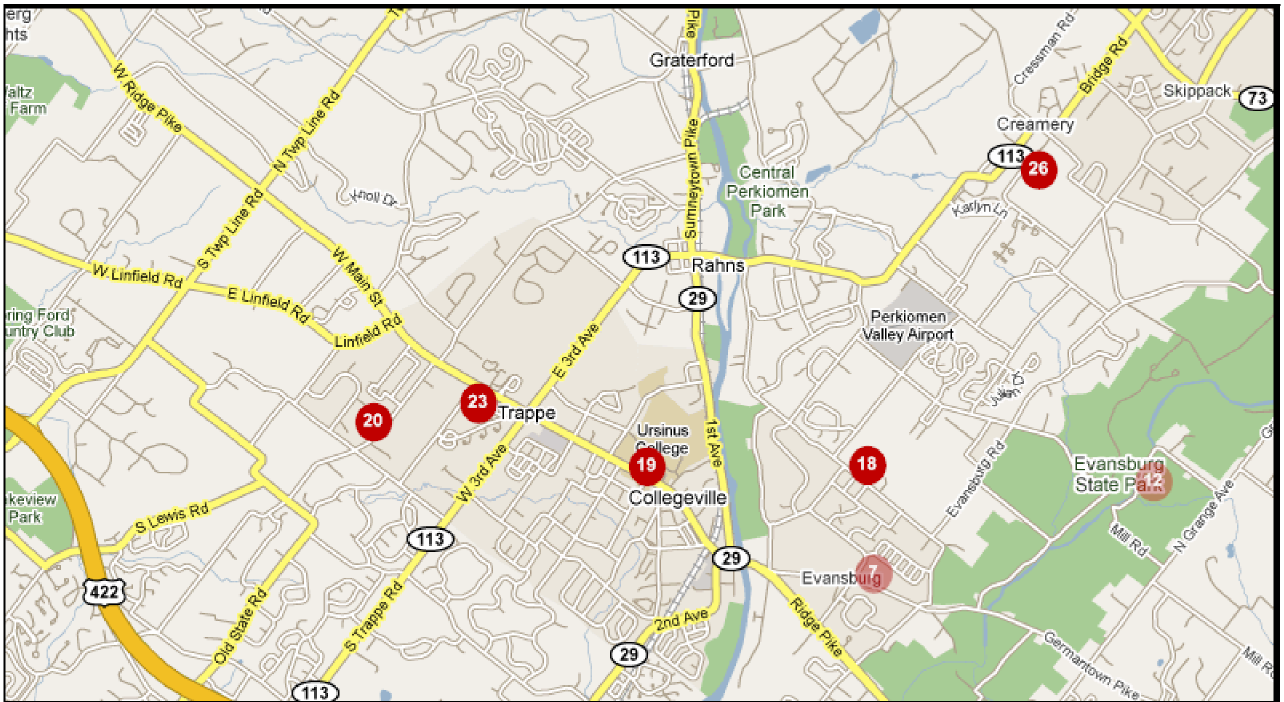
WIND ROSE PLOT: **Collegeville 2008**	DISPLAY: **Wind Speed** **Direction (blowing from)**



COMMENTS:	DATA PERIOD: 2008	COMPANY NAME: Pennsylvania DEP	
	2008 **Jan 1 - Dec 31** **00:00 - 23:00**	**Pennsylvania DEP**	
		MODELER: **Air Toxics Monitoring Section**	pennsylvania DEPARTMENT OF ENVIRONMENTAL PROTECTION
	CALM WINDS: **2.04%**	TOTAL COUNT: **8783 hrs.**	
	AVG. WIND SPEED: **1.20 m/s**	DATE: 5/20/08 **5/22/2009**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

D. Summary of Intensive Sampling Efforts



Sampling Site Number	Location	TCE Concentration (ppbv)	Sampling Date
7	Evansburg United Methodist Church	1.50	10/17/07
12	Evansburg SP Site	0.07	10/15/07
		<0.06	10/16/07
18	Jean Rosset French Memorial Park	0.43	10/15/07
19	Collegeville Site	0.46	10/15/07
		0.18	10/16/07
20	7th Ave Water tower	7.20	10/16/07
23	5th Ave Fire Station	0.18	10/16/07
26	Skippack Township Building	0.14	10/15/07
Average[1]		**1.13**	
Median		**0.18**	

