FIELD TEST OF AN ULTRAVIOLET DIFFERENTIAL OPTICAL ABSORPTION SPECTROMETER FOR REMOTE AIR TOXICS SENSING

BY

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LIST OF ABBREVIATIONS

ENE	East Northeast
ESE	East Southeast
IEPA	Illinois Environmental Protection Agency
m-xylene	Meta Xylene
NO_2	Nitrogen Dioxide
NO_X	Nitrogen Oxides
NNE	North Northeast
NNW	North Northwest
O_3	Ozone
ppbC	Parts Per Billion of Carbon
ppm	Parts Per Million
ppt	Parts Per Trillion
SSE	South Southeast
SSW	South Southwest
ug/m^3	Micrograms Per Meter Cubed
US E.P.A.	United States Environmental Protection Agency
UV-DOAS	Ultraviolet Differential Optical Absorption Spectrometer
VOC	Volatile Organic Compound
WSW	West Southwest
WNW	West Northwest

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SUMMARY

Emergency response teams and site remediation personnel faced with fugitive toxic air emissions need a monitoring tool that can continuously identify and quantify hazardous air pollutants in real time. The ultraviolet differential optical absorption spectrometer (UV-DOAS) provides this capability by using a projector fitted with a Xenon vapor lamp, which transmits an ultraviolet light beam to a spectrometer built within a receiver. The spectrum's narrow absorption bands are analyzed, various gases are identified, and the concentrations of these gases are detected simultaneously.

This study demonstrates and evaluates the use of UV-DOAS during and after capping and slope stabilization activities at the Paxton landfill in southeast Chicago. Due to the temporary nature of this project, the projector was bolted onto a wooden pallet, which was secured to the roof of one trailer located on the north end of the landfill, and the receiver was placed near an open window inside another trailer situated at the south end of the landfill. With a monitoring path length of 232 meters and located along the fence line of the landfill, the UV-DOAS reported concentrations of benzene, toluene, m-xylene, styrene, ozone, and nitrogen dioxide every three minutes. The UV-DOAS concentrations for the organic compounds were compared with the data obtained from VOC canister samples placed along the beam path. Ultraviolet differential optical absorption spectrometry concentrations for nitrogen dioxide and ozone were compared with data obtained from a TECO 42 NO_x monitor and a Dasibi Model 1003 AH ozone monitor.

Based on our experiences, we found that maintaining the UV-DOAS often involved more than one person and was time consuming. Specific maintenance activities included: aligning the projected ultraviolet beam with the receiver, changing the bulb for the lamp, fuse, mirror, and power supply, as well as sanding down the lamp's anode and cathode connectors to eliminate corrosion. It took more than 130 person-hours and over 25 site visits to maintain the UV-DOAS. Total UV-DOAS monitoring time during the study was 235 hours. When detecting benzene, toluene, m-xylene, and styrene, our results show no association between the UV-DOAS and the VOC canister samples. However, when detecting nitrogen dioxide and ozone, a strong association was seen between the UV-DOAS and the direct reading monitors.

It is necessary that the UV-DOAS be installed on a stable platform (i.e. embedded in concrete or installed in a tower), so as to obtain accurate and reliable data. Most importantly, two operators are required to maintain this remote sensing device, especially when realigning the projected beam with the receiver. Based on our experiences, the UV-DOAS may not be appropriate for temporary use or in emergency response situations.

Even though a strong association was demonstrated between the NO_2 and O_3 detected by UV-DOAS and the direct reading monitors, the UV-DOAS did not detect organic compound concentrations comparable to those detected by the canister samples. Therefore, our data suggest that the UV-DOAS may not be suitable for organic compound measurements.

I. INTRODUCTION

A. Rationale

Potential advantages of a remote sensing device are as follows:

- The user does not physically have to be at the exact location
- It can monitor continuously (or semi-continuously)
- It can detect fugitive emissions

The ultraviolet differential optical absorption spectrometer (UV-DOAS) is a type of remote sensing device. The UV-DOAS has been reputed to simultaneously detect various compounds, such as volatile organic compounds, ozone, sulfur dioxide, and nitrogen dioxide. In order to test such a device, a widely dispersed pollution source is required. For this project, a landfill was chosen as the pollution source.

B. Objectives

In order to evaluate the strengths and limitations of the SANOA UV-DOAS, the air monitoring results were compared to the data obtained by a Dasibi Model 1003AH ozone monitor, a TECO 42 nitrogen oxides monitor, as well as the volatile organic compounds (VOCs) from whole air samples collected in stainless steel canisters.

C. Background

The SANOA multi gas long path air quality monitoring system is designed to detect a number of major pollutants through ultraviolet differential optical absorption spectrometer (UV-DOAS) (Environnement S.A., 1997; Brocco et al., 1997). The basis for the UV-DOAS method is the ability of various compounds to absorb light within a wavelength range of 240-340nm (ultraviolet to visible). Aromatic hydrocarbons, such as benzene, are detected in a wavelength range of 250 and 290nm (Brocco et al., 1997; Barrefors, 1996). The absorption along the light path is proportional to the absorptivity and concentration of the compound, as well as the length of the path (Barrefors, 1996). UV-DOAS determinations of concentration are based on the Beer-Lambert's Law expressed as:

$$I(\lambda) = I_o(\lambda) \exp\left[-L \times \sigma(\lambda) \times C \right] \quad \textbf{(1)}$$

where $I(\lambda)$ = absorption spectrum in presence of pollutants, $I_o(\lambda)$ = emission spectrum, C = compound concentration, L = optical path length, and $\sigma(\lambda)$ = pollutant cross-section or absorption characteristic (Environnement S.A., 1997). For UV-DOAS applications, the above equation is expressed as:

$$\Delta \Sigma(\lambda) = \Delta \log \left(\frac{I_o(\lambda)}{I(\lambda)} \right) = L \times C \times \Delta \sigma(\lambda) \qquad \textbf{(2)}$$

In order to study the quantity of gas in the atmosphere, the atmospheric absorption differential spectrum, $\Delta\Sigma(\lambda)$, is compared to the differential cross sections, $\Delta\sigma(\lambda)$ (Environnement S.A., 1997).

In contrast to other air monitoring techniques that detect the concentrations of a single or small set of compounds, the UV-DOAS offers continuous measurement of ozone, nitrogen dioxide, sulfur dioxide, and volatile organic compounds simultaneously (Brocco et al., 1997; Chanda et al., 1997; Environnement S.A., 1997). Unlike gas chromatography (combined either with flame ionization detection, photoionization detection, or mass spectrometry), the UV-DOAS provides direct in-situ detection without any complications due to chemical loss in the sampling procedures (Volkamer et al., 1998). However, the detection limits for gas chromatography (0.3 – 1.2 ppt) may be more sensitive than the UV-DOAS (for a path length of 500m, the detection limit ranges from 0.2 – 1.1ppb) (Volkamer et al., 1998; Environnement S.A., 1997). Furthermore, when compared to other long-path remote sensing devices, such as the Non-Dispersive Infrared or the Fourier Transform Infrared, the UV-DOAS detection limits have fewer interferences occurring and appear to be more sensitive (Volkamer et al., 1998; Chandra et al., 1997).

But despite the UV-DOAS' capability to quantify simultaneously air pollutants up to a path length of 500 meters, there have been reported problems associated with the quality of the measurements. Volkamer (et al., 1998) identifies oxygen as a potential interference with DOAS measurements of aromatic hydrocarbons species. In most cases, oxygen absorption in a measured spectrum will be stronger by an order of magnitude than the aromatic absorption features (Volkamer et al., 1998). In a study conducted by Barrefors, poor correlation was found between the DOAS data and from simultaneously measured gas chromatography data (1996). Because the adsorbent tube samples taken at several points along the DOAS light path did not show any significant differences in the hydrocarbon concentrations, Barrefors could not attribute the lack of correlation in the DOAS and gas chromatography data to the inhomogenities of the atmosphere (1996). However, Barrefors suggests that the incorrect DOAS results may be due to the presence of several hydrocarbons with similar spectra [giving] rise to severe interference effects (1996).

It is expected that the spectrum analysis procedure specific to the SANOA UV-DOAS would eliminate the interferences between different pollutants. The aim of this study was to evaluate the SANOA UV-DOAS measurements along the fence line of the Paxton landfill, a site undergoing remediation, as well as to determine if the instrument is suitable for monitoring hazardous air pollutants at Superfund sites or toxic emissions arising from emergency response situations.

II. METHODOLOGY

A. Design

The SANOA UV-DOAS consists of three components: a receiver containing the spectrometer, an ultraviolet beam projector, and a computer system with the Vision Air software installed. As seen in Figure 1, the projector, fitted with a xenon vapor lamp, sends out a beam of ultraviolet light ranging between 200 nanometers to 800 nanometers towards the receiver. Inside the projector is a mirror fitted with a ball-and-socket joint which can be easily oriented using the two micrometer screws located in the back (Environnement S.A., 1997). These screws allow the UV-DOAS operator to properly focus the UV beam onto the inlet mirror of the receiver. The second component of the UV-DOAS, the receiver or the measuring unit, is shown in Figure 2. This particular part of the remote sensing device uses the inlet mirror to capture the spectrum of light and directs it into the entrance slit of the spectrometer (Environnement S.A., 1997). After a photodiode array detector measures the diffracted light, the spectrum is sent for analysis to the SANOA Vision Air software. Key functions of the Vision Air software include:

- Configuration set-up of the SANOA UV-DOAS
- Calculation of measured concentrations
- Spectra loading and analysis
- Display of results: creation of tables and graphs

B. Setting

The SANOA UV-DOAS was installed at the Paxton Landfill (see Figure 3), which is located on the southeast side of Chicago. Shut down in 1992 by the Illinois Environmental Protection Agency (IEPA), Paxton II underwent remediation and the leachate at this particular landfill was pumped out periodically in order to stabilize the structure. As a result of the leachate removal, the landfill readily emits volatile organic compounds (VOCs), specifically toluene. The landfill itself is divided into two areas: Paxton II, which stands 170 feet tall, was improperly constructed and at risk of collapsing, and Paxton I, where the SANOA UV-DOAS was set up. The various industries that surround the Paxton landfill are as follows: to the east is a coke oven plant, to the north is a metal processing company, to the south is an environmental waste treatment facility, and to the southwest is another operating landfill.

Figure 4 shows the general set-up of the SANOA UV-DOAS, which involved two trailers separated by an optical path length of 232 meters (820 feet). On the south end of the Paxton site, Trailer #1 housed the computer system, as well as the receiver, which was situated on a tabletop and facing an open window. Trailer #2, located on the north end of the Paxton site, contained the direct reading instruments for ozone and nitrogen dioxide (see Figure 5). The SANOA ultraviolet beam projector was bolted down to a wooden pallet, which was secured to the top of Trailer #2. Located approximately 10 feet south of Trailer #2 was the Campbell Scientific Inc. Portable Meteorological Station, which detected the wind direction and wind speed.

C. Calibration Procedures

In order to improve the accuracy of the measurements recorded by the UV-DOAS and direct reading monitors, it was necessary to perform a zero and span check. In doing this one is able to track the drift or change of the response of automated analyzers over time (E. Roberts Alley & Associates, 1998).

1. Ultraviolet Differential Optical Absorption Spectrometer Calibration

For this study the UV-DOAS was calibrated for benzene and toluene on April 7, 2000 and April 13, 2000. The calibration process involved simulating, with a 34 mm long built-in cell, a given pollution concentration over the optical monitoring path of 232 meters (Environnement S.A., 1997). The scheme implies that the simulated concentration is added to an existing background concentration and doesn't replace the ambient concentration (Environnement S.A., 1997).

Before performing the zero and span gas check, the UV-DOAS must be allowed to run for at least 20 minutes. Temperature and pressure in hPa should be recorded. Also, one must verify the ambient pollution is typically 15% of the maximum concentrations observed usually (Environnement S.A., 1997). The calibration process began with purging the built-in calibration cell with zero air, which in this case was ambient air. After 15 minutes, the last 5 measurements and the time detected were recorded and the average background concentration was calculated. Next, span gas from a certified standard gas cylinder was introduced, with a flow rate of 0.5 liters per minute, into the calibration cell. Again, after 15 minutes, the last 5 measurements and the time detected were recorded and the average calibration concentration was calculated. Finally, the calibration cell was purged with ambient air for another 15 minutes. Another average background concentration was recorded.

Summarized in Table I, results from the calibration were entered into a span check data spreadsheet, which calculated the span factor adjustment. The detailed span check data sheets may be found in Figures 33 to 36, Appendix A. It is recommended by the manufacturer that the new span factor be used in the configuration system of the UV-DOAS when the following conditions occur (Environnement S.A., 1997):

- Low pollution background is < 15% of the maximum concentrations measured and low background instability is < 20%
- Good repeatability of results over several span steps, better than the difference with current span factor
- The difference between the current and new span factor is greater than 4%

If the resulting span factor is not within the range of 0.7 and 1.3, then the manufacturer should be consulted for a system check.

TABLE I UV-DOAS CALIBRATION DATA

Compound	Date	Background 1 (ug/m3)	Calibration (ug/m3)	Background 2 (ug/m3)	Current span factor	New Span Factor	Adjusted (YES or NO)
BENZENE	4/7/00	23.36	72.82	26.42	1.0	1.040	NO
	4/13/00	7.96	57.302	13.596	1.0	1.031	NO
TOLUENE	4/7/00	21.03	56.26	14.98	1.0	1.501	YES
	4/13/00	5.4	50.47	4.598	1.0	1.218	YES

2. Nitrogen Oxides Monitor Calibration

Using the manual or multipoint method, the TECO 42 NOx monitor was calibrated on January 25, 2000 and March 29, 2000. Multipoint calibrations are made by challenging the analyzer with several different known concentrations, noting the response, and changing the offset and range of the analyzer to show linearity across the spectrum of concentrations introduced (E. Roberts Alley & Associates Inc., 1998). NOx calibration data may be found in Table IX, Appendix B.

3. Ozone Monitor Calibration

The primary calibration for the Dasibi Model 1003AH ozone monitor occurred on October 12, 1999. The calibration was performed as follows (Dasibi Environmental Corporation, 1997):

- Allow the monitor to warm up for at least 30 minutes.
- Assemble ozone source and prepare a KI set-up or UV photometer (your reference)
- Set zero offset adjustment switch to zero and the mode selector to SPAN
- Subtract 0.05 from the display and record this as the span number.
- Set the mode selector switch to OPERATE
- With zero air flowing allow monitor to stabilize. Average 10 display readings for (about 4 minutes) to obtain the zero reading. Simultaneously, read the reference.
- Set ozone generator until a reading of 0.4ppm is seen. Allow reading to stabilize. Average the 10 display readings and obtain reading from reference.
- Repeat process three times for points between 0 and 0.4 ppm.
- Determine slope and interce pt by performing a least squares analysis.
- The intercept is the true zero offset plus the 0.05 ppm. Based on the slope and old span factor, a new span factor is calculated using the equation:
  NEW SPAN FACTOR = OLD SPAN FACTOR / SLOPE

The ozone calibration data may be found in Table X, Appendix B.

D. Procedures

Data collection occurred over a period of 11 days. Table II summarizes the number of hours of data collected from the UV-DOAS and direct reading monitors, as well as the number of canister samples collected. A detailed log of the canister sample collection may be found in Table IX of the Appendix B.

TABLE II MONITORING SCHEDULE

HOURS OF MONITORING			Number of Canisters Collected
UV- DOAS	TECO 42 NOx Monitor	Dasibi Model 1003AH Ozone Monitor	
0	0	0	2
0	0	0	4
0	24	24	3
24	24	24	12
24	24	24	12
15	24	24	6
14	24	24	6
24	24	24	3
24	24	24	6
24	24	24	9
24	21	24	9
24	20	24	4
24	23	24	6
14	12	12	8
235	268	276	90

The first part of the study involved detecting NO_2 and O_3 simultaneously with direct reading monitors and the UV-DOAS. Nitrogen dioxide concentrations were analyzed by the TECO 42 NO_x monitor. The Dasibi Model 1003AH monitor analyzed atmospheric concentrations of ozone. The direct reading monitors, both configured to detect hourly average concentrations, were set-up inside Trailer #2.

Benzene, toluene, m-xylene, and styrene were measured simultaneously with the UV-DOAS and VOC canisters. The UV-DOAS detected these particular compounds every three minutes; thus, it was necessary to average the values in order to determine the hourly concentrations. Each electro-polished stainless steel canister, as seen in Figure 6, collected an ambient VOC sample for one hour.

During each one-hour sampling period, three canisters were placed between the two trailers at three different locations along the UV beam. Canister location #1 was positioned at the south end, approximately 20 to 30 feet from Trailer #1. Canister location #2 was in the middle, approximately 500 feet away from both Trailer #1 and Trailer #2. Canister location #3 was positioned at the north end, approximately 20 to 30 feet from Trailer #2. In addition to collecting along the projected beam, canister samples placed near the leachate collection wells, downwind and upwind were obtained when winds were blowing from the northwest, southwest, and east. This type of collection helped characterize the background concentrations coming from the Paxton landfill. After the sampling, the canisters were shipped to the IEPA Springfield laboratories for gas chromatography analysis with flame ionization and electron capture detection. A 57-hydrocarbon standard was applied to the data, with units of the concentration in ppbc (parts per billion of carbon) (Dombro et al, 2000).

Wind data were also collected throughout this study in order to try to locate possible sources of the VOCs detected by the UV-DOAS and the reference methods. Due to technical difficulties with the meteorological station at the Paxton site, we were unable to collect wind data from March 31, 2000 to April 23, 2000. For this particular time period we used the wind data collected from the Illinois EPA meteorological station located in Alsip, Illinois. However, once the meteorological station at Paxton was configured properly, wind data collection resumed on April 24. In addition to keeping track of the concentrations detected by the UV-DOAS, direct reading monitor and canister samples, a log of events regarding the project was recorded (Appendix B). The log contains information such as events leading to the preparation and installation of the UV-DOAS, the number of alignments performed on the UV-DOAS, total visits needed to perform alignments, total number of person-hours spent aligning, total visits needed to maintain and calibrate the UV-DOAS, total number of person-hours spent maintaining and calibrating the UV-DOAS, light intensity, how many canisters were collected on a particular day, where the canisters were located, when canister samples were collected, as well as wind direction.

Figure 1. UV-DOAS Projector on the roof of Trailer #2.

Figure 2. UV-DOAS Receiver inside Trailer #1.

Figure 3. Paxton Landfill, Chicago, Illinois.

Figure 4. Location of trailers at the Paxton Landfill. Trailer #1 (on the right) and Trailer #2 (in the background) are separated by a distance of 232 meters.

Figure 5. TECO 42 NOx Monitor (on the right) and Dasibi Model 1003AH Ozone Monitor (on the left) inside Trailer # 2.

Figure 6. VOC Canister Sample.

III. RESULTS

As seen in Table III, ozone (O_3) and nitrogen dioxide (NO_2) were measured continuously and simultaneously with the UV-DOAS and direct reading instruments. One hour average O_3 and NO_2 concentrations were compared with the hourly averaged UV-DOAS data. One-hour UV-DOAS averages for organic compounds were also compared with the canister samples. The UV-DOAS results are reported on the basis of the ambient plus 5 degrees Celsius. The canister samples are reported on the basis of 25 degrees Celsius. The maximum adjustment in the UV-DOAS concentrations due to these differences in temperature would be less than 3% for these data. Table IV displays the one-hour average concentrations for benzene, toluene, and m-xylene detected for the specified time period. The data for styrene may be found in Table X, Appendix B. Table V shows the background concentrations detected from the canister samples.

Tables VI and VII provide an overview of events occurring throughout this study. In Table VI, a standard version of the activity log indicates the specific situation that occurred on each day and the number of person hours spent at the site. There are three types of events summarized in Table VI: Site Preparation (i.e. installation of the UV-DOAS or placement of the trailers), Equipment Maintenance (i.e. realigning the UV beam with the receiver), and Monitoring (i.e. collecting canister samples and valid UV-DOAS data). A summary of hours spent aligning the projector with the receiver and maintaining the UV-DOAS, as well as the number of site visits required to perform these maintenance operations is found in Table VII. Table XI of the Appendix B is the detailed log of activities occurring throughout this study.

TABLE III NITROGEN DIOXIDE AND OZONE DATA (ug/m3)

Date	Wind Direction	Hour [a]	Nitrogen Dioxide		Ozone	
			Direct Reading Monitor	UV-DOAS	Direct Reading Monitor	UV-DOAS
9-Apr-00	SSW	0	77.57	89.33	4.10	12.76
	SSW	1	72.14	82.06	6.15	13.23
	SSW	2	67.66	75.40	8.21	16.35
	SSW	3	50.37	70.41	18.48	18.84
	SSW	4	36.39	53.12	36.95	23.03
	SSW	5	26.94	37.47	53.35	39.12
	WSW	6	16.90	30.14	55.35	46.97
	WSW	7	21.58	20.34	49.13	50.59
	WSW	8	25.64	23.01	59.23	48.53
	WNW	9	24.19	25.46	65.14	55.94
	WNW	10	20.99	22.99	70.99	60.54
	WNW	11	20.15	18.19	72.79	66.12
	WNW	12	18.92	15.65	76.57	68.38

TABLE III NITROGEN DIOXIDE AND OZONE DATA (ug/m3)

Date	Wind Direction	Hour [a]	Nitrogen Dioxide		Ozone	
			Direct Reading Monitor	UV-DOAS	Direct Reading Monitor	UV-DOAS
	WNW	13	15.41	13.50	86.45	72.68
	NNW	14	26.45	7.29	81.99	80.35
	NNW	15	34.23	21.49	65.85	74.40
	ENE	16	16.60	3.86	85.62	97.07
	ENE	17	17.73	16.16	77.58	82.89
	ENE	18	35.65	22.10	57.69	85.76
	ESE	19	35.48	42.56	51.75	61.05
	NNW	20	40.52	40.27	37.90	49.58
	NNE	21	86.26	44.05	4.00	36.10
	NNW	22	87.31	80.22	4.01	17.18
	WSW	23	87.78	100.03	6.04	11.47
10-Apr-00	WNW	0	85.71	96.99	4.04	13.91
	NNW	1	70.61	102.24	14.17	11.76
	ENE	2	27.81	84.95	56.83	28.09
	NNE	3	24.17	28.32	54.92	71.72
	NNE	4	26.95	29.23	52.97	64.90
	ENE	5	31.48	26.77	46.93	66.17
	ENE	6	35.43	38.99	42.89	55.29
	ENE	7	31.93	40.92	51.10	54.43
	ENE	8	27.03	33.63	57.22	61.23
	ENE	9	23.29	29.41	61.28	65.95
	ENE	10	15.85	27.64	69.42	69.22
	ENE	11	35.21	23.47	53.08	75.13
	ENE	12	66.67	42.66	28.56	60.12
	ENE	13	41.42	69.53	48.93	40.74
	ENE	14	43.15	49.52	46.86	57.10
	ENE	15	52.67	54.06	42.75	48.20
	ENE	16	45.83	51.38	46.81	53.24
	ENE	17	38.62	46.03	50.89	55.26
	ENE	18	44.30	44.23	48.88	58.36
	ENE	19	52.74	49.70	42.80	55.24
	ENE	20	44.97	59.43	48.97	48.01
	ENE	21	44.23	43.45	49.01	58.88
	NNE	22	41.51	43.50	42.90	57.44
	ENE	23	37.02	46.64	47.00	45.52
11-Apr-00	ENE	0	46.22	38.67	38.83	49.27
	ENE	1	51.50	46.99	36.78	44.62

TABLE III NITROGEN DIOXIDE AND OZONE DATA (ug/m3)

Date	Wind Direction	Hour [a]	Nitrogen Dioxide		Ozone	
			Direct Reading Monitor	UV-DOAS	Direct Reading Monitor	UV-DOAS
	ENE	2	55.21	52.26	36.77	42.37
	NNE	3	45.80	49.36	44.94	43.20
	NNE	4	42.47	37.13	38.80	53.95
	NNE	5	47.17	38.25	38.80	49.43
	NNE	6	37.77	51.82	38.80	39.83
	NNE	7	30.33	45.72	44.93	43.44
	NNE	8	29.36	38.25	49.02	49.00
	NNE	9	18.60	34.45	59.25	49.99
	NNE	10	19.19	24.77	59.25	59.86
	NNW	11	22.32	27.65	59.24	61.26
	NNE	12	21.33	31.16	57.18	60.69
	NNE	13	20.16	28.70	65.35	59.49
	NNE	14	21.53	29.09	63.31	65.33
		15				
		16				
		17				
		18				
		19				
		20				
		21				
		22				
		23				
12-Apr-00	ENE	10	66.55	41.76	38.58	57.08
	ENE	11	62.08	71.23	34.41	39.93
	ENE	12	48.97	65.53	50.49	44.82
	ENE	13	39.39	40.49	58.43	59.23
	ENE	14	31.05	42.34	70.44	66.75
	ENE	15	21.76	20.83	84.39	83.02
	ENE	16	19.62	17.26	88.31	85.91
	ENE	17	28.25	12.16	78.22	96.62
	ENE	18	25.93	27.49	78.17	85.82
	ENE	19	37.27	27.90	64.16	86.23
	ENE	20	44.80	46.11	58.19	66.14
	ENE	21	37.90	43.59	62.23	66.27
	ENE	22	47.94	37.95	52.23	68.39
	ENE	23	52.20	42.82	48.24	64.73
13-Apr-00	ESE	0	61.69	61.54	24.14	50.02

TABLE III NITROGEN DIOXIDE AND OZONE DATA (ug/m3)

Date	Wind Direction	Hour [a]	Nitrogen Dioxide		Ozone	
			Direct Reading Monitor	UV-DOAS	Direct Reading Monitor	UV-DOAS
	ESE	1	89.51	91.46	12.08	26.27
	SSE	2	67.19	107.47	28.21	16.16
	SSE	3	58.56	80.59	32.27	32.97
	SSE	4	59.20	64.37	28.26	34.50
	SSE	5	63.90	64.18	24.25	31.91
	SSE	6	52.91	69.10	38.42	28.75
	SSE	7	40.71	50.41	56.64	45.44
	SSE	8	23.62	35.30	78.79	62.46
	SSE	9	20.86	19.17	86.67	81.90
	SSE	10	18.68	16.38	90.44	87.72
	SSE	11	21.67	8.31	88.05	74.77
	SSE	12	20.82	14.54	85.71	72.10
	SSE	13	23.96	15.11	85.34	77.67
	SSW	14	22.58	18.23	87.11	76.95
	SSW	15	24.24	18.41	86.93	77.51
	SSW	16	22.66	18.45	84.74	76.39
	SSE	17	25.99	18.68	78.60	73.85
	SSE	18	37.20	22.71	66.65	68.37
	SSE	19	67.54	39.78	31.32	57.09
	SSE	20	81.04	72.57	13.70	28.05
	SSE	21	74.17	83.89	17.63	17.05
	SSE	22	74.65	77.81	17.66	20.25
	SSE	23	75.34	81.19	13.76	17.43
24-Apr-00	[b] *N/A*	0	36.78	29.89	72.35	60.78
	N/A	1	34.50	32.28	82.47	63.19
	N/A	2	47.08	28.58	68.45	71.31
	N/A	3	28.78	42.73	88.68	58.17
	N/A	4	30.74	21.16	82.70	75.91
	N/A	5	30.17	21.68	74.68	75.78
	N/A	6	62.91	27.52	36.36	63.64
	N/A	7	49.94	59.10	38.38	31.57
	N/A	8	56.01	35.03	34.26	37.19
	N/A	9	55.98	42.58	42.15	32.67
	NNE	10	52.94	37.69	52.04	40.12
	ESE	11	30.80	39.63	75.86	46.10
	NNW	12	25.02	25.70	81.70	60.21
	NNW	13	25.56	16.36	81.60	70.75

TABLE III NITROGEN DIOXIDE AND OZONE DATA (ug/m3)

