CONTRACT NO. A832-135
FINAL REPORT
MAY 1991

Determination of Source Contributions to High Ambient Carbon Monoxide Concentrations and Categorization of Carbon Monoxide Potential

State of California
AIR RESOURCES BOARD
Research Division

DETERMINATION OF SOURCE CONTRIBUTIONS TO HIGH AMBIENT CARBON MONOXIDE CONCENTRATIONS AND CATEGORIZATION OF CARBON MONOXIDE POTENTIAL

Final Report
Contract No. A832-135

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ABSTRACT

A study to characterize the spatial and temporal behavior of the carbon monoxide (CO) buildup in Lynwood and in the Los Angeles basin surrounding Lynwood was performed during the winter of 1989–90. The monitoring data were collected from 36 stations in the Los Angeles Basin during three intensive study periods. Two of these periods produced high-CO exceedance episodes and are reported here. They were: a 24-hour period during 19–20 December 1989 and a 40-hour period during 8–10 January 1990. Statistical analysis of the data from these episodes shows higher concentrations of CO in Lynwood than in other areas of the basin. The cumulative frequency distributions suggest that Hawthorne and Lynwood have either strong local source influences or meteorological/geographical factors. The vertical distribution of CO indicates that the concentrations between 15 and 30 meters are strongly influenced by the same sources that influence the surface concentrations; however, CO concentrations at 30–45 meters may be influenced by transported carbon monoxide from more distant sources as well.

Because of missing data and a relatively sparse sampling network along the transport paths, the results of the tracer experiment are inconclusive: the transport pattern has not been documented in great detail over the entire study area, nor during the entire study period. However, these data do indicate that the episodes cannot be due simply to stagnation and pooling of local contaminants.

Comparison of meteorological conditions between the Lynwood and Vernon stations shows that the Lynwood stations have lower wind speed and lower inversion height during both intensives. The morning CO episodes and the traffic counts show strong correlation; however, the evening peak, several hours after the typical evening traffic-volume peak, may indicate stronger meteorological and geographic influence on the evening episodes.

ACKNOWLEDGEMENTS

The authors wish to thank the staff of the Air Resources Board, from both Sacramento and El Monte, who assisted in performing the tethersonde measurements in Lynwood under tiring and less than ideal operating conditions; these include Eric Fujitn, Lowell Ashbaugh, and Steve Gouze. Special acknowledgement goes to Chuck Bennett and Doug Lawson for their help in pulling together the resources needed to make this project successful, for their helpful guidance in designing the final project plan and for the long hours spent surveying the sampling network with us.

We also acknowledge the assistance of the South Coast Air Quality Management District for providing ready access to their monitoring stations and for their accurate predictions of meteorological conditions that were conducive to high concentrations of carbon monoxide in the Basin.

Southern California Edison, CalTrans and the Department of Ecology of the State of Washington generously provided the use of their integrating samplers, without which this study would have been quite different in scope.

Some of the data presented in this report were kindly provided by Dr. Peter Groblicki of General Motors Research Laboratory. These data were most useful in confirming the spatial patterns seen in the network.

Finally, we acknowledge the considerable contributions to this project by the technical staff who worked long and difficult shifts to assure that this disperse and sometimes difficult-to-service sampler network was deployed and operated on schedule.

This report was submitted in fulfillment of ARB Contract Number A832-135 for project proposed under the title "Determination of Source Contributions to High Ambient Carbon Monoxide Concentrations and Categorization of Carbon Monoxide Potential" by AV Projects, Inc. under the sponsorship of the California Air Resources Board. Work was completed as of January 22, 1990.

SUMMARY AND CONCLUSIONS

This study has sought to characterize the spatial and temporal variation of the carbon monoxide (CO) concentrations during periods of high CO concentrations near the local monitoring station in Lynwood, which is maintained by the South Coast Air Quality Management District, and has further sought to characterize the variability of CO across the Los Angeles Basin with respect to these occurrences in Lynwood. The goal of this study has been to discover the factors that appear to influence the CO episodes most significantly and, if possible, to quantify the relative roles of local and area emissions in those episodes.