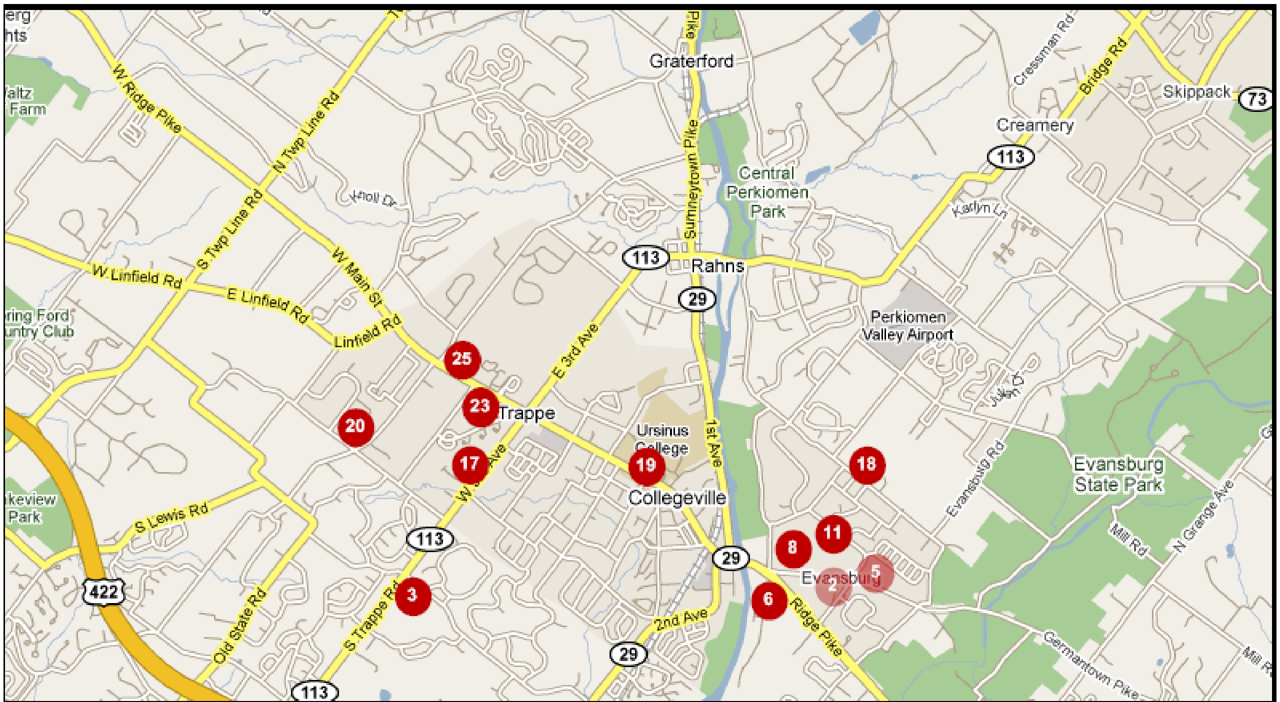
[1] ½ the MDL was substituted for values that were non-detect

Figure 2a. Location of sampling sites and individual TCE values for 24-hour intensive sampling effort conducted in October of 2007.

Sampling Site Number	Location	TCE Concentration (ppbv)	Sampling Date
11	Crosskeys Road Air Stripper	0.04	2/20/08
12	Evansburg SP Site	0.05	2/20/08
		<0.02	2/21/08
13	Route 29 Air Stripper	0.04	2/20/08
14	Clamer St. Air Stripper	0.03	2/20/08
15	Spring City Site	<0.02	2/20/08
		<0.02	2/21/08
16	Water Works Park	0.39	2/20/08
18	Jean Rosset French Memorial Park	0.04	2/19/08
19	Ursinus College	0.05	2/20/08
		0.04	2/21/08
22	Rambo Park	0.5	2/19/08
Average[1]		**0.10**	
Median		**0.04**	

[1] ½ the MDL was substituted for values that were non-detect

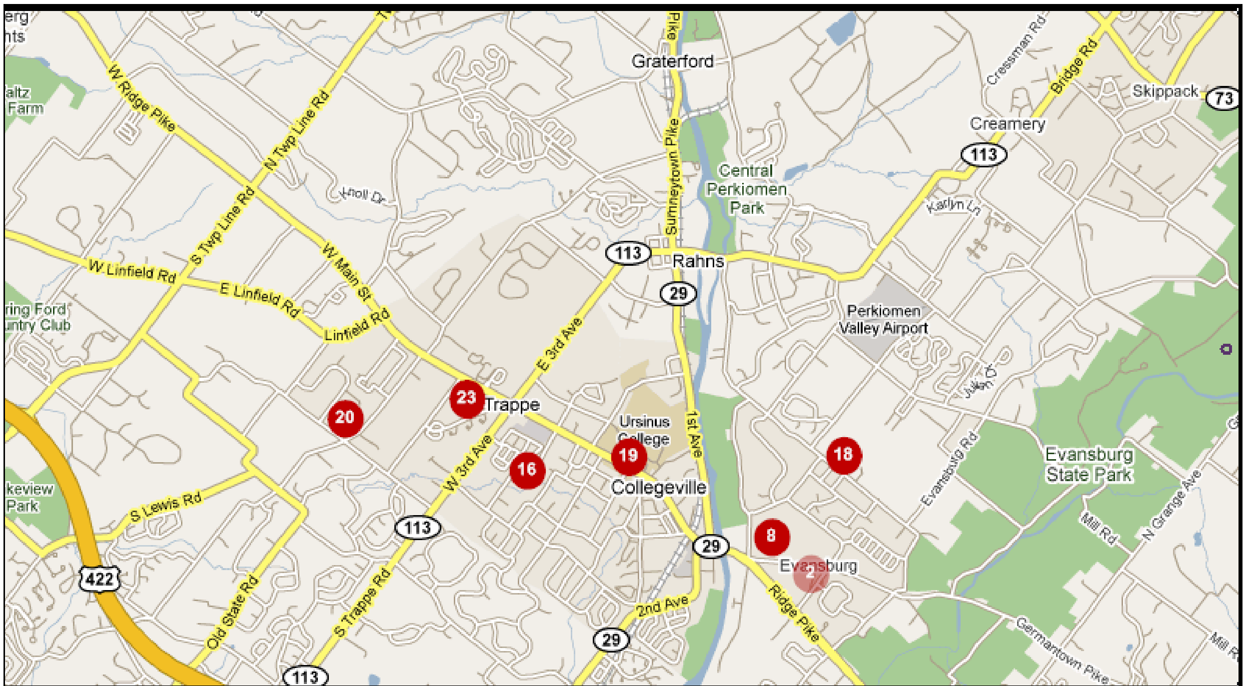
Figure 2b. Location of sampling sites and individual TCE values for 24-hour intensive sampling effort conducted in February of 2008.