Date	Wind Direction	Hour [a]	Nitrogen Dioxide		Ozone	
			Direct Reading Monitor	UV-DOAS	Direct Reading Monitor	UV-DOAS
	NNW	14	19.06	14.65	93.50	69.98
	NNW	15	11.82	7.27	99.48	79.99
	NNW	16	10.68	2.76	97.50	82.97
	SSE	17	12.98	1.62	89.61	81.49
	NNE	18	14.33	3.77	87.75	77.39
	NNE	19	15.70	5.57	87.91	76.30
	NNE	20	11.51	6.88	92.11	75.79
	NNE	21	12.50	2.64	90.29	76.99
	NNW	22	20.61	3.29	82.41	75.50
	NNW	23	32.80	11.44	76.50	72.49
25-Apr-00	NNW	0	29.37	25.34	82.66	60.61
	WSW	1	36.55	21.01	80.71	69.83
	NNE	2	43.53	22.96	68.64	67.89
	SSW	3	27.87	37.54	80.79	61.01
	ESE	4	25.95	16.26	76.78	65.74
	ESE	5	36.63	16.07	66.74	69.17
	NNW	6	21.54	27.43	85.03	58.85
	NNE	7	22.70	11.71	85.03	68.24
	NNE	8	56.15	13.81	88.90	69.00
	NNE	9	16.61	10.06	92.68	72.35
	NNE	10	15.80	8.77	94.51	81.42
	NNE	11	17.71	9.62	92.38	81.55
	NNE	12	16.92	11.70	94.29	76.04
	NNE	13	12.48	12.00	96.20	76.80
	NNE	14	11.32	6.27	98.14	77.23
	NNE	15	11.51	5.37	94.10	74.96
	NNE	16	10.93	5.39	96.05	73.96
	NNE	17	13.41	4.48	91.97	74.63
	NNE	18	15.89	10.76	89.92	72.65
	NNE	19	21.45	13.39	83.93	71.72
	NNE	20	31.24	18.61	76.00	70.18
	NNE	21	26.50	30.68	76.13	63.39
	NNW	22	34.78	20.91	68.17	61.60
	NNW	23	41.34	37.42	58.19	53.98
26-Apr-00	WSW	0	59.46	42.73	42.17	49.05
	NNW	1	44.48	46.99	56.26	46.73
	NNW	2	58.98	36.22	38.22	51.71

TABLE III NITROGEN DIOXIDE AND OZONE DATA (ug/m3)

Date	Wind Direction	Hour [a]	Nitrogen Dioxide		Ozone	
			Direct Reading Monitor	UV-DOAS	Direct Reading Monitor	UV-DOAS
	NNW	3	72.56	69.43	22.15	30.56
	NNW	4	69.93	78.18	18.14	22.00
	NNW	5	80.45	80.25	68.61	22.38
	NNW	6	67.95	83.29	48.48	21.40
	NNE	7	33.69	42.79	82.83	51.34
	NNE	8	68.11	23.69	52.35	82.25
	NNE	9	70.35	58.38	44.13	57.21
	NNE	10	62.87	64.21	56.00	52.48
	NNE	11	66.00	52.12	55.89	61.84
	NNE	12	67.83	55.15	57.82	56.54
	NNE	13	82.62	67.54	39.82	53.77
	NNE	14	70.50	87.98	57.66	40.64
	NNE	15	71.71	74.23	57.56	54.79
	NNE	16	64.56	71.53	53.50	54.41
	NNE	17	35.43	74.52	87.00	52.56
	NNE	18	35.18	26.97	73.01	91.84
	NNE	19	74.59	35.05	21.68	79.79
	SSW	20	87.46	86.24	7.88	25.72
	NNE	21			1.97	14.80
	SSE	22			3.96	7.29
	SSW	23				
28-Apr-00	WNW	0	80.50	63.80	19.77	51.20
	NNW	1			3.96	21.89
	WNW	2			3.97	8.99
	WNW	3	81.64	124.45	19.90	7.98
	NNW	4	77.41	93.04	17.95	27.06
	ESE	5	90.75	85.89	5.99	32.37
	WNW	6			8.00	14.51
	WNW	7			22.02	17.05
	WNW	8	88.38	101.50	31.94	31.85
	ESE	9	76.21	90.20	59.65	44.11
	NNE	10	56.36	59.63	77.22	64.62
	NNE	11	61.82	35.77	72.99	83.33
	ESE	12	74.28	45.61	59.01	77.94
	ENE	13	66.78	72.59	80.48	64.56
	NNE	14	64.21	56.16	92.07	86.14
	NNE	15	47.03	46.54	115.36	98.09

TABLE III NITROGEN DIOXIDE AND OZONE DATA (ug/m3)

Date	Wind Direction	Hour [a]	Nitrogen Dioxide		Ozone	
			Direct Reading Monitor	UV-DOAS	Direct Reading Monitor	UV-DOAS
	NNE	16	31.23	27.17	124.87	115.30
	NNE	17	42.18	30.23	109.07	117.64
	NNE	18	44.01	34.40	99.23	117.32
	NNE	19	60.40	37.47	66.14	101.78
	ENE	20	18.65	60.93	109.01	69.04
	WSW	21	20.75	14.90	81.92	115.24
	ESE	22	17.82	19.45	58.73	84.21
	ESE	23	13.19	16.00	51.13	65.57
	NNE	0	92.63	110.55	1.96	5.93
1-May-00	NNE	1			1.97	9.60
	NNE	2	82.86	124.87	15.76	7.15
	NNE	3	73.07	104.42	53.20	22.73
	SSE	4	56.46	77.16	59.11	54.27
	SSW	5	60.02	58.45	43.33	58.21
	SSW	6	90.72	69.06	5.90	37.82
	SSE	7	90.50	93.66	3.93	11.07
	SSE	8	91.05	96.66	5.90	8.73
	WSW	9	78.22	102.07	7.87	7.89
	NNW	10	64.82	96.44	49.15	17.68
	WSW	11	58.80	59.11	64.90	58.67
	ESE	12	47.14	52.15	78.70	72.76
	SSE	13	69.60	46.17	33.46	81.85
	SSW	14	52.08	113.96	66.94	32.05
	NNW	15	35.48	64.83	92.55	66.39
	SSW	16	35.85	34.56	92.52	81.81
	NNE	17	45.82	32.71	80.66	87.06
	NNE	18	50.12	44.80	66.85	77.24
	NNE	19	45.21	48.41	49.14	68.16
	NNE	20	84.83	49.61	5.90	45.41
	NNE	21	65.71	101.38	37.44	13.70
	NNE	22	85.86	71.46	5.92	38.91
	NNE	23	88.85	104.61	-1.98	10.99
3-May-00	NNE	0	72.71	75.22	27.45	30.24
	NNE	1	81.11	70.12	15.71	29.04
	NNE	2	73.50	78.57	27.53	20.28
	NNE	3	47.57	76.58	49.24	28.57
	NNE	4	51.98	48.61	43.39	43.45

TABLE III NITROGEN DIOXIDE AND OZONE DATA (ug/m3)

Date	Wind Direction	Hour [a]	Nitrogen Dioxide		Ozone	
			Direct Reading Monitor	UV-DOAS	Direct Reading Monitor	UV-DOAS
	NNE	5	54.88	54.35	43.44	39.24
	NNE	6	58.14	55.33	45.45	38.75
	NNE	7	44.50	50.39	61.25	40.37
	ESE	8	28.92	57.12	84.80	37.88
	ESE	9	26.52	17.43	94.21	69.90
	ESE	10	22.12	17.65	107.58	75.30
	ESE	11	17.94	14.70	118.92	85.99
Average Concentration.			44.73	44.64	56.05	55.11
Total # of Points			225	225	232	232

[a] Hours with no data recorded indicate that either the UV-DOAS or direct reading monitors were not functioning properly.

[b] Wind data were not available from 00:00 to 09:00 hours on April 24, 2000. This was due to an improper configuration of the meteorological station. Station was reconfigured correctly at 09:45 hours.

TABLE IV. BENZENE, TOLUENE, and M-XYLENE CONCENTRATIONS

Date	Wind Direction	Canister Position[a]	Canister ID	Start Time	Stop Time	BENZENE		TOLUENE		M-XYLENE	
						Canister	UV-DOAS	Canister	UV-DOAS	Canister	UV-DOAS
9-Apr-00	ENE	#1 along the beam	A21027	15:24	16:24	2.11	17.40	0.60	21.18	0.88	14.73
9-Apr-00	ENE	#2 along the beam	A21110	15:26	16:26	3.40	17.85	72.13	21.24	3.03	15.39
9-Apr-00	ENE	#3 along the beam	A22235	15:29	16:29	3.29	18.49	0.71	21.26	1.82	16.15
9-Apr-00	ENE	#1 along the beam	A21136	18:11	19:11	1.29	27.03	0.60	33.82	0.61	13.12
9-Apr-00	ENE	#3 along the beam	A21037	18:06	19:06	1.19	24.67	0.00	33.77	0.99	12.01
9-Apr-00	ESE	#1 along the beam	A21106	19:13	20:13	1.83	27.07	2.89	36.34	3.63	10.48
9-Apr-00	ESE	#2 along the beam	A21040	19:17	20:17	1.51	27.23	2.02	37.15	1.76	10.18
9-Apr-00	ESE	#3 along the beam	A21031	19:22	20:22	1.46	27.28	1.20	36.98	1.27	10.14
10-Apr-00	ENE	#1 along the beam	A21062	11:25	12:25	1.44	23.95	0.00	36.83	0.73	10.84
10-Apr-00	ENE	#2 along the beam	A21124	11:24	12:24	1.55	24.20	0.00	36.83	0.79	10.84
10-Apr-00	ENE	#3 along the beam	A21083	11:21	12:21	2.38	24.20	0.00	37.11	0.62	10.84
10-Apr-00	ENE	#1 along the beam	A21105	12:38	13:38	2.21	25.84	0.00	39.50	0.56	17.09
10-Apr-00	ENE	#2 along the beam	A22224	12:32	13:32	2.43	25.61	0.56	39.30	1.58	17.17
10-Apr-00	ENE	#3 along the beam	A21033	12:27	13:27	3.31	25.24	0.67	39.13	0.68	17.00
10-Apr-00	ENE	#1 along the beam	A21081	13:50	14:50	1.16	24.48	0.39	40.35	0.90	19.53
10-Apr-00	ENE	#2 along the beam	A21052	13:44	14:44	3.48	23.88	0.78	39.84	0.96	21.21
10-Apr-00	ENE	#3 along the beam	A21075	13:38	14:38	2.70	23.94	0.61	40.15	0.56	21.29
10-Apr-00	ENE	#1 along the beam	A21055	15:03	16:03	1.21	32.24	0.45	25.79	0.51	27.29
10-Apr-00	ENE	#2 along the beam	A21041	15:04	16:04	4.30	31.12	0.95	25.79	1.01	27.29
10-Apr-00	ENE	#3 along the beam	A21073	15:06	16:06	5.29	31.12	0.95	26.25	0.68	28.43
11-Apr-00	NNE	#1 along the beam	A21089	12:34	13:34	1.44	28.67	1.12	28.71	1.07	9.40
11-Apr-00	NNE	#2 along the beam	A21085	12:37	13:37	1.49	29.21	1.06	27.61	1.24	8.92
11-Apr-00	NNE	#3 along the beam	A22228	12:41	13:41	1.49	30.17	1.01	27.23	1.30	8.53
11-Apr-00	NNE	#1 along the beam	22325	13:44	14:44	1.49	28.37	0.89	27.22	0.85	9.07
11-Apr-00	NNE	#2 along the beam	A21120	13:47	14:47	1.54	24.30	0.95	39.86	0.96	20.21
11-Apr-00	NNE	#3 along the beam	A21113	13:51	14:51	1.43	24.48	1.00	40.35	0.73	19.53

TABLE IV. BENZENE, TOLUENE, and M-XYLENE CONCENTRATIONS

Date	Wind Direction	Canister Position[a]	Canister ID	Start Time	Stop Time	BENZENE Canister	BENZENE UV-DOAS	TOLUENE Canister	TOLUENE UV-DOAS	M-XYLENE Canister	M-XYLENE UV-DOAS
12-Apr-00	ENE	#1 along the beam	A21060	10:45	11:45	2.47	22.72	2.83	16.09	2.02	9.68
12-Apr-00	ENE	#2 along the beam	A21064	10:50	11:50	2.41	23.12	2.61	16.91	1.85	9.32
12-Apr-00	ENE	#3 along the beam	A21134	10:52	11:52	2.80	23.27	2.55	17.41	1.51	8.65
12-Apr-00	ENE	#1 along the beam	A21042	11:47	12:47	2.57	20.79	1.11	22.53	1.12	10.54
12-Apr-00	ENE	#2 along the beam	A21127	11:51	12:51	4.05	20.13	1.49	22.61	1.17	11.33
12-Apr-00	ENE	#3 along the beam	A21048	11:55	12:55	2.57	20.07	1.11	22.80	1.12	11.68
13-Apr-00	SSW	#1 along the beam	A21011	13:52	14:51	1.34	11.70	0.87	5.44	2.30	5.64
13-Apr-00	SSW	#2 along the beam	A21076	13:51	14:49	1.34	11.63	0.76	5.45	2.08	5.69
13-Apr-00	SSW	#3 along the beam	22330	13:46	14:46	1.29	11.93	0.81	5.45	1.97	5.67
24-Apr-00	ENE	#1 along the beam	N03425	10:50	11:50	5.19	9.95	1.53	10.44	1.16	22.48
24-Apr-00	ENE	#2 along the beam	A21141	10:47	11:47	5.84	10.65	1.64	10.61	1.44	22.98
24-Apr-00	ENE	#3 along the beam	N03494	10:45	11:45	6.93	10.82	2.02	9.85	1.33	23.04
24-Apr-00	NNW	#1 along the beam	A22229	11:58	12:58	5.24	6.26	3.55	14.65	1.32	24.63
24-Apr-00	NNW	#2 along the beam	N03491	11:53	12:53	7.12	6.83	2.67	14.50	1.65	27.39
24-Apr-00	NNW	#3 along the beam	N03429	11:46	12:46	4.16	8.09	3.11	12.43	1.76	30.34
25-Apr-00	NNE	#1 along the beam	C16700	15:03	16:03	1.36	11.00	0.93	-1.67	1.16	5.14
25-Apr-00	NNE	#2 along the beam	A21077	15:05	16:05	1.25	11.04	0.88	-0.67	0.89	5.23
25-Apr-00	NNE	#3 along the beam	N01048	15:00	16:00	1.25	11.73	0.88	-1.51	1.49	5.08
25-Apr-00	NNE	#1 along the beam	N03490	16:15	17:15	1.25	10.80	0.71	0.59	1.11	5.91
25-Apr-00	NNE	#2 along the beam	N03428	16:23	17:21	1.35	11.03	0.60	1.02	0.83	5.98
25-Apr-00	NNE	#3 along the beam	N03424	16:16	17:12	1.30	11.24	0.66	0.34	0.89	5.92
25-Apr-00	NNE	#1 along the beam	C16691	17:16	18:16	1.35	12.33	0.66	2.94	1.11	5.84
25-Apr-00	NNE	#2 along the beam	N03433	17:21	18:21	1.30	12.77	0.77	1.57	0.99	5.64
25-Apr-00	NNE	#3 along the beam	N03496	17:12	18:12	1.25	11.70	0.71	3.02	1.05	5.90
26-Apr-00	NNE	#1 along the beam	N03456	8:55	9:55	1.68	31.59	0.88	32.93	0.94	19.36
26-Apr-00	NNE	#2 along the beam	N03435	9:00	10:00	3.64	31.77	1.10	33.13	1.16	20.22

TABLE IV. BENZENE, TOLUENE, and M-XYLENE CONCENTRATIONS

Date	Wind Direction	Canister Position[a]	Canister ID	Start Time	Stop Time	BENZENE Canister	BENZENE UV-DOAS	TOLUENE Canister	TOLUENE UV-DOAS	M-XYLENE Canister	M-XYLENE UV-DOAS
26-Apr-00	NNE	#3 along the beam	N03427	9:04	10:04	4.29	31.74	1.59	33.31	1.66	20.58
26-Apr-00	NNE	#1 along the beam	9804	9:57	10:57	3.58	25.87	1.10	27.38	1.05	18.80
26-Apr-00	NNE	#2 along the beam	N03430	10:00	11:00	3.09	29.08	1.04	27.62	1.05	18.03
26-Apr-00	NNE	#3 along the beam	A22337	10:03	11:03	3.57	29.26	1.10	28.11	1.11	18.43
26-Apr-00	NNE	#1 along the beam	902	11:00	12:00	4.92	32.64	1.75	33.84	1.10	31.29
26-Apr-00	NNE	#2 along the beam	A21108	11:04	12:04	0.00	32.71	0.00	34.00	1.43	31.13
26-Apr-00	NNE	#3 along the beam	A21005	11:07	12:07	4.76	30.88	0.98	34.71	0.72	31.17
28-Apr-00	WSW	#1 along the beam	N03489	837	937	3.94	16.97	8.34	30.59	5.78	10.42
28-Apr-00	WSW	#2 along the beam	N03487	843	943	3.34	17.83	6.49	30.87	4.51	10.42
28-Apr-00	WSW	#3 along the beam	N03493	848	948	4.36	17.69	9.48	29.23	6.55	10.15
1-May-00	NNW	#1 along the beam	A21034	1533	1633	3.73	10.03	1.94	9.43	1.91	9.22
1-May-00	NNW	#2 along the beam	N03432	1530	1630	3.25	9.20	2.16	8.69	1.91	8.54
1-May-00	NNW	#3 along the beam	N03426	1523	1623	2.67	9.79	2.26	9.52	1.42	9.90
1-May-00	NNE	#1 along the beam	N03488	1644	1744	3.14	11.56	1.56	9.86	1.09	12.35
1-May-00	NNE	#2 along the beam	N03434	1637	1737	3.62	11.33	1.51	9.48	1.20	11.81
1-May-00	NNE	#3 along the beam	N03455	1633	1733	4.64	11.84	2.05	10.19	1.14	12.34
3-May-00	ESE	#1 along the beam	A21061	1010	1111	1.48	13.38	1.45	-1.62	1.35	3.70
3-May-00	ESE	#2 along the beam	N03495	1007	1107	1.43	13.42	1.61	-1.66	1.30	3.75
3-May-00	ESE	#3 along the beam	A21098	1013	1113	1.38	13.26	0.00	-1.46	1.13	3.83
3-May-00	ESE	#1 along the beam	A22230	1147	1247	1.16	15.94	0.80	-4.04	1.56	2.65
3-May-00	ESE	#2 along the beam	A21099	1141	1241	1.26	15.85	0.80	-3.38	2.10	3.00
3-May-00	ESE	#3 along the beam	A21109	1130	1230	1.26	16.14	0.80	-2.27	1.29	3.73
AVERAGE CONCENTRATIONS **N = 74 points**						**2.62**	**19.86**	**2.40**	**20.15**	**1.45**	**13.66**

[a] Canister location 1 is near the south end trailer; canister location 2 was approximately 500 yards from the south end trailer, as well as from the north end trailer; canister location 3 is near the north end trailer.

TABLE V BACKGROUND CONCENTRATIONS FOR BENZENE, TOLUENE, AND M-XYLENE, ug/m3

Date	Wind Direction	Location	Canister ID	Start Time	Stop Time	BENZENE Canister Sample	BENZENE UV-DOAS[a]	TOLUENE Canister Sample	TOLUENE UV-DOAS[a]	M-XYLENE Canister Sample	M-XYLENE UV-DOAS[a]
5-Nov-99	SSW	on roof of trailer 2 (north end of landfill)	22337	10:13	11:13	0.64	*n/a*	1.88	n/a	0.05	n/a
5-Nov-99	SSW	on ground near trailer 1 (south end of landfill)	A21100	10:45	11:45	0.64	*n/a*	1.51	n/a	0.16	n/a
31-Mar-00	ENE	well on south end	A22327	1530	1630	3.24	*n/a*	4.84	n/a	4.29	n/a
31-Mar-00	ENE	well on north end	A21065	1550	1650	2.87	*n/a*	2.15	n/a	1.41	n/a
31-Mar-00	ENE	downwind sample	A21096	1600	1700	6.27	*n/a*	4.14	n/a	4.18	n/a
31-Mar-00	ENE	upwind sample	A21114	1620	1720	3.19	*n/a*	1.99	n/a	2.01	n/a
4-Apr-00	NNW	upwind sample	A21130	1209	1309	0.58	*n/a*	0.48	n/a	0.49	n/a
4-Apr-00	NNW	downwind sample	A21020	1240	1340	1.38	*n/a*	0.91	n/a	1.03	n/a
4-Apr-00	NNW	well on east side	A22242	1230	1330	0.64	*n/a*	0.97	n/a	0.98	n/a
9-Apr-00	NNW	upwind sample	A21045	15:41	16:41	3.89	22.40	0.00	22.16	0.00	15.55
9-Apr-00	NNE	upwind sample	A21012	18:03	19:03	n/a	24.59	n/a	33.77	n/a	11.84
9-Apr-00	NNE	upwind sample	A21117	19:29	20:29	1.73	26.48	0.00	35.98	0.00	10.10
28-Apr-00	WSW	upwind sample	N03431	906	1006	4.20	17.22	0.01	24.26	0.01	8.14
3-May-00	SSE	downwind sample	A21067	945	1045	1.43	13.81	0.01	-0.498	-0.18	4.32
3-May-00	SSE	downwind sample	A21079	1120	1229	1.37	15.90	0.00	-2.39	-0.03	3.72

[a] Concentrations measured by UV-DOAS during the canister sampling interval. Since background concentrations were measured at different locations from the ultraviolet beam, the UV-DOAS and the canister samples should not be expected to be comparable.

TABLE VI. SUMMARY OF EVENTS AT THE LANDFILL SITE [a]

Date	# of Hours Spent at Site	# of Persons	# of person –hours	Event
13-Sep-99	2.5	5	12.5	SITE PREPARATION – Tour of the Paxton Landfill
25-Oct-99	5	1	5	SITE PREPARATION - Trailers delivered to the landfill
27-Oct-99	3	2	6	SITE PREPARATION – Commonwealth Edison inspector visits landfill and determines how electricity can be supplied to the trailers. Installation of a riser is necessary to support electrical cable from transformer to Trailer #2 on north end. Electrical cable from Trailer # 2 to Trailer #1 will be buried.
2-Nov-99	n/a	n/a		SITE PREPARATION – First electrical contractor inspects site and provides us with an estimate for the hook-up.
5-Nov-99	3	2	6	MONITORING - 2 preliminary canister samples in order to determine the typical concentrations at the site. One canister located on top of trailer 2 on north end. Second canister on the ground near trailer 1 on south end.
3-Nov-99	n/a	n/a		SITE PREPARATION – Second electrical contractor inspects site and provides an estimate for the installation of riser and meter.
10-Nov-99 to 23-Nov-99	n/a	n/a		SITE PREPARATION – The contractor from Edgewater begins installing the riser and meter near our trailers.
30-Nov-99	n/a	n/a		SITE PREPARATION – Installation of electrical cables at the site. Power is obtained by the two trailers.
9-Dec-99	7	2	14	SITE PREPARATION / EQUIPMENT MAINTENANCE / MONITORING – UV-DOAS is installed. Technical representative

TABLE VI. SUMMARY OF EVENTS AT THE LANDFILL SITE [a]

Date	# of Hours Spent at Site	# of Persons	# of person –hours	Event
				from France provides training on the operation of the UV-DOAS.
10-Dec-99 11-Dec-99	10	3	30	EQUIPMENT MAINTENANCE / MONITORING – Training on UV-DOAS.
14-Dec-99	4	4	16	EQUIPMENT MAINTENANCE - Performed realignment of the UV beam with the receiver.
21-Dec-99	4	2	8	EQUIPMENT MAINTENANCE - Performed realignment of the UV beam with the receiver.
23-Dec-99	4	2	8	EQUIPMENT MAINTENANCE / SITE PREPARATION - Performed realignment of the UV beam with the receiver. Attempted to install meteorological station. Installation not successful, because ground was frozen.
10-Jan-00	6	3	18	EQUIPMENT MAINTENANCE / SITE PREPARATION - The computer system froze. After rebooting the system, the beam was tracked down with the receiver. Realignment not successful. IEPA representative installed the ozone monitor in Trailer # 2. Meteorological station installed.
12-Jan-00	4	2	8	EQUIPMENT MAINTENANCE – Realignment of UV beam performed during the day. Not successful.
14-Jan-00	5	2	10	EQUIPMENT MAINTENANCE – Alignment attempted early in the morning, while it is still dark. No success in achieving alignment. Light intensity and peak still very low.
19-Jan-00	6	2	12	EQUIPMENT MAINTENANCE – Attempted alignment early in the evening. The beam was very weak and difficult to see. Even though alignment was achieved, spectrum intensity level of 10000 to 16000 points and light intensity 50% to 90% not attained.

TABLE VI. SUMMARY OF EVENTS AT THE LANDFILL SITE [a]

Date	# of Hours Spent at Site	# of Persons	# of person –hours	Event
24-Jan-00	5	4	20	EQUIPMENT MAINTENANCE – Alignment attempted early in the morning, while it is still dark. No success in achieving alignment. Light intensity and peak still very low.
25-Jan-00	4	2	8	EQUIPMENT MAINTENANCE – Alignment attempted early in the morning, while it is still dark. No success in achieving alignment. Light intensity and peak still very low.
27-Jan-00	4	2	8	EQUIPMENT MAINTENANCE – Alignment attempted early in the morning, while it is still dark. No success in achieving alignment. Light intensity and peak still very low.
2-Feb-00	4	2	8	EQUIPMENT MAINTENANCE – Alignment attempted early in the morning, while it is still dark. No success in achieving alignment. Light intensity and peak still very low.
7-Feb-00	3	2	6	EQUIPMENT MAINTENANCE – Went to the site and light in the projector was out. Fan inside the projector not working.
9-Feb-00	6	2	12	EQUIPMENT MAINTENANCE – Replaced light bulb, but the projector still did not work.
11-Feb-00	n/a	n/a		EQUIPMENT MAINTENANCE – Conference call with technical representatives and engineers. Arrangements were made to have one of the engineers look at the projector.
14-Feb-00	4	2	8	EQUIPMENT MAINTENANCE - Engineer and UIC student took projector apart and checked the voltage coming through the power supply and to the lamp. It was discovered that the 2amp fuse was burnt out, so old fuse was replaced with a 4amp fuse. Fan starts to work, but the lamp is still out. Engineer takes back the UV-DOAS to his lab in Geneva.
21-Feb-00	5	2	10	EQUIPMENT MAINTENANCE – Reinstall the projector with a new power supply and light bulb.

TABLE VI. SUMMARY OF EVENTS AT THE LANDFILL SITE [a]

Date	# of Hours Spent at Site	# of Persons	# of person –hours	Event
22-Feb-00	4	2	8	EQUIPMENT MAINTENANCE / MONITORING – Alignment in the evening was successful and ideal spectrum intensity level of 15,000 points was achieved. Attempt to collect UV-DOAS data.
23-Feb-00	2.5	2	5	EQUIPMENT MAINTENANCE / MONITORING- Computer system froze and we needed to reboot the system. Light visibility was too low. No alignment was attempted due to rainy conditions.
25-Feb-00	4	2	8	EQUIPMENT MAINTENANCE / MONITORING – Alignment was performed early in the morning. Difficult to do due to the foggy conditions. However, alignment was achieved. Collected UV-DOAS data.
29-Feb-00	4	2	8	EQUIPMENT MAINTENANCE – Realignment of UV beam performed during the day. Not successful.
3-Mar-00	2	2	4	EQUIPMENT MAINTENANCE – Came to the site and noticed that projector was out again. Fan was still working.
8-Mar-00	2.5	2	5	EQUIPMENT MAINTENANCE – Met with engineer and changed the light bulb. Apparently, the old light bulb's tip melted off and left a hole in the bulb. Lamp is working again.
15-Mar-00	4	2	8	EQUIPMENT MAINTENANCE – Alignment performed and successful. However, peak and light intensity numbers kept on dropping every 3 minutes. Could not perform the calibration on the instrument. Very windy conditions that day.
16-Mar-00	4	1	4	EQUIPMENT MAINTENANCE – Realignment needed.
17-Mar-00	4	2	8	EQUIPMENT MAINTENANCE – Realignment of UV beam performed during the day. Not successful.

