3.1 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.

3.1.1 Location of Calvert City, Kentucky, EDC Study Sites

A map of the study area is presented in Figure 3-1. The location of the main ethylene dichloride emission source is 37°3'5"N., 88°19'36"W., at an elevation of 150.88 meters (at stack exit). Stack height is 45.72 meters. 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

Location — Warren Petroleum Co.
Calvert City Terminal
Calvert City, Kentucky

This site was located within the fenced area of the Warren Petroleum Co., Calvert City terminal, 800 meters and 130° southeast of the B.F. Goodrich plant. Propane gas (only) is stored at

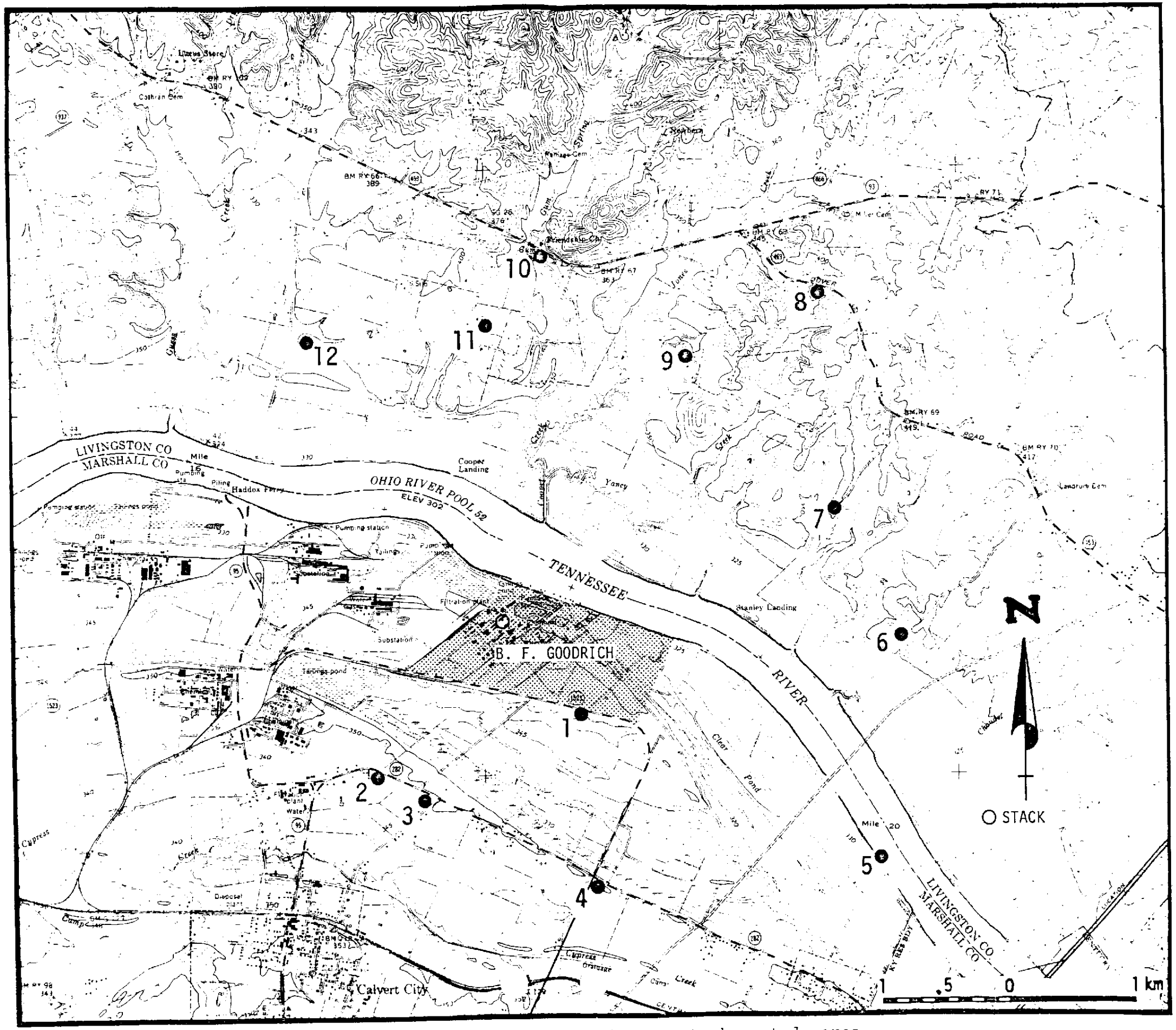

Figure 3-1. Map of Calvert City, Kentucky, study area.

this site. Elevation was 105 meters. A meteorological system and an EDC sampler were at this location. Exposure was excellent.

Site 2

Location Residence of Roy Springer
Highway 282
Calvert City, Kentucky

This site was located in the front yard of the Springer residence, 1280 meters and 217° southwest of the B.F. Goodrich plant. Elevation was 107 meters. The area between the B.F. Goodrich plant and the site was open, with scattered trees. There was a small woods to the south of the site.

Site 3

Location Residence of Carl Deekes
Highway 282
Calvert City, Kentucky

This site was located atop a small building next to the Deekes residence, 1260 meters and 197° south-southwest of the B.F. Goodrich plant. Elevation was 107 meters, with the roof 3 meters above the ground. Exposure was excellent. The area between the site and the plant was open, with scattered trees.

Site 4

Location Residence of James Stowe
Routes 282 and 1523
Calvert City, Kentucky

This site was located in the front yard of the Stowe residence, 1960 meters and 153° south-southeast of the B.F. Goodrich plant. Elevation was 107 meters. The area between the site and the plant had scattered woods. Exposure was good.

Site 5

Location Guinn Fish Camp
Gilbertsville, Kentucky

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

Site 6

Location Farm of Gerald Devine
Grand Rivers, Kentucky

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

Site 7

Location Farm of Willard Jones
Grand River, Kentucky

This site was located on the Jones pig farm, 2860 meters 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 meters, with the wellhouse roof being 2 meters above the ground.

Site 8

Location Residence of Charles Johnson
Grand River, Kentucky

This site was located in the backyard of the Johnson residence, 3700 meters 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 meters.

Site 9

Location Residence of Ed Gillum
Grand River, Kentucky

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

Site 10

Location Pinks Barbeque
Smithland, Kentucky

This site was located in an open area behind the Pinks Barbeque Stand, 3000 meters and 8° north of the B.F. Goodrich

plant. Elevation was 110 meters. 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

Location Farm of Ralph Bloodworth
Smithland, Kentucky

This site was located in a large open area near the barn on the Bloodworth farm. Distance from the B.F. Goodrich plant was 2540 meters and 355° north. Elevation was 119 meters. The area between the site and the plant was open farmland.

Site 12

Location Residence of Preston Bloodworth
Smithland, Kentucky

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

3.1.2 Location of Lake Charles, Louisiana, EDC Study Sites

A map of this study area is presented in Figure 3-2. The location of the principal ethylene dichloride emission source is 30°15'9"N., 93°17'5"W., at an elevation of 49.68 meters (at stack exit). Stack height is 45.11 meters. 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 samplers, except as indicated in individual site descriptions, were located on the ground at an elevation of 5 to 10 meters above sea level.

Site 1

Location Residence of John C. Dyson
Rt. 2, Box 1145
Westlake, Louisiana

This site was located in the front yard of the Dyson residence, about 1200 meters and 178° south of the main vent stack of 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 x 30 meters) 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 meters south of the point.

Site 2

Location Residence of Irene Gray
Rt. 2, Box 735
Westlake, Louisiana

This site was located in the front yard of the Gray residence, 590 meters 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 an area of the front yard that had no trees within 10 meters.

Site 3

Location Residence of Paul Victoria
Rt. 2, Box 794 M
Westlake, Louisiana

This site was located in the front yard of the Victoria residence, 940 meters 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 so as to have excellent exposure in all directions.

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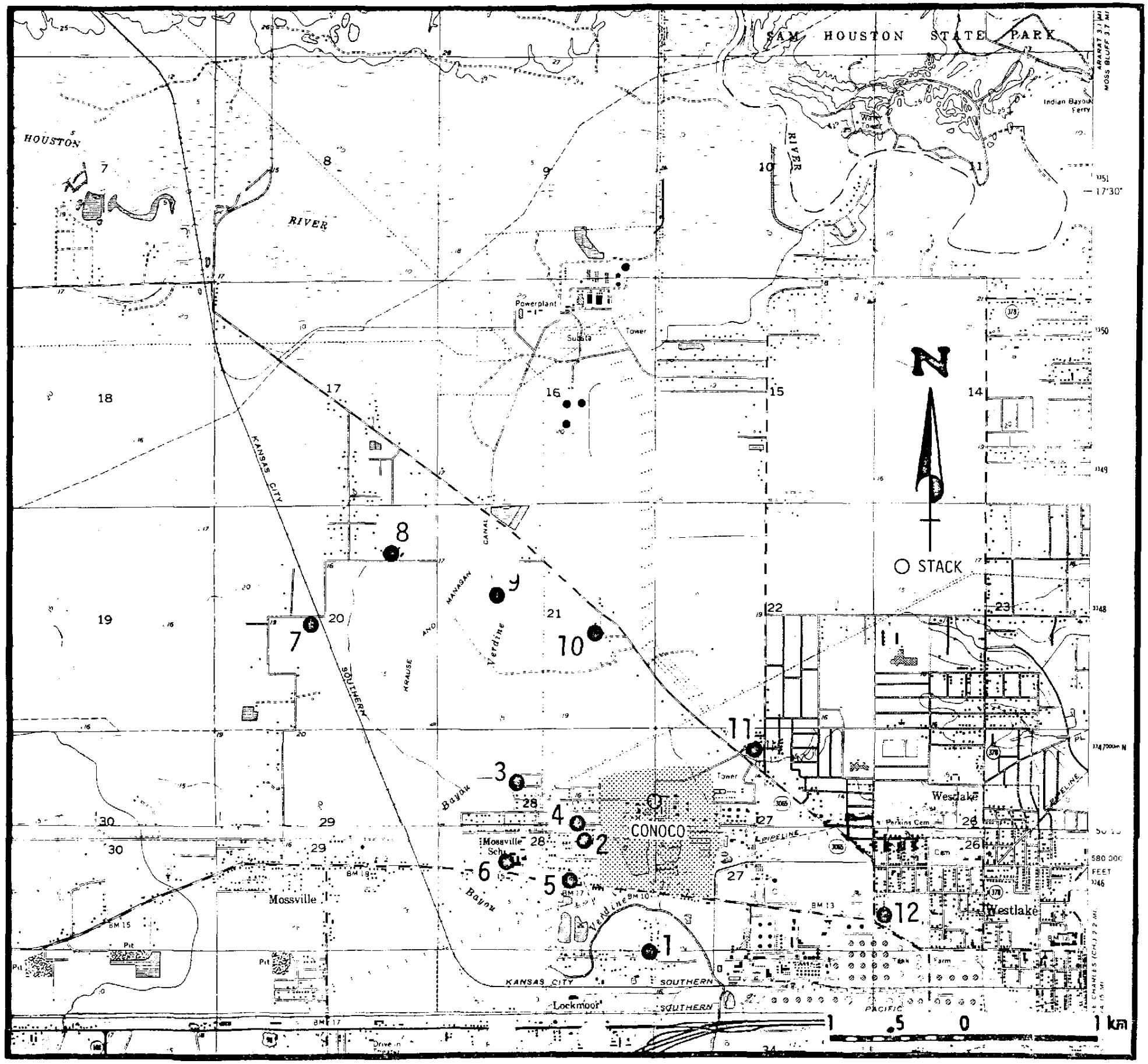

Figure 3-2. Map of Lake Charles, Louisiana, study-area.

Site 4

Location Residence of Oriese Thomas
Rt. 2, Box 748
Westlake, Louisiana

This site was located in the front yard of the Thomas residence, 570 meters and 242° southwest of the main vent stack of the Conoco plant, and in the same residential area as 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

Location Thomas Body Shop
Michigan Avenue and Old Spanish Trail
Westlake, Louisiana

This site was located on the roof of the Thomas Body Shop, 870 meters and 219° southwest of the main vent stack of the Conoco plant. The roof area, being 7 meters above the ground, had good exposure in all directions. Work activities at the body shop were confined to a few hours in the evening. No painting, degreasing, or gasoline services were done on site.

Site 6

Location Mossville Elementary School
Old Spanish Trail
Westlake, Louisiana

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

Site 7

Location Residence of Jerry Harding
Evergreen Drive
Westlake, Louisiana

This site was located in the backyard of the Harding residence, 2770 meters and 297° 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 8

Location Residence of Shirley Bunch
Evergreen Drive
Westlake, Louisiana

This site was located in the front yard of the Bunch residence, 2570 meters 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

Location Residence of Gerald Bult
Powell Lane
Westlake, Louisiana

This site was located 1800 meters 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 meters. The area between the plant and the site was open with the exception of a few trees.

Site 10

Location Residence of John Hyde
Rt. 2, Box 1586
Westlake, Louisiana

This site was located in the backyard of the Hyde residence, 1190 meters 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

Location Residence of Herman Dyson
2215 Margaret Street
Westlake, Louisiana

This site was located in the backyard of the Dyson residence, 880 meters and 70° east of the main vent stack of the Conoco plant. There were a few trees in the vicinity of the sampler, but the area between this site and the Conoco plant was open.

Site 12

Location Residence of Harold Daily
913 Carroll Street
Westlake, Louisiana

This site was located in the backyard of the Daily residence, 2020 meters 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.

3.1.3 Location of New Orleans, Louisiana, EDC Study Sites

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

- Shell Chemical Plant, Norco, Louisiana, at 30°0'15"N., 90°25'30"W., and an elevation of 36.5 meters (at stack exit). The stack height is 33.53 meters.
- Union Carbide, Hahnville, Louisiana, at 29°59'06" N., 90°26'15" W., and an elevation of 18.29 meters (at stack exit). The stack height is 15.24 meters. The stack is equipped with an incinerator.

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 meters above sea level. A 10-meter-high levee 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

Location Hopkins Fruit Stand
Highway 61 and Prescott Road
Laplace, Louisiana

This site was located 4000 meters and 343° north-northwest of the Shell plant; and 6000 meters and 5° north of the Union Carbide plant. Adjacent to the site was the Bonnet Carre floodway, a flat wooded area 2000 meters wide running between the Mississippi River and Lake Pontchartrain. Route 61, a four-lane highway with moderate traffic, passed within 30 meters of the site. The sampler was located on top of a small cooler next to the fruit stand. The sampler inlet was 3 meters above the ground.

Site 2

Location Residence of Neil Madere
195 Evangeline Road
Laplace, Louisiana

This site was located 4050 meters and 295° northwest of the Shell plant; and 4200 meters 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

Location Residence of Joseph Calcayvno
Rt. 1, Box 731
Laplace, Louisiana

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

Site 4

Location U.S. Army Corps of Engineers
Bonnet Carre Maintenance Area
Norco, Louisiana

This site was located inside the fenced area of the Bonnet Carre maintenance facilities, U.S. Army Corps of Engineers. A meteorological system and an EDC sampler were located here. The

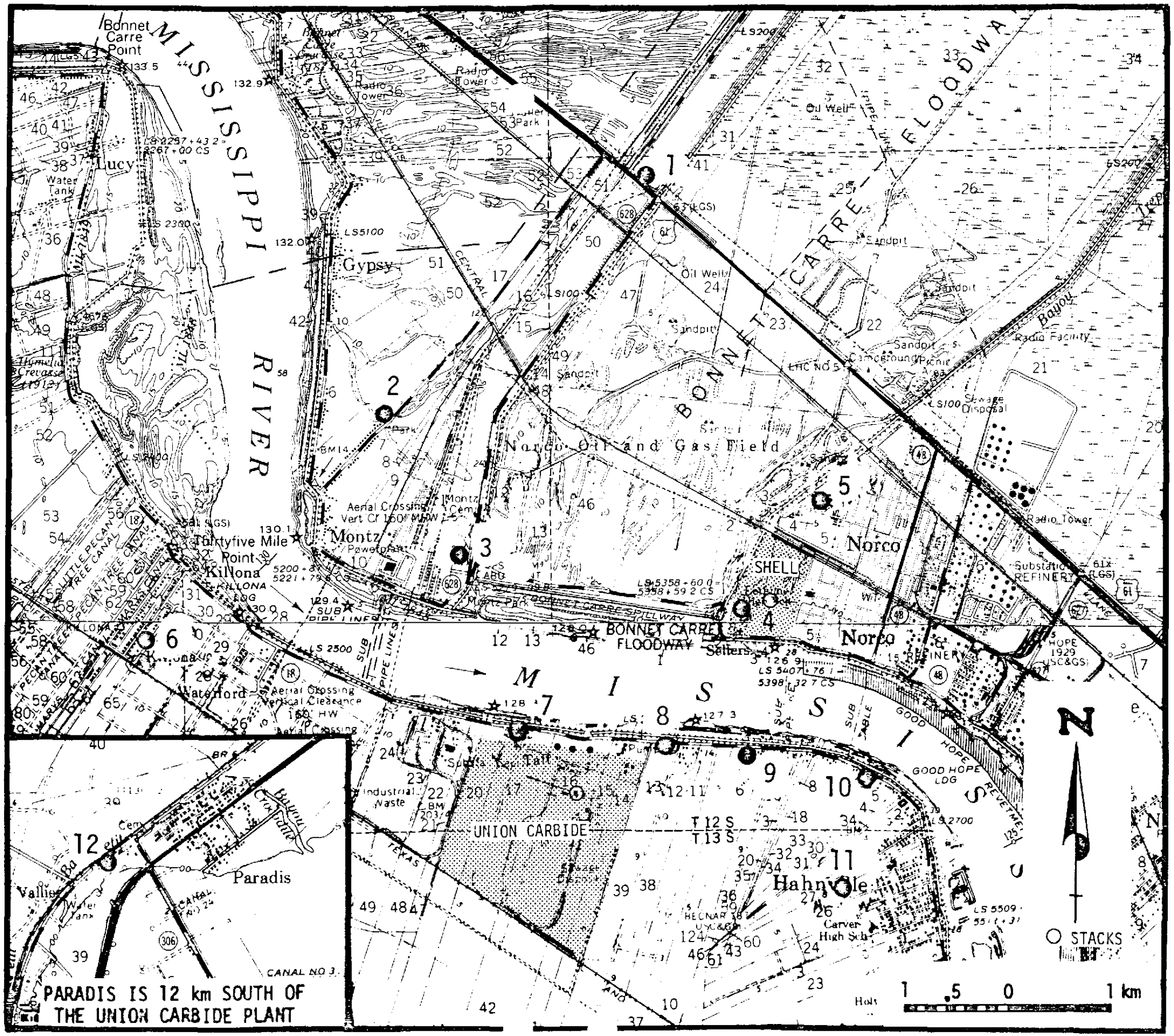

Figure 3-3. Map of New Orleans, Louisiana, study area.

site was 400 meters and 299° southwest of the Shell plant; and 2700 meters and 37° northeast of the Union Carbide plant. The Bonnet Carre floodway levee was 50 meters to the west; and the Mississippi River levee was 300 meters 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

Location — Residence of R.V. Jacob
524 Alleman Street
Norco, Louisiana

This site was located in the backyard of the Jacob residence, 825 meters and 32° northeast of the Shell plant; and 3500 meters 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

Location — Residence of Corrine Woods
Post Office Box 454
Killona, Louisiana

This site was located in the front yard of the Woods residence, 6050 meters and 266° west of the Shell plant; and 4600 meters 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

Location — Marie's Cafe
Rt. 18
Hahnville, Louisiana

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

Site 8

Location — Residence of Leona Triche
Rt. 1, Box 10
Hahnville, Louisiana

This site was located in the backyard of the Triche residence, 1850 meters and 212° southwest of the Shell plant; and 850 meters and 60° northeast of the Union Carbide plant. Exposure in all directions was excellent. The Mississippi River levee was 100 meters north of this site.

Site 10

Location — Residence of Adolph Lorio
Rt. 1, Post Office Box 95
Hahnville, Louisiana

This site was located in the front yard of the Lorio residence, 2075 meters and 155° southeast of the Shell plant; and 2575 meters and 85° east of the Union Carbide plant. There were no trees in the area of the sampler. Exposure was good in all directions. The Mississippi River levee was 110 meters north of this site.

Site 11

Location — Residence of Sam Alleman
Box 333
Hahnville, Louisiana

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

Site 12

Location — Residence of Ray Doucet
Post Office Box 3455
Paradis, Louisiana

This site was located in the backyard of the Doucet residence, 14,450 meters and 189° south of the Shell plant; and 12,200 meters 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 that they could often smell the chemical plant when the wind was from the north.

3.2 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 3-4). This document defined PEDCo's level of liability and removed liability from EPA.

The following equipment was used in the studies:

- Twelve EPA samplers modified by PEDCo so that duplicate samples could be taken at a flow rate of 65 cc/min for 24 hours (see Figure 3-5).[6]
- One Bendix Aerovane Model 141/120 wind speed/direction system with a 10-meter 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.

3.2.1 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 3-6).
3. Record the vacuum reading, which must be in excess of 375 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 3-7. Break the adsorption tube ends and connect the tube to the sampler.

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 3-4. Property use agreement document.

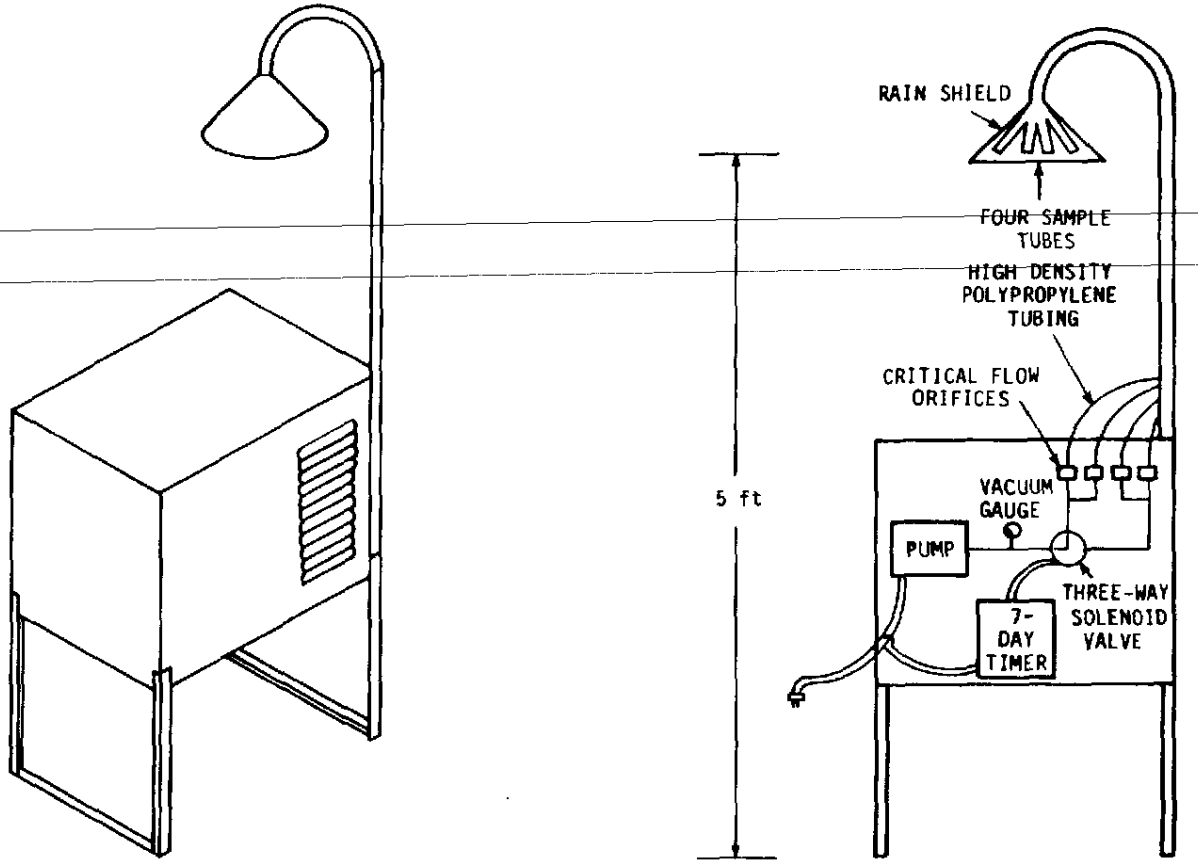

Figure 3-5. Sketch of 24-hour integrated sampler for EDC monitoring.

SAMPLE DATA FORM

Site Number: _____ Start Date _____ Time _____

Site Location: _____ End Date _____ Time _____

Operator: _____

Tube Numbers

Front _____

Back _____

Flow Rate

Start _____ cc/min.

Mid _____ cc/min.

Final _____ cc/min.

Average _____ cc/min.

Running Time Meter

Final _____

Start _____

Sample Time _____ min.

Vacuum in. Hg

Start _____

Mid _____

Final _____

Average Flow Rate____ X Total Sample Time __ = __ Sample Volume cc.

Remarks: _____

_____

Weather Conditions: _____

_____

_____

Figure 3-6. Sample data form.

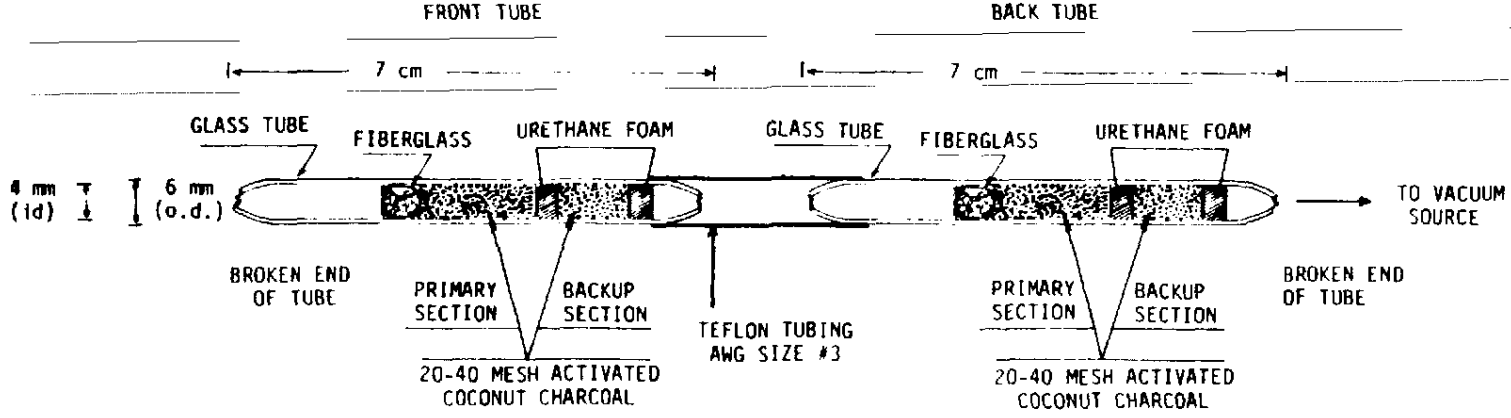

Figure 3-7. Diagram of tandem charcoal tubes for EDC sampling showing broken ends.

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 ± 5 cc/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 hours and record the date, time, and final vacuum reading.

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

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.

3.2.2 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-meter 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 also 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-hour 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-meter 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.

3.3 LABORATORY ANALYSIS

3.3.1 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-hour 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.

3.3.2 Sample Analyses

The samples were desorbed in carbon disulfide and analyzed by gas chromatographic separation and mass spectrographic detection. An internal standard was added to the carbon disulfide

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 carbon disulfide, 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-hour 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.

4.1 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, Ky., are summarized in Table 4-1; refer to subsection 3.1.1 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 4-1 through 4-13. The reduced meteorological data collected during the study period are presented in Appendix B.

4.2 LAKE CHARLES, LOUISIANA, STUDY AREA

The EDC levels found during the Lake Charles, La., study are summarized in Table 4-2; refer to subsection 3.1.2 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 4-14 through 4-25. The reduced meteorological data collected during the study period are presented in Appendix C.

4.3 NEW ORLEANS, LOUISIANA, STUDY AREA

The EDC levels determined during the New Orleans study are summarized in Table 4-3; refer to subsection 3.1.3 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 4-26 through 4-35. The reduced meteorological data collected during this study period are presented in Appendix D.

TABLE 4-1. DATA SUMMARY OF EDC LEVELS ($\mu g/m^3$)[a] IN CALVERT CITY, KY., 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		
9-9-78	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] Preliminary study, with sampling conducted from 8 a.m. All other study periods were midnight to midnight.

