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Monitoring of Ambient Levels of Ethylene Dichloride (EDC) in the Vicinity of EDC Production and User Facilities

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March 1979

MONITORING OF AMBIENT LEVELS OF EDC NEAR PRODUCTION AND USER FACILITIES

by

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Cincinnati, Ohio 45246

Contract No. 68-02-2722

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FOREWORD

Measurement and monitoring research efforts are designed to anticipate potential environmental problems, to support regulatory actions by developing an in-depth understanding of the nature and processes that impact health and the ecology, to provide innovative means of monitoring compliance with regulations and to evaluate the effectiveness of health and environmental protection efforts through the monitoring of long-term trends. The Environmental Monitoring and Support Laboratory, Research Triangle Park, North Carolina, is responsible for development of: environmental monitoring technology and systems; agency-wide quality assurance programs for air pollution measurement systems; and technical support to EPA's Office of Air, Noise and Radiation, Office of Toxic Substances, and Office of Enforcement.

This study was conducted at the request of the Office of Air, Noise and Radiation for use in health risk assessment. A system for measurement of ethylene dichloride in ambient air was developed and evaluated. Field monitoring was conducted and data on ethylene dichloride concentrations in ambient air reported for three geographic areas. Precision and accuracy of the reported data were characterized through implementation of a quality assurance program.

Thomas R. Hauser
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ABSTRACT

A study was conducted near ethylene dichloride (EDC) production and user facilities to determine ambient EDC levels. The results will be used in health risk assessment studies now in progress. Three geographical study areas were selected, and a 10-day monitoring program was conducted at each. Integrated sampling was conducted over a 24-h period at 12 locations within each study area. Meteorological measurements, consisting of wind speed, wind direction, temperature, relative humidity, and rainfall were also made. The EDC in the ambient air was collected on charcoal sorption tubes, eluted with an organic solvent, and quantitated by gas chromatographic (GC) separation and mass spectrographic (MS) detection techniques. Ambient levels of EDC at some locations were found to be in excess of 500 $\mu g/m^3$ (125 ppb). These high levels occurred during atmospheric conditions of calm or low wind speeds.

The field monitoring activities, laboratory analyses, quality assurance program, and EDC levels obtained are presented in this report.

This report was submitted in fulfillment of Assignment No. 8 of Contract No. 68-02-2722 by PEDCo Environmental, Inc., under the sponsorship of the U.S. Environmental Protection Agency. This report covers the period August 1978 to February 1979, and work was completed as of March 23, 1979.

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SECTION 1

INTRODUCTION

Ambient air quality data giving the levels of ethylene dichloride (EDC) in populous areas near EDC production and user facilities are needed for health risk assessment studies now under way by the U.S. Environmental Protection Acency (EPA), Office of Air Quality Planning and Standards. The EPA Environmental Monitoring and Support Laboratory (EMSL), Research Triangle Park, North Carolina, of the Office of Research and Development, was selected to sponsor this project.

To obtain the data, a method was developed and laboratory tested for the measurement of ambient levels of EDC in the range of $\mu g/m^3$ (ppb). The method involves sampling for 24-h (with a charcoal tube as the collection medium), desorbing the charcoal in an organic solvent, and measuring the EDC levels by separation and detection through GC/MS. The method was laboratory-tested at various temperature, humidity, and EDC levels; and proved to be an analytical technique with an overall EDC recovery of 80 to 90 percent (1-5).

This method was used to measure ambient EDC levels around three production and user facilities. In each study, 24-h integrated samples were collected at 12 locations for each of 10 days. Meteorological conditions were also monitored. Based on the prevailing meteorological conditions, samples were selected for analysis for each 24-h period. This selectivity reduced the number of samples to be analyzed, but at no loss of data: samples taken upwind of the emission source were expected to show only background EDC levels; therefore, fewer samples from these areas were analyzed. About 70 percent of all samples collected were analyzed.

Sampling was conducted at the following locations:

- Calvert City, Kentucky: B.F. Goodrich facility
- Lake Charles, Louisiana: Conoco facility
- New Orleans, Louisiana: Shell and Union Carbide facilities

The results of these field sampling activities and subsequent analyses are presented in detail.

SECTION 2

CONCLUSIONS

Ethylene dichloride was found to be present in the ambient air at all three geographical areas studied.

The highest levels recorded in the Calvert City, Kentucky, study area were about 170 $\mu g/m^3$ (18 ppb). The EDC levels in the New Orleans study area peaked on two occasions at 170 $\mu g/m^3$ (42 ppb) at a site near an EDC handling operation. Levels at other sites in this study area were about 10 $\mu g/m^3$ (2.5 ppb). The highest levels of ambient EDC were recorded in the Lake Charles, Louisiana, study area. Concentrations of EDC were found to be in the range of 200 to 500 $\mu g/m^3$ (49 to 125 ppb) at several sites throughout the 10-day study.

Ambient EDC levels are a product of the plant production rate, extent of emission control, and meteorological and topographical features. These elements, which are beyond the scope of this report, must be considered when using these data in health risk assessment.

The precision of the analytical method, based on statistical analysis (relative standard deviation) of replicate standard solutions, was determined to be 3 percent. The precision of both the analytical and sampling methods, based on statistical analysis (relative standard deviation) of replicate samples, was determined to be 6 percent. Standard check samples prepared by EPA and by PEDCo were used to determine the accuracy of the analytical method. The EPA check samples yielded an average recovery of 72 percent, and the PEDCo samples, an average recovery of 97 percent. In an attempt to find the reason for this discrepancy, a statistical evaluation was made of the possibility of EDC decay on the tube between the times of preparation and analysis; but no biases were observed. Because the reason for the discrepancy could not be ascertained, the accuracy of the analytical method can only be estimated as between 72 and 97 percent.

SECTION 3

SAMPLING PROTOCOL

Field studies were conducted in the vicinity of three EDC production and user facilities selected by the EPA Office of Air Quality Planning and Standards. In each study, 24-h integrated samples were collected daily at 12 locations for a 10-day period. Duplicate samples were collected at each site. The activated charcoal tubes were kept sealed until they were placed on the sampling unit, and they were resealed with plastic caps after sampling. The tubes were stored in the dark at 0°C until analysis. The average time between sampling and analysis was 15 days.

Field study design was coordinated with EPA in the following technical areas:

- Statistical design
- Field study equipment
- Field study techniques
- Data interpretation
- Quality assurance
- Analytical procedures

SITE SELECTION

The three study areas selected by EPA were:

- Calvert City, Kentucky: Location of the B.F. Goodrich facility
- Lake Charles, Louisiana: Location of the Conoco and PPG facilities
- New Orleans, Louisiana: Location of the Shell Oil and Union Carbide facilities.

PEDCo, with the assistance of an EPA meteorologist, selected 1 meteorological and 12 sampling sites at each study area. Each site is described below in detail.

Location of Calvert City, Kentucky, EDC Study Sites

A map of the study area is presented in Figure 1. The location of the main EDC emission source is 37°3'5"N, 88°19'36"W. Elevation at stack exit is 150.88 m; stack height is 45.72 m. The study area is located in the lands on both sides of the Tennessee River near Calvert City, Kentucky. B.F. Goodrich's chemical plant is located on the flat land south of the river. Sites 1 through 4 were placed near the plant; site 5 was located on the river east of the plant; and sites 6 through 12 were located in low, partially wooded hills north of the river.

Site 1--

This site was located within the fenced area of the Warren Petroleum Co., Calvert City terminal, 800 m and 130° southeast of the B.F. Goodrich plant. Propane gas (only) is stored at this site. Elevation was 105 m. A meteorological system and an EDC sampler were at this location. Exposure was excellent.

Site 2--

This site was located on Highway 282 in Calvert City in the front yard of the Roy Springer residence, 1280 m and 217° southwest of the B.F. Goodrich plant. Elevation was 107° m. The area between the B.F. Goodrich plant and the site was open, with scattered trees. A small woods was situated south of the site.

Site 3--

This site was located on Highway 282 in Calvert City atop a small building next to the Carl Deekes residence, 1260 m and 197° south-southwest of the B.F. Goodrich plant. Ground elevation was 107 m, with the roof 3 m above the ground. Exposure was excellent; the area between the site and the plant was open, with scattered trees.

Site 4--

This site was located at Routes 282 and 1523 in Calvert City in the front yard of the James Stowe residence, 1960 m and 153° south-southeast of the B.F. Goodrich plant. Elevation was 107 m. The area between the site and the plant had scattered woods. Exposure was good.

Site 5--

This site was located on the floating boat dock at the Guinn Fish Camp, in Gilbertsville, 3440 m and 120° east-southeast of the B.F. Goodrich plant. Elevation was 91 m. The dock floated in the Tennessee River, 10 m from shoreline, and exposure to emissions channeled up the river valley was excellent.

Site 6--

This site was located behind a tool shed on the Gerald Devine pig farm, 3200 m and 89° east of the B.F. Goodrich plant. The sampler was set on a small grassy knoll at a 119-m elevation, with excellent exposure in all directions.

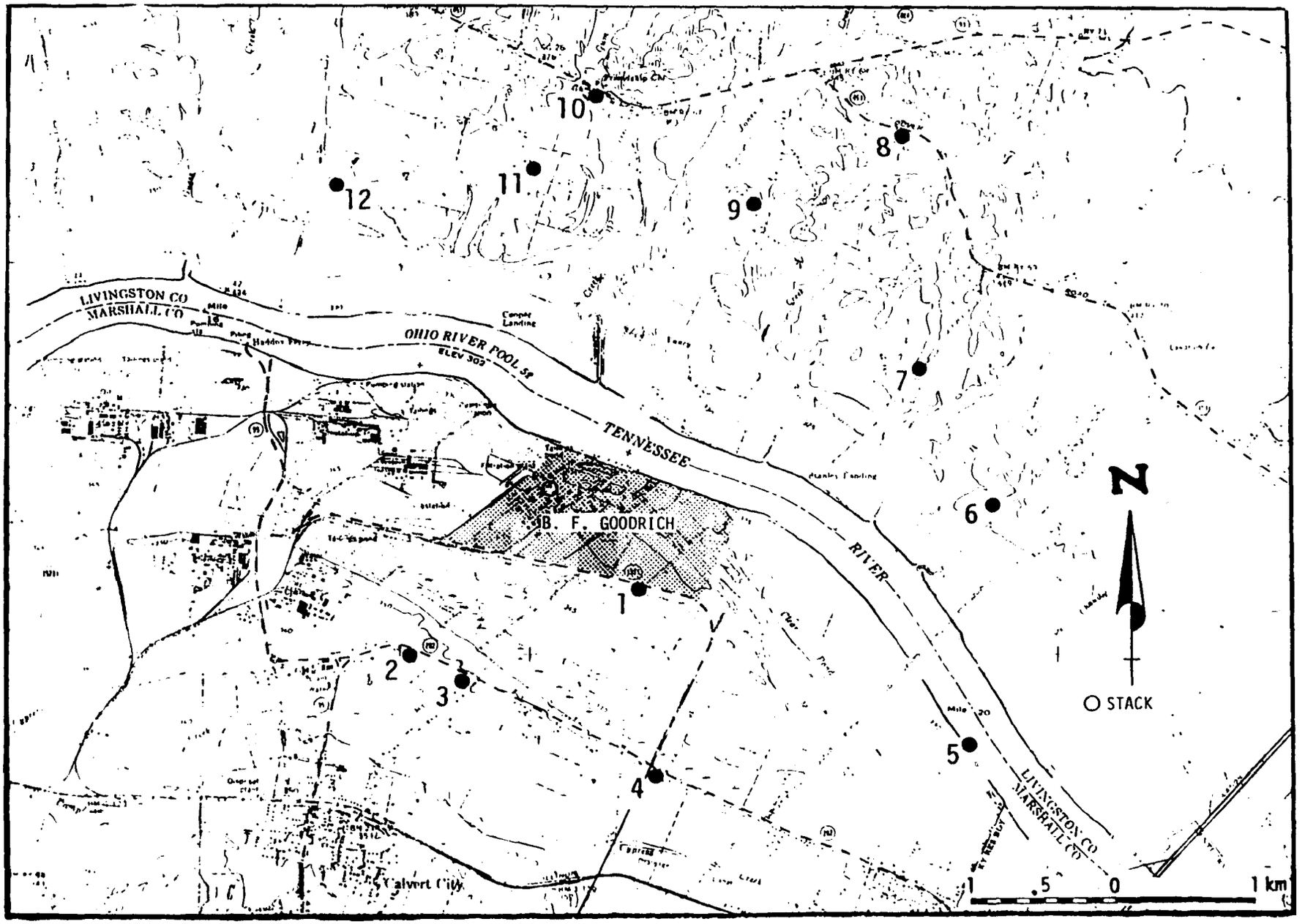


Figure 1. Map of Calvert City, Kentucky, study area.

Site 7--

This site was located on the Willard Jones pig farm in Grand River, 2860 m and 70° east-northeast of the B.F. Goodrich plant. The farm was situated on the side of a small valley running down to the Tennessee River. The sampler was placed atop a small wellhouse. Ground elevation at this site was 122 m, with the wellhouse roof 2 m above the ground.

Site 8--

This site was located in the backyard of the Charles Johnson residence, in Grand River 3700 m and 44° northeast of the B.F. Goodrich plant. Open pasture land lay in the area between this site and the banks of the Tennessee River. Exposure was excellent. Elevation at this site was 128 m.

Site 9--

This site was located in the front yard of the Ed Gillum residence in Grand River, 2680 m and 35° northeast of the B.F. Goodrich plant. Elevation was 113 m. The area between this site and the B.F. Goodrich plant was open farmland.

Site 10--

This site was located in an open area behind the Pinks Barbeque Stand in Smithland, 3000 m and 8° north of the B.F. Goodrich plant. Elevation was 110 m. Because it was in a heavily wooded valley, this did not appear to be a very good site, but local residents stated that smells from the plants located across the Tennessee River always seemed worse in this valley.

Site 11--

This site was located in a large open area near the barn on the Ralph Bloodworth farm in Smithland. Distance from the B.F. Goodrich plant was 2350 m; direction from the plant was 355° north; elevation was 119 m. The area between the site and the plant was open farmland.

Site 12--

This site was located in the large backyard of the Preston Bloodworth residence in Smithland, 2750 m and 329° north-northwest of the B.F. Goodrich plant at a 107-m elevation. The area between this site and the plant was open farmland. Exposure was excellent.

Location of Lake Charles, Louisiana, EDC Study Sites

A map of this study area is presented in Figure 2. The location of the principal EDC emission source is 30°15'9"N, 93°17'5"W. Elevation at stack exit is 49.68 m; stack height is 45.11 m. The study area is in the flat coastal plains of southern Louisiana, west of the junction of the Calcasieu River with Lake St. Charles. The town of Westlake, in which the Conoco plant is located, consists of residential and industrial areas. All Westlake samplers, except as indicated in individual site descriptions, were located on the ground at an elevation of 5 to 10 m above sea level.

Site 1--

This site was located in the front yard of the John C. Dyson residence (Route 2, Box 1145), about 1200 m and 178° south of the main vent stack of

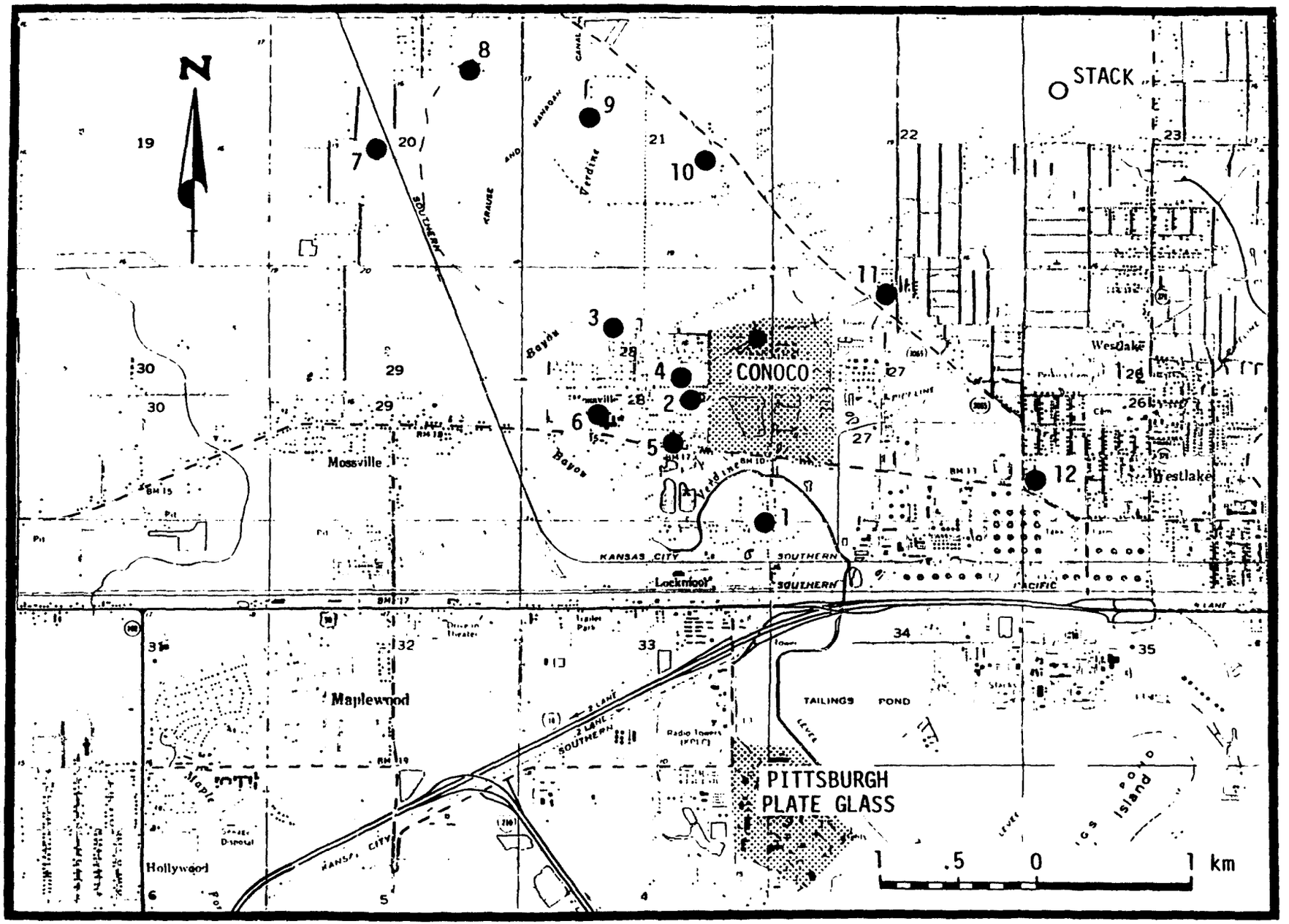


Figure 2. Map of Lake Charles, Louisiana, study area.

the Conoco plant. Trousdale Road, a tree-lined, north-south road in front of the Dyson residence, terminated at the plant property line just south of the main vent stack. When winds were from the north, this road channeled emissions from the plant to site 1.

The sampler was located in a large 30- by 30-m section of the front yard that was open to Trousdale Road. The area to the northeast and south was scattered with trees, the area to the west was heavily wooded. An EDC plant operated by Pittsburgh Plate Glass (PPG) is located approximately 1800 m south of the site.

Site 2--

This site was located in the front yard of the Irene Gray residence (Route 2, Box 735), 590 m and 228° southwest of the main vent stack of the Conoco plant. The area consisted of tall trees with very little undergrowth. Streets ran north-south and east-west. The neighborhood was an old subdivision with many vacant lots that had become overgrown. The eastern side of the area bordered the Conoco property. During periods of little or no wind, emissions from the plant drifted into the area. The sampler was located in a front yard area that had no trees within 10 m.

Site 3--

This site was located in the front yard of the Paul Victoria residence (Route 2, Box 794 M), 940 m and 275° west of the main vent stack of the Conoco plant. Located at the fringe of the residential area described in site 2, this location was well exposed, with only a few small trees. The sampler was located for excellent exposure in all directions.

Site 4--

This site was located in the front yard of the Oriese Thomas residence (Route 2, Box 748), 570 m and 242° southwest of the main vent stack of the Conoco plant, and in the residential area described for site 2. The sampler was located near the corner of two streets and had good exposure, even though the area was wooded. Vehicle traffic in the neighborhood was very light.

Site 5--

This site was located on the roof of the Thomas Body Shop (Michigan Avenue and Old Spanish Trail), 870 m and 219° southwest of the main vent stack of the Conoco plant. The roof area, 7 m above the ground, had good exposure in all directions. Work activities at the body shop were confined to a few hours in the evening, and included no painting, degreasing, or gasoline services.

Site 6--

This site was located at the Mossville Elementary School (Old Spanish Trail), 1140 m and 244° southwest of the main vent stack of the Conoco plant. The school was in a large open area between Westlake and Mossville. The sampler was placed on the roof of one of the auxiliary buildings, and was 4 m above the ground.

Site 7--

This site was located in the backyard of the Jerry Harding residence (Evergreen Drive), 2770 m and 297° northwest of the main vent stack of the Conoco plant. The area between the plant and this site was open, with a few trees.

Site 8--

This site was located in the front yard of the Shirley Bunch residence (Evergreen Drive), 2570 m and 313° northwest of the main vent stack of the Conoco plant. The area between the plant and this site was open, with very few trees.

Site 9--

This site was located at the residence of Gerald Bult (Powell Lane), 1800 m and 323° northwest of the main vent stack of the Conoco plant. An EDC sampler and meteorological tower were located in a large open field behind the Bult residence. No large obstructions were present within 200 m. The area between the plant and the site was open with the exception of a few trees.

Site 10--

This site was located in the backyard of the John Hyde residence (Route 2, Box 1586), 1190 m and 343° north of the main vent stack of the Conoco plant. The area near the sampler was open, with the exception of a few scattered pine trees.

Site 11--

This site was located in the backyard of the Herman Dyson residence (2215 Margaret Street), 880 m and 70° east of the main vent stack of the Conoco plant. A few trees were in the vicinity of the sampler, but the area between this site and the Conoco plant was open.

Site 12--

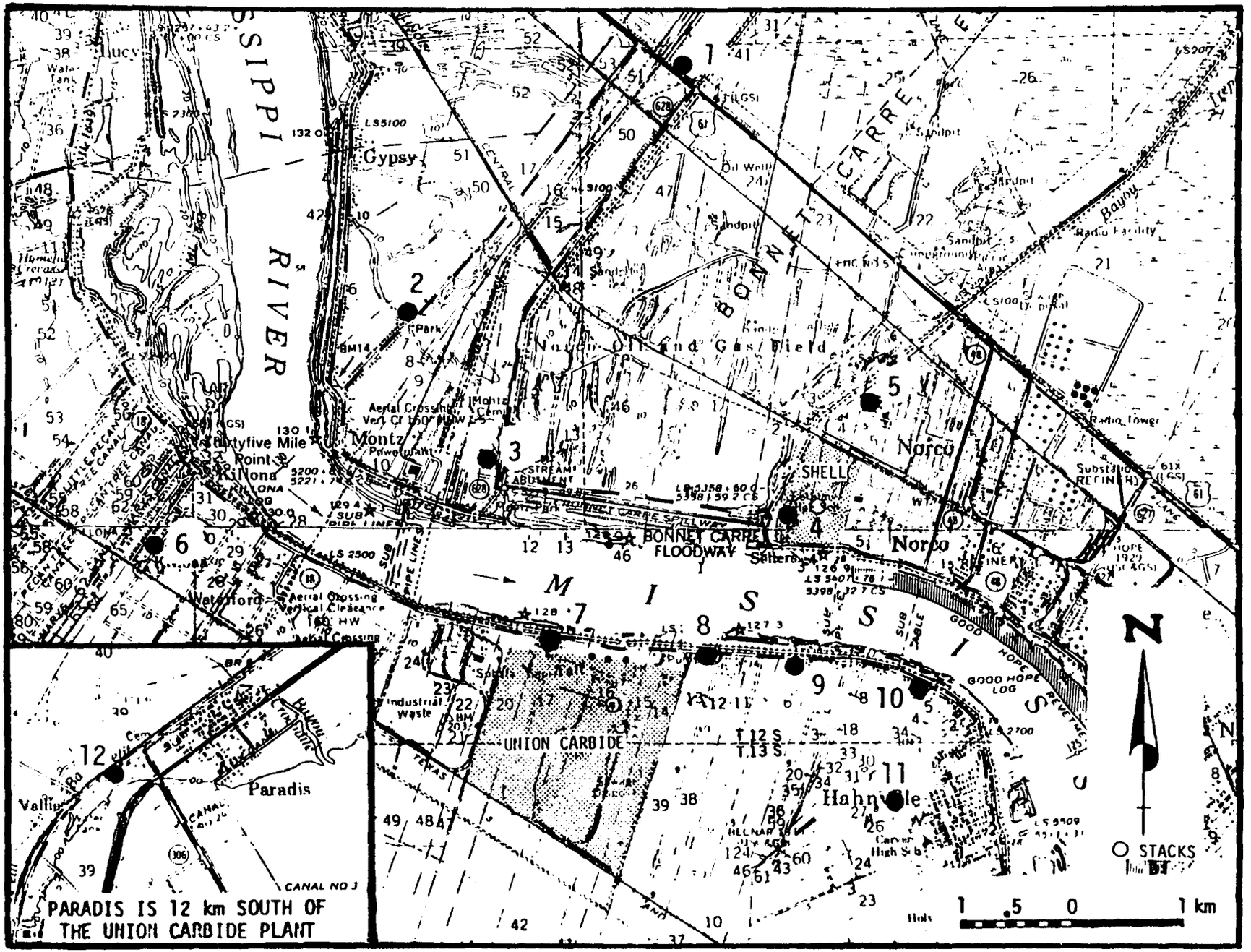
This site was located in the backyard of the Harold Daily residence (913 Carroll Street), 2020 m and 117° southeast of the main vent stack of the Conoco plant. This was a residential area, and the site had a large open yard containing only a few small trees. Exposure was good in all directions.

Location of New Orleans, Louisiana, EDC Study Sites

A map of the New Orleans, Louisiana, study area is presented in Figure 3. The principal EDC emission sources are:

- Shell Chemical Plant, Norco, Louisiana, at 30°0'15"N, 90°25'30"W. Elevation at stack exit is 36.5 m; stack height is 33.53 m.

- Union Carbide, Hahnville, Louisiana, at 29°59'06' N, 90°26'15"W. Elevation at stack exit is 18.29 m; stack height is 15.24 m. The stack is equipped with an incinerator.


MISSISSIPPI RIVER
BONNET CARRE SPILLWAY
BONNET CARRE FLOODWAY
Gypsy
Montz
Norco
Hahnville
Paradis
Killona
Waterford
UNION CARBIDE
SHELL
Industrial Waste
Sandpit
Radio Tower
Oil Well
Aerial Crossing
Vertical Clearance
Stream Abutment
Good Hope Log
Canal No 3
Texas
Bayou
Radio Facility
Substation
Refinery
Park
Cemetery
Powerplant
Sewerplant
Water Tank
Lucy
Twelve Mile Point
Sugar Refinery
Sugar Mill
Sugar Cane
Pecan Tree
Canal
Levee
Pipe Line
Sub Station
Sub Station
Sub Station

The study area is in the flat delta lands on both sides of the Mississippi River north of New Orleans, Louisiana. All samplers, except as indicated in individual site descriptions, were located on the ground at an elevation of 3 to 6 m above sea level. A levee of 10-m height runs along both sides of the Mississippi River and along the Bonnet Carre floodway, which connects the Mississippi River with Lake Pontchartrain. The study area is residential, intermingled with chemical plants and oil refineries. A large swamp area is located south of the Union Carbide plant.