Sampling Site Number	Location	TCE Concentration (ppbv)	Sampling Date
2	Locker Room Self Storage	0.04	5/15/08
3	Anderson Farm Park	0.12	5/13/08
		0.09	5/15/08
5	Superior Tube Fence line	<0.02	5/15/08
6	Collegeville Inn	0.06	5/13/08
8	Old Ballpark next to Superior	0.13	5/13/08
11	Crosskeys Rd Air Stripper	0.81	5/14/08
17	VFW	0.06	5/15/08
18	Jean Rosset French Memorial Park	<0.02	5/14/08
19	Ursinus College	0.13	5/14/08
		<0.02	5/15/08
20	7th Ave Water tower	1.50	5/13/08
		0.90	5/14/08
23	5th Ave Fire Station	0.02	5/14/08
25	Trappe Borough Office	0.08	5/14/08
Average[1]		**0.26**	
Median[1]		**0.08**	

[1] ½ the MDL was substituted for values that were non-detect

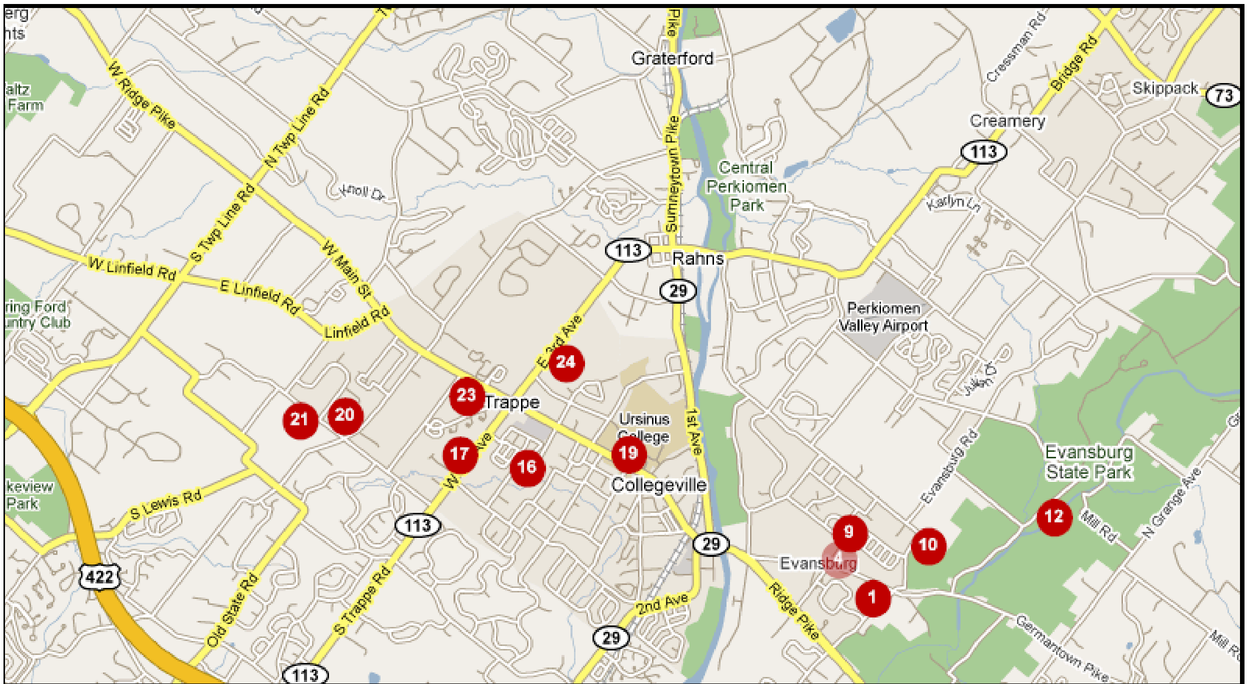
Figure 2c. Location of sampling sites and individual TCE values for 24-hour intensive sampling effort conducted in May of 2008.



Sampling Site Number	Location	TCE Concentration (ppbv)	Sampling Date
2	Locker Room Self Storage	0.01	8/18/08
		0.02	8/19/08
		0.04	8/20/08
8	Old Ballpark next to Superior	0.01	8/19/08
		0.10	8/20/08
16	Water Works Park	0.04	8/18/08
18	Jean Rosset French Memorial Park	0.02	8/18/08
19	Ursinus College	0.01	8/19/08
		0.01	8/22/08
		0.03	8/22/08
20	7th Ave Water tower	0.01	8/18/08
		0.20	8/19/08
		0.45	8/20/08
23	5th Ave Fire Station	2.20	8/18/08
		0.01	8/19/08
		1.40	8/20/08
Average[1]		**0.29**	
Median[1]		**0.03**	

[1] ½ the MDL was substituted for values that were non-detect

Figure 2d. Location of sampling sites and individual TCE values for 24-hour intensive sampling effort conducted in August of 2008.



Sampling Site Number	Location	TCE Concentration (ppbv)	Sampling Date
1	St. James Episcopal Church	0.03	11/17/08
		<0.02	11/18/08
4	Superior Tube Property	0.06	11/17/08
		<0.02	11/18/08
9	Superior Tube Property	0.03	11/19/08
10	Evansburg Pike & Skip View Ln	0.04	11/19/08
12	Evansburg SP Site	<0.02	11/17/08
		<0.02	11/20/08
16	Water Works Park	0.49	11/17/08
		0.08	11/18/08
17	VFW	3.10	11/17/08
		0.74	11/18/08
19	Collegeville Site	<0.02	11/17/08
		0.09	11/20/08
		0.08	11/20/08
20	7th Ave Water tower	<0.02	11/17/08
		<0.02	11/18/08
21	Borough Line Road Power Lines	<0.02	11/19/08
23	5th Ave Fire Station	0.56	11/19/08
24	South Elementary School	0.13	11/19/08
Average[1]		**0.28**	
Median[1]		**0.05**	

[1] ½ the MDL was substituted for values that were non-detect

Figure 2e. Location of sampling sites and individual TCE values for 24-hour intensive sampling effort conducted in November of 2008.