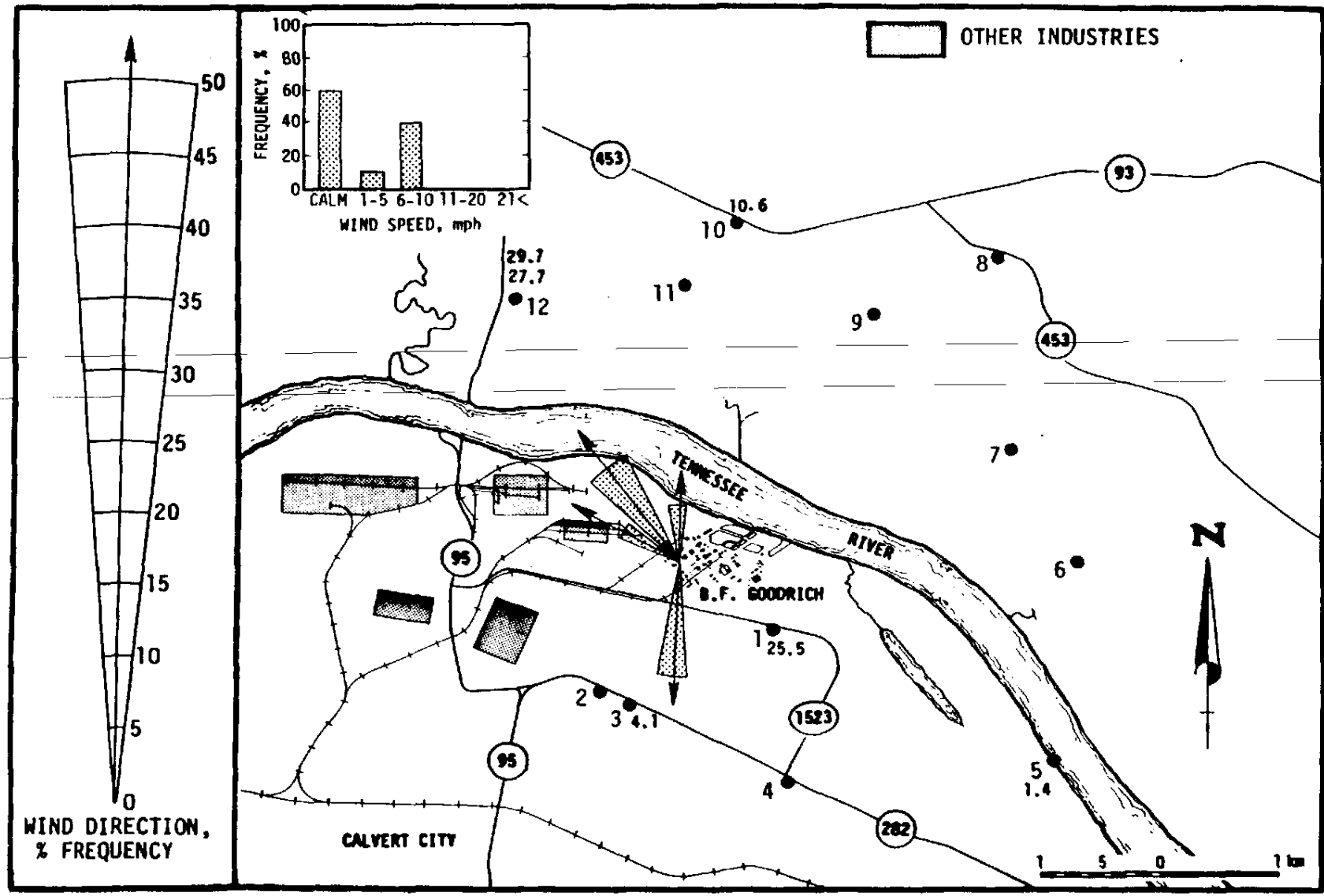

Figure 4-1. Results of preliminary dichloride study, Calvert City, Ky., for 8-26-78 (8 a.m.) to 8-27-78 (8 a.m.). EDC concentration given in Mg/m^3

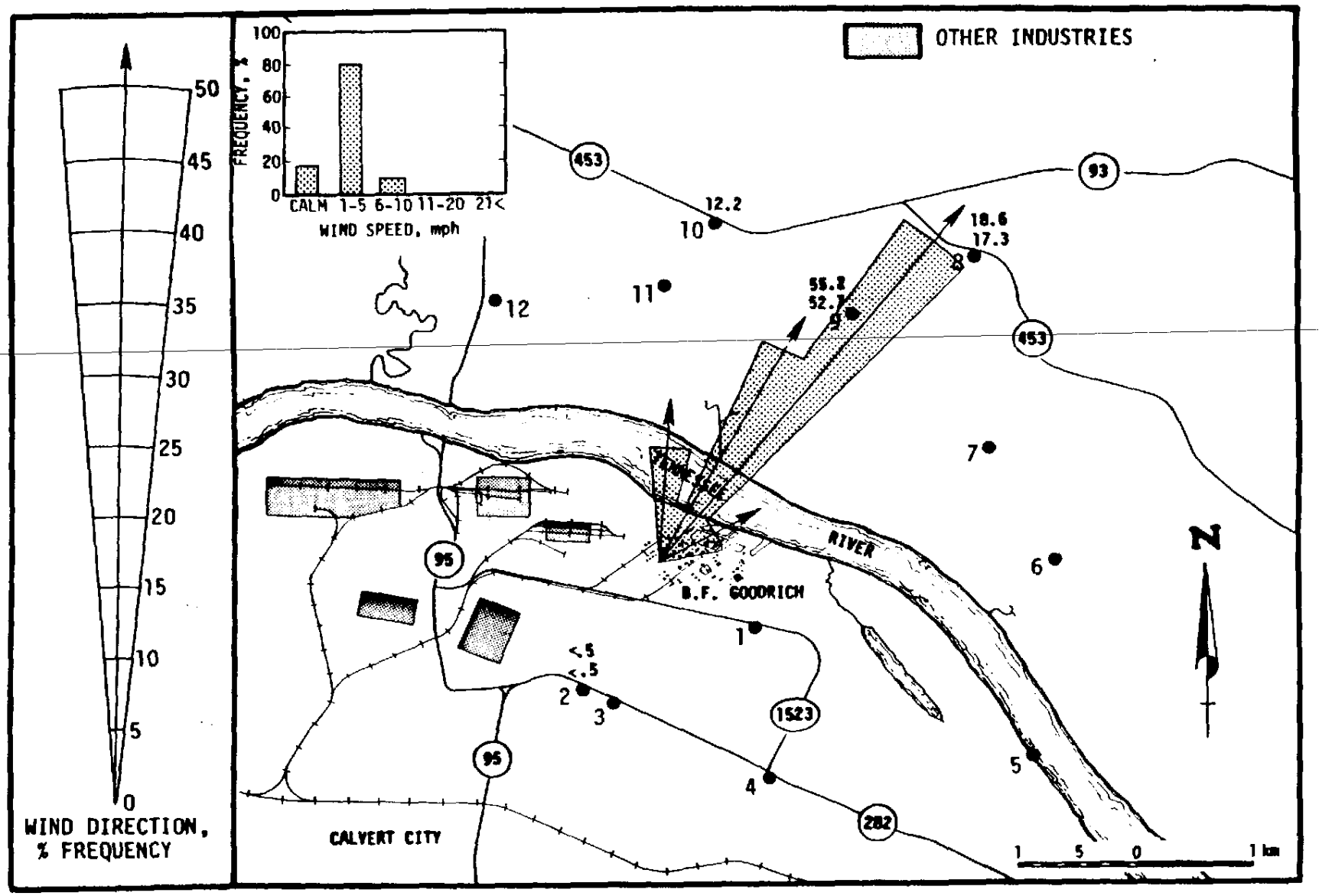

Figure 4-2. Results of preliminary ethylene dichloride study, Calvert City, Ky., for 8-27-78 (8 a.m.) to 8-28-78 (8 a.m.). EDC concentration given in $\mu g/m^3$.

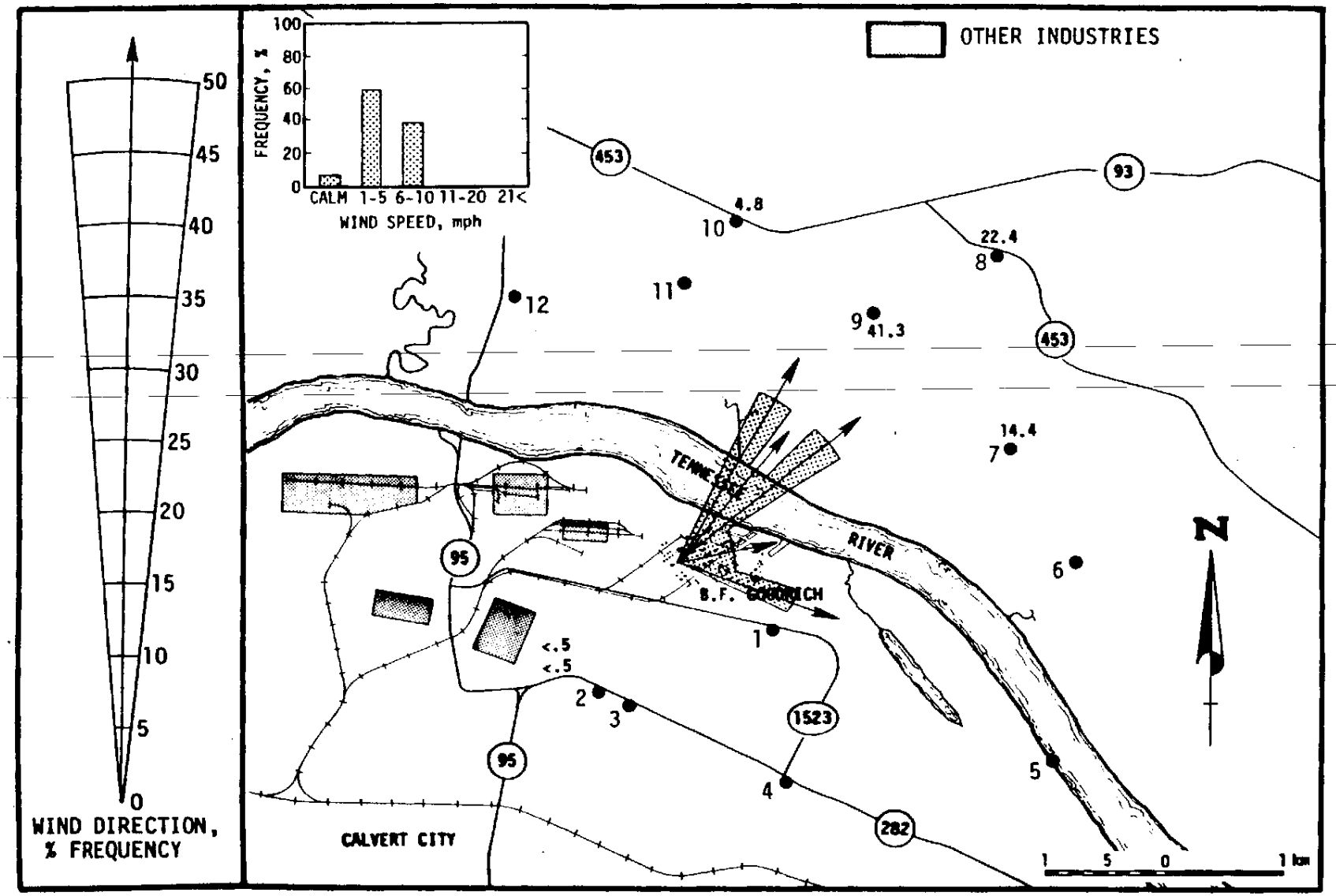

Figure 4-3. Results of preliminary ethylene dichloride study, Calvert City, Ky., for 8-28-78 (8 a.m.) to 8-29-78 (8 a.m.). EDC concentration given in $\mu g/m^3$.

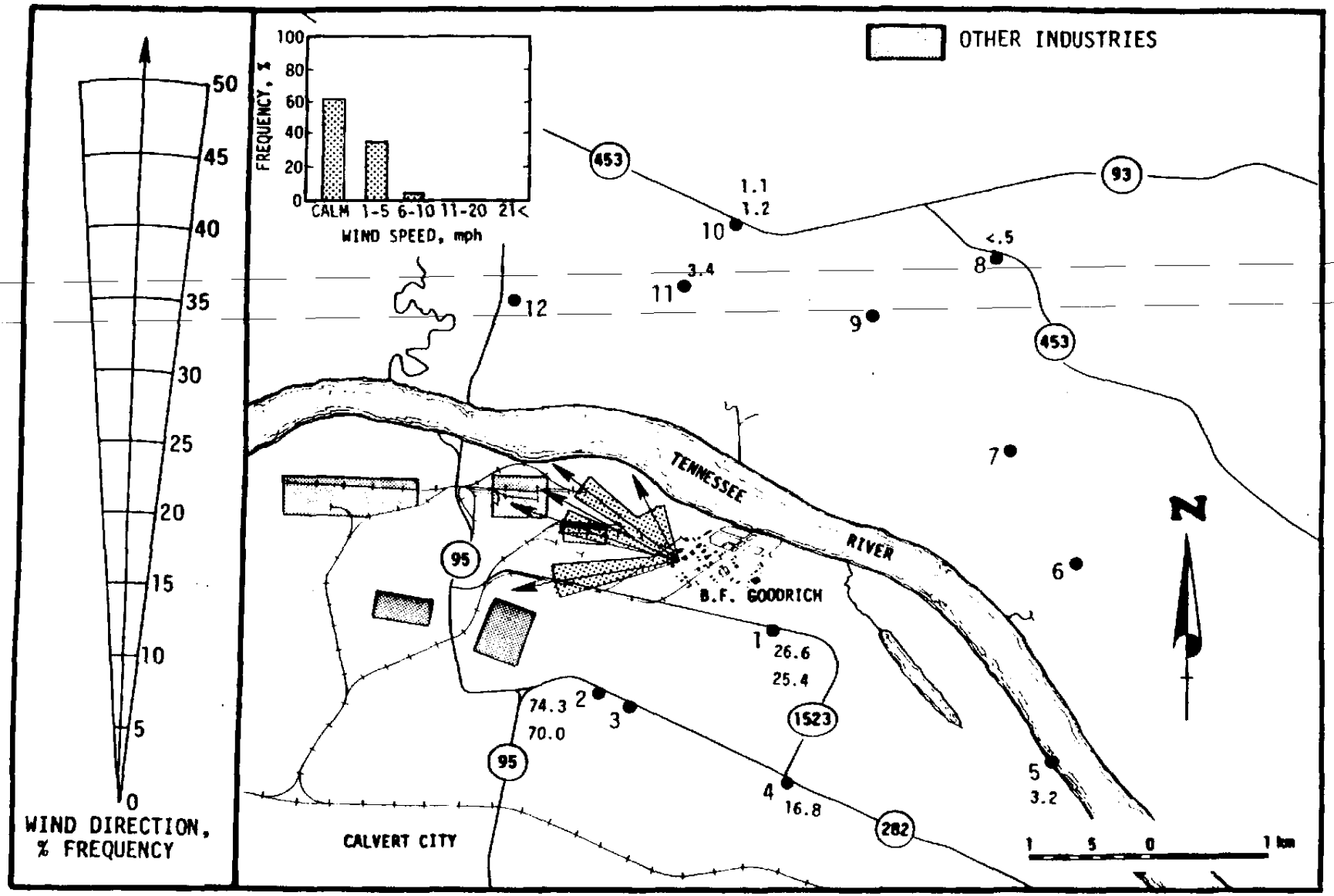

Figure 4-4. Results of ethylene dichloride study, Calvert City, Ky., 9-9-78. EDC concentration given in $\mu g/m^3$.

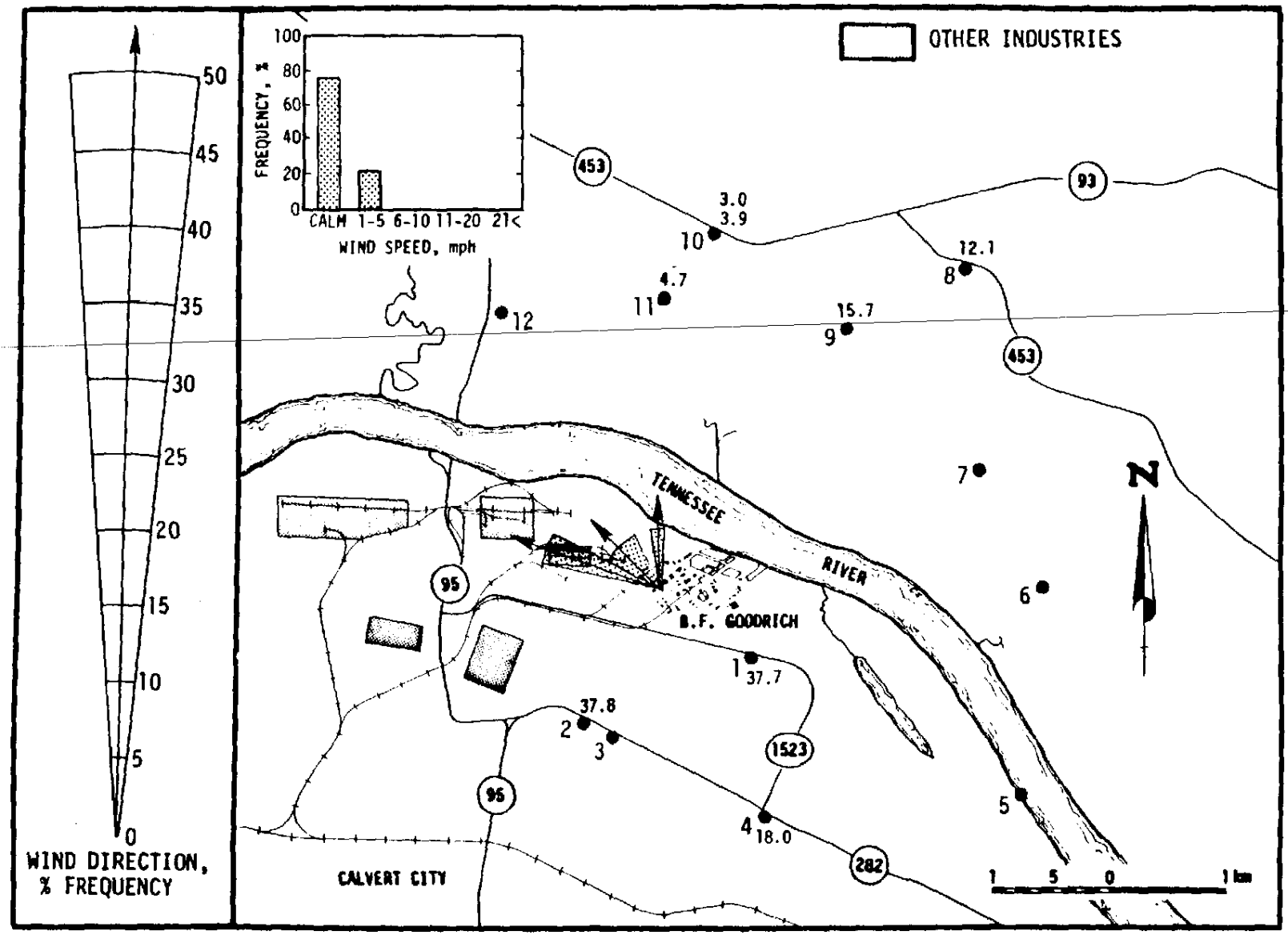

Figure 4-5. Results of ethylene dichloride study, Calvert City, Ky., 9-10-78.
EDC concentration given in $\mu g/m^3$.

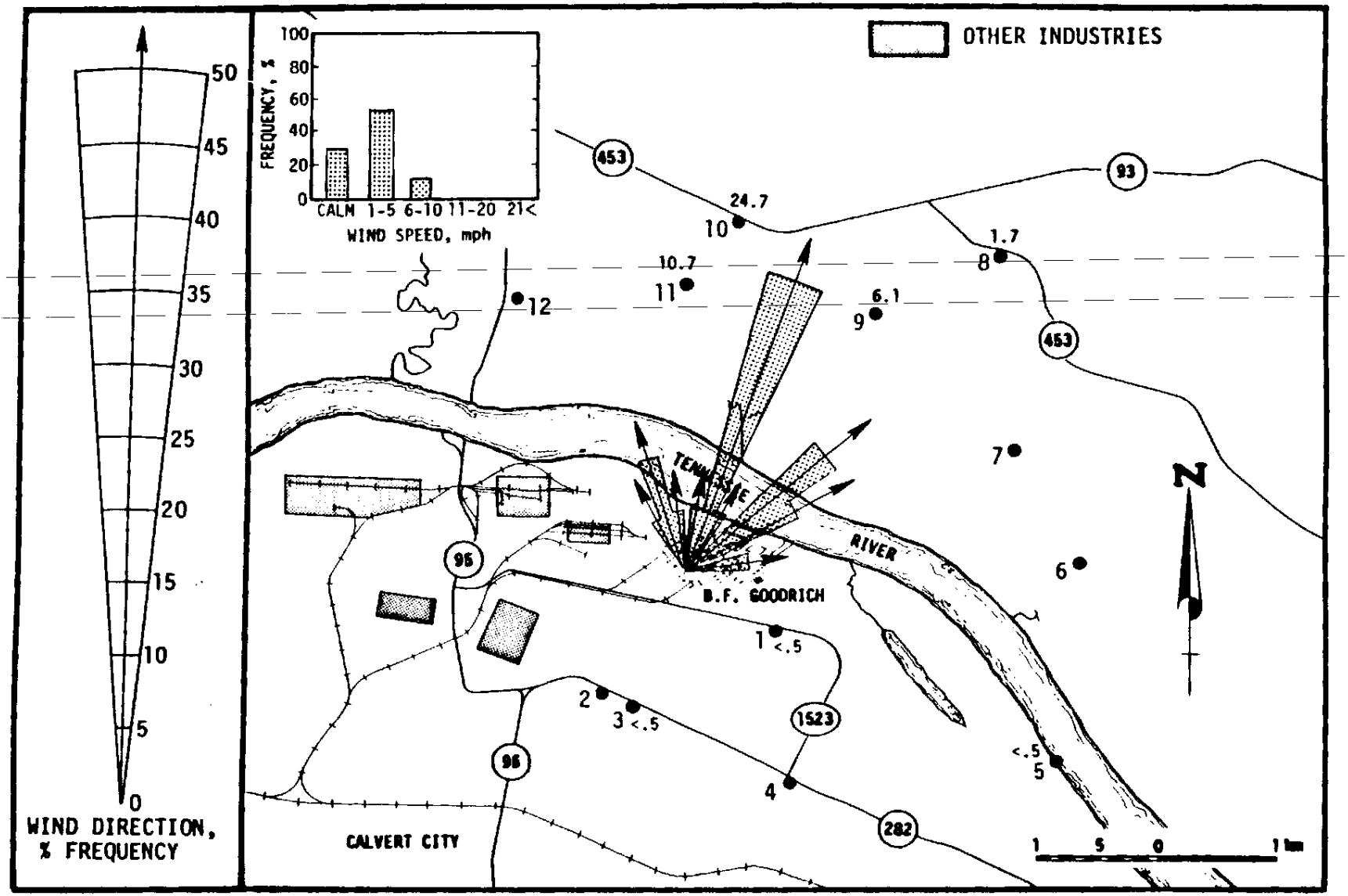

Figure 4-6. Results of ethylene dichloride study, Calvert City, Ky., 9-11-78. EDC concentration given in $\mu g/m^3$.

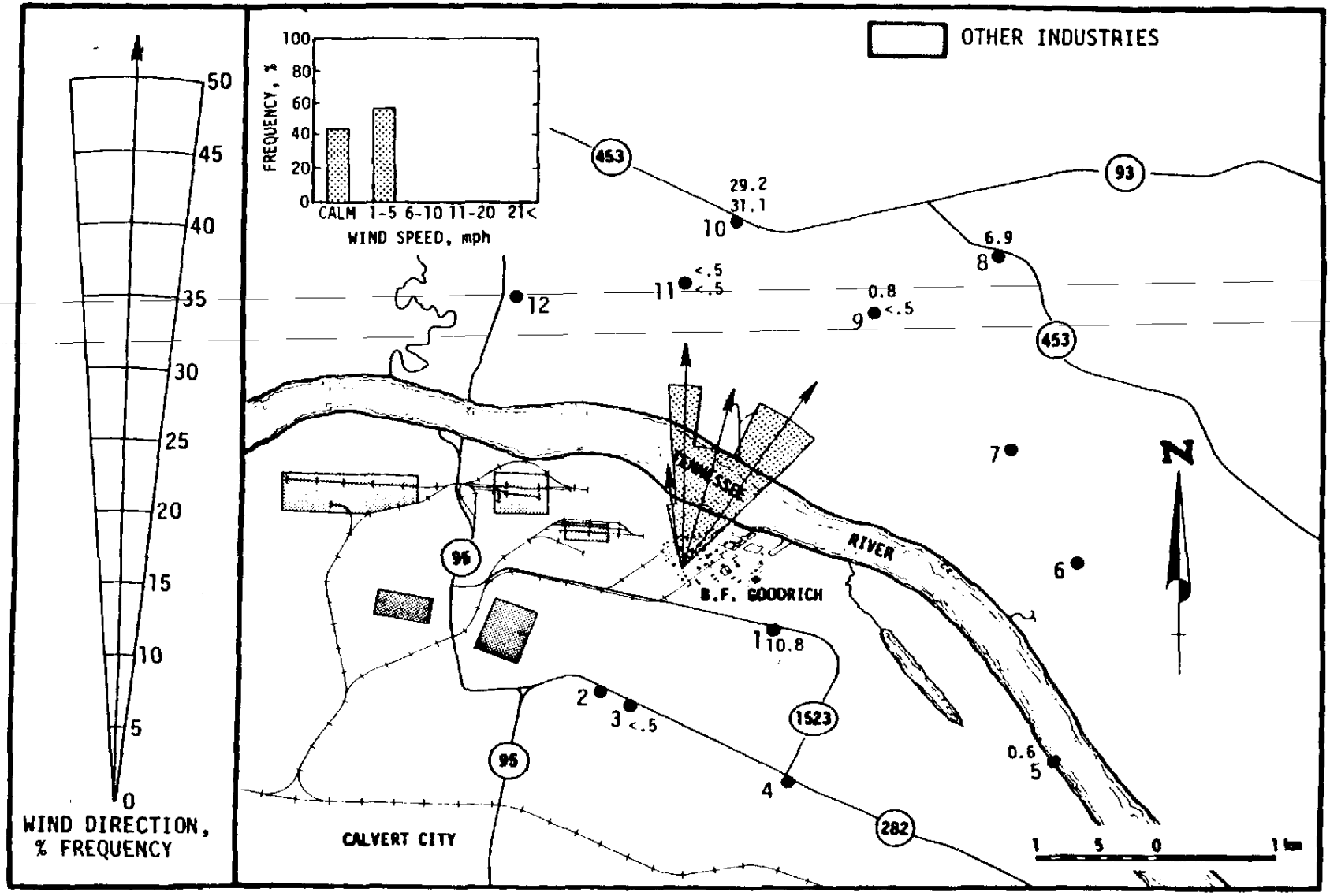

Figure 4-7. Results of ethylene dichloride study, Calvert City, Ky., 9-12-78. EDC concentration given in $\mu g/m^3$.

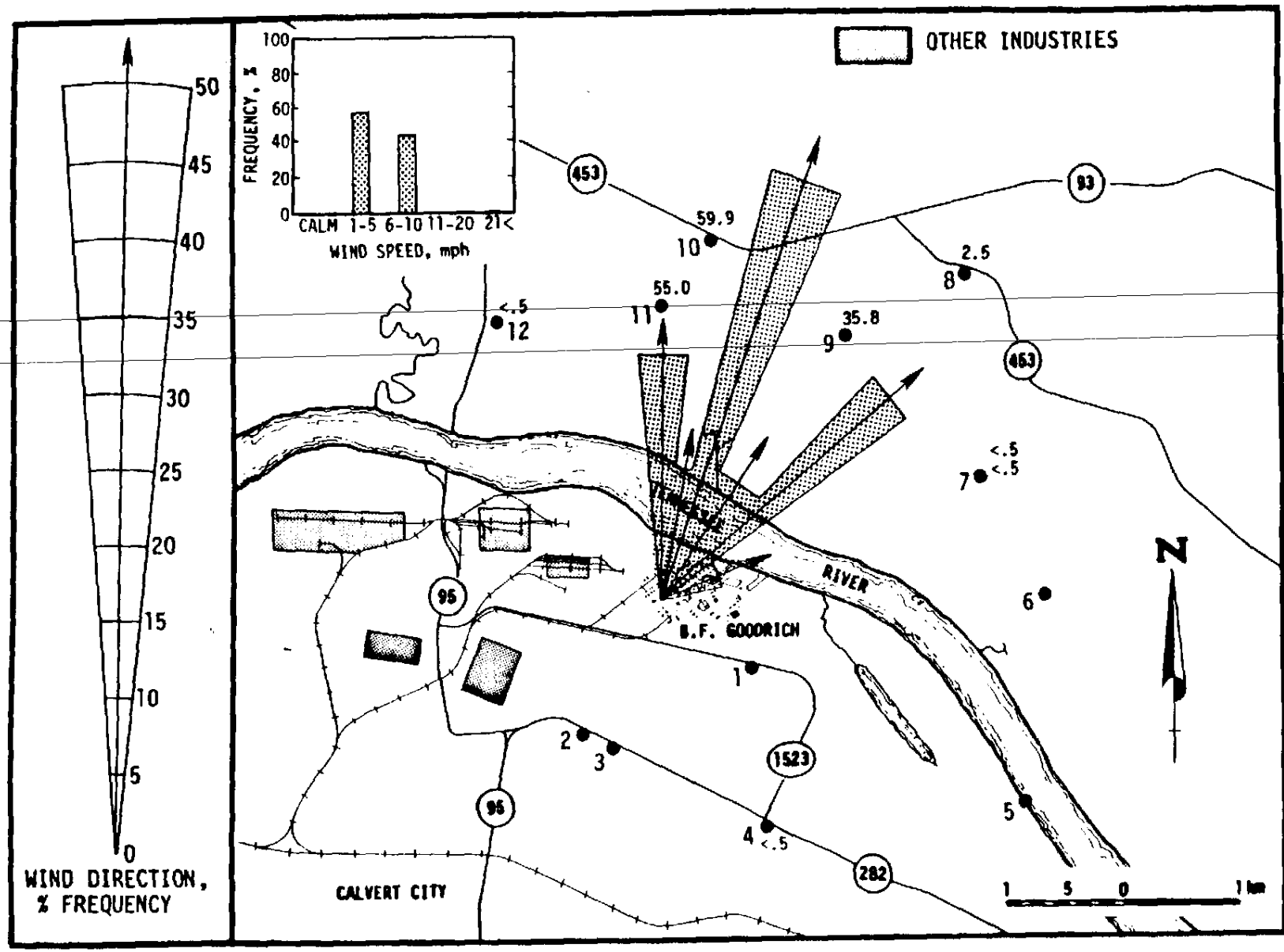

Figure 4-8. Results of ethylene dichloride study, Calvert City, Ky., 9-13-78
EDC concentration given in $\mu g/m^3$.

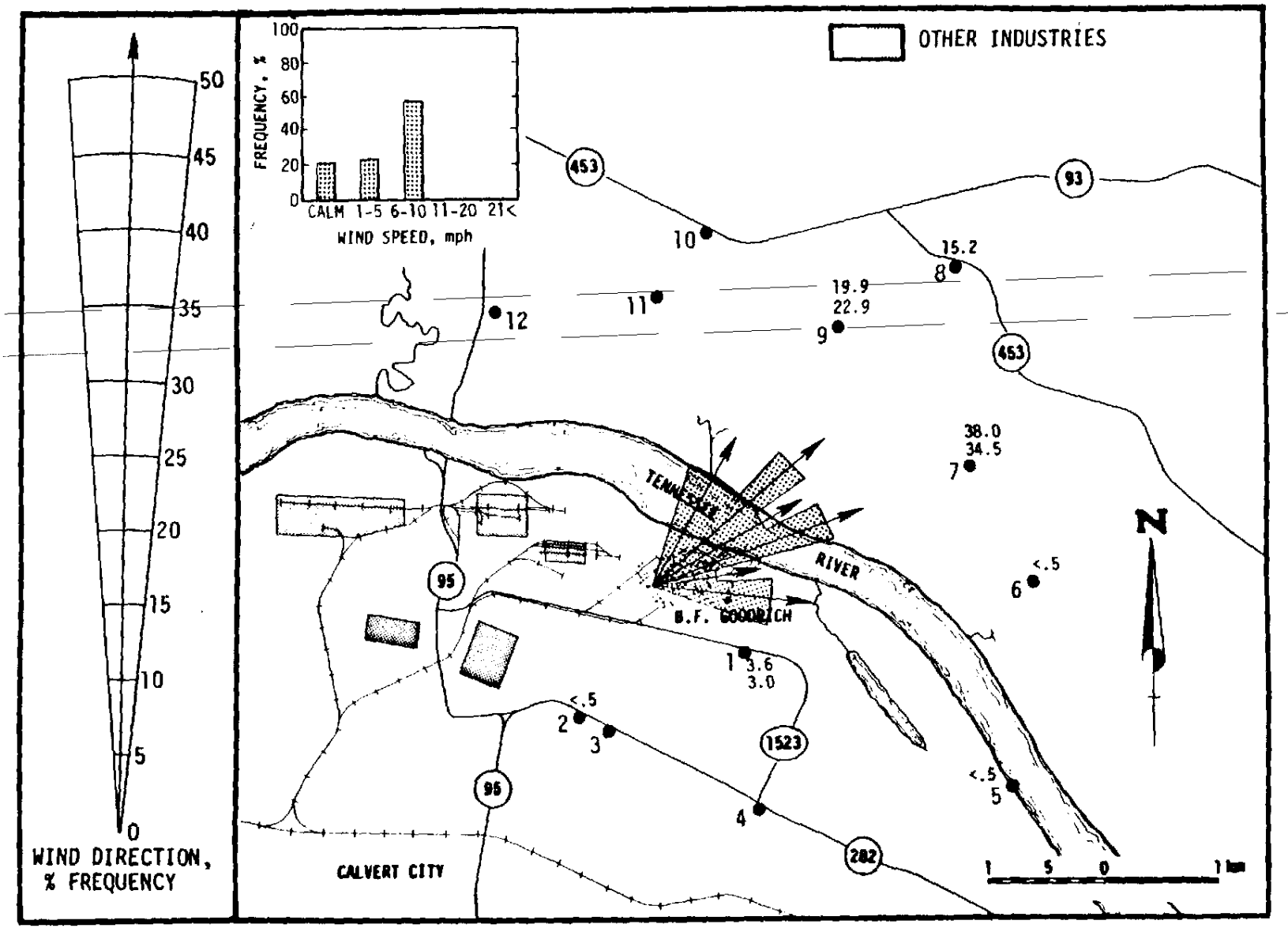

Figure 4-9. Results of ethylene dichloride study, Calvert City, Ky., 9-14-78. EDC concentration given in $\mu g/m^3$.