Site 1--

This site was located in Laplace at the Hopkins Fruit Stand (Highway 61 and Prescott Road), 4000 m and 343° north-northwest of the Shell plant; and 6000 m and 5° north of the Union Carbide plant. Adjacent to the site is the Bonnet Carre floodway, a flat, wooded area of 2000-m width running between the Mississippi River and Lake Pontchartrain. Route 61, a four-lane highway with moderate traffic, passed within 30 m of the site. The sampler was located on top of a small cooler next to the fruit stand. The sampler inlet was 3 m above the ground.

Site 2--

This site was located in Laplace at the residence of Neil Madere (195 Evangeline Road), 4050 m and 295° northwest of the Shell plant; and 4200 m and 310° northwest of the Union Carbide plant. Located in an area of new homes with large open yards, this site had good exposure in all directions.

Site 3--

This Laplace site was located in the front yard of the Joseph Calcayvno residence (Route 1, Box 731), 3025 m and 275° west of the Shell plant; and 2675 m and 331° northwest of the Union Carbide plant. The area around the Calcayvno residence was open for 200 m in all directions, giving excellent exposure. The 10-m high Bonnet Carre floodway levee was 250 m to the east. The Mississippi River levee of the same height was 500 m to the south.

Site 4--

This site was located in Norco inside the fenced area of the Bonnet Carre maintenance facilities, U.S. Army Corps of Engineers. A meteorological system and EDC sampler were located here. The site was 400 m and 299° southwest of the Shell plant; and 2700 m and 37° northeast of the Union Carbide plant. The Bonnet Carre floodway levee was 50 m to the west and the Mississippi River levee was 300 m to the south. Under calm wind conditions, emissions from the Shell plant could be held in the pocket formed by the junction of the two levees.

Site 5--

This site was located in Norco in the backyard of the R.V. Jacob residence (524 Alleman Street), 825 m and 32° northeast of the Shell plant; and 3500 m and 37° northeast of the Union Carbide plant. Located in a residential area of the west part of Norco, this site had excellent exposure to the Shell plant.

Site 6--

This site was located in Killona in the front yard of the Corrine Woods residence, 6050 m and 266° west of the Shell plant; and 4600 m and 289° northwest of the Union Carbide plant. Located at the eastern edge of Killona, the site had excellent exposure to the north, east, and south.

Site 7--

The sampler at this Hahnville site was located on the roof of Marie's Cafe (Route 18), at a height of 5 m above the ground. The site was 2850 m and 24° southwest of the Shell plant; and 1000 m and 314° northwest of the Union Carbide plant. The 10-m-high Mississippi River levee was 40 m north of the site. Exposure in all directions was good.

Site 8--

This site was located in Hahnville in the backyard of the Leona Triche residence (Route 1, Box 10), 1850 m and 212° southwest of the Shell plant; and 850 m and 60° northeast of the Union Carbide plant. Exposure in all directions was excellent. The Mississippi River levee was 100 m north of this site.

Site 10--

This Hahnville site was located in the front yard of the Adolph Lorio residence (Route 1), 2075 m and 155° southeast of the Shell plant; and 2575 m and 85° east of the Union Carbide plant. No trees were in the area of the sampler. Exposure was good in all directions. The Mississippi River levee was 110 m north of this site.

Site 11--

This site was located in Hahnville in the backyard of the Sam Alleman residence (Box 333), 2950 m and 168° southeast of the Shell plant; and 2450 m and 109° east of the Union Carbide plant. The area of the yard was open with excellent exposure.

Site 12--

This site was located in Paradis in the backyard of the Ray Doucet residence, 14,450 m and 189° south of the Shell plant; and 12,200 m and 181° south of the Union Carbide plant. The area between this site and the Union Carbide plant was heavily forested swampland. Residents of the house stated they could often smell the chemical plant when the wind was from the north.

FIELD SAMPLING

After the sites were selected, PEDCo contacted the property owners and made arrangements for placement of the sampling equipment. These arrangements were documented in an Agreement to Use Property form (Figure 4). This document defined PEDCo's level of liability and removed liability from EPA.

The following equipment was used in the studies:

- Twelve EPA samplers were modified (6) by PEDCo to take duplicate samples at a flow rate of 65 cm^3/min for 24 h (See Figure 5)

AGREEMENT TO USE PROPERTY

_____, the Undersigned, for _____dollars,
(PRINT)

receipt of which is hereby acknowledged, and other good and valuable consideration hereby agrees to the following:

1. PEDCo Environmental, Inc., (PEDCo) as an agent of the U.S. Environmental Protection Agency (EPA) may set up and operate an air monitoring station at_____

   _____

   _____

   _____

   for the period of _____ to _____

2. PEDCo shall be permitted vehicular access to said station as required for its installation, maintenance, and removal.

3. The undersigned shall supply and pay for all electrical energy required to operate the air quality monitors located at the station.

PEDCo agrees to the following:

1. At the termination of this agreement the air monitoring station and all equipment related thereto will be removed and the property restored to its original condition at no expense to the Undersigned.

_____
Undersigned

_____
PEDCo Environmental, Inc.

Figure 4. Property use agreement document.

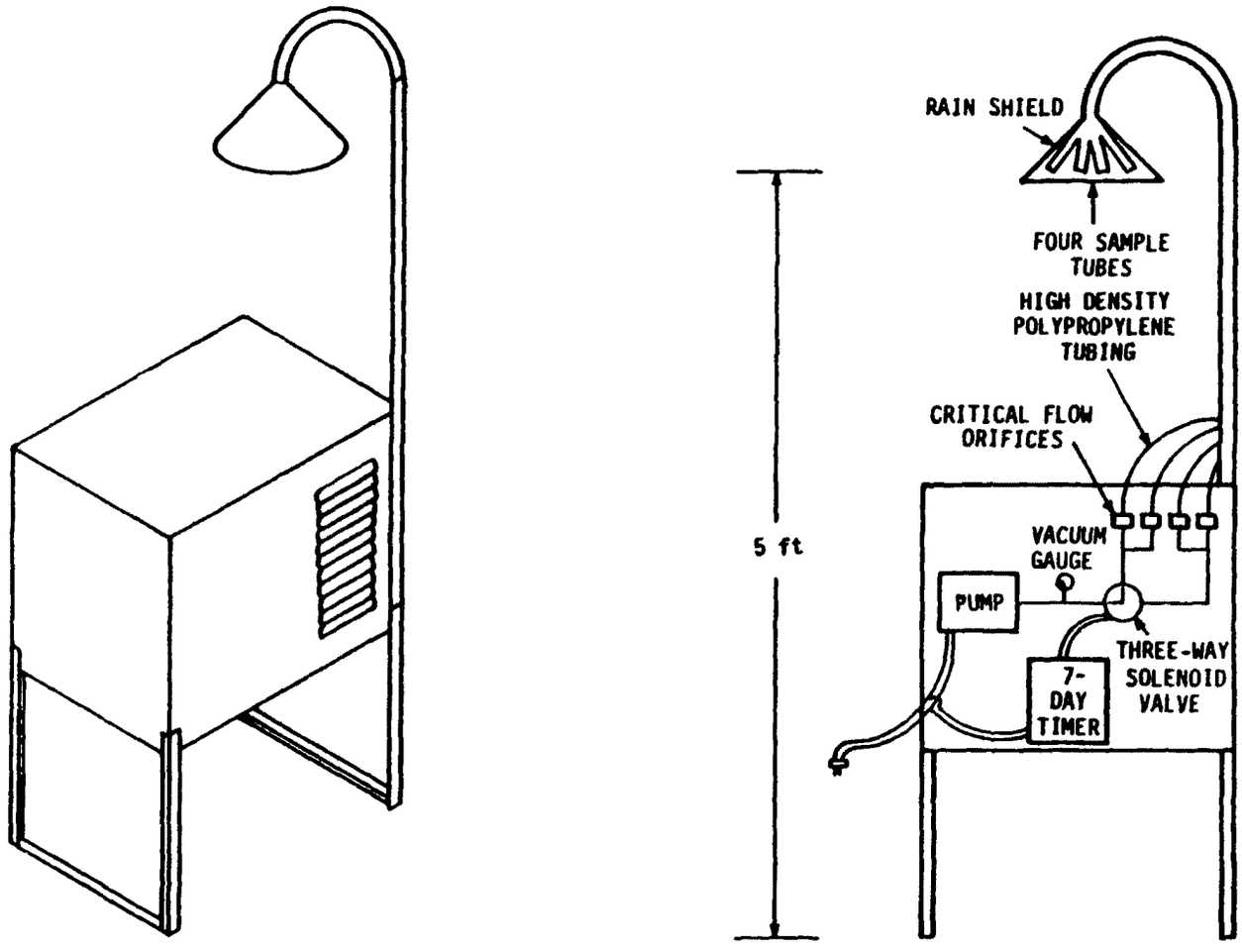


Figure 5. Sketch of 24-h integrated sampler for EDC monitoring.

- One Bendix Aerovane Model 141/120 wind speed/direction system with a 10-m tower

- One Weather Measure Corporation Model H-311 hygrothermograph to measure temperature and relative humidity

The 12 sampling sites were selected for their position on the perimeter of the study area, as close as possible to the places where EPA meteorologists had predicted maximum impact. The wind system and hygrothermograph were located at the sampling site most representative of meteorological conditions in the study area.

Routine Sampling Activities

The following step-by-step procedure was followed by the PEDCo field technician at each sampling site.

1. Inspect the sampling site and equipment for possible vandalism or anything unusual. Record findings in the study log book.

2. Record the adsorption tube number, site location, and sampler location on the sample data form (Figure 6).

3. Record the vacuum reading, which must be in excess of 373 mm. If vacuum is less than 375 mm, check sampler for leaks, or replace sampler with the spare supplied.

4. Connect two tubes in tandem, as shown in Figure 7. Break the adsorption tube ends and connect the tube to the sampler.

5. Connect the rotameter to the other end of the adsorption tube and record the initial flow derived from the rotameter calibration curve; record on the sample data form and in the operator's log. The flow rate should be 65 $\pm$ 5 cm^3/min. Take remedial action if the rate is not within this range.

6. Remove the rotameter from the adsorption tube.

7. Record the starting date and time on the sample data form and in the operator's log.

8. Return to the sampling site midway through the sampling period; measure and record the flow rate and vacuum.

9. Return to the sampling site after 24 h and record the date, time, and final vacuum reading.

10. Connect the rotameter; measure and record the final flow as in Step 5.

SAMPLE DATA FORM

Site Number: _____ Start Date _____ Time _____

Site Location: _____ End Date _____ Time _____

Operator: _____

Tube Numbers

Front _____

Back _____

Flow Rate

Start _____ cm^3/min

Mid _____ cm^3/min

Final _____ cm^3/min

Average _____ cm^3/min

Running Time Meter

Final _____

Start _____

Sample Time _____ min

Vacuum in. Hg

Start _____

Mid _____

Final _____

Average Flow Rate_____x Total Sample Time_____ = _____ Sample Volume cm^3.

Remarks: _____

_____

Weather Conditions: _____

_____

_____

Figure 6. Sample data form.

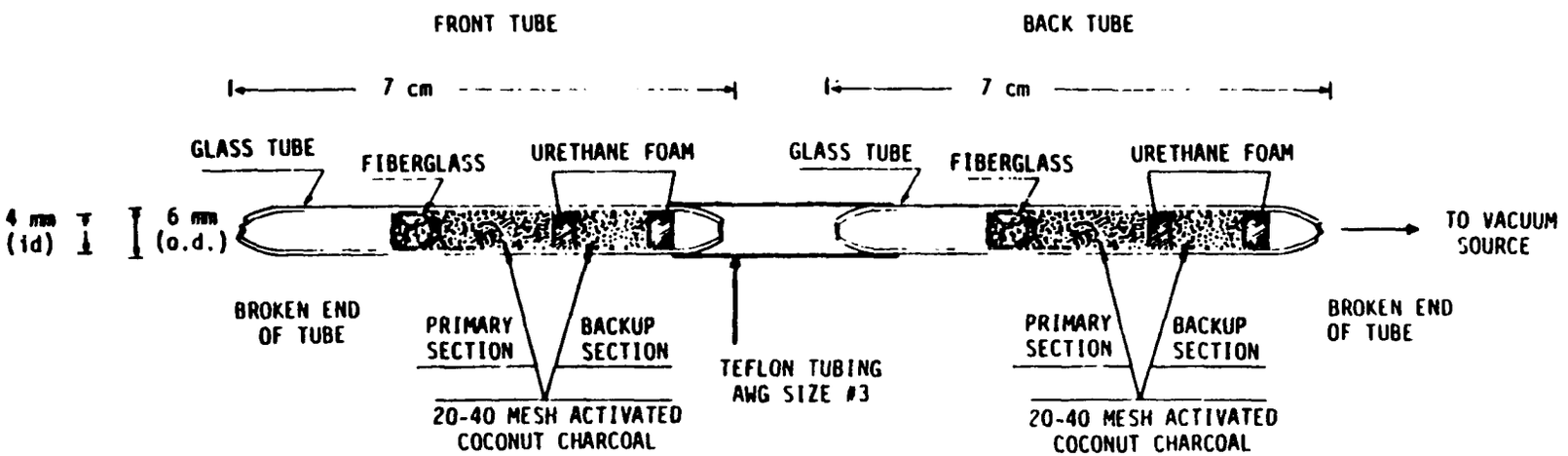


Figure 7. Diagram of tandem charcoal tubes for EDC sampling, showing broken ends.

11. Disconnect the adsorption tube and place plastic caps on each end.

12. Place the adsorption tube and the record sheet in the refrigerated sample custody case.

13. Store the samples in complete darkness at 0°C during transfer to the laboratory and until they are analyzed.

Meteorological Measurements

The meteorological station was installed at the sampling site where the most representative meteorological conditions prevailed. A Bendix Model 120 sensor/transmitter was used in conjunction with a Bendix Model 141 recorder to measure wind speed and direction. The sensor/transmitter was located at the top of a 10-m tower.

Before and after the 10-day operation period, the system was checked for proper orientation and bearing wear as described in the manufacturer's manual. The recorder was calibrated at the same intervals, by putting into the unit known voltage levels representing the response from the transmitters.

Wind speed and direction were recorded on dual chart paper, with wind speed tracing the top portion of the chart and wind direction the lower portion. The chart paper was premarked to show hourly increments. Recorder charts were marked each day with the correct time and date. At the end of each 10-day study, the chart was removed and wind data reduced.

Wind speed was measured in miles per hour. The data were reduced to find an average for a specific hour by visually drawing a line (based on judgment) through the middle of the wind speed trace, and recording that figure on a meteorological data record sheet.

Wind direction was measured in degrees. A template was placed proportionately between two hourly indicators stamped on the chart, and the prevailing direction was recorded on the data sheet.

A wind rose for each 24-h sampling period was then constructed from the reduced data.

A Model H-311 hygrothermograph was used to measure temperature and relative humidity. This model uses a bimetallic strip for measuring temperature, and a human hair bundle for measuring relative humidity. Temperature and relative humidity were recorded simultaneously on a 18-cm chart mounted on a clock-driven drum. Temperature was recorded on the upper half of the chart, and relative humidity on the lower half.

The hygrothermograph was housed in a louvered shelter mounted at the 2-m level of the meteorological tower. The correct time and date were marked on the recorder charts each day. At the end of a 10-day study, the chart was removed, and the temperature and relative humidity data were reduced and recorded on the meteorological data form.

LABORATORY ANALYSIS

Sample Handling

All samples collected in the field were stored in the dark at 0°C within a small refrigerator. Under these conditions, they were hand-carried to the PEDCo laboratory. At the laboratory, they were logged in the sample receipt record and assigned a laboratory sample code. Samples were selected for analyses after referring to information about the prevailing meteorological conditions for each 24-h sampling period. Samples from sites downwind of the emission source and from background sites were selected for analysis. Each day, 50 to 70 percent of the exposed tubes were selected for analysis. In addition to the analyses of duplicate field samples, about 10 percent of the desorbed samples were selected for replicate analysis. Internal standard solutions and check samples were also analyzed.

Sample Analyses

The samples were desorbed in carbon disulfide (CS_2) and analyzed by GC separation and MS detection. An internal standard was added to the CS_2 desorbing solution to provide a specific ion abundance, which was used to monitor the operational characteristics of the mass spectrometer during analyses. This internal standard, in conjunction with a series of external standards of EDC in CS_2, was used to identify and measure the amounts of EDC present in the field samples. One analytical run consisted of a series of three standards, followed by ten samples and four to five quality assurance samples. This analytical scheme was then repeated. Details of the method used to analyze EDC in samples from charcoal adsorption tubes are presented in Appendix A.

SECTION 4

DATA PRESENTATION

Ambient levels of EDC and meteorological data for the three study areas are presented in tabular and graphic form for each 24-h sampling period.

The precision of the analytical method, based on statistical analysis (relative standard deviation) of replicate standard solutions, was determined to be 3 percent. The precision of both the analytical and sampling methods, based on statistical analysis (relative standard deviation) of replicate samples, was determined to be 6 percent. Standard check samples prepared by EPA and by PEDCo were used to determine the accuracy of the analytical method. The EPA check samples yielded an average recovery of 72 percent; and the PEDCo samples, an average recovery of 97 percent. In an attempt to find the reason for this discrepancy, a statistical evaluation was made of the possibility of EDC decay on the tube between the times of preparation and analysis; but no biases were observed. Because the reason for the discrepancy could not be ascertained, the accuracy of the analytical method can only be estimated as between 72 and 97 percent.

CALVERT CITY, KENTUCKY, STUDY AREA

A preliminary 3-day field study was conducted to evaluate the sampling and analytical approach. This study demonstrated that the sampling approach and the analytical methodology were capable of meeting the objectives of the study. The EDC levels found during the study in Calvert City, Kentucky, are summarized in Table 1; refer to Section 3, Location of Calvert City, Kentucky, EDC Study Sites, for site locations. The EDC levels and prevailing meteorological conditions for each day of the study have been plotted on maps of the study area, and these are presented in Figures 8 through 20. The reduced meteorological data collected during the study period are presented in Appendix B.

LAKE CHARLES, LOUISIANA, STUDY AREA

The EDC levels found during the Lake Charles, Louisiana, study are summarized in Table 2; refer to Section 3, Location of Lake Charles, Louisiana, EDC Study Sites, for site locations. The EDC levels and prevailing meteorological conditions for each day of this study have been plotted on maps of the study area, and are presented in Figures 21 through 32. The reduced meteorological data collected during the study period are presented in Appendix C.

NEW ORLEANS, LOUISIANA, STUDY AREA

The EDC levels determined during the New Orleans study are summarized in Table 3; refer to Section 3, Location of New Orleans, Louisiana, EDC Study Sites, for site locations. The EDC levels and prevailing meteorological conditions for each day during the study have been plotted on maps of the study area, and are presented in Figures 33 through 42. The reduced meteorological data collected during this study period are presented in Appendix D.

TABLE 1. DATA SUMMARY OF EDC LEVELS ($\mu g/m^3$)[a] IN CALVERT CITY, KENTUCKY, STUDY AREA

Date sampled	Site location											
	1	2	3	4	5	6	7	8	9	10	11	12
8-26-78[b]	25.5		4.1		1.4					10.6		28.7
8-27-78[b]		<0.5						18.0	54.0	12.2		
8-28-78[b]		<0.5					14.4	22.4	41.3	4.8		
9-09-78	26.0	72.2		16.8	3.2			<0.5		1.2	3.4	
9-10-78	37.7	37.8		18.0				12.1	15.7	3.5	4.7	
9-11-78	<0.5		<0.5		<0.5			1.7	6.1	24.7	10.7	
9-12-78	10.8		<0.5		0.6			6.9	0.7	30.2	<0.5	
9-13-78				<0.5			<0.5	2.5	35.8	59.9	55.0	<0.5
9-14-78	3.3	<0.5			<0.5	<0.5	36.3	15.2	21.4			
9-15-78		<0.5	<0.5	<0.5	<0.5	<0.5	9.0	<0.5	<0.5	<0.5	<0.5	
9-16-78		8.2	<0.5				0.7	<0.5	<0.5	<0.5	<0.5	
9-17-78	<0.5		<0.5			<0.5	<0.5		67.8	12.0		<0.5
9-18-78		<0.5		<0.5	<0.5		<0.5		24.5	30.0	46.4	<0.5

[a] For conversion, 1 $\mu g/m^3$ is equivalent to 0.247 ppb.

[b] Sampling on this day was part of a 3-day preliminary study, with sampling conducted from 8 a.m. All other study periods were midnight to midnight.

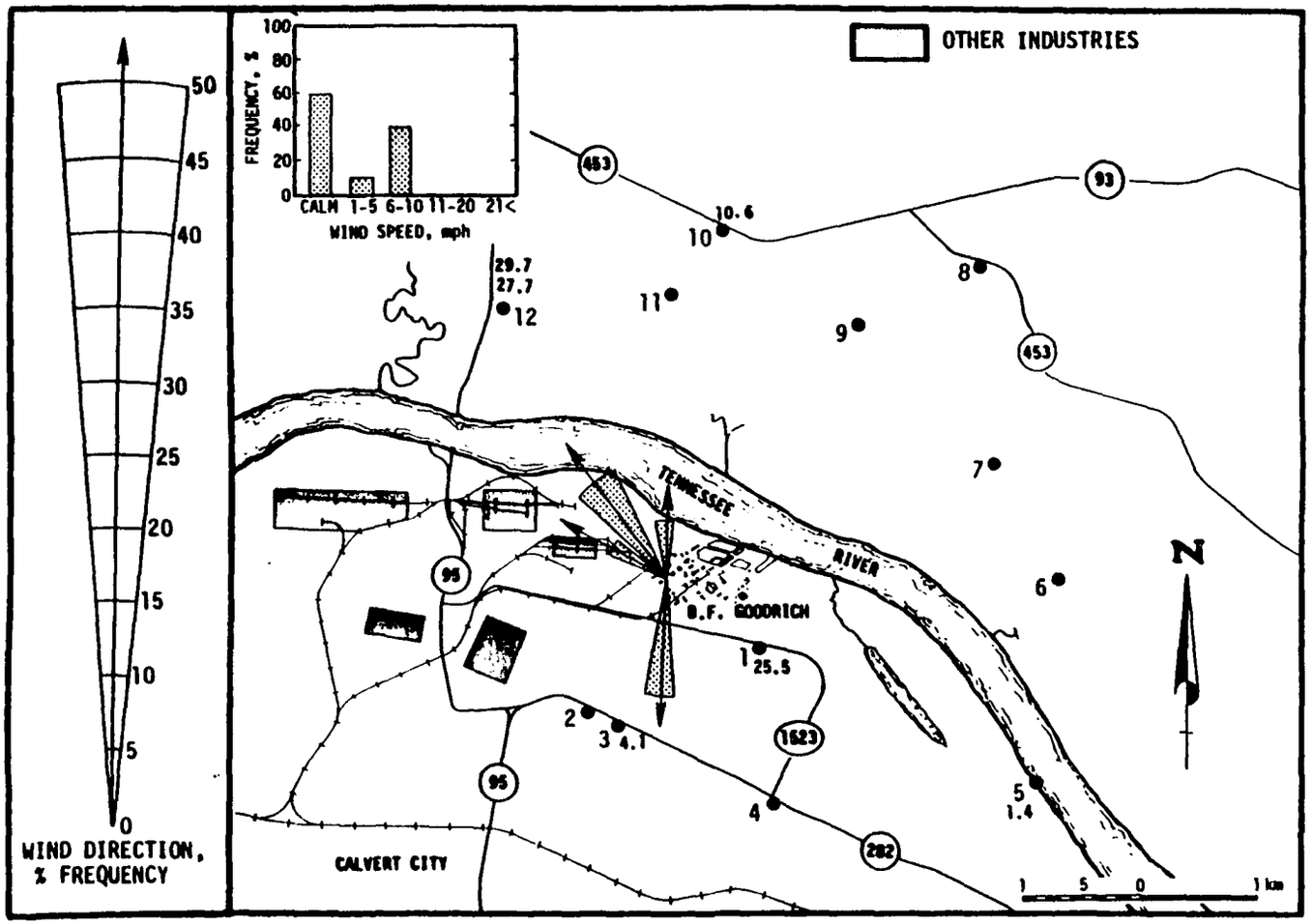


Figure 8. Results of preliminary EDC study, Calvert City, Kentucky for 8/26/78 (8 a.m.) to 8/27/78 (8 a.m.). EDC concentrations are given in $\mu g/m^3$.

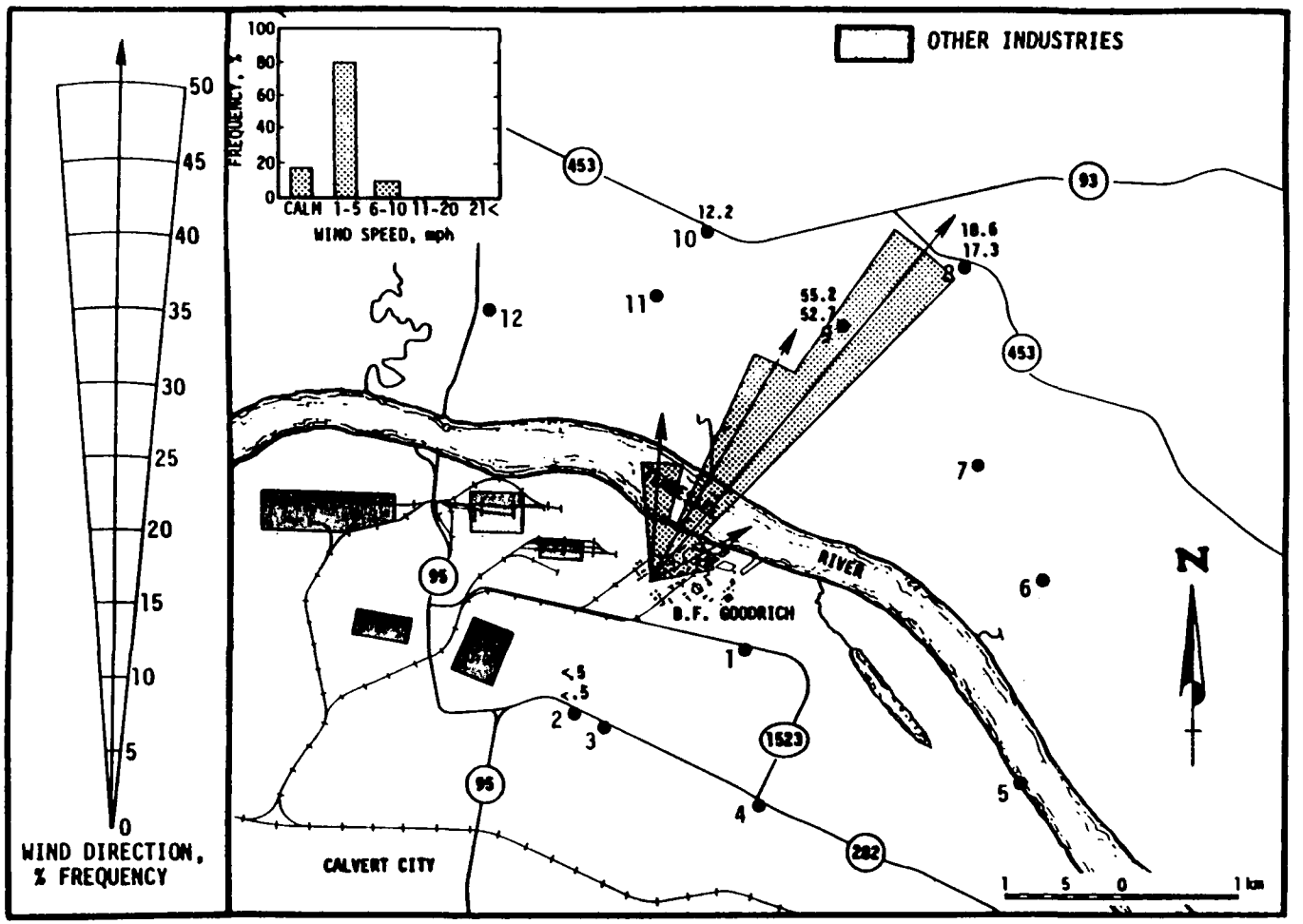


Figure 9. Results of preliminary EDC study, Calvert City, Kentucky, for 8/27/78 (8 a.m.) to 8/28/78 (8 a.m.). EDC concentrations are given in $\mu g/m^3$.