TABLE VI. SUMMARY OF EVENTS AT THE LANDFILL SITE [a]

Date	# of Hours Spent at Site	# of Persons	# of person –hours	Event
26-Mar-00	2	1	2	EQUIPMENT MAINTENANCE – Went to the site to check on the UV-DOAS. The lamp in the projector is out again.
27-Mar-00	2	1	2	MONITORING – Downloaded the UV-DOAS files and emails them to technical representative in France.
29-Mar-00	7	2	14	EQUIPMENT MAINTENANCE – Sanded down the connectors to the lamp. Projector begins to work again. Came back to the site at 9pm to do the alignment. The projector was aligned with the receiver but still the numbers are too low.
31-Mar-00	7	2	14	EQUIPMENT MAINTENANCE / MONITORING – Adjusted the light bulb within the projector. Performed realignment, but numbers were still too low. Two canister samples from the leachate wells, one upwind sample, and one downwind sample were collected.
4-Apr-00	4	2	8	MONITORING – Collected one canister sample from well, one upwind sample, and one downwind sample.
6-Apr-00	5	2	10	EQUIPMENT MAINTENANCE –Technical representative from France arrives in Chicago. He aligned the beam with the mirror.
7-Apr-00	6	3	18	EQUIPMENT MAINTENANCE – Technical representative attempted to replace the mirror in the projector, but could not due to the rain. Alignment, benzene & toluene calibrations of the UV-DOAS, and baseline adjustment performed.
8-Apr-00	6	3	18	EQUIPMENT MAINTENANCE – Technical representative changed the mirror in the projector and improved the alignment of the projector.
9-Apr-00	8	2	16	MONITORING / EQUIPMENT MAINTENANCE – Collected 12 canister samples with the winds coming from the NW and NE. Alignment

TABLE VI. SUMMARY OF EVENTS AT THE LANDFILL SITE [a]

Date	# of Hours Spent at Site	# of Persons	# of person –hours	Event
				improved.
10-Apr-00	7	2	14	MONITORING / EQUIPMENT MAINTENANCE – Collected 12 canister samples with the winds coming from the NW and NE. Alignment improved.
11-Apr-00	6	2	12	MONITORING / EQUIPMENT MAINTENANCE – Collected 6 canister samples with the winds coming from the NW and NE. Alignment improved.
12-Apr-00	4	2	8	MONITORING – Collected 6 canister samples
13-Apr-00	4	2	8	MONITORING / EQUIPMENT MAINTENANCE – Collected 3 Canister samples. Benzene and toluene calibrations performed.
19-Apr-00	3	1	3	EQUIPMENT MAINTENANCE – 21 canisters delivered to Paxton. 22 canisters available for sampling. UV-DOAS requires realignment.
21-Apr-00	5.5	2	11	EQUIPMENT MAINTENANCE – Performed realignment. No canister samples were collected because of the windy conditions (wind speed >20 m.p.h.) at the site.
24-Apr-00	6	1	6	MONITORING – Collected 6 canister samples
25-Apr-00	7	1	7	EQUIPMENT MAINTENANCE / MONITORING – Realignment performed. Collected 9 canister samples. Each set of three was placed along the beam
26-Apr-00	6	1	6	MONITORING - Collected 9 canister samples.
28-Apr-00	7	2	14	MONITORING – Collected 4 samples. Three canisters were placed along the beam and one upwind.
1-May-00	6	1	6	MONITORING / EQUIPMENT MAINTENANCE – Collected 6 samples. All were placed along the

TABLE VI. SUMMARY OF EVENTS AT THE LANDFILL SITE [a]

Date	# of Hours Spent at Site	# of Persons	# of person –hours	Event
				beam. Changed the filters and silica gel for ozone and NOx monitors
2-May-00	n/a	n/a		Delivered canister samples at Maywood IEPA office and picked up new canisters.
3-May-00	5	1	5	MONITORING – Collected 8 canister samples. Six samples were collected along the beam and two samples were collected downwind.
Total hours	243		493.5	

[a] A complete Paxton project activity log is shown in Table VIII, Appendix B.

TABLE VII SUMMARY OF UV-DOAS MAINTENANCE

Activity	Hours
Total hours to align projector with receiver (person-hours)	*137*
Total number of trips to align projector with receiver	*29*
Total number of 1 hour canister measurements	*75*
Total hours for maintenance and calibration (person-hours)	*59*
Total number of trips for maintenance and calibration	*10*

IV. DISCUSSION

A. Log of Events Leading to the Preparation, Installation, and Data Collection of the Ultraviolet Differential Optical Absorption Spectrometer

The temporary nature of this study prevented the installation of a permanent, fixed platform for the SANOA UV-DOAS. Instead the projector was bolted down to a wooden pallet, secured to the roof of Trailer #2, and 232 meters away, the receiver was housed inside Trailer #1. In 29 out of 50 site visits we found that the projector was out of alignment with the receiver and thus, realignment of the beam was necessary. The misalignment of the beam was due to various weather conditions (i.e. high winds, freezing/thawing, snow, etc.) affecting the stability of the UV-DOAS system, as well as the trailers. A total of 137 person-hours were spent on realigning the beam (Table VII).

It is important that the beam is aligned perfectly in order to ensure reliability and accuracy of the UV-DOAS data collected. Two persons are often needed to perform this task. Alignment can be done during the day. However, from our experience, it is more time consuming and the beam is more difficult to see. Therefore, it is recommended that realignment of the ultraviolet beam take place during the evening or before sunrise. One operator would observe light intensity, as well as the highest peak detected indicated by the Vision Air software. Through radio communication, another operator, who is on top of the roof of Trailer #2, listens for the values and adjusts the beam through two knobs that move it right or left and up or down. Alignment is achieved when light intensity is between the ranges of 30 to 90 percent and when the spectrum intensity level detected is between the ranges of 10,000 to 16,000 points.
In addition to realignment of the UV-DOAS, 10 site visits (refer to Tables VI and VII) were required to maintain and calibrate this remote sensing device. We encountered maintenance issues, such as replacing the light bulb of projector's xenon vapor lamp, changing the projector's fan filter, sanding down the corrosion buildup on the cathode and anode wires of the lamp, and having to replace the projector's power supply and mirror. A total of 59 person-hours were spent maintaining the instrument.

B. Comparison of the Ultraviolet Differential Optical Absorption Spectrometer Measurements with Reference Method Measurements

Table VIII summarizes the descriptive statistics (slope of the best fitted line, R^2, and the overall average concentration) obtained by plotting the relationship between the reference method (VOC canister sample or direct reading monitor measurements) and the SANOA UV-DOAS. The associations between the UV-DOAS and reference method data sets were determined by comparing the paired concentrations.

TABLE VIII COMPARISON DATA FOR THE UV-DOAS AND THE SPECIFIED REFERENCE METHOD

Compound	Number of Data Points	Slope	R^2	UV-DOAS Average Concentration ug/m3	Average Reference Method Concentration, ug/m3	
					Direct Reading Monitor[a]	VOC Canister Sample
NO_2	225	1.016	0.67	44.64	44.73	n/a
O3	232	0.683	0.68	55.11	56.03	n/a
Benzene	74	-----	-----	19.86	n/a	2.62
Toluene	74	-----	-----	20.13	n/a	1.45
M-Xylene	74	-----	-----	13.66	n/a	1.45
Styrene	74	-----	-----	8.55	n/a	0.46

[a] Nitrogen dioxide concentrations analyzed by TECO 42 NOx monitor. Ozone concentrations analyzed by Dasibi Model 1003AH ozone monitor.

1. Ozone and Nitrogen Dioxide

One hour average concentrations were calculated for both nitrogen dioxide and ozone. By referring to Table III, the hours where no data were recorded indicate that either the UV-DOAS or direct reading monitor was not functioning properly or the concentration of the compound was non-detectable. Figure 7 represents the relationship between the UV-DOAS and the direct reading monitor for ozone. A strong association is seen between the two ozone measurement methods ($R^2 = 0.67$). In addition, the overall ozone UV-DOAS average ($AVG_{UV\text{-}DOAS} = 55.11$ ug/m3) and direct reading monitor average ($AVG_{DRM} = 56.05$ ug/m3) are consistent with each other.

Figure 8 shows the relationship between the UV-DOAS and the nitrogen dioxide direct reading monitor. The two methods are strongly associated ($R^2 = 0.68$) with similar averages ($AVG_{UV\text{-}DOAS} = 44.6$ ug/m3 and $AVG_{DRM} = 44.7$ ug/m3). The slope is close to 1.0 and the intercept is close to zero.

Method comparison was also carried out comparing only the nighttime measurements and only daytime measurements. (Day was defined as 0600 to 1800 hours). When plotting the concentrations detected at night and during the day (Figures 9 and 10), not only were there strong associations between the direct reading monitors and the UV-DOAS, but also patterns consistent with meteorology were seen for both NO_2 and O_3. During the evening, NO_2 concentrations were higher at night (Figure 9A) than during the day (Figure 9B), which is consistent with the nighttime radiation inversion. During the evening hours, the layers of air close to the ground are cooled down more than the upper layers. The lower layers of air remain stable, thus, trapping pollutants like NO_2 and causing them to increase in concentration. In contrast, the O_3 concentrations were found to be lower at night (Figure 10A) than during the day (Figure 10B), which is consistent with the lack of sunlight driving the ozone forming process.

Nitrogen dioxide and ozone concentrations detected by the UV-DOAS and the direct reading monitors were also plotted against wind direction to see if any major sources were evident. Figures 11 and 12 show the O_3 and NO_2 distribution with direction. Based on the plots, no direction was found to be more notable for either O_3 or NO_2. It was expected that the concentrations would be non-directional, but it remained possible that a significant NO_2 source direction might be identified. However, this was not the case.

2. Benzene, Toluene, m-Xylene and Styrene Data

For the organic compounds, Figures 13 through 16 represents the relationship seen between the UV-DOAS and the canister samples. No associations were seen between the UV-DOAS and canister samples for benzene, toluene, m-xylene, and styrene. Even when the UV-DOAS data were plotted according to the position of the canister along the beam, as seen in Figure 17, no correlation could be found. Position plots for toluene, m-xylene, and styrene also showed no correlation between the UV-DOAS data and the canister data.

Also, for all the organic pollutants, adjustments were performed in order to further determine the relationship between the UV-DOAS and the canister samples. When the UV-DOAS was calibrated for the first time on April 7, 2000 the span factor used to configure the Visionair software was possibly set too high. In order to adjust the data to the appropriate span factor and compensate for the offset, the Environnement S.A. technical representative recommended that approximately 34 to 35 ug/m3 be subtracted from the toluene data and 16 ug/m3 subtracted from the benzene data recorded from April 9, 2000 through April 12, 2000 (Table XV, Appendix B). However, even when the benzene and toluene concentrations were adjusted, Figures 18 and 19 still show no correlation between the canisters and the UVDOAS.

Similarly in Figure 20 and Figure 21, which include only the data collected after the second UV-DOAS calibration on April 13, no correlation between the two monitoring methods is apparent. The styrene data obtained from the canister sampling were also adjusted by eliminating the non-detectable data (or the zero values). Figure 22 shows a slight correlation between the UV-DOAS and the canister samples.

Figures 23 to 26 shows the effect of variability in the canister samples. Note that the vertical and horizontal scales are not of equal length. Variations of the concentrations between three simultaneously collected canisters (0 – 7 ug/m3) were not enough to explain the lack of association in UV-DOAS and canister concentrations for benzene, toluene, m-xylene, and styrene.

Wind direction plots (Figures 27 and 28) were used as an attempt to locate sources of benzene and toluene. Figure 27 shows the average UV-DOAS and canister concentrations for benzene plotted against the 8 wind directions (NNE, ENE, ESE, SSE, SSW, WSW, WNW and NNW). It was expected that concentrations of benzene would be higher when winds are coming from the northeast direction, because a coke oven plant, a significant source of this organic compound, is located on that particular side of the Paxton landfill. This was demonstrated by the UV-DOAS data set, but not by the canister samples. However, based on our canister results, we see high concentrations of benzene coming from an unidentified source in the WSW and NNW directions. As for toluene, it was expected that the concentrations would be higher when the winds were coming from the west, possibly due to the VOC emission from the landfill leachate. Figure 28 shows the UV-DOAS and canister samples support this expectation. Ultraviolet differential optical absorption spectrometer toluene concentrations were also shown to be originating from an unknown source in the NNE and ENE directions.

In Figure 29, the sum of the concentrations for benzene, toluene, and m-xylene for both UV-DOAS and canister samples. No association was seen between the UV-DOAS and canister samples for the sum of the organic compounds.

Benzene-toluene ratio plots were also created to determine if there is an association between the UV-DOAS and the canister samples. Figure 30 represents the benzene-toluene ratios for both the UV-DOAS and canisters. As seen in the figure, the benzene-toluene ratio for UV-DOAS is different from the ratio obtained from the canister samples.

Benzene-toluene ratios were also plotted individually for the UV-DOAS and canisters. Figure 31 shows the benzene-toluene ratio plot for the UV-DOAS. Figure 32 shows the benzene-toluene ratio plot for the canister samples. The two benzene-toluene ratio plots are not related. However, when considered individually, an association is seen. In both figures, there is a similar pattern for the benzene concentration average being approximately equal to the toluene concentration average. But the slopes for each ratio plot are entirely different.

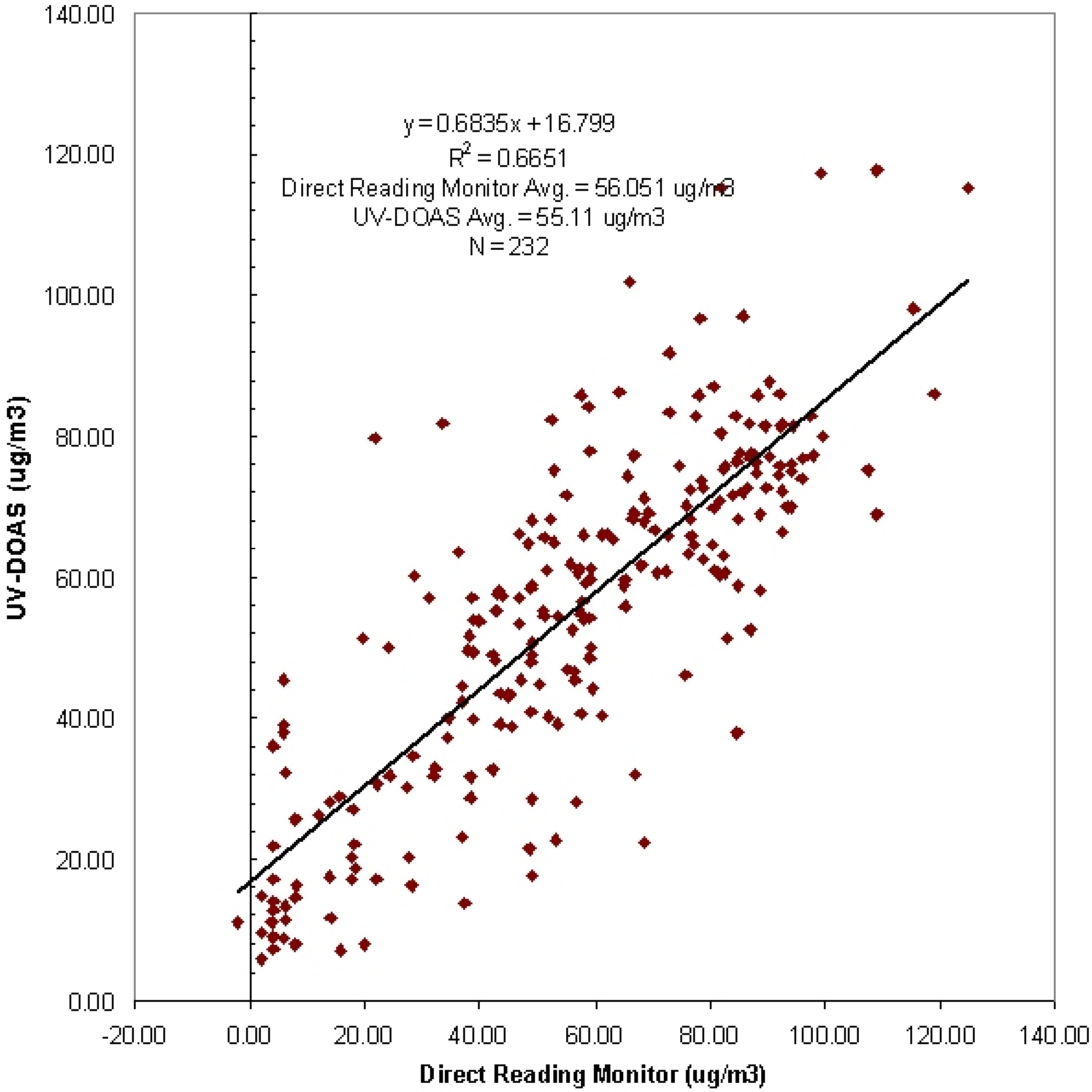


Figure 7. Comparison of direct reading and UV-DOAS ozone concentrations.

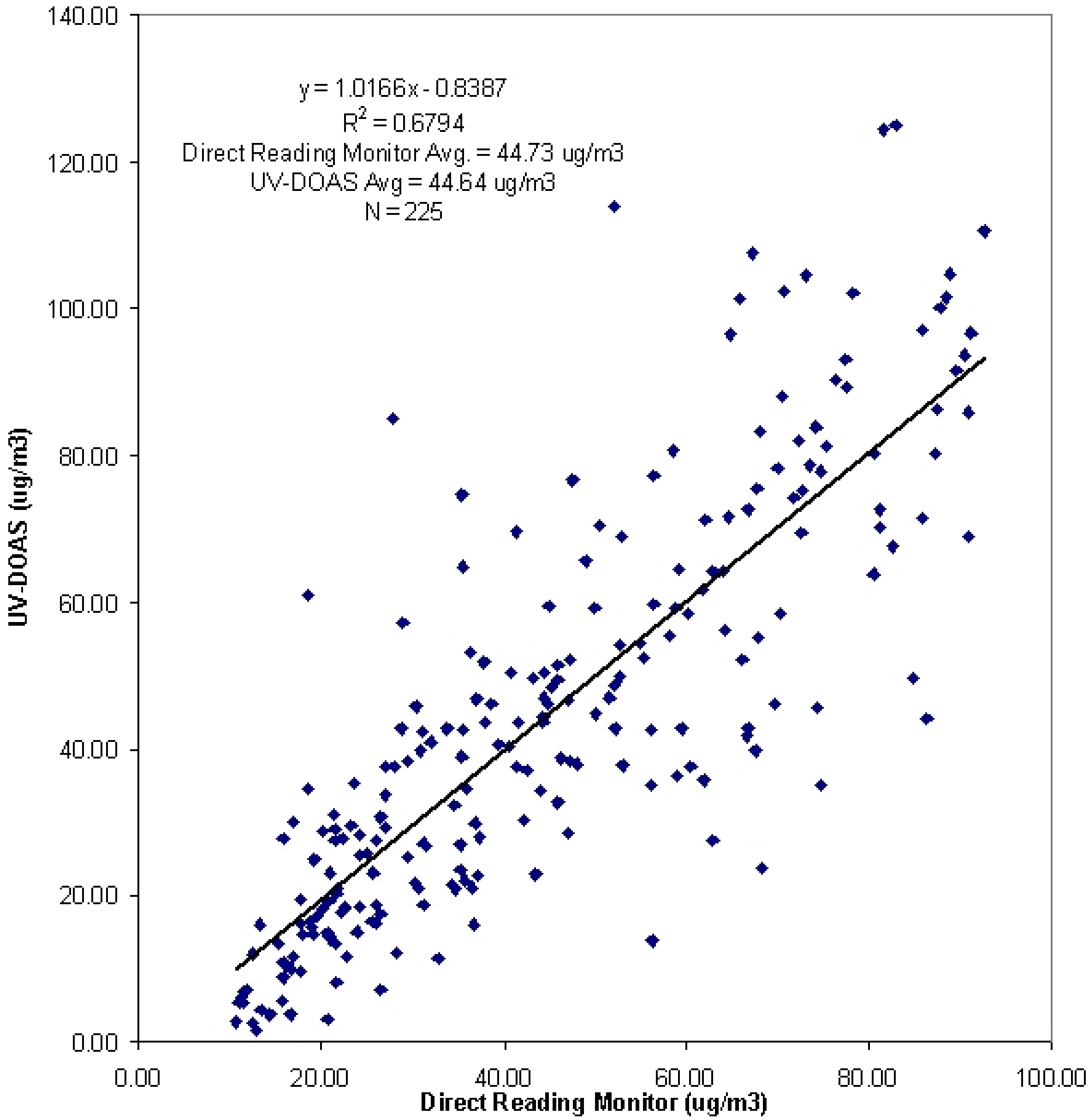
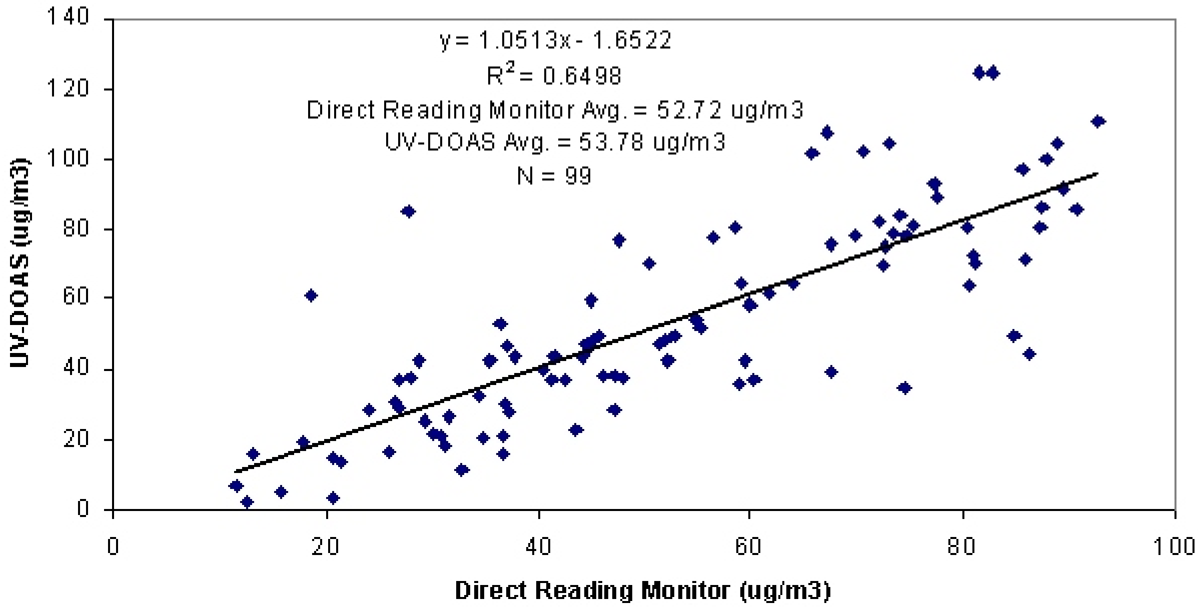


Figure 8. Comparison of direct reading and UV-DOAS nitrogen dioxide concentrations.



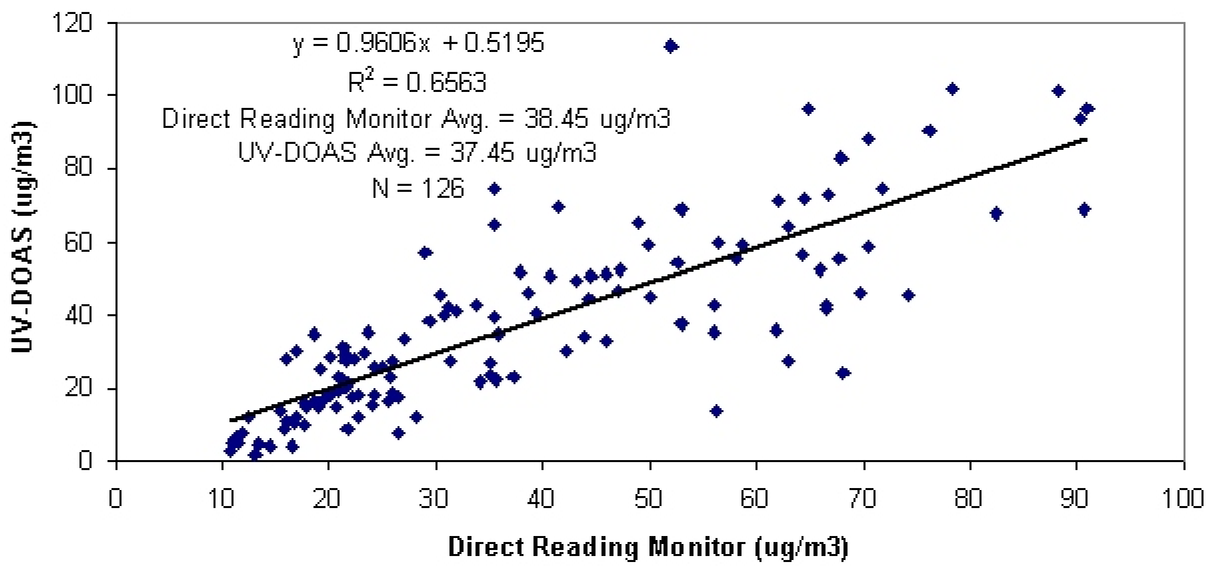
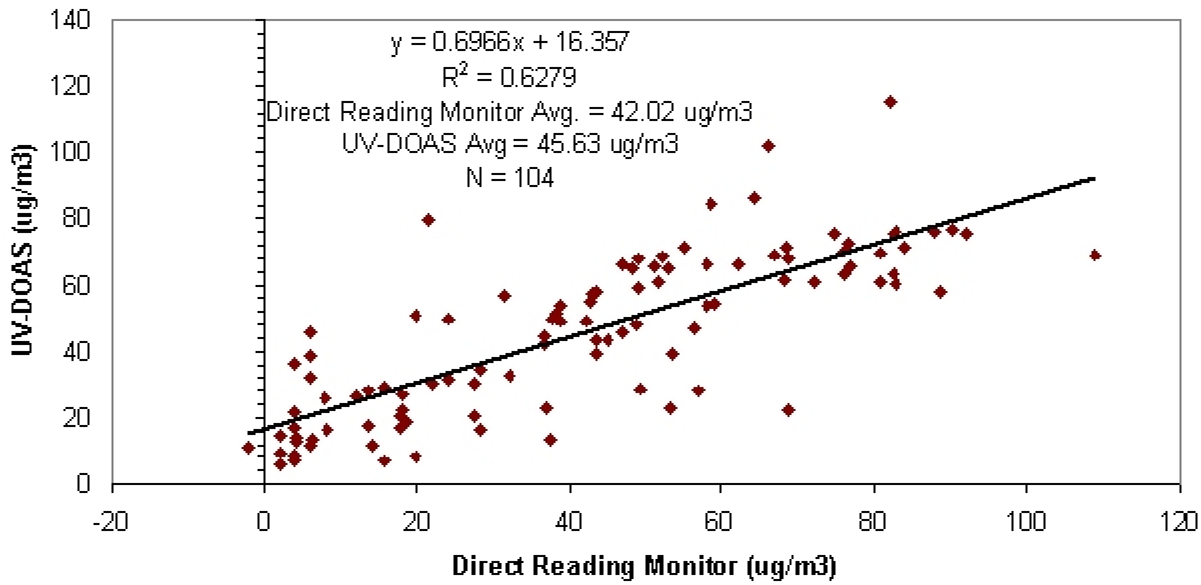


Figure 9. Direct reading and UV-DOAS nitrogen dioxide concentrations (A) nighttime, 1900 to 0500 hours, (B) daytime, 0600 to 1800 hours.



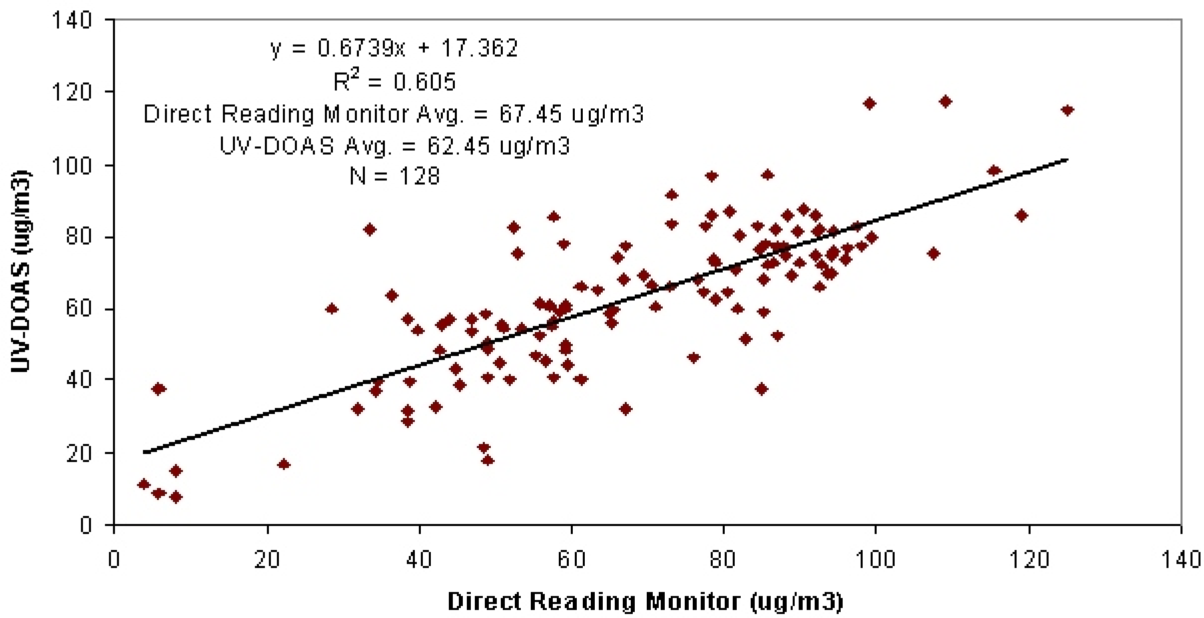


Figure 10. Direct reading and UV-DOAS ozone concentrations, (A) nighttime, 1900 to 0500 hours, (B) daytime, 0600 to 1800 hours.