E. Technical Summary of Collocated Sampling

A second sampler was collocated at the Collegeville site (Ursinus College) and began operation on March 7, 2008. This sampler operated simultaneously with the original sampler that had been installed in 2007. Table 13 summarizes the comparison of paired results from these simultaneously operating samplers. In order to assess the precision of the samples, sampling periods were included if both a valid sample was available for the main and the collocated samplers during the same sampling period. Additionally, compounds with less than 10 paired values or with one or more values below the MDL were excluded from the analysis. Data for a total of 17 compounds met the above criteria.

In order to evaluate precision between the collocated samples the average percent difference, pooled standard deviation and 95% probability limits were calculated by compound. Precision refers to how well the air concentrations of a particular compound measured at the two identical samplers compare to each other. The results of the precision analysis show considerable variability among the 17 compounds. It is recommended that collocated samples should be within a +/- 15% probability interval estimate. Collocated data for two of the 17 compounds met this criteria which include dichlorodifluoromethane and trichlorofluoromethane. The probability limits for the other 15 compounds were outside this range. A portion of this variability may be explained by low concentrations and small sample sizes.

A paired t-test was performed on the data to evaluate whether there was a statistically significant difference between the collocated mean values by compound. Although the individual variation between sampling measurements was large as evidenced by the large probability limits, the overall mean differences between the paired samples were comparable. The results of the t-test show that no significant difference could be detected between the mean concentrations for each compound (results not shown).

Table 13. Comparison of data from collocated samplers at the Collegeville site.

Compound	Number of Data Pairs	Average (ppbv)		Average Percent Difference	Pooled Standard Deviation	95% Probability Limits	
		Main Sampler	Co-located Sampler			Lower Limit	Upper Limit
1,1,2-Trichloro-1,2,2-trifluoroethane	33	0.072	0.071	-1.9	10.7	-16.7	13.0
2-Butanone	33	1.55	1.39	-3.0	67.0	-95.8	89.8
Acetone	33	11.7	9.2	-16.1	55.4	-92.9	60.7
Benzene	28	0.157	0.153	-4.8	23.0	-36.6	27.1
Carbon tetrachloride	33	0.088	0.089	0.7	14.3	-19.2	20.6
Chloromethane	33	0.499	0.503	7.8	11.6	-16.1	16.0
Dichlorodifluoromethane	33	0.474	0.472	-0.5	4.1	-6.2	5.2
Ethylbenzene	14	0.056	0.062	9.1	29.5	-31.7	49.9
Methylene chloride	29	0.094	0.092	-2.2	14.9	-22.9	18.5
n-Heptane	20	0.093	0.113	21.0	49.6	-47.7	89.7
n-Hexane	19	0.107	0.106	-4.4	26.7	-41.4	32.6
Propene	30	0.980	0.981	-2.3	24.7	-36.5	32.0
Toluene	32	0.373	0.353	-1.7	51.0	-72.4	68.9
Trichloroethylene (TCE)	23	0.117	0.105	-13.4	36.0	-63.3	36.6
Trichlorofluoromethane	33	0.318	0.318	-0.1	6.9	-9.6	9.4
m&p-Xylene	22	0.137	0.141	4.3	33.0	-41.4	50.0
o-Xylene	15	0.060	0.056	-8.6	26.2	-44.8	27.7

F. Technical Summary of Trend Analysis

Trend analysis was performed to evaluate whether there was a positive or negative trend over time for TCE concentrations measured at the Collegeville and Evansburg State Park sampling sites (refer to Table 14 and Figures 3 and 4). The analyses followed the recommendations of Helsey, 2005. The Mann-Kendall test of trends was performed using Minitab statistical software. This is a non-parametric test for identifying trends in time series data. One benefit of this analysis is that the data need not follow a particular distribution. An additional advantage is that the analysis is not as sensitive to non-detect nor outlying values. A very high positive value of S, the Mann-Kendall statistic, is an indicator of an increasing trend, and a very low negative value indicates a decreasing trend. This should also be evaluated along with the p-value which indicates whether the trend is significant or not.

Prior to running the analysis, a Kruskal-Wallis test was performed to evaluate whether TCE concentrations varied across seasons of the year. This relationship was not found to be significant at the 95% confidence level at either site allowing for the use of a Mann-Kendall test for trends rather than a seasonal Kendall test. The result of running the Mann-Kendall test on the TCE data for Collegeville resulted in Mann-Kendall test statistics ranging between -2.9 and -3.97 indicating negative downward trends (refer to Table 14). Additionally, all analyses resulted in p-values less than 0.05 indicating a strong probability (at the 95% level) that a negative trend in the data exists. This trend held true regardless of whether the dataset included or excluded an outlying value of 18 ppbv (measured on 6/29/07) and whether ½ MDL was substituted for non-detect values or not.

A downward trend in TCE concentration over time was also observed for the Evansburg State Park sampling site where the probability of a negative trend over time was significant at the 95 % confidence level (refer to Table 14). Outlying values were not excluded from this analysis. Figures 3 and 4 show the data fitted with a Kendall-Theil line demonstrating the downward trend in TCE concentrations over the sampling period. Kendall-Theil lines were fitted to the data using Kendall-Theil Robust Line software available from the United States Geological Services (USGS, 2009a).

Table 14. Summary of Mann-Kendall statistical analyses on the measured TCE concentration at the Collegeville and Evansburg SP sites.