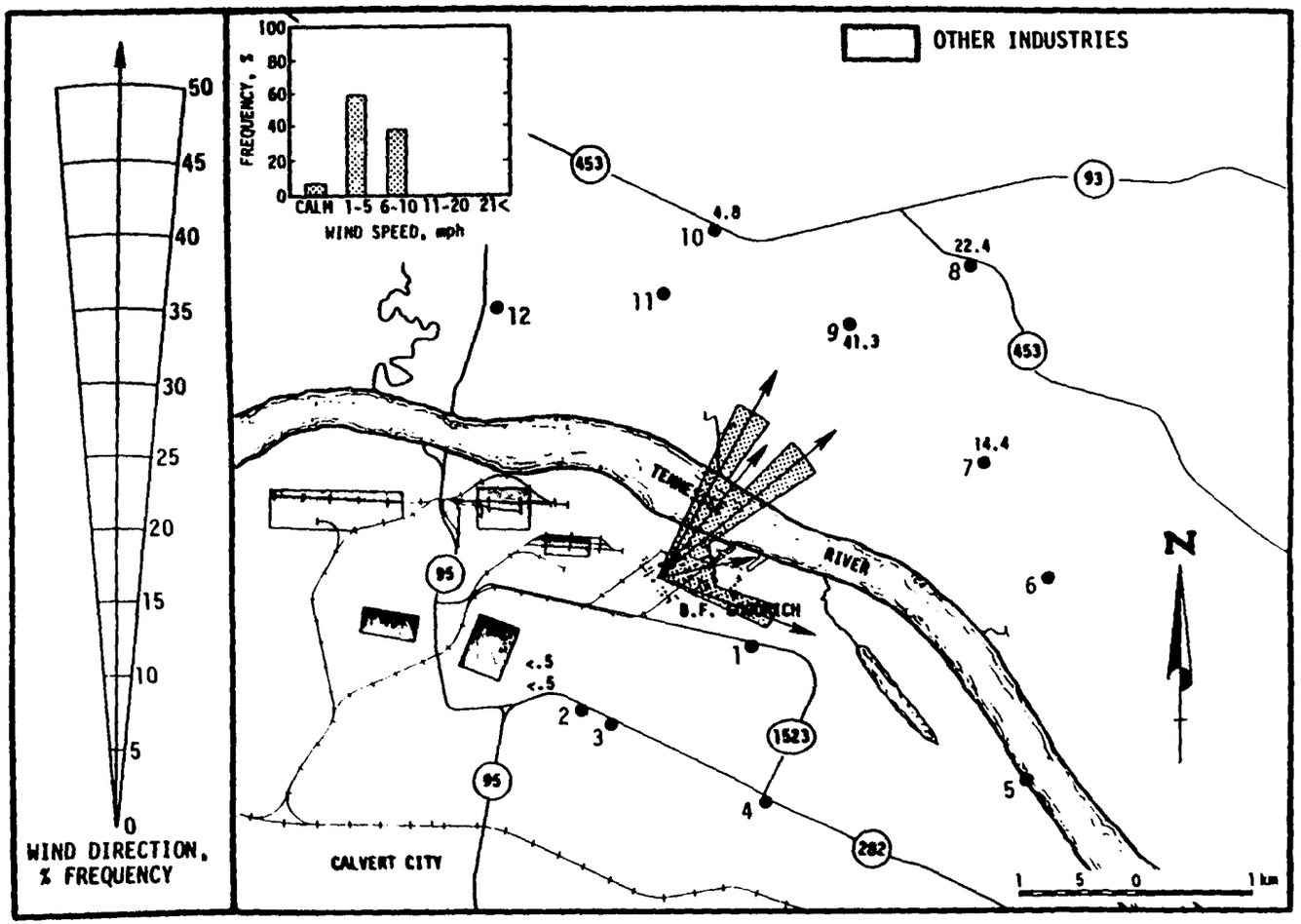


Figure 10. Results of preliminary EDC study, Calvert City, Kentucky, for 8/28/78 (8 a.m.) to 8/29/78 (8 a.m.). EDC concentrations are given in $\mu g/m^3$.

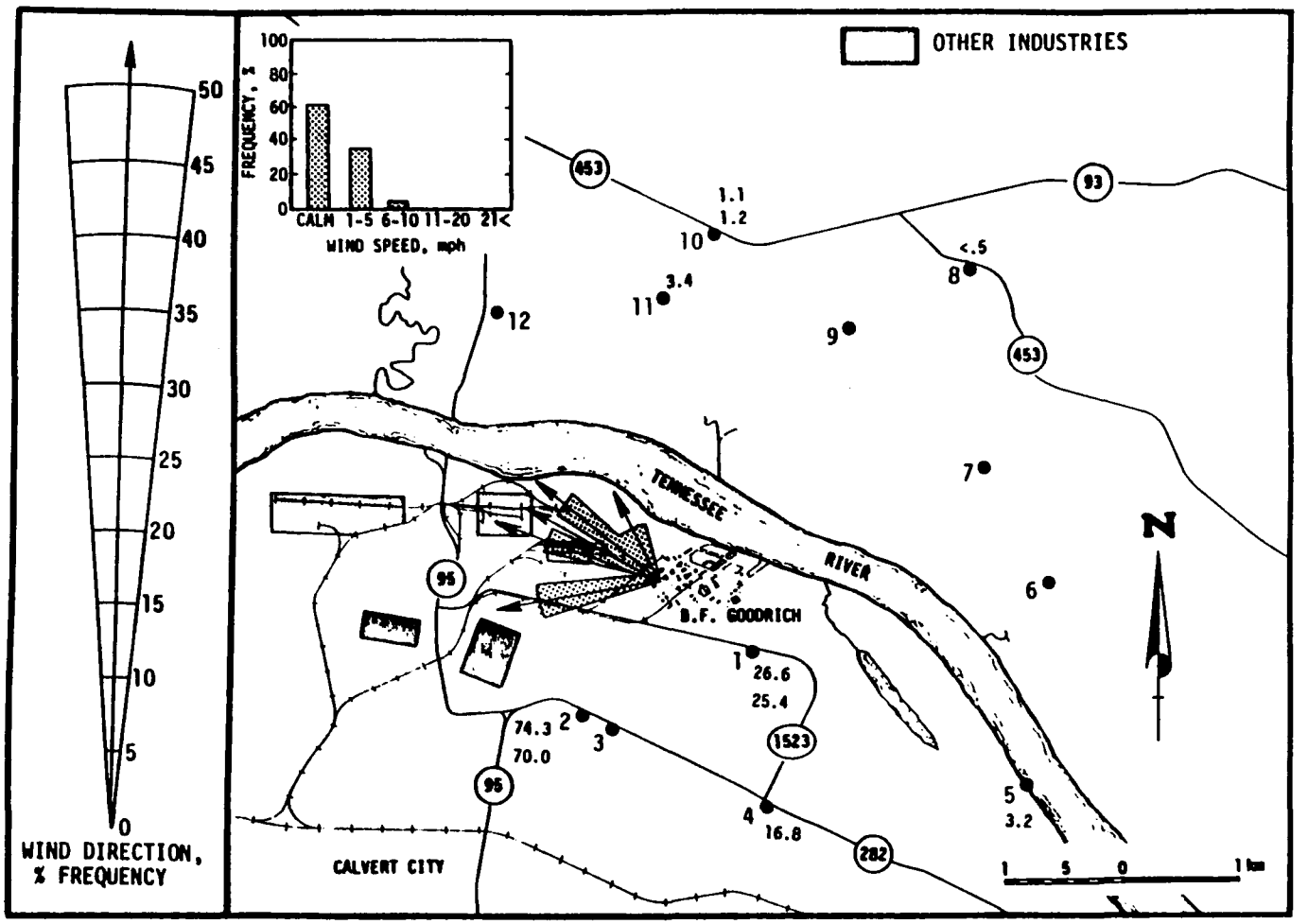


Figure 11. Results of EDC study, Calvert City, Kentucky, 9/9/78. EDC concentrations are given in $\mu g/m^3$.

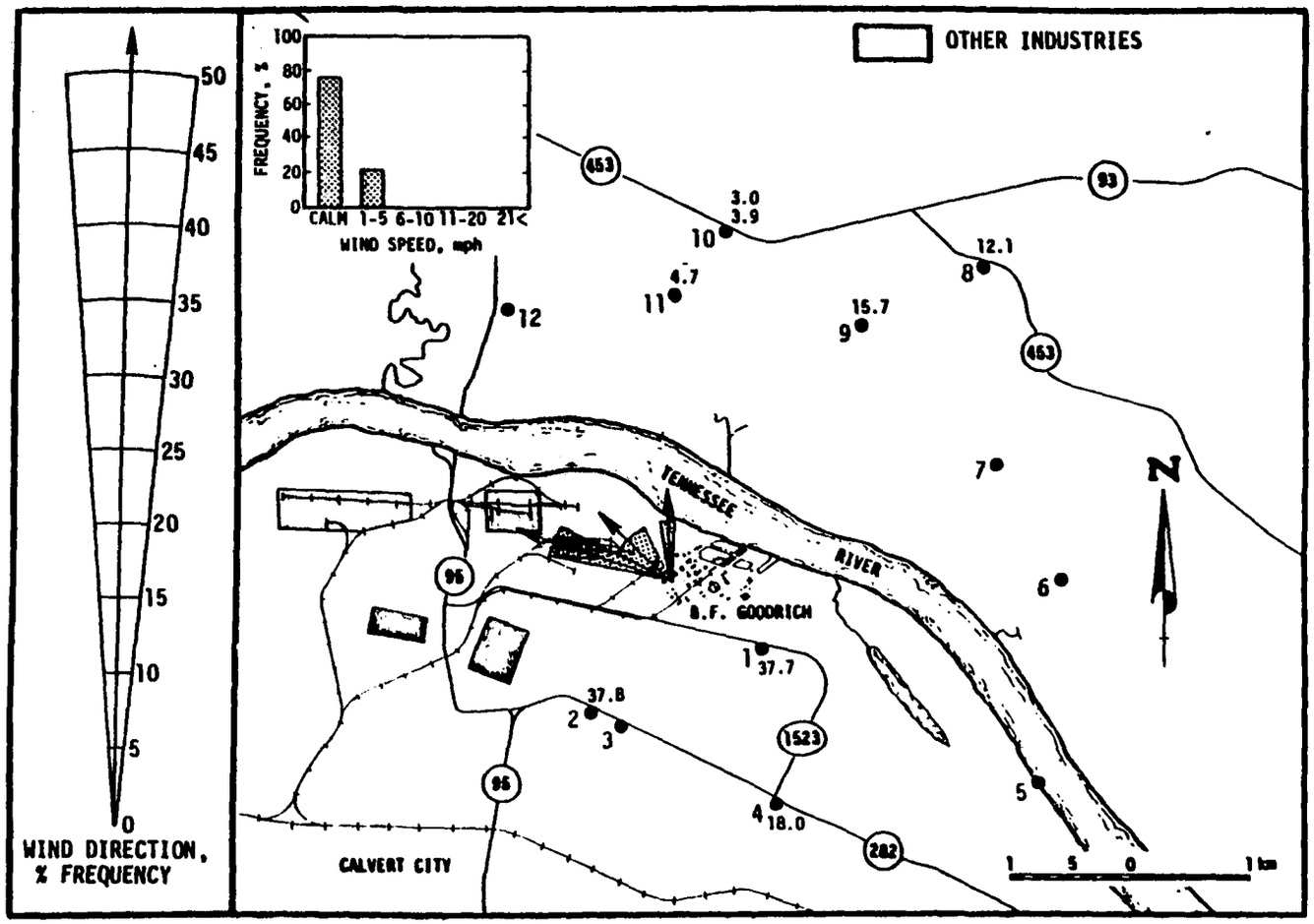


Figure 12. Results of EDC study, Calvert City, Kentucky, 9/10/78. EDC concentrations are given in $\mu g/m^3$.

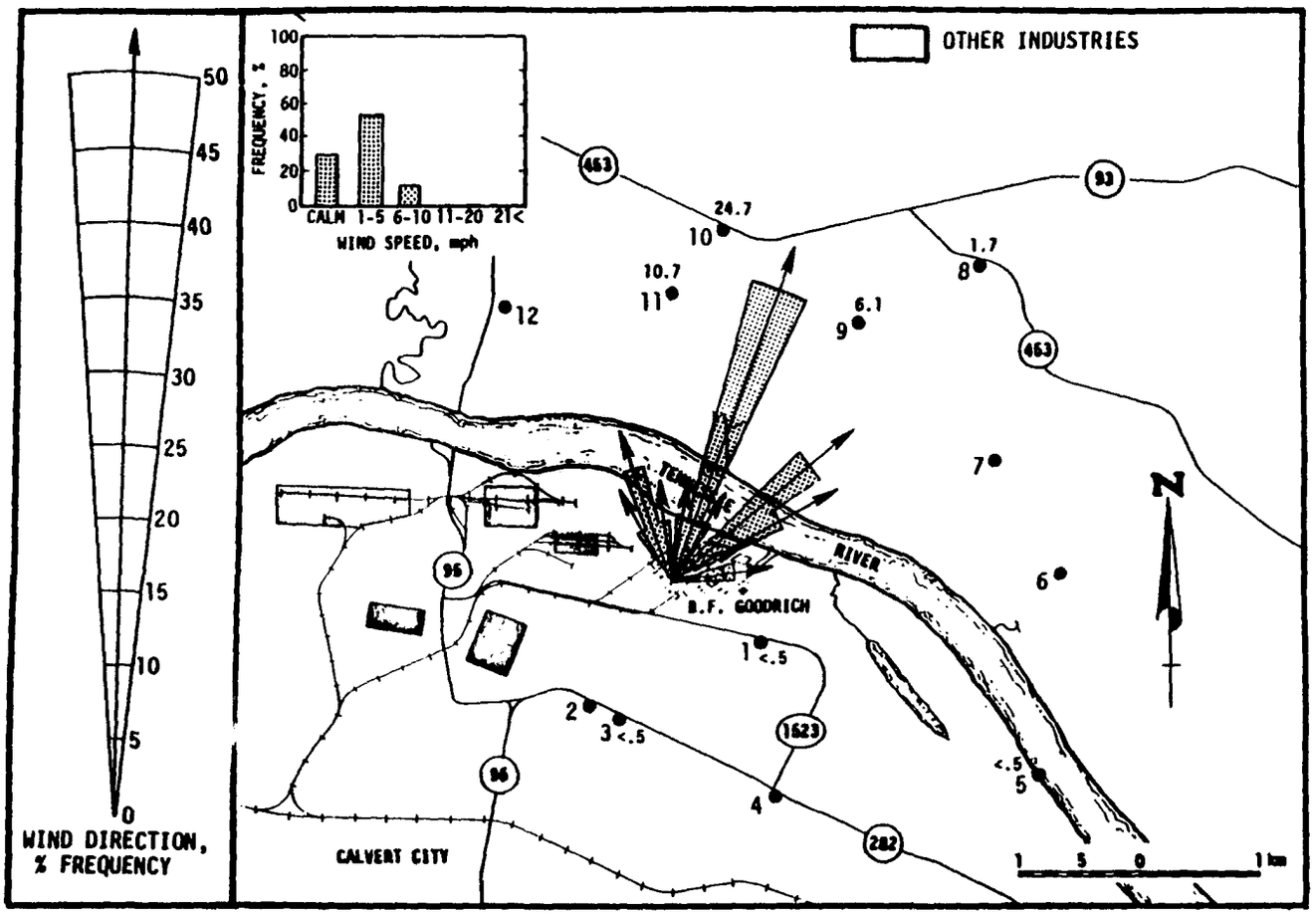


Figure 13. Results of EDC study, Calvert City, Kentucky, 9/11/78. EDC concentrations are given in $\mu g/m^3$.

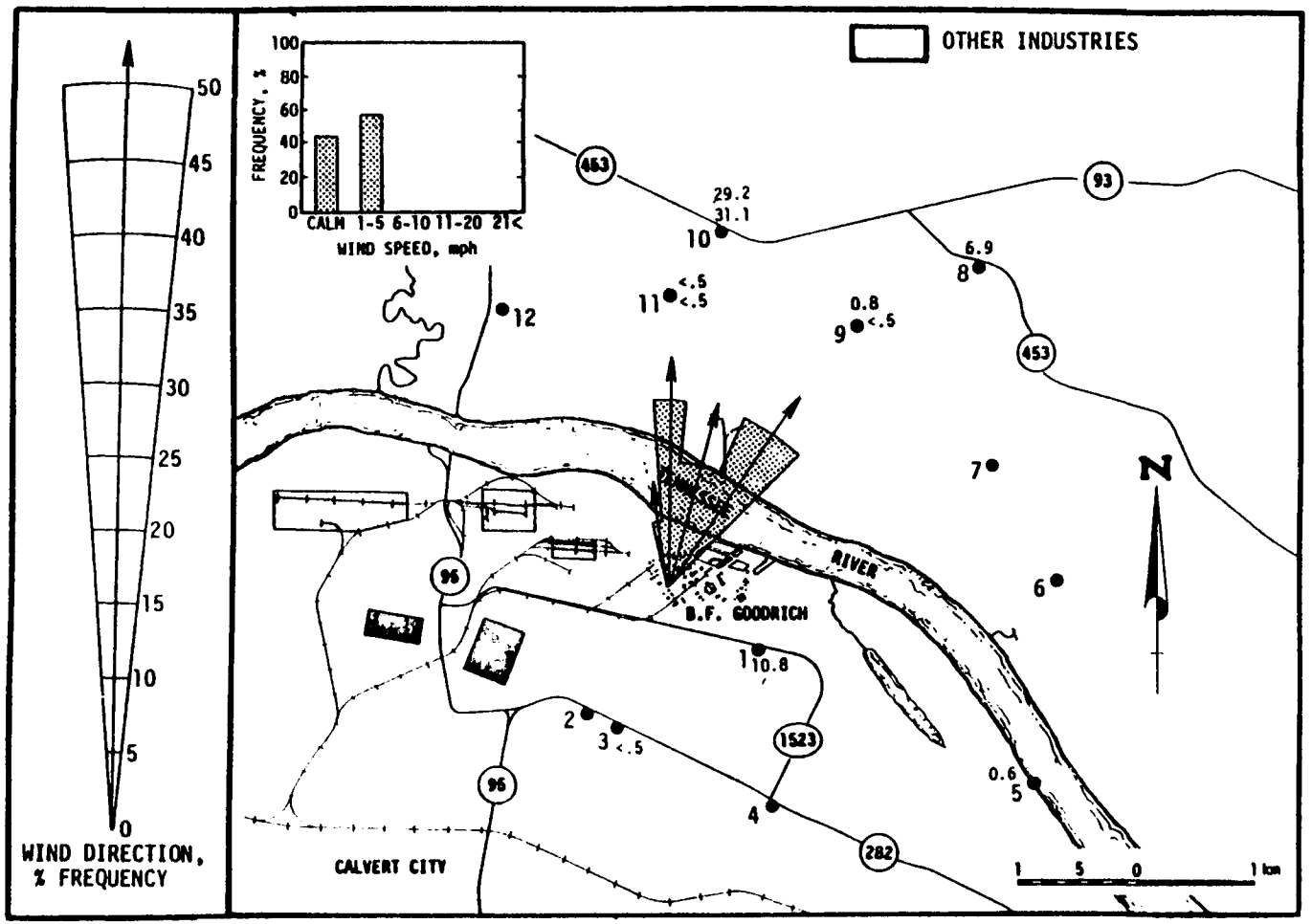


Figure 14. Results of EDC study, Calvert City, Kentucky, 9/12/78. EDC concentrations are given in $\mu g/m^3$.

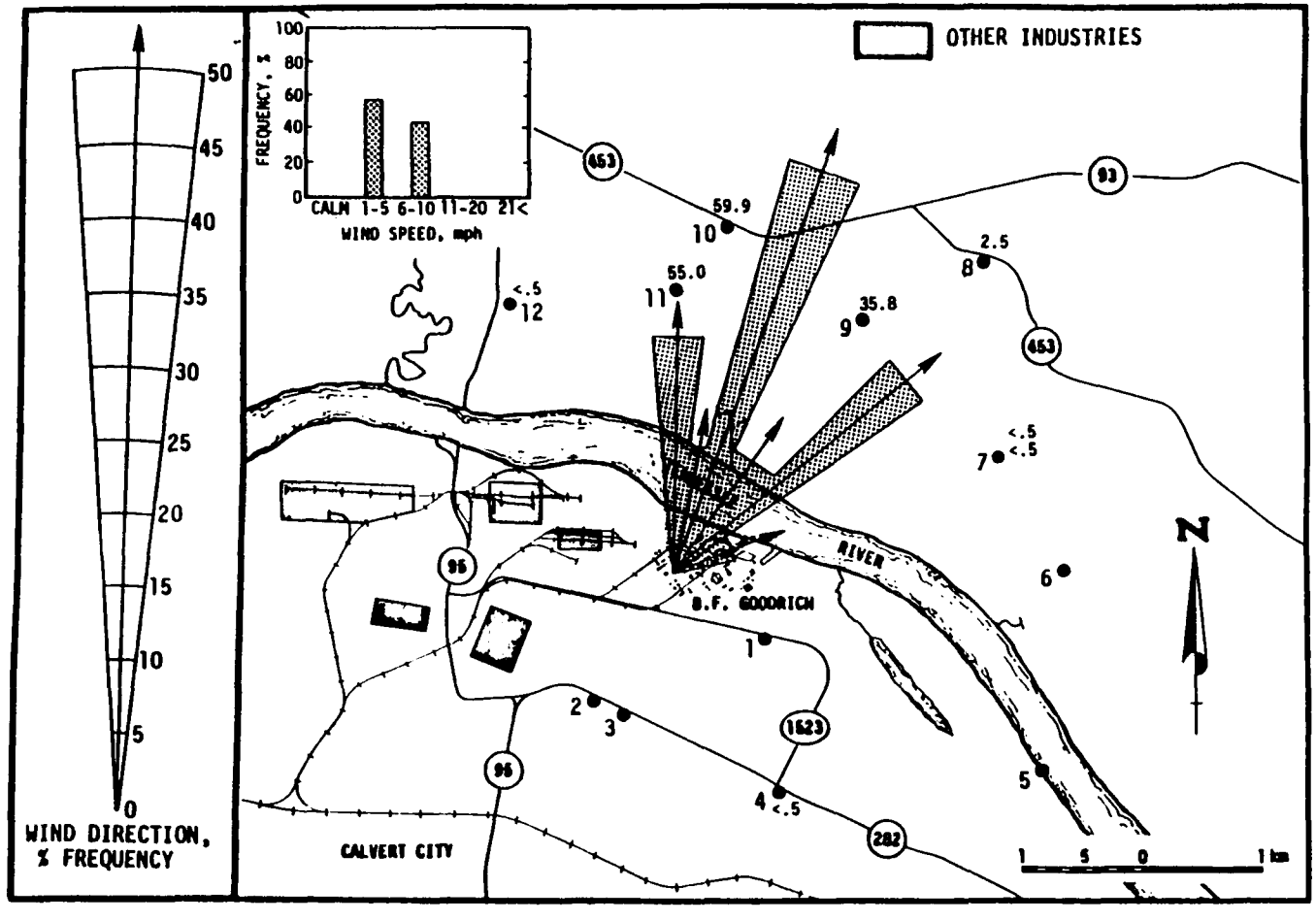


Figure 15. Results of EDC study, Calvert City, Kentucky, 9/13/78. EDC concentrations are given in $\mu g/m^3$.

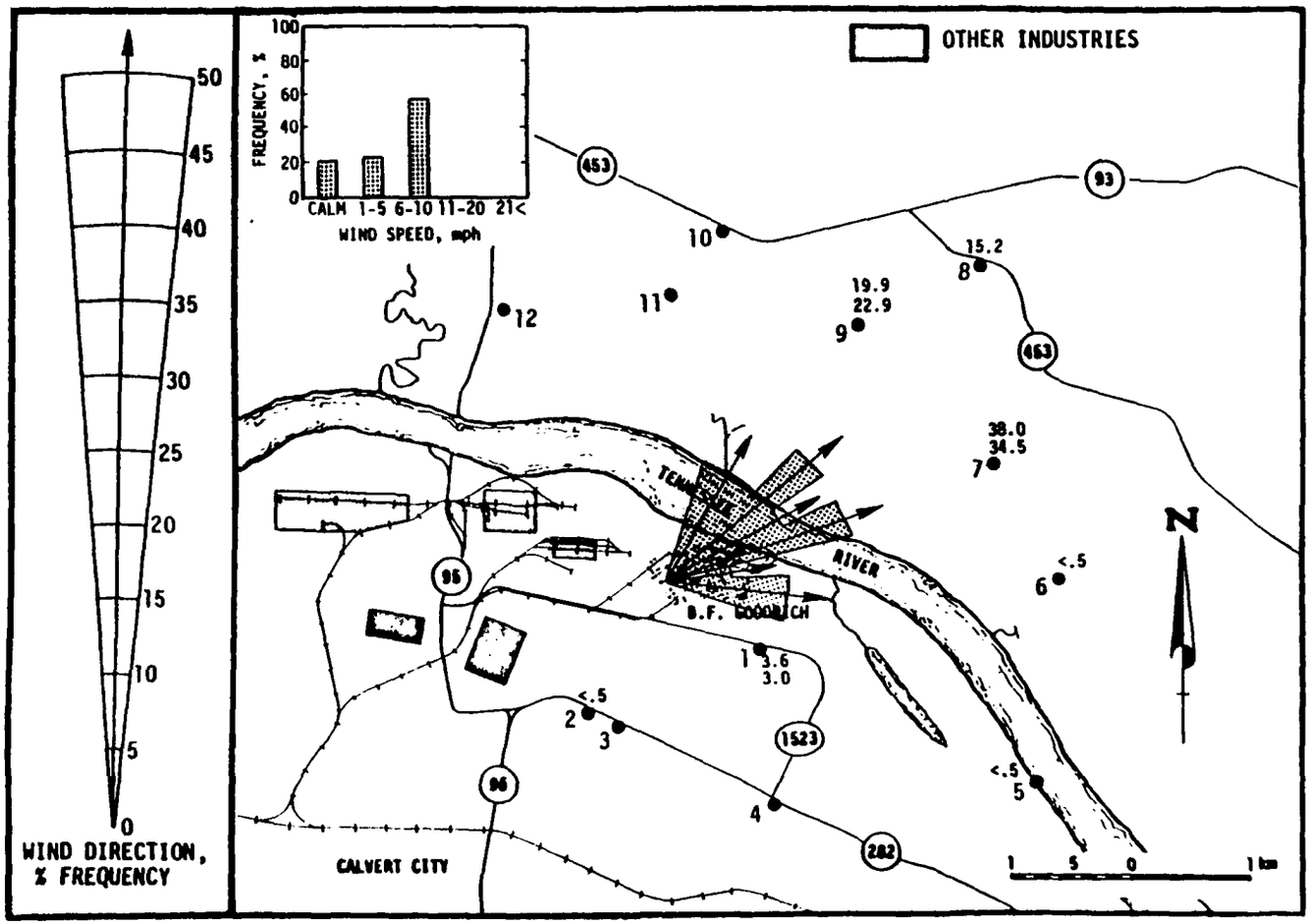


Figure 16. Results of EDC study, Calvert City, Kentucky 9/14/78. EDC concentrations are given in $\mu g/m^3$.