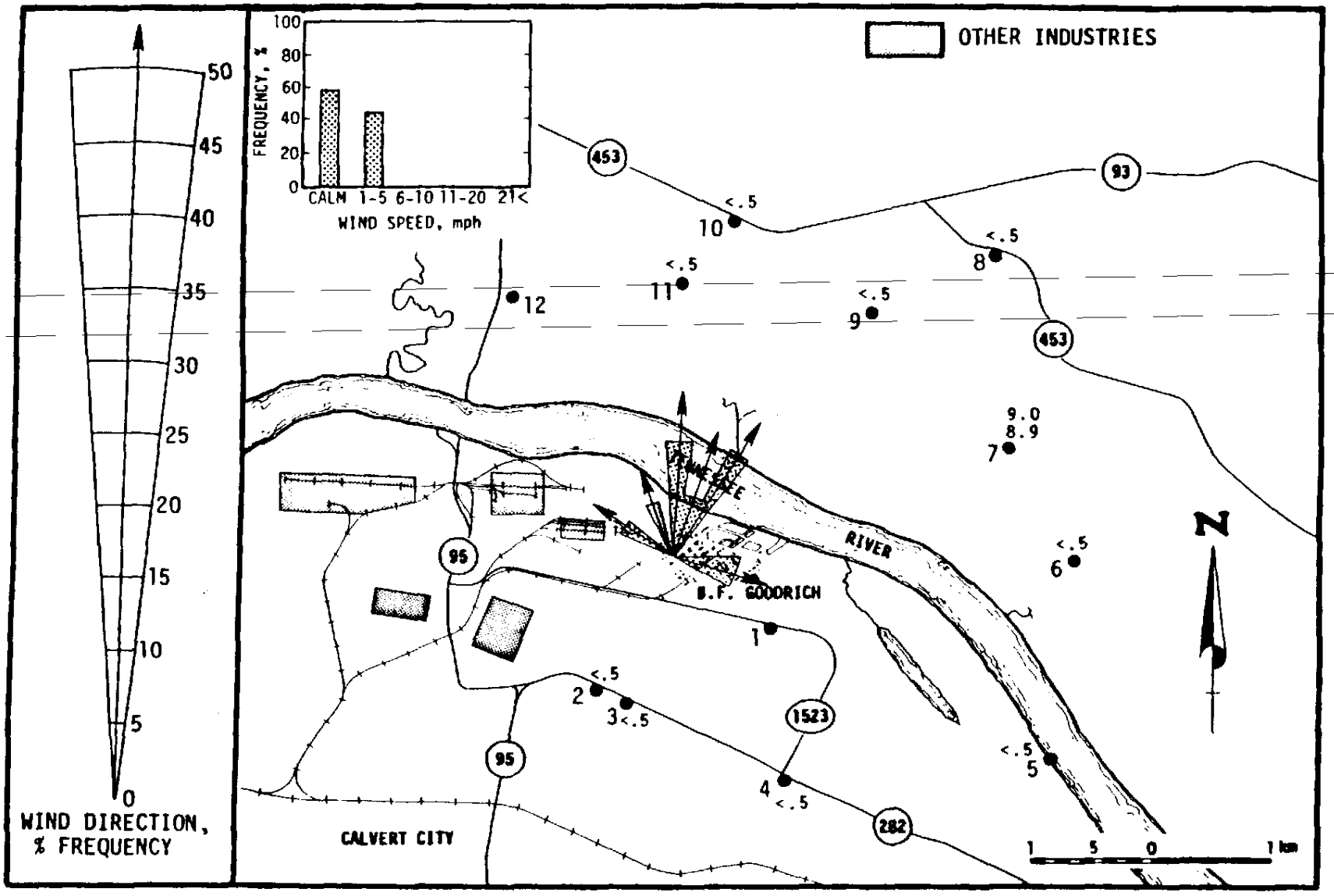

Figure 4-10. Results of ethylene dichloride study, Calvert City, Ky., 9-15-78.
EDC concentration given in $\mu g/m^3$.

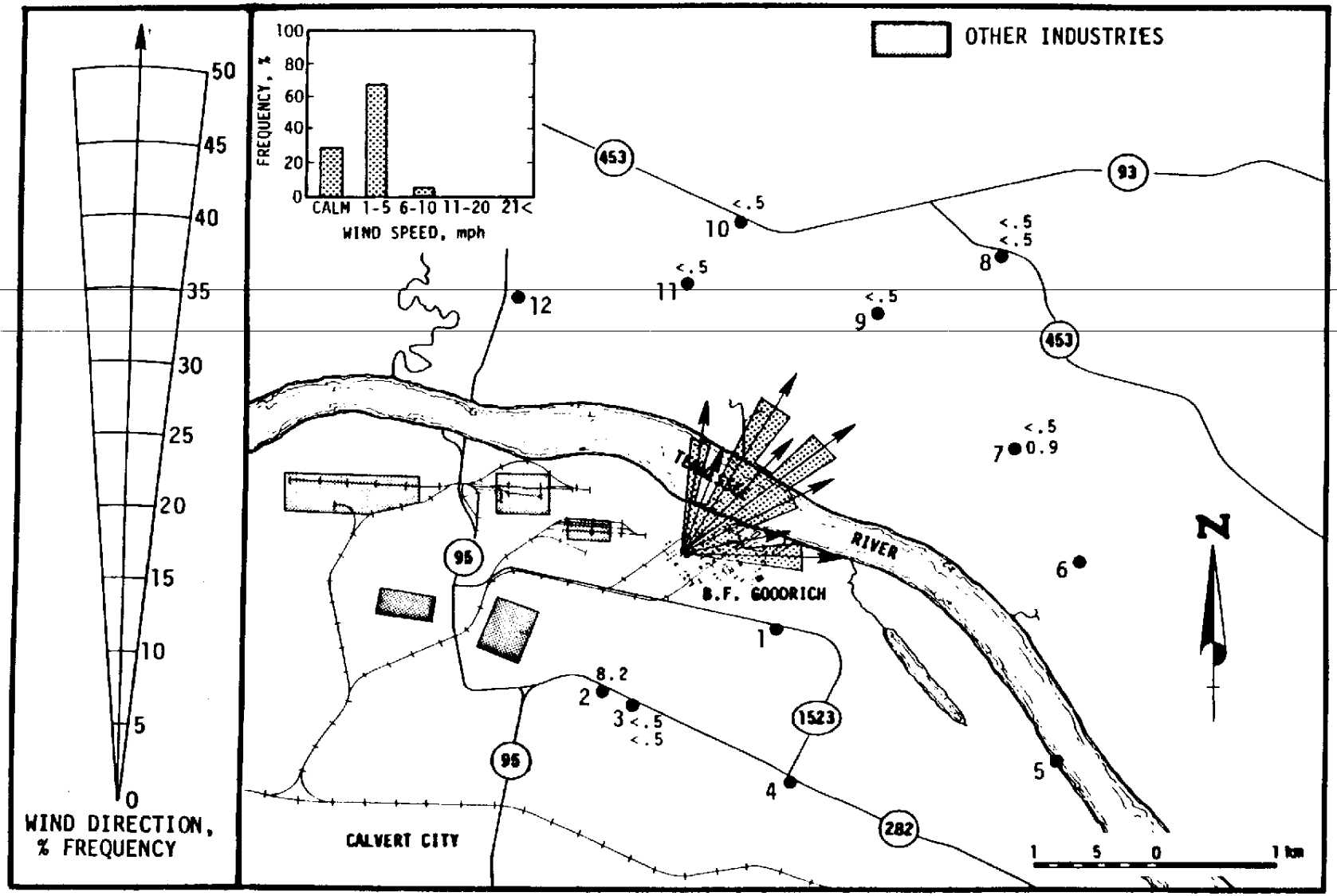

Figure 4-11. Results of ethylene dichloride study, Calvert City, Ky., 9-16-78. EDC concentration given in $\mu g/m^3$.

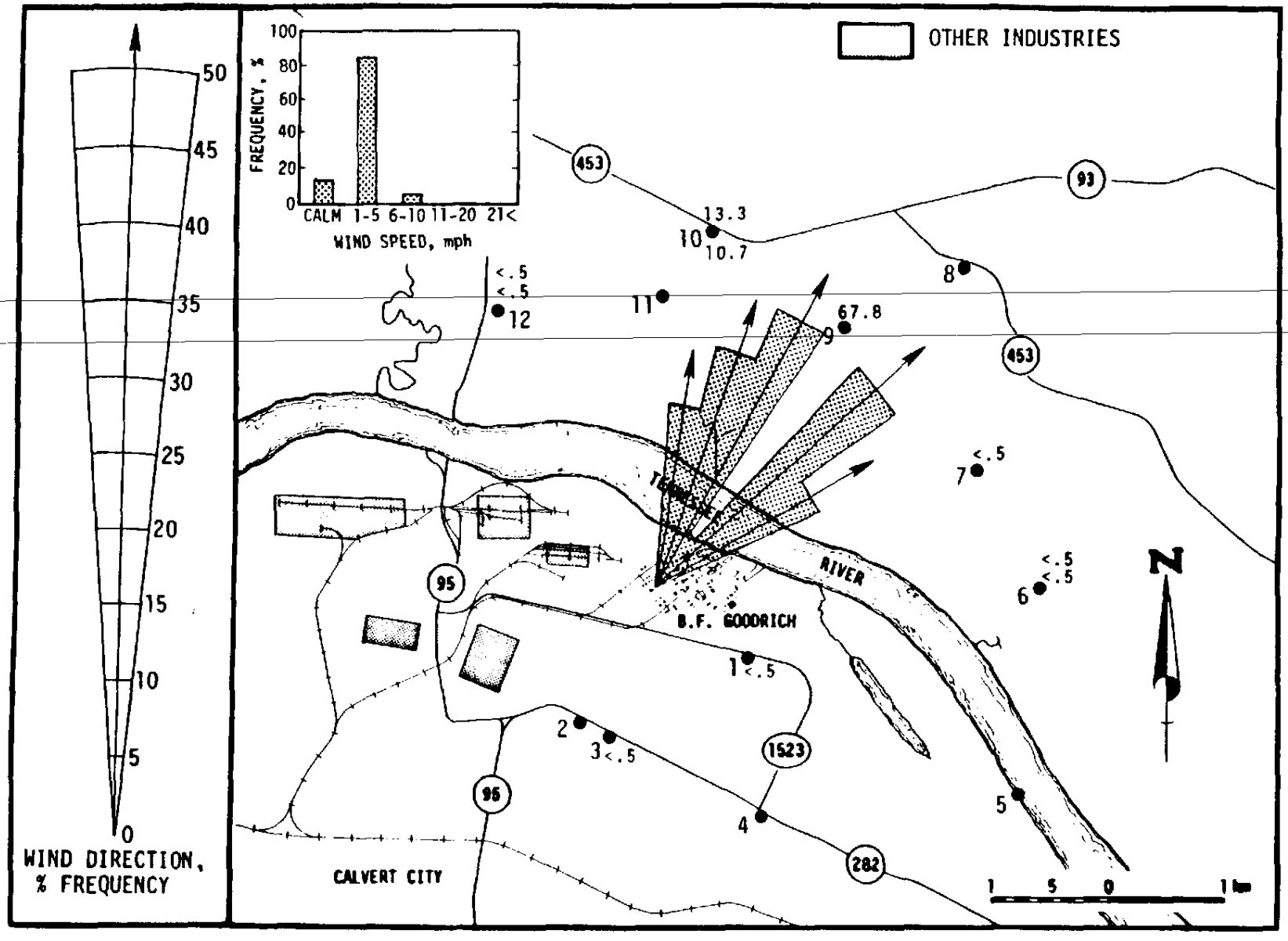

Figure 4-12. Results of ethylene dichloride study, Calvert City, Ky., 9-17-78. EDC concentration given in $\mu g/m^3$.

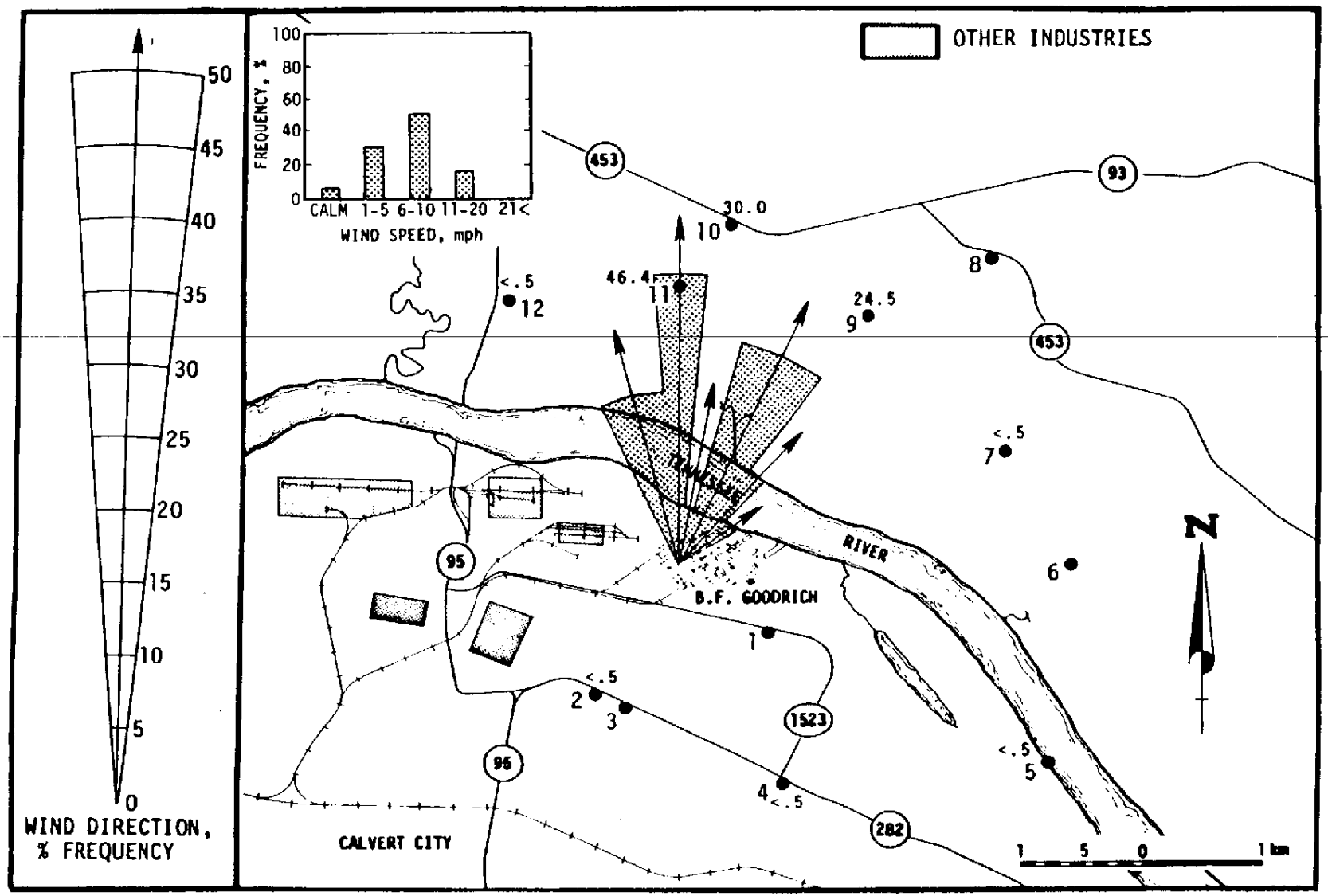

Figure 4-13. Results of ethylene dichloride study, Calvert City, Ky., 9-18-78. EDC concentration given in $\mu g/m^3$.

TABLE 4-2. DATA SUMMARY OF EDC LEVELS ($\mu g/m^3$)[a] IN LAKE CHARLES, LA., 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
10-1-78	227.6	199.9	20.5	87.8	122.0	42.0	1.9	0.6	5.7		51.0	9.7
10-2-78	76.7	6.0		5.1	5.8				10.7	7.1	324.3	19.2
10-3-78	225.2	147.3	52.3	41.0	295.5	33.6	27.3	32.8	30.2	36.2	581.6	497.8
10-4-78	47.6	472.5	60.3	274.8	280.1	96.2	21.6	14.9		14.9	3.1	39.6
10-5-78	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.

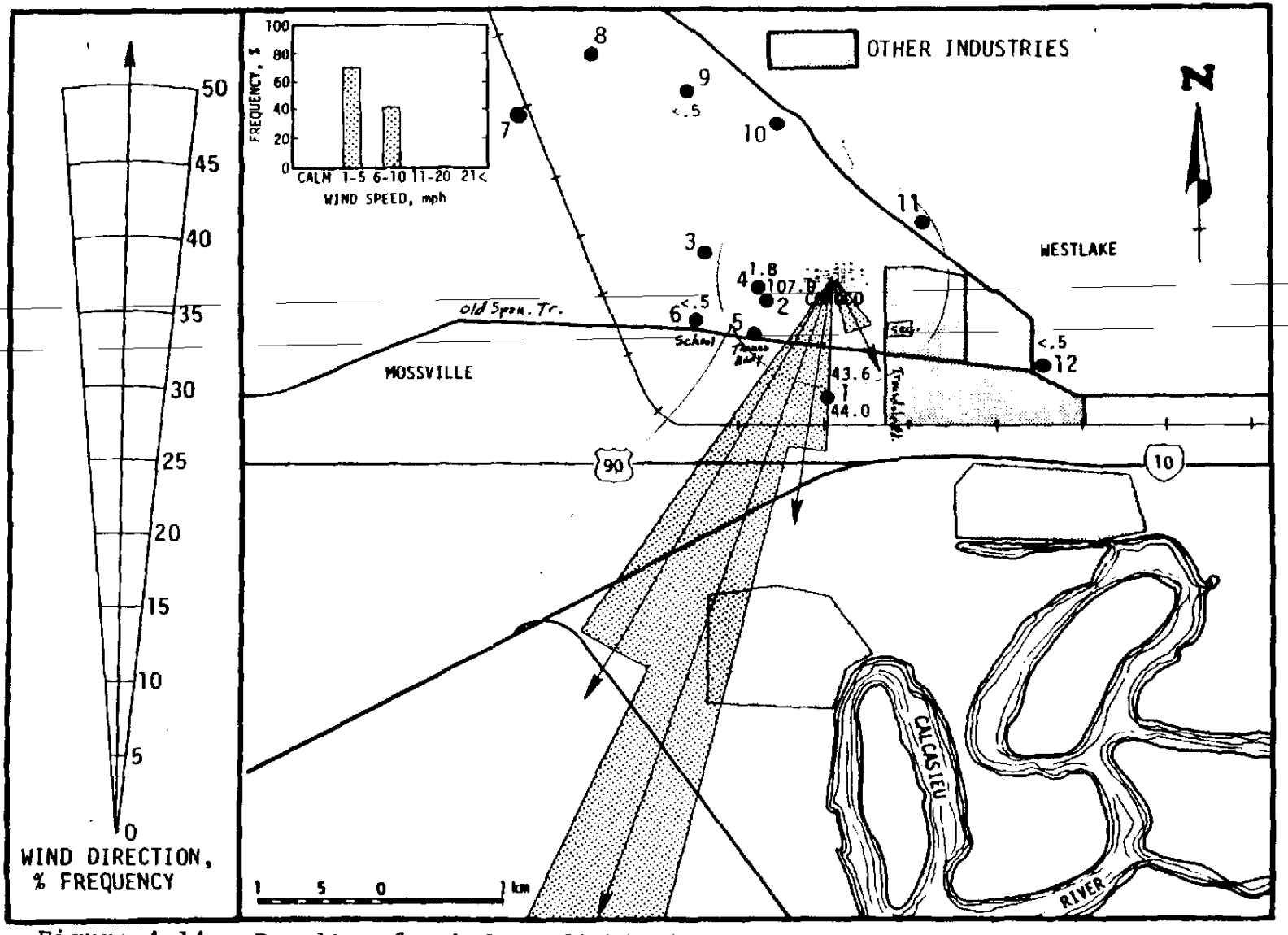

Figure 4-14. Results of ethylene dichloride study, Lake Charles, La., 9-24-78. EDC concentration given in $\mu g/m^3$.

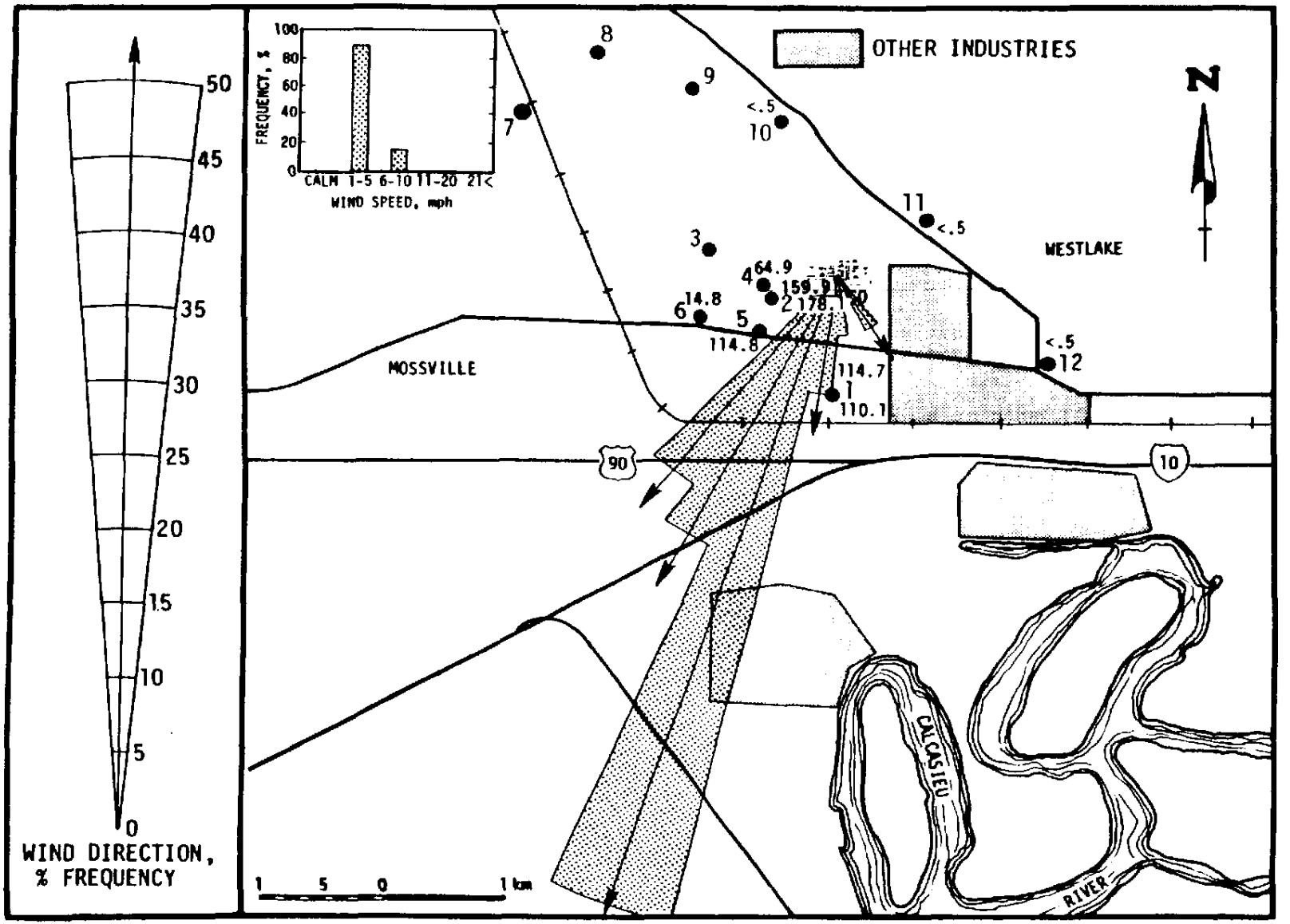

Figure 4-15. Results of ethylene dichloride study, Lake Charles, La., 9-25-78. EDC concentration given in $\mu g/m^3$.

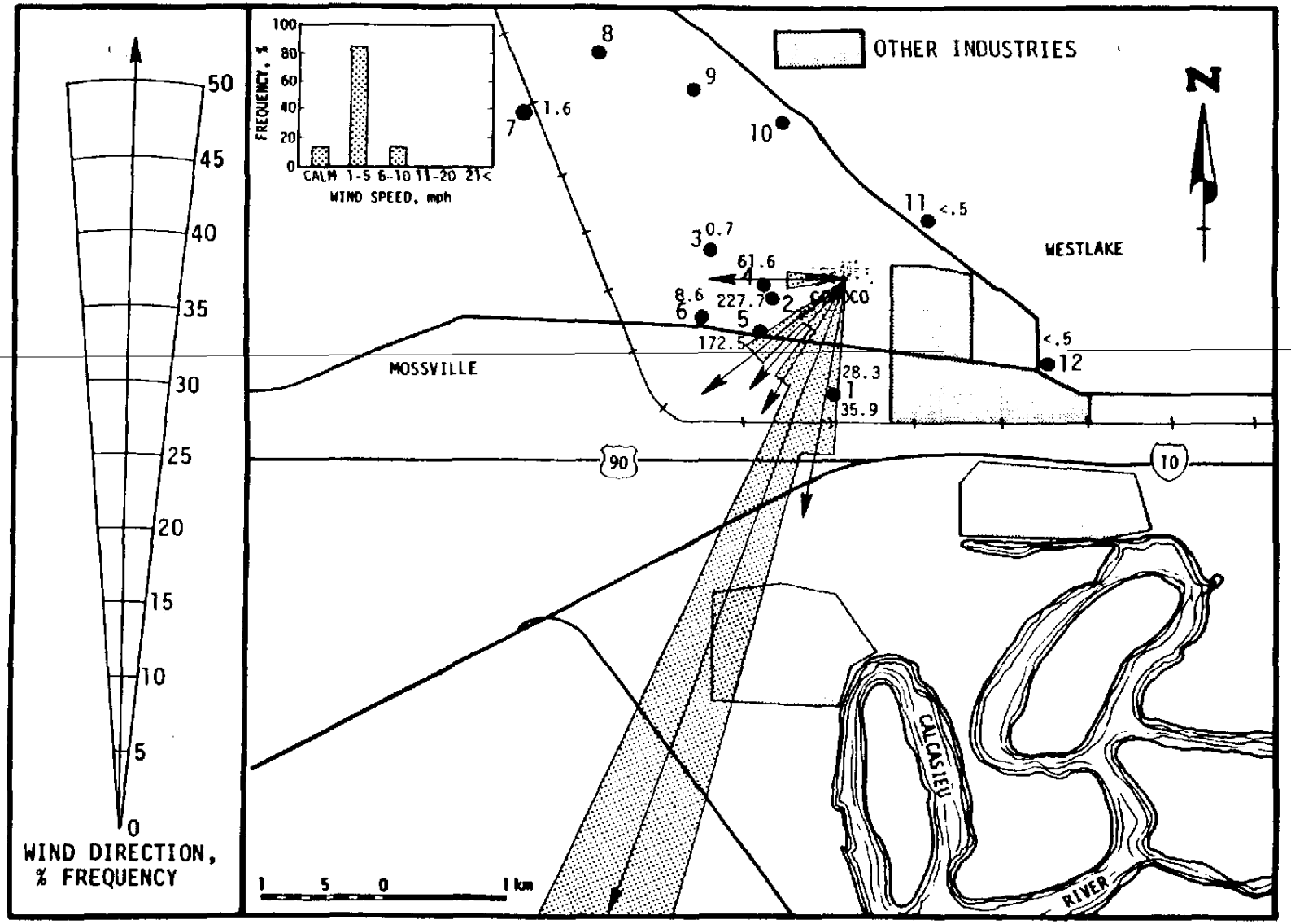

Figure 4-16. Results of ethylene dichloride study, Lake Charles, La., 9-26-78. EDC concentration given in $\mu g/m^3$.

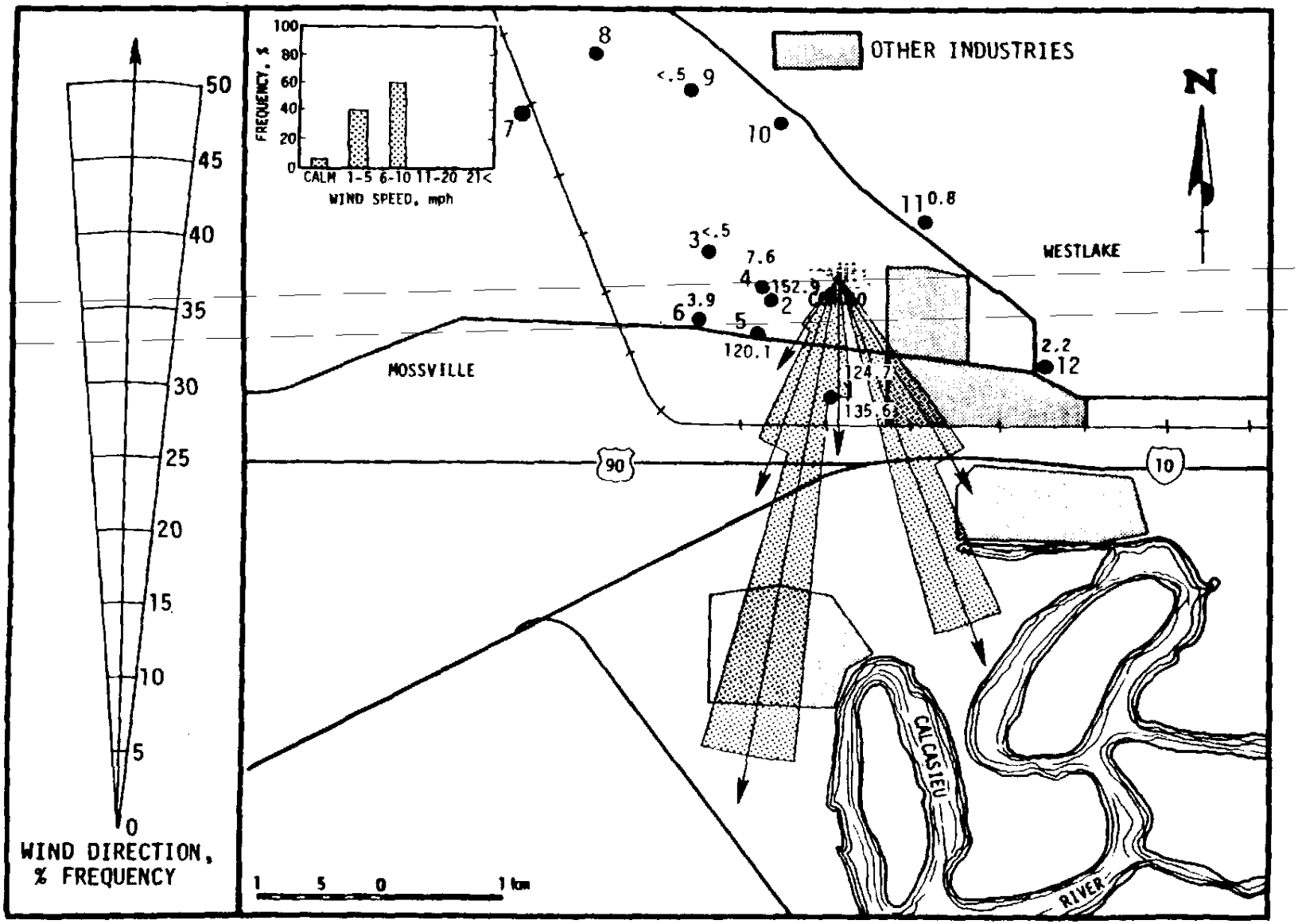

Figure 4-17. Results of ethylene dichloride study, Lake Charles, La., 9-27-78. EDC concentration given in µg/m3.