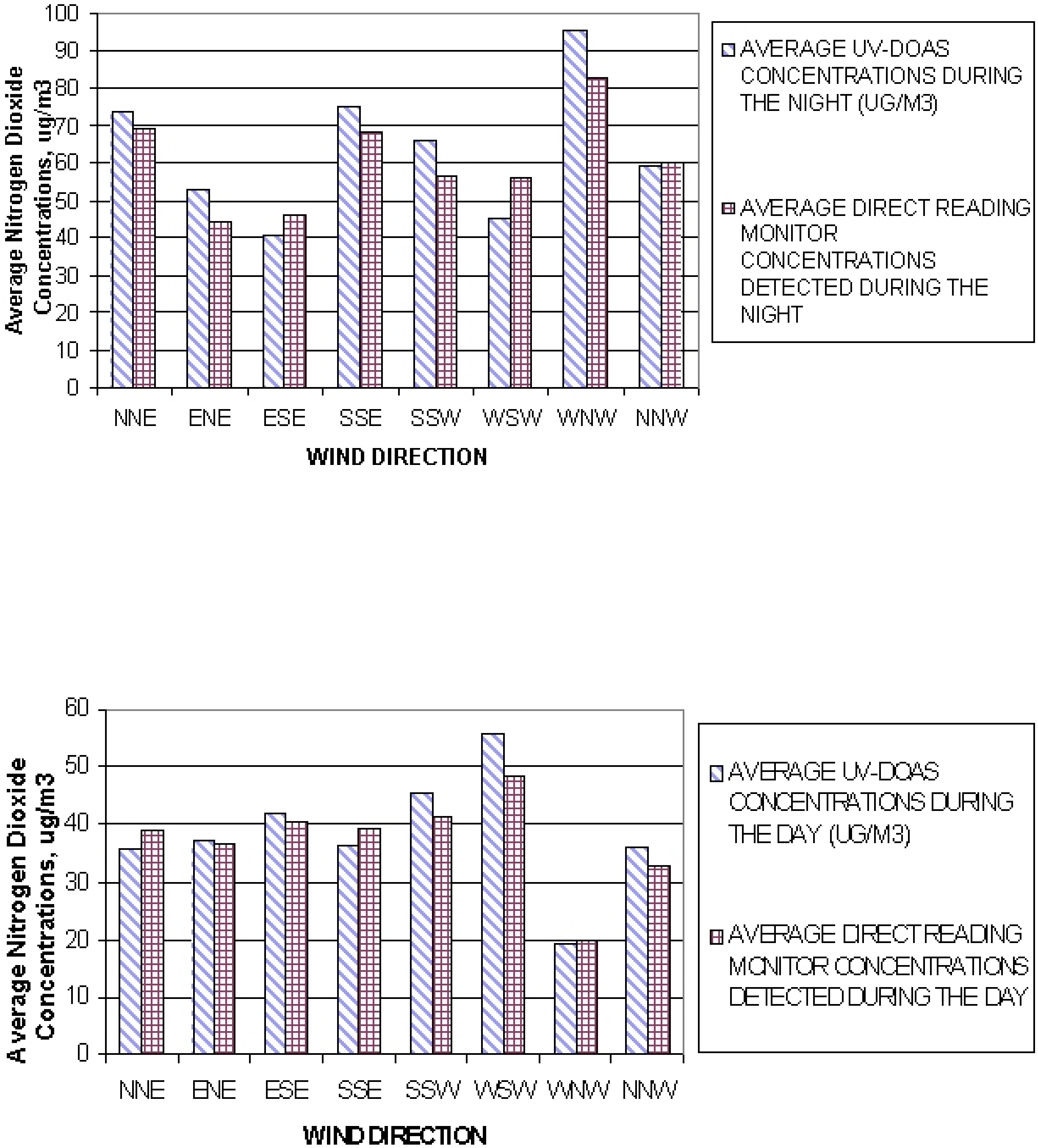
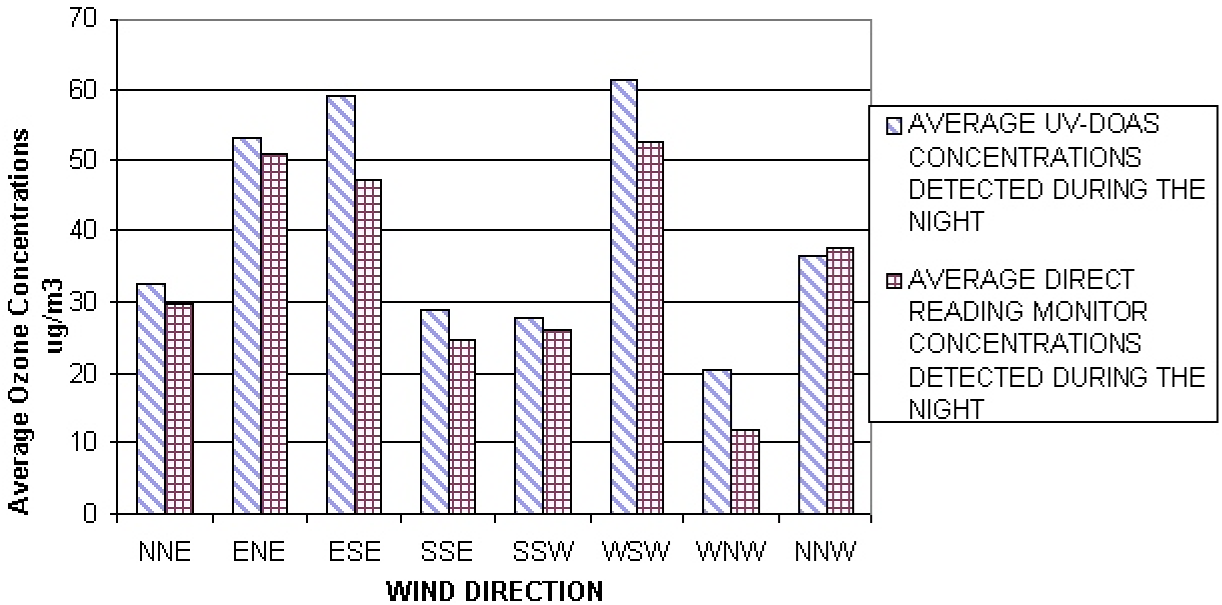


Figure 11. Average NO_2 concentrations vs. wind direction, (A) nighttime, 1900 to 0500 hours (B) daytime, 0600 to 1800 hours.



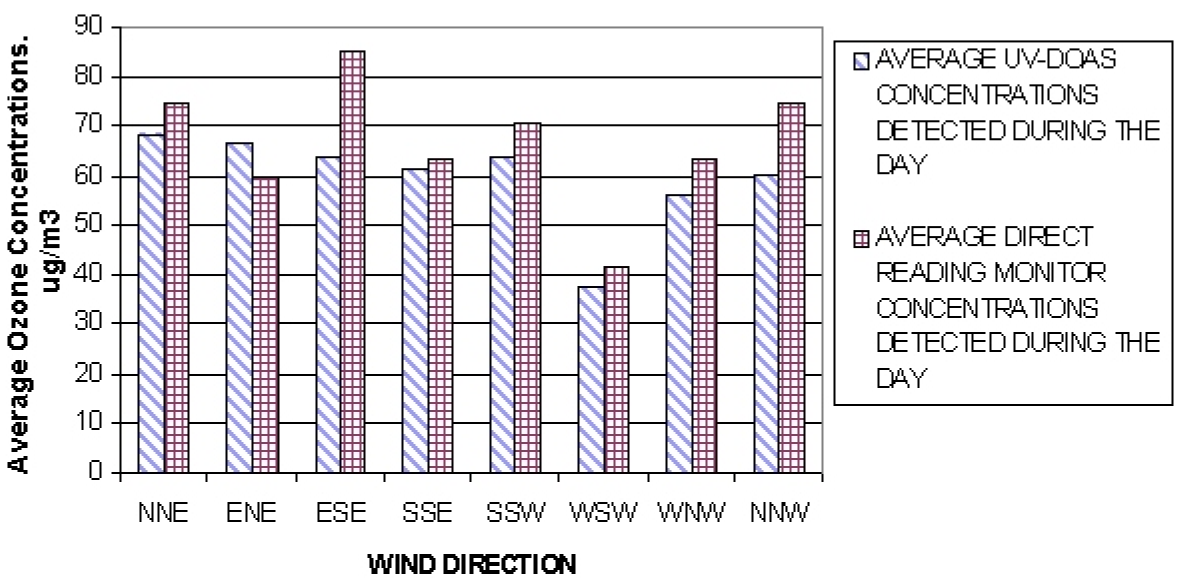


Figure 12. Average ozone concentrations vs. wind direction, (A) nighttime, 1900 to 0500 hours, (B) daytime, 0600 to 1800 hours.

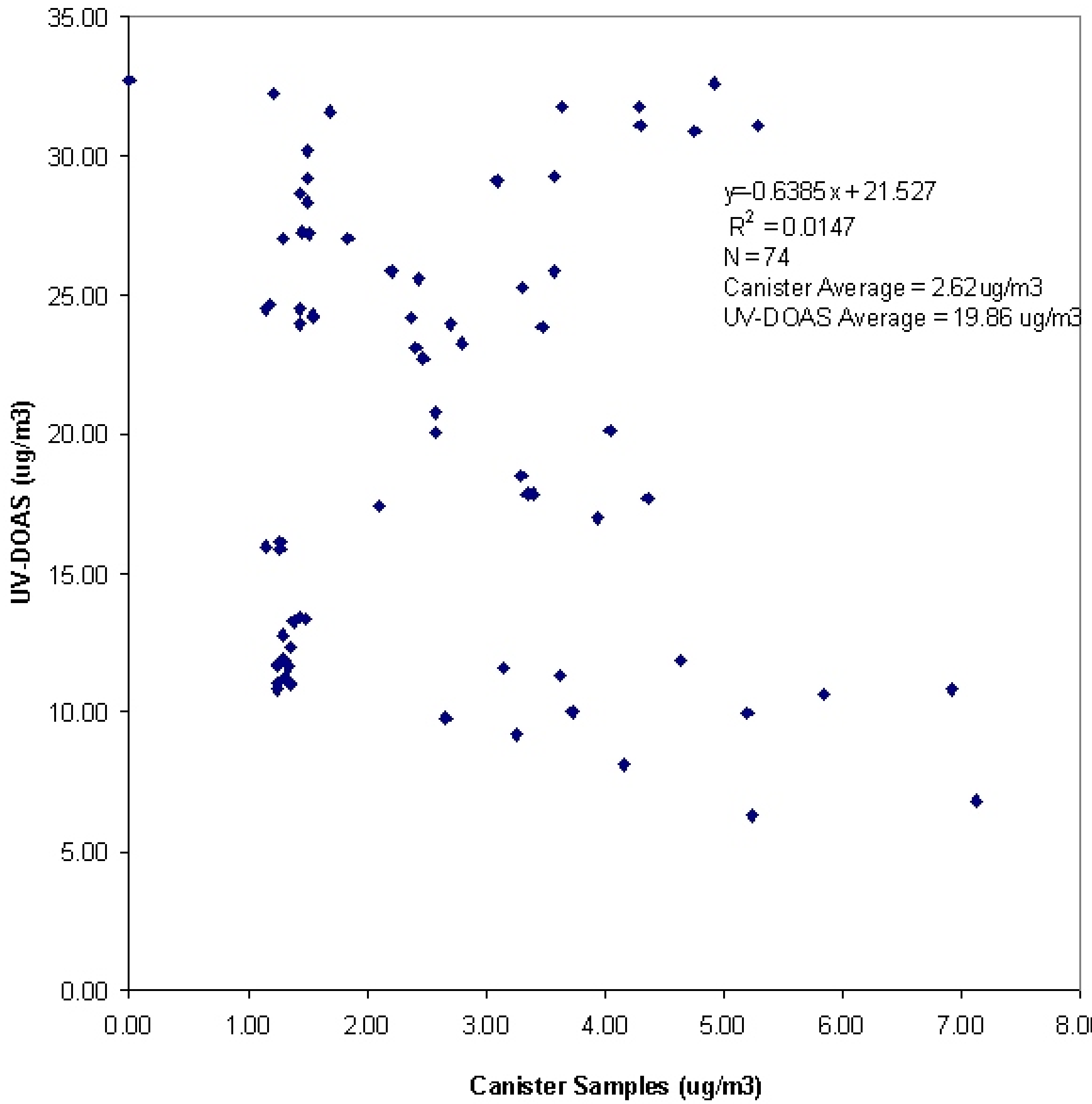


Figure 13. Relationship plot of the one-hour average benzene concentrations.

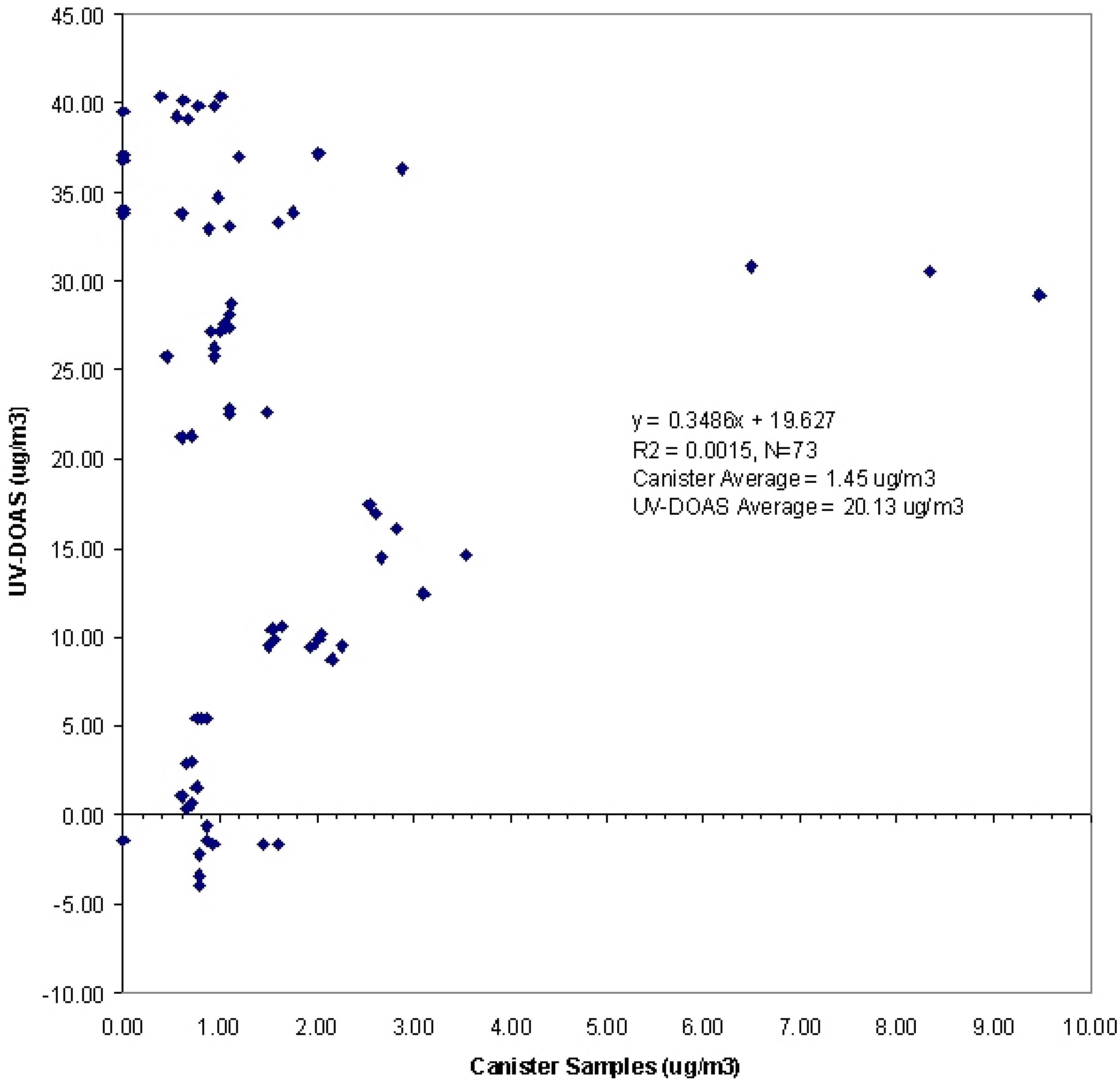


Figure 14. Relationship plot of the one-hour average toluene concentrations.

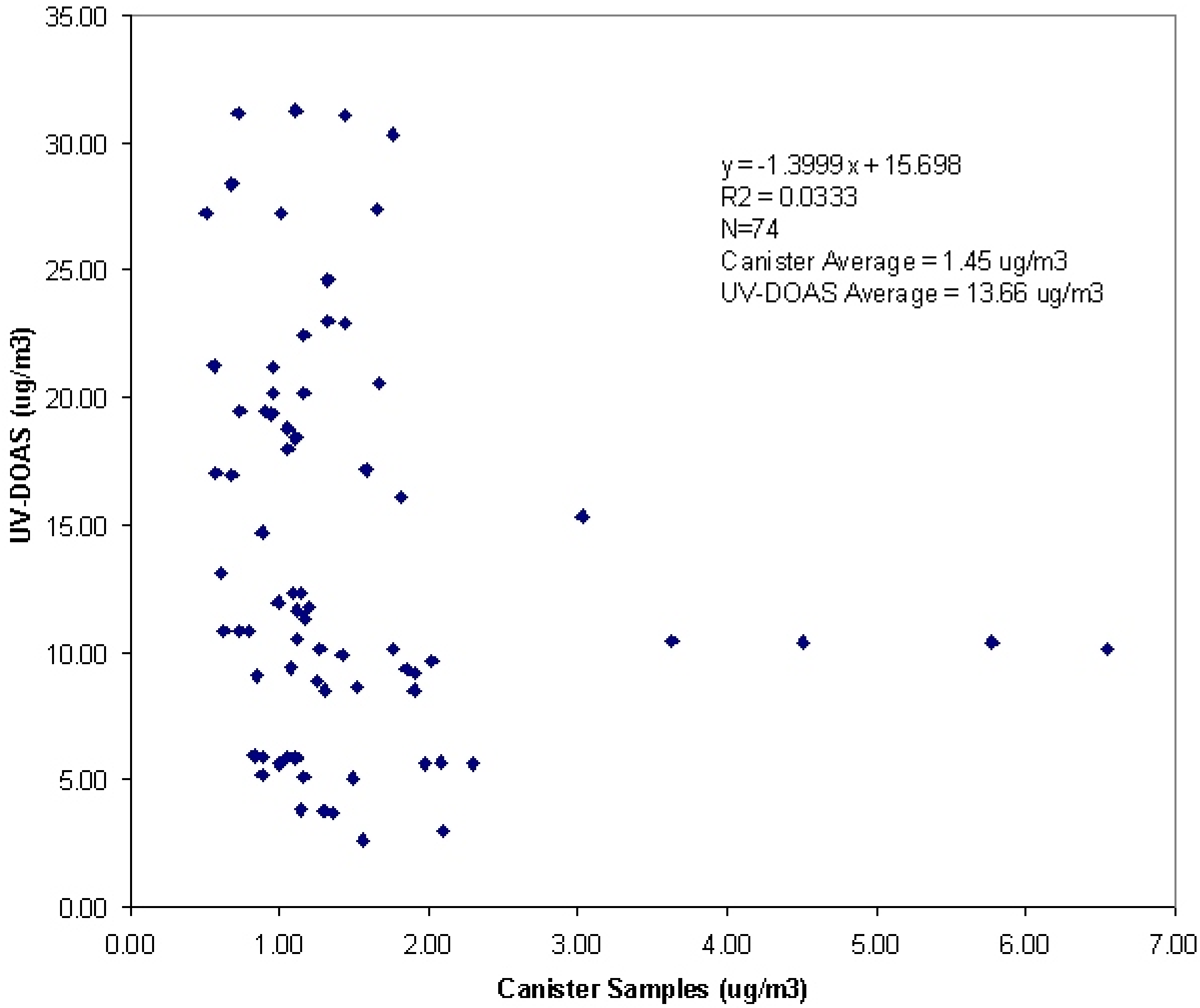


Figure 15. Relationship plot of the one-hour average m-xylene concentrations.

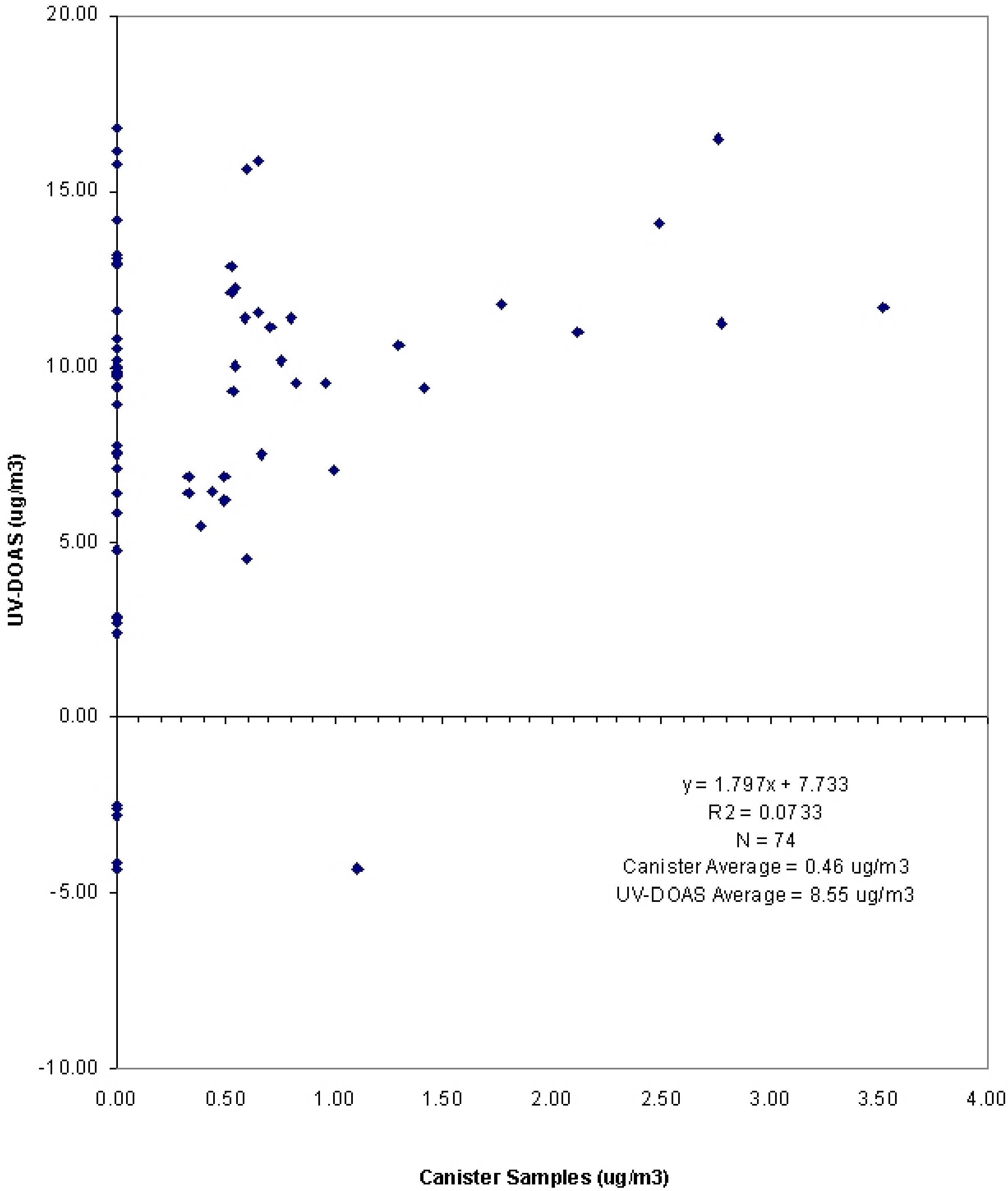


Figure 16. Relationship plot of the one-hour average styrene concentrations.

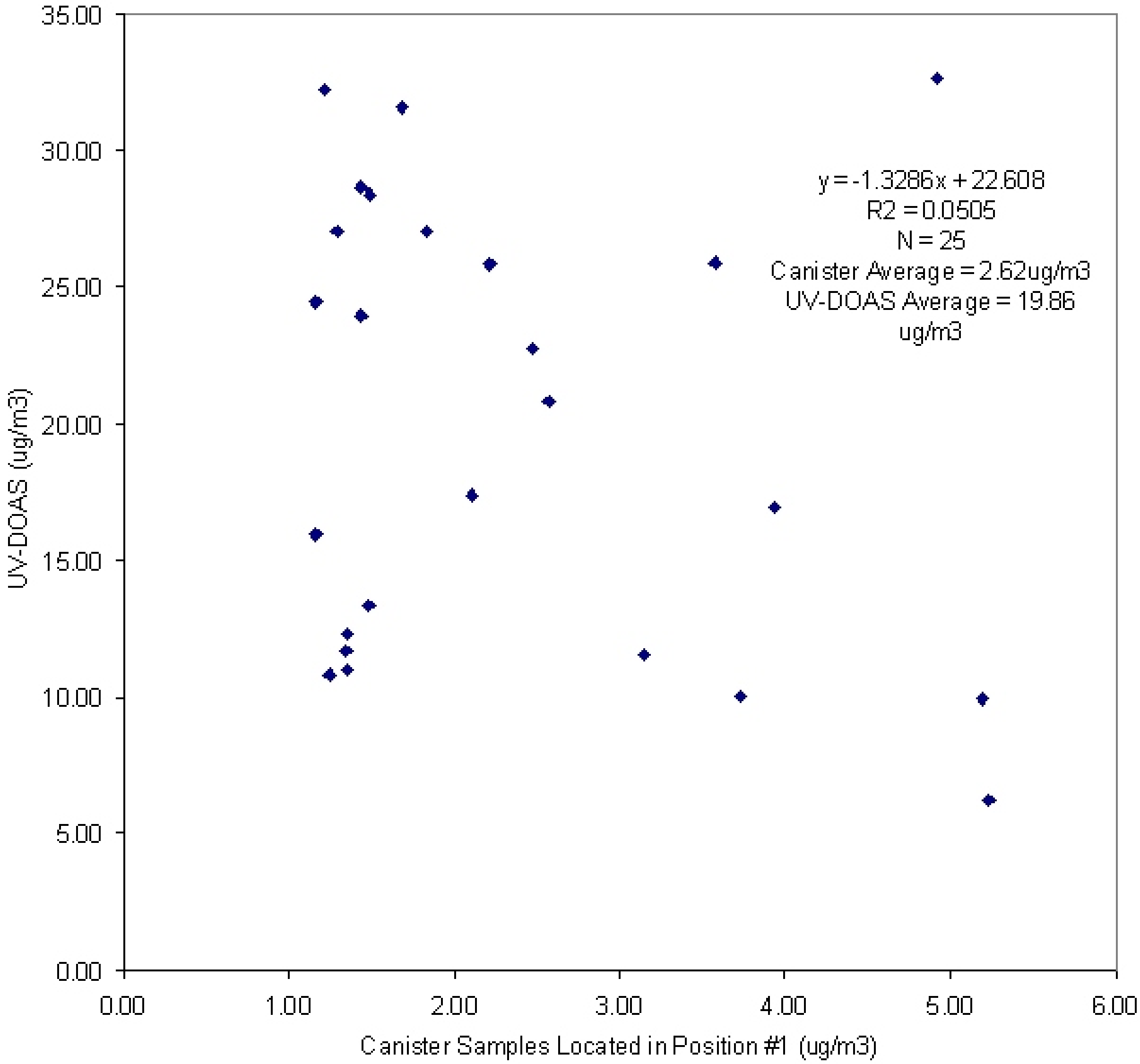


Figure 17A. Benzene concentrations: UV-DOAS data versus data obtained from canisters located in Position 1.