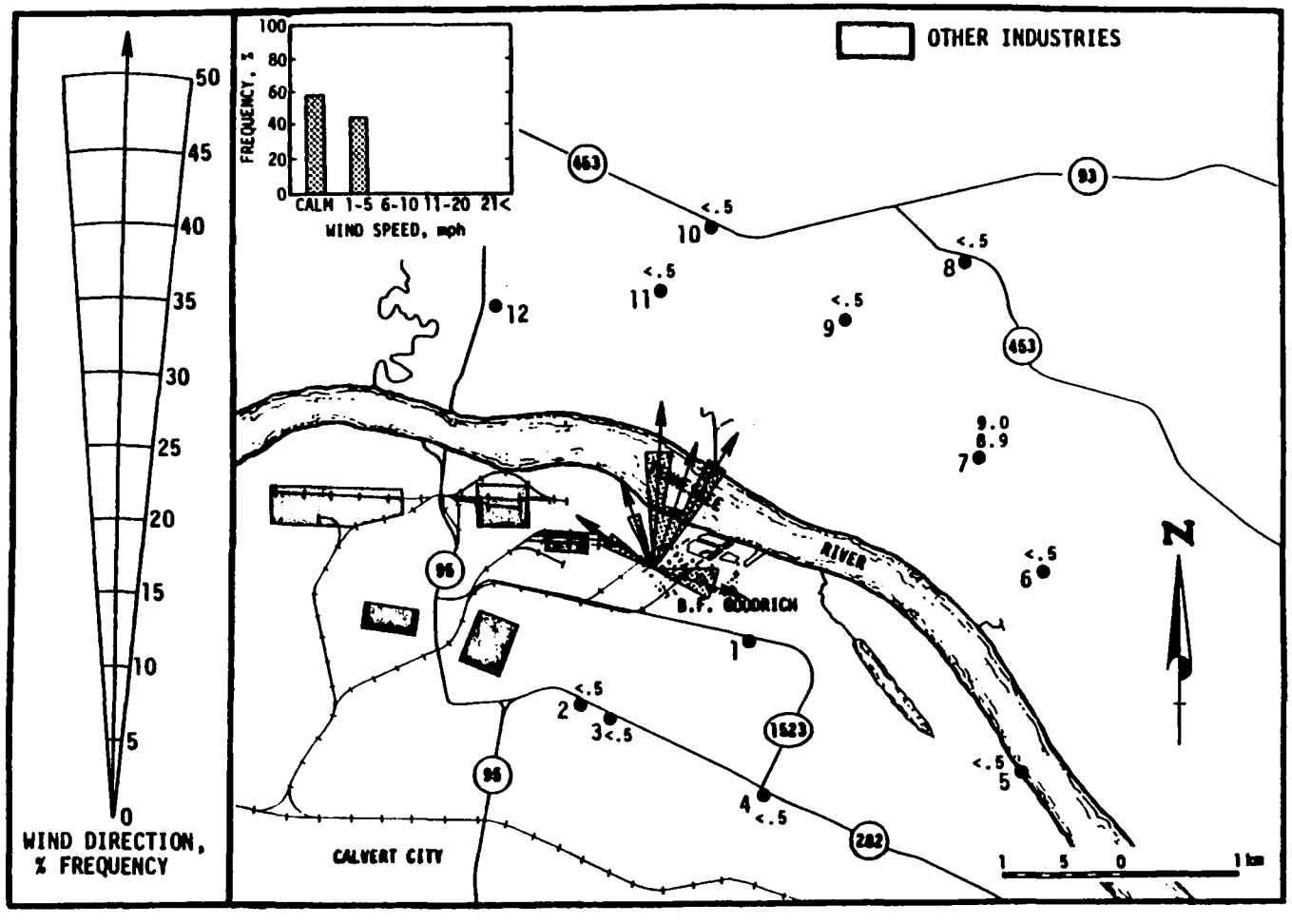


Figure 17. Results of EDC study, Calvert City, Kentucky, 9/15/78. EDC concentrations are given in $\mu g/m^3$.

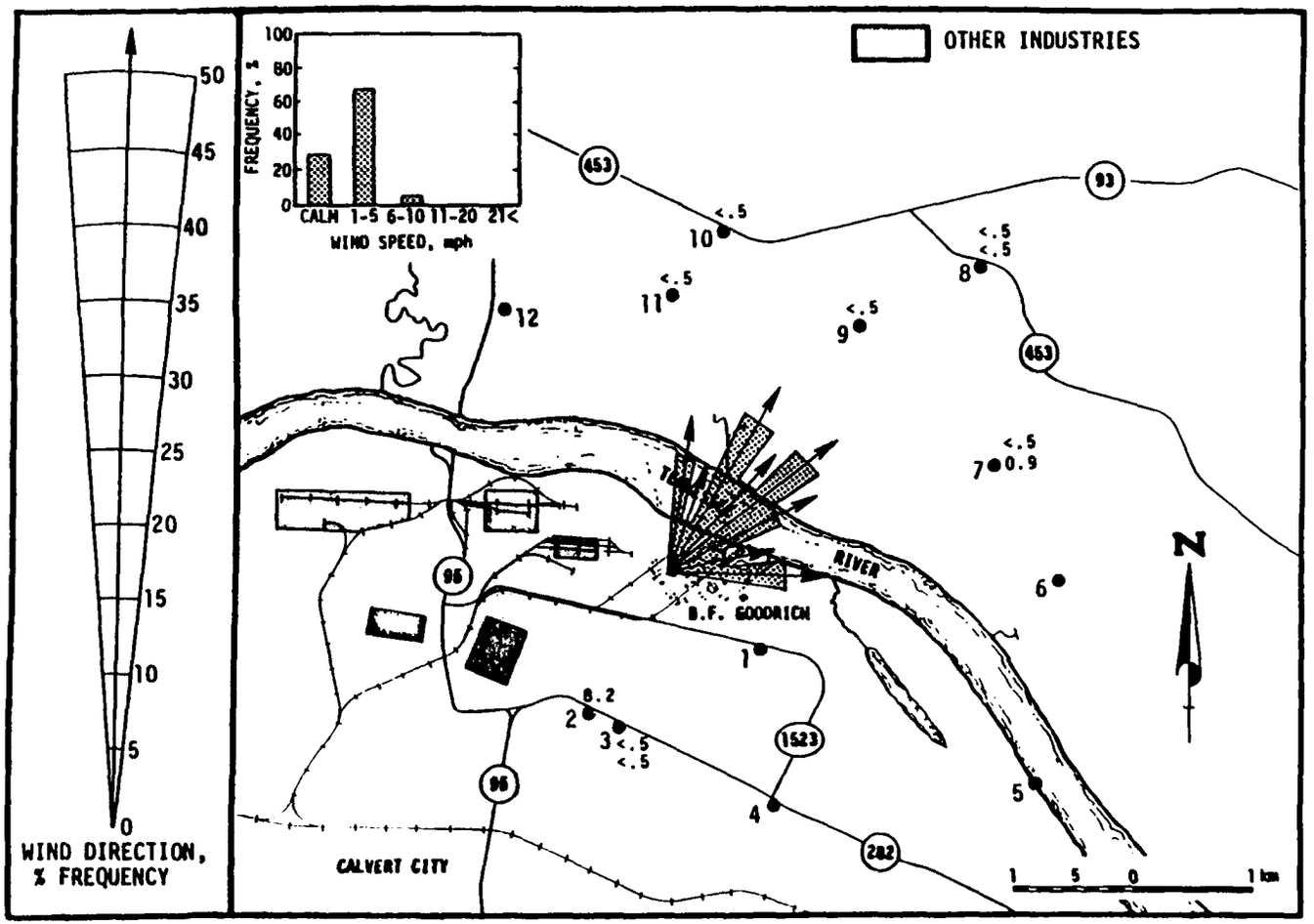


Figure 18. Results of EDC study, Calvert City, Kentucky, 9/16/78. EDC concentrations are given in $\mu g/m^3$.

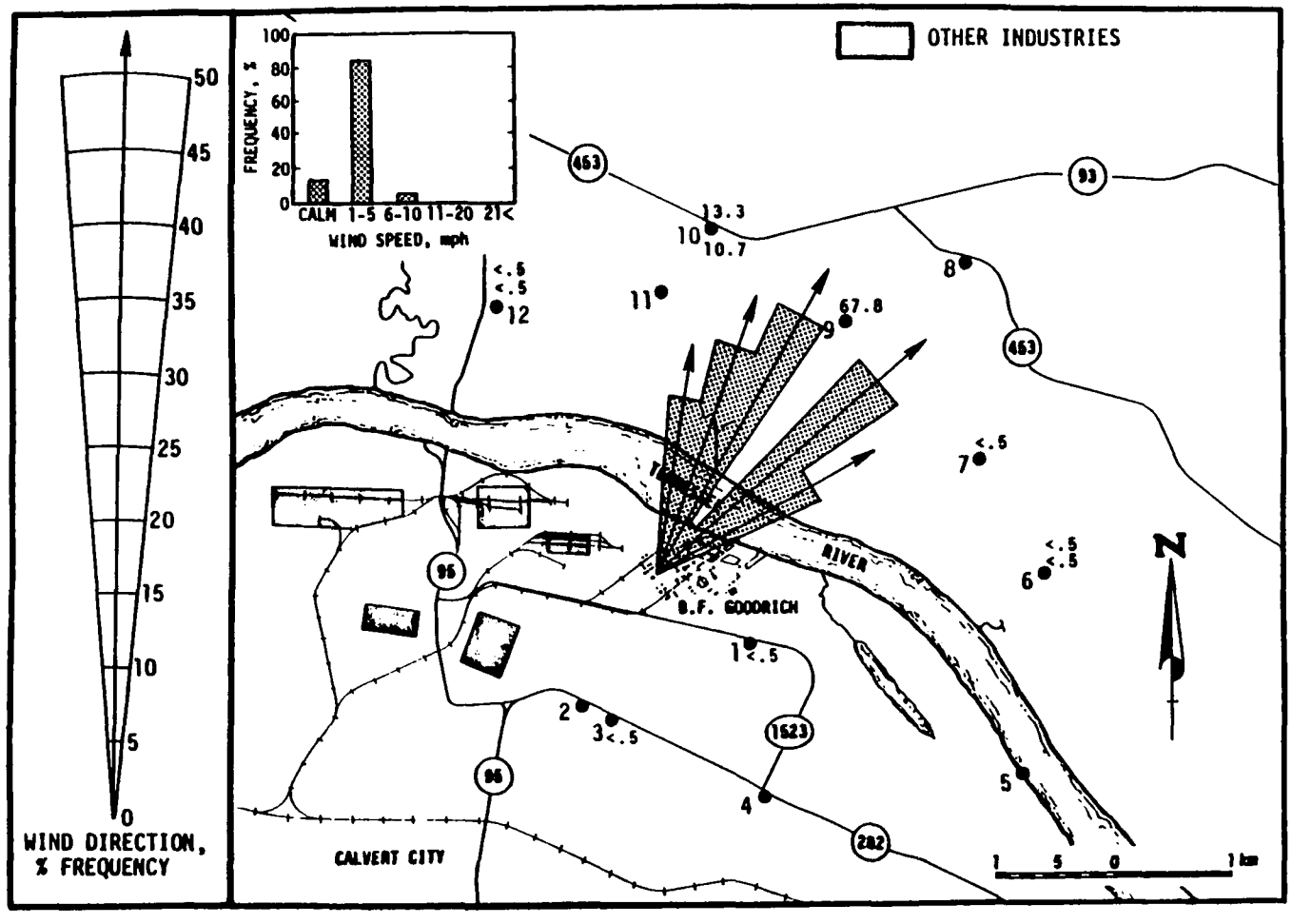


Figure 19. Results of EDC study, Calvert City, Kentucky, 9/17/78. EDC concentrations are given in $\mu g/m^3$.

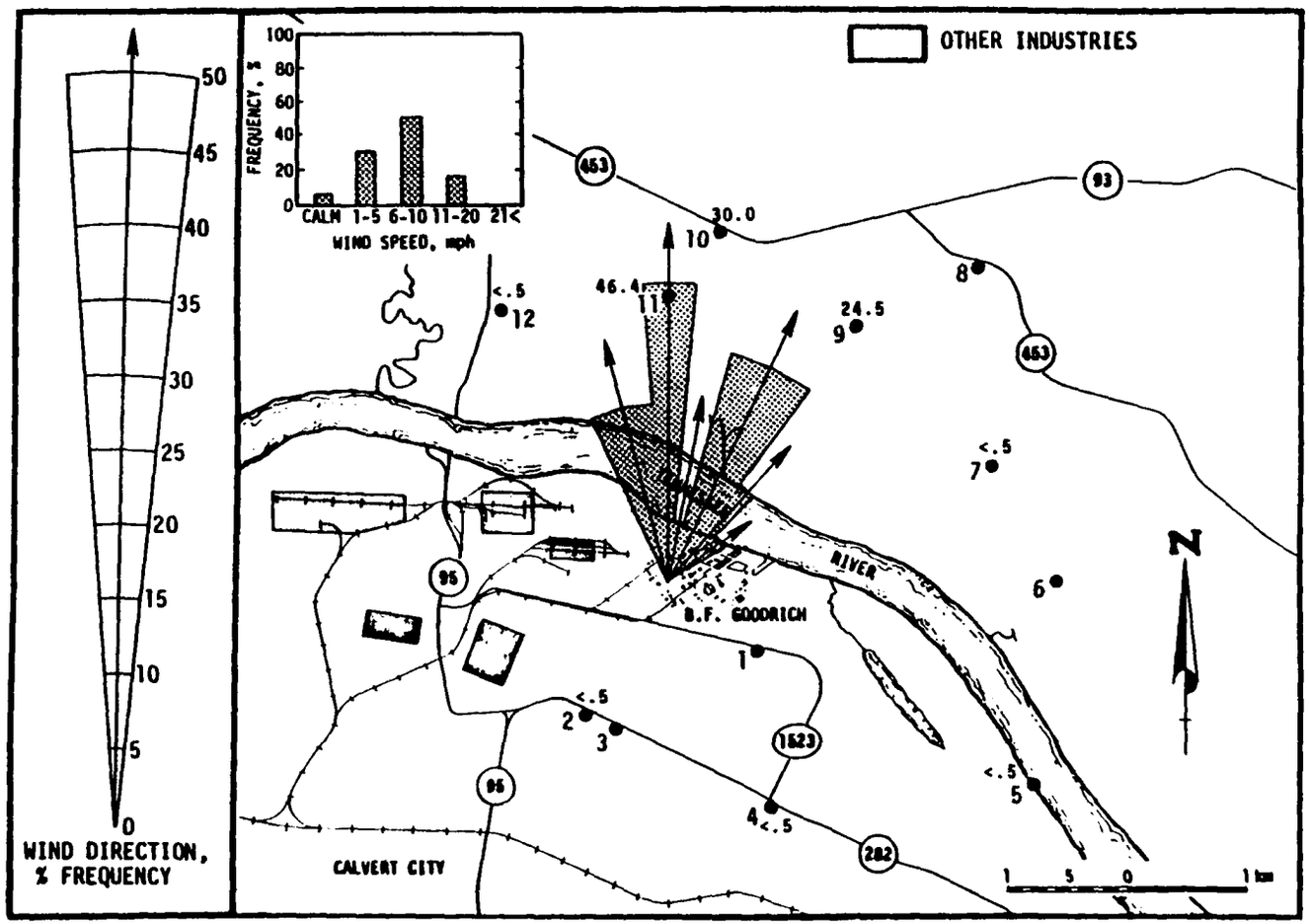


Figure 20. Results of EDC study, Calvert City, Kentucky, 9/18/78. EDC concentrations are given in $\mu g/m^3$.

TABLE 2. DATA SUMMARY OF EDC LEVELS ($\mu g/m^3$)[a] IN LAKE CHARLES, LOUISIANA, STUDY AREA

Date sampled	Site location											
	1	2	3	4	5	6	7	8	9	10	11	12
9-24-78	43.8	107.0		1.8	<0.5				<0.5			<0.5
9-25-78	112.4	167.0		64.9	114.8					<0.5	<0.5	<0.5
9-26-78	32.1	227.7	0.7	61.6	172.5	8.6	1.6				<0.5	<0.5
9-27-78	103.2	152.9	<0.5	7.6	120.1	3.9			<0.5		0.8	2.2
9-28-78	39.5	267.4	<0.5	18.2	88.7	3.2	<0.5		<0.5	0.5		3.2
9-29-78	1.4	651.7	40.0	744.8	383.3	171.6	<0.5			0.9	<0.5	0.8
9-30-78	77.0	193.7		230.7	120.8	89.7			0.9			0.9
10-01-78	277.6	199.9	20.5	87.8	122.0	42.0	1.9	0.6	5.7		51.0	9.7
10-02-78	76.7	6.0		5.1	5.8				10.7	7.1	324.3	19.2
10-03-78	225.2	147.3	52.3	41.0	295.5	33.6	27.3	32.8	30.2	36.2	581.6	497.8
10-04-78	47.6	472.5	60.3	274.8	280.1	96.2	21.6	14.9		14.9	3.1	39.6
10-05-78	269.5	387.4	67.2	182.2	248.4	96.4			28.5	19.9	15.0	24.2

[a] For conversion, 1 $\mu g/m^3$ is equivalent to 0.247 ppb.

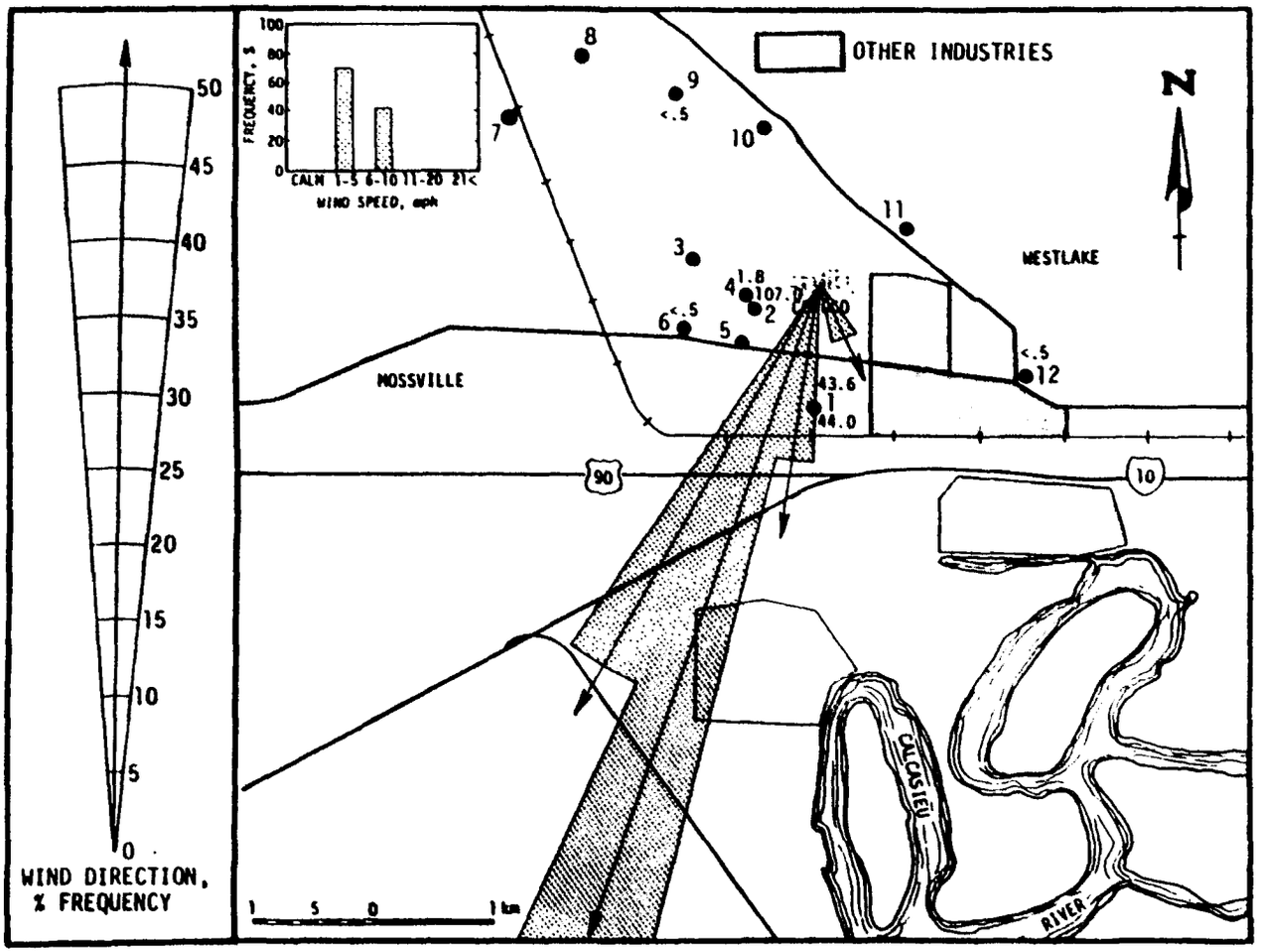


Figure 21. Results of EDC study, Lake Charles, Louisiana, 9/24/78. EDC concentrations are given in $\mu g/m^3$.

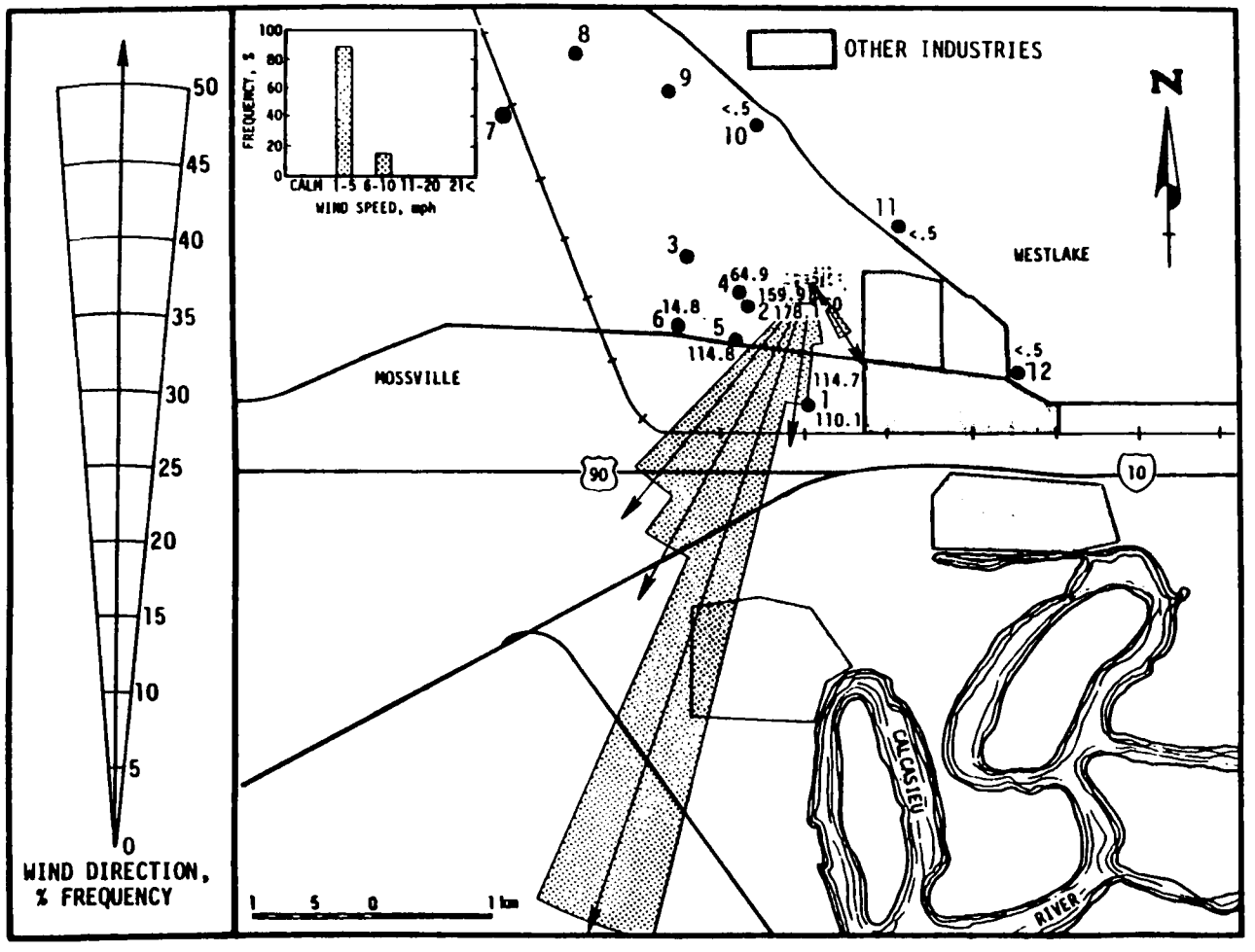


Figure 22. Results of EDC study, Lake Charles, Louisiana, 9/25/78. EDC concentrations are given in $\mu g/m^3$.