We have demonstrated clearly in our displays of the data that the Lynwood area constitutes a relative "hot spot" for CO; differences between the local Lynwood CO concentration profiles and those of the greater basin area are significant. Only in Hawthorne were there CO concentrations whose magnitude was comparable to those observed throughout the Lynwood area.

Meteorological conditions and high traffic volumes appear to be a dominant factor influencing the CO concentrations both in the evening and in the morning. During both periods, the episodes are coupled with apparent maxima in vehicular traffic. This can be inferred from comparison of the temporal patterns of both: the high CO concentration in the morning is coincident with high traffic counts and low inversion heights; the somewhat lower CO concentrations that result in the evening following similar, somewhat more disperse traffic count patterns and relatively high inversions. The delayed evening peak is convincing evidence of meteorology's significance; in addition, our sounding data show that cooling of the surface air mass can be associated with the buildup in CO concentration in the evening.

The entire Lynwood area seems to be a "Hot Spot." As noted above, our data suggest that the meteorology is a driving factor in the off-peak episodes. The meteorological data suggest to us that the Lynwood meteorology differs considerably from that in Vernon, which is less than 10 kilometers away. The characteristic wind speed is less than in Vernon and the temperature soundings suggest that the mixing height may be lower and the inversion stronger in Lynwood as well.

We have also compared the relative concentrations of CO at several different heights above ground level. Comparing elevated and surface CO patterns, we see evidence of a transported component of CO above what may be a surface-based inversion. At both 30 and 45 meters above the ground, we observed higher CO levels than in the intervening 15-meter samples. This observation and the apparent motion of the CO cloud during episodes suggest that transport of CO should not be overlooked for its role in the episodic buildups.

In conclusion, in this study, traffic volumes appear to be the major source factors for the CO. Complex meteorological factors, and possibly topographical factors, neither well quantified in this study, appear to amplify the influence of these sources.

RECOMMENDATIONS

Because our tethersonde measurements have revealed rather significant differences in the apparent mixing conditions in Vernon and Lynwood during the two intensive study periods studied, we recommend further extensive quantification of the area's meteorology during episodes. This need not be performed along with additional CO monitoring; the CO data from the Lynwood AQMD station appear to be adequately representative of the Lynwood area.

The meteorology (such as wind speed, wind direction, inversion base, and inversion intensities) that might influence mixing and dilution of surface-generated pollutants should be quantified at a number of locations across the Basin and in the Lynwood area. These data need to be collected with the goal of modeling the pollutant impacts that would result from known CO sources operating in the areas, under the influence of the meteorology that is characterized. We believe this modeling exercise will be considerably more complex than is typically done to estimate CO impacts, since it will involve the influences of the terrain and surface temperature as well as simple dispersion considerations. Since Lynwood and Hawthorne are both frequent exceedance areas, both should be included in the study design; Lynwood, however, should receive the most attention. Vernon could also be included to ensure that there are data to establish some connection with previous observations in the Basin.

Another issue of lesser importance to understanding the basis of CO episodes would be to identify important sources other than motor vehicles that may be contributing to the high CO in the Basin. We recommend that particular attention be paid to quantifying the importance of these other sources in the Lynwood area. The frequency distributions of CO during the two episodes show some evidence of local influences at several monitoring sites in Lynwood. Similar evidence was seen in the mobile monitoring that GM performed. A careful inventory of industrial sources in the area or a monitoring survey of the area, using a mobile monitoring system, should allow a better evaluation of the importance of these source contributions to the CO problem.

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TABLES

Section 1

INTRODUCTION

Monitoring stations in seven of California's air basins have reported carbon monoxide (CO) concentrations that exceeded state and federal ambient air quality standards during 1986 or 1987. The most frequent violations have been reported from the Lynwood, Hawthorne, and Burbank stations located in the South Coast Air Basin. The highest CO concentrations in California have been measured at the Lynwood station, in west-central Los Angeles.