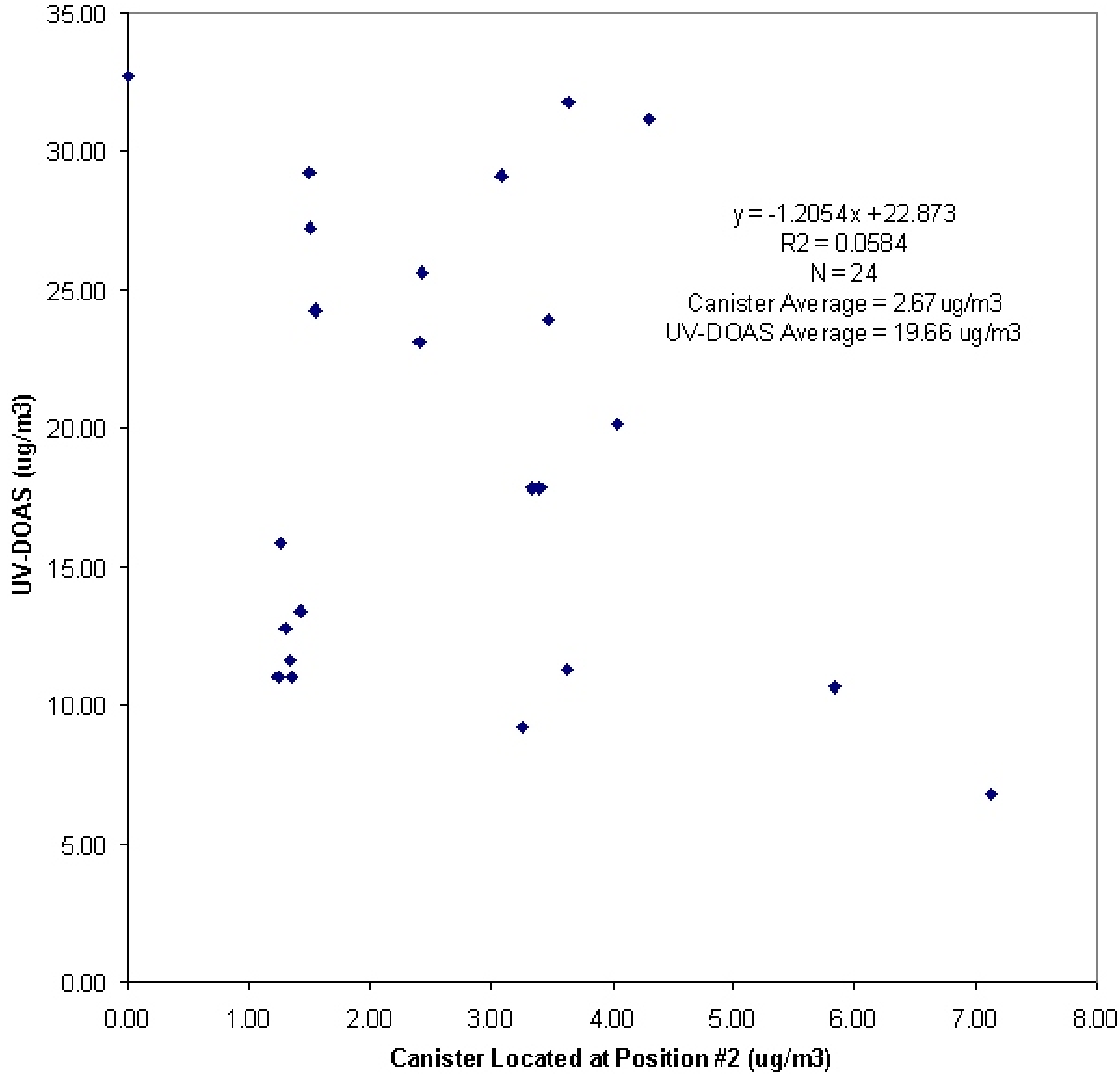


Figure 17B. Benzene concentrations: UV-DOAS data versus data obtained from canisters located in Position 2.

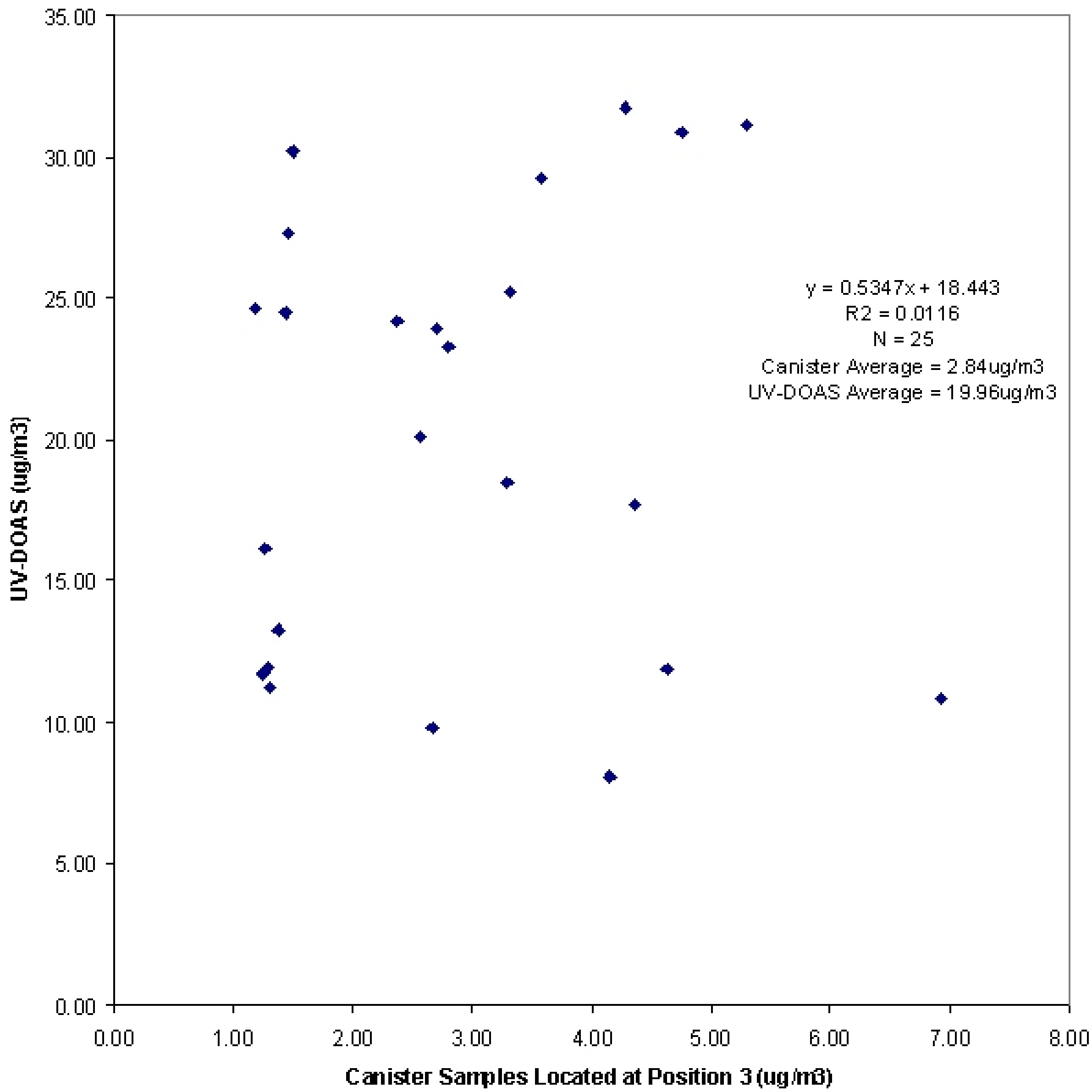


Figure 17C. Benzene concentrations: UV-DOAS data versus data obtained from canisters located in Position 3.

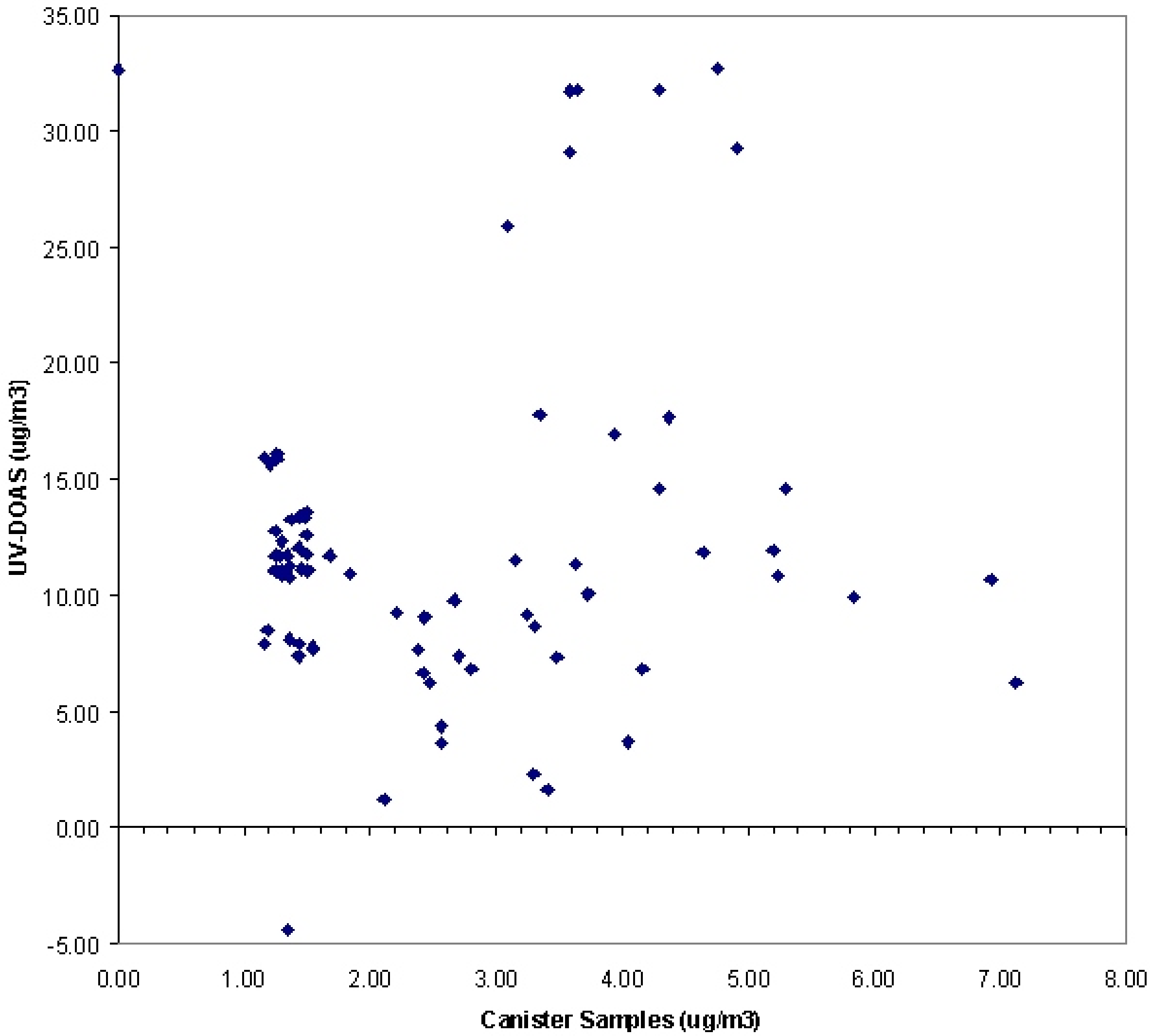


Figure 18. One hour average benzene concentrations (with offset adjustments).

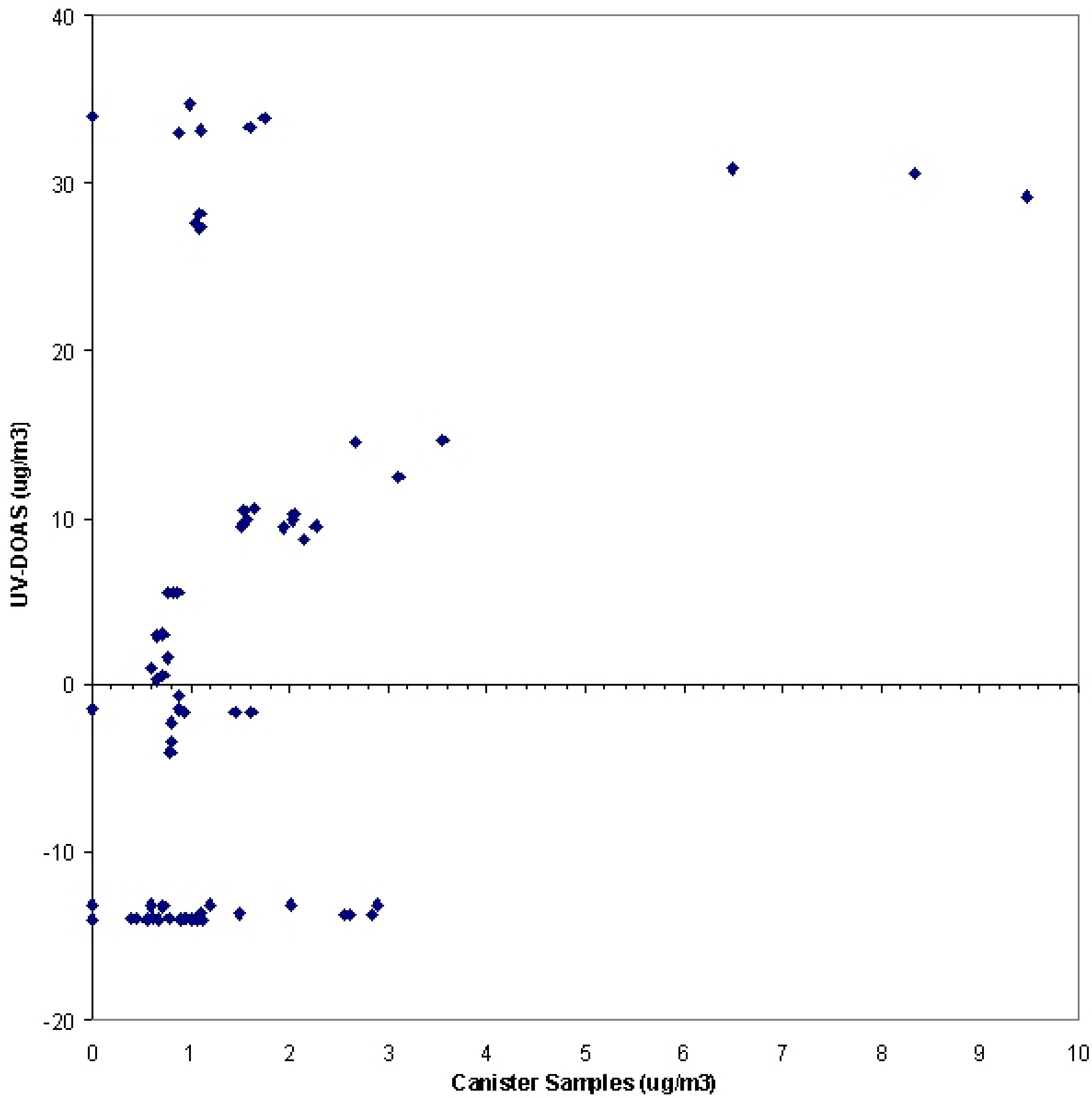


Figure 19. One hour average toluene concentrations (with offset adjustments).

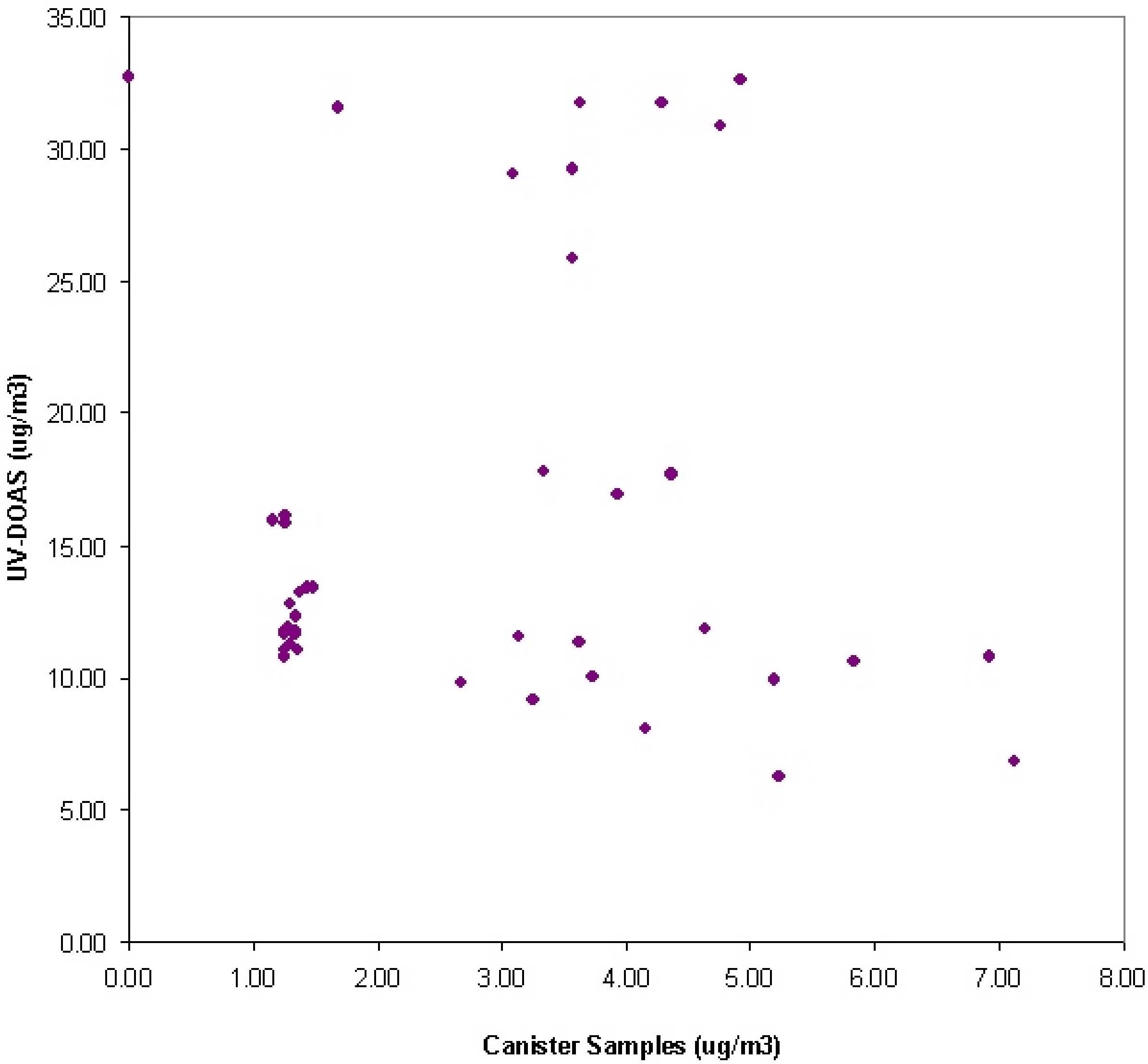


Figure 20. One hour average benzene concentrations (after April 13, 2000 UV-DOAS calibration).

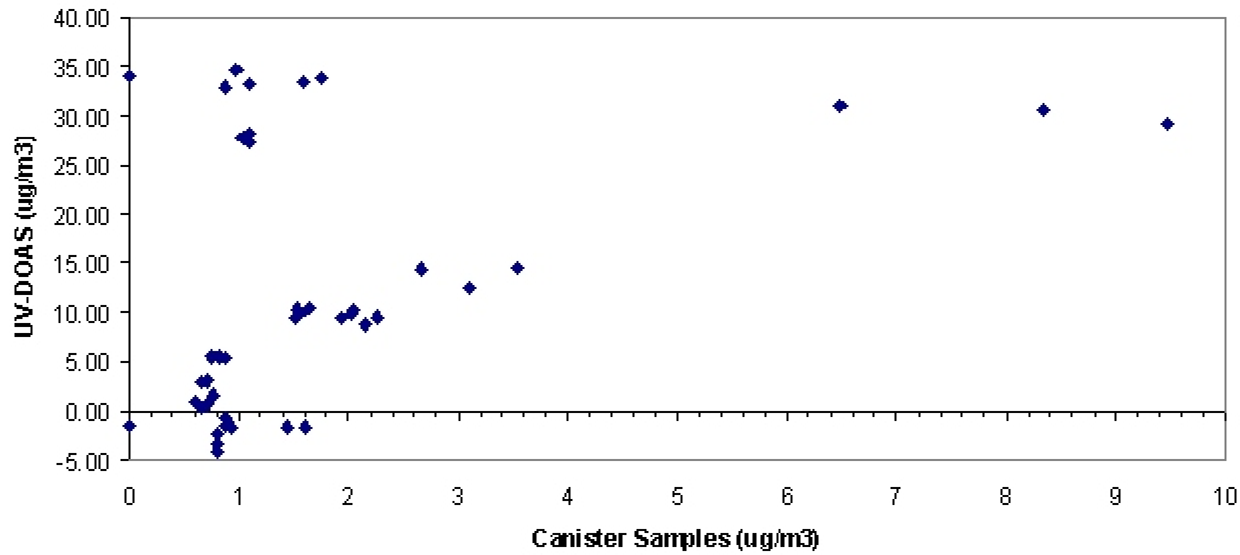


Figure 21. One hour average toluene concentrations (after April 13, 2000 UV-DOAS calibration).

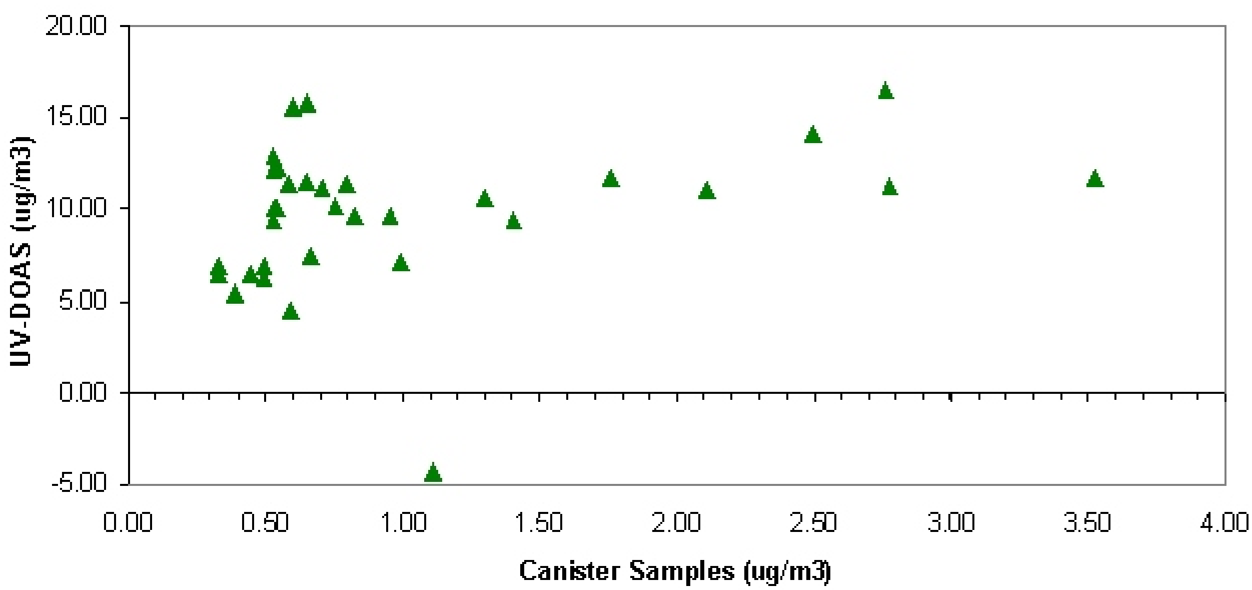


Figure 22. One hour average styrene concentrations (non-detectable data excluded).

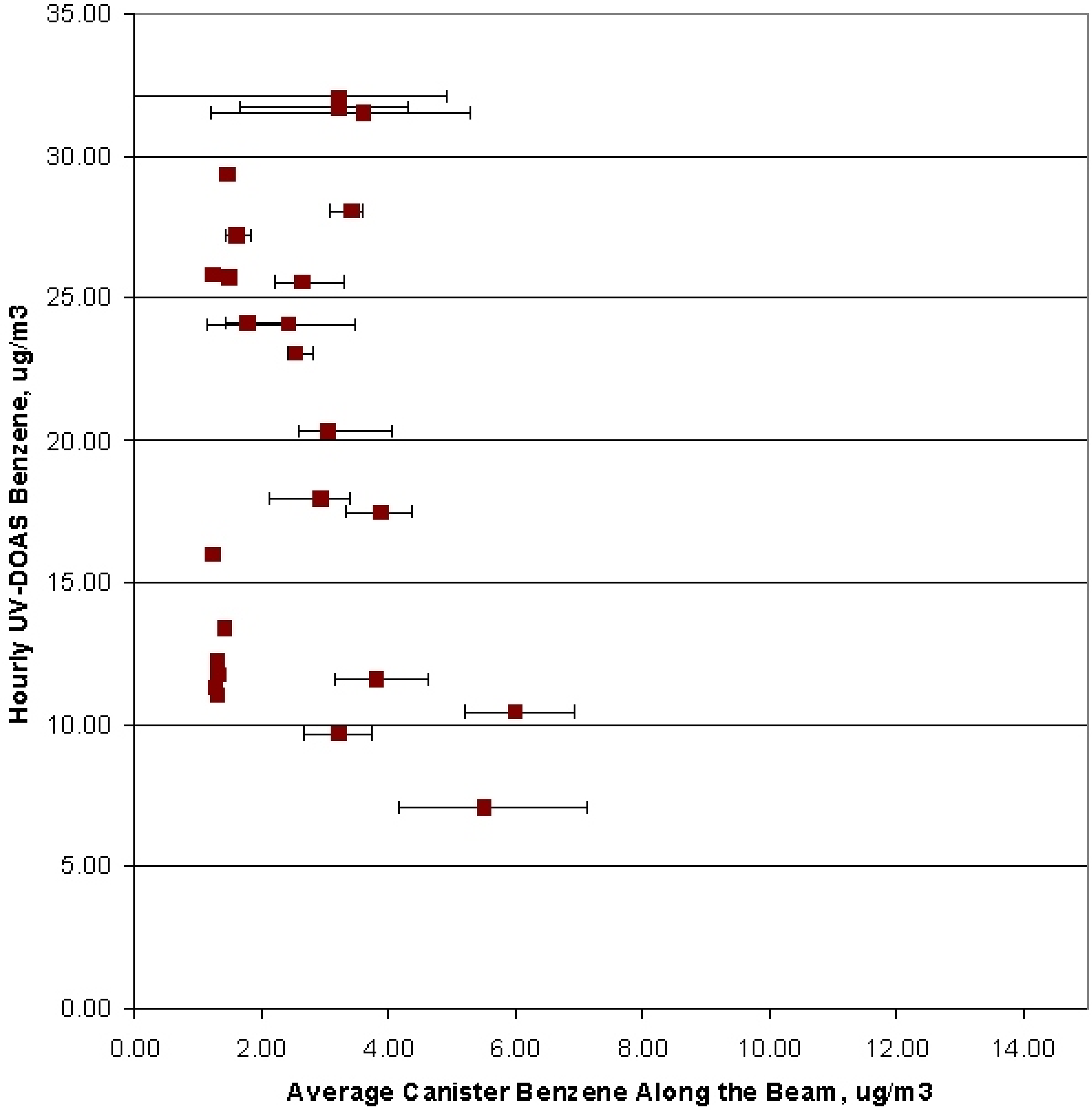


Figure 23. Effect of canister benzene variation vs. UV-DOAS.

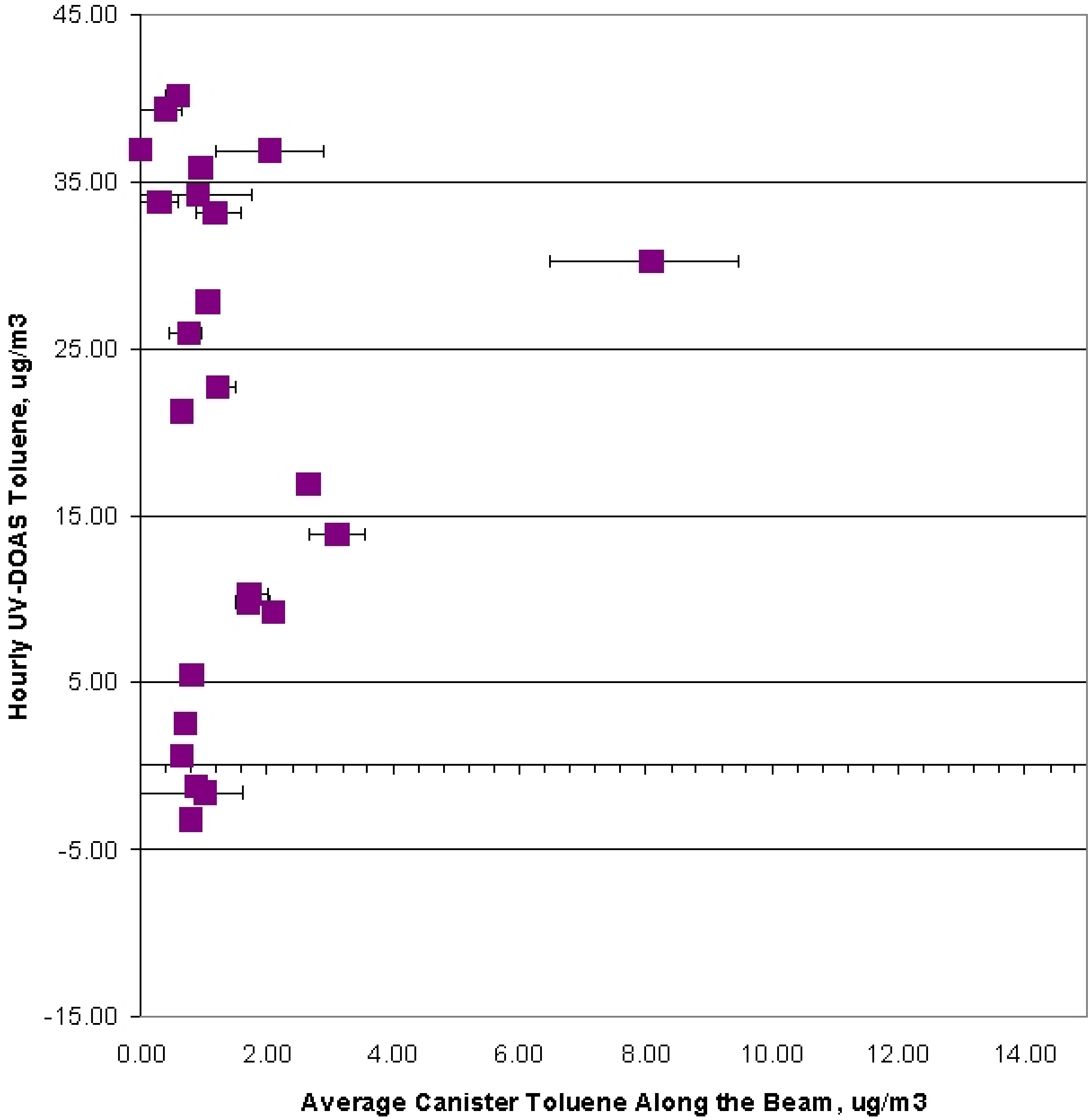


Figure 24. Effect of canister toluene variation vs. UV-DOAS.