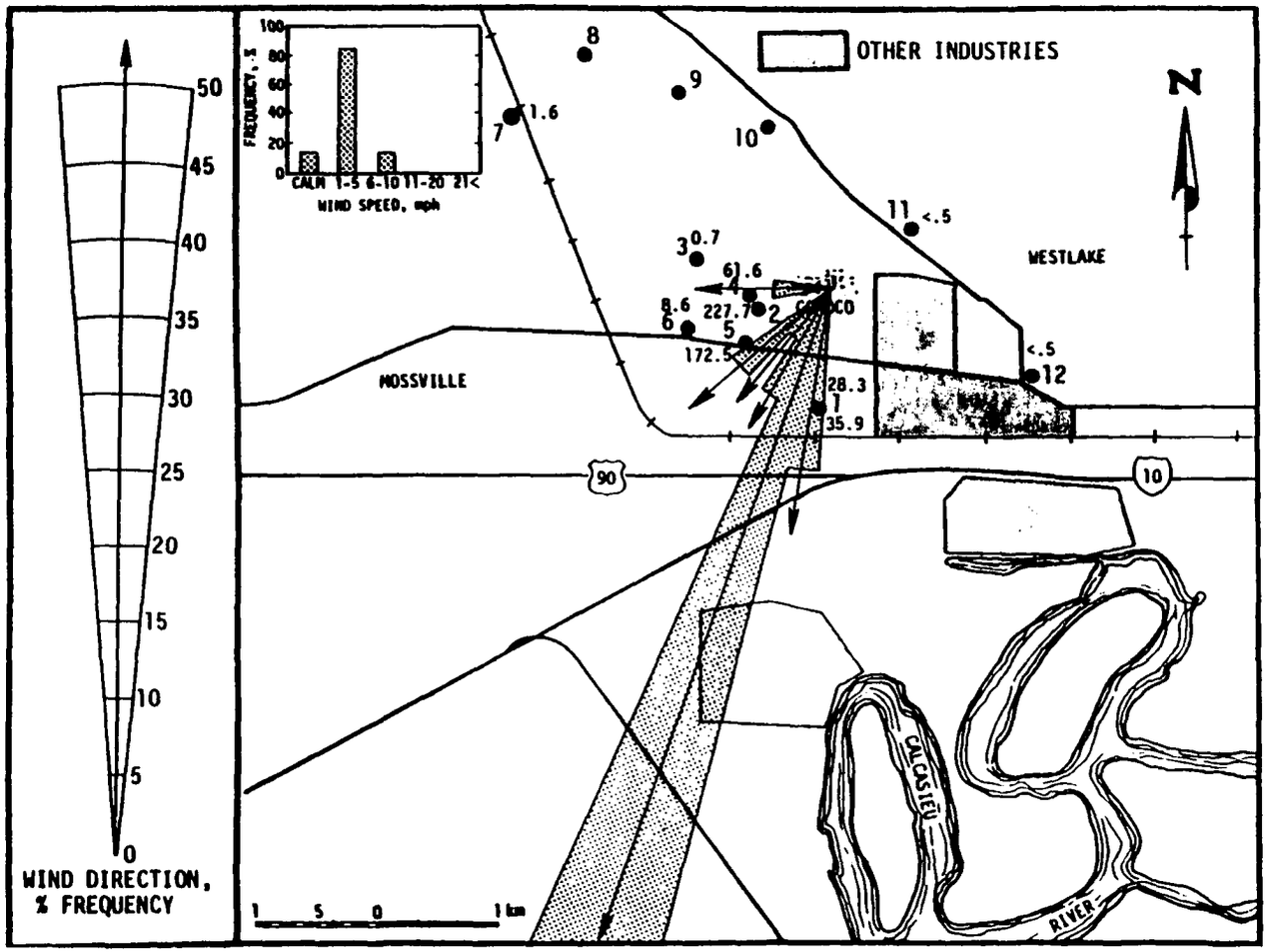


Figure 23. Results of EDC study, Lake Charles, Louisiana, 9/26/78. EDC concentrations are given in $\mu g/m^3$.

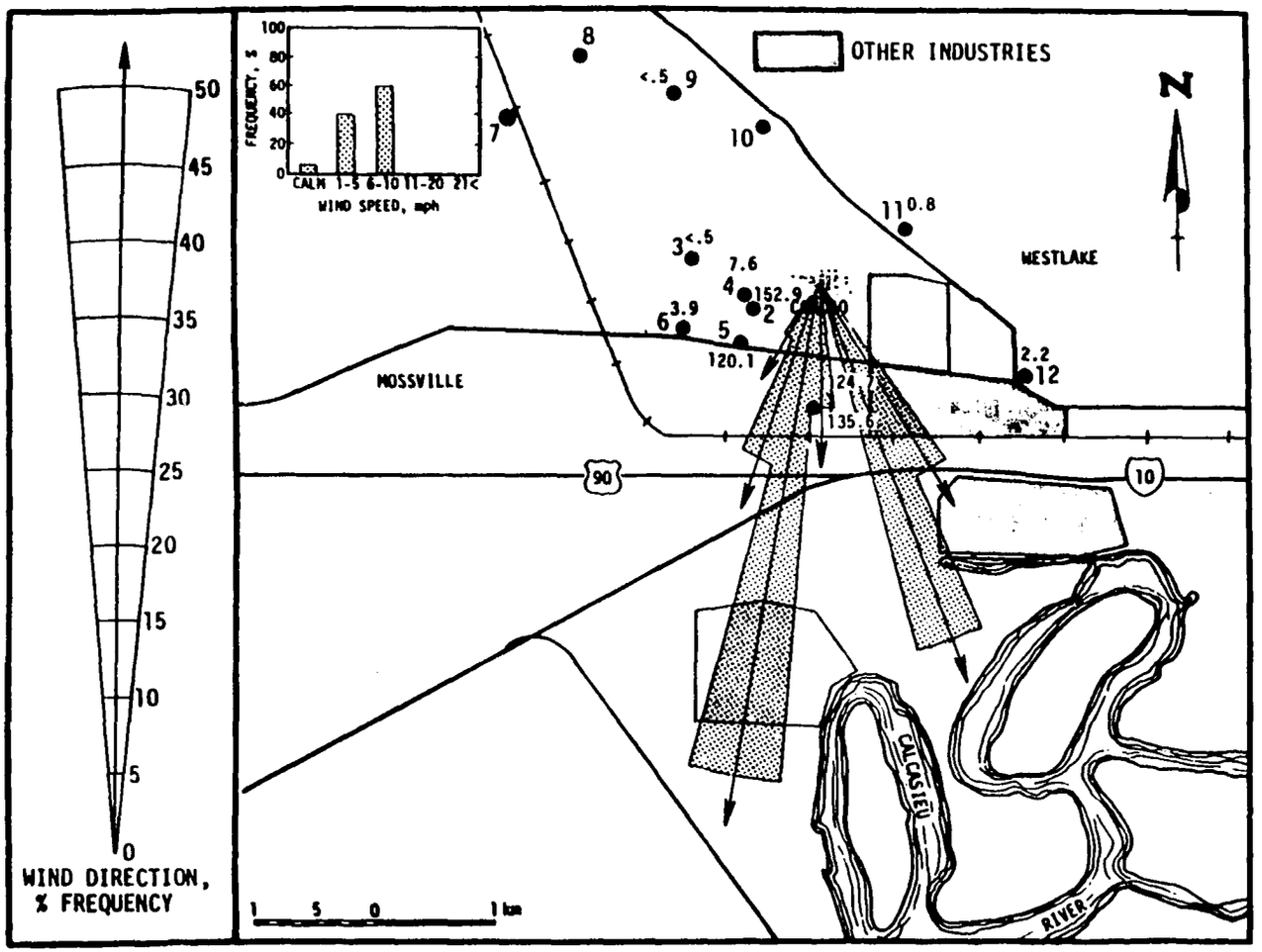


Figure 24. Results of EDC study, Lake Charles, Louisiana, 9/27/78. EDC concentrations are given in $\mu g/m^3$.

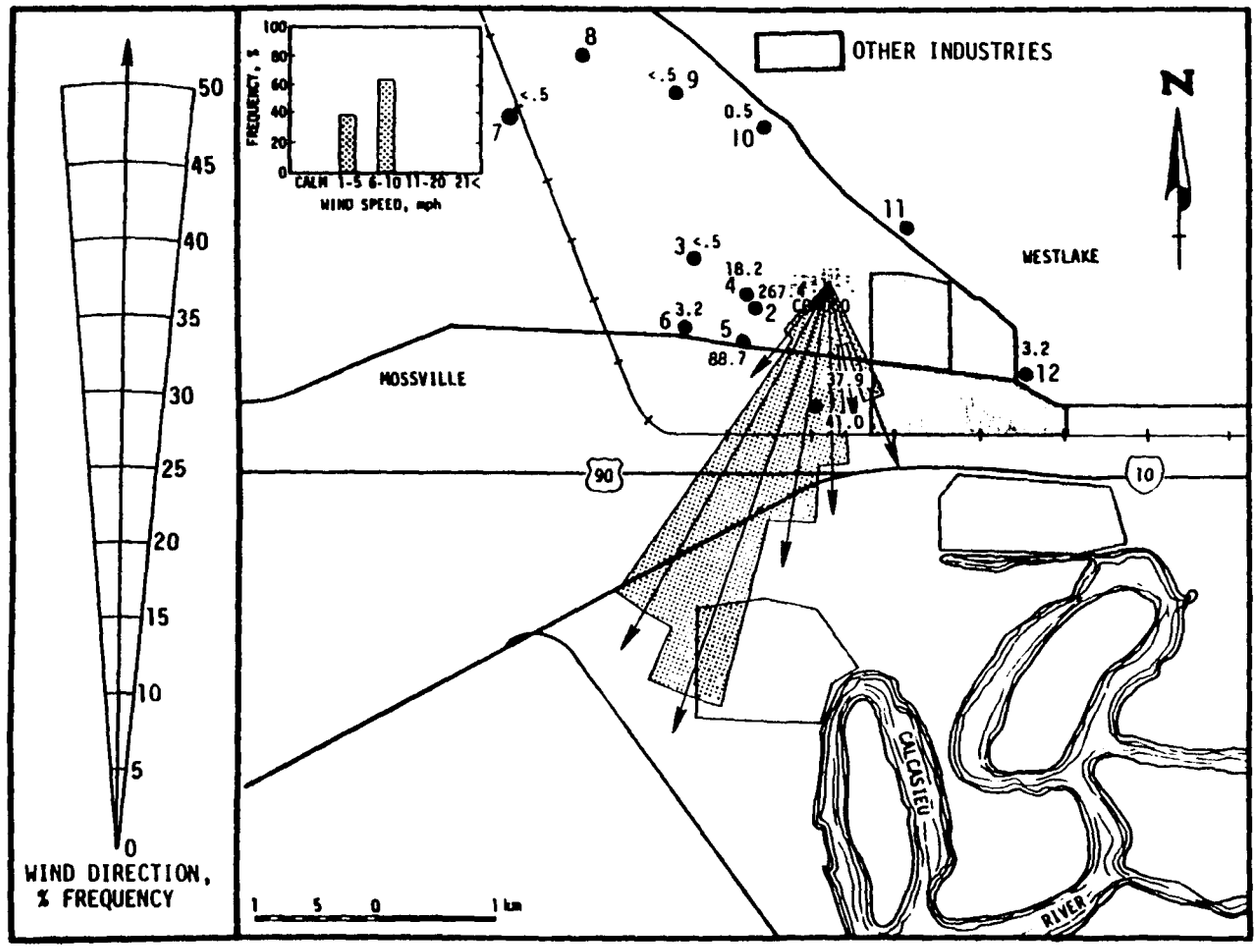


Figure 25. Results of EDC study, Lake Charles, Louisiana, 9/28/78. EDC concentrations are given in $\mu g/m^3$.

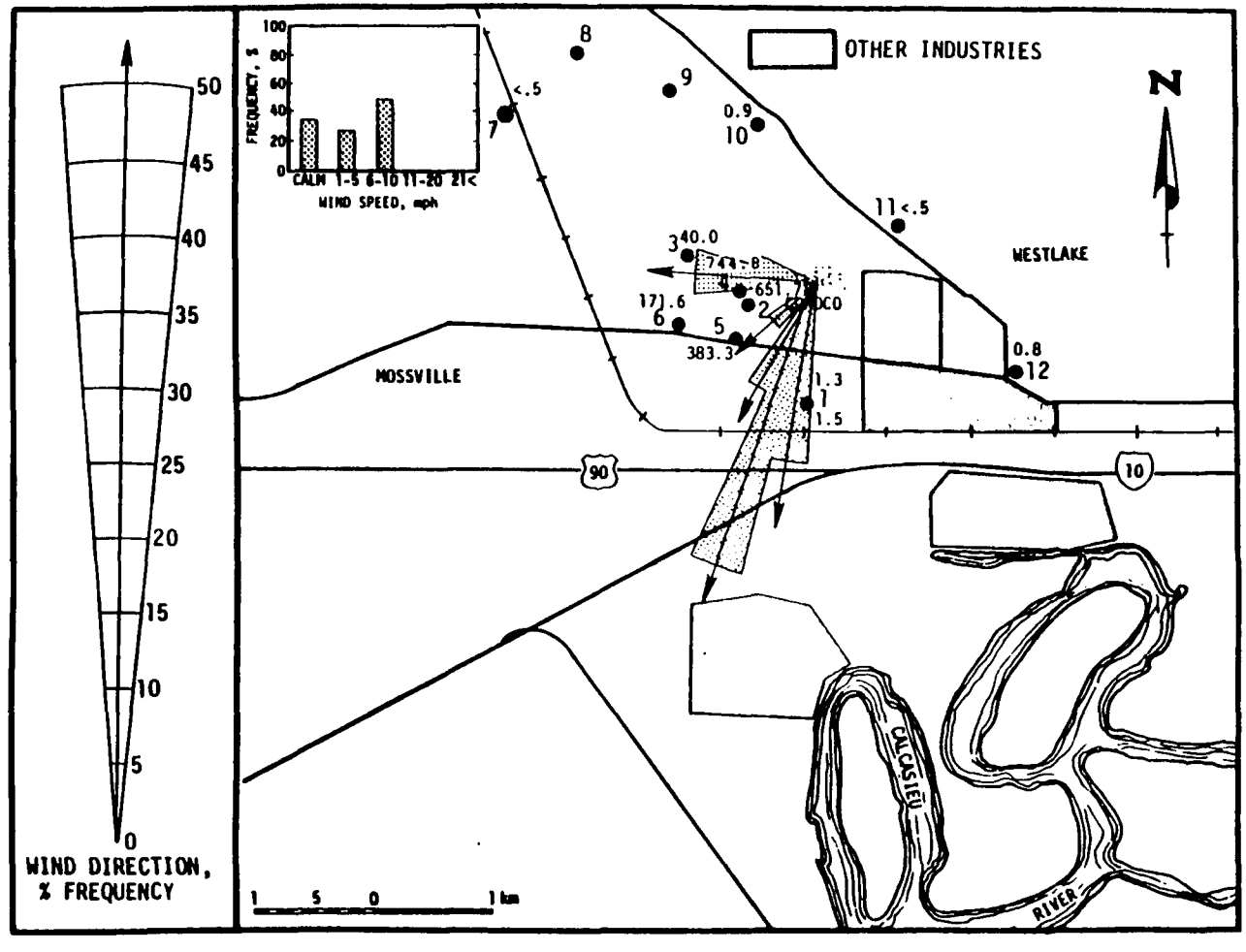


Figure 26. Results of EDC study, Lake Charles, Louisiana, 9/29/78. EDC concentrations are given in $\mu g/m^3$.

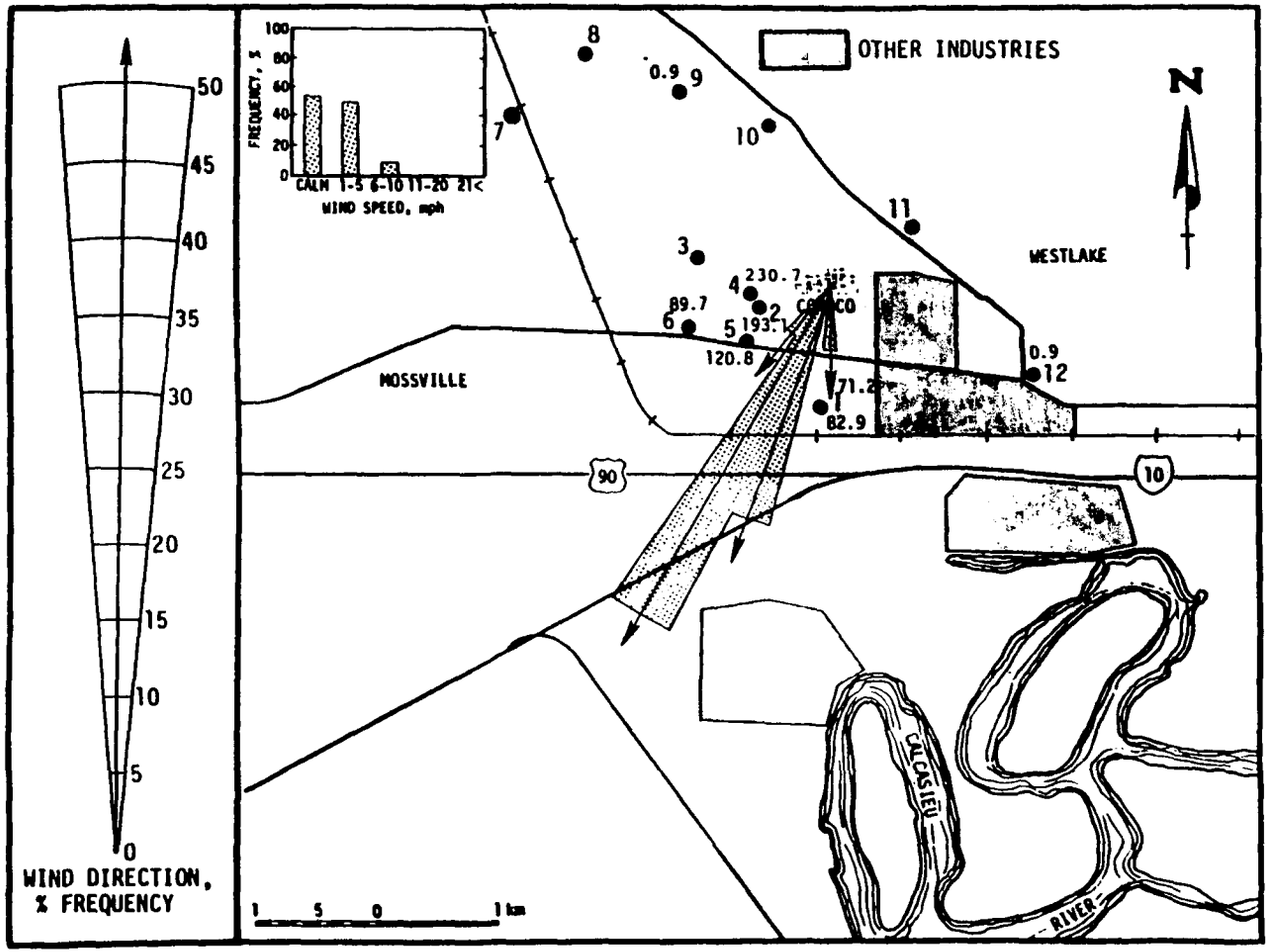


Figure 27. Results of EDC study, Lake Charles, Louisiana, 9/30/78. EDC concentrations are given in $\mu g/m^3$.

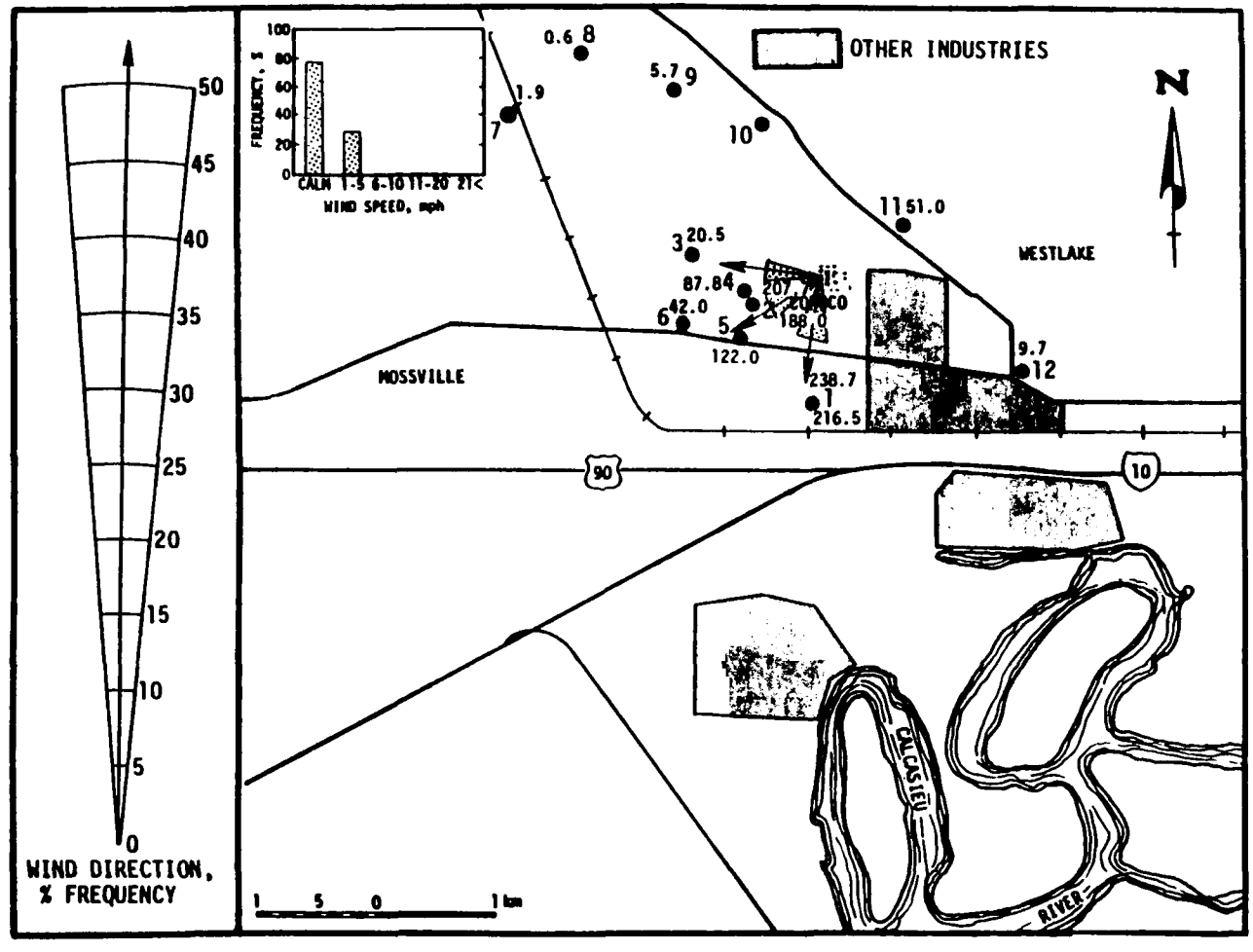


Figure 28. Results of EDC study, Lake Charles, Louisiana, 10/1/78. EDC concentrations are given in $\mu g/m^3$.

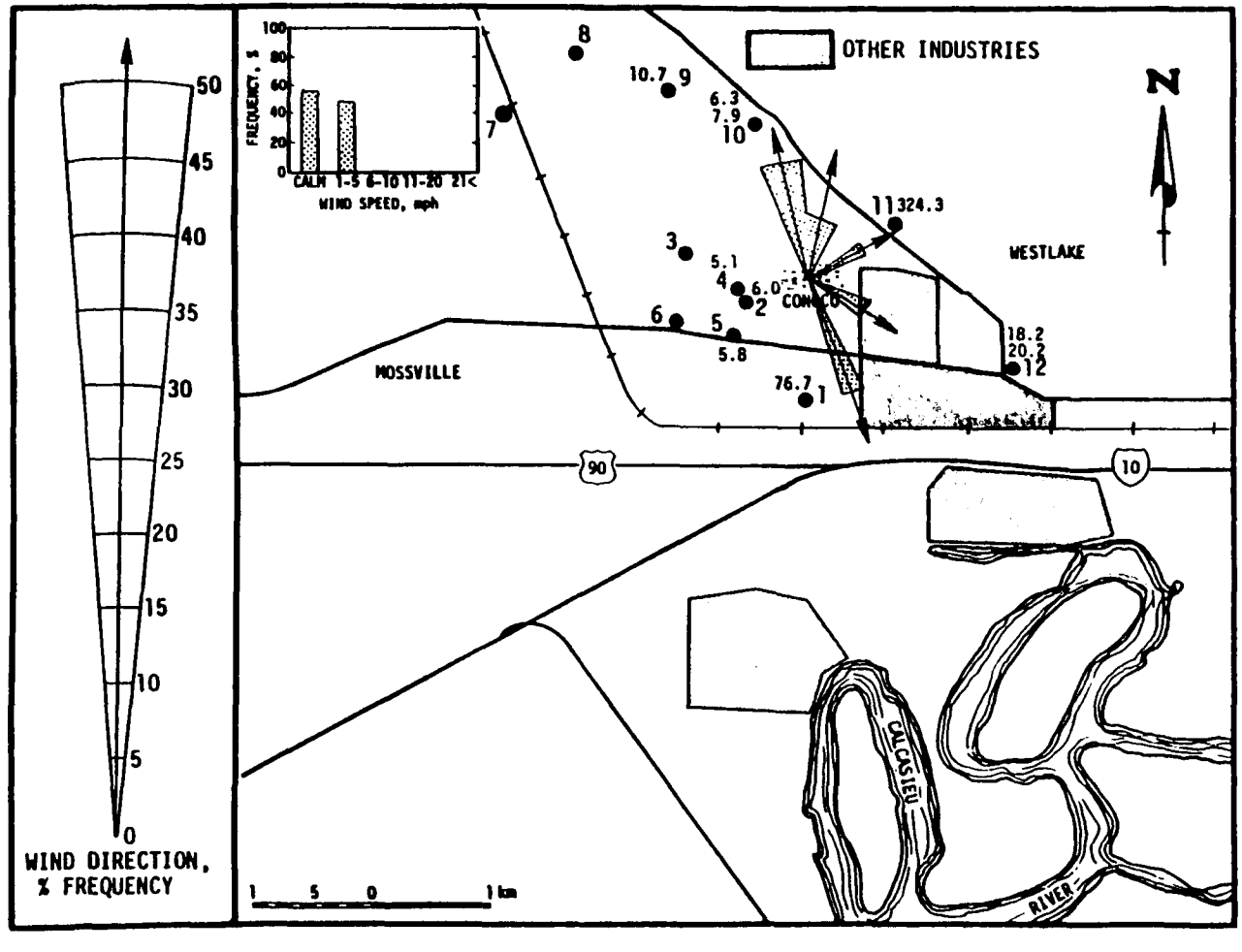


Figure 29. Results of EDC study, Lake Charles, Louisiana, 10/2/78. EDC concentrations are given in $\mu g/m^3$.