Data Description	Mann-Kendall Statistic (S)	p-Value	Number of Values
Collegeville (2007 – 2008)			
All data with ½ the MDL substituted for ND values	-3.11	0.0009	101
All data with ½ the MDL substituted for ND values and excluding an outlying value of 18 ppbv	-2.90	0.002	100
All data above the MDL (excluding all non-detect values)	-3.67	0.0001	79
All data above the MDL and excluding an outlying value of 18 ppbv	-3.44	0.0003	78
Evansburg SP (2005-2008)			
All data with ½ the MDL substituted for ND values	-4.50	<0.0001	253
All data above the MDL (excluding non-detects)	-5.21	<0.0001	127

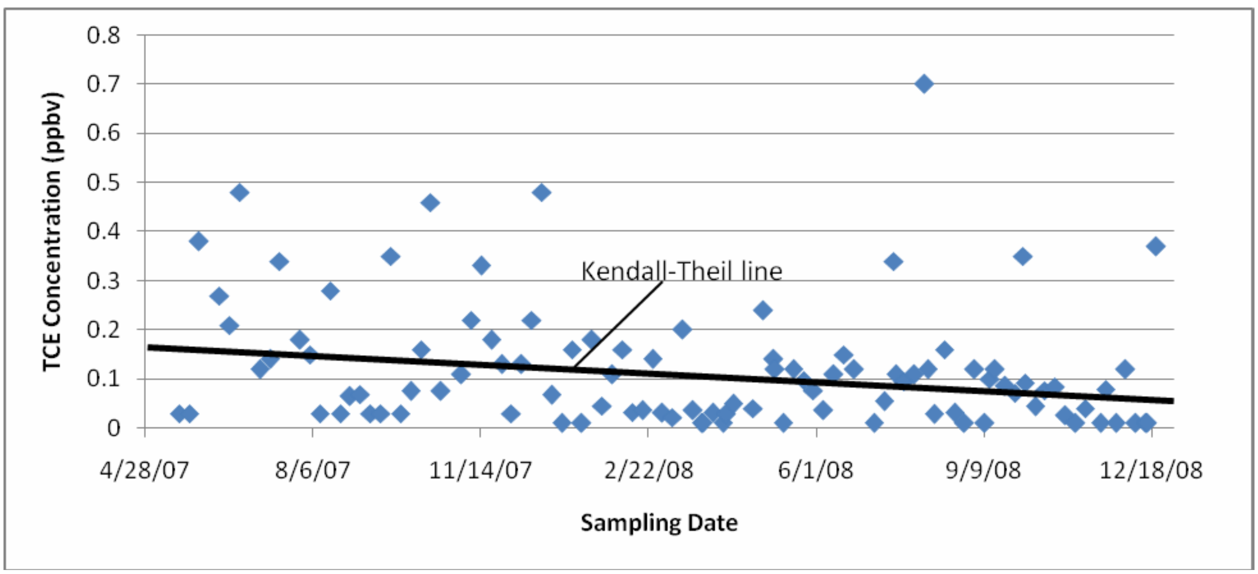


Figure 3. Scatterplot of TCE concentrations measured at the Collegeville site over time. This graph includes ½ the MDL substituted for non-detect vales and excludes the outlier of 18 ppbv obtained on 2007. The Kendall-Theil line has been fitted to the data.

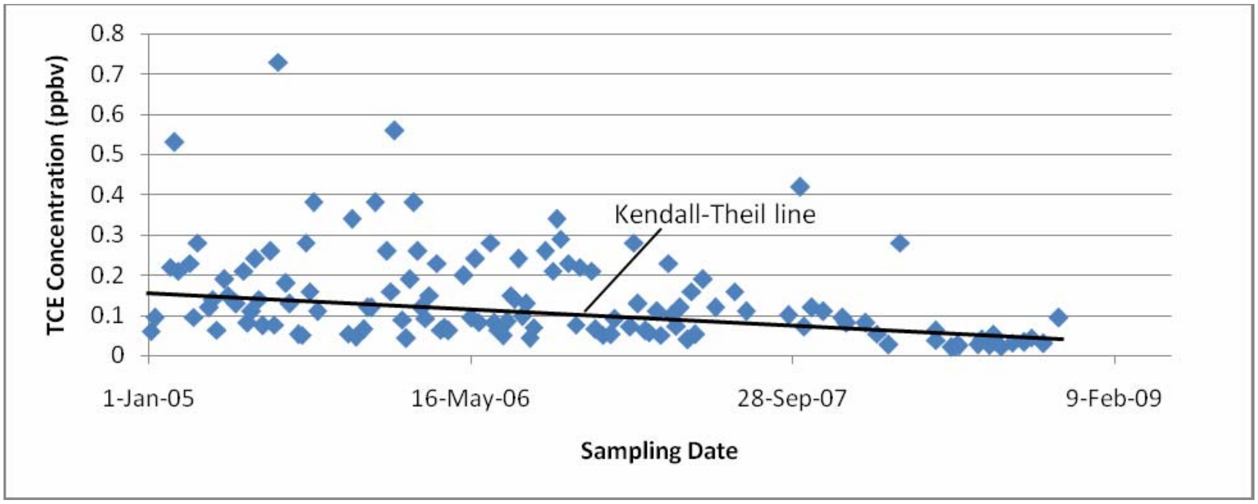


Figure 4. Scatterplot of TCE concentrations measured at the Evansburg SP site over time. This graph includes ½ the MDL substituted for non-detect values. The Kendall-Theil line has been fitted to the data.