In order to develop measures to reduce regional and local CO concentrations and to meet the air quality standards, the spatial and temporal distribution of CO must be characterized and the contribution of local sources, such as vehicle emissions to areawide levels, must be better understood. In 1989, the California Air Resources Board (ARB), Research Division, contracted AeroVironment Inc. (AV) to perform a monitoring study in Lynwood and at other locations in the Basin to characterize the spatial and temporal behavior of the CO for several high exceedance episodes during the period from 15 November 1989 to 30 January 1990. This period has historically been the one with the greatest frequency of such exceedance episodes.

During the planning phase of the study, a study design was finalized that would employ integrating samplers at approximately 36 locations in the basin, including several with balloon-borne elevated sampling probes. Samplers were to be deployed only for short-term intensive monitoring of episodes on a predictive basis. The samplers were to be distributed in a more-or-less radial pattern of decreasing density centered at the South Coast Air Quality Management District's (AQMD) Lynwood air monitoring station. Figure 1-1 is a map of the study region showing the distribution of the monitoring locations and other features of the program that are described below. Figure 1-2 shows the layout of the monitoring network in Lynwood. Collection of surface wind data (at 10 meters) and wind and temperature data from two tethersonde sites (limited to altitudes less than 100 meters) was incorporated. In addition, so that we might better understand the contribution of different areas around Lynwood to the air parcels being sampled, four tracer release sites were chosen from which different perfluorocarbon gases could be released during the first six hours of each study day. Traffic counting stations were set up on selected surface streets to provide information about the probable source strength from local mobile source contributors.

For more information about the study, a work plan that describes this overall study design and its execution in more detail is included as Appendix A of this final report.

We have also incorporated into this report data from the traffic counts CalTrans made for the ARB. For the monitoring periods of interest, we have also included the data from three AQMD continuous CO monitoring stations where we placed collocated integrating samplers; these stations are in Lynwood, 90-749