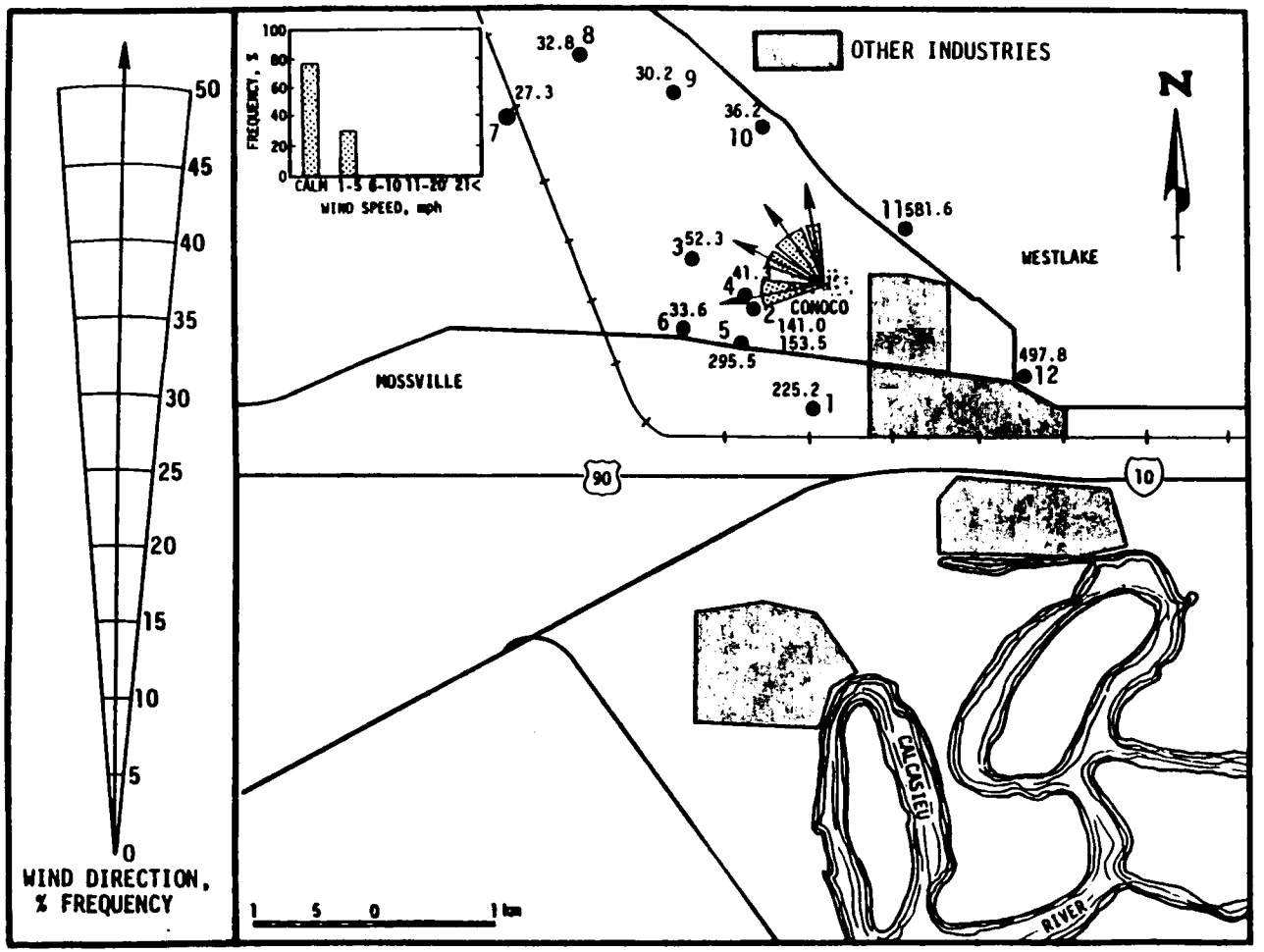


Figure 30. Results of EDC study, Lake Charles, Louisiana, 10/3/78. EDC concentrations are given in $\mu g/m^3$.

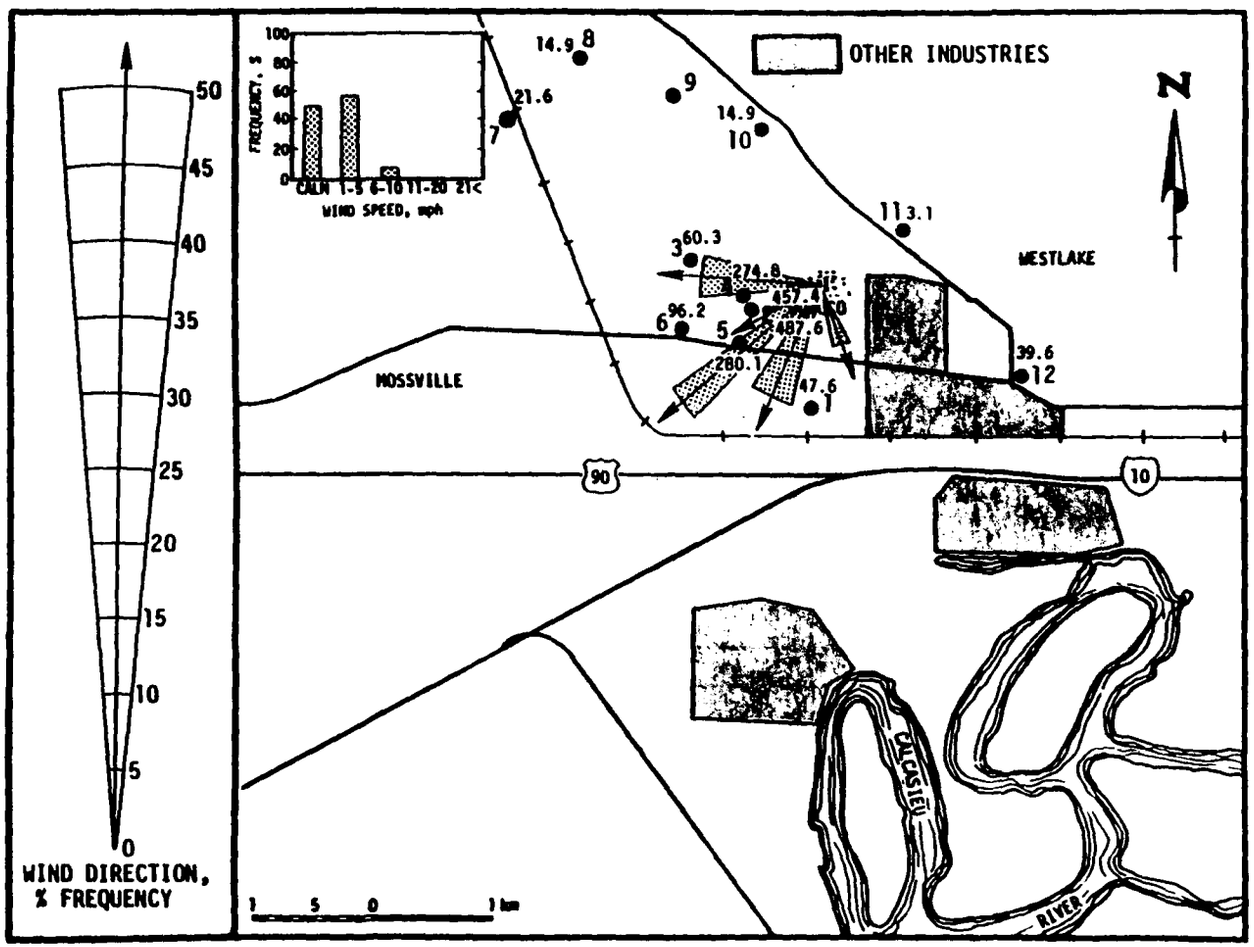


Figure 31. Results of EDC study, Lake Charles, Louisiana, 10/4/78. EDC concentrations are given in $\mu g/m^3$.

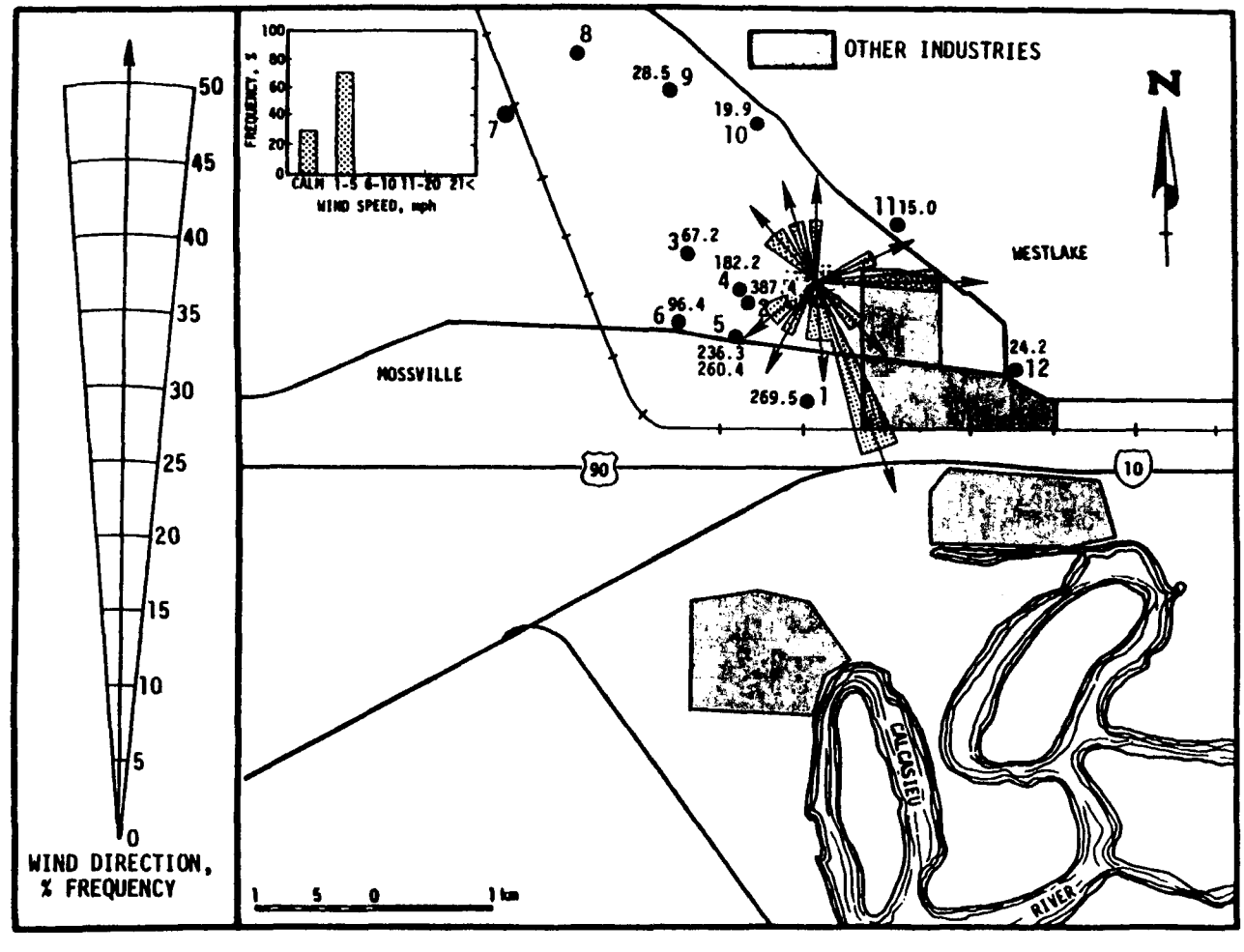


Figure 32. Results of EDC study, Lake Charles, Louisiana, 10/5/78. EDC concentrations are given in $\mu g/m^3$.

TABLE 7. ANALYSIS OF COLLOCATED SAMPLES FROM NEW ORLEANS, LOUISIANA, STUDY AREA

Date sampled	Site no.	EDC concentration, $\mu g/m^3$		$\bar{x}$[a]	s[b]
		Sample A	Sample B		
10-10-78	8	11.1	14.5	12.8	2.4
10-11-78	2	0.6	0.8	0.7	0.14
10-11-78	8	8.9	8.4	8.65	0.35
10-12-78	2	3.2	2.6	2.9	0.42
10-12-78	7	25.8	22.8	24.3	2.12
10-12-78	9	1.2	1.8	1.5	0.21
10-13-78	9	7.4	6.0	6.7	0.99
10-14-78	4	0.6	17.4	17.65	0.35
10-14-78	12	1.2	1.1	1.15	0.07
10-15-78	4	37.6	38.0	37.8	0.28
10-15-78	8	14.2	13.8	14.0	0.28
10-16-78	4	8.5	10.3	9.4	1.27
10-16-78	8	9.1	8.1	8.6	0.71
10-16-78	11	3.2	3.2	3.2	0
10-17-78	4	146.9	195.8	171.35	34.58
10-18-78	8	28.9	29.3	29.1	0.28
10-19-78	4	32.2	30.1	30.65	1.48
10-19-78	7	9.8	9.6	9.7	0.14
10-19-78	9	6.7	7.5	7.1	0.57

[a] $\bar{x}$ = mean.

[b] s = standard deviation.

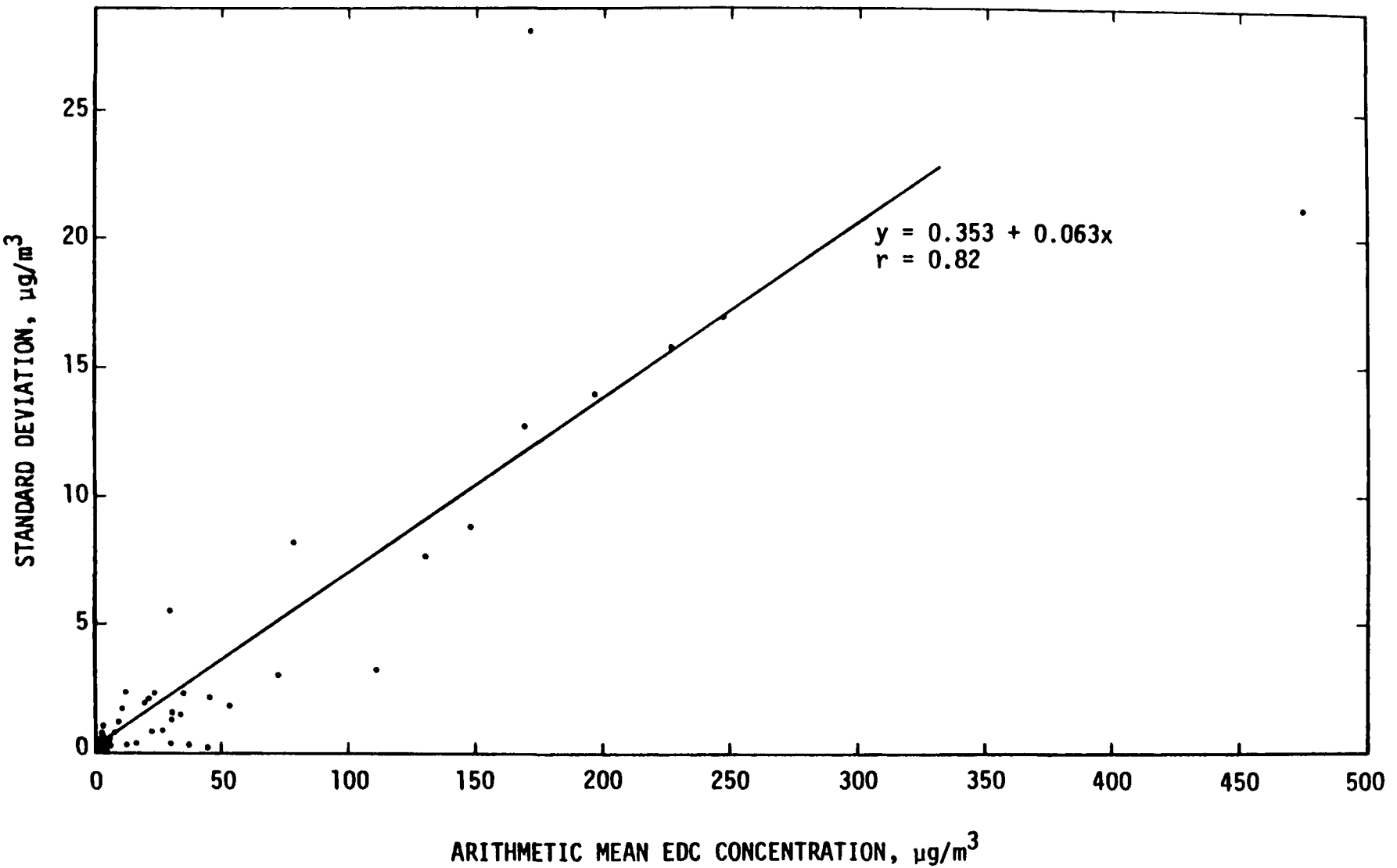


Figure 44. Standard deviation and arithmetic mean concentration of EDC for collocated samples.

TABLE 8. DUPLICATE ANALYSIS OF DESORBED SAMPLES FROM CALVERT CITY, KENTUCKY, STUDY AREA

Date sampled	Site no.	EDC, $\mu g/m^3$ Run 1	Run 2	$\bar{x}$[a]	s[b]
9-09-78	10	ND[c]			
9-10-78	1	38.4	37.0	37.7	0.99
9-12-78	10	28.3	30.2	29.3	1.34
9-13-78	11	55.8	54.3	55.1	1.06
9-14-78	7	39.0	37.1	38.05	1.34
9-15-78	7	9.0	8.6	8.8	0.28
9-16-78	9	ND	ND		
9-16-78	2	8.2	8.2	8.2	0
9-17-78	10	13.0	13.6	13.3	0.42

[a] $\bar{x}$ = mean.

[b] s = standard deviation.

[c] ND = not detected.

TABLE 9. DUPLICATE ANALYSIS OF DESORBED SAMPLES FROM LAKE CHARLES, LOUISIANA, STUDY AREA

Date sampled	Site no.	EDC, $\mu g/m^3$ Run 1	Run 2	$\bar{x}$[a]	s[b]
9-24-78	1	43.6	45.4	44.5	1.3
9-25-78	4	66.4	63.1	64.8	2.33
9-27-78	5	121.6	119.3	120.5	1.62
9-28-78	1	37.0	38.8	37.9	1.3
9-29-78	6	164.8	178.4	171.6	9.6
10-3-78	12	503.3	493.4	498.4	7.0
10-4-78	2	504.2	471.9	488.1	22.9
10-5-78	4	185.2	179.5	182.4	4.0
10-5-78	10	19.7	19.9	19.8	0.14

[a] $\bar{x}$ = mean.

[b] s = standard deviation.

TABLE 10. DUPLICATE ANALYSIS OF DESORBED SAMPLES FROM NEW ORLEANS, LOUISIANA, STUDY AREA

Date sampled	Site no.	EDC, μg Run 1	EDC, μg Run 2	$\bar{x}$[a]	s[b]
10-10-78	4	ND[c]	ND		
10-10-78	12	6.5	6.1	6.3	0.28
10-12-78	4	7.6	7.2	7.4	0.28
10-12-78	9	1.5	2.2	1.85	0.49
10-13-78	9	6.0	6.1	6.05	0.07
10-14-78	12	1.1	0.7	0.9	0.28
10-15-78	11	4.0	4.7	4.35	0.49
10-16-78	8	8.1	8.0	8.05	0.07
10-17-78	6	ND	ND		
10-17-78	7	5.8	4.9	5.35	0.63
10-18-78	8	29.2	28.6	28.9	0.42
10-19-78	10	4.2	3.5	3.85	0.49

[a] $\bar{x}$ = mean.

[b] s = standard deviation.

[c] ND = not detected.

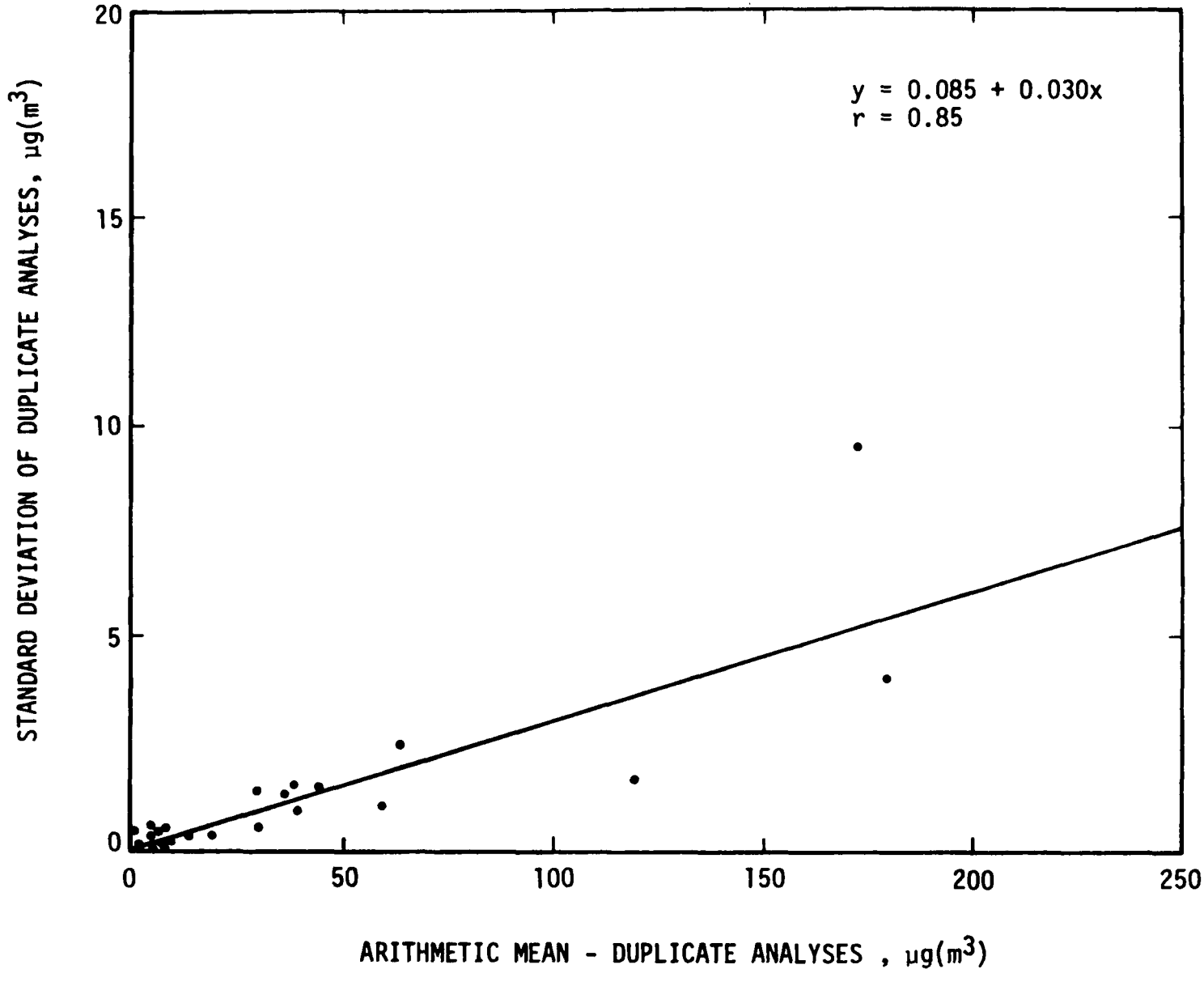


Figure 45. Standard deviation and mean concentration of EDC for duplicate analyses of selected samples.

stock solution of EDC, and submit it to the analyst. The data from this quality control check on the working standard solutions are presented in Table 11.

To develop a relationship between the amount of EDC in the standard solution and that found by the PEDCo analyst, PEDCo analyzed these results by regression analysis. The precision of the amount of EDC added was assumed to be substantially better than the precision of the amount determined by the GC/MS analysis.

The relationship between the quantity of EDC determined by the GC/MS analysis and that in the prepared standard solution can be expressed as:

$$y = 0.12 + 0.97x$$

where y = ng/µl EDC determined by the GC/MS

x = ng/µl EDC in the standard solution

Based upon this relationship, the recovery of EDC in the standard solution by the GC/MS procedure varies from 109 percent at 1 ng/µl to 98 percent at 12 ng/µl.

EVALUATION OF QUALITY CONTROL CHECK SAMPLES

Two sets of quality control check samples, with known levels, were prepared by EMSL at EPA and by the PEDCo Laboratory. Anaylsis of these samples was performed along with the routine analysis of samples collected in the field.

Check Samples Prepared by EPA

The EPA provided 48 samples having known amounts of EDC ranging from 1.18 to 8.26 µg. These samples were prepared by using an EDC permeation tube, which was gravimetrically calibrated, and a dilution system. Each charcoal tube was charged with EDC by sampling at a known flow rate of about 65 cm^3/min from the dilution system. By varying the sampling time for each tube produced, the analyst was able to calculate the content of EDC adsorbed on the tube.

Table 12 presents the results of the PEDCo analysis (by GC/MS) of the 48 EPA check samples. The quantity of EDC found by PEDCo was significantly less than that reported by EPA. In 9 EPA samples reported to contain 1.18 µg EDC, for example, PEDCo found an average of 0.81 µg, for a recovery rate of only 69 percent. In 17 samples reported to contain 5.90 µg EDC, PEDCo found an average of 4.64 µg, for a recovery rate of 79 percent.

Table 12 also shows the standard deviation for the replicate analysis for each of the levels of EDC added by EPA to its check samples. It is apparent that the standard deviation increases as the level of EDC is increased. Over the range of EDC levels added by EPA, the relative standard deviation varies from 20 to 25 percent.

TABLE 11. ANALYSES OF UNKNOWN EXTERNAL STANDARD SOLUTIONS OF EDC

Date analyzed	EDC concentration, ng/μℓ Added	Found[a]
10-19-78	1.25	1.50
10-20-78	1.43	1.44
10-20-78	5.04	5.03
10-20-78	3.67	4.40
10-23-78	6.25	5.71
10-23-78	6.25	5.83
10-24-78	1.58	1.69
10-24-78	1.58	1.68
10-24-78	6.25	6.22
10-26-78	3.13	3.26
10-31-78	2.60	2.64
11-10-78	0.78	0.89
11-13-78	0.65	0.50
11-13-78	12.43	12.33
11-14-78	6.28	6.78
11-15-78	3.26	3.21
11-16-78	4.96	4.67
11-17-78	2.71	2.67
11-28-78	6.94	6.65
11-29-78	3.49	3.53
11-30-78	3.14	3.10

[a]An average 101.3 percent $\pm$ σ 9.6 was recovered.

TABLE 12. EDC (μg) FOUND IN EPA QUALITY ASSURANCE SAMPLES

EDC added by EPA (μg)									
1.18		2.36		3.54		5.90		8.26	
Sample	EDC found[a]	Sample	EDC found[b]	Sample	EDC found[c]	Sample	EDC found[d]	Sample	EDC found[e]
C	0.53	D	1.37	A	2.62	E	5.45	B	4.47
G	0.66	H	1.27			L	4.67	F	6.75
J	0.89	I	1.50			M	4.84	K	6.07
22	0.89	N	1.13			P	3.56	O	7.49
25	0.64	R	2.07			V	7.47	Q	0.45[f]
26	1.05	T	1.31			W	3.89	U	6.64
27	0.95	X	1.68			11	4.14	Y	4.81
31	0.99	10	0.94			12	2.72		
33	0.65	13	1.76			16	1.27[f]		
		14	1.11			18	6.83		
		15	2.14			19	4.90		
		17	1.95			21	2.56		
		20	1.84			23	4.86		
						24	4.85		
						28	4.13		
						29	4.70		
						30	4.51		
						32	4.79		

[a]Mean = 0.81 μg, standard deviation = 0.19 μg, recovery = 69.00 percent, relative standard deviation = 23.00 percent.
[b]Mean = 1.54 μg, standard deviation = 0.39 μg, recovery = 65.00 percent, relative standard deviation = 25.00 percent.
[c]Mean = 2.62 μg, standard deviation = 0 μg, recovery = 74.00 percent, relative standard deviation = 0 percent.
[d]Mean = 4.64 μg, standard deviation = 1.22 μg, recovery = 79.00 percent, relative standard deviation = 26.00 percent.
[e]Mean = 6.04 μg, standard deviation = 1.18 μg, recovery = 73.00 percent, relative standard deviation = 20.00 percent.
[f]Value was deleted from analysis due to gross error.

Check Samples Prepared by PEDCo

PEDCo prepared a set of 16 quality assurance samples, 8 having an EDC level of 4.51 μg, and 8 at a level of 9.02 μg. The samples were prepared by using a standard gas mixture of EDC (contained under pressure in a cylinder), and a dilution system. Figure 46 is a diagram of this system, with which the two series of check samples were prepared simultaneously. Critical flow orifices were selected to provide a sampling rate of 65 $\pm$ 1 cm^3/min. An excess flow of the EDC gas mixture was established through the eight-port glass sampling manifold. Eight tubes were connected to the critical flow orifices. Sampling was conducted for 15.0 min to produce the low-level check samples, and 30.0 min to produce the high-level ones. The amount of EDC adsorbed on each tube was then calculated from the concentration of EDC, as assayed by the supplier, and derived from the sampling rate and time period.