G. Technical Summary of Air Dispersion Modeling

Overview

Air dispersion modeling was conducted using AERMOD View modeling software which is a commercially available interface that integrates the various components of the AERMOD software developed and distributed by the Environmental Protection Agency (EPA) (EPA, 2008). This software is used for modeling short-range dispersion from stationary industrial sources and is considered to be the industry standard for conducting such analyses. The overall goal of utilizing this model was to determine the pollutant concentration at various locations from the source taking into consideration emission source number and characteristics, meteorological information, terrain details and building downwash potential.

The following represents a summary of the assumptions that were included in the model.

- The emissions data for TCE for January 1 through June 30, 2009 was typical and representative of future emissions.
- The TCE emissions from Superior Tube were considered to be negligible (approximately 15 pounds/month) and were not included in the model.
- The modeling region was assumed to be rural based on predominate land use characteristics.
- Fugitive and stack emission sources were assigned a proportion of emission rates based on the efficiency of the carbon adsorbers (air pollution control devices installed by Accellent to reduce TCE emissions).
- Monthly emissions were discounted by the fraction of actual operating hours on a monthly basis since the facility did not operate on a 24-hour basis.
- Building downwash was significant and included in the model.
- Emission sources with horizontal release and subject to building downwash were assigned a velocity of 0.001 meters per second (based on EPA guidelines).
- Meteorological data from the Limerick Generating Station for a three-year period (2006 through 2008) is representative of the meteorological conditions within the modeling domain.
- All emission sources were modeled as point sources.
- Receptors (locations) within the plant boundaries were not representative of a typical residential exposure and thus were removed from the final output. Fence line receptors were placed 25 meters apart around the plant perimeter to represent locations with maximum exposures.

Modeling Region and Spatial Distribution

A modeling region was set up to evaluate the TCE concentrations within the Collegeville area. This region included a 3.5 kilometer square with the center located within the property of the Accellent facility (refer to Figure 5). This area was modeled as a rural location using the land use classification system outlined by Auer (EPA, 2008). The dispersion model was run to evaluate the spatial distribution of TCE concentrations at 951 locations (receptors) within the modeling region. Receptor locations within the plant boundary of the Accellent facility (a total of 7) were removed from the model. A total of 52 receptors were placed 25 meters apart along the plant perimeter.

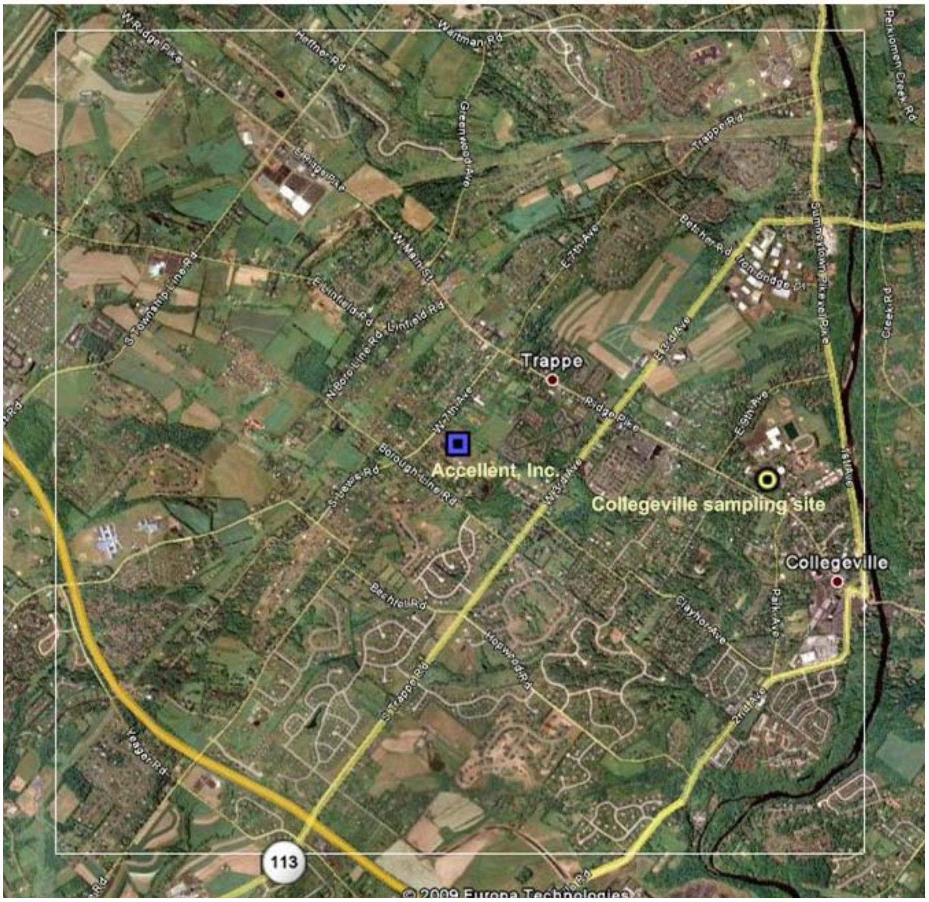


Figure 5. Map of modeling region. This aerial photograph shows the locations of the Accellent facility, the Collegeville sampling site and the extents of the modeling region (bounded by square).

Model Inputs

Meteorological data

Surface meteorological data was obtained from two separate meteorological stations located at the Limerick Generating Station for January 1, 2006 through December 31, 2008. The two meteorological stations are located approximately 5 ½ miles northwest of the center of the modeling domain. Figure 6 displays the wind rose summary for the surface data from the Limerick Generating station meteorological site. Upper air soundings data was obtained from the National Climate Data Center. The soundings were measured at the Phillips Air Force Base located in Aberdeen, Maryland and included the same three-year period as the surface data.