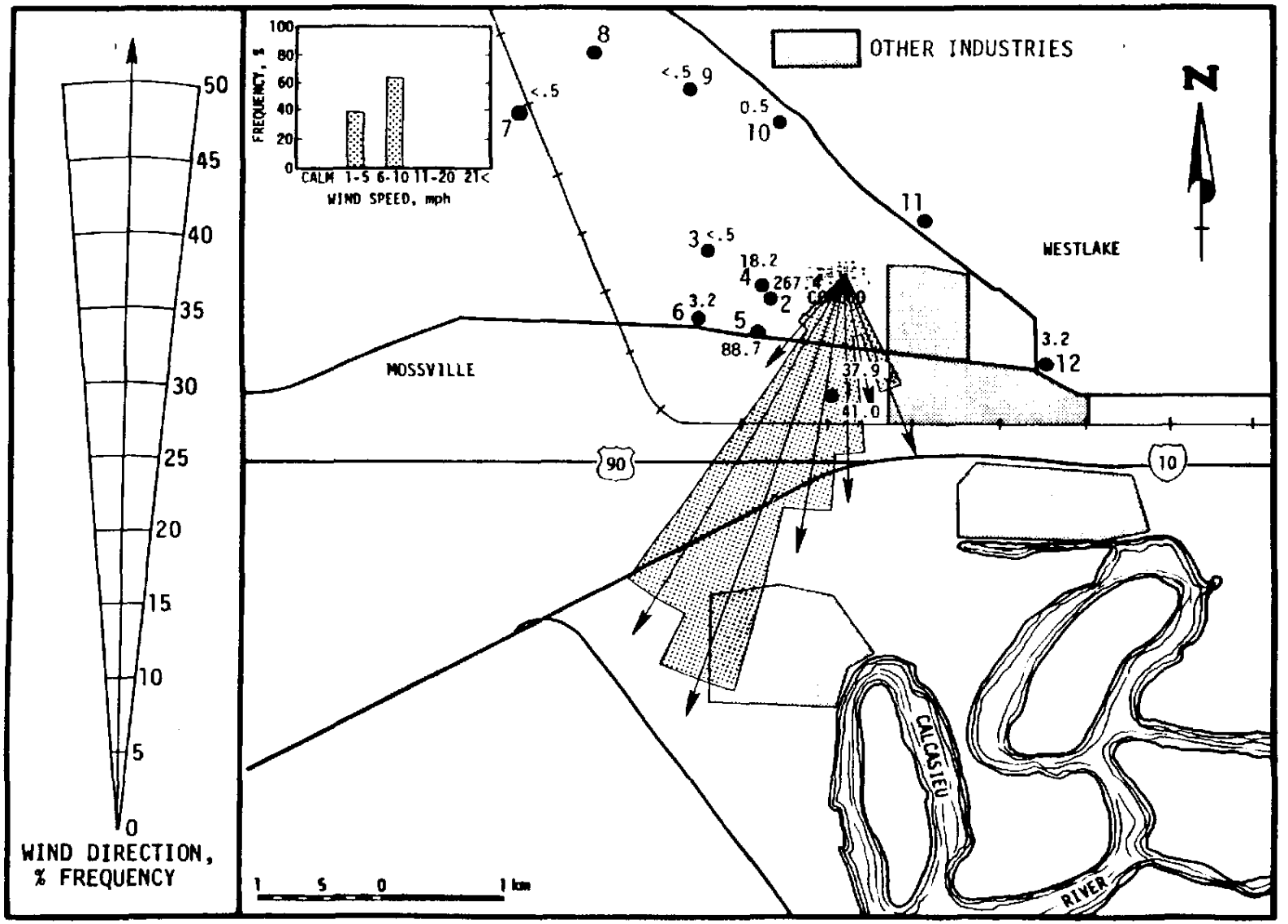

Figure 4-18. Results of ethylene dichloride study, Lake Charles, La., 9-28-78. EDC concentration given in $\mu g/m^3$.

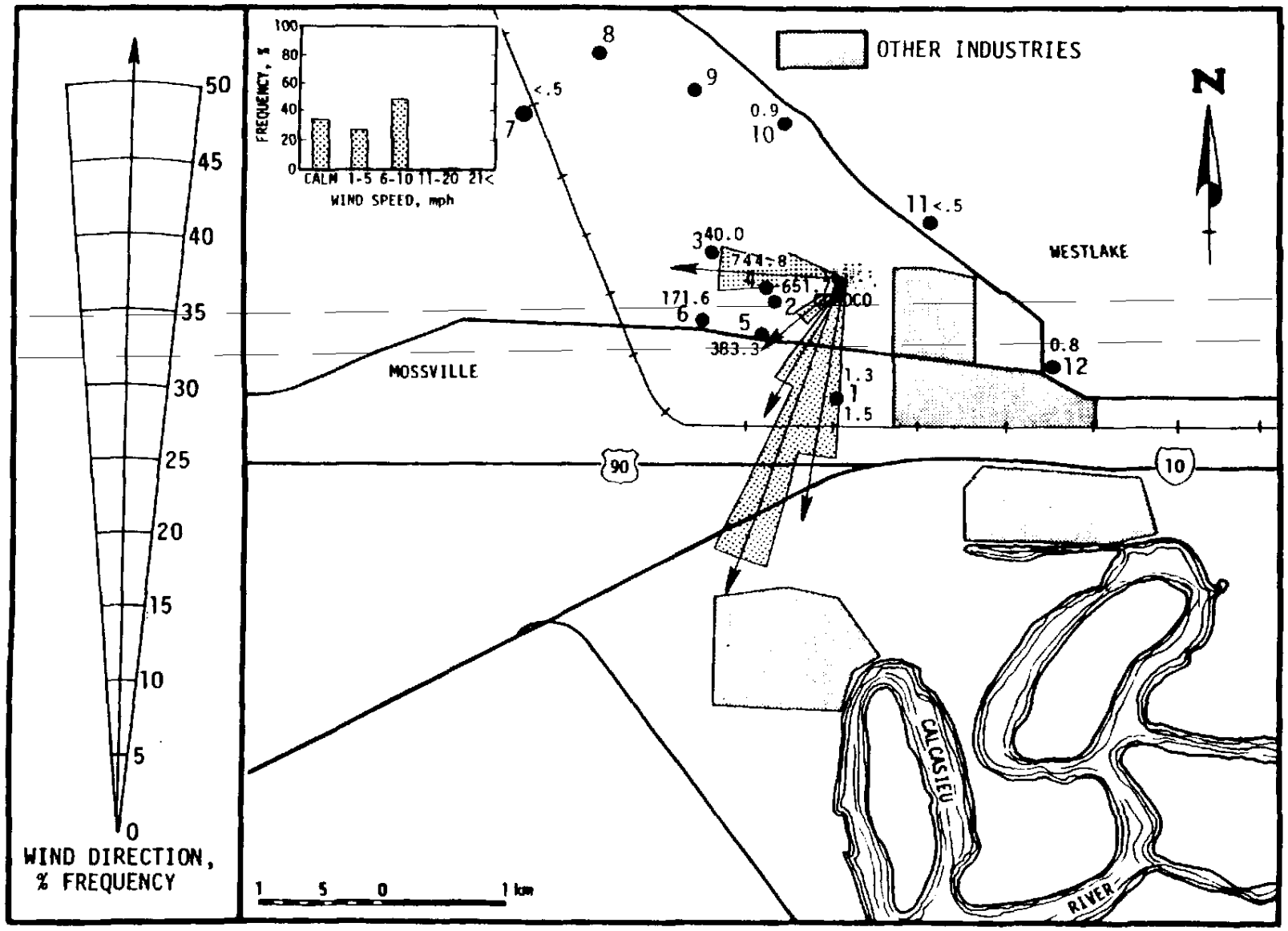

Figure 4-19. Results of ethylene dichloride study, Lake Charles, La., 9-29-78. EDC concentration given in $\mu g/m^3$.

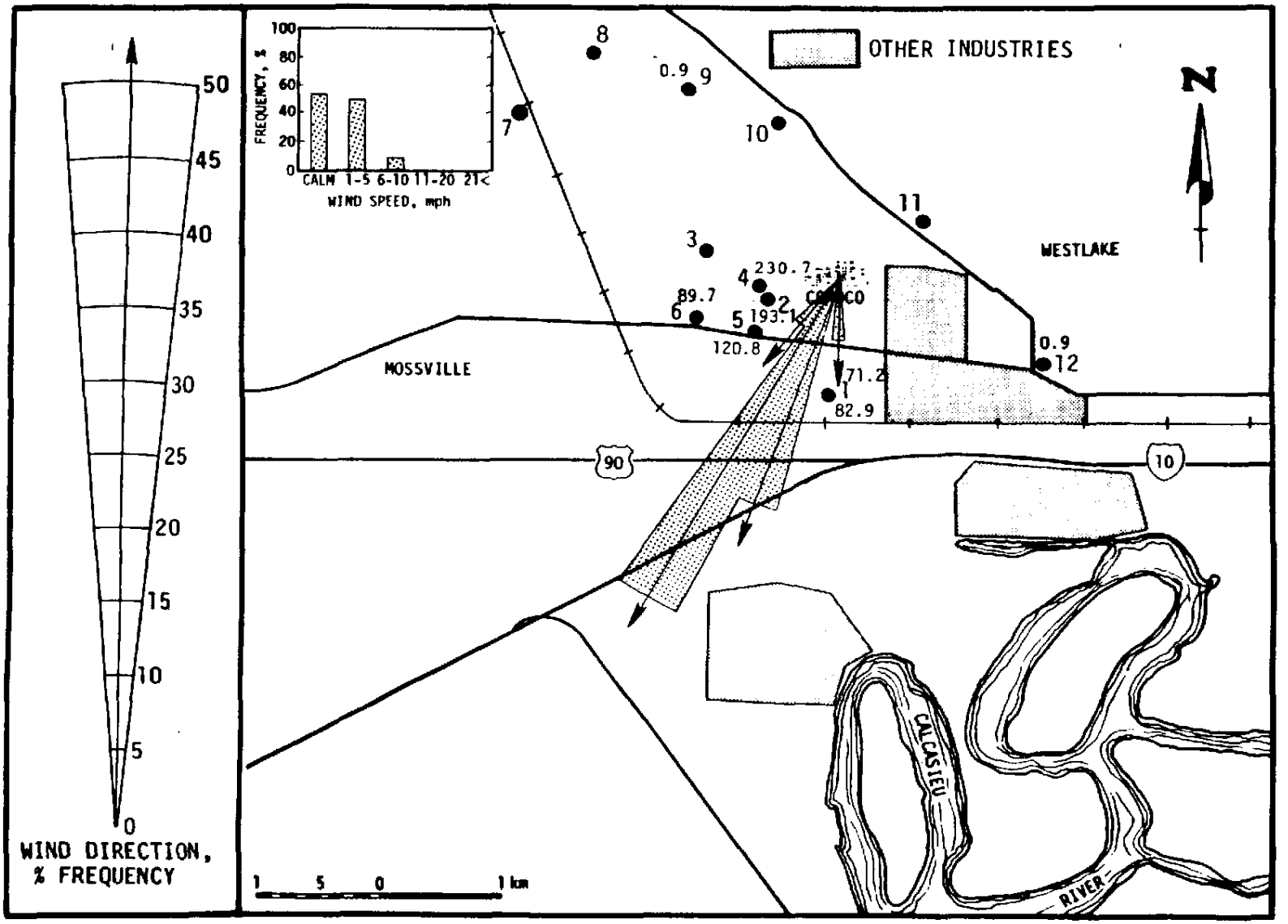

Figure 4-20. Results of ethylene dichloride study, Lake Charles, La., 9-30-78. EDC concentration given in $\mu g/m^3$.

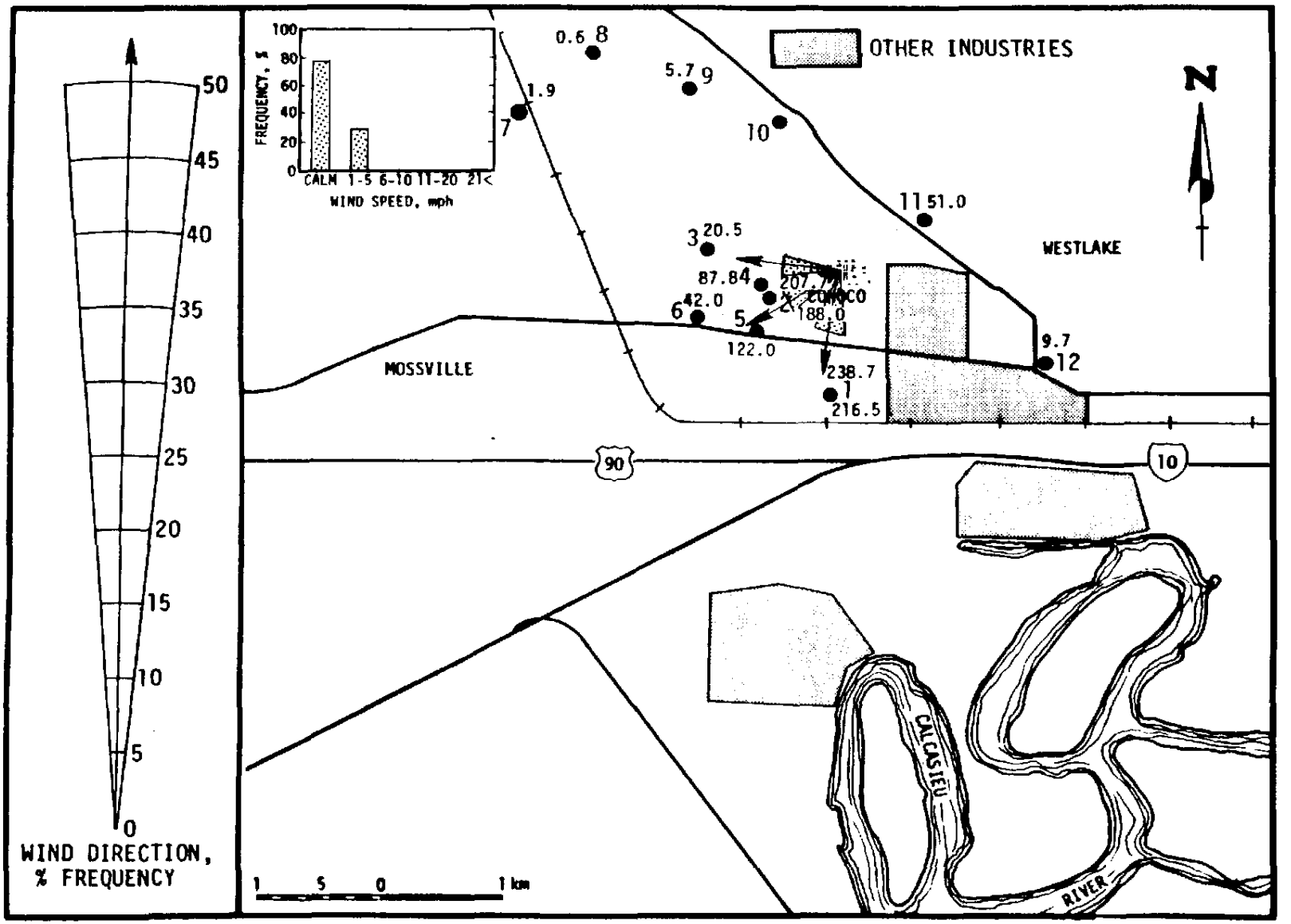

Figure 4-21. Results of ethylene dichloride study, Lake Charles, La., 10-1-78. EDC concentration given in $\mu g/m^3$.

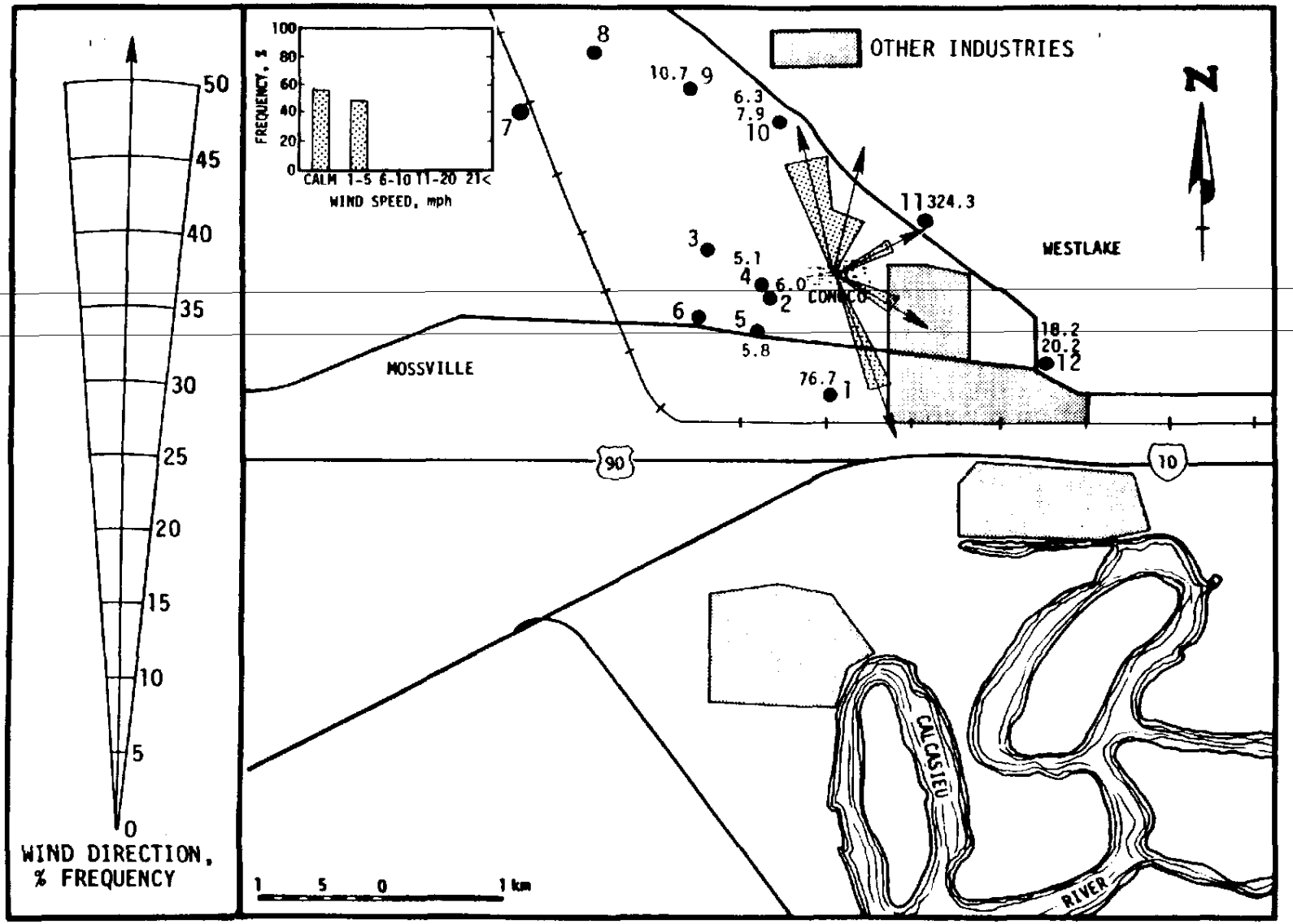

Figure 4-22. Results of ethylene dichloride study, Lake Charles, La., 10-2-78. EDC concentration given in $\mu g/m^3$.

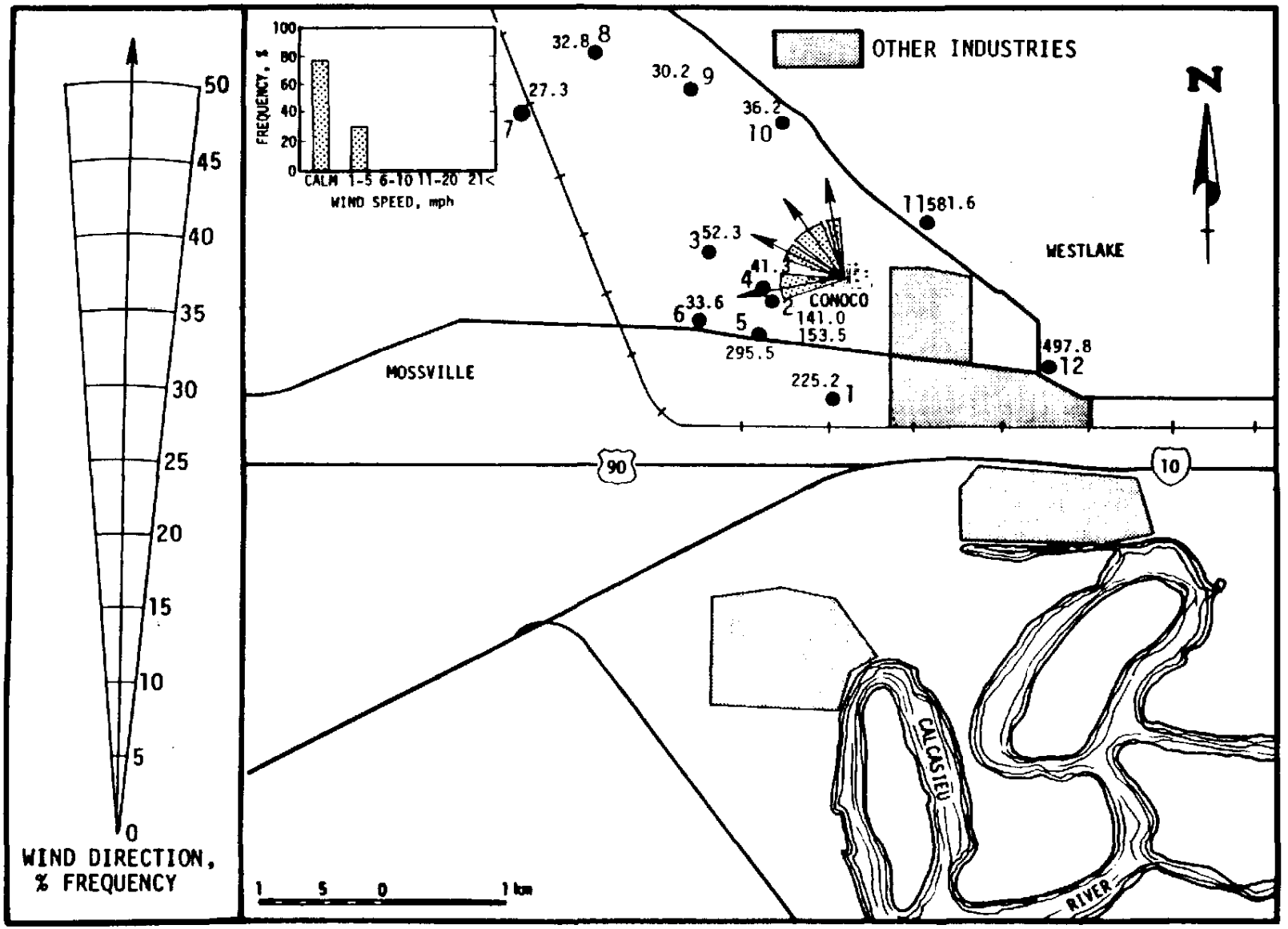

Figure 4-23. Results of ethylene dichloride study, Lake Charles, La., 10-3-78. EDC concentration given in $\mu g/m^3$.

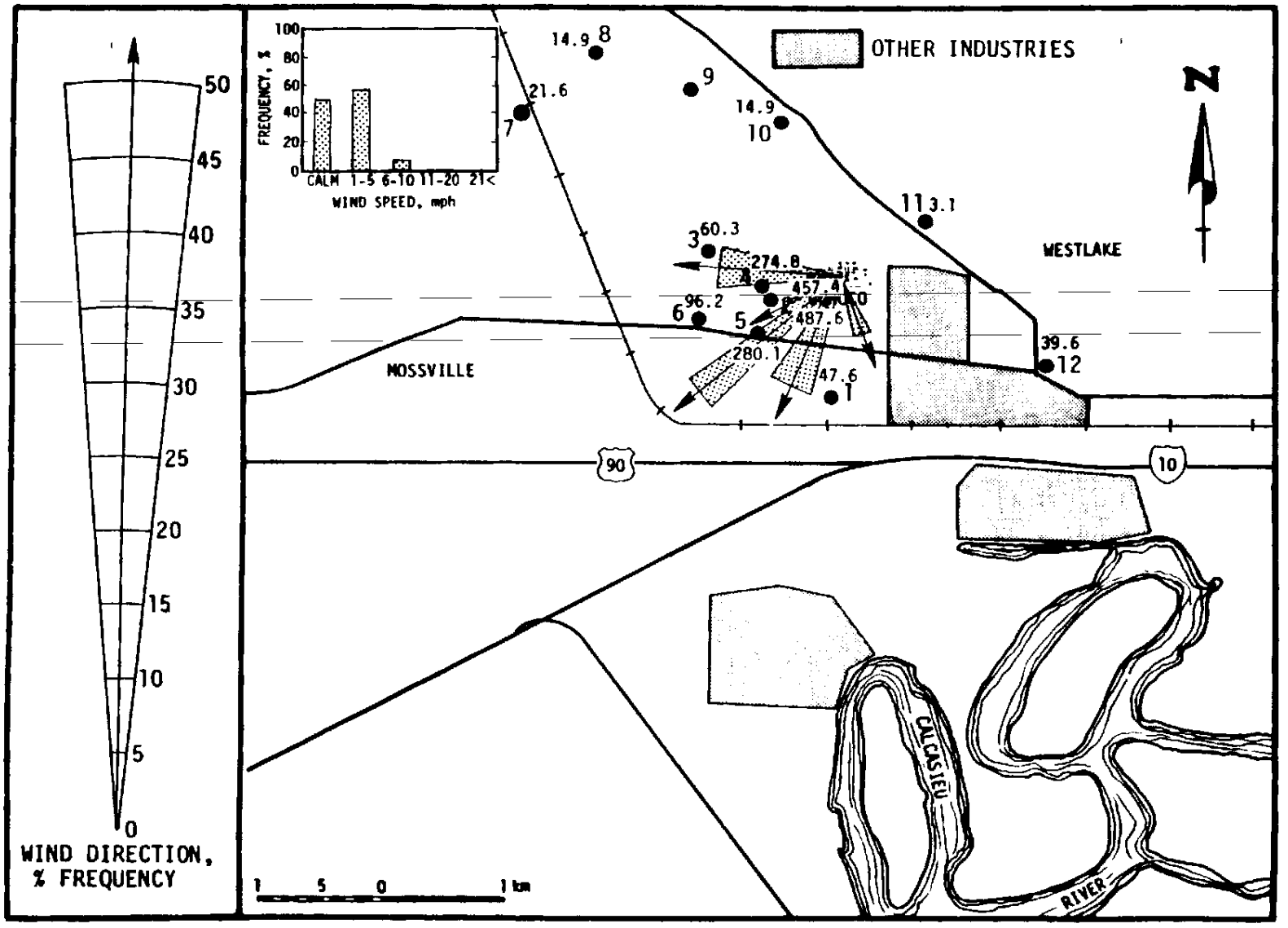

Figure 4-24. Results of ethylene dichloride study, Lake Charles, La., 10-4-78. EDC concentration given in $\mu g/m^3$.

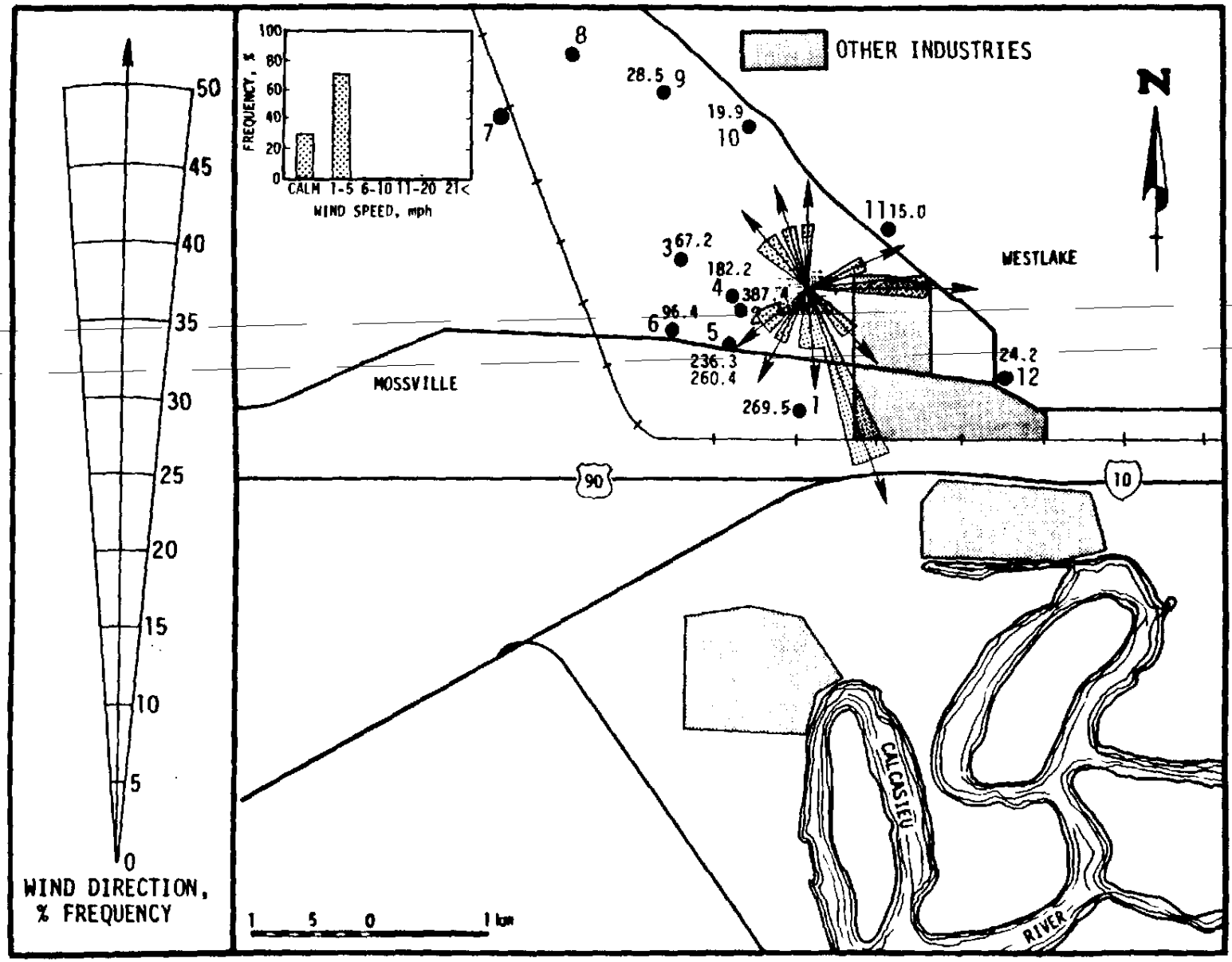

Figure 4-25. Results of ethylene dichloride study, Lake Charles, La., 10-5-78. EDC concentration given in $\mu g/m^3$.