Table 13 presents the results of PEDCo's analysis (by GC/MS) of these quality assurance samples. For the eight samples prepared at the level of 4.51 μg, the average amount of EDC found was 4.45, or a recovery rate of 99 percent. For the eight samples prepared at the level of 9.02 μg, the average amount of EDC found was 8.61 μg, or a recovery rate of 95 percent. The standard deviations were 0.30 μg and 0.27 μg for the 4.51- and the 9.02-μg EDC levels, respectively. The standard deviation did not change significantly for the two levels of EDC considered in this analysis.

Comparison of Analyses of EPA and PEDCo Check Samples

Analytical results from the two sets of quality assurance samples differed considerably. The EDC recovery rates for the samples prepared by EPA were between 65 and 79 percent; but the rates for the samples prepared by PEDCo were 95 and 99 percent. Further, the standard deviation for the EPA samples increased as the EDC level increased: from 0.19 μg at the 1.18-μg level, to 1.18 μg at the 8.26-μg level. Because the analytical methods were identical for both sets of samples, the difference in the results cannot be explained without further investigation.

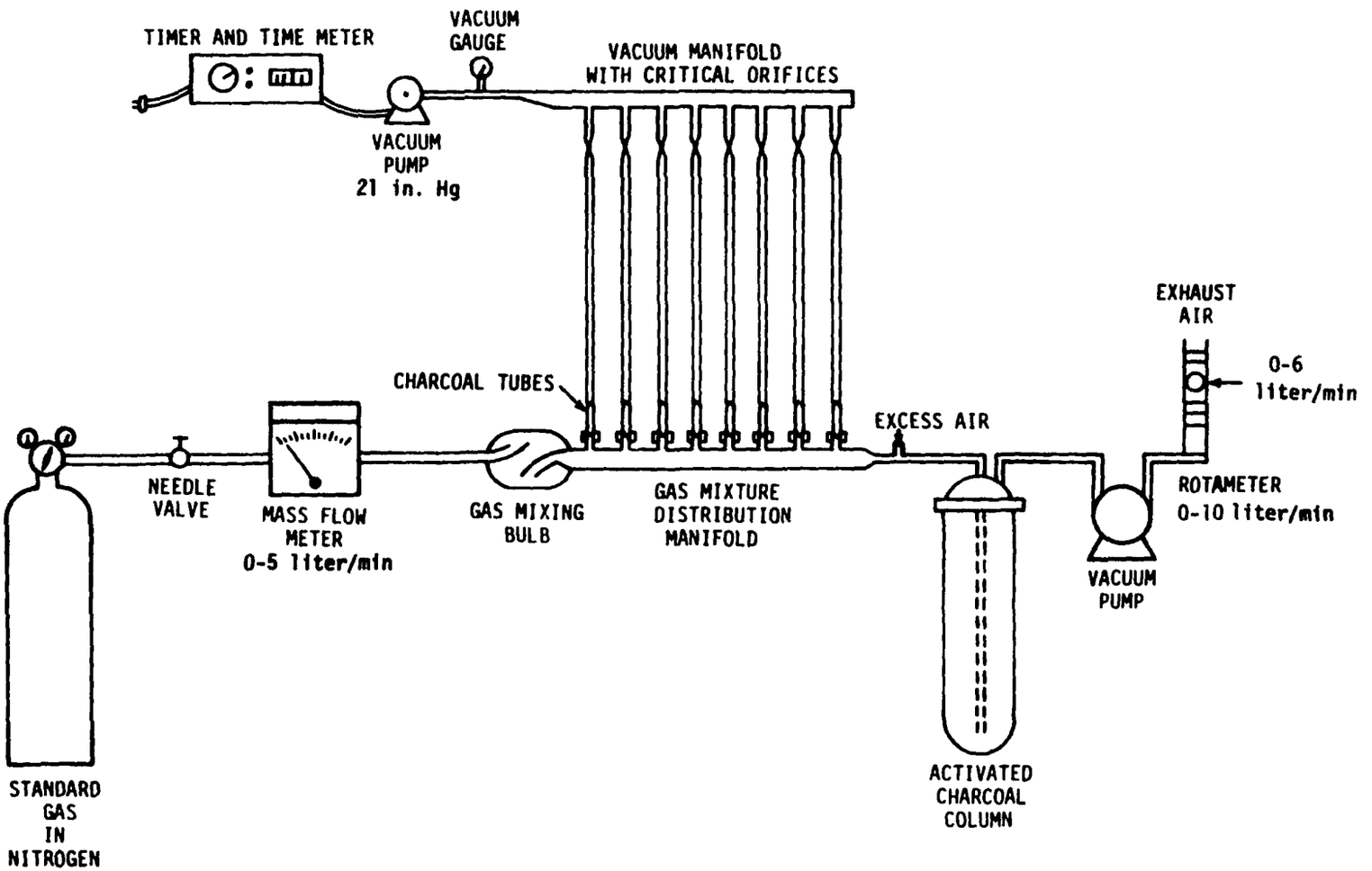


Figure 46. Apparatus for generator and sampling gas mixtures of EDC on charcoal tubes.

TABLE 13. EDC (μg) FOUND
IN THE EIGHT PEDCo QUALITY ASSURANCE SAMPLES

EDC added by PEDCo (μg)	
4.51	9.02
EDC found[a]	EDC found[b]
4.67	8.29
4.27	8.83
4.12	8.31
4.63	8.72
4.86	8.88
4.71	8.65
4.31	8.28
4.05	8.91

[a]Mean = 4.45 μg, standard deviation = 0.30 μg, recovery = 99.00 percent, relative standard deviation = 6.7 percent.

[b]Mean = 8.61 μg, standard deviation = 0.27 μg, recovery = 95.00 percent, relative standard deviation = 3.1 percent.

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APPENDIX A

TENTATIVE METHOD FOR DETERMINING ATMOSPHERIC EDC BY 24-HOUR INTEGRATED SAMPLING

This method has been drafted from available information, as presented in the bibliography, and from laboratory and limited field evaluation. It is still under investigation and is subject to revision.

PRINCIPLES OF THE METHOD

- A known volume of air is drawn through a charcoal tube for a period of 24 h to trap the vapors present.
- The charcoal in the tube is transferred to a small, stoppered sample container, where it is desorbed with a solvent mixture of CS_2 and an internal standard compound (1-bromohexane).*
- An aliquot of the desorbed sample is injected into a GC instrument that uses an MS detector.
- The ratio of the EDC peak area to the 1-bromohexane peak area is determined; this ratio is compared with the ratio of peak areas obtained from a standard in order to ascertain the amount of EDC present in the sample.

RANGE AND SENSITIVITY

The limit of detection is approximately 0.5 $\mu g/m^3$ (0.13 ppb). The maximum of the range is approximately 500 $\mu g/m^3$ (125 ppb); it may be increased by diluting the sample after extraction.

This method was evaluated over an EDC range of 2.5 to 348 $\mu g/m^3$ (0.6 to 86 ppb), at temperatures of 25° and 30°C and relative humidities of 64 and 99+ percent, respectively. The sampling rate was 65 cm^3/min at 760 mm Hg for 24 h. The charcoal adsorption tube (Figure A-1), which consists of two sections of

*Warning: Because EDC is a suspected carcinogen, care must be taken to protect operators from breathing fumes. Carbon disulfide is toxic, and its vapors form explosive mixtures with air; therefore, this material should be handled in a well-ventilated room with a fume hood.

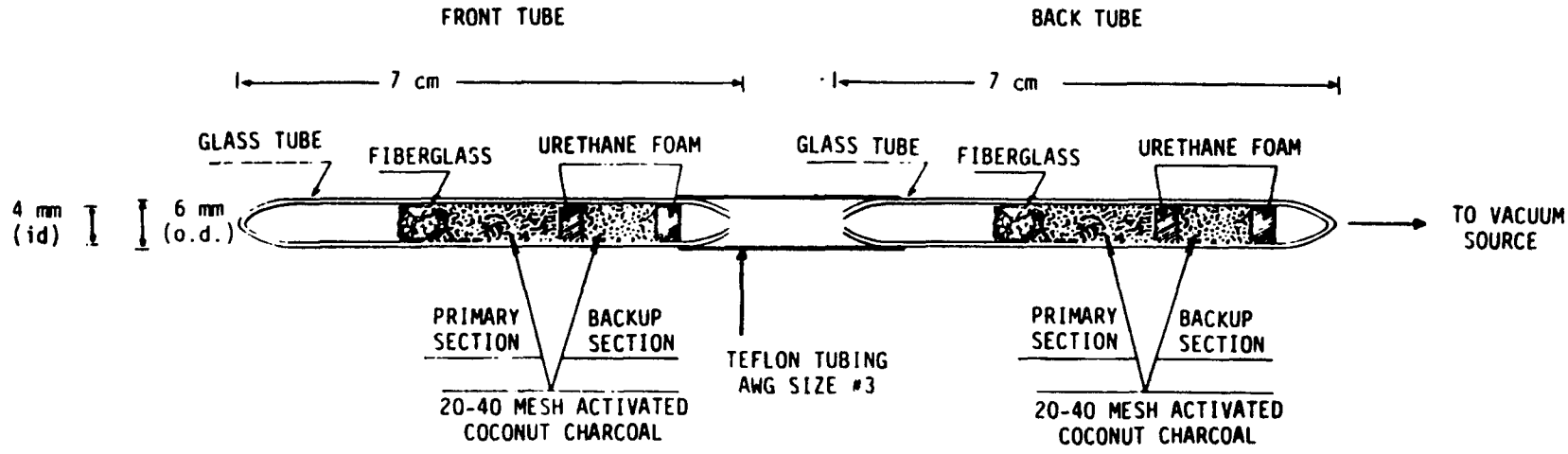

Figure A-1. Diagram of tandem charcoal tubes for EDC sampling.

activated charcoal separated by a section of urethane foam, contained 150 mg charcoal; and each tube was backed with a second tube to determine breakthrough. Laboratory evaluations were conducted with a single charcoal tube and yielded an average total method efficiency (i.e., adsorption and desorption) of approximately 90 percent for EDC levels of 2.5 to 126 $\mu g/m^3$ (0.6 to 31 ppb). At concentrations of 348 $\mu g/m^3$ (86 ppb), approximately 10 percent of the EDC was found on the back portion of the charcoal tube. At an EDC concentration of approximately 2.5 $\mu g/m^3$ (0.6 ppb), the overall method efficiency was approximately 80 percent. The backup tube was analyzed, but the amount of EDC it contained could not be measured because of the detection limit of the GC/MS system.

Although no effect from humidity was observed during the laboratory evaluations at the 65-cm^3/min sampling rate, water condensing within the charcoal tube during field sampling could affect the adsorption efficiency. Sampling for 24 h at rates in excess of 65 cm^3/min affected the collection efficiency. Tests were conducted at an EDC concentration equivalent to 139 $\mu g/m^3$ (34 ppb) a flow rate of 500 cm^3/min, and a relative humidity of 99 percent; the resulting overall method efficiency was less than 20 percent. If a particular atmosphere is suspected of containing a high level of EDC and high levels of humidity, a shorter sampling time should be used.

INTERFERENCES

It is extremely unlikely that any common pollutants now in the ambient atmosphere have sufficient concentrations to interfere with the measurement of EDC. Several criteria must be met for identification and quantification. The retention time, and the specific mass ions of 49, 62, 98, and 100, are monitored simultaneously. All four of these ions should be presented by a peak of the same retention time as that for EDC to obtain positive EDC quantification. The data system of the spectrometer uses the response of mass ion 62 for quantification.

PRECISION AND ACCURACY

Replicate GC/MS analyses of standard liquid mixtures and sample aliquots must not deviate by more than $\pm$ 5 percent. No information is presently available on accuracy for the total method. The precision of the analytical method, based on statistical analysis (relative standard deviation) of replicate standard solutions, was determined to be 3 percent. The precision of both the analytical and sampling methods, based on statistical analysis (relative standard deviation) of replicate samples, was determined to be 6 percent. Standard check samples prepared by EPA and by PEDCo were used to determine the accuracy of the analytical method. The EPA check samples yielded an average recovery of 72 percent; and the PEDCo samples, an average recovery of 97 percent. To find the reason for this discrepancy, a statistical evaluation was made of the possibility of EDC decay on the tube between the times of preparation and analysis; but no biases were observed. Because the reason for the discrepancy could not be ascertained, the accuracy of the analytical method can only be estimated as between 72 and 97 percent.

ADVANTAGES AND DISADVANTAGES OF THE METHOD

The sampling device is small and portable, and it uses no liquids. Interferences are minimal, and most can be eliminated by altering chromatographic conditions.

The amount of sample that can be taken, however, is limited by the sampling rate and by the capacity of the tube. When the sample value obtained for the backup tube exceeds 10 percent of that found on the first tube, the possibility of sample loss exists.

Although a GC/MS system for separation and detection is more expensive than an FID detection system, it is the only one readily available that has the required sensitivity and provides the maximum number of conditions that must be met before a chromatographic peak is integrated. Other detection systems (FID, electrolytic conductivity, and electron capture) were attempted, but they presented problems that could not be circumvented.

APPARATUS AND MATERIALS

Sample Collection Materials

- Pump: Capable of maintaining an air pressure differential greater than 0.5 atmospheres at the desired flow rate
- Critical orifice: 30-gauge, 1/2-in. hypodermic needle to control flow rate at approximately 65 cm^3/min
- Filter cartridge: Disposable 47-mm diameter, 0.45-μm filter porosity (Millipore Filter Corporation, Bedford, Massachusetts)
- Charcoal adsorption tubes: 150-mg, standard NIOSH type, (SKC Corporation, Pittsburgh, Pennsylvania)
- Vacuum gauge: 0 to 760 mm Hg
- Airflow meter: Rotameter type 0 to 120 cm^3/min, calibrated against an NBS traceable bubble meter

Sample Recovery Materials

- Muffle furnace: For operation at 250°C
- Syringe: 0 to 1 ml, gastight, with Teflon plunger
- Vials (sample): 2-ml capacity
- Caps: Screw type, with septum hole for 2-ml vials
- Serum cap liners: Teflon-coated rubber, for sealing vials and caps

- Ultrasonic cleaner: 1/2- to 1-gal capacity (Bronson Cleaning Equipment, Sheldon, Connecticut)

Analytical Equipment

- Gas chromatograph with mass spectrometer: Hewlett-Packard 5992-A or equivalent, with glass jet separator and data system
- Chromatographic column: Nickel, 6.1 m x 2 mm I.D., containing 10 percent SP 1000 on 80/100 Supelcoport
- Microsyringes: 0- to- 10-µl, 0- to-100-µl, and 0- to-500-µl ranges
- Vials (sample): 5-ml and 50-ml capacity, with screw caps and Teflon-lined serum cap liners
- Pipettes: Volumetric Class A, 50-ml, 5-ml, and 1-ml

Reagents Used

- Chromatographic quality CS_2
- 1,2-dichloroethane, reagent grade
- 1-bromohexane, reagent grade
- Purified helium

PROCEDURE

Cleaning of Equipment

All glassware used for laboratory analysis is washed with detergent, thoroughly rinsed with tapwater and distilled water, dried, and placed in a muffle furnace at 350°C for 30 min to remove traces of organic compounds.

Collection of Samples

Duplicate tandem tubes, consisting of two 150-mg charcoal tubes, are used for sampling; each is identified as either the front tube or the backup tube. A 30-gauge, 1/2-in. hypodermic needle is installed for critical orifice flow control. The ends from each tube are removed by breaking the glass bead off with pliers or a small wirecutter. The two tubes are connected with Teflon tubing (5-mm I.D.) so that the large (100-mg) section of charcoal will be exposed to the sampled air when the tubes are connected to the sampler. The tubes are then connected to the sampler, and the pump is activated. Figure A-2 shows a diagram of the sampler.

A record is kept of the initial vacuum, starting time, the adsorption tube number, and the site location. The sampling rate is measured by connecting a rotameter (which has been calibrated with an NBS traceable bubble meter) to the inlet of the tandem charcoal sampling tube; the initial flow is then recorded.

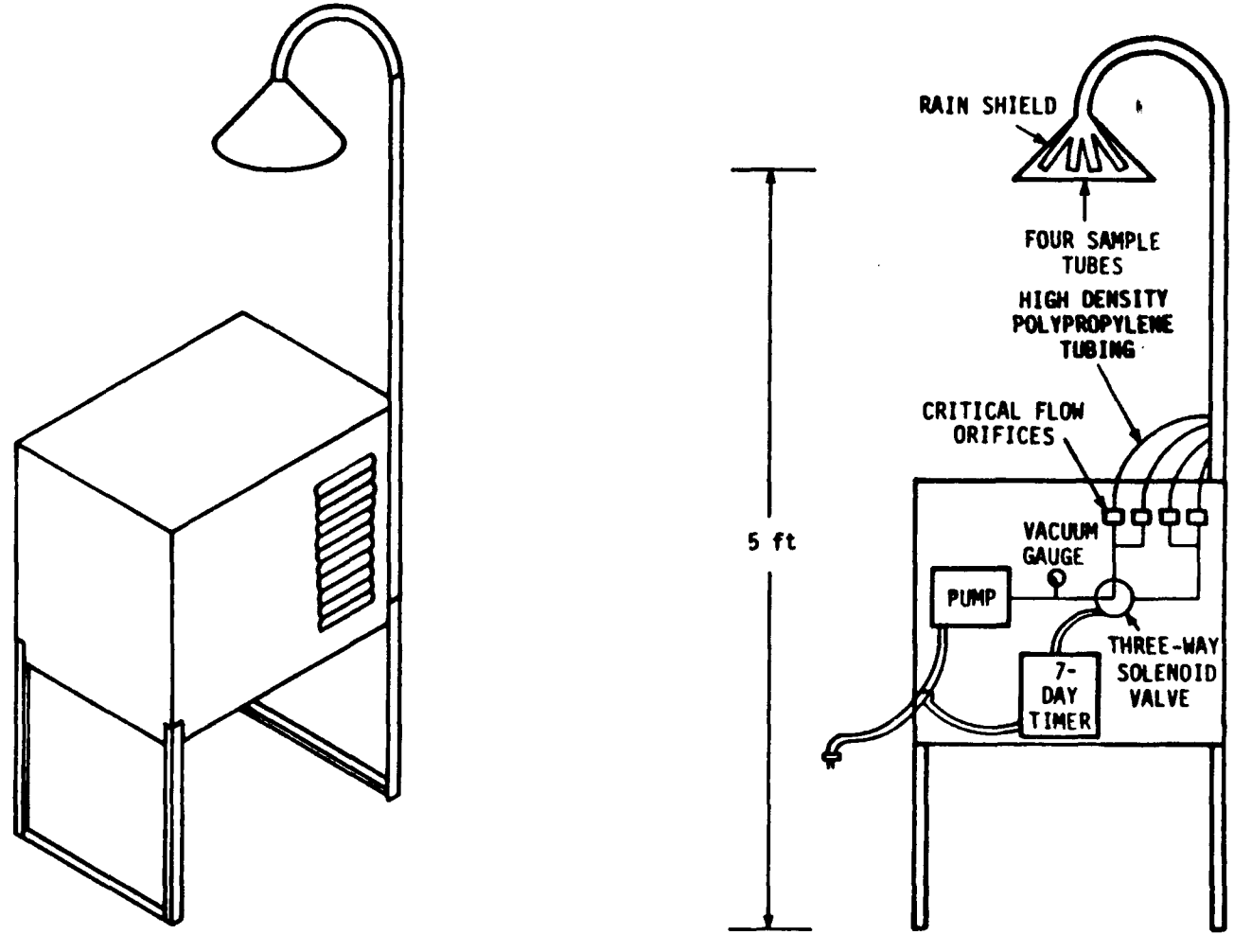

Figure A-2. Sketch of 24-hour integrated sampler for EDC monitoring.

The shield to protect from light and rain is placed over the adsorption tubes, and sampling is continued for 24 ± 0.25 h. At the end of the sampling period, the time, final vacuum, and flow rate are read and recorded as before. Samples are then removed from the sampler, plastic caps are placed on the adsorption tubes, the tubes are wrapped in aluminum foil, and they are stored in a freezer at 0°C or less until laboratory analyses can be performed. One of every twenty tubes used for field monitoring is retained and returned to the laboratory as a blank.

Sample Recovery

The contents of the 150-mg charcoal tube are transferred into a clean, 2-ml vial, and a Teflon serum cap liner is placed on the vial and secured with a screw cap. By use of a 1-ml, gastight syringe, 0.750 ml of a cold (0°C) mixture of CS_2 and 1-bromohexane is injected through the septum into the vial containing the charcoal. See Appendix A, Standards, Calibration, and Analyses, for the preparation of this desorption reagent. The vial is placed in an ultrasonic cleaner, which contains ice and water, for 30 minutes. The sample, containing the charcoal in contact with the CS_2, is then stored at 0°C or less until GC separation and analyses are performed.

Analyses

Column Preconditioning--

Before its initial use, the chromatographic column is treated with heat to remove impurities. To do this, a flow of 20 to 30 ml/min of pure helium is established through the column, and the temperature of the column is raised from ambient by 2°C/min to 200°C. This temperature is maintained for 40 h.

GC/MS Conditions--

The typical operating conditions for EDC analyses when specific ion monitoring is done on a Hewlett-Packard 5992-A analyzer are as follows:

- Helium: Vacuum gauge reads 0.45 atmosphere
- Injector temperature: 179°C
- Oven temperature: 120°C isothermal
- Solvent elution time: 5.3 min
- Run time: 12.5 min
- Electron multiplier voltage: As indicated from the autotune
- Ion masses for EDC: 62, 49, 98, 100, and 102 amu
- Ion masses for 1-bromohexane: 57, 85
- Dwell times: 750.0 ms for ions 62, 49, 57, 85; and 500.0 ms for 98, 100, 102

- Selective ion monitoring window sizes: 0.10 amu
- Amount of CS_2 injected: 4 ml
- Retention time of EDC: 6.4 min
- Retention time of 1-bromohexane: 9.0 min

Sample Injection--

The first step in analysis is to inject the sample into the gas chromatograph. To eliminate difficulties arising from blowback or distillation within the syringe needle, the solvent flush injection technique should be used A 10-µl syringe is flushed with solvent several times to wet the barrel and plunger; then 1 µl of pure CS_2 is drawn into the syringe. The needle is removed from the solvent, and the plunger is pulled back about 0.5 µl to separate the solvent flush from the sample; a pocket of air is used as a marker. The needle is then immersed in the sample, and a 4-µl aliquot is withdrawn. The volume of the needle must be carefully selected, because the sample contained in it will be completely injected. After the needle is removed from the sample and before it is injected into the gas chromatograph, the plunger is pulled back 1 µl to minimize evaporation of the sample from the tip of the needle. The sample occupies 3.9 to 4.0 µl in the barrel of the syringe. When duplicate injections of a solution are made, no more than a 3 percent difference in area can be expected when using the same syringe.

Measurement of Area--

The areas of the EDC and 1-bromohexane peaks are determined by an electronic integration system capable of determining the area of all ions monitored at the same retention time. A printout of the area, expressed in integration units, is obtained. The most predominant ion or base peak in the mass spectrum of EDC, m/e 62, is selected for quantitation of the EDC. For 1-bromohexane, m/e 85 is selected for quantitation; this ion is not the base peak, but it is less subject to interference from other compounds than the base peak.

STANDARDS, CALIBRATION, AND ANALYSES

Preparation of Desorbing Solution and Standards

Preparation of Desorbing Solution--

Add 5.0 µl of 1-bromohexane into a 250-ml volumetric flask containing 240 ml CS_2, and bring to volume with CS_2. The concentration of the 1-bromohexane solution is 23.5 ng/µl.

Weekly Preparation of Stock Standard Solution--

Add 5.0 µl of pure EDC to a 10-ml volumetric flask containing 9.8 ml of the desorbing solution and bring to volume with the desorbing solution. This gives an EDC concentration of 0.628 µg/µl.

Daily Preparation of Working Standard Procedure--

Place 20 µl of the stock standard solution in a 5.0-ml volumetric flask containing 4.8 ml of the desorbing solution, and bring to volume with the CS_2-n-bromohexane desorbing solution. This gives an EDC concentration of 2.512 ng/µl.

Calibration of the GC/MS System

The GC/MS system is set up according to the conditions described above in this Appendix under Procedure, Analyses. Before being used, the instrument is autotuned in the manner described in the manufacturer's operations manual. A 4-µl aliquot of the working standard is injected onto the GC column and analyzed. A response ratio, based on the area obtained from the EDC peak (ion 62) and divided by the area obtained from the 1-bromohexane peak (ion 85), is calculated and used to find the concentration of EDC in real samples. The following equation indicates how the response ratio is obtained:

$$\text{Response ratio} = \frac{A_1}{A_2} = R$$

where A_1 = area of the EDC ion in integration units

A_2 = area of the 1-bromohexane ion in the integration units

Since R is a ratio instead of an absolute area, variations among injections in the amount of sample or the detector response will not affect its value. The average response ratio is determined, and any single response ratio must not deviate from the average by more than $\pm$ 5 percent. If a response ratio is beyond this limit, an error has occurred in the injection of the sample or in the preparation of the working standard, or an instrument problem must be corrected.

Analyses of Samples

A 4-µl aliquot is withdrawn from the desorbed sample, containing the contents of the charcoal tube and the 750 µl of CS_2-1-bromohexane used as the eluting reagent. The areas of the mass 62 ions from EDC and mass 85 ions from 1-bromohexane are recorded. An injection of 4 µl of a standard, which is in the range of the samples being analyzed, is made into every tenth sample. The response ratio is calculated and compared with the original calibration, as in the above Calibration of the GC/MS System. A blank tube, prepared as described in Procedure, Collection of Samples, is analyzed in the same manner. Any area resulting from the specific ion of mass 62 is recorded.

CALCULATIONS

Uncorrected Sample Volume

The volume of air sample is not corrected to Standard Temperature and Pressure because of the uncertainty associated with 24-h average temperature and atmospheric pressure changes during sampling. The air sample volume taken for analysis is determined as follows:

$$V_m = \frac{F_1 + F_2}{2} \times T \times 10^{-6}$$

where V_m = volume of gas sampled (uncorrected), m^3

F_1 = measured flow rate before sampling, ml/min

F_2 = measured flow rate after sampling, ml/min

T = sampling time, min

EDC Concentration

Calculation of the EDC collected on the adsorption tube--

From the integrated areas for ion masses 62 and 85, as discussed above (Standards, Calibration, and Analyses, Analyses of Samples), the EDC content collected on the charcoal tube and corrected for the blank is calculated as follows:

$$W_{EDC} = \frac{(R_{spl} - R_{blk})}{R_{std}} \times C \times V$$

where W_{EDC} = weight EDC, ng

$R_{spl} = \frac{\text{area EDC}}{\text{area 1-bromohexane}}$ from sample

$R_{blk} = \frac{\text{area EDC}}{\text{area 1-bromohexane}}$ from blank

$R_{std} = \frac{\text{area EDC}}{\text{area 1-bromohexane}}$ from standard

C = concentration of standard, ng/µl

V = volume of CS_2 and 1-bromohexane desorbing solution mixture used to desorb the charcoal tube (this volume is 750 µl under normal conditions)

Calculation of EDC concentration*--

The concentration of EDC as $\mu g/m^3$ in the sampled ambient air is calculated as follows:

$$C_{EDC} = \frac{W_{EDC}}{Vm} \times 10^{-3}$$

* The overall method efficiency has been determined to be 90 ± 10 percent. A correction factor of 1.1 can be used if desired. C_{EDC} is multiplied by 1.1 to obtain the concentration corrected for method efficiency. For levels in excess of 10 $\mu g/m^3$, the backup adsorption tube can be analyzed and the concentration added to the results from the first adsorption tube. In this case, no correction factor is recommended.

where C_{EDC} = concentration of EDC in the ambient air sampled, $\mu g/m^3$

W_{EDC} = weight of EDC, corrected for the blank, ng

Vm = volume of air sampled under sampling conditions, m^3

If desired, the concentration of EDC may be calculated as parts per billion EDC; ppb = $\mu g/m^3$ x 0.247.