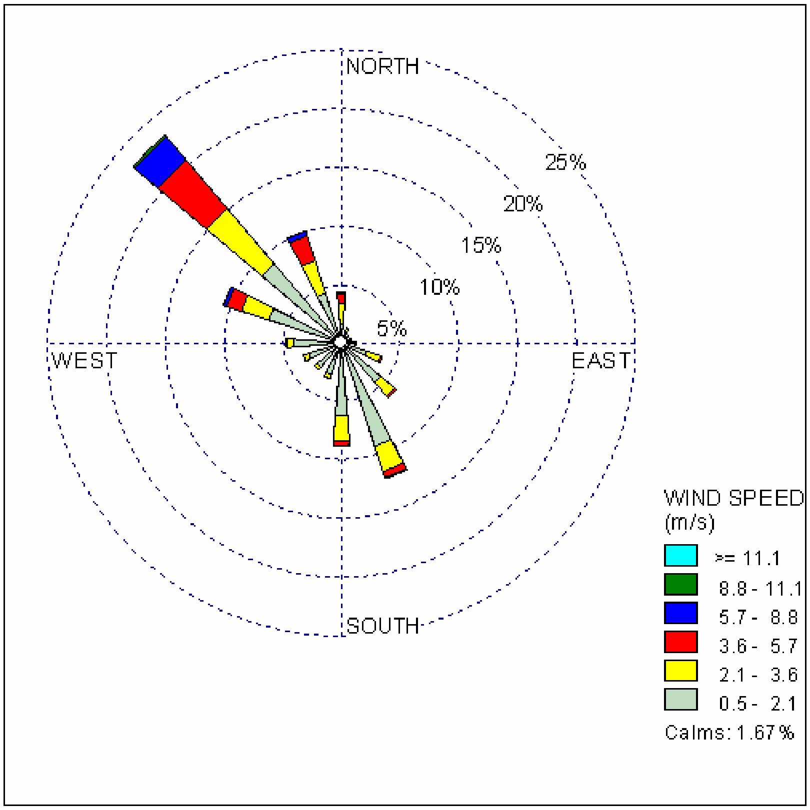


Figure 6. Wind rose for meteorological data collected at the Limerick Generating Station (2006 through 2008). The wind rose represents the direction the wind is blowing from.

Terrain and Land Cover Data

Land cover data for the modeling domain was obtained from the United States Geological Survey (USGS) National Land Cover Database, 2001 archives (USGS, 2009b). Terrain data in National Elevation Data format was gathered from the USGS website (USGS 2009c). This data contains information on topographical features of both the sampling and receptor area since these details can have a significant effect on the dispersion and subsequent pollutant concentration at ground level.

Facility and Emission Source Data

Building dimensions, stack characteristics and locations, and TCE emission information for the Accellent, Inc. facility were obtained through information supplied by facility personnel and through direct measurement. Stack diameters, heights and velocity were directly measured. One exhaust fan with a cap and horizontal release and subject to building downwash, was assigned a velocity of 0.001 m/sec as recommended by EPA.

Table 15 summarizes the emission sources included in the model and the estimated percentage of TCE emissions assigned to each emission source. In order to determine the TCE emission rate for each source, the reported emissions in pounds per year were divided by the total hours of operation for each process. The determination of emission rates per source were determined by weighting each emission source according to the estimated proportions summarized in Table 16.

Table 15. Summary of 2009 TCE emissions by month at Accellent, Inc. from each of the three sources.

	Plant 1 Degreaser		Plant 2 Degreaser		Fab Degreaser	
Month	**Tons**	**Hours**	**Tons**	**Hours**	**Tons**	**Hours**
Jan-09	0.9	587.5	3.0	577.2	0.2	533.5
Feb-09	0.2	616.25	0.6	518	0.0	523.8
Mar-09	0.7	673.5	1.8	599.5	0.1	642
Apr-09	0.6	588.9	1.6	604.8	0.1	548.1
May-09	0.5	647	1.4	597	0.1	562.8
Jun-09	0.8	606.5	1.9	694	0.2	599.3
Total	**3.6**	**3720**	**10.2**	**3591**	**0.88**	**3410**

Table 16. Summary of the proportion of TCE emissions estimated for each emission source.

	Estimated % of Emissions Assigned to Each Component[1]		
Component	**Plant 1 Degreaser**	**Plant 2 Degreaser**	**Fab Degreaser**
Plant 1 Carbon Adsorber Stack (CAS)	10%	42%	0%
Plant 2 Vertical Roof Stack[2]	0%	29%	0%
Fugitive/Horizontal Exhausters	90%	29%	100%
Total Emissions	100%	100%	100%

[1] Considered representative due to CAS systems being on-line for 12 full months before end of June, 2009.
[2] Assumes 50% of fugitive emissions are exhausted from basement corner exhaust to roof stack (conservative estimate because this includes greater than half of basement exhaust flow).

The Building Input Profile Program was utilized to determine whether the wake effect of nearby structures was significant enough to have an effect on the movement of the pollutants from an emission source. This phenomenon, referred to as building downwash, serves to increase the concentration of pollutants as it moves the plume closer to ground level.

Modeling Results

The model was run to incorporate the 24-hour time-weighted averages as that of the permanent and temporary sampling sites within the Collegeville area. Annual average TCE concentrations estimated by the model are appropriate for calculating excess lifetime cancer risks due to inhalation exposure to TCE. Table 17 summarizes the modeling results for the average annual TCE concentrations and associated cancer risk values. The highest modeled average annual TCE concentration in the modeling region was determined to be 4.6 ppbv occurring at a location at the Accellent facility perimeter (refer to Figure 7). The minimum concentration in the modeling region was 0.02 ppbv and found at locations 1.5 kilometers and greater from the facility. These minimum and maximum TCE values correspond to an excess lifetime cancer risk ranging from 0.1 to 28 in 10,000 population. The average TCE concentration across the entire modeling domain was estimated to be 0.31 ppbv which corresponds to an excess lifetime cancer risk of 1.9 per 10,000.