CO Monitoring Stations

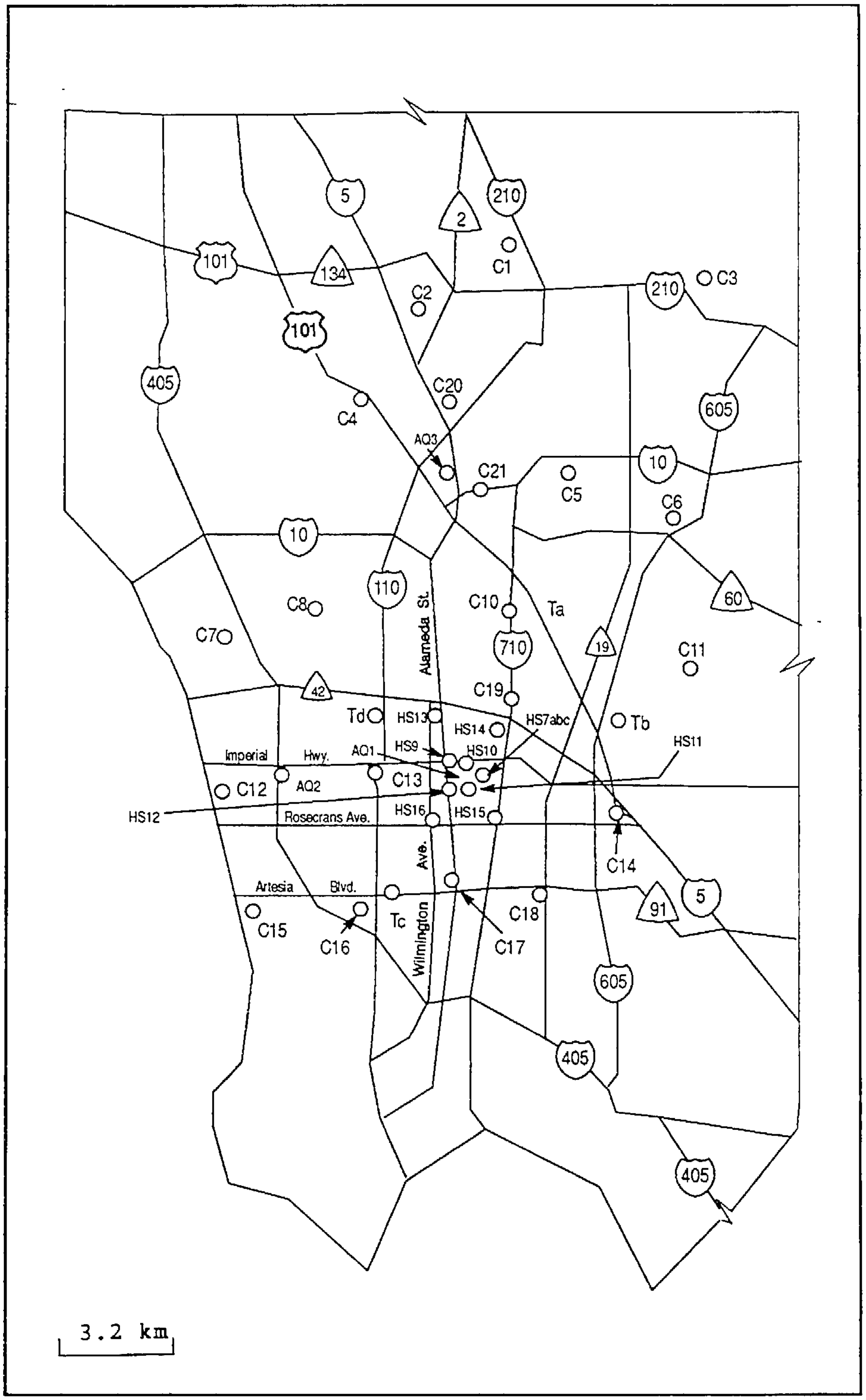


FIGURE 1–1.