EFFECTS OF STORAGE

Few data are available on the storage of charcoal tubes containing adsorbed EDC; however, some evidence indicates that compounds with similar chemical characteristics are adversely affected by strong sunlight and heat. Tubes should be stored in a dark place and at a low temperature. Carbon disulfide-1-bromohexane solutions of EDC in the $\mu g/m^3$ range are stable for at least 1 month if they are refrigerated in a sealed serum bottle with minimum head space. No information is available on the storage of samples containing other active substances commonly found in ambient air.

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APPENDIX B
METEOROLOGICAL DATA
FROM CALVERT CITY, KENTUCKY, STUDY

TABLE B-1. METEOROLOGICAL DATA,
CALVERT CITY, KENTUCKY, 8/26/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00				
01				
02				
03				
04				
05				
06				
07				
08	2	120	72	90
09	2	150	76	88
10	2	150	76	83
11	1	-	80	76
12	2	360	83	67
13	2	360	85	62
14	2	120	85	63
15	2	140	86	60
16	2	140	87	55
17	1	-	86	56
18	0	-	85	64
19	0	-	81	78
20	0	-	77	91
21	0	-	75	94
22	0	-	74	95
23	0	-	73	95

TABLE B-2. METEOROLOGICAL DATA,
CALVERT CITY, KENTUCKY, 8/27/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	0	-	73	95
01	0	-	73	93
02	0	-	72	94
03	0	-	72	93
04	0	-	72	94
05	0	-	72	94
06	0	-	72	94
07	0	-	73	91
08	2	180	76	85
09	2	200	80	76
10	2	220	84	65
11	3	210	87	61
12	3	210	88	57
13	4	240	90	54
14	6	220	90	52
15	5	220	90	51
16	6	220	90	52
17	5	220	89	*
18	3	230	87	*
19	2	250	83	*
20	1	-	81	*
21	1	-	79	*
22	2	190	78	*
23	2	180	76	*

* Recorder malfunction.

TABLE B-3. METEOROLOGICAL DATA, CALVERT CITY, KENTUCKY, 8/28/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	2	180	76	*
01	0	-	73	*
02	0	-	72	*
03	0	-	71	*
04	2	190	72	*
05	4	210	73	*
06	4	210	72	*
07	4	220	74	*
08	6	220	76	*
09	6	240	79	76
10	6	230	82	71
11	7	220	84	67
12	7	220	85	63
13	6	230	87	60
14	10	290	84	59
15	1	-	79	76
16	1	-	83	82
17	2	230	84	72
18	6	280	82	66
19	8	290	77	71
20	1	-	74	80
21	1	-	73	87
22	2	250	72	1
23	2	260	71	95

* Recorder malfunction.

TABLE B-4. METEOROLOGICAL DATA,
CALVERT CITY, KENTUCKY, 8/29/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	2	270	70	95
01	1	-	70	96
02	1	-	70	97
03	0	-	70	97
04	0	-	70	97
05	1	-	70	97
06	2	210	70	97
07	2	210	70	96
08	2	210	70	96
09				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				

TABLE B-5. METEOROLOGICAL DATA, CALVERT CITY, KENTUCKY, 9/9/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	0	-	69	93
01	0	-	69	90
02	0	-	68	90
03	0	-	67	90
04	0	-	66	93
05	0	-	66	95
06	0	-	66	95
07	0	-	66	95
08	0	-	67	94
09	0	-	68	93
10	0	-	69	93
11	2	110	69	92
12	2	120	69	88
13	2	130	70	86
14	2	130	74	84
15	1	-	75	82
16	1	-	78	81
17	1	-	79	78
18	6	080	80	74
19	3	080	78	75
20	0	-	74	76
21	0	-	72	75
22	0	-	71	79
23	0	-	69	84

TABLE B-6. METEOROLOGICAL DATA, CALVERT CITY, KENTUCKY, 9/10/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	0	-	69	87
01	0	-	68	88
02	0	-	67	91
03	0	-	67	91
04	0	-	66	91
05	0	-	65	90
06	0	-	65	88
07	0	-	66	86
08	0	-	68	80
09	0	-	72	76
10	0	-	78	73
11	1	-	80	70
12	2	120	83	63
13	3	110	84	61
14	1	-	85	59
15	1	-	85	56
16	1	-	85	51
17	0	-	84	52
18	0	-	82	59
19	0	-	79	67
20	0	-	73	84
21	0	-	72	90
22	0	-	69	94
23	0	-	69	95

TABLE B-7. METEOROLOGICAL DATA, CALVERT CITY, KENTUCKY, 9/11/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	0	-	67	95
01	0	-	67	95
02	0	-	66	95
03	0	-	65	95
04	0	-	65	95
05	0	-	65	95
06	0	-	64	95
07	1	-	64	95
08	2	210	67	94
09	1	200	70	89
10	2	170	75	83
11	3	160	78	76
12	3	160	80	67
13	5	150	80	60
14	4	200	82	59
15	7	230	83	56
16	7	230	82	51
17	7	230	79	56
18	6	240	74	67
19	4	240	69	83
20	3	260	69	95
21	1	200	69	94
22	3	200	68	94
23	1	190	67	94

TABLE B-8. METEOROLOGICAL DATA,
CALVERT CITY, KENTUCKY, 9/12/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	0	-	66	95
01	1	-	66	95
02	1	-	66	94
03	1	-	66	94
04	0	-	67	94
05	0	-	67	93
06	0	-	67	94
07	0	-	67	95
08	0	-	68	94
09	0	-	68	93
10	0	-	69	91
11	4	220	70	93
12	4	210	71	87
13	5	210	73	88
14	5	220	77	78
15	5	220	79	71
16	3	210	80	70
17	1	-	80	69
18	0	-	78	73
19	1	-	77	80
20	2	190	75	87
21	2	190	75	89
22	1	-	73	88
23	0	-	72	92

TABLE B-9. METEOROLOGICAL DATA, CALVERT CITY, KENTUCKY, 9/13/78*

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	9	200	70	95
01	7	200	70	95
02	7	200	69	94
03	4	200	69	94
04	6	220	68	96
05	7	230	67	96
06	6	230	67	96
07	7	230	68	96
08	3	200	70	94
09	4	210	73	91
10	5	210	76	85
11	5	250	78	78
12	4	230	79	73
13	4	230	76	71
14	5	240	77	82
15	6	220	79	80
16	3	200	78	73
17	3	180	77	73
18	1	-	77	75
19	4	180	75	76
20	4	180	74	80
21	5	190	73	77
22	8	200	72	79
23	10	180	72	85

* Rainfall of 0.75 in. occurred from 2000 to 2400 hours.

TABLE B-10. METEOROLOGICAL DATA, CALVERT CITY, KENTUCKY, 9/14/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	9	200	71	88
01	7	200	71	89
02	7	210	70	91
03	4	210	69	92
04	7	220	69	91
05	8	230	69	91
06	7	230	70	91
07	7	230	70	91
08	6	240	71	91
09	8	250	72	90
10	9	250	74	87
11	6	250	75	84
12	4	220	77	80
13	7	240	77	79
14	6	270	78	78
15	5	260	78	77
16	6	270	79	77
17	5	280	81	72
18	2	280	81	67
19	0	-	80	64
20	0	-	76	74
21	0	-	73	85
22	0	-	70	94
23	0	-	68	96

*Rainfall of 2.3 in. occurred from 0000 to 0300 hours.

TABLE B-11. METEOROLOGICAL DATA,
CALVERT CITY, KENTUCKY, 9/15/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	0	-	67	96
01	0	-	67	96
02	0	-	67	96
03	0	-	66	96
04	0	-	65	96
05	2	190	64	96
06	0	-	64	96
07	0	-	64	96
08	0	-	65	96
09	1	-	66	96
10	2	180	70	94
11	2	180	71	91
12	2	200	76	84
13	2	210	78	76
14	1	-	79	74
15	2	290	80	74
16	3	280	81	71
17	0	-	82	63
18	0	-	81	63
19	0	-	76	64
20	0	-	70	85
21	0	-	69	93
22	0	-	67	95
23	1	-	66	95

TABLE B-12. METEOROLOGICAL DATA, CALVERT CITY, KENTUCKY, 9/16/78*

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	2	230		
01	2	230		
02	3	220		
03	1	-		
04	0	-		
05	1	-		
06	1	-		
07	1	-		
08	1	-		
09	1	-		
10	0	-		
11	0	-		
12	0	-		
13	2	240		
14	3	270		
15	5	270		
16	5	250		
17	6	260		
18	2	240		
19	0	-		
20	0	-		
21	0	-		
22	2	190		
23	2	210		

*Rainfall occurred with 0.01 in. accumulation.

TABLE B-13. METEOROLOGICAL DATA,
CALVERT CITY, KENTUCKY, 9/17/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	3	220	69	94
01	3	210	68	95
02	3	210	67	95
03	2	190	67	95
04	1	-	66	95
05	0	-	65	95
06	0	-	65	95
07	0	-	65	95
08	3	230	68	95
09	5	230	72	91
10	4	230	76	82
11	5	240	81	73
12	5	240	83	65
13	5	240	84	56
14	6	230	85	49
15	5	230	86	47
16	5	210	86	47
17	4	200	85	53
18	3	200	83	59
19	1	-	81	63
20	1	-	77	69
21	1	-	75	74
22	3	200	75	82
23	3	210	75	82

TABLE B-14. METEOROLOGICAL DATA,
CALVERT CITY, KENTUCKY, 9/18/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	10	180	75	84
01	10	190	75	86
02	7	180	75	88
03	5	180	74	89
04	7	170	73	89
05	8	170	72	91
06	10	180	71	94
07	13	200	71	94
08	10	200	74	93
09	13	200	76	90
10	9	210	80	83
11	12	210	81	78
12	10	210	84	69
13	10	210	85	64
14	10	230	86	67
15	12	220	87	63
16	8	220	87	58
17	4	200	87	57
18	5	180	85	55
19	5	170	82	58
20	4	160	78	65
21	4	160	74	77
22	0	-	73	89
23	5	170	72	88

APPENDIX C
METEOROLOGICAL DATA
FROM LAKE CHARLES, LOUISIANA, STUDY

TABLE C-1. METEOROLOGICAL DATA,
LAKE CHARLES, LOUISIANA, 9/24/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	4	010	73	81
01	3	020	72	78
02	4	020	71	78
03	5	020	69	80
04	6	020	69	72
05	5	020	68	71
06	7	020	67	71
07	7	020	67	68
08	4	020	72	50
09	7	020	76	39
10	7	020	80	32
11	7	030	82	31
12	4	030	83	32
13	5	030	82	37
14	5	030	82	35
15	7	030	83	35
16	6	020	83	35
17	3	030	81	39
18	3	030	77	49
19	3	010	74	58
20	5	330	70	73
21	5	340	71	66
22	4	010	70	65
23	6	020	70	65

TABLE C-2. METEOROLOGICAL DATA,
LAKE CHARLES, LOUISIANA, 9/25/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	5	020	69	64
01	3	020	67	68
02	5	020	66	67
03	5	020	66	67
04	5	020	65	66
05	4	020	64	66
06	5	020	63	65
07	6	010	64	62
08	4	020	67	50
09	7	020	68	51
10	5	030	74	45
11	4	040	78	43
12	6	040	82	41
13	5	030	82	37
14	5	040	82	37
15	4	030	83	35
16	4	030	84	28
17	4	040	82	35
18	3	030	78	47
19	3	010	73	67
20	5	330	71	74
21	4	360	72	70
22	3	020	74	62
23	5	020	73	67

TABLE C-3. METEOROLOGICAL DATA,
LAKE CHARLES, LOUISIANA, 9/26/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	4	020	73	67
01	4	020	71	60
02	5	010	71	60
03	4	020	68	64
04	4	010	67	68
05	4	020	67	68
06	5	020	67	68
07	6	020	67	68
08	4	020	69	64
09	4	020	74	55
10	6	050	78	57
11	5	040	81	52
12	4	050	83	50
13	4	090	84	48
14	3	030	85	43
15	3	020	85	40
16	2	030	85	43
17	2	010	83	50
18	0	-	79	60
19	0	-	77	68
20	3	020	76	71
21	5	020	77	68
22	5	020	76	71
23	4	020	75	70

TABLE C-4. METEOROLOGICAL DATA,
LAKE CHARLES, LOUISIANA, 9/27/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	3	010	74	62
01	1	360	73	61
02	2	010	69	76
03	2	340	69	76
04	3	020	69	76
05	0	-	70	73
06	3	010	69	76
07	5	350	69	76
08	7	010	72	66
09	6	010	74	62
10	7	020	77	64
11	7	010	81	56
12	10	020	81	56
13	7	030	81	56
14	7	020	81	56
15	8	350	81	56
16	8	350	80	54
17	5	350	79	50
18	7	350	77	55
19	6	340	74	59
20	6	340	73	54
21	7	350	72	58
22	7	360	72	58
23	5	010	72	58

TABLE C-5. METEOROLOGICAL DATA,
LAKE CHARLES, LOUISIANA, 9/28/78*

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	5	360	72	58
01	6	340	71	66
02	6	350	71	66
03	6	360	70	70
04	5	340	70	70
05	7	010	70	70
06	5	010	70	73
07	7	010	70	78
08	11	360	72	70
09	9	020	73	67
10	10	030	74	66
11	11	030	75	60
12	12	030	75	55
13	9	030	73	70
14	9	020	72	62
15	8	020	70	73
16	6	020	70	80
17	5	020	69	85
18	4	020	68	80
19	3	020	67	85
20	4	030	67	85
21	3	010	67	85
22	5	030	67	85
23	6	040	67	85

*Rainfall of 0.02 in. occurred from 0400 to 0600 hours.

TABLE C-6. METEOROLOGICAL DATA,
LAKE CHARLES, LOUISIANA, 9/29/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	5	030	67	85
01	4	010	67	85
02	4	020	67	85
03	5	020	67	85
04	5	020	67	85
05	6	010	67	85
06	5	010	67	85
07	7	020	67	80
08	7	020	69	72
09	7	030	73	63
10	8	050	76	53
11	7	100	78	50
12	8	100	80	45
13	6	110	80	39
14	6	090	81	37
15	6	090	81	40
16	0	-	81	40
17	0	-	80	41
18	0	-	75	55
19	0	-	71	68
20	0	-	70	72
21	0	-	69	76
22	0	-	69	76
23	0	-	69	80

TABLE C-7. METEOROLOGICAL DATA,
LAKE CHARLES, LOUISIANA, 9/30/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	0	-	68	87
01	0	-	68	87
02	0	-	70	78
03	0	-	70	78
04	0	-	70	78
05	3	020	69	80
06	0	-	68	87
07	4	020	67	85
08	5	020	72	67
09	5	020	75	55
10	5	040	79	43
11	6	030	81	44
12	5	030	83	39
13	2	030	84	37
14	2	360	84	32
15	3	030	85	29
16	4	030	85	29
17	2	030	84	30
18	0	-	78	46
19	0	-	74	59
20	0	-	72	73
21	0	-	69	80
22	0	-	69	85
23	0	-	68	87

TABLE C-8. METEOROLOGICAL DATA,
LAKE CHARLES, LOUISIANA, 10/1/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	0	-	68	87
01	0	-	67	85
02	0	-	65	90
03	0	-	65	90
04	0	-	64	90
05	0	-	64	90
06	0	-	64	90
07	0	-	65	85
08	0	-	70	80
09	3	360	77	64
10	2	020	79	50
11	2	010	82	40
12	2	060	84	33
13	2	070	86	29
14	3	100	85	28
15	0	-	87	25
16	0	-	86	26
17	0	-	83	31
18	0	-	77	64
19	0	-	74	74
20	0	-	74	74
21	0	-	72	83
22	0	-	70	90
23	0	-	70	90

TABLE C-9. METEOROLOGICAL DATA,
LAKE CHARLES, LOUISIANA, 10/2/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	0	-	69	94
01	0	-	69	90
02	0	-	67	95
03	0	-	67	95
04	0	-	67	90
05	0	-	67	90
06	0	-	67	90
07	0	-	67	85
08	0	-	70	86
09	1	-	76	63
10	3	340	81	52
11	2	240	82	50
12	1	-	83	44
13	2	160	85	36
14	2	160	85	34
15	4	170	85	34
16	4	190	83	41
17	3	200	80	55
18	2	170	76	68
19	2	180	72	83
20	0	-	71	85
21	0	-	70	90
22	0	-	70	86
23	0	-	69	90

TABLE C-10. METEOROLOGICAL DATA,
LAKE CHARLKES, LOUISIANA, 10/3/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	0	-	68	90
01	0	-	67	90
02	0	-	67	90
03	0	-	67	90
04	0	-	66	90
05	0	-	67	85
06	0	-	67	85
07	0	-	68	87
08	0	-	71	88
09	0	-	73	82
10	0	-	78	68
11	1	-	80	55
12	1	-	82	43
13	1	-	83	43
14	2	140	84	36
15	1	-	82	46
16	0	-	78	60
17	3	170	77	64
18	0	-	74	74
19	0	-	72	80
20	0	-	72	78
21	0	-	71	86
22	0	-	69	85
23	0	-	68	90

TABLE C-11. METEOROLOGICAL DATA,
LAKE CHARLES, LOUISIANA, 10/4/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	0	-	68	90
01	3	340	68	87
02	0	-	68	87
03	0	-	67	90
04	3	020	66	90
05	2	020	67	90
06	3	030	67	85
07	3	030	66	90
08	4	060	67	85
09	6	050	72	61
10	5	050	74	55
11	5	050	77	44
12	2	090	80	41
13	4	100	82	40
14	1	-	83	40
15	3	090	84	39
16	0	-	84	36
17	0	-	83	34
18	0	-	78	52
19	0	-	76	68
20	0	-	74	74
21	0	-	72	83
22	0	-	71	88
23	0	-	69	90

TABLE C-12. METEOROLOGICAL DATA,
LAKE CHARLES, LOUISIANA, 10/5/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	0	-	69	90
01	0	-	68	90
02	0	-	67	90
03	1	-	67	90
04	2	340	67	90
05	1	-	67	90
06	1	-	67	90
07	0	-	67	85
08	2	350	70	86
09	3	030	76	70
10	1	-	81	55
11	2	130	82	50
12	4	060	84	39
13	1	-	84	36
14	2	320	87	30
15	3	180	87	30
16	1	-	84	41
17	1	-	82	49
18	1	-	77	70
19	2	250	75	79
20	0	-	75	79
21	0	-	73	86
22	0	-	72	86
23	0	-	72	86

APPENDIX D
METEOROLOGICAL DATA
FROM NEW ORLEANS, LOUISIANA, STUDY

TABLE D-1. METEOROLOGICAL DATA,
NEW ORLEANS, LOUISIANA, 10/10/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	3	080	64	83
01	0	-	63	80
02	5	360	62	74
03	5	020	62	67
04	6	020	63	63
05	6	020	63	59
06	8	020	65	64
07	4	010	65	49
08	6	030	68	46
09	7	030	69	45
10	8	030	71	48
11	7	040	73	51
12	5	020	75	56
13	7	030	77	59
14	8	030	78	65
15	8	030	78	67
16	8	060	77	72
17	7	110	76	75
18	3	110	74	78
19	2	120	73	80
20	2	120	71	83
21	0	-	70	85
22	0	-	69	87
23	0	-	69	88

TABLE D-2. METEOROLOGICAL DATA,
NEW ORLEANS, LOUISIANA, 10/11/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	0	-	68	88
01	0	-	68	89
02	0	-	67	89
03	0	-	66	89
04	0	-	66	89
05	2	360	66	89
06	1	-	66	89
07	0	-	67	88
08	3	030	68	87
09	7	030	68	86
10	6	030	68	84
11	6	030	75	81
12	6	030	85	76
13	6	030	87	72
14	5	040	88	66
15	5	010	88	64
16	4	110	87	66
17	5	120	86	69
18	5	120	83	75
19	5	120	82	81
20	4	120	80	83
21	4	120	79	84
22	3	120	78	85
23	2	120	78	86

TABLE D-3. METEOROLOGICAL DATA,
NEW ORLEANS, LOUISIANA, 10/12/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	3	120	78	86
01	2	120	77	86
02	2	120	77	86
03	3	110	76	86
04	2	100	76	86
05	2	100	76	86
06	2	100	76	86
07	2	100	77	86
08	3	100	77	83
09	3	130	80	74
10	7	120	86	61
11	8	130	89	53
12	5	140	90	51
13	8	360	91	56
14	8	360	87	66
15	4	050	87	68
16	7	120	89	70
17	8	110	89	69
18	4	120	87	74
19	4	120	81	80
20	4	120	80	84
21	3	120	79	85
22	2	120	79	86
23	2	120	78	86

TABLE D-4. METEOROLOGICAL DATA,
NEW ORLEANS, LOUISIANA, 10/13/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	0	-	77	86
01	0	-	77	87
02	0	-	75	87
03	0	-	75	87
04	0	-	73	87
05	0	-	72	87
06	0	-	71	87
07	4	020	71	87
08	3	030	74	87
09	2	100	78	84
10	3	360	83	75
11	5	360	85	69
12	3	360	87	64
13	5	020	88	57
14	7	360	89	54
15	5	330	90	48
16	3	320	87	48
17	0	-	85	60
18	0	-	80	72
19	0	-	76	73
20	0	-	73	76
21	0	-	72	78
22	10	350	72	78
23	13	350	72	76

TABLE D-5. METEOROLOGICAL DATA,
NEW ORLEANS, LOUISIANA, 10/14/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	14	350	68	74
01	13	350	67	74
02	15	350	64	75
03	15	360	62	70
04	14	360	62	63
05	16	010	61	61
06	16	010	61	57
07	16	010	61	53
08	17	010	61	52
09	20	010	62	50
10	19	010	65	47
11	17	010	64	38
12	14	010	65	36
13	14	360	66	28
14	16	360	66	28
15	15	350	66	27
16	15	350	64	26
17	15	350	60	30
18	12	360	57	38
19	9	350	53	45
20	7	340	53	60
21	7	350	54	63
22	12	010	54	60
23	13	010	54	54

TABLE D-6. METEOROLOGICAL DATA,
NEW ORLEANS, LOUISIANA, 10/15/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	13	010	53	55
01	12	010	53	57
02	9	010	52	59
03	6	020	48	60
04	2	310	43	80
05	2	320	42	94
06	4	330	44	95
07	4	330	48	98
08	0	-	58	70
09	7	030	61	46
10	9	040	63	35
11	7	060	64	33
12	7	060	65	30
13	5	050	66	30
14	4	030	67	29
15	2	330	67	27
16	0	-	67	27
17	0	-	62	32
18	0	-	57	48
19	1	-	55	59
20	2	200	55	70
21	2	240	55	73
22	4	250	55	78
23	4	240	54	82

TABLE D-7. METEOROLOGICAL DATA,
NEW ORLEANS, LOUISIANA 10/16/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	2	220	53	87
01	2	250	52	89
02	2	240	51	93
03	0	-	49	95
04	0	-	48	97
05	0	-	48	97
06	0	-	49	97
07	0	-	52	96
08	9	290	60	92
09	9	290	63	80
10	7	310	70	57
11	8	270	72	44
12	9	290	75	33
13	9	290	77	27
14	8	290	78	27
15	6	300	78	28
16	7	320	77	29
17	3	330	74	35
18	3	330	66	57
19	4	340	61	70
20	7	350	61	75
21	12	360	61	64
22	13	010	60	50
23	12	010	58	52

TABLE D-8. METEOROLOGICAL DATA,
NEW ORLEANS, LOUISIANA, 10/17/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	11	010	56	55
01	12	020	56	57
02	11	030	57	58
03	11	030	57	57
04	11	040	56	57
05	10	040	55	59
06	10	050	54	62
07	10	060	55	64
08	11	060	57	62
09	11	050	58	60
10	11	050	59	57
11	10	050	61	56
12	10	030	63	52
13	10	040	63	47
14	8	050	64	43
15	8	040	64	43
16	5	350	64	42
17	4	310	62	45
18	0	-	58	59
19	0	-	56	65
20	0	-	55	87
21	0	-	54	96
22	0	-	52	99
23	0	-	51	99

TABLE D-9. METEOROLOGICAL DATA,
NEW ORLEANS, LOUISIANA, 10/18/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	1	-	50	100
01	0	-	52	94
02	1	-	50	93
03	5	020	53	95
04	6	010	57	89
05	5	010	55	79
06	5	020	54	87
07	6	010	55	85
08	6	020	56	88
09	8	030	60	81
10	8	040	65	72
11	8	030	67	69
12	9	040	69	68
13	9	040	71	67
14	8	050	74	65
15	9	060	75	65
16	8	070	75	68
17	6	100	75	66
18	4	110	75	65
19	3	120	74	67
20	0	-	71	71
21	0	-	70	75
22	1	-	68	80
23	1	-	67	85

TABLE D-10. METEOROLOGICAL DATA, NEW ORLEANS, LOUISIANA, 10/19/78

Hour	Wind Speed (mph)	Wind Direction (°)	Temperature (°F)	Relative Humidity (%)
00	2	010	65	94
01	2	010	64	98
02	2	010	64	96
03	2	350	66	92
04	4	350	66	95
05	4	330	66	98
06	4	360	67	99
07	3	360	67	99
08	5	010	69	99
09	8	020	70	99
10	7	010	73	98
11	8	010	75	55
12	7	360	76	46
13	5	360	77	46
14	8	350	78	46
15	7	340	79	43
16	3	340	79	43
17	1	-	77	49
18	2	280	70	70
19	0	-	66	81
20	1	-	63	94
21	1	-	61	93
22	1	-	60	95
23	0	-	59	95

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA 600/4-79-029	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Monitoring of Ambient Levels of Ethylene Dichloride (EDC) in the Vicinity of EDC Production and User Facilities		5. REPORT DATE April 1979
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Lawrence A. Elfers, et. al.		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS PEDCo Environmental, Inc. 11499 Chester Road Cincinnati, Ohio 45246		10. PROGRAM ELEMENT NO. 1AD606
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15. SUPPLEMENTARY NOTES		

16. ABSTRACT

A study was conducted near ethylene dichloride (EDC) production and user facilities to determine ambient EDC levels. The results will be used in health risk assessment studies now in progress. Three geographical study areas were selected, and a 10-day monitoring program was conducted at each. Integrated sampling was conducted over a 24-hour period at 12 locations within each study area. Meteorological measurements, consisting of wind speed, wind direction, temperature, relative humidity, and rainfall were also made. The EDC in the ambient air was collected on charcoal sorption tubes, eluted with an organic solvent, and quantitated by gas chromatographic separation and mass spectrographic detection techniques. Ambient levels of EDC at some locations were found to be in excess of 500 $\mu g/m^3$ (125 ppb). These high levels occurred during atmospheric conditions of calm or low wind speeds.

The field monitoring activities, laboratory analyses, quality assurance program, and EDC levels obtained are presented in this report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
air pollution toxic substances chlorinated hydrocarbons	field studies ethylene dichloride	68 A 43 F

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