Table 17. Summary of modeling results for average annual TCE concentrations.

Parameter	Average Annual TCE Concentration (ppbv)	Excess Lifetime Cancer Risk (per 10,000 population)
Maximum value in modeling region	4.6	28
2nd highest value in modeling region	4.1	25
Minimum value in modeling region	0.02	0.1
Average value in modeling region	0.31	1.9

All of the modeled annual average TCE concentrations (4.6 ppbv and less) were lower than the reference concentration (40 $\mu g/m^3$ or 7.5 ppbv) for TCE. Therefore, the model did not predict TCE concentrations within the modeling region that are likely to result in chronic non-cancer health risks.

Figure 8 displays the maximum modeled daily (24-hour) TCE concentrations for the modeling region. Maximum 24-hour values can be compared to the minimal risk levels for non-cancer health risks. The acute and intermediate MRLs for TCE are 2,000 ppbv and 100 ppbv respectively as discussed on page 37 of this report. The maximum TCE concentration estimated by the model was 25.1 ppbv which is lower than either of these MRL values. The highest modeled concentrations were located on the Accellent facility perimeter.

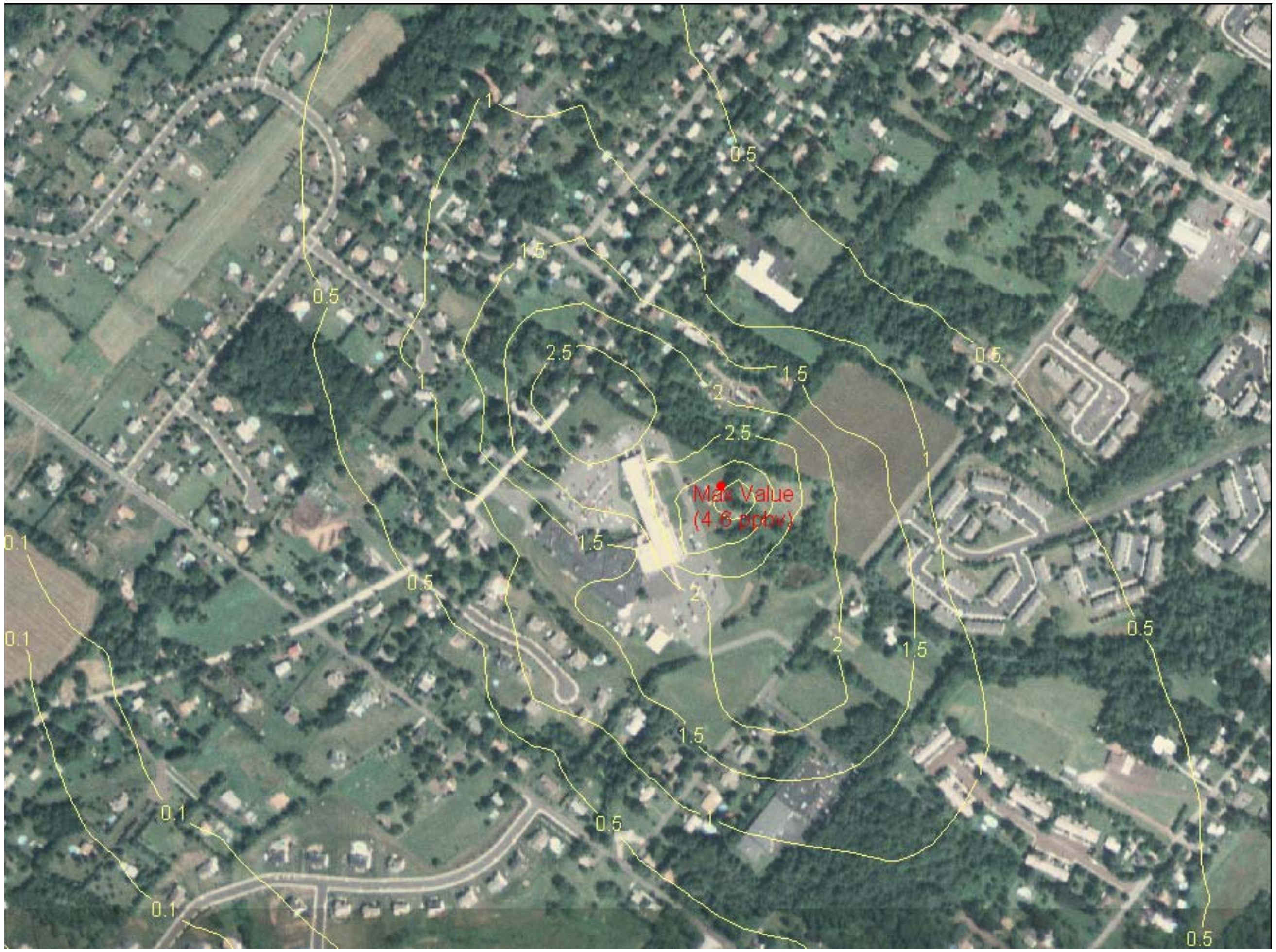


Figure 7. Modeled yearly average TCE concentration contours (ppbv) near the Accellent, Inc. facility. The location of the highest modeled concentration is shown in red. This graphic represent a geographic area approximately 1500 m x 1150 m.

Figure 8. Modeled maximum 24-hour TCE concentration contours (ppbv). The location of the highest modeled concentration is shown in red. This graphic represents a geographic area approximately 1500 m x 1150 m.

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