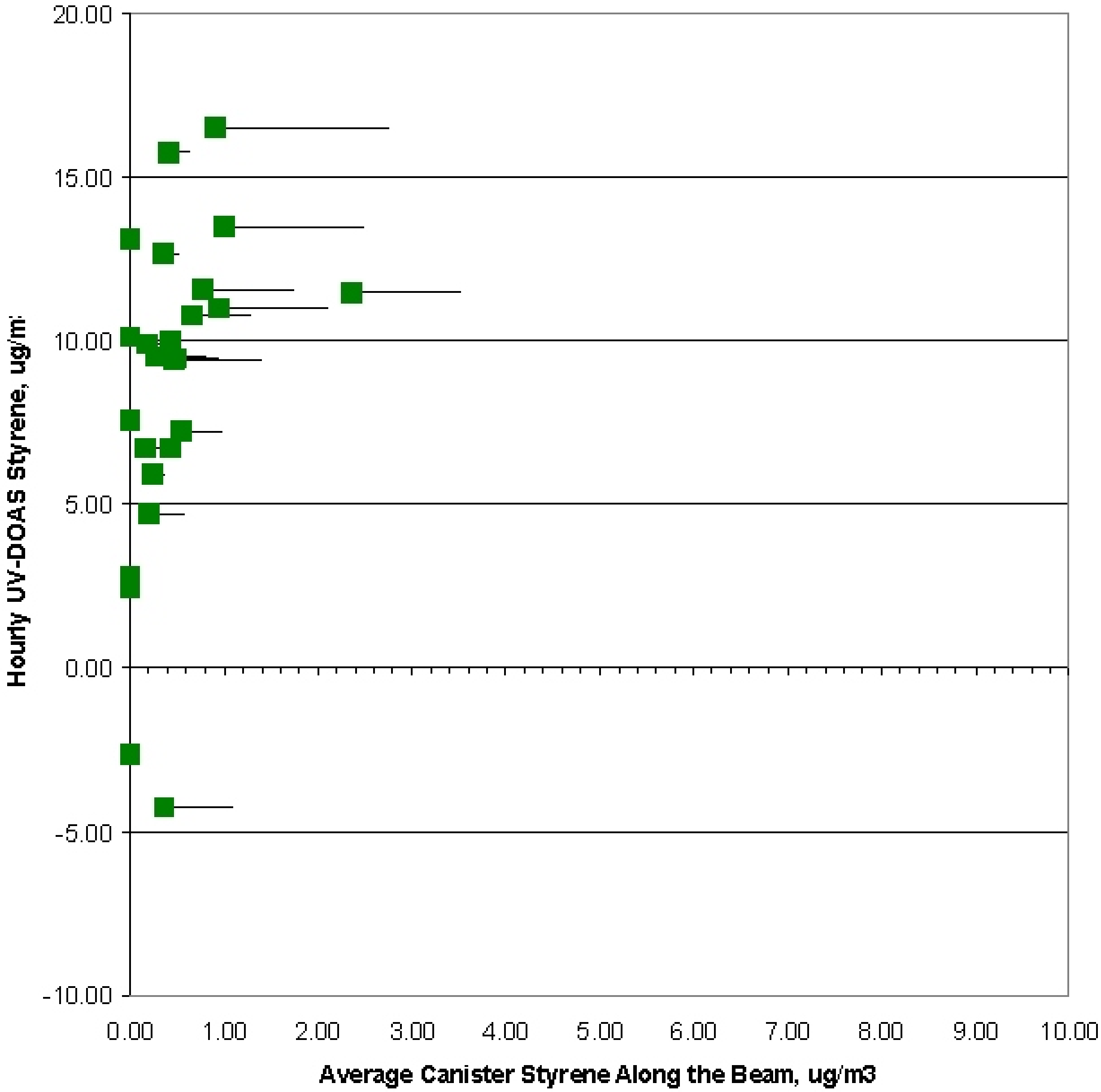


Figure 25. Effect of canister styrene variation vs. UV-DOAS.

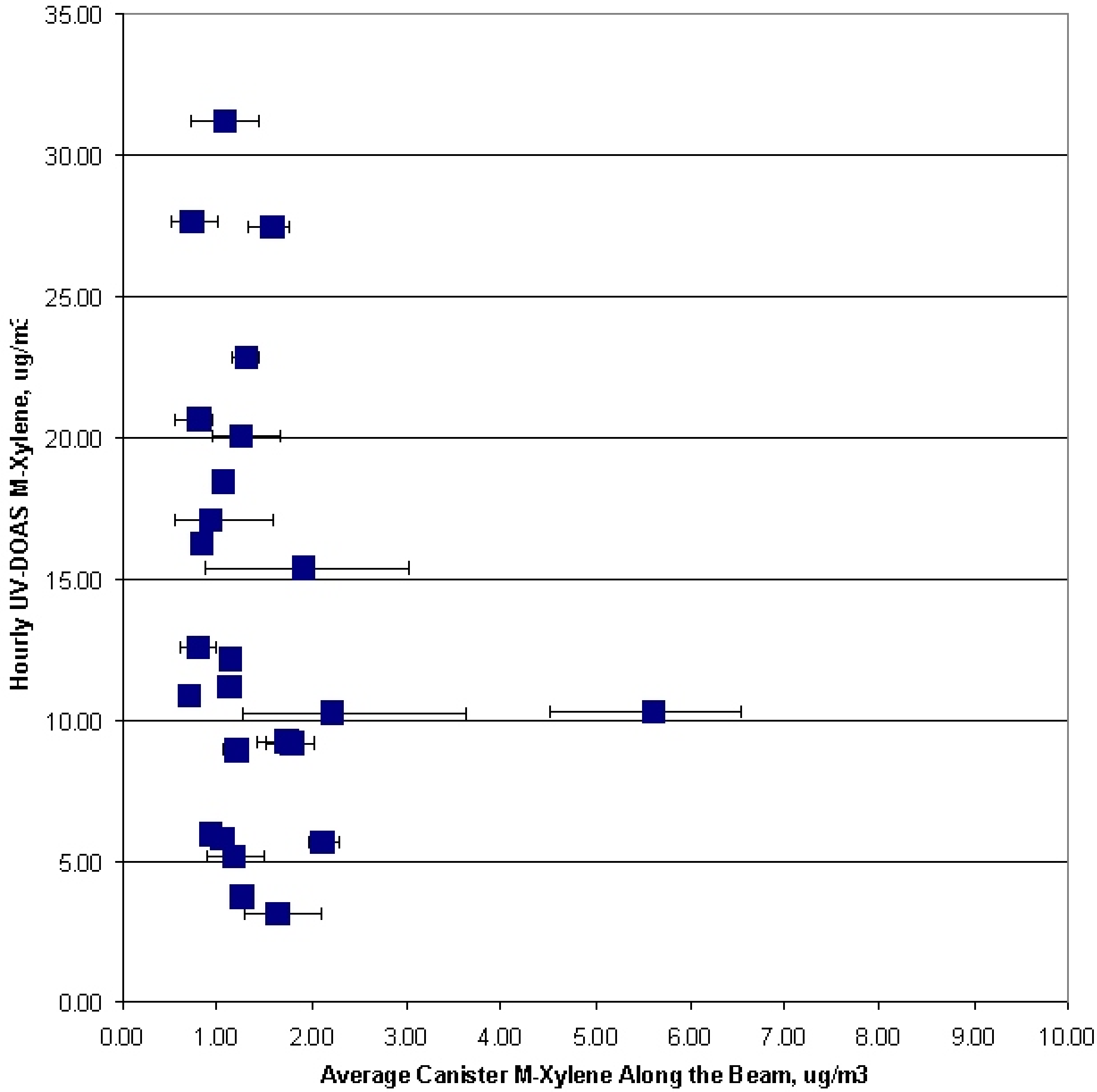


Figure 26. Effect of canister m-xylene variation vs. UV-DOAS.

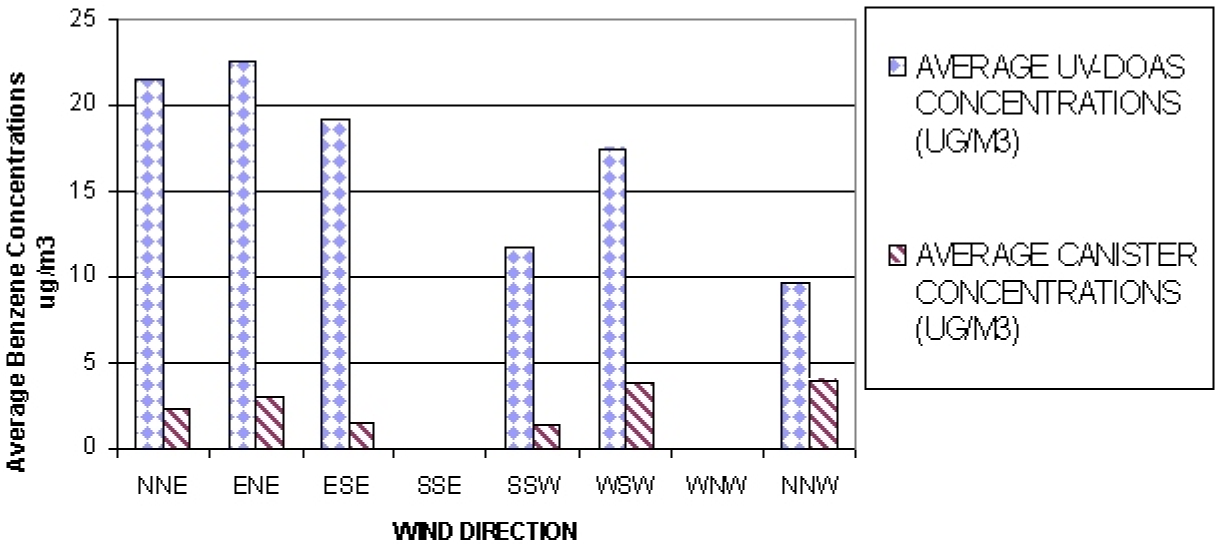


Figure 27. Average benzene concentrations vs. wind direction.

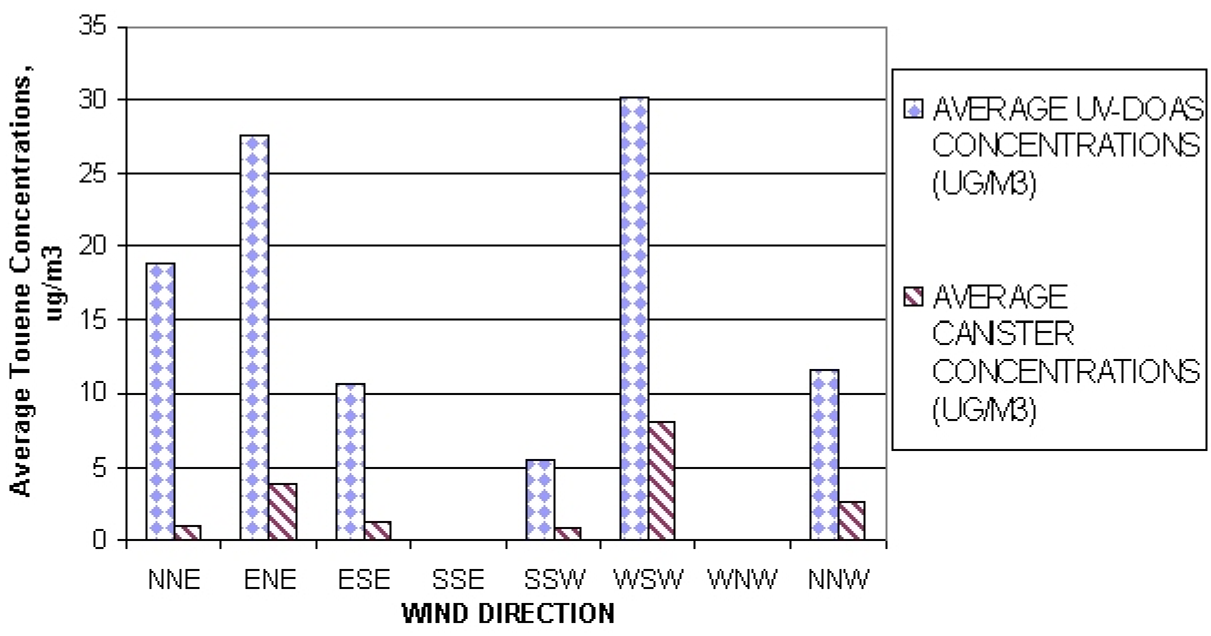


Figure 28. Average toluene concentrations vs. wind direction.

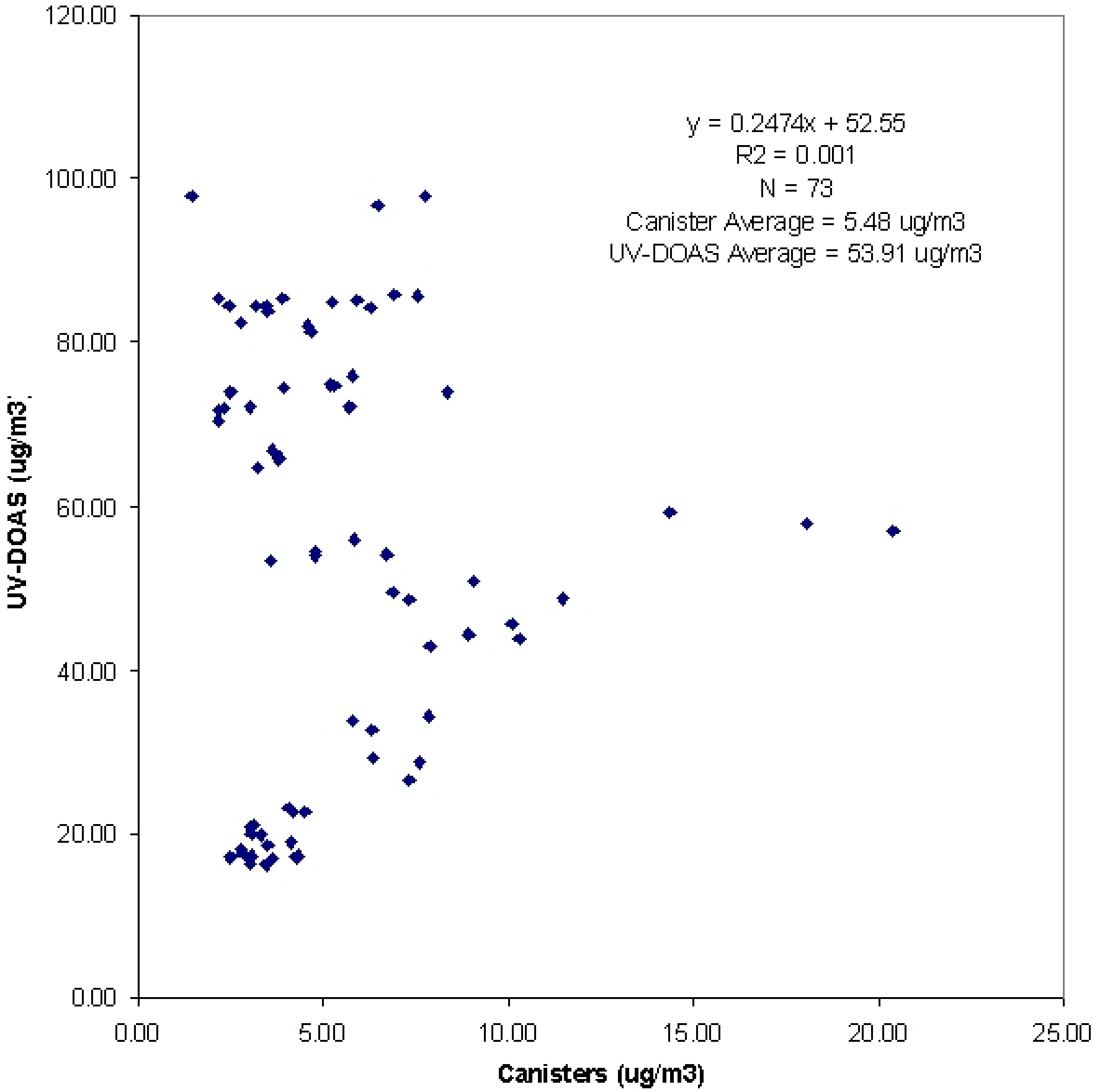


Figure 29. Relationship plot of the sum of benzene, toluene, and m-xylene concentrations obtained by the UV-DOAS and canister samples.

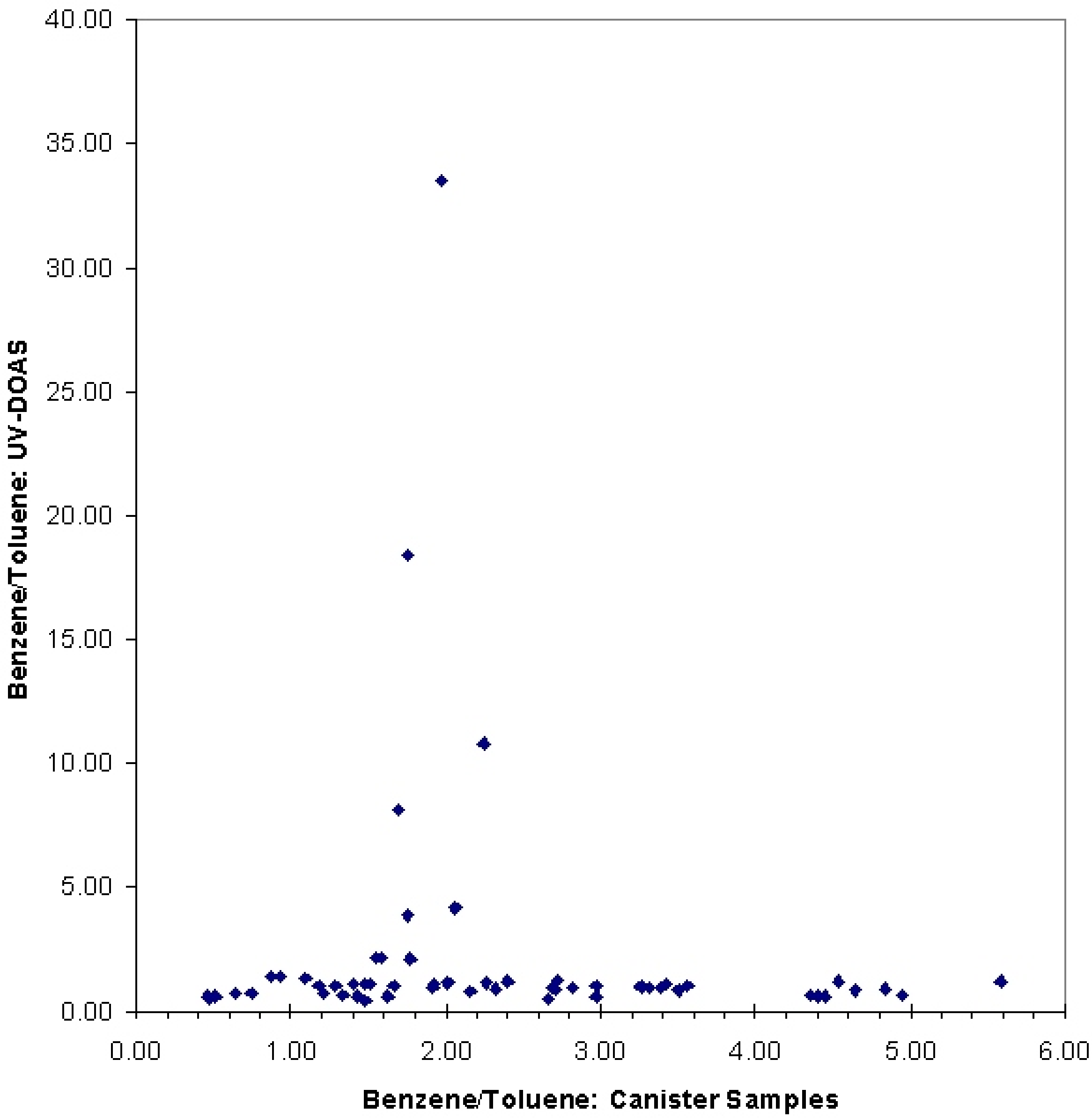


Figure 30. Benzene-toluene ratios for UV-DOAS vs. benzene-toluene ratios for the canister samples.

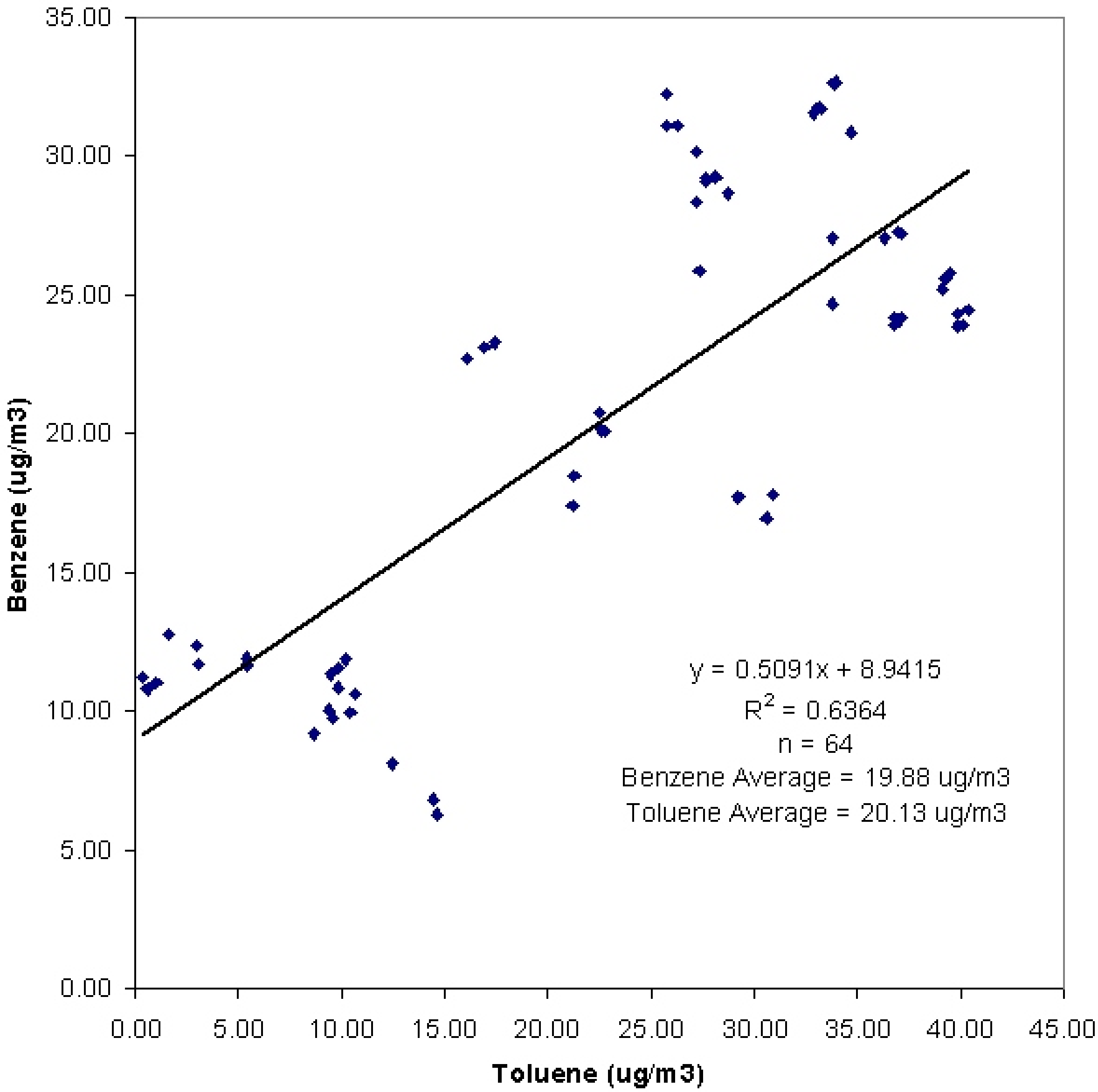


Figure 31. Benzene-toluene ratio plot for the UV-DOAS.

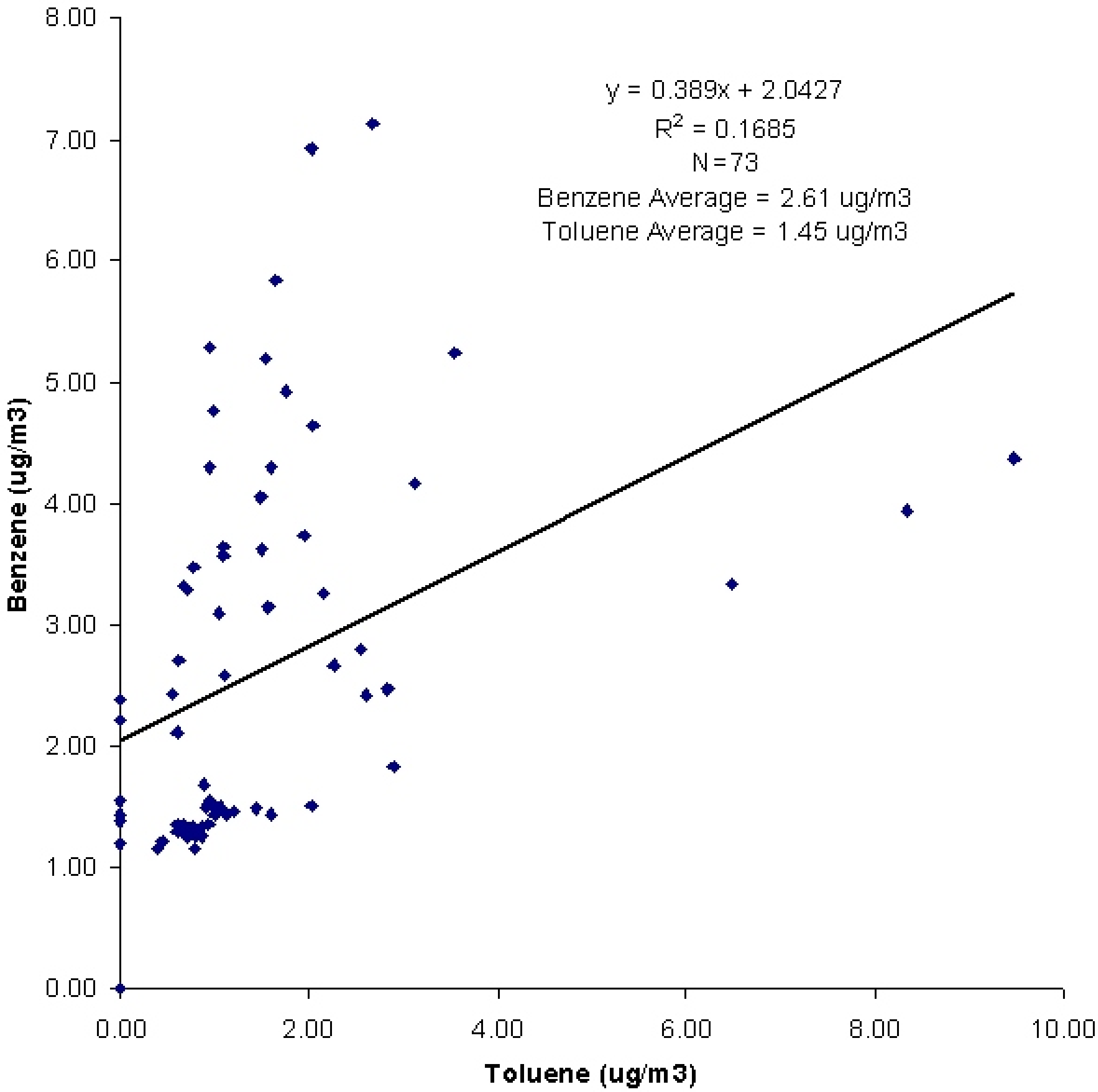


Figure 32. Benzene-toluene ratio plot for the canister samples.