TABLE 4-3. DATA SUMMARY OF EDC LEVELS ($\mu g/m^3$)[a] IN NEW ORLEANS, LA., STUDY AREA

Date sampled	Site location											
	1	2	3	4	5	6	7	8	9	10	11	12
10-10-78	<0.5		5.8	43.2	0.9		6.8	12.8		0.5		6.4
10-11-78	<0.5	0.7		45.4	<0.5	16.8	5.5	8.7				5.6
10-12-78		2.9	2.5	7.4	<0.5	20.7	24.3	1.8	1.5			0.7
10-13-78	0.6	2.7	5.2	23.7	<0.5		0.8	6.5	6.7		8.7	
10-14-78	<0.5		<0.5	0.6	<0.5		0.6	1.1	17.6	0.7	<0.5	1.2
10-15-78	1.2		0.8	37.8	3.1		2.0	14.0	0.7	13.1	4.4	
10-16-78		3.7		9.4	3.6		3.9	8.6	10.0	3.0	3.2	2.6
10-17-78		6.2		117.4	<0.5	<0.5	5.3	10.8	6.2	3.6	1.1	
10-18-78	<0.5	1.1	2.4	169.0	9.1		<0.5	29.1	6.2	6.0	<0.5	2.0
10-19-78	<0.5			31.2	<0.5		9.7	<0.5	7.1	3.8	<0.5	6.2

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

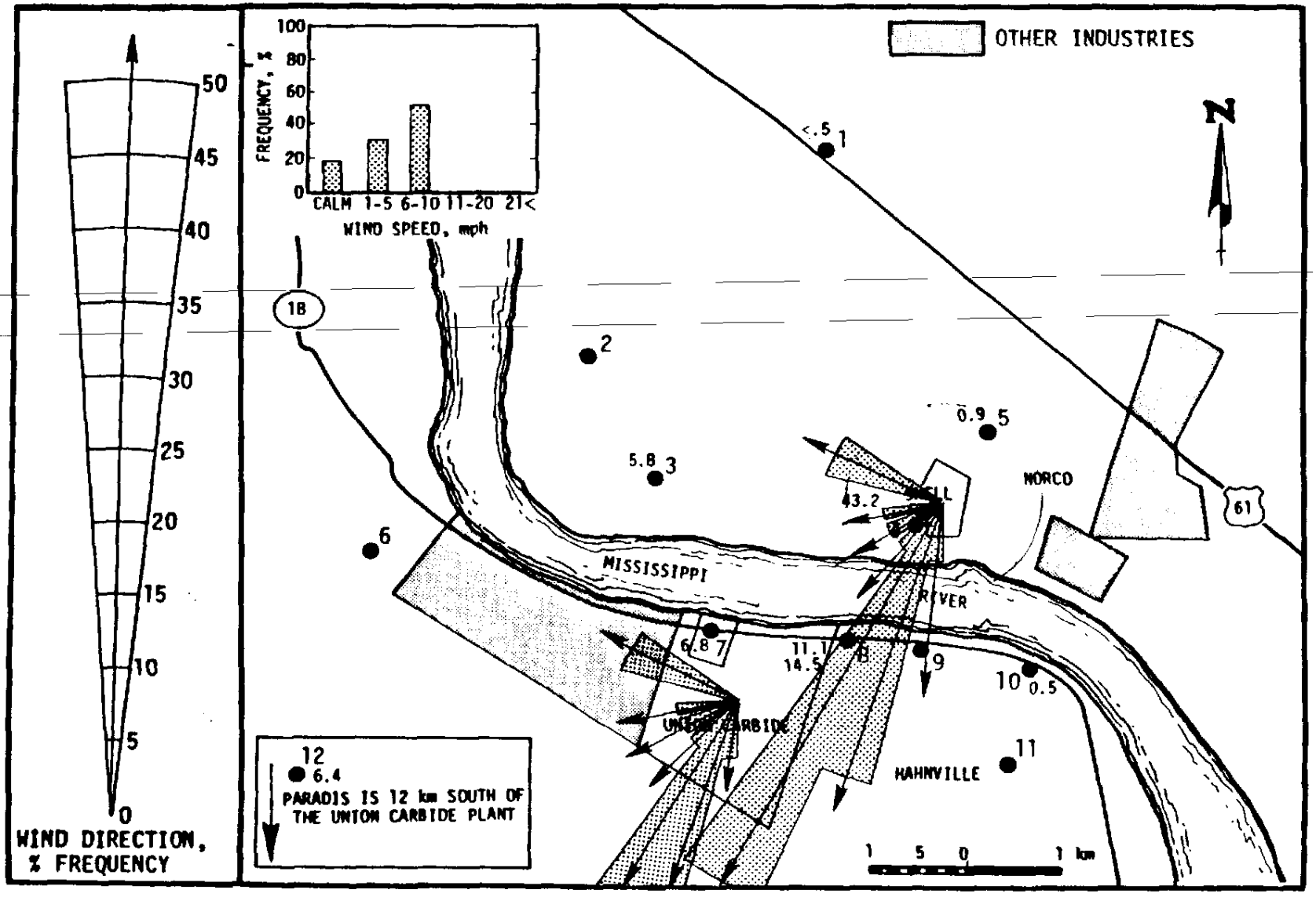

Figure 4-26. Results of ethylene dichloride study, New Orleans, La., 10-10-78. EDC concentration given in $\mu g/m^3$.

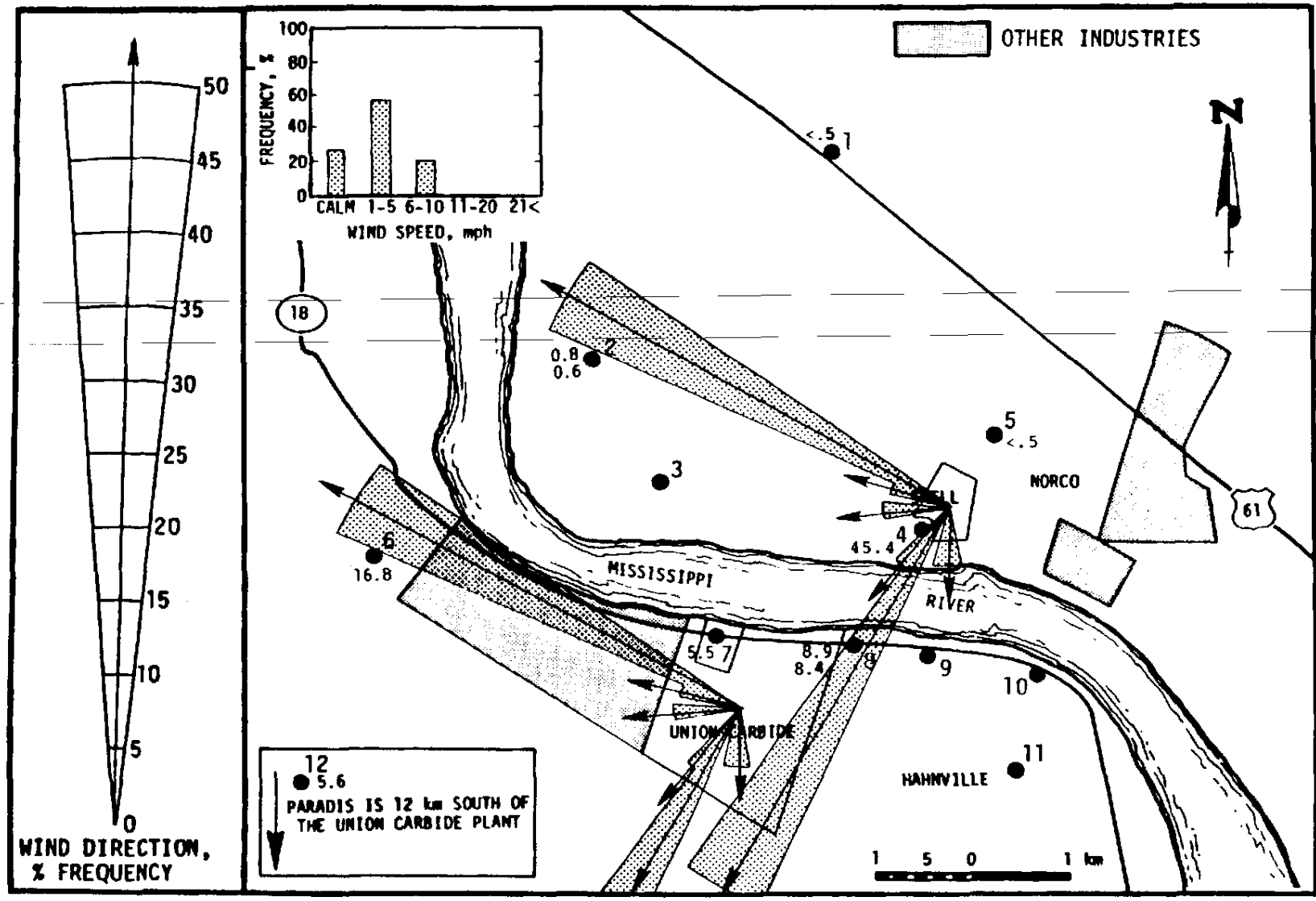

Figure 4-27. Results of ethylene dichloride study, New Orleans, La., 10-11-78. EDC concentration given in $\mu g/m^3$.

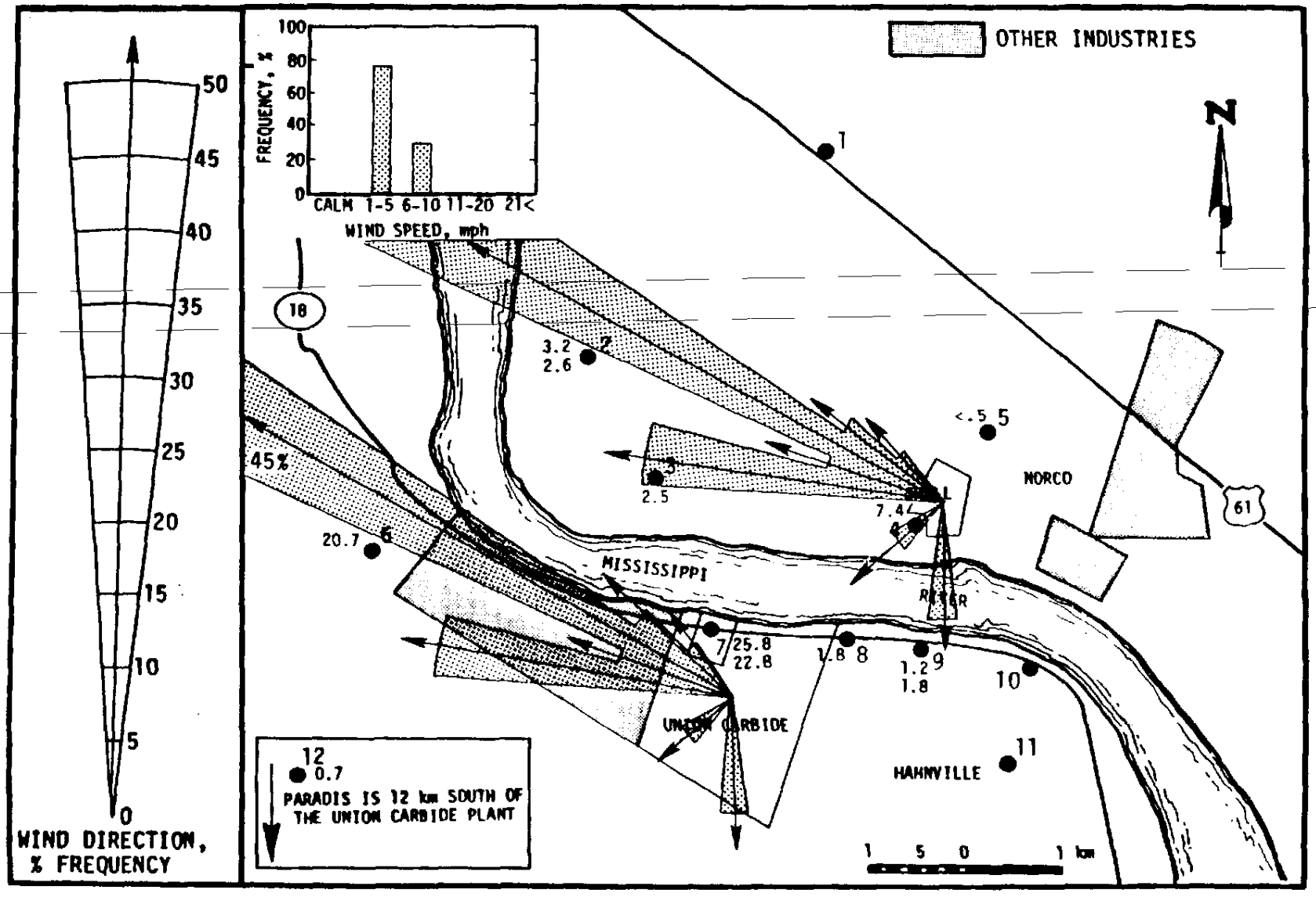

Figure 4-28. Results of ethylene dichloride study, New Orleans, La., 10-12-78. EDC concentration given in $\mu g/m^3$.

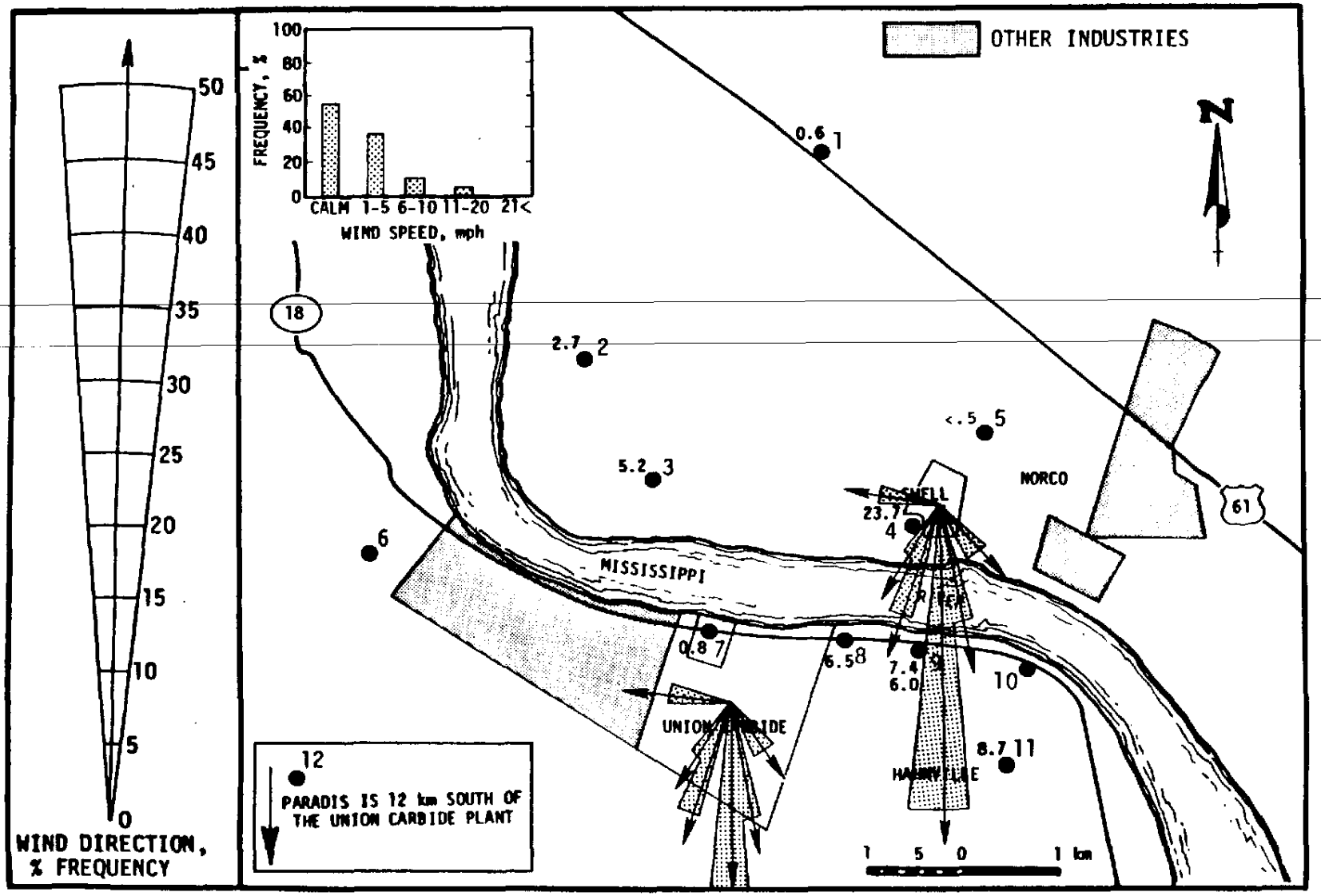

Figure 4-29. Results of ethylene dichloride study, New Orleans, La., 10-13-78. EDC concentration given in $\mu g/m^3$.

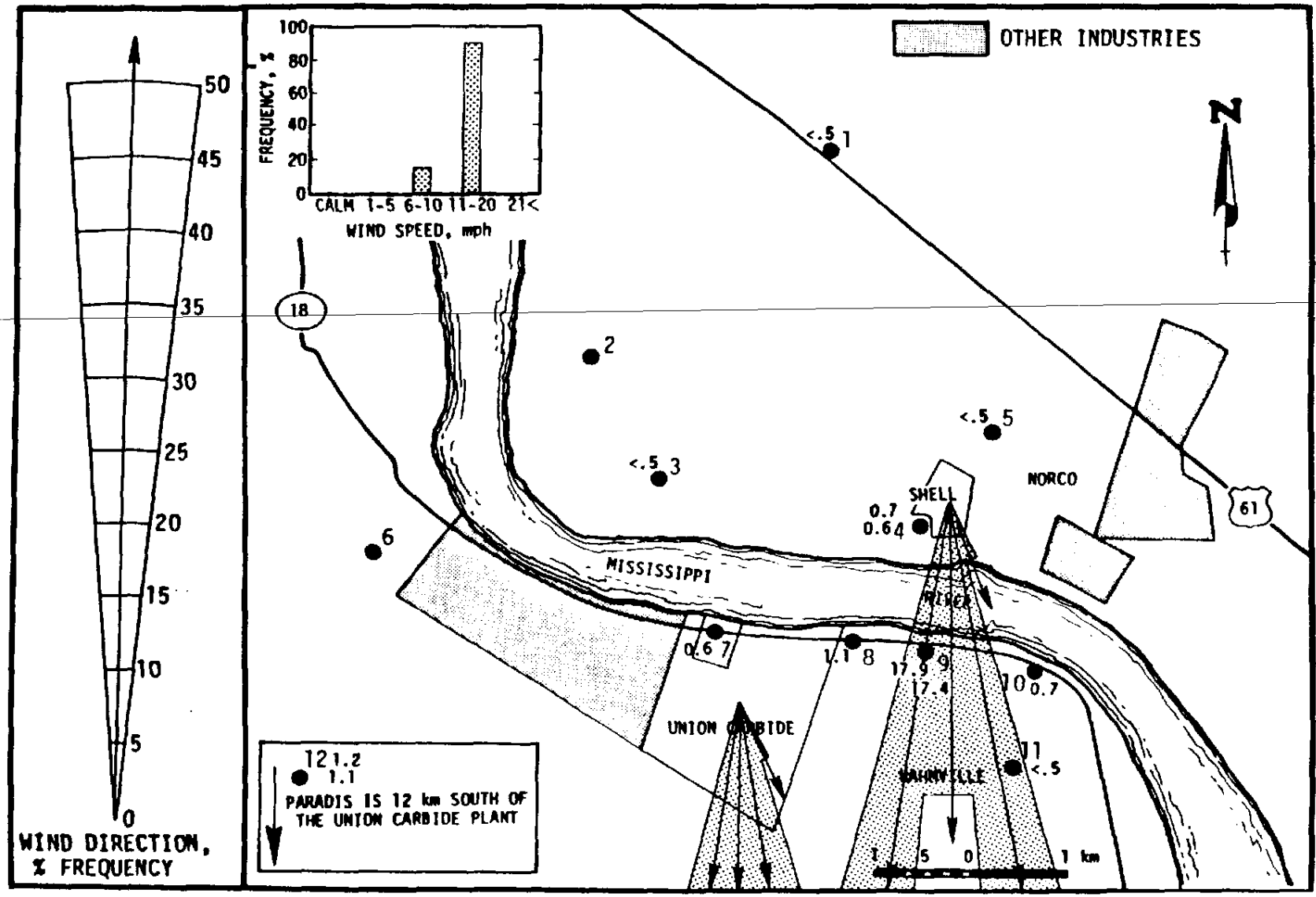

Figure 4-30. Results of ethylene dichloride study, New Orleans, La., 10-14-78. EDC concentration given in $\mu g/m^3$.

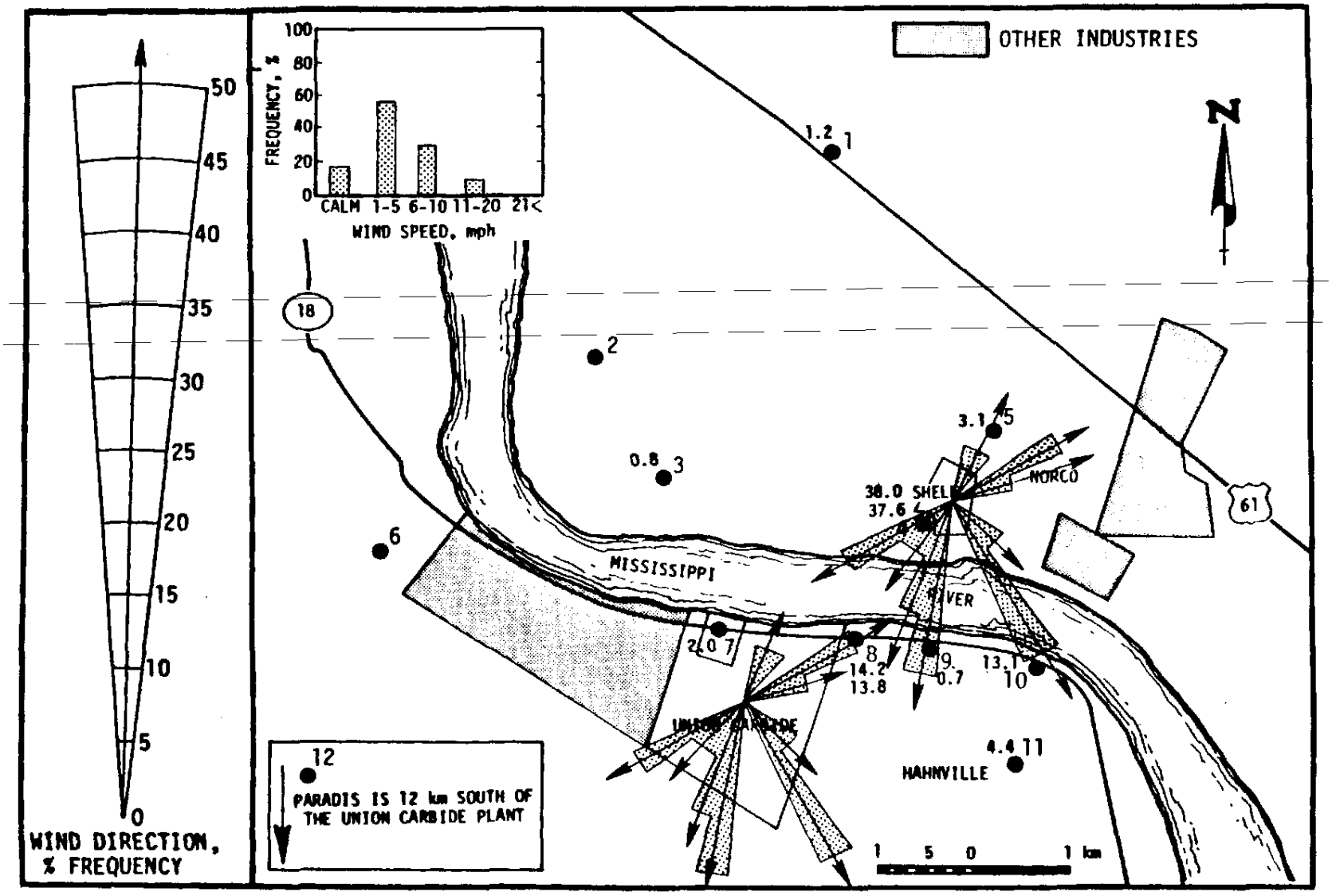

Figure 4-31. Results of ethylene dichloride study, New Orleans, La., 10-15-78. EDC concentration given in $\mu g/m^3$.

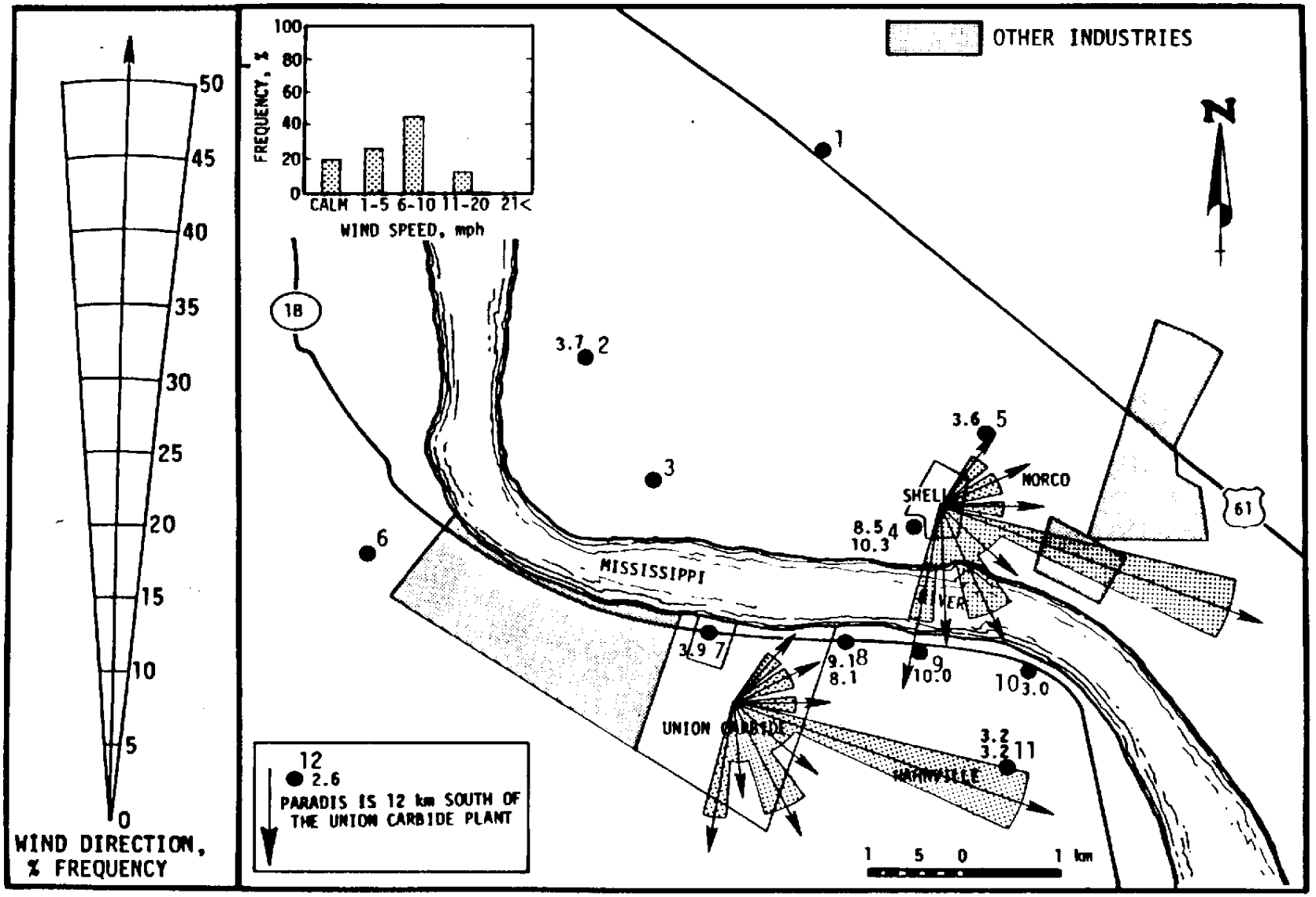

Figure 4-32. Results of ethylene dichloride study, New Orleans, La., 10-16-78. EDC concentration given in $\mu g/m^3$.

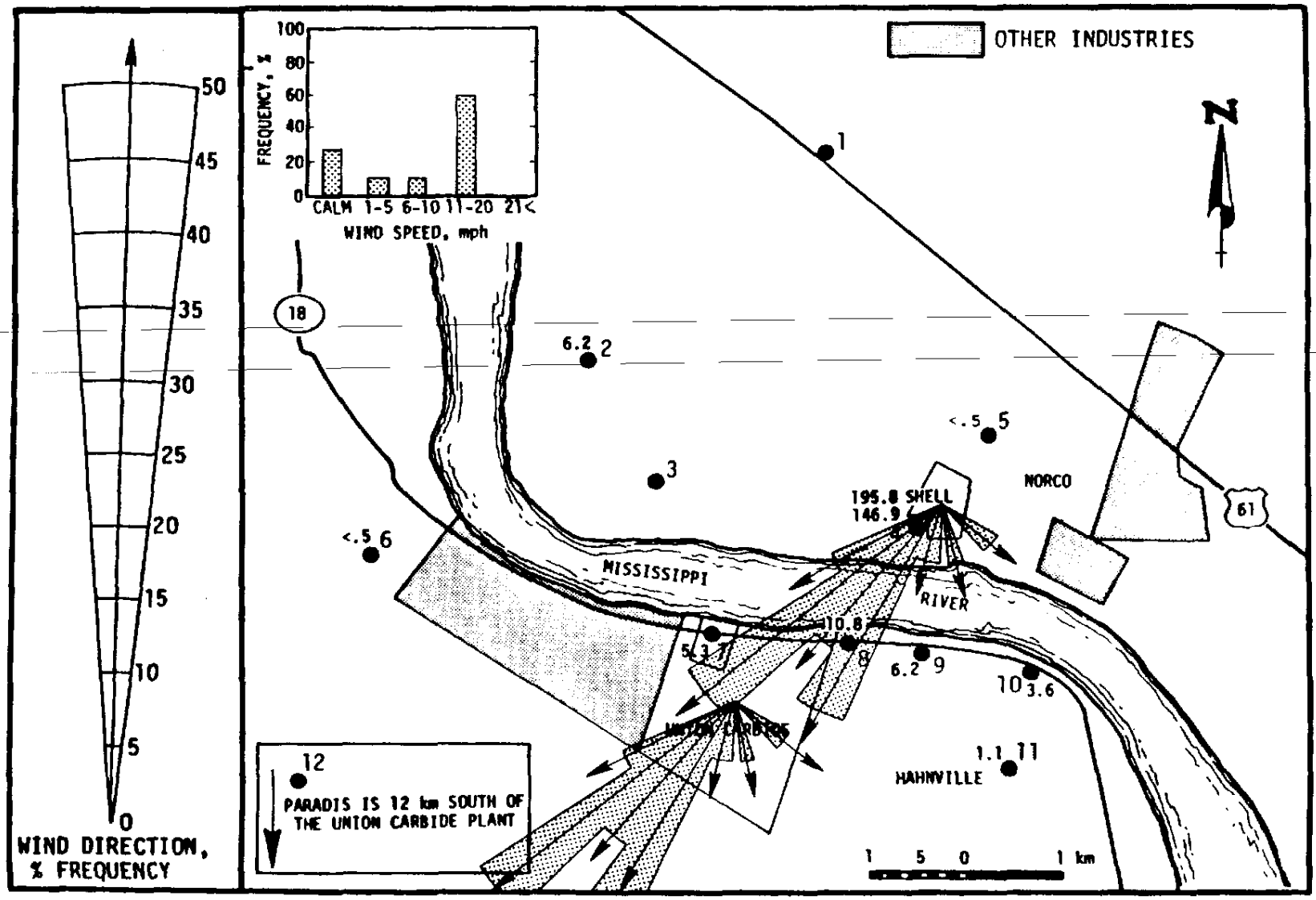

Figure 4-33. Results of ethylene dichloride study, New Orleans, La., 10-17-78. EDC concentration given in $\mu g/m^3$.

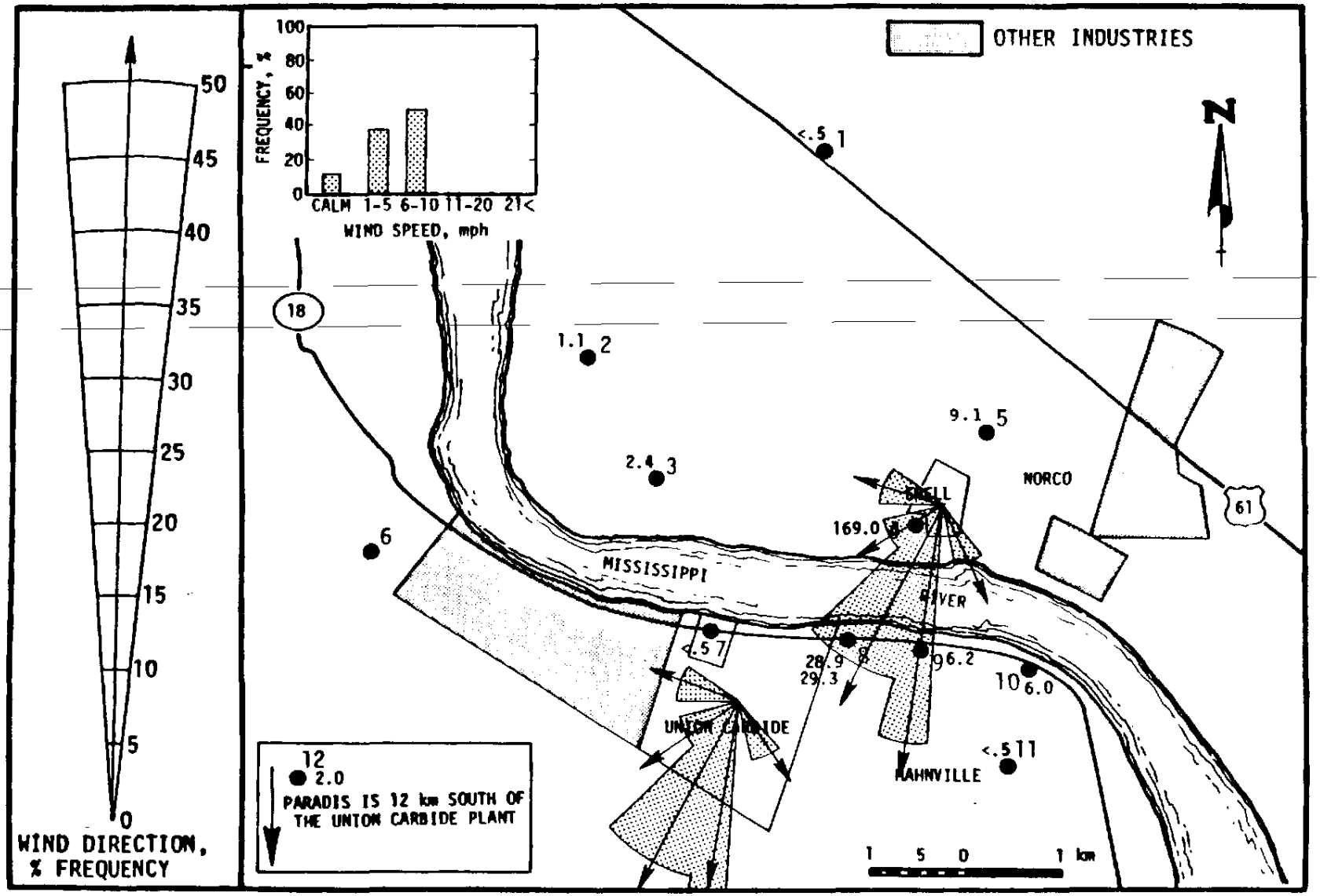

Figure 4-34. Results of ethylene dichloride study, New Orleans, La., 10-18-78. EDC concentration given in $\mu g/m^3$.

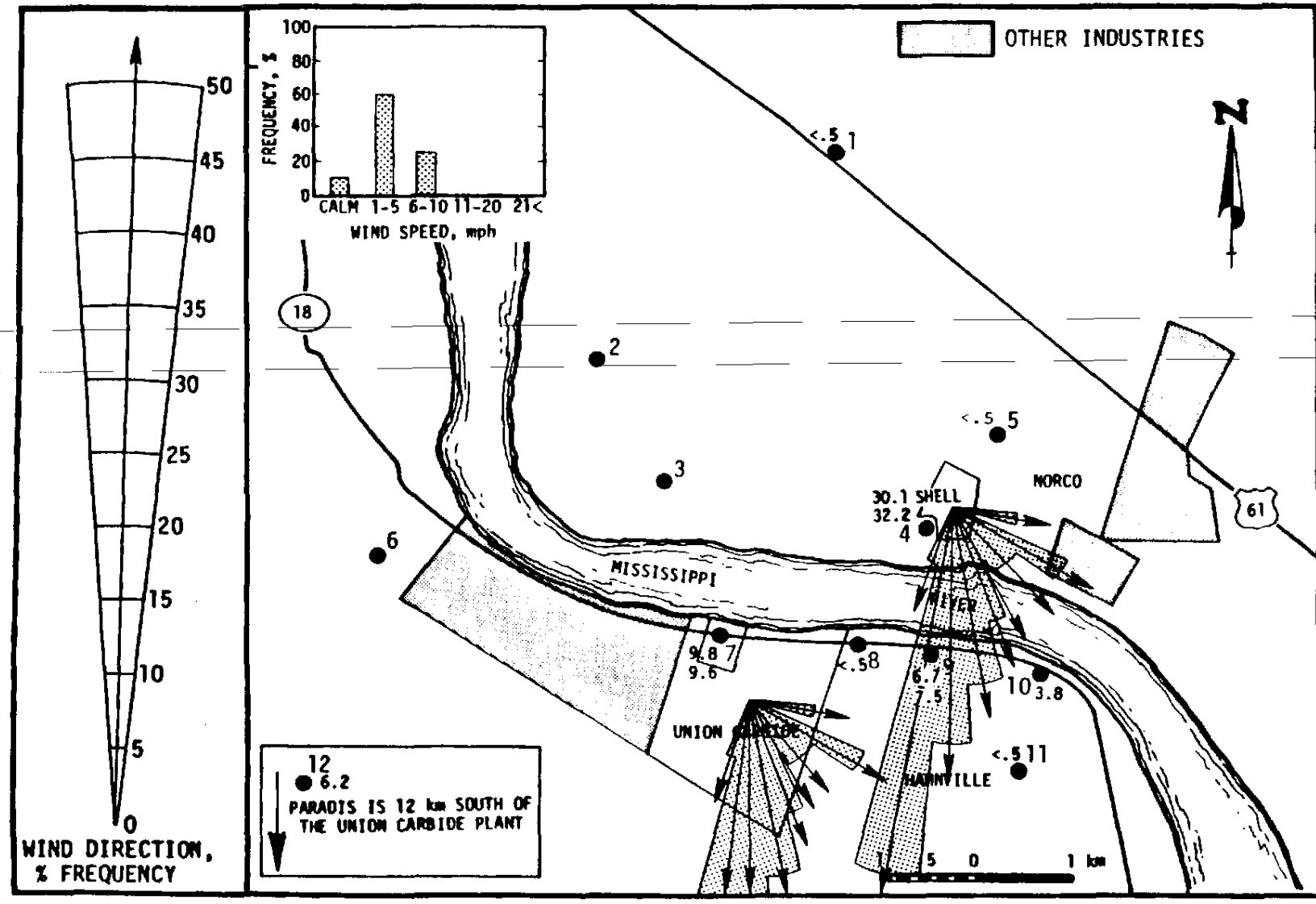

Figure 4-35. Results of ethylene dichloride study, New Orleans, La., 10-19-78. EDC concentration given in $\mu g/m^3$.

SECTION 5

QUALITY ASSURANCE PROGRAM

Because of the importance of the data being collected, adherence to strict quality control procedures was needed in sample collection, handling, and analysis.

5.1 SAMPLE COLLECTION

Duplicate samples (consisting of two sets of tandem charcoal adsorption tubes) were collected at each site, and a rotameter was used to take flow measurements. Readings were taken at the beginning, at midpoint, and at the end of the 24-hour sampling period. The rotameter was calibrated with an NBS traceable soap bubble meter at the beginning and end of each 10-day sampling period.

The length of the sampling period was measured by a time meter attached to each sampler. All meters were checked for proper operation before sampling commenced, and they were found to be within ± 0.1 percent. The actual start and stop times each day were controlled by a 24-hour timer that started and ended each sampling period at midnight.

5.2 SAMPLE HANDLING

Each tube was numbered with the date and site location. Tube seals were broken on the site. During sample collection, the charcoal tubes were protected from light and rain by a metal shield. After being removed from the sampler, the tubes were capped and refrigerated at 0°C until brought to the laboratory for analysis.

5.3 SAMPLE ANALYSES

The GC/MS instrument was calibrated with three external standard solutions before sample analysis. An internal standard was also incorporated to monitor the response of the mass spectrometer. None of these standards could deviate by more than ± 5 percent from the average. A standard was analyzed after each 10 samples analyzed, and was required to meet the same criterion of ± 5 percent. If a standard response was beyond this limit, immediate corrective action was taken before continuing sample analysis; but no corrections were made to previous analyses.

One out of every 10 samples analyzed was an EDC quality control check sample. These samples were prepared by the EPA and were analyzed blind. Twenty percent of all duplicate samples collected from each study area were analyzed, and extracts of 10 percent of all the samples analyzed were reanalyzed. PEDCo generated its own sets of internal quality control samples, and analyzed them with each batch of samples from the field. These data were used to measure the internal accuracy of the analytical

method. The specific quality control data are presented in the following sections.

5.4 QUALITY CONTROL DATA PRESENTATION

5.4.1 Quality Control Check of Solvents, Charcoal Tubes, and Standard Reference Materials

Solvents--

The solvent used for the desorption of EDC from the charcoal tubes was Fisher Reagent Quality carbon disulfide. Lot No. C184 was used for the analyses in this study. The solvent was analyzed by GC/MS more than 30 times (several analyses were made on each bottle opened), and no EDC was detected.

Charcoal Tubes--

More than thirty 150-mg charcoal tubes (see Figure 5.1) of Lot No. 107, manufactured by the SKC Corporation, Pittsburgh, Pennsylvania, were analyzed by GC/MS during the analyses of the field samples, and no EDC was detected.

Analyses of Field-Exposed Charcoal Tubes--

During the three field studies, about 60 charcoal tubes were exposed with one end open to the ambient air for a period of 24 hours. This test was conducted to find out if EDC would migrate into a tube before or after dynamic sampling was initiated. Over 20 tubes were selected at random from those used in the three study areas, and analysis for EDC was performed. No EDC was detected by the GC/MS analysis of these tubes.

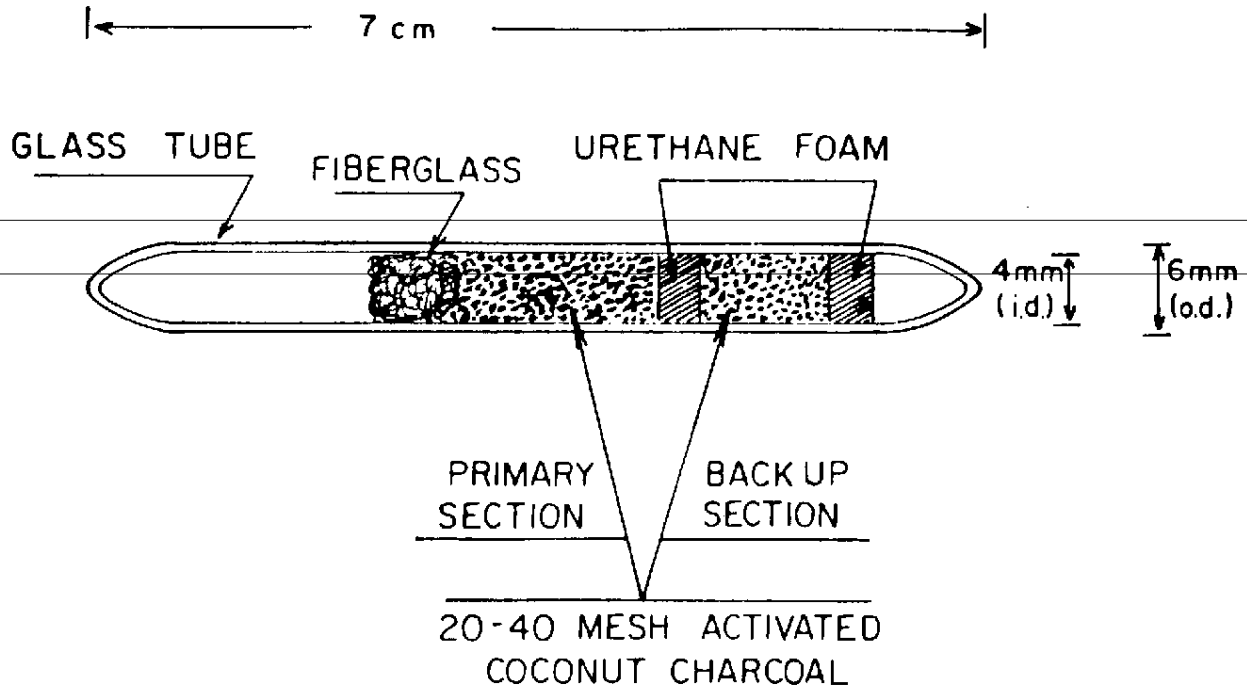

Figure 5-1. Diagram of a 150-mg charcoal tube.

Purity Check of EDC Standard--

Ethylene dichloride supplied by Chem Services, West Chester, Pennsylvania (Lot No. 0-642), with a purity quoted by the manufacturer at 99+ percent, was used for the preparation of EDC external standard solutions. A GC/MS analysis of this material, using the same conditions as for the analysis of field samples, did not show the presence of contamination from other compounds. The manufacturer's assay of 99+ percent was, therefore, assumed to be accurate; and no corrections were made with respect to the purity of this reagent when it was used for the preparation of external standard solutions.

5.4.2 Evaluation of EDC Breakthrough While Sampling High Levels of EDC

The preliminary tests of the methodology did not include breakthrough tests at extremely high EDC levels. During the study at Lake Charles, Louisiana, high levels were encountered. To detect breakthrough, PEDCo analyzed the second 150-mg charcoal tube in the series for the presence of EDC. Several tubes were selected for analysis, and EDC was detected in the backup tubes of two. Breakthrough was experienced only at the EDC range of 200 to 600 $\mu g/m^3$ (60-180 ppb), and amounted to about 1 percent. The breakthrough could result from nonhomogeneous charcoal packing within some of the tubes, because it was not detected in all samples in that range. Table 5-1 summarizes these tests.

TABLE 5-1. ANALYSIS OF BACKUP TUBES FROM HIGH LEVEL EDC SAMPLING

Date sampled	Site No.	EDC $\mu g/m^3$	
		Front	Back
9-25-78	1	114.7	<0.5
9-26-78	1	35.9	<0.5
9-29-78	2	651.7	<0.5
10-1-78	1	216.5	1.5
10-3-78	2	141.0	<0.5
10-3-78	11	581.6	6.2
10-4-78	2	457.4	<0.5

5.4.3 Analysis of Collocated Samples

All of the sampling was performed in duplicate. About 10 percent of the collocated samples were selected for further statistical analysis, to establish the total sampling and analytical error. Tables 5-2 through 5-4 present the results of these analyses for the three study areas, together with the arithmetic means and standard deviation of the results from the collocated samples.

These data show that the standard deviation of EDC concentrations, as determined by collocated sampling, increases as the EDC concentration increases. The relationship between the standard deviation and the mean EDC concentration is most clear in the data from Lake Charles, La. (Table 5-3). A graphic presentation of this relationship for all the collocated samples is given in Figure 5-2.

Because of the apparent relationship between the standard deviation and the mean, the variability between concentrations (based on the collocated sampling) is expressed in terms of the relative standard deviation [i.e., $s/\bar{x}$ (100)]. Regression analysis showed the relative standard deviation for these data to be approximately 6 percent. This variability is a measure of the precision of both the sampling and the analytical procedures.

5.4.4 Duplicate Analysis of Desorbed Field Samples

The relative standard deviation of 6 percent is an estimate of the combined precision of sampling and analysis. To derive an

TABLE 5-2. ANALYSIS OF COLLOCATED SAMPLES FROM CALVERT CITY, KENTUCKY, STUDY AREA

Date sampled	Site No.	EDC concentration, $\mu g/m^3$		$\bar{x}$	s
		Sample A	Sample B		
8-26-78	12	27.7	29.7	28.70	1.41
8-27-78	9	55.2	52.7	53.95	1.77
8-27-78	8	18.6	17.3	17.95	0.92
9-9-78	2	74.3	70.0	72.15	3.04
9-9-78	1	26.6	25.4	26.0	0.85
9-9-78	10	1.1	1.2	1.15	0.07
9-10-78	10	3.0	3.9	3.45	0.64
9-12-78	10	29.2	31.1	29.65	1.34
9-12-78	9	0.8	0.5	6.50	0.21
9-14-78	9	19.9	22.9	21.40	2.12
9-14-78	7	38.0	34.5	36.25	2.47
9-14-78	1	3.6	3.0	3.30	0.42
9-15-78	7	9.0	8.9	8.95	0.07
9-16-78	7	0.9	0.5	0.7	0.28
9-17-78	10	13.3	10.7	12.0	1.84

$\bar{x}$: Mean

s: Standard deviation

TABLE 5-3. ANALYSIS OF COLLOCATED SAMPLES FROM LAKE CHARLES, LOUISIANA, STUDY AREA

Date sampled	Site No.	EDC concentration, $\mu g/m^3$			
		Sample A	Sample B	$\bar{x}$	s
9-24-78	1	43.6	44.0	43.8	0.28
9-25-78	1	114.7	110.1	112.4	3.25
9-25-78	2	159.9	178.1	169.0	12.87
9-26-78	1	28.3	35.9	32.1	5.37
9-27-78	1	124.7	135.6	13[illegible].15	7.71
9-28-78	1	37.9	41.0	39.45	2.19
9-29-78	1	1.3	1.5	1.4	0.14
9-30-78	1	71.2	82.9	77.05	8.27
10-1-78	1	238.7	216.5	227.6	15.7
10-1-78	2	188.0	207.7	197.85	13.9
10-2-78	10	6.3	7.9	7.1	1.13
10-2-78	12	18.2	20.2	19.2	1.41
10-3-78	2	141.0	153.5	147.25	8.84
10-4-78	2	457.4	487.6	472.5	21.35
10-5-78	5	236.3	260.4	248.35	17.0

$\bar{x}$: Mean

s: Standard deviation

TABLE 5-4. ANALYSIS OF COLLOCATED SAMPLES FROM NEW ORLEANS, LOUISIANA, STUDY AREA

Date sampled	Site No.	EDC concentration ($\mu g/m^3$)		$\bar{x}$	s
		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	0.7	0.65	0.22
10-14-78	9	17.9	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

$\bar{x}$: Mean

s: Standard deviation

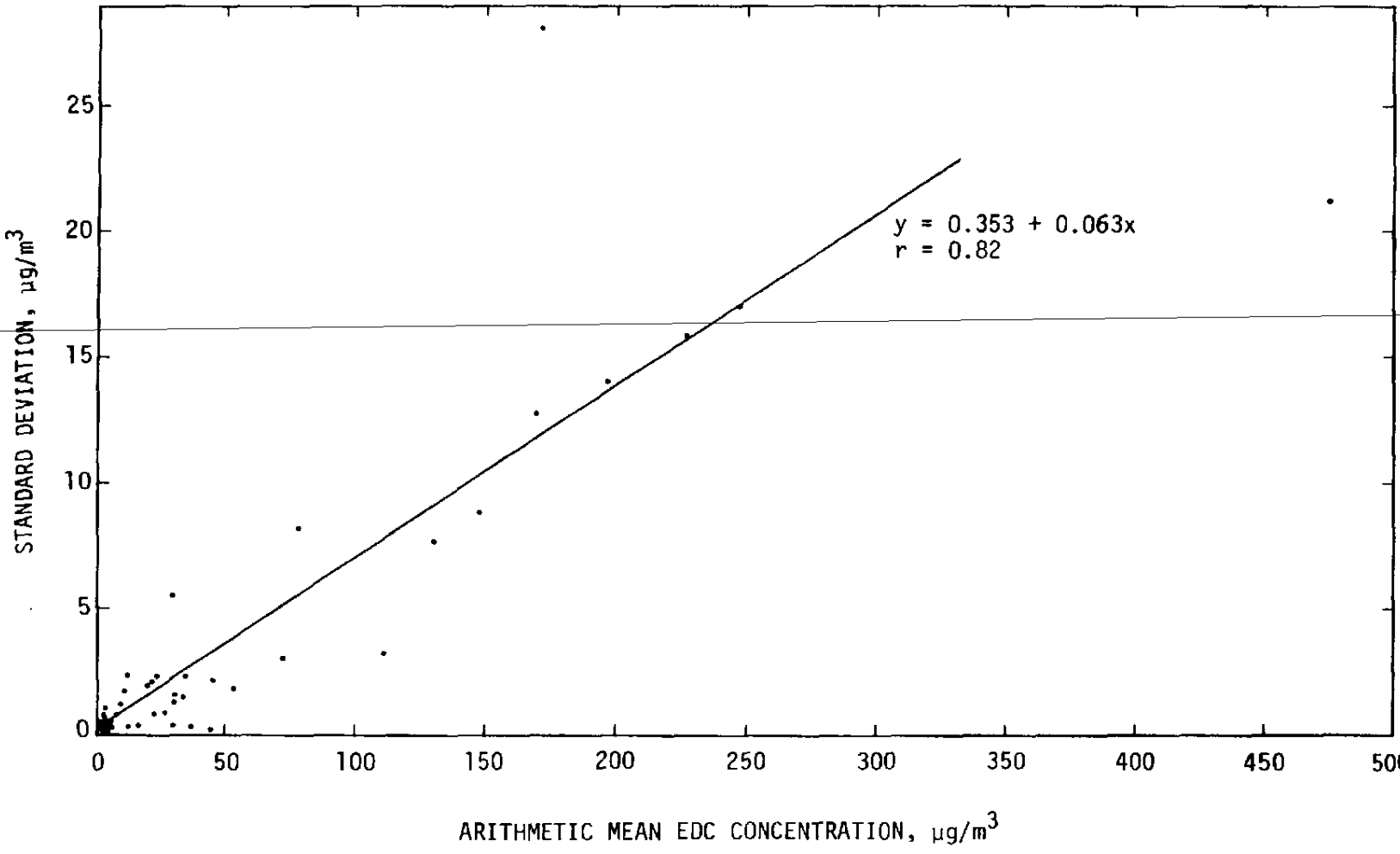

Figure 5-2. Standard deviation and arithmetic mean concentration of EDC for collocated samples.

estimate of the precision of the analytical method alone, duplicate EDC analyses of desorbed samples were run on 10 percent of all the samples analyzed. Table 5-5 through 5-7 present the results of the duplicate analysis, together with the mean and standard deviations for each set of duplicates. The relationship between the mean and the standard deviation is presented graphically in Figure 5-3. As with the analysis of collocated samples, the standard deviation of the duplicate samples is proportional to the average concentration. The relative standard deviation (i.e., precision) of the analytical method is approximately 3 percent.

5.4.5 Precision of Ambient EDC Measurements

The precision (i.e., relative standard deviation) of an individual EDC measurement is approximately 6 percent. This estimate, which is based on the analysis of ambient EDC measurements in the three study areas, includes the precision of both the sampling technique and the analytical method. Precision of the analytical method alone, as derived from duplicate analyses of desorbed samples, is approximately 3 percent.

5.4.6 Analysis of External Quality Control Unknown Solutions

The GC/MS analyses of samples from the field studies were conducted by several chemists over a period of 2 months. Each chemist was scheduled a work period in which to prepare standards from a master stock solution and analyze a batch of 30 to 40 samples. Another chemist, independent of the one performing the

TABLE 5-5. DUPLICATE ANALYSIS OF DESORBED SAMPLES FROM CALVERT CITY, KENTUCKY, STUDY AREA

Date sampled	Site No.	EDC, $\mu g/m^3$		$\bar{x}$	s
		Run 1	Run 2		
9-9-78	10	ND			
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

$\bar{x}$: Mean

s: Standard deviation

ND: Not detected

TABLE 5-6. DUPLICATE ANALYSIS OF DESORBED SAMPLES FROM LAKE CHARLES, LOUISIANA, STUDY AREA

Date sampled	Site No.	EDC, $\mu g/m^3$		$\bar{x}$	s
		Run 1	Run 2		
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
10-5-78	4	185.2	179.5	182.4	4.0
10-5-78	10	19.7	19.9	19.8	0.14
10-4-78	2	504.2	471.9	488.1	22.9

$\bar{x}$: Mean

s: Standard deviation

TABLE 5-7. DUPLICATE ANALYSIS OF DESORBED SAMPLES FROM NEW ORLEANS, LOUISIANA, STUDY AREA

Date Sampled	Site No.	EDC, µg		$\bar{x}$	s
		Run 1	Run 2		
10-10-78	4	ND	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

$\bar{x}$: Mean

s: Standard deviation

ND: Not detected

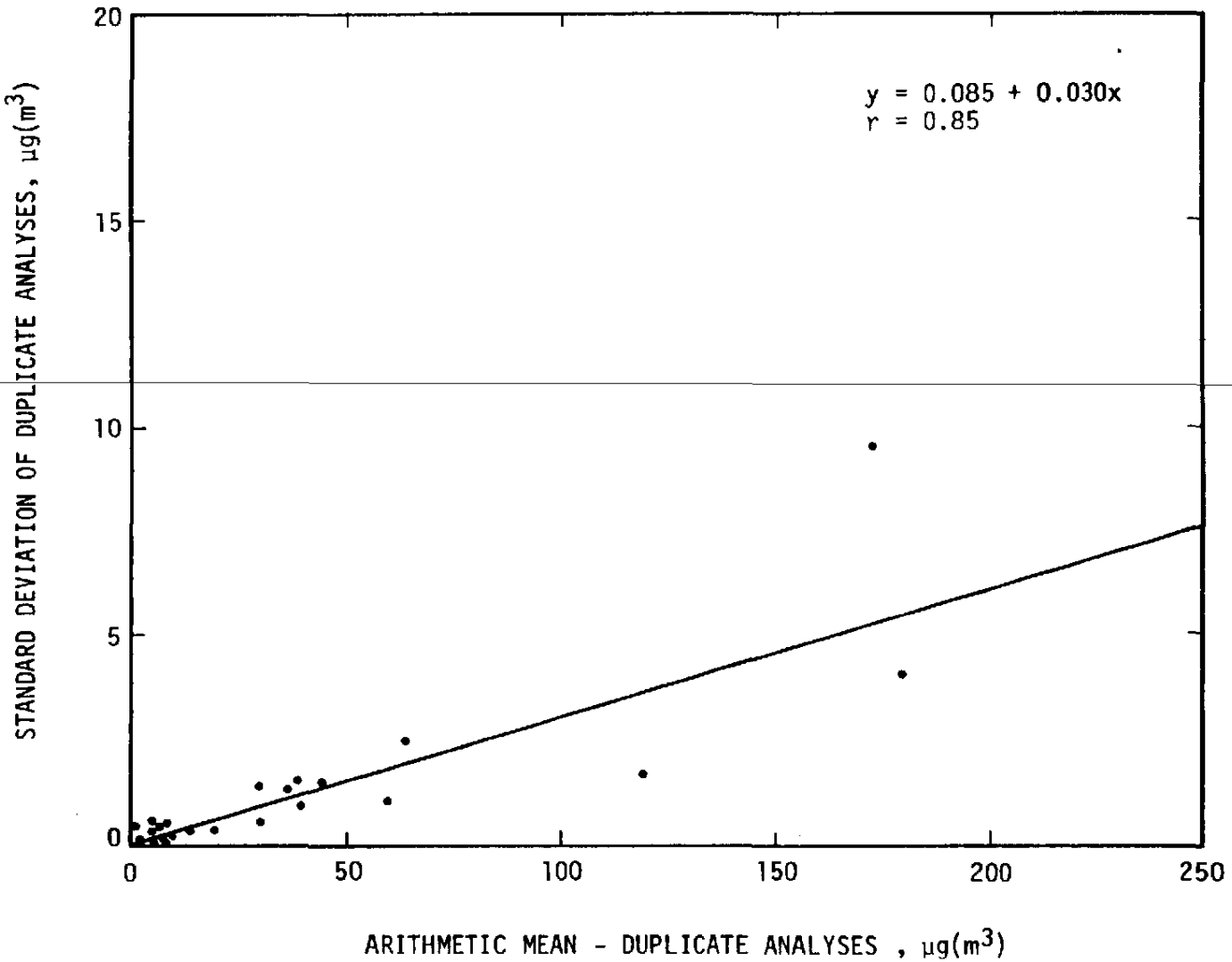

Figure 5-3. Standard deviation and mean concentration of EDC for duplicate analyses of selected samples.

analyses, would prepare an external check standard from an independent 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 5-8.

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 assumption was made that the precision of the amount of EDC added was 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.

5.5 EVALUATION OF QUALITY CONTROL CHECK SAMPLES

Two sets of quality control check samples, with known levels, were prepared by the EPA Environmental Monitoring and Support Laboratory (EMSL) and by the PEDCo Laboratory. These samples were analyzed along with the routine analysis of samples collected in the field.

TABLE 5-8. ANALYSES OF UNKNOWN EXTERNAL STANDARD SOLUTIONS OF EDC

Date analyzed	EDC concentration, ng/μℓ	
	Added	Found
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
Average 101.3 $\pm$ σ 9.6		

5.5.1 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 cc/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 5-9 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 nine 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 5-9 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.

5.5.2 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

TABLE 5-9. QUANTITY OF EDC FOUND IN EPA QUALITY ASSURANCE SAMPLES
(EDC in μg)

Amount of EDC added by EPA									
1.18		2.36		3.54		5.90		8.26	
Sample No.	EDC found	Sample No.	EDC found	Sample No.	EDC found	Sample No.	EDC found	Sample No.	EDC found
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[a]
25	0.64	R	2.07			V	7.47	Q	0.45[a]
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[a]		
33	0.65	13	1.76			16	1.27[a]		
		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		
Mean	0.81		1.54		2.62		4.64		6.04
Std.dev.	0.19		0.39		0		1.22		1.18
Recovery, %	69.00		65.00		74.00		79.00		73.00
Relative std. dev., %	23.00		25.00		0		26.00		20.00

[a] Deleted -- gross error.

(contained under pressure in a cylinder), and a dilution system. Figure 5-4 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 ± 1 cc/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 minutes to produce the low-level check samples, and 30.0 minutes 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 5-10 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. There is no significant change in the standard deviation for the two levels of EDC considered in this analysis.