V. CONCLUSIONS

It is necessary that the UV-DOAS be installed on a stable platform (i.e. embedded in concrete or installed on the rooftop of a building), so as to ensure the alignment of the projected ultraviolet beam with the receiver. From our experience, 29 site visits were required to align the projected beam. Most importantly, two operators are required to maintain this remote sensing device. The UV-DOAS may not be appropriate for temporary use or in emergency response situations.

Even though a strong association was demonstrated between the NO_2 and O_3 detected by UV-DOAS and the direct reading monitors, based on our observations as seen in Table VII, the UV-DOAS did not accurately detect organic compound concentrations comparable to those detected by the canister samples. Therefore, our data suggest that the UV-DOAS is not suitable for toxic air measurements. Specific conclusions were:

- A strong association was found between the UV-DOAS and the direct ozone-reading monitor with a slope of about 0.68.
- A strong association was found between the UV-DOAS and the direct nitrogen dioxide reading monitor with a slope of about 1.0.
- No association was found for the benzene concentrations detected by the UV-DOAS and the canister samples. The UV-DOAS average and canister average differed by 17ug/m3.
- No association was found for the toluene concentrations detected by the UV-DOAS and the canister samples. The UV-DOAS average and canister average differed by 18ug/m3.
- No association was found for the m-xylene concentrations detected by the UV-DOAS and the canister samples. The UV-DOAS average and canister average differed by 12ug/m3.
- No association was found for the styrene concentrations detected by the UV-DOAS and the canister samples. The UV-DOAS average and canister average differed by 8ug/m3.
- No association was found for the sum of the benzene, toluene, and m-xylene concentrations detected by the UV-DOAS and the canister samples.
- The overall benzene-toluene ratio plot for both the UV-DOAS and the canister samples showed no association.
- Associations were found in the individual benzene-toluene ratio plots for the UV-DOAS and the canister samples. Average benzene concentrations were approximately equal to the average toluene concentrations.

VI RECOMMENDATIONS

The following recommendations are made based on the results of this study:

- To ensure stability of the SANOA UV-DOAS system, both the projector and receiver should be embedded in a fixed support, such as concrete or on the roof of a building. By doing this, the UV-DOAS operator could possibly reduce maintenance time, obtain proper beam alignment, and obtain reliable measurements.

- When maintaining the UV-DOAS system, at least two trained operators should be present, most especially when realigning the projected beam.

- When using the UV-DOAS for the first time, a thorough hands-on training session should cover the following topics.

    - Maintaining the projector and receiver (i.e. changing the lamp bulb or fan filter).

    - Align the beam using the tracking system, performing focal adjustments, and using “eyeball techniques”.

    - Operation of the Visionair computer software.

    - Interpretation of the configuration values (i.e. ideal peak or light visibility for obtaining proper alignment or reliable measurements).

    - Calibration of the UV-DOAS system.

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SANOA
Span check data sheet

Reference conditions

Serial number		VisionAIR Ver.	3.35
Customer	Paxton	Date	07-Apr-00

Test conditions

Current calibration factor	1.000	Component	Ben
Monitoring path length: L=	232 m	Molar weight: Mw=	78.11 g/Mol
Tdet=	10 °C	Gas cylinder concentration: Ccell =	101 ppm
ppb conversion used :	Standard		5 °C
☑ Barometric Pressure correction		Barometric pressure (Pa):	1015 hPa

Required only if no pressure sensor is connected for ppb units mode or if µg/m3 units mode is selected

Conversion factor ppm to µg/m3 — *Fc= (Mw * 12186.5)/(273.15+Tdet)x Pa/Po* — Fc = 3367.58

(Po =1013.25 hPa)

Conversion Factor path to Cell — *Fp = L/Lcell* — Fp = 6823.53

Measurement data unit: µg/m3

	t1	t2	t3
Time:	15:30	15:48	16:09
Gas:	Zero Air	Ben	Zero Air
Monitored concentrations: C=	23.36 µg/m3	72.82 µg/m3	26.42 µg/m3

Data Processing

Relative background instability	Sr = 100x(C3-C1)/C2	4.2%
Background pollution at t2	Cf = (C1+C3)/2	24.89 µg/m3
Corrected concentration at t2	Cc = C2-Cf	47.93 µg/m3

Data comparison

	Theoritical Concentrations Ceff	Monitored Concentrations Cmon	Difference (Cmon-Ceff)/Ceff
Atmosphere	49.8 µg/m3	47.9 µg/m3	-3.8%
Cell	101.0 ppm	97 ppm	-3.8%

Ceff/Cmon x previous span factor

New Span factor = 1.040

Figure 33. UV-DOAS span check data sheet for the benzene calibration performed on April 7, 2000.

APPENDIX A

SANOA
Span check data sheet

Reference conditions

Serial number:

VisionAIR Ver.: 3.35

Customer: Paxton

Date: 13-Apr-00

Test conditions

Current calibration factor: 1.000

Component: Ben

Monitoring path length: L= 232 m

Molar weight: Mw= 78.11 g/Mol

Tdet= 20.51 °C

Gas cylinder concentration: Ccell = 101 ppm

ppb conversion used : Standard

5 °C

☑ Barometric Pressure correction

Barometric pressure (Pa): 1013.25 hPa

Required only if no pressure sensor is connected for ppb units mode or if µg/m3 units mode is selected

Conversion factor ppm to µg/m3: *Fc= (Mw * 12186.5)/(273.15+Tdet)x Pa/Po*, Fc = 3241.46

(Po =1013.25 hPa)

Conversion Factor path to Cell: *Fp = L/Lcell*, Fp = 6823.53

Measurement data unit: µg/m3

	t1		t2		t3	
Time:	12:15		12:36		12:51	
Gas:	Zero Air		Ben		Zero Air	
Monitored concentrations: C=	7.96	µg/m3	57.302	µg/m3	13.596	µg/m3

Data Processing

Relative background instability	Sr = 100x(C3-C1)/C2	9.8%	
Background pollution at t2	Cf = (C1+C3)/2	10.778	µg/m3
Corrected concentration at t2	Cc = C2-Cf	46.524	µg/m3

Data comparison

	Theoritical Concentrations Ceff		Monitored Concentrations Cmon		Difference *(Cmon-Ceff)/Ceff*
Atmosphere	48.0	µg/m3	46.5	µg/m3	-3.0%
Cell	101.0	ppm	98	ppm	-3.0%

Ceff/Cmon x previous span factor

New Span factor = 1.031

Figure 34. UV-DOAS span check data sheet for the benzene calibration performed on April 13, 2000.

APPENDIX A

SANOA
Span check data sheet

Reference conditions

Serial number: [ ] VisionAIR Ver. 3.35

Customer: Paxton Date: 07-Apr-00

Test conditions

Current calibration factor: 1.000 Component: Tol

Monitoring path length: L= 232 m Molar weight: Mw= 92.14 g/Mol

Tdet= 10 °C Gas cylinder concentration: Ccell = 98.8 ppm

ppb conversion used : Standard 5 °C

☑ Barometric Pressure correction Barometric pressure (Pa): 1013 hPa

Required only if no pressure sensor is connected for ppb units mode or if µg/m3 units mode is selected

Conversion factor ppm to µg/m3 — *Fc= (Mw * 12186.5)/(273.15+Tdet)x Pa/Po* — Fc = 3964.64

(Po =1013.25 hPa)

Conversion Factor path to Cell — *Fp = L/Lcell* — Fp = 6823.53

Measurement data unit: µg/m3

	t1	t2	t3
Time:	16:09	16:33	16:57
Gas:	Zero Air	Tol	Zero Air
Monitored concentrations: C=	21.03 µg/m3	56.26 µg/m3	14.98 µg/m3

Data Processing

Relative background instability	Sr = 100x(C3-C1)/C2	10.8%
Background pollution at t2	Cf = (C1+C3)/2	18.005 µg/m3
Corrected concentration at t2	Cc = C2-Cf	38.255 µg/m3

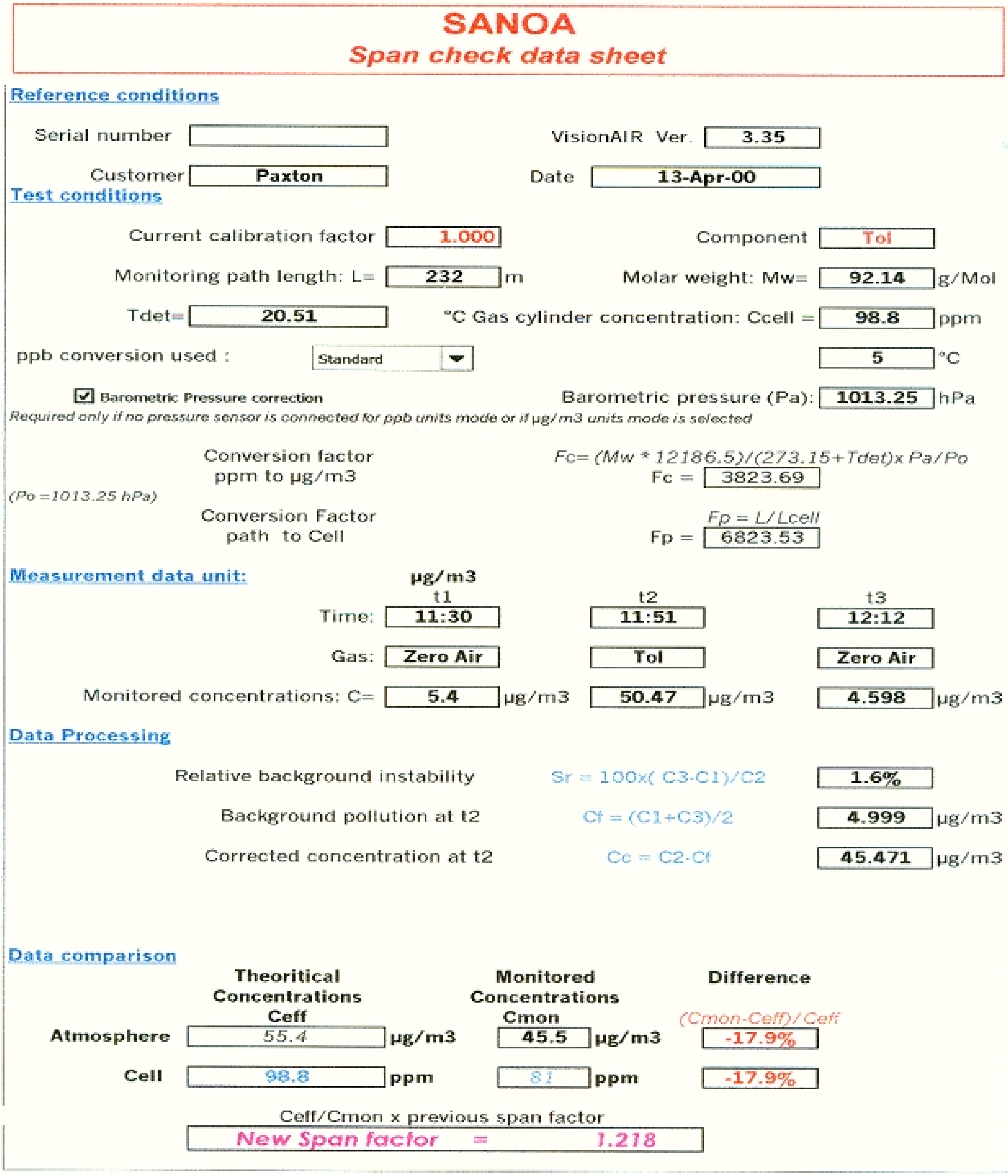
Data comparison

	Theoritical Concentrations Ceff	Monitored Concentrations Cmon	Difference (Cmon-Ceff)/Ceff
Atmosphere	57.4 µg/m3	38.3 µg/m3	-33.4%
Cell	98.8 ppm	66 ppm	-33.4%

Ceff/Cmon x previous span factor

New Span factor = 1.501

Figure 35. UV-DOAS span check data sheet for the toluene calibration performed on April 7, 2000.



SANOA
Span check data sheet

Reference conditions

Serial number: | VisionAIR Ver. 3.35

Customer: Paxton | Date: 13-Apr-00

Test conditions

Current calibration factor: 1.000 | Component: Tol

Monitoring path length: L= 232 m | Molar weight: Mw= 92.14 g/Mol

Tdet= 20.51 °C | Gas cylinder concentration: Ccell = 98.8 ppm

ppb conversion used : Standard | 5 °C

☑ Barometric Pressure correction | Barometric pressure (Pa): 1013.25 hPa

Required only if no pressure sensor is connected for ppb units mode or if µg/m3 units mode is selected

Conversion factor ppm to µg/m3 | *Fc= (Mw * 12186.5)/(273.15+Tdet)x Pa/Po* | Fc = 3823.69

(Po =1013.25 hPa)

Conversion Factor path to Cell | *Fp = L/Lcell* | Fp = 6823.53

Measurement data unit: µg/m3

	t1	t2	t3
Time:	11:30	11:51	12:12
Gas:	Zero Air	Tol	Zero Air
Monitored concentrations: C=	5.4 µg/m3	50.47 µg/m3	4.598 µg/m3

Data Processing

Relative background instability	Sr = 100x(C3-C1)/C2	1.6%
Background pollution at t2	Cf = (C1+C3)/2	4.999 µg/m3
Corrected concentration at t2	Cc = C2-Cf	45.471 µg/m3

Data comparison

	Theoritical Concentrations Ceff	Monitored Concentrations Cmon	Difference (Cmon-Ceff)/Ceff
Atmosphere	55.4 µg/m3	45.5 µg/m3	-17.9%
Cell	98.8 ppm	81 ppm	-17.9%

Ceff/Cmon x previous span factor

New Span factor = 1.218

Figure 36. UV-DOAS span check data sheet for the toluene calibration performed on April 13, 2000.

APPENDIX B

TABLE IX: TECO 42 NOx MONITOR CALIBRATION DATA

DATE	NO2 standard (ppm)	NO2 observed (response / ppm)	NOx Standard (ppm)	NOx Observed (response / ppm)	NO Standard (ppm)	NO Observed (response / ppm)
3-25-2000	0.414	0.414	0.472	0.472	0.472	0.472
	0.305	0.306	0.29	0.294	0.29	0.294
	0.203	0.205	0.188	0.189	0.188	0.189
	0.082	0.084	0.124	0.125	0.124	0.125
	0.0	0.0	0.0	0.0	0.0	0.0
3-29-2000	0.405	0.411	0.472	0.477	0.472	0.476
	0.301	0.312	0.188	0.194	0.188	0.194
	0.076	0.090	0.124	0.130	0.124	0.131
	0.0	-0.3	0.0	0.4	0.0	0.7

TABLE X: DASIBI MODEL 1003AH OZONE MONITOR CALIBRATION

EPA # / JOB #	Calibration Standard	Date	Slope	Intercept	Correlation Coefficient	Measured Zero
A15996 / 9279-04	Photometer #A14233	10-12-1999	0.972	21.4	0.999	22.5

TABLE XI: LOG OF PAXTON LANDFILL ACTIVITIES

Date	Event	No. of site visits	No. of Persons	No. of Hours Spent at Site	No. of Alignments	Light Vis (Luminous Flux)	Peak	No. of Canisters Collected	Wind Direction
13-Sep-99	Donna Kenski, Dr. Wadden, and I visit the Paxton Landfill in Chicago. Two representatives from the Illinois Environmental Protection Agency (IEPA) gave us a tour.	1	5	2.5					
14-Sep-99 to 25-Sep-99	Trailer arrangements are made with Mobile Office and with Jerry from the Illinois EPA. Calibration gases and extension cords are ordered. Decision was made to power the air monitoring equipment with electricity instead of generators.								
20-Sep-99	Alain from Environnement SA notifies us that we need 100 volts or more to power the 300W projector and the 250W receiver								
4-Oct-99	Neema Amatya joins the Paxton project team								
6-Oct-99	Discussion with Donna on the exact location of the trailers at the landfill								
7-Oct-99	Conference call with France and Altech. Environnement SA explains that the UV-DOAS will be shipped out								

Date	Event	No. of site visits	No. of Persons	No. of Hours Spent at Site	No. of Alignments	Light Vis (Luminous Flux)	Peak	No. of Canisters Collected	Wind Direction
	Oct. 25th and it will arrive at Altech by Nov. 1 or 2nd. The tentative schedule is to install instrument and start our training the week of Nov. 9.								
14-Oct-99	Donna, Dr.Scheff, and I visit the IEPA's Northbrook site and observe a remote sensing device that is also based on ultraviolet differential optical absorption spectrometry. Later in the afternoon, we discuss more about the location of the trailers.								
25-Oct-99	Our trailers are delivered to the landfill around 2pm.	1	1	5					
27--Oct-99	Commonwealth Edison inspector visits our site and figures out how we can obtain electricity to our trailers. He explains we need to install a riser in order to prevent the electrical wire, connected to the transformer, from sagging once it reaches trailer. Cables to be buried under 1-2 feet of dirt.	1	2	3					
28-Oct-99 to 01-Nov-99	Neema contacts McWilliams Inc., our first electrical contractor								
2-Nov-99	Mcwilliams contractor visits the site and provides us with an estimate for the electrical hook-up. His estimate is too high. We begin looking for another electrical contractor.								
3-Nov-99	We contacted Edgewater Electric to								

Date	Event	No. of site visits	No. of Persons	No. of Hours Spent at Site	No. of Alignments	Light Vis (Luminous Flux)	Peak	No. of Canisters Collected	Wind Direction
	provide us with an estimate for the electrical hook-up to the two trailers.								
5-Nov-99	Neema and I collect 2 preliminary canister samples in order to determine the toxic air emissions at the site. One canister located on top of trailer 2 on north end. Second canister near trailer 1 on south end.	1	2	3				2	SSW
10-Nov-99 to 23-Nov-99	The contractor from Edgewater begins installing the riser and meter near our trailers.								
30-Nov-99	Commonwealth Edison installs electrical wires at the site. There is power to the two trailers.								
9-Dec-99	UD-DOAS is installed. Jean-Cristophe trains us on how to use these air monitoring equipment.	1	2	7					
10-Dec-99 to 11-Dec-99	Training on UV-DOAS. After the training, we find out from the gas company that they lost our order for the calibration gases.	2	3	10					
14-Dec-99	Focal adjustment (or alignment) performed.	1	4	4	1				
21-Dec-99	Focal adjustment (or alignment) performed.	1	2	4	1				
23-Dec-99	Aligned the projector with the receiver.	1	2	4	1				

Date	Event	No. of site visits	No. of Persons	No. of Hours Spent at Site	No. of Alignments	Light Vis (Luminous Flux)	Peak	No. of Canisters Collected	Wind Direction
	Attempt to install the meteorological station, but the ground is frozen.								
10-Jan-00	Go to the site to maintain the UV-DOAS. The computer system froze. After rebooting the system, we performed the tracking procedure. Ideal numbers were not attained and alignment was not achieved. Jerry from IEPA installed the ozone monitor in trailer 2 Meteorological station installed.	1	3	6	1				
12-Jan-00	Attempted alignment.	1	2	4	1				
14-Jan-00	Alignment attempted early in the morning, while it is still dark. No success in achieving alignment. Light intensity and peak still very low.	1	2	5	1	20-25%			
19-Jan-00	Attempted alignment early in the evening. The beam was very weak and difficult to see. Even though alignment was achieved, we still could not get our ideal peak and light intensity.	1	2	6	1				
24-Jan-00	Perform alignment and tracking procedures.	1	4	5	1				
25-Jan-00	Alignment performed	1	2	4	1				
27-Jan-00	Alignment performed	1	2	4	1				

Date	Event	No. of site visits	No. of Persons	No. of Hours Spent at Site	No. of Alignments	Light Vis (Luminous Flux)	Peak	No. of Canisters Collected	Wind Direction
2-Feb-00	Alignment performed	1	2	4	1				
7-Feb-00	Went to the site and light in the projector was out. Fan inside the projector not working.	1	2	3	1				
9-Feb-00	Donna and I changed the light bulb, but the projector still did not work.	1	2	6	1				
11-Feb-00	Conference call with Environnment SA and Altech. Arrangements were made to have one of the Altech engineers look at the projector.								
14-Feb-00	John from Altech and myself, took projector apart and checked the voltage coming through the power supply and to the lamp. We found out that the 2amp fuse was burnt out, so we replaced it with a 4amp fuse. Fan starts to work, but the lamp is still out. John takes the projector back to the Altech labs and contacts France for more information.	1	2	4					
21-Feb-00	John and Donna reinstall the projector with a new power supply and light bulb.	1	2	5					
22-Feb-00	Alignment in the evening was successful and ideal spectrum intensity level of 15,000 was achieved.	1	2	4	1				

Date	Event	No. of site visits	No. of Persons	No. of Hours Spent at Site	No. of Alignments	Light Vis (Luminous Flux)	Peak	No. of Canisters Collected	Wind Direction
23-Feb-00	Computer system froze and we needed to reboot the system. Light visibility was too low. No alignment was attempted because of the rainy conditions.	1	2	2.5		less than 20%			
25-Feb-00	Alignment was performed early in the morning. Difficult to do due to the foggy conditions. However, we were successful in obtaining ideal peak and light intensity.	1	2	4	1	50 to 80%	11000 to 13000		
29-Feb-00	Aligned the projector with the receiver	1	2	4	1				
3-Mar-00	Came to the site and noticed that projector was out again. Fan was still working. I wanted to change the light bulb but did not have the tools to do so.	1	2	2					
8-Mar-00	Met with John from Altech and we changed the light bulb. Apparently, the old light bulb's tip melted off and left a hole in the bulb. Lamp is working again.	1	2	2.5					
15-Mar-00	Alignment performed and successful. However, peak and light intensity numbers kept on dropping every 3 minutes. We could not perform the calibration on the instrument. Very windy conditions that day.	1	2	4	1	30 to 50%	15000		

Date	Event	No. of site visits	No. of Persons	No. of Hours Spent at Site	No. of Alignments	Light Vis (Luminous Flux)	Peak	No. of Canisters Collected	Wind Direction
16-Mar-00	Realignment was necessary due to high winds disturbing the projector.	1	1	4	1				
17-Mar-00	Alignment performed.	1	2	4	1				
26-Mar-00	Neema goes to the site to check on the UV-DOAS. The lamp in the projector is out again.	1	1	2					
27-Mar-00	Neema retrieves the STX files and emails them to Environnement SA	1	1	2					
29-Mar-00	Sanded down the connectors to the lamp. Projector begins to work again. Came back to the site at 9pm to do the alignment. The projector was aligned with the receiver but still the numbers are too low.	2	2	7	1				
31-Mar-00	I adjusted the light bulb within the projector. Neema and I perform the alignment procedures and numbers are still too low. Two canister samples from the leachate wells, one upwind sample, and one downwind sample were collected.	1	2	7	1	less than .01%		4	ENE
4-Apr-00	Neema and Donna collected one canister sample from well, one upwind sample, and one downwind sample.	1	2	4	1			3	NNW
6-Apr-00	Jean Cristophe Nicolas from Environnement SA is in Chicago. Aligned the beam with the mirror.	1	2	5		25%			

Date	Event	No. of site visits	No. of Persons	No. of Hours Spent at Site	No. of Alignments	Light Vis (Luminous Flux)	Peak	No. of Canisters Collected	Wind Direction
7-Apr-00	Jean Cristophe tried to replace the mirror in the projector, but could not due to the rain. Alignment, benzene & toluene calibration of the UV-DOAS, and baseline adjustment were performed.	1	3	6	1	30%			
8-Apr-00	Jean Cristophe changed the mirror in the projector and improved the alignment of the projector.	1	3	6	1				
9-Apr-00	Jean Cristophe and I collected 12 canister samples with the winds coming from the NW and NE. Alignment was improved.	1	2	8	1	>100%		12	NW and 4pm winds changed to NE
10-Apr-00	I collected 12 canister samples with the winds coming from the NE. Improved alignment of the UV-DOAS.	1	2	7	3	>100%		12	ENE
11-Apr-00	I collected 6 canister samples with the winds coming from the NE. Improved alignment once.	1	2	6	1	>100%		6	NNE
12-Apr-00	Jean Cristophe and Neema collected 6 canister samples.	1	2	4	1			6	ENE
13-Apr-00	Collected 3 Canister samples. Benzene and toluene calibrations performed.	1	2	4	1			3	SSW
19-Apr-00	21 canisters delivered to Paxton. 22	1	1	3		1.00%	< 8000		

Date	Event	No. of site visits	No. of Persons	No. of Hours Spent at Site	No. of Alignments	Light Vis (Luminous Flux)	Peak	No. of Canisters Collected	Wind Direction
	canisters available for sampling. UV-DOAS requires a realignment.								
21-Apr-00	Donna and I performed a realignment. No canister samples were collected because of the windy conditions (wind speed >20 m.p.h.) at the site.	1	2	5.5	1	60 to 100%	10000 to 16000		N
24-Apr-00	Collected 6 canister samples. Each set of three canisters was placed along the beam.	1	1	6		20% to 60%	10000 to 11000	6	ENE
25-Apr-00	Realignment performed. Collected 9 canister samples. Each set of three were placed along the beam	1	1	7	1	60% to 100%	11000 to 16000	9	NNE
26-Apr-00	Collected 9 canister samples. Each set placed along the beam	1	1	6		50% to 150%	12000 to 16000	9	East
28-Apr-00	Collected 4 samples. Three canisters were placed along the beam and one upwind.	1	2	7				4	West
1-May-00	Collected 6 samples. All were placed along the beam. Changed the filters and silica gel for ozone and NOx monitors	1	1	6	20% - 78%			6	North
2-May-00	Delivered canister samples at Maywood IEPA office and picked up new canisters.								
3-May-00	Collected 8 canister samples. Six samples were collected along the	1	1	5				8	South

Date	Event	No. of site visits	No. of Persons	No. of Hours Spent at Site	No. of Alignments	Light Vis (Luminous Flux)	Peak	No. of Canisters Collected	Wind Direction
	beam and two samples were collected downwind.								
	TOTAL	**53**		**243**				**90**	

APPENDIX B (continued)

TABLE XII: CANISTER LOG

Date	Canister	Start Time	Stop Time	Pressure (inHg)	Post Pressure (psig)	Wind Direction	Location	# of Canisters
5-Nov-99	22337	10:13	11:13	-30	0	SSW	on roof of trailer 2 (north end of landfill)	2
5-Nov-99	A21100	10:45	11:45	-30	0	SSW	on ground near trailer 1 (south end of landfill)	
31-Mar-00	A22327	1530	1630	-28	0	ENE	well on south end	4
31-Mar-00	A21065	1550	1650	-30	-4	ENE	well on north end	
31-Mar-00	A21096	1600	1700	-30	-4	ENE	downwind sample	
31-Mar-00	A21114	1620	1720	-30	0	ENE	upwind sample	
4-Apr-00	A21130	1209	1309	-30	0	NNW	upwind sample	3
4-Apr-00	A21020	1240	1340	-30	0	NNW	downwind sample	
4-Apr-00	A22242	1230	1330	-30	0	NNW	well on east side	
9-Apr-00	A21027	15:24	16:24	-30	0	ENE	#1 along the beam	4
9-Apr-00	A21110	15:26	16:26	-25	0	ENE	#2 along the beam	
9-Apr-00	A22235	15:29	16:29	-30	0	ENE	#3 along the beam	
9-Apr-00	A21045	15:41	16:41	-30	0	NNE	upwind sample	
9-Apr-00	A21136	18:11	19:11	-30	0	ENE	#1 along the beam	4
9-Apr-00	A21146	18:09	19:09	0 psig	0	ENE	#2 along the beam	
9-Apr-00	A21037	18:06	19:06	-28	0	ENE	#3 along the beam	
9-Apr-00	A21012	18:03	19:03	-30	0	NNE	upwind sample	
9-Apr-00	A21106	19:13	20:13	-30	0	ESE	#1 along the beam	4
9-Apr-00	A21040	19:17	20:17	-28	0	ESE	#2 along the beam	
9-Apr-00	A21031	19:22	20:22	-30	0	ESE	#3 along the beam	
9-Apr-00	A21117	19:29	20:29	-30	0	NNE	upwind sample	
10-Apr-00	A21062	11:25	12:25	-30	0	ENE	#1 along the beam	3
10-Apr-00	A21124	11:24	12:24	-30	0	ENE	#2 along the beam	