5.5.3 Comparison of Analyses of EPA and PEDCo Check Samples

The results from the analyses of the two sets of quality assurance samples differ considerably. The EDC recovery rates

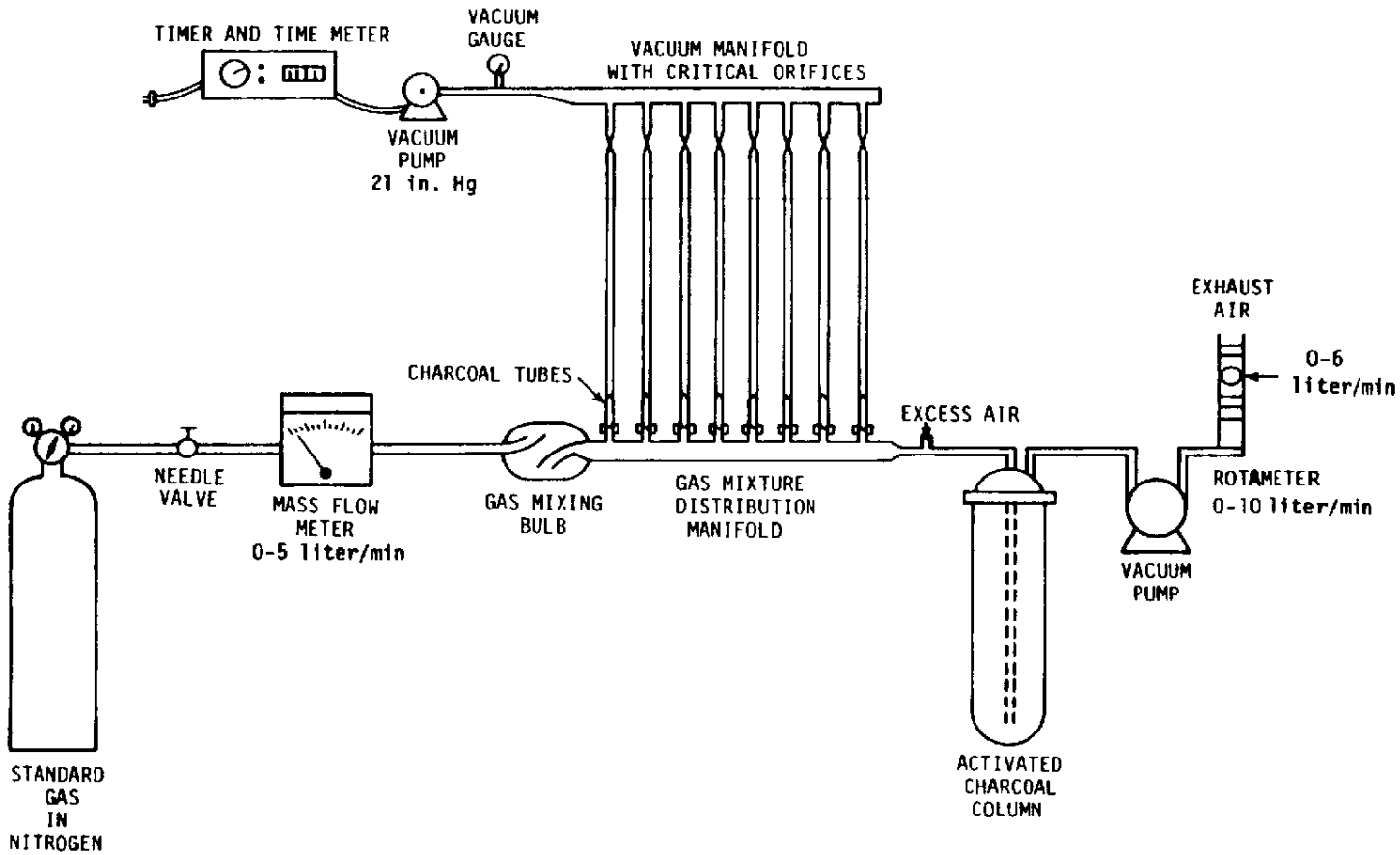

Figure 5-4. Apparatus for generator and sampling gas mixtures of EDC on charcoal tubes.

TABLE 5-10. QUANTITY OF EDC FOUND IN PEDCo QUALITY ASSURANCE SAMPLES
(EDC in µg)

	Amount of EDC added by PEDCo	
	4.51	9.02
	EDC found	EDC found
	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
Mean	4.45	8.61
Std. dev.	0.30	0.27
Recovery, %	99.00	95.00
Relative std. dev., %	6.7	3.1

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.

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APPENDIX A

TENTATIVE METHOD FOR THE DETERMINATION OF ETHYLENE DICHLORIDE IN THE ATMOSPHERE BY 24-HOUR INTEGRATED SAMPLING

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TENTATIVE METHOD FOR THE DETERMINATION OF ETHYLENE DICHLORIDE IN THE ATMOSPHERE 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.

1. Principles of the Method

(a) A known volume of air is drawn through a charcoal tube for a period of 24 hours to trap the ethylene dichloride (EDC) vapors present.

(b) The charcoal in the tube is transferred to a small, stoppered sample container, where it is desorbed with a solvent mixture of carbon disulfide and an internal standard compound (1-bromohexane).*

(c) An aliquot of the desorbed sample is injected into a gas chromatograph that uses a mass spectrometer as the detector.

(d) The ratio of the peak area for EDC to the peak area for 1-bromohexane is determined and compared with the ratio of peak

* 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.

areas obtained from a standard, to ascertain the amount of EDC present in the sample.

2. Range and Sensitivity. The limit of detection is approximately 1 $\mu g/m^3$ (0.3 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 to 320 $\mu g/m^3$ (0.6 to 95 ppb), at temperatures of 25° and 30°C and relative humidities of 64 and 99+ percent, respectively. The sampling rate was 65 cc/min at 760 mm Hg for 24 hours. The charcoal adsorption tube (Figure A-1), which consists of two sections of 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. The evaluations yielded an average total method efficiency (i.e., adsorption and desorption) in excess of 90 percent for EDC levels of 3 to 30 $\mu g/m^3$ (10 to 100 ppb). At concentrations of 30 $\mu g/m^3$ (100-ppb), 10 percent of the EDC was found on the second (backup) charcoal tube. At an EDC concentration of approximately 15 $\mu g/m^3$ (0.5 ppb), the overall method efficiency was 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. A small peak was observed, however, indicating the presence of breakthrough.

Although no effect from humidity was observed at the 65 cc/min sampling rate, water condensing within the charcoal tube

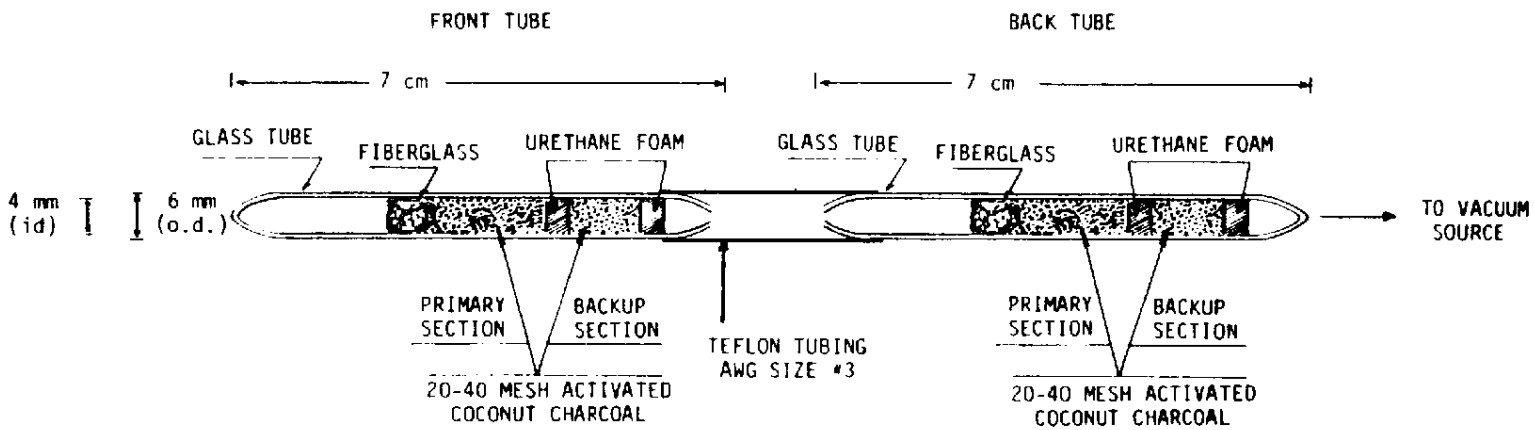

Figure A-1. Diagram of tandem charcoal tubes for EDC sampling.

during sampling will affect the adsorption efficiency. Sampling for 24 hours at rates in excess of 65 cc/min will affect the collection efficiency. At an EDC concentration of 10 $\mu g/m^3$ (30 ppb), tests conducted at a flow rate of 500 cc/min and a relative humidity of 99 percent resulted in an overall method efficiency of less than 20 percent. If a particular atmosphere is suspected of containing a high level of EDC, a shorter sampling time should be used.

3. 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 EDC to obtain positive EDC quantification. The data system of the spectrometer will use the response of mass ion 62 for quantification.

4. Precision and Accuracy. Replicate GC/MS analyses of standard liquid mixtures and sample aliquots must not deviate by more than ±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. 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.

5. 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.

6. Apparatus and Materials

(a) 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 cc/min.
- Filter cartridge: Disposable 47 mm diameter, 0.45 μm filter porosity. (Millipore Filter Corp., Bedford, Massachusetts).
- Charcoal adsorption tubes: 150-mg, standard NIOSH type, connected in tandem as shown in Figure A-1.
- Vacuum gauge: 0 to 760 mm Hg.
- Airflow meter: Rotameter type 0 to 120 cc/min, calibrated against an NBS traceable bubble meter.

(b) 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)

(c) 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.
- Micro syringes: 0 to 10, 0 to 100, and 0 to 500 microliter range.
- 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.

(d) Reagents used--

- Chromatographic quality carbon disulfide.
- 1,2-dichloroethane, reagent grade.
- 1-bromohexane, reagent grade.
- Purified helium.

7. Procedure

(a) Cleaning of Equipment: All glassware used for the laboratory analysis should be washed with detergent, thoroughly rinsed with tapwater and distilled water, dried, and placed in a muffle furnace at 350°C for 30 minutes to remove traces of organic compounds.

(b) Collection of Samples: Duplicate tandem tubes, consisting of two 150-mg charcoal tubes, are used for sampling; each is identified as being 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. The shield to protect from light and rain is placed over the adsorption tubes, and sampling is continued for 24 ± 0.25 hours. 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 20 tubes used for field monitoring is retained and returned to the laboratory as a blank.

(c) 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

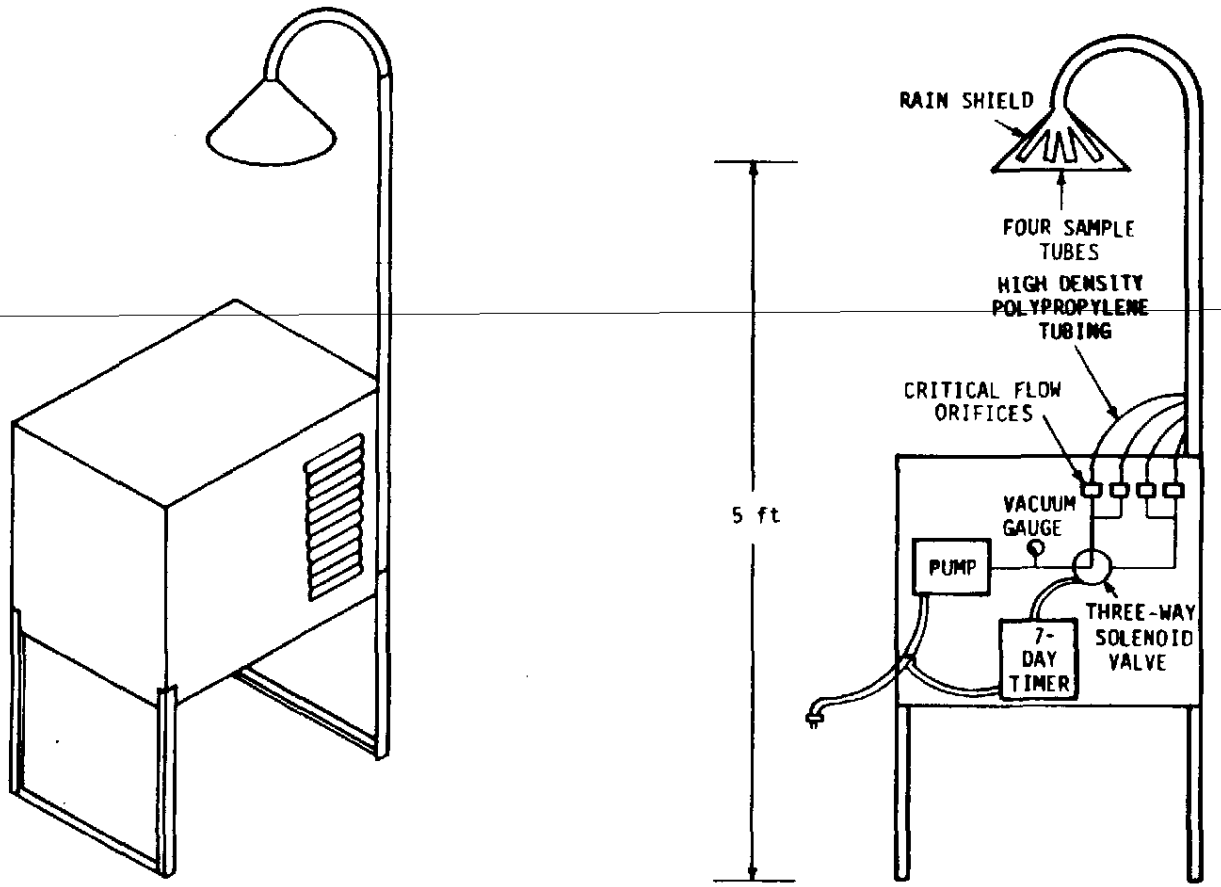

Figure A-2. Sketch of 24-hour integrated sampler for EDC monitoring.

of carbon disulfide and 1-bromohexane is injected through the septum into the vial containing the charcoal. See Section 8(a) 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 carbon disulfide, is then stored at 0°C or less until GC separation and analyses are performed.

(d) 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 hours.

- GC/MS conditions--The typical operating conditions for the analyses of EDC 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 - 170°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 µl.

Retention time of EDC - 6.4 min.

Retention time of 1-bromohexane - 9.0 min.

- Sample injection--The first step in the analysis is the injection of 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. Observe that 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 that is capable of determining the area of all ions that are 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.

8. Standards, Calibration, and Analyses

(a) Preparation of Desorbing Solution and Standards:

- Preparation of desorbing solution (prepared weekly)--Add 5.0 µl of 1-bromohexane into a 250-ml volumetric flask containing 240 ml CS_2 and bring to volume with carbon disulfide. The concentration of the 1-bromohexane solution is 23.5 ng/µl.

- Preparation of stock standard solution (prepared weekly)--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.

- Preparation of working standard procedure (prepared daily)--Take 20 µl of the stock standard solution, put it 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.

(b) Calibration of the GC/MS system: The GC/MS system is set up according to the conditions described above in 7(d). Before being used, the instrument is autotuned in the manner described in the manufacturer's operations manual. Four microliters of the working standard are 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 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 ± 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 there is a problem in the instrument that must be corrected.

(c) Analyses of Samples: Four microliters are 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 8(b). A blank tube, prepared as described in 7(b), is analyzed in the same manner. Any area resulting from the specific ion of mass 62 is recorded.

9. Calculations

(a) Uncorrected Sample Volume: The volume of air sample is not corrected to Standard Temperature and Pressure because of the uncertainty associated with 24-hour 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 = the volume of gas sampled (uncorrected), m^3

F_1 = the measured flow rate before sampling, ml/min

F_2 = the measured flow rate after sampling, ml/min

T = the sampling time, min

(b) Ethylene Dichloride Concentration:

° Calculation of the EDC collected on the adsorption tube. From the integrated areas for ion masses 62 and 85, as discussed in 8(c), 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 in nanograms

$R_{spl} = \frac{\text{area EDC}}{\text{area 1-bromohexane}}$ 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 in 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:

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

where:

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

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

Vm is the volume of air sampled under sampling conditions, in m^3

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

10. 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 one 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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* The overall method efficiency has been determined to be 90 ± 10 percent. A correction factor of 1.1 can be used if desired. $\bar{C}_{EDC}$ 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.

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APPENDIX B

METEOROLOGICAL DATA FROM CALVERT CITY, KENTUCKY, STUDY

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: Calvert City, Ky. DATE 8/26/78

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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.

LOCATION: Calvert City, Ky. DATE 8/27/78

VVC 000012471

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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	91
23	2	260	71	95

* Recorder malfunction.

LOCATION: Calvert City, Ky. DATE 8/28/78

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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				

LOCATION: Calvert City, Ky.

DATE 8/29/78

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: Calvert City, Ky. DATE 9/9/78

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: Calvert City, Ky.

DATE 9/10/78

VVC 000012475

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: Calvert City, Ky.

DATE 9/11/78

VVC 000012476

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: Calvert City, Ky.

DATE 9/12/78

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

NOTE: 0.75" rain from 2000 to 2400 hours.

LOCATION: Calvert City, Ky.

DATE 9/13/78

VVC 000012478

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

NOTE: 2.3" rain, from 0000 to 0300 hours.

LOCATION: Calvert City, Ky.

DATE 9/14/78

VVC 000012479

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: Calvert City, Ky.

DATE 9/15/78

VVC 000012480

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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		

NOTE: 0.01" rain.

LOCATION: Calvert City, Ky. DATE 9/16/78

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: Calvert City, Ky.

DATE 9/17/78

VVC 000012482

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: Calvert City, Ky. DATE 9/18/78

APPENDIX C

METEOROLOGICAL DATA FROM LAKE CHARLES, LOUISIANA, STUDY

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: Lake Charles, La.

DATE 9/24/78

VVC 000012485

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

DATE 9/25/78

LOCATION: Lake Charles, La.

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: Lake Charles, La. DATE 9/26/78

VVC 000012487

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: Lake Charles, La.

DATE 9/27/78

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

NOTE: 0.02" rain from 0400 to 0600 hours.

LOCATION: Lake Charles, La. DATE 9/28/78

VVC 000012489

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: Lake Charles, La. DATE 9/29/78

VVC 000012490

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: Lake Charles, La.

DATE 9/30/78

VVC 000012491

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: Lake Charles, La.

DATE 10/1/78

VVC 000012492

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: Lake Charles, La. DATE 10/2/78

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: Lake Charles, La. DATE 10/3/78

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: Lake Charles, La.

DATE 10/4/78

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: Lake Charles, La.

DATE 10/5/78

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: Lake Charles, La.

DATE 10/5/78

VVC 000012497

APPENDIX D

METEOROLOGICAL DATA FROM NEW ORLEANS, LOUISIANA, STUDY

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: New Orleans, La. DATE 10/10/78

VVC 000012499

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: New Orleans, La.

DATE 10/11/78

VVC 000012500

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: New Orleans, La.

DATE 10/12/78

VVC 000012501

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: New Orleans, La.

DATE 10/13/78

VVC 000012502

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: New Orleans, La.

DATE 10/14/78

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: New Orleans, La. DATE 10/15/78

VVC 000012504

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: New Orleans, La.

DATE 10/16/78

VVC 000012505

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: New Orleans, La.

DATE 10/17/78

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: New Orleans, La.

DATE 10/18/78

METEOROLOGICAL DATA

HOUR	WIND		Temp., °F	Rel. Hum., %
	Speed, mph	Direction, °		
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

LOCATION: New Orleans, La.

DATE 10/19/78

VVC 000012508

conoco

Lake Charles VCM Plant

Conoco Chemicals Company
A Division of Conoco Inc.
P.O. Box 605
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(318) 491-5211

Fille' Lewis

CERTIFIED MAIL #315656

October 29, 1979

Richard Goudeau
Louisiana Wildlife and Fisheries
1213 Lakeshore Drive
Lake Charles, LA 70605

Dear Mr. Goudeau,

Attached is the information you requested during your plant inspection on October 17, 1979. The information includes three strip charts and integrator readings for the waste treatment system effluent flow.

Chart 1 includes temperature and flow information for the waste treatment system effluent. The waste treatment system effluent is sampled at discharge point 201. Chart 2 includes pH and dissolved oxygen content information also gathered at discharge point 201. Chart 3 contains acid neutralization pit effluent flow information and effluent temperature and pH information for the combined waste streams. The neutralization pit effluent flow is measured at discharge point 101 and the combined waste streams information is collected at discharge point 001. During the duration of the plant inspection, there was no measurable acid neutralization pit effluent flow. The discharge point identification numbers are per the discharge point identification numbers listed in the VCM Plant's NPDES Permit of August 26, 1979.

Integrator readings were also recorded. The integrator reading for the waste treatment system at discharge point 201 was 569,393 x 100 gallons at 10:40 on October 18, 1979.

Should any additional information be required, please advise.

Sincerely,

Gary Foshee

Gary Foshee
Chief Process Engineer

br
cc:
R. A. LaFleur
bcc: REL,CRH,HJN,MAF,RLH,GLF,PLF,JOG,JWW,(JCL)

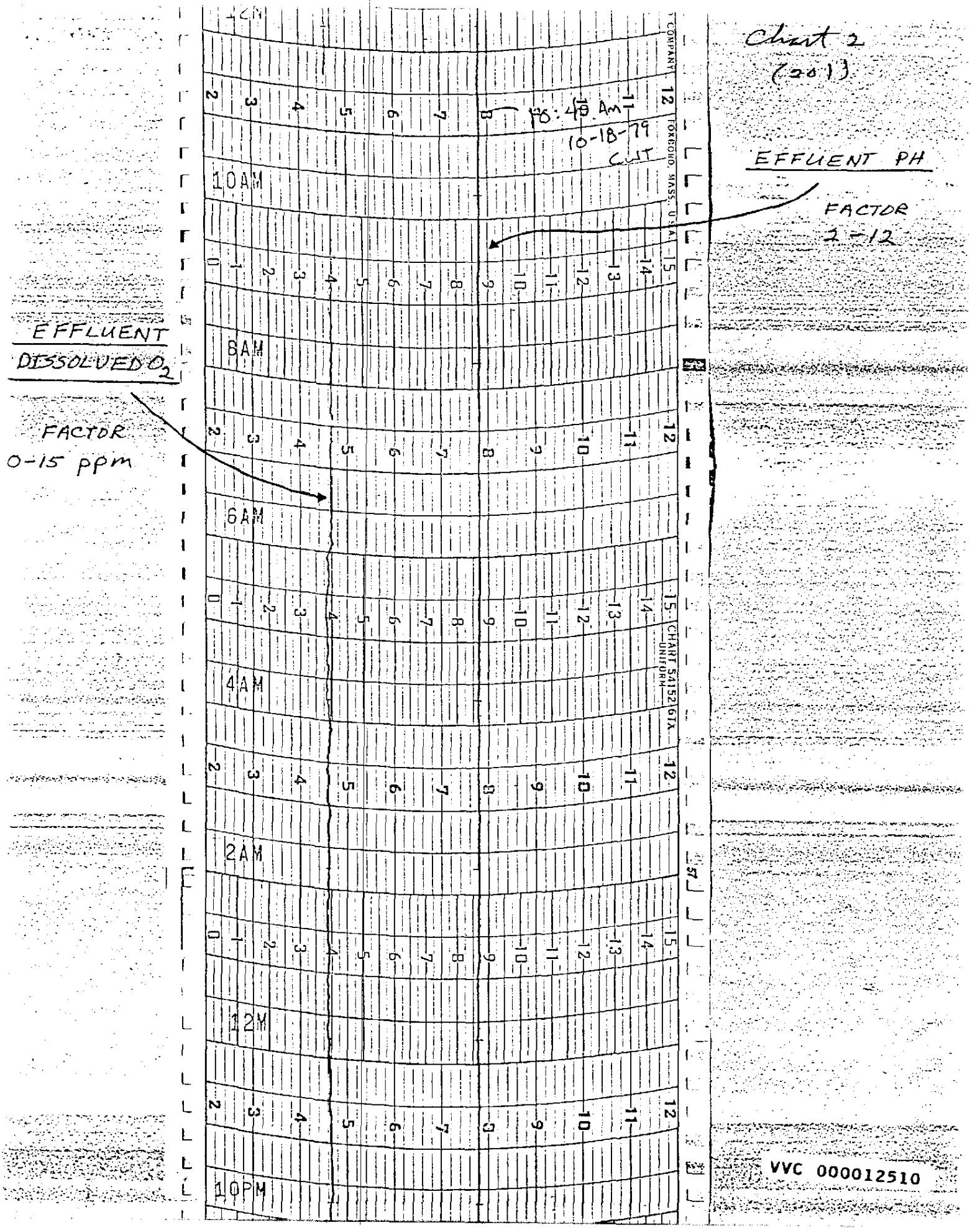


Chart 2
(201)
EFFLUENT PH
FACTOR
2-12
EFFLUENT
DISSOLVED O_2
FACTOR
0-15 ppm
10-18-79
CST
10 AM
8 AM
6 AM
4 AM
2 AM
12 M
10 PM
FOXBORO, MASS., U.S.A.
CHART 5415216TX
UNIFORM
VVC 000012510

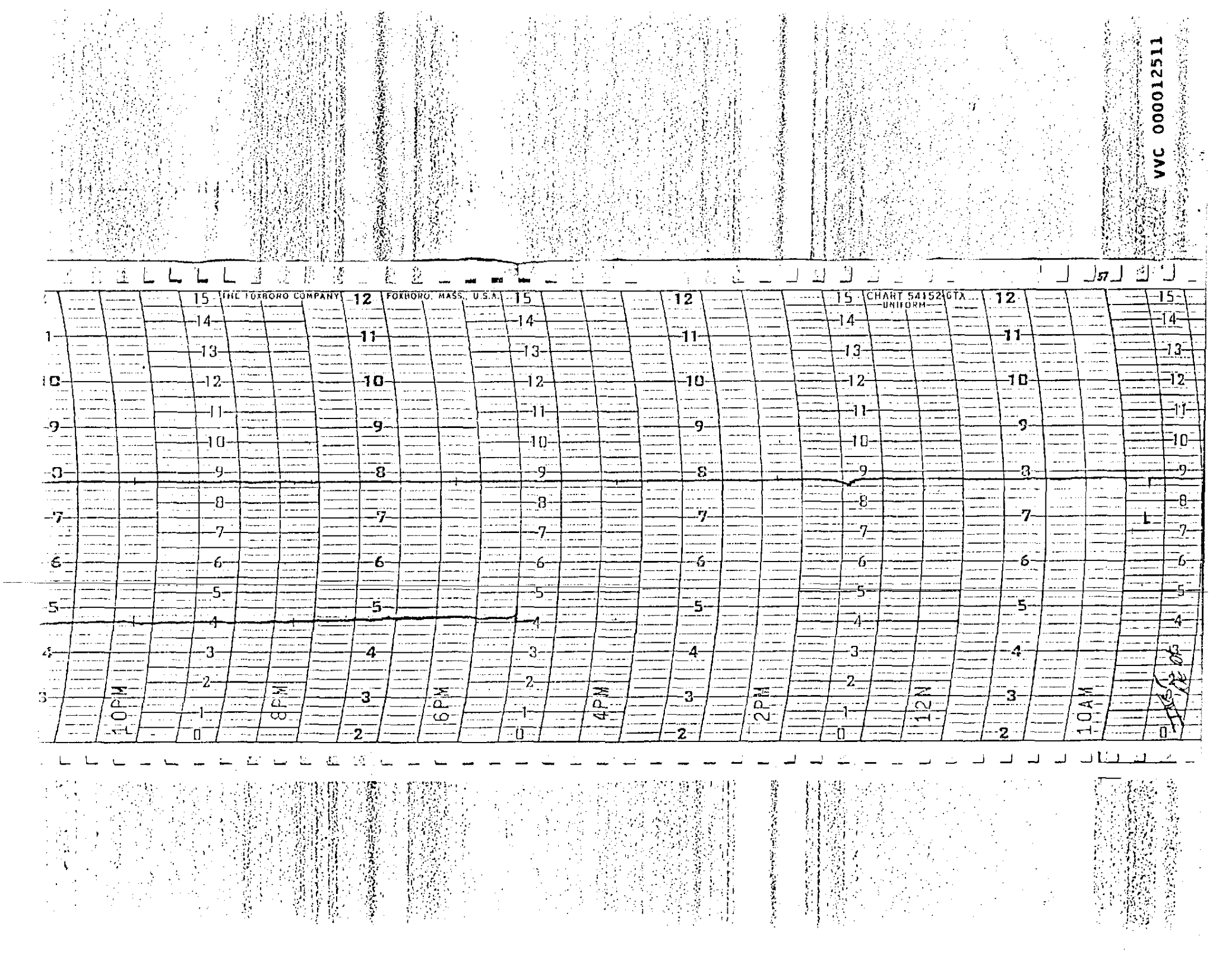
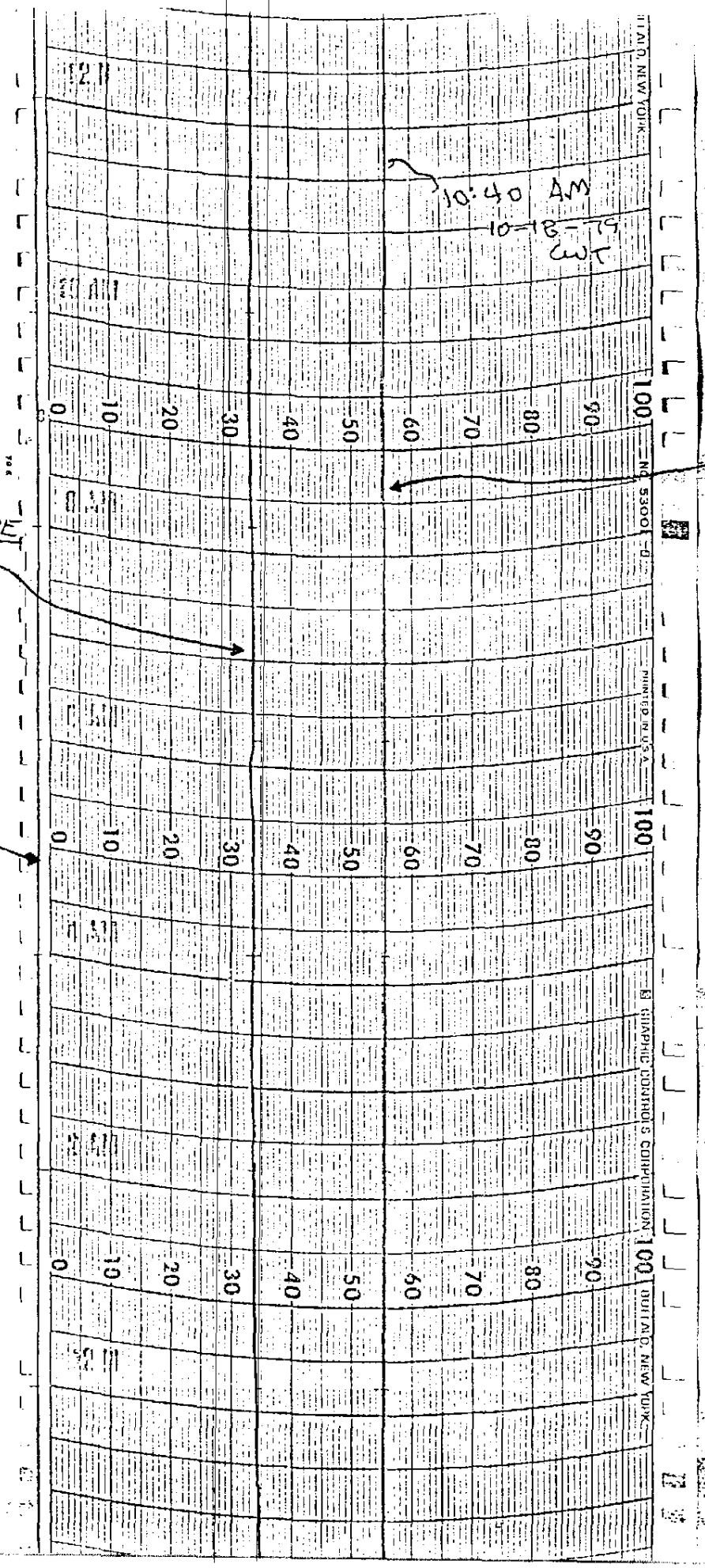
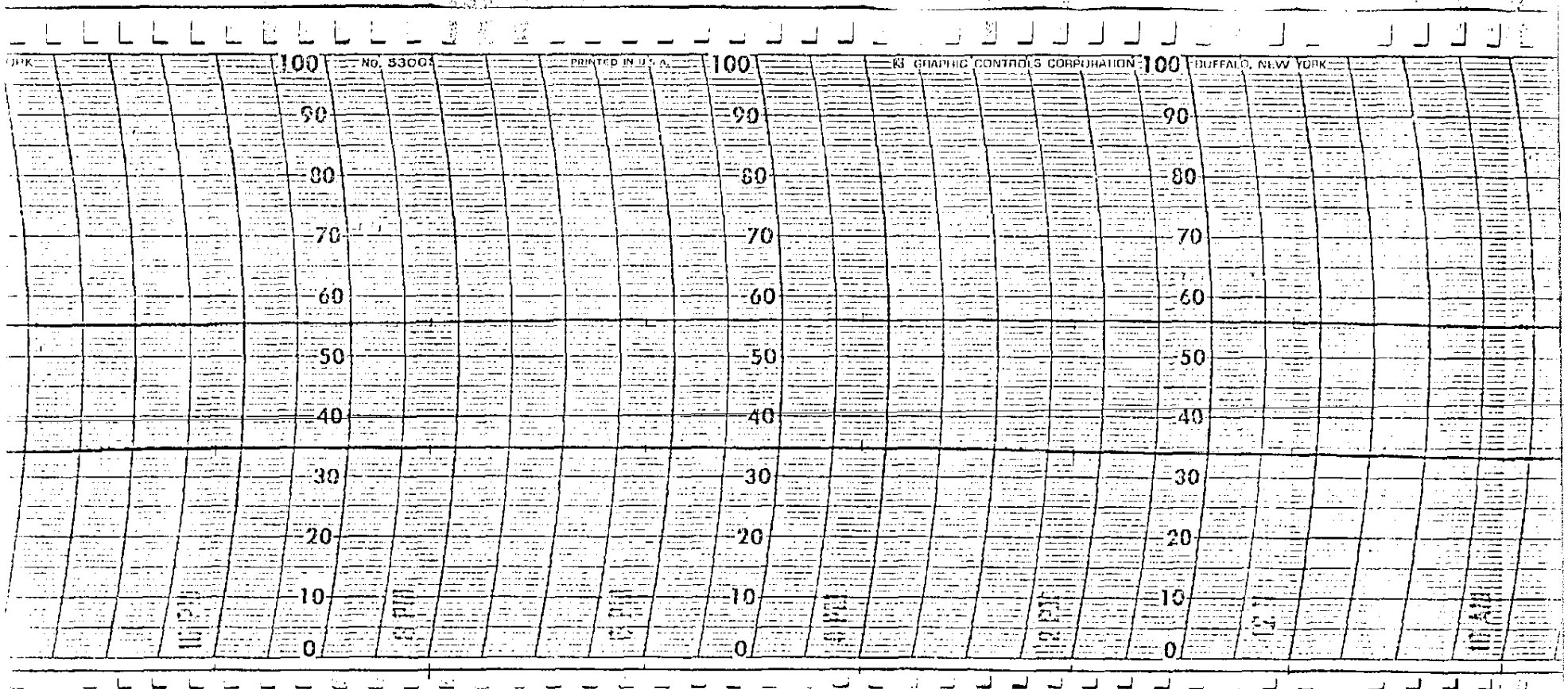