Date	Canister	Start Time	Stop Time	Pressure (inHg)	Post Pressure (psig)	Wind Direction	Location	# of Canisters
10-Apr-00	A21083	11:21	12:21	-30	0	ENE	#3 along the beam	
10-Apr-00	A21105	12:38	13:38	-30	0	ENE	#1 along the beam	3
10-Apr-00	A22224	12:32	13:32	-30	0	ENE	#2 along the beam	
10-Apr-00	A21033	12:27	13:27	-28	0	ENE	#3 along the beam	
10-Apr-00	A21081	13:50	14:50	-30	0	ENE	#1 along the beam	3
10-Apr-00	A21052	13:44	14:44	-30	0	ENE	#2 along the beam	
10-Apr-00	A21075	13:38	14:38	-30	0	ENE	#3 along the beam	
10-Apr-00	A21055	15:03	16:03	-30	0	ENE	#1 along the beam	3
10-Apr-00	A21041	15:04	16:04	-30	0	ENE	#2 along the beam	
10-Apr-00	A21073	15:06	16:06	-30	0	ENE	#3 along the beam	
11-Apr-00	A21089	12:34	13:34	-30	0	NNE	#1 along the beam	3
11-Apr-00	A21085	12:37	13:37	-30	0	NNE	#2 along the beam	
11-Apr-00	A22228	12:41	13:41	-28	0	NNE	#3 along the beam	
11-Apr-00	22325	13:44	14:44	-30	0	NNE	#1 along the beam	3
11-Apr-00	A21120	13:47	14:47	-30	0	NNE	#2 along the beam	
11-Apr-00	A21113	13:51	14:51	-28	0	NNE	#3 along the beam	
12-Apr-00	A21060	10:45	11:45	-28	0	ENE	#1 along the beam	3
12-Apr-00	A21064	10:50	11:50	-30	0	ENE	#2 along the beam	
12-Apr-00	A21134	10:52	11:52	-30	0	ENE	#3 along the beam	
12-Apr-00	A21042	11:47	12:47	-30	0	ENE	#1 along the beam	3
12-Apr-00	A21127	11:51	12:51	-30	0	ENE	#2 along the beam	
12-Apr-00	A21048	11:55	12:55	-30	0	ENE	#3 along the beam	
13-Apr-00	A21011	13:52	14:51	-30	0	SSW	#1 along the beam	3
13-Apr-00	A21076	13:51	14:49	-29	0	SSW	#2 along the beam	
13-Apr-00	22330	13:46	14:46	-30	0	SSW	#3 along the beam	
24-Apr-00	N03425	10:50	11:50	-30	0	ENE	#1 along the beam	3
24-Apr-00	A21141	10:47	11:47	-30	0	ENE	#2 along the beam	
24-Apr-00	N03494	10:45	11:45	-30	0	ENE	#3 along the beam	
24-Apr-00	A22229	11:58	12:58	-30	0	NNW	#1 along the beam	3

Date	Canister	Start Time	Stop Time	Pressure (inHg)	Post Pressure (psig)	Wind Direction	Location	# of Canisters
24-Apr-00	N03491	11:53	12:53	-28	0	NNW	#2 along the beam	
24-Apr-00	N03429	11:46	12:46	-30	0	NNW	#3 along the beam	
25-Apr-00	C16700	15:03	16:03	-30	0	NNE	#1 along the beam	3
25-Apr-00	A21077	15:05	16:05	-30	0	NNE	#2 along the beam	
25-Apr-00	N01048	15:00	16:00	-28	0	NNE	#3 along the beam	
25-Apr-00	N03490	16:15	17:15	-30	0	NNE	#1 along the beam	3
25-Apr-00	N03428	16:23	17:21	-30	0	NNE	#2 along the beam	
25-Apr-00	N03424	16:16	17:12	-30	0	NNE	#3 along the beam	
25-Apr-00	C16691	17:16	18:16	-30	0	NNE	#1 along the beam	3
25-Apr-00	N03433	17:21	18:21	-30	0	NNE	#2 along the beam	
25-Apr-00	N03496	17:12	18:12	-30	0	NNE	#3 along the beam	
26-Apr-00	N03456	8:55	9:55	-30	0	NNE	#1 along the beam	3
26-Apr-00	N03435	9:00	10:00	-28	0	NNE	#2 along the beam	
26-Apr-00	N03427	9:04	10:04	-28	0	NNE	#3 along the beam	
26-Apr-00	9804	9:57	10:57	-30	0	NNE	#1 along the beam	3
26-Apr-00	N03430	10:00	11:00	-30	0	NNE	#2 along the beam	
26-Apr-00	A22337	10:03	11:03	-30	0	NNE	#3 along the beam	
26-Apr-00	902	11:00	12:00	-30	0	NNE	#1 along the beam	3
26-Apr-00	A21108	11:04	12:04	-28	0	NNE	#2 along the beam	
26-Apr-00	A21005	11:07	12:07	-26	0	NNE	#3 along the beam	
28-Apr-00	N03489	837	937	-30	0	WSW	#1 along the beam	4
28-Apr-00	N03487	843	943	-30	0	WSW	#2 along the beam	
28-Apr-00	N03493	848	948	-30	0	WSW	#3 along the beam	
28-Apr-00	N03431	906	1006	-28	0	WSW	upwind sample	
1-May-00	A21034	1533	1633	-30	0	NNW	#1 along the beam	3
1-May-00	N03432	1530	1630	-26	0	NNW	#2 along the beam	
1-May-00	N03426	1523	1623	-30	0	NNW	#3 along the beam	
1-May-00	N03488	1644	1744	-30	0	NNE	#1 along the beam	3
1-May-00	N03434	1637	1737	-29	0	NNE	#2 along the beam	

Date	Canister	Start Time	Stop Time	Pressure (inHg)	Post Pressure (psig)	Wind Direction	Location	# of Canisters
1-May-00	N03455	1633	1733	-30	-1	NNE	#3 along the beam	
3-May-00	A21061	1010	1111	-30	0	ESE	#1 along the beam	
3-May-00	N03495	1007	1107	-28	0	ESE	#2 along the beam	4
3-May-00	A21098	1013	1113	-30	0	ESE	#3 along the beam	
3-May-00	A21067	945	1045	-30	0	ESE	Downwind Sample	
3-May-00	A22230	1147	1247	-30	0	ESE	#1 along the beam	4
3-May-00	A21099	1141	1241	-28	0	ESE	#2 along the beam	
3-May-00	A21109	1130	1230	-30	0	ESE	#3 along the beam	
3-May-00	A21079	1120	1229	-30	0	SSE	Downwind Sample	

TOTAL # OF CANISTER SAMPLES COLLECTED:	**90**
NUMBER OF CANISTERS AT THE SITE:	0
NUMBER OF CANISTERS NEEDED TO COMPLETE PROJECT	0
PROPOSED # OF SAMPLES FOR PAXTON PROJECT	90

APPENDIX B (continued)

TABLE XIII STYRENE CONCENTRATION DATA

DATE	Wind Direction	Canister Position	Canister ID	Start Time	Stop Time	STYRENE (ug/m3) Canister Sample	UV-DOAS
9-Apr-00	ENE	#1 along the beam	A21027	15:24	16:24	0.60	4.53
9-Apr-00	ENE	#2 along the beam	A21110	15:26	16:26	0.00	4.77
9-Apr-00	ENE	#3 along the beam	A22235	15:29	16:29	0.00	4.77
9-Apr-00	ENE	#1 along the beam	A21136	18:11	19:11	0.00	2.39
9-Apr-00	northeast	#2 along the beam	A21146	18:09	19:09	n/a	2.42
9-Apr-00	ENE	#3 along the beam	A21037	18:06	19:06	0.00	2.42
9-Apr-00	ESE	#1 along the beam	A21106	19:13	20:13	0.00	2.90
9-Apr-00	ESE	#2 along the beam	A21040	19:17	20:17	0.00	2.83
9-Apr-00	ESE	#3 along the beam	A21031	19:22	20:22	0.00	2.70
10-Apr-00	ENE	#1 along the beam	A21062	11:25	12:25	1.11	-4.31
10-Apr-00	ENE	#2 along the beam	A21124	11:24	12:24	0.00	-4.31
10-Apr-00	ENE	#3 along the beam	A21083	11:21	12:21	0.00	-4.17
10-Apr-00	ENE	#1 along the beam	A21105	12:38	13:38	0.00	-2.63
10-Apr-00	ENE	#2 along the beam	A22224	12:32	13:32	0.00	-2.51
10-Apr-00	ENE	#3 along the beam	A21033	12:27	13:27	0.00	-2.80
10-Apr-00	ENE	#1 along the beam	A21081	13:50	14:50	0.33	6.40
10-Apr-00	ENE	#2 along the beam	A21052	13:44	14:44	0.00	5.86
10-Apr-00	ENE	#3 along the beam	A21075	13:38	14:38	0.39	5.46
10-Apr-00	ENE	#1 along the beam	A21055	15:03	16:03	0.33	6.86
10-Apr-00	ENE	#2 along the beam	A21041	15:04	16:04	0.50	6.86
10-Apr-00	ENE	#3 along the beam	A21073	15:06	16:06	0.44	6.43
11-Apr-00	NNE	#1 along the beam	A21089	12:34	13:34	0.00	7.12
11-Apr-00	NNE	#2 along the beam	A21085	12:37	13:37	1.00	7.09
11-Apr-00	NNE	#3 along the beam	A22228	12:41	13:41	0.66	7.48
11-Apr-00	NNE	#1 along the beam	22325	13:44	14:44	0.00	7.54
11-Apr-00	NNE	#2 along the beam	A21120	13:47	14:47	0.50	6.18
11-Apr-00	NNE	#3 along the beam	A21113	13:51	14:51	0.00	6.40
12-Apr-00	ENE	#1 along the beam	A21060	10:45	11:45	0.00	8.89
12-Apr-00	ENE	#2 along the beam	A21064	10:50	11:50	0.82	9.56
12-Apr-00	ENE	#3 along the beam	A21134	10:52	11:52	0.00	10.01
12-Apr-00	ENE	#1 along the beam	A21042	11:47	12:47	0.00	10.51
12-Apr-00	ENE	#2 along the beam	A21127	11:51	12:51	0.00	9.98
12-Apr-00	ENE	#3 along the beam	A21048	11:55	12:55	0.00	9.85
13-Apr-00	SSW	#1 along the beam	A21011	13:52	14:51	0.00	12.97
13-Apr-00	SSW	#2 along the beam	A21076	13:51	14:49	0.00	13.10
13-Apr-00	SSW	#3 along the beam	22330	13:46	14:46	0.00	13.21
24-Apr-00	ENE	#1 along the beam	N03425	10:50	11:50	0.00	9.44
24-Apr-00	ENE	#2 along the beam	A21141	10:47	11:47	0.00	9.42
24-Apr-00	ENE	#3 along the beam	N03494	10:45	11:45	1.41	9.38
24-Apr-00	NNW	#1 along the beam	A22229	11:58	12:58	0.00	10.16
24-Apr-00	NNW	#2 along the beam	N03491	11:53	12:53	1.30	10.63

DATE	Wind Direction	Canister Position	Canister ID	Start Time	Stop Time	STYRENE (ug/m3)	
						Canister Sample	UV-DOAS
24-Apr-00	NNW	#3 along the beam	N03429	11:46	12:46	0.65	11.52
25-Apr-00	NNE	#1 along the beam	C16700	15:03	16:03	0.00	7.49
25-Apr-00	NNE	#2 along the beam	A21077	15:05	16:05	0.00	7.73
25-Apr-00	NNE	#3 along the beam	N01048	15:00	16:00	0.00	7.56
25-Apr-00	NNE	#1 along the beam	N03490	16:15	17:15	0.00	9.87
25-Apr-00	NNE	#2 along the beam	N03428	16:23	17:21	0.54	10.02
25-Apr-00	NNE	#3 along the beam	N03424	16:16	17:12	0.00	9.78
25-Apr-00	NNE	#1 along the beam	C16691	17:16	18:16	0.71	11.13
25-Apr-00	NNE	#2 along the beam	N03433	17:21	18:21	2.12	11.02
25-Apr-00	NNE	#3 along the beam	N03496	17:12	18:12	0.00	10.82
26-Apr-00	NNE	#1 along the beam	N03456	8:55	9:55	0.65	15.85
26-Apr-00	NNE	#2 along the beam	N03435	9:00	10:00	0.00	15.77
26-Apr-00	NNE	#3 along the beam	N03427	9:04	10:04	0.60	15.64
26-Apr-00	NNE	#1 along the beam	9804	9:57	10:57	0.54	12.27
26-Apr-00	NNE	#2 along the beam	N03430	10:00	11:00	2.50	14.08
26-Apr-00	NNE	#3 along the beam	A22337	10:03	11:03	0.00	14.15
26-Apr-00	NNE	#1 along the beam	902	11:00	12:00	2.76	16.50
26-Apr-00	NNE	#2 along the beam	A21108	11:04	12:04	0.00	16.81
26-Apr-00	NNE	#3 along the beam	A21005	11:07	12:07	0.00	16.15
28-Apr-00	WSW	#1 along the beam	N03489	837	937	0.76	10.20
28-Apr-00	WSW	#2 along the beam	N03487	843	943	0.54	10.04
28-Apr-00	WSW	#3 along the beam	N03493	848	948	0.00	9.72
1-May-00	NNW	#1 along the beam	A21034	1533	1633	0.00	11.60
1-May-00	NNW	#2 along the beam	N03432	1530	1630	0.59	11.37
1-May-00	NNW	#3 along the beam	N03426	1523	1623	1.76	11.77
1-May-00	NNE	#1 along the beam	N03488	1644	1744	2.78	11.25
1-May-00	NNE	#2 along the beam	N03434	1637	1737	0.80	11.41
1-May-00	NNE	#3 along the beam	N03455	1633	1733	3.52	11.71
3-May-00	ESE	#1 along the beam	A21061	1010	1111	0.00	9.45
3-May-00	ESE	#2 along the beam	N03495	1007	1107	0.95	9.56
3-May-00	ESE	#3 along the beam	A21098	1013	1113	0.53	9.33
3-May-00	ESE	#1 along the beam	A22230	1147	1247	0.00	12.92
3-May-00	ESE	#2 along the beam	A21099	1141	1241	0.53	12.87
3-May-00	ESE	#3 along the beam	A21109	1130	1230	0.53	12.14
					Average Conc.	**0.46**	**8.55**

APPENDIX B (continued)

TABLE XIV STYRENE BACKGROUND CONCENTRATIONS

DATE	WIND DIRECTION	LOCATION	CANISTER ID	START TIME	STOP TIME	CANISTER SAMPLES		UV-DOAS
						ppbc	ug/m3	ug/m3
5-Nov-99	SSW	on roof of trailer 2 (north end of landfill)	22337	10:13	11:13		0	n/a
5-Nov-99	SSW	on ground near trailer 1 (south end of landfill)	A21100	10:45	11:45		0	n/a
31-Mar-00	ENE	well on south end	A22327	1530	1630	1.4	0.745808	n/a
31-Mar-00	ENE	well on north end	A21065	1550	1650	0.6	0.319632	n/a
31-Mar-00	ENE	downwind sample	A21096	1600	1700	1.6	0.852352	n/a
31-Mar-00	ENE	upwind sample	A21114	1620	1720	0.7	0.372904	n/a
4-Apr-00	NNW	upwind sample	A21130	1209	1309	0.7	0.372904	n/a
4-Apr-00	NNW	downwind sample	A21020	1240	1340	1.2	0.639264	n/a
4-Apr-00	NNW	well on east side	A22242	1230	1330	0.9	0.479448	n/a
9-Apr-00	NNW	upwind sample	A21045	15:41	16:41	0	0	5.806
9-Apr-00	NNE	upwind sample	A21012	18:03	19:03	0	0	2.473
9-Apr-00	NNE	upwind sample	A21117	19:29	20:29	0	0	2.604
28-Apr-00	WSW	upwind sample	N03431	906	1006	1.6	0.862751	10.09
3-May-00	SSE	Downwind Sample	A21067	945	1045	0.9	0.478079	9.422
3-May-00	SSE	Downwind Sample	A21079	1120	1229	0.9	0.475306	12.038

APPENDIX B (continued)

TABLE XV ADJUSTED BENZENE & TOLUENE CONCENTRATIONS FROM 4/9/00 THROUGH 4/12/00

DATE	WIND DIRECTION	LOCATION	CANISTER ID	START TIME	STOP TIME	BENZENE (ug/m3)				TOLUENE (ug/m3)			
						CANISTER SAMPLE	*Adjusted UV-DOAS*	*offset adjustment*	UV-DOAS	CANISTER SAMPLE	*Adjusted UV-DOAS*	*offset adjustment*	UV-DOAS
9-Apr-00	NNW	#1 along the beam	A21027	15:24	16:24	2.11	***1.20***	*16.20*	17.40	0.60	***-13.22***	*34.40*	21.18
9-Apr-00	ENE	#2 along the beam	A21110	15:26	16:26	3.40	***1.65***	*16.20*	17.85	n/a	***n/a***	*n/a*	n/a
9-Apr-00	ENE	#3 along the beam	A22235	15:29	16:29	3.29	***2.29***	*16.20*	18.49	0.71	***-13.22***	*34.40*	21.26
9-Apr-00	ENE	#1 along the beam	A21136	18:11	19:11	1.29	***10.86***	*16.17*	27.03	0.60	***-13.14***	*34.32*	33.82
9-Apr-00	ENE	#3 along the beam	A21037	18:06	19:06	1.19	***8.51***	*16.16*	24.67	0.00	***-13.14***	*34.32*	33.77
9-Apr-00	ESE	#1 along the beam	A21106	19:13	20:13	1.83	***10.89***	*16.18*	27.07	2.89	***-13.17***	*34.35*	36.34
9-Apr-00	ESE	#2 along the beam	A21040	19:17	20:17	1.51	***11.05***	*16.18*	27.23	2.02	***-13.17***	*34.35*	37.15
9-Apr-00	ESE	#3 along the beam	A21031	19:22	20:22	1.46	***11.10***	*16.18*	27.28	1.20	***-13.18***	*34.36*	36.98
10-Apr-00	ENE	#1 along the beam	A21062	11:25	12:25	1.44	***7.37***	*16.58*	23.95	0.00	***-14.03***	*35.21*	36.83
10-Apr-00	ENE	#2 along the beam	A21124	11:24	12:24	1.55	***7.62***	*16.58*	24.20	0.00	***-14.03***	*35.21*	36.83
10-Apr-00	ENE	#3 along the beam	A21083	11:21	12:21	2.38	***7.62***	*16.58*	24.20	0.00	***-14.03***	*35.21*	37.11
10-Apr-00	ENE	#1 along the beam	A21105	12:38	13:38	2.21	***9.27***	*16.57*	25.84	0.00	***-14.00***	*35.18*	39.50
10-Apr-00	ENE	#2 along the beam	A22224	12:32	13:32	2.43	***9.04***	*16.57*	25.61	0.56	***-14.00***	*35.18*	39.30
10-Apr-00	ENE	#3 along the beam	A21033	12:27	13:27	3.31	***8.67***	*16.57*	25.24	0.67	***-14.00***	*35.18*	39.13
10-Apr-00	ENE	#1 along the beam	A21081	13:50	14:50	1.16	***7.93***	*16.55*	24.48	0.39	***-13.96***	*35.14*	40.35
10-Apr-00	ENE	#2 along the beam	A21052	13:44	14:44	3.48	***7.33***	*16.55*	23.88	0.78	***-13.96***	*35.14*	39.84
10-Apr-00	ENE	#3 along the beam	A21075	13:38	14:38	2.70	***7.39***	*16.55*	23.94	0.61	***-13.97***	*35.15*	40.15
10-Apr-00	ENE	#1 along the beam	A21055	15:03	16:03	1.21	***15.70***	*16.54*	32.24	0.45	***-13.93***	*35.11*	25.79
10-Apr-00	ENE	#2 along the beam	A21041	15:04	16:04	4.30	***14.58***	*16.54*	31.12	0.95	***-13.93***	*35.11*	25.79
10-Apr-00	ENE	#3 along the beam	A21073	15:06	16:06	5.29	***14.58***	*16.54*	31.12	0.95	***-13.93***	*35.11*	26.25
11-Apr-00	NNE	#1 along the beam	A21089	12:34	13:34	1.44	***12.08***	*16.59*	28.67	1.12	***-14.05***	*35.23*	28.71
11-Apr-00	NNE	#2 along the beam	A21085	12:37	13:37	1.49	***12.62***	*16.59*	29.21	1.06	***-14.05***	*35.23*	27.61
11-Apr-00	NNE	#3 along the beam	A22228	12:41	13:41	1.49	***13.58***	*16.59*	30.17	1.01	***-14.05***	*35.23*	27.23
11-Apr-00	NNE	#1 along the beam	22325.00	13:44	14:44	1.49	***11.78***	*16.59*	28.37	0.89	***-14.05***	*35.23*	27.22
11-Apr-00	NNE	#2 along the beam	A21120	13:47	14:47	1.54	***7.75***	*16.55*	24.30	0.95	***-13.96***	*35.14*	39.86
11-Apr-00	NNE	#3 along the beam	A21113	13:51	14:51	1.43	***7.93***	*16.55*	24.48	1.00	***-13.96***	*35.14*	40.35
12-Apr-00	ENE	#1 along the beam	A21060	10:45	11:45	2.47	***6.25***	*16.46*	22.72	2.83	***-13.77***	*34.95*	16.09

DATE	WIND DIRECTION	LOCATION	CANISTER ID	START TIME	STOP TIME	BENZENE (ug/m3)				TOLUENE (ug/m3)			
						CANISTER SAMPLE	*Adjusted UV-DOAS*	*offset adjustment*	UV-DOAS	CANISTER SAMPLE	*Adjusted UV-DOAS*	*offset adjustment*	UV-DOAS
12-Apr-00	ENE	#2 along the beam	A21064	10:50	11:50	2.41	***6.66***	*16.46*	23.12	2.61	***-13.76***	*34.94*	16.91
12-Apr-00	ENE	#3 along the beam	A21134	10:52	11:52	2.80	***6.82***	*16.46*	23.27	2.55	***-13.76***	*34.94*	17.41
12-Apr-00	ENE	#1 along the beam	A21042	11:47	12:47	2.57	***4.38***	*16.42*	20.79	1.11	***-13.67***	*34.85*	22.53
12-Apr-00	ENE	#2 along the beam	A21127	11:51	12:51	4.05	***3.72***	*16.41*	20.13	1.49	***-13.67***	*34.85*	22.61
12-Apr-00	ENE	#3 along the beam	A21048	11:55	12:55	2.57	***3.66***	*16.41*	20.07	1.11	***-13.66***	*34.84*	22.80
13-Apr-00	SSW	#1 along the beam	A21011	13:52	14:51	1.34	11.70		11.70	0.87	5.44		5.44
13-Apr-00	SSW	#2 along the beam	A21076	13:51	14:49	1.34	11.63		11.63	0.76	5.45		5.45
13-Apr-00	SSW	#3 along the beam	22330.00	13:46	14:46	1.29	11.93		11.93	0.81	5.45		5.45
24-Apr-00	ENE	#1 along the beam	N03425	10:50	11:50	5.19	9.95		9.95	1.53	10.44		10.44
24-Apr-00	ENE	#2 along the beam	A21141	10:47	11:47	5.84	10.65		10.65	1.64	10.61		10.61
24-Apr-00	ENE	#3 along the beam	N03494	10:45	11:45	6.93	10.82		10.82	2.02	9.85		9.85
24-Apr-00	NNW	#1 along the beam	A22229	11:58	12:58	5.24	6.26		6.26	3.55	14.65		14.65
24-Apr-00	NNW	#2 along the beam	N03491	11:53	12:53	7.12	6.83		6.83	2.67	14.50		14.50
24-Apr-00	NNW	#3 along the beam	N03429	11:46	12:46	4.16	8.09		8.09	3.11	12.43		12.43
25-Apr-00	NNE	#1 along the beam	C16700	15:03	16:03	1.36	11.00		11.00	0.93	-1.67		-1.67
25-Apr-00	NNE	#2 along the beam	A21077	15:05	16:05	1.25	11.04		11.04	0.88	-0.67		-0.67
25-Apr-00	NNE	#3 along the beam	N01048	15:00	16:00	1.25	11.73		11.73	0.88	-1.51		-1.51
25-Apr-00	NNE	#1 along the beam	N03490	16:15	17:15	1.25	10.80		10.80	0.71	0.59		0.59
25-Apr-00	NNE	#2 along the beam	N03428	16:23	17:21	1.35	11.03		11.03	0.60	1.02		1.02
25-Apr-00	NNE	#3 along the beam	N03424	16:16	17:12	1.30	11.24		11.24	0.66	0.34		0.34
25-Apr-00	NNE	#1 along the beam	C16691	17:16	18:16	1.35	12.33		12.33	0.66	2.94		2.94
25-Apr-00	NNE	#2 along the beam	N03433	17:21	18:21	1.30	12.77		12.77	0.77	1.57		1.57
25-Apr-00	NNE	#3 along the beam	N03496	17:12	18:12	1.25	11.70		11.70	0.71	3.02		3.02
26-Apr-00	NNE	#1 along the beam	N03456	8:55	9:55	1.68	31.59		31.59	0.88	32.93		32.93
26-Apr-00	NNE	#2 along the beam	N03435	9:00	10:00	3.64	31.77		31.77	1.10	33.13		33.13
26-Apr-00	NNE	#3 along the beam	N03427	9:04	10:04	4.29	31.74		31.74	1.59	33.31		33.31
26-Apr-00	NNE	#1 along the beam	9804.00	9:57	10:57	3.58	25.87		25.87	1.10	27.38		27.38

DATE	WIND DIRECTION	LOCATION	CANISTER ID	START TIME	STOP TIME	BENZENE (ug/m3)				TOLUENE (ug/m3)			
						CANISTER SAMPLE	*Adjusted UV-DOAS*	*offset adjustment*	UV-DOAS	CANISTER SAMPLE	*Adjusted UV-DOAS*	*offset adjustment*	UV-DOAS
26-Apr-00	NNE	#2 along the beam	N03430	10:00	11:00	3.09	29.08		29.08	1.04	27.62		27.62
26-Apr-00	NNE	#3 along the beam	A22337	10:03	11:03	3.57	29.26		29.26	1.10	28.11		28.11
26-Apr-00	NNE	#1 along the beam	902.00	11:00	12:00	4.92	32.64		32.64	1.75	33.84		33.84
26-Apr-00	NNE	#2 along the beam	A21108	11:04	12:04	0.00	32.71		32.71	0.00	34.00		34.00
26-Apr-00	NNE	#3 along the beam	A21005	11:07	12:07	4.76	30.88		30.88	0.98	34.71		34.71
28-Apr-00	WSW	#1 along the beam	N03489	837	937	3.94	16.97		16.97	8.34	30.59		30.59
28-Apr-00	WSW	#2 along the beam	N03487	843	943	3.34	17.83		17.83	6.49	30.87		30.87
28-Apr-00	WSW	#3 along the beam	N03493	848	948	4.36	17.69		17.69	9.48	29.23		29.23
1-May-00	NNW	#1 along the beam	A21034	1533	1633	3.73	10.03		10.03	1.94	9.43		9.43
1-May-00	NNW	#2 along the beam	N03432	1530	1630	3.25	9.20		9.20	2.16	8.69		8.69
1-May-00	NNW	#3 along the beam	N03426	1523	1623	2.67	9.79		9.79	2.26	9.52		9.52
1-May-00	NNE	#1 along the beam	N03488	1644	1744	3.14	11.56		11.56	1.56	9.86		9.86
1-May-00	NNE	#2 along the beam	N03434	1637	1737	3.62	11.33		11.33	1.51	9.48		9.48
1-May-00	NNE	#3 along the beam	N03455	1633	1733	4.64	11.84		11.84	2.05	10.19		10.19
3-May-00	ESE	#1 along the beam	A21061	1010	1111	1.48	13.38		13.38	1.45	-1.62		-1.62
3-May-00	ESE	#2 along the beam	N03495	1007	1107	1.43	13.42		13.42	1.61	-1.66		-1.66
3-May-00	ESE	#3 along the beam	A21098	1013	1113	1.38	13.26		13.26	0.00	-1.46		-1.46
3-May-00	ESE	#1 along the beam	A22230	1147	1247	1.16	15.94		15.94	0.80	-4.04		-4.04
3-May-00	ESE	#2 along the beam	A21099	1141	1241	1.26	15.85		15.85	0.80	-3.38		-3.38
3-May-00	ESE	#3 along the beam	A21109	1130	1230	1.26	16.14		16.14	0.80	-2.27		-2.27
			AVERAGE CONCENTRATIONS:			**2.60**	**13.21**		**19.94**	**1.47**	**1.59**		**20.10**
			# OF POINTS			**74**	**74**		**74**	**73**	**73**		**73**