VVC 000012511
THE FOXBORO COMPANY
FOXBORO, MASS., U.S.A.
CHART 54152-GTX
UNIFORM
10PM
8PM
6PM
4PM
12PM
12N
10AM

Chart 3



VVC 000012512



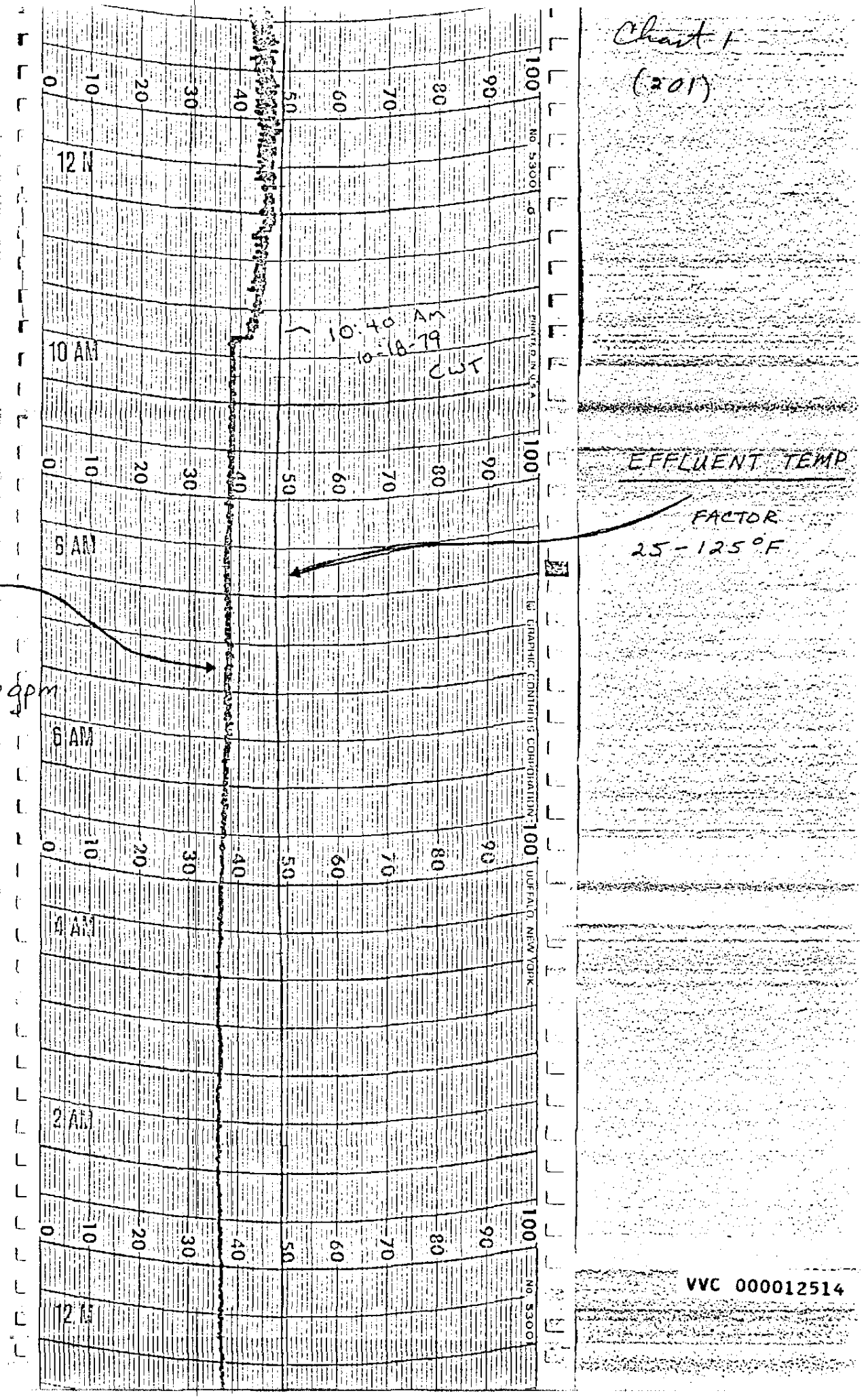
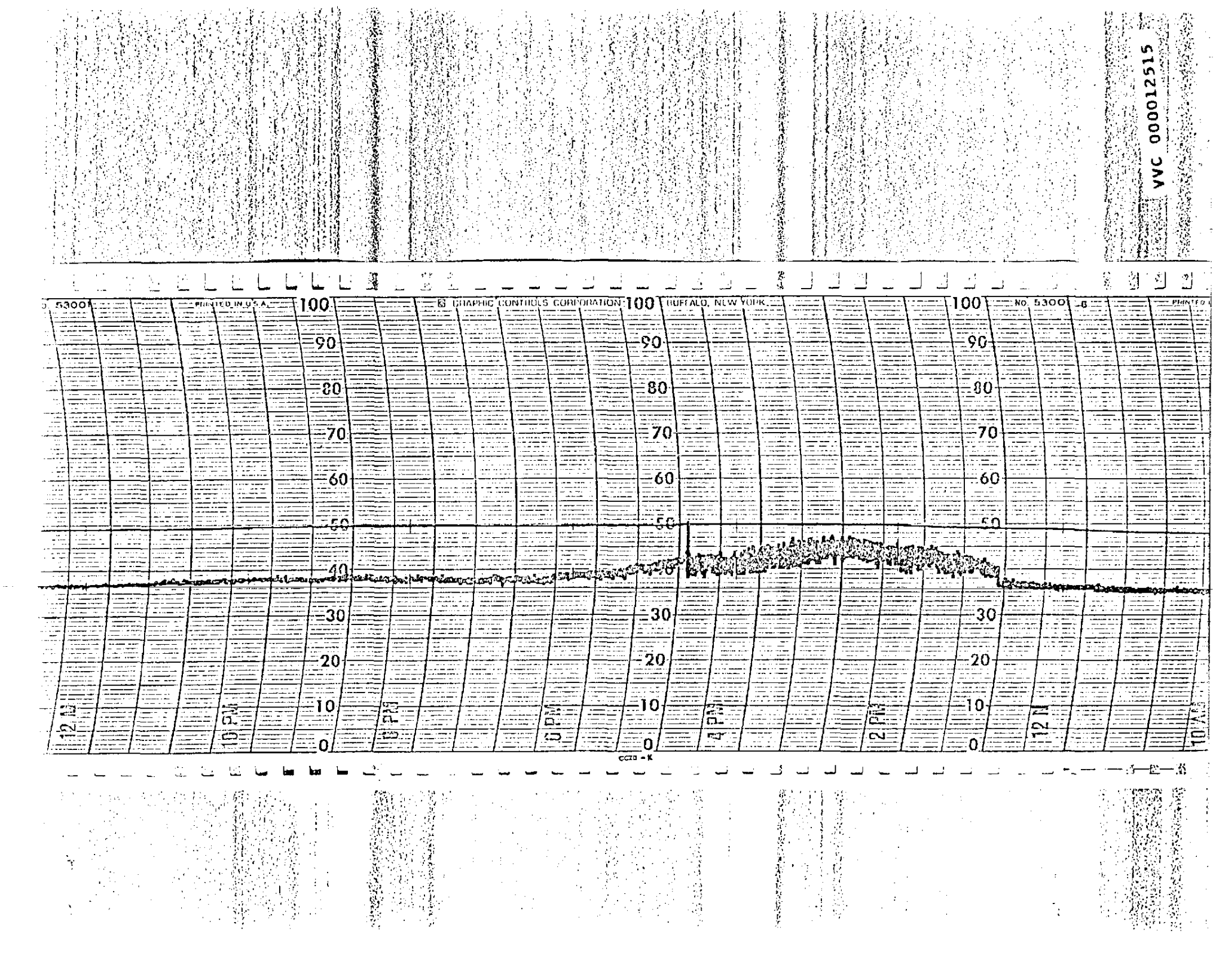


Chart 1
(201)
12 N
10 AM
6 AM
6 AM
4 AM
2 AM
12 N
10:40 AM
10-18-79
EFFLUENT TEMP
FACTOR
25-125°F
EFFLUENT
FLOW
FACTOR
-100) X 10 gpm
0
10
20
30
40
50
60
70
80
90
100
NO. 5300
PRINTED IN U.S.A.
GRAPHIC CONTROLS CORPORATION
BUFFALO, NEW YORK
VVC 000012514


VVC 000012515
5300
PRINTED IN U.S.A.
GRAPHIC CONTROLS CORPORATION
BUFFALO, NEW YORK
NO. 5300
100
90
80
70
60
50
40
30
20
10
0
12 AM
10 PM
8 PM
6 PM
4 PM
2 PM
12 N
10 AM

La. Wildlife + Fisheries 10-18-79

	Conoco	LAW =
NH_3	.239	< 0.5
COD	63	608!
TSS	19	30
BOD	3.03	3.0
Org Cl	30.6	

Jim DeBernardi

JCL

conoco

To Jim Hall, Jack Reid Date 10/17/79

Attached relates to VCM Plt. set up on PCB law & its handling.

T to LCVCM

CONOCO

RECEIVED

OCT 22 1979

Interoffice Communication

To J. A. DeBernardi

From H. J. Garrison 5065

Date September 18, 1979

Subject EPA Final Rule Regarding PCBs

The purpose of this letter is to summarize the final EPA rule regarding PCBs and to document the VCM Plant's current compliance position and policies to control compliance. The basis for discussion is the Final Rule for Polychlorinated Biphenyls (PCB's) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions published on May 31, 1979 in the Federal Register (44 FR 31514) by the U. S. Environmental Protection Agency. Also a publication of questions and answers to help meet the requirements of the new rule which was recently prepared by the Industry Assistance Office and Office of Toxic Substances in the U. S. Environmental Protection Agency was used.

Basically, the VCM Plant is most affected with the rules governing transformers. The only PCB capacitor (BL-301 motor) was replaced during the last turnaround (February, 1979) and disposed in accordance with the EPA regulations in May, 1979, through Chemical Waste Management Incorporated. Transformers are categorized by the rule as PCB Transformers (contain greater than 500 ppm PCB), PCB-Contaminated Transformers (contain between 50 ppm and 500 ppm PCB), and Non-PCB Transformers (contain less than 50 ppm PCB). All of our transformers fall in the PCB-Contaminated category. Attached is an up-to-date listing of transformers in the VCM Plant. This list should be updated if additions of transformers are made.

The final rule appears to have been designated to include most transformers in the PCB-Contaminated Transformer category in order to minimize expenses and simplify requirements (and probably enforcement) for servicing, disposal, labeling, and use. Transformers can be reclassified as a Non-PCB Transformer if its dielectric fluid has been tested or otherwise verified to contain less than 50 ppm PCB; however, there is very little incentive to do so since actions required by the Rule are practically the same for PCB-Contaminated Transformers and for Non-PCB Transformers.

A file has been set up to contain all documents related to the plant's compliance with the PCB regulations. This file will be kept with the other EPA files and will be maintained in a similar manner.

The following paragraphs detail actions and responsibilities with regard to the servicing, disposal, spills, testing, labeling, and recordkeeping requirements as it pertains to PCB-Contaminated Transformers in the VCM Plant:

SERVICING: PCB-Contaminated Transformers are subject to no restrictions on servicing (including rebuilding) or coil and casing disposal, except that after July 1, 1979, servicing of PCB-Contaminated Transformers must be performed either by the owner or operator or by someone who has an exemption from the EPA, from

SERVICING (Continued)
the processing and distribution bans. Routine servicing of transformers includes such activities as testing the dielectric fluid, filtering the fluid, removal of some fluid and then returning or replacing it, replacing gaskets, etc. Prior to servicing of transformers or purchasing dielectric fluid, a copy of the EPA exemption must be presented to the Plant Superintendent or Plant Manager for approval of such work.

DISPOSAL: Once the fluid is drained, a PCB-Contaminated transformer can be scrapped or sold for scrap. The PCB-Contaminated fluid, however, must be disposed of in high efficiency boilers, in approved chemical waste landfills, or in Annex I incinerators. Non-liquid PCBs at any concentration such as contaminated rags, absorbent materials, contaminated soils and other solids must be disposed of in Annex II chemical waste landfills. Prior to disposal of any PCB-Contaminated Transformer, Fluid, or Article, the Plant Superintendent or Plant Manager's approval must be obtained to ensure that all applicable regulations have been reviewed and are being fulfilled.

SPILLS: Under the authority of TSCA, PCB spills have to be reported whenever the incident poses a substantial risk to human health or the environment. In addition a spill should also be reported when the volume or extent of the spill is unknown--such as spills that enter drainage systems or threaten water courses. As a general rule, spills involving a single capacitor do not have to be reported unless PCBs threaten or enter a water course. Because of the greater threat to health and the environment, transformer spills should be reported--unless only minor leaks, such as bushing leaks, are involved. Any spilling or leaking should be stopped, contained and repaired as soon as possible. Reporting of a spill should follow the established policy and procedures outlined by the TSCA plan for the VCM plant.

The first priority is to control the spread of any spill by damming or diking the leak and preventing the spill from entering any drainage systems or waterways. Clean-up should begin once the spill is contained. Retrieval of spilled liquid, removal of contaminated soil or debris, and in some cases, special PCB sorbents or special filtration/carbon absorption removal of PCBs from water may be required.

TESTING: Testing of transformers to classify them as PCB-Contaminated Transformers, is not necessary. If for one reason or another testing is needed, there are specific EPA approved test procedures that should be followed to validate the testing.

LABELING: PCB-Contaminated Transformers, containing between 50 and 500 ppm PCB, are not required to be labeled. An unmarked transformer is automatically assumed to be a PCB-Contaminated Transformer. However, if a transformer has no nameplate information and there is a reasonable suspicion that PCBs may be present above 500 ppm---the transformer should be labeled as a PCB Transformer, until the PCB content can be verified.

RECORDKEEPING: Other than the documentation file the VCM Plant has adopted on the subject, recordkeeping is not required by the VCM Plant. Specifically, the Rule requires that if you own or operate a facility which uses PCBs or PCB Items, or have either stored, you are to keep records of their disposition. This applies to facilities using or storing at least 99.4 pounds (45 kilograms) of PCBs in PCB Container(s); one or more PCB Transformers; or 50 or more PCB High or Low Voltage Large Capacitors. These records shall be maintained for at least 5 years after the facility ceases using or storing PCBs or PCB Items in prescribed quantities.

Basically, any purchase of transformer/capacitors, servicing of transformers, disposal of transformers and/or fluids, or spills should be thoroughly documented in the official EPA PCB File and approved if appropriate by the Plant Superintendent or Plant Manager. By copy of this letter to all supervisors, their responsibilities with respect to PCB should be understood. If there are any questions or if clarification is needed now or in the future, please let me know. Also any differences of interpretation should be resolved as soon as possible.

H. Garrison

H. Garrison

CC: Supervisors -- EPA PCB File

lg

VCM PLANT TRANSFORMERS

As of: September 12, 1979

Transformer	Serial No.	Service
ITE	14754	13.2 KV/4160V
ITE	14757	Substation A
ITE	14756	Substation B
ITE	14755	Substation C
ITE	15408	Substation D
UPTEGRAFF	84412	Spare 13.2 KV/4160V
Westinghouse	- - - -	Dock Vent Recovery
Westinghouse	- - - -	Dock Vent Recovery
Westinghouse	- - - -	Dock Vent Recovery
Westinghouse	71-C-6011	Secondary Waste Treatment
Westinghouse	78-C-687138	Incinerator Area
Westinghouse	78-C-687136	Incinerator Area
GE	L-247119	VCM Loading Exposure Reduction

File level

CONOCO

VCM Plant

Formerly Conoco Chemicals Co., A Div. of CONOCO, Inc.
Continental Oil Company
P.O. Box 605
Westlake, Louisiana 70669
(318) 491-5211

CERTIFIED MAIL #316097
RETURN RECEIPT REQUESTED

October 19, 1979

RECEIVED
OCT 25 1979

Paul D. Fahrenthold (WH-552)
Organic Chemicals Branch
Effluent Guidelines Division
Environmental Protection Agency
401 M Street, S.W.
Washington, DC 20460

Dear Mr. Fahrenthold:

Attached is the completed questionaire on the design factors and operating conditions of the steam stripper in operation at CONOCO's VCM Plant in Westlake, Louisiana. We presently operate one steam stripper but are in the process of installing a spare steam stripper for use during downtime of the primary stripper. Data has been enclosed only for the stripper we presently operate. Operation of the spare steam stripper should parallel that of the primary stripper presently in operation. If you should require further assistance, please contact Gary L. Foshee, Chief Process Engineer, at 318/491-5062.

Sincerely,

J. A. DeBernardi
Plant Manager

br
cc:
R. A. LaFleur
BCC:
REL-JCL-CRH-HJN-MAF-RLH-GLF-PLF-JOG-JWW

VVC 000012522

Form Approved
OMB No. 158-R0160

COMPANY CONOCO, INC.

LOCATION VCM PLANT, LAKE CHARLES

DATE 10/19/79

STEAM STRIPPING

Copy and answer Parts I through IV of this questionnaire for each steam stripper used to reduce the raw waste loading prior to direct discharge or discharge to an end-of-pipe treatment system (whether it be a publicly owned treatment works, a regional industrial treatment system, your own on-site treatment system, or other system such as a nearby refinery's biological treatment system).

PART I

1. List the names of all process(es) whose waste water discharges constitute a portion of the feed (charge) to the steam stripper. In the event more than one process waste water stream makes up the charge (feed) to the stripper, give the approximate percentage of each stream on a flow or weight rate basis. Please place the percentages of each stream in the table below.

Wastewater streams from the oxychlorination, EDC wash, and EDC purification processes are combined in the steam stripper feed drum, T-110, and discharged to the steam stripper.

Stripper Feed Source	*Percentage of Feed
1. Oxychlorination	1. 52.4% (gpm)
2. EDC Wash	2. 31.1% (gpm)
3. EDC Purification	3. 16.5% (gpm)

Total Feed flow (gpm)	and/or	weight (lb/hr)
80		

*Indicate whether basis is weight (lb/hr) or flow (gpm).

COMPANY CONOCO INC.

LOCATION VCM PLANT, LAKE CHARLES

DATE 10/19/79

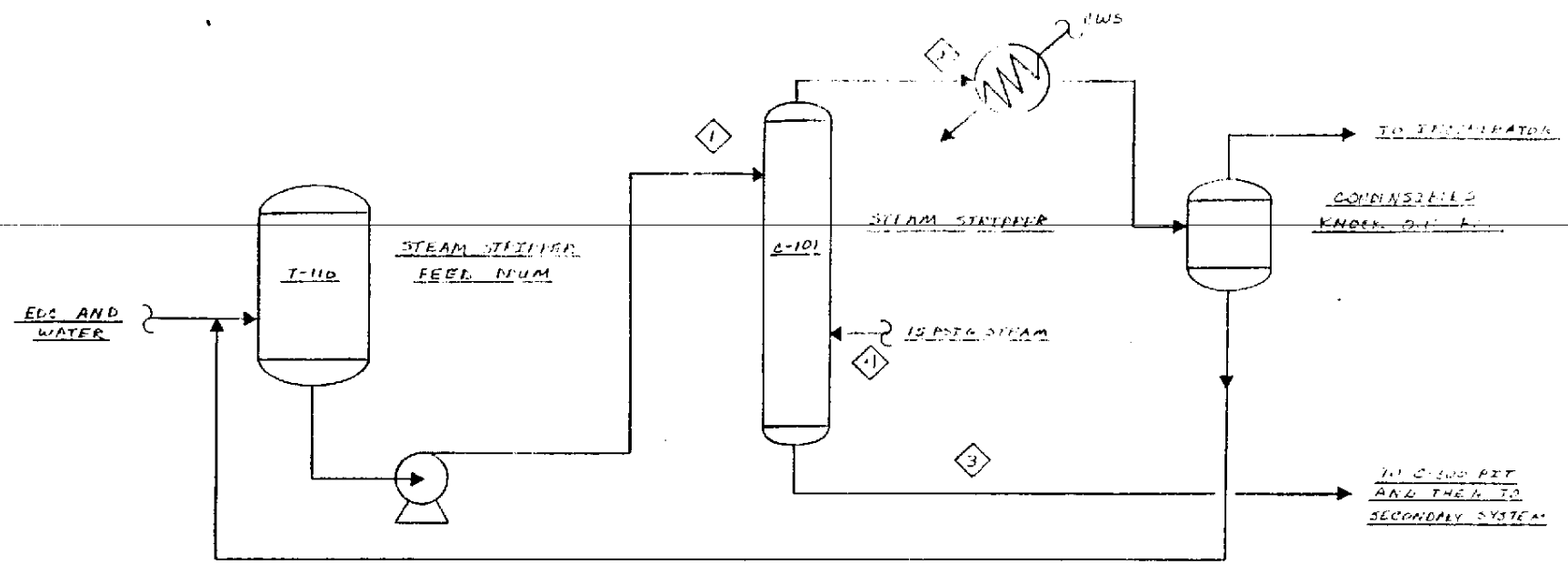
PART II

This part of the survey requests information adequate to assemble a trial material balance around the stripper. Operating data is the preferred source of information requested in this part. Flow or stream composition data gased on limited monitoring or calculations (engineering estimates) is required as an alternative.

1. Please attach a process flow diagram of the steam stripper. Kindly number and label all waste streams that are associated with the operation of the stripper such as the charge (feed), reflux, overhead product, decanter water, bottoms, etc. Indicate in your drawing major equipment items such as pumps, heat exchangers, etc. A sample sketch has been provided for reference.

2. Complete the attached Table I with the information requested for each stream numbered in the sketch prepared in (1) above. Note that two sets of information are requested. One set consists of general stream characterization parameters such as flow, temperature, pH, BOD, TOC, etc. with spaces for additional or different characteristics, and organic or inorganic compounds known to be present. The second set labeled "component" refers to priority pollutants identified or indicated to be present in the waste waters associated with the stripper.

VCM-



NOTES

1. REROUTING OF THE STRIPPER OVERHEAD THROUGH THE CONDENSIBLES KNOCK OUT POT IS CURRENTLY UNDER CONSTRUCTION. THE PRESENT PIPING CONFIGURATION RETURNS THE TOTAL OVERHEAD STREAM TO AN UPSTREAM PHASE SEPARATION VESSEL. THEREFORE, THE VAPOR-LIQUID SPLIT AT THE CONDENSIBLES KNOCK OUT POT HAS NOT BEEN DETERMINED AT THIS TIME.

ISU	DATE	DESCRIPTION	BY	CKD.	APD
	10/3/79		ASH		

CONTINENTAL OIL COMPANY
LAKE CHARLES VCM PLANT
LAKE CHARLES, LA.

STEAM STRIPPER SYSTEM
(SIMPLIFIED)

SHEET ___ OF ___ SCALE:

APPROVED:
DATE:

VCM -

REV

VVC 000012525

BRUNING 40534 38314

Part II

TABLE I

	STREAM NUMBER				
	1	2	3	4	5
FLOW, lb/hr	43,150	4,720	42,870	7,530	
TEMP, °C	54.4	102.3	107.7	121.1	
EDC (PPM)	9,400	85,200	85	0	
VCM (PPM)	15	140	0	0	
SEE NOTES 1-2					
COMPONENT	Concentration ppm				
	SEE NOTE 3.	SEE NOTE 3.	SEE NOTE 3.		

Company

Location

Date

VVC 000012526

Complete Table I according to instructions on page 2.

NOTES

1) Flow, temperature, and composition data are from plant test run and plant operating data.

2) COD, BOD, etc., has not been monitored. The steam stripper was designed for removal of EDC and VCM from plant wastewater streams.

3) A complete analysis of these streams has not been conducted but the following priority pollutants have been identified as constituents of the streams. Concentration ranges are not indicated because the results presented below were obtained by analysis of a single sample and the concentration ranges have not been defined.

Priority Pollutant
Vinyl Chloride
Chloroethane
1,1 Dichloroethylene
1,2-trans-dichloroethylene
Chloroform
1,2-dichloroethane
Carbon tetrachloride
Trichloroethylene

COMPANY CONOCO INC.

LOCATION VCM PLANT, LAKE CHARLES

DATE 10/19/79

PART III

This part of the survey requests information essential to evaluate the operating performance of the stripper and the energy consumption of the operation per unit of pollutant removed from the waste water.

1. Utility Requirements

A. Steam Requirements

Pressure 30 psia

Temperature 250 ^{o}F

RATE 6,000 lbs/hr

Is open steam used or does the column utilize a reboiler ?

X Open Steam _____ Reboiler

B. Cooling Water Use

Condenser Influent Temperature 83 ^{o}F

Condenser Effluent Temperature Unknown ^{o}F

Flow Rate Unknown gal/hr.

C. Other Energy Requirements

Electricity 30,000/yr. kwh

Compressed air 5 scfm

Inert gas - scfm

2. Column Specifics

(The sketch called for in II (1) above can be expanded upon to provide the following information).

COMPANY CONOCO, INC.

LOCATION VCM PLANT - LAKE CHARLES

DATE 10/19/79

Part III (Continued)

A. Feed Rate 43,150 lb/hr

B. Feed Temperature 130 °F

C. Operating Pressure

Top 17 psia

Bottom 19 psia

D. Operating Temperature

Top 216 °F

Bottom 226 °F

E. Column Diameter 4' - 0" I.D. ft.

F. Number of Theoretical Trays (if known) - No.

G. Actual Number of Installed Trays or Packing Height 15' - 0" ft. No. or ft. (specify)

H. Type of Trays or Packing Cascade Mini Rings

I. Tray Spacing - ft.

J. Overall Column Height 26' - 0" ft.

K. Reflux Ratio* (if any) -

L. Reflux Rate - lb/hr

M. Reflux Temperature - °F

N. Bottoms Flow Rate 42,870 lb/hr

O. Bottoms Temperature 226 °F

P. Materials of Construction

Trays -

Packing Polypropylene

VVC 000012529

*Use overhead flow rate as the basis of this value

COMPANY CONOCO, INC.

LOCATION VCM PLANT, LAKE CHARLES

DATE 10/19/79

Part III (Continued)

Column or Vessel Column

3. Specify the ultimate disposition of column overheads (i.e., incineration, returned to process, etc.) for both the aqueous and the organic phases.

The stripper column overhead is routed through a condenser and knock out pot. The condensed liquids are returned to the steam stripper feed drum. The noncondensed vapor is incinerated.

4. Specify the method of disposition of column bottoms. (i.e., discharged to biological treatment, discharged directly to surface waters, reused as cooling tower make-up, etc.)

The steam stripper bottoms are discharged to biological treatment.

5. Are there any substances present in the influent stream to the steam stripper that interfere with the removal of the pollutant(s) listed in (2) above.(i.e., maximum boiling azeotropes, pH adjustment, foaming, scaling, necessity to equalize flow or feed concentration, etc.). If so, please list and explain the nature of the interferences and any methods devised to minimize or eliminate these interferences. Also explain how successful these methods have been.

NO

6. Operating Specifics

A. Is the steam stripper operated in a continuous or batch mode ? If batch, explain.

Continuous

B. Explain the method of treatment of the process wastewater that is normally discharged to the stripper when the steam stripper is down for repair.

Process wastewater will be fed to the spare steam stripper after its completion. Wastewater is presently by-passed during stripper down time.

COMPANY CONOCO INC.

LOCATION VCM PLANT, LAKE CHARLES

DATE 10/19/79

PART IV

Your responses to the following questions will be used to determine the desireability of additional follow-up relating to capital and operating costs associated with the steam stripper.

A. Was the steam stripper installed as a new piece of equipment ?

Yes X No ____

B. When was the steam stripper installed ?

December, 1967 Estimated spare stripper completion - January 1980

C. Do you have detailed cost information (both capital and operating) relating to the steam stripper as a separate unit ?

Yes X NO ____

D. Are you willing to share this cost information with EPA to be used to verify the cost of the installation of steam strippers for the treatment of waste water.

Yes X No ____

E. Operating Labor

Direct Operating 40 work-days/yr

Maintenance 15 work-days/yr

Supervisory 5 work-days/yr

F. Do you have V-L equilibrium data which was used to design the stripper from your own experiments, or Henry's Law Constants, or vapor pressure data, or activity coefficient data, or other correlations?

No ____ Yes X Identify which one Vapor pressure data used in conjunction with the Ideal Gas Law.

G. Do you have information regarding the cost impacts of installing the stripper on the following off-site activities ? (check either Yes or No, or indicate (a), (b) or (c) as appropriate).

	Yes	No
a. Steam generation or a major revision in distribution.	___	X

VVC 000012531

COMPANY CONOCO INC.

LOCATION VCM PLANT, LAKE CHARLES

DATE 10/19/79

Part IV (Continued)

	Yes	No
b. electrical substation capacity	___	X
c. Instrument air capacity	___	X
d. Valve/Piping/Wiring systems to supply a, b, or c	(a) (b) (c)	(a) (b) (c) X X X