90-750

Lynwood Monitoring Stations

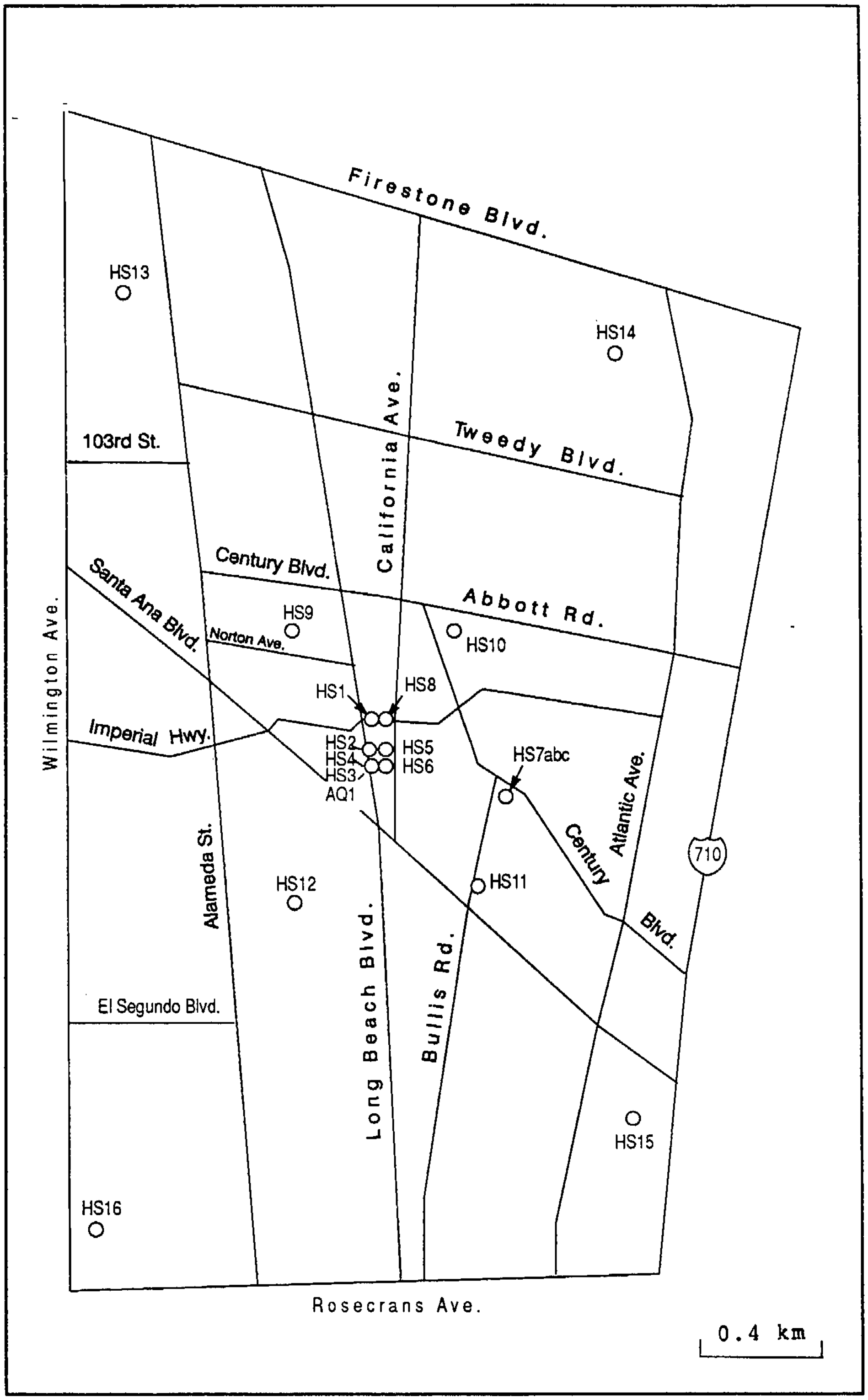


FIGURE 1–2.

Hawthorne and downtown Los Angeles. Data from measurements Dr. Peter Groblicki of GM Research (GM) made of CO concentrations using mobile monitors have been examined and are included in the report.

Other adjunct information, which is not incorporated in this report, was collected through AV subcontracts during this study. Dr. Donald Stedman of the University of Denver performed remote sensing measurements of CO and CO_2 emissions from tailpipes of automobiles along selected traffic routes near Lynwood and Hawthorne. He also recorded the license numbers of the vehicles so that vehicle inspection information could be retrieved from the Bureau of Auto Repair. This monitoring was performed over a ten-day period that included the second of three intensive episodes monitored using the integrating sampler network. Information from the Stedman study has been reported to the ARB separately. A summary is attached to this report as Appendix G. In another exercise performed through AV subcontract, videotapes were made during each intensive monitoring period of vehicles and their license plates at several surface street locations and one freeway location in the study monitoring regions. These tapes are being archived, without reduction of the data, pending future resources and need for the information. (Some difficulty was encountered collecting these data, resulting in reliable video quality only during daylight hours.)

Three 24-hour intensive study periods were planned for monitoring. The AQMD predicted the episodes, in cooperation with the ARB. AV responded to these calls for monitoring by deploying the integrating samplers and coordinating the activities of the tracer release subcontractor, Tracer Technology, Inc. (T-T), the traffic monitoring subcontractors, Newport Traffic, Inc., and Golden State Traffic Counts (for part of the third episode), and the traffic video subcontractor, Richmond Photographic Services.

Three intensive study periods were sampled. The first of these intensives, on 5–6 December, was deemed not to constitute a satisfactory episode by the ARB contract manager and those data are not incorporated in this report. Data from the second and third episodes, which were true high-CO episodes, are reported here.

Another contractor, Global Geochemistry Corporation, also monitored during this winter period to identify possible sources of CO. A summary of these results is attached as Appendix H.

Section 2

GENERAL DESCRIPTION OF THE OBSERVED CO EPISODES

Samples for CO and the four different tracers were collected during episodes on 19–20 December 1989 (Episode 2) and 8–10 January 1990 (Episode 3). Thirty-six stations, listed in Table 2-1, were operated during these episodes. Tethersonde soundings and traffic counts for corresponding periods were also collected. The sites where these data were recorded are also noted in the table.

2.1 STATISTICAL DESCRIPTION OF THE CO MONITORING DATA

A statistical summary of the data has been made for each station and for each episodic period. The mean, median and 90th percentile concentrations, peak hour, second-highest hour and the highest eight-hour average of the data from each site were calculated and tabulated in Tables 2-2 and 2-3 for the periods of 19–20 December 1989 and 8–10 January 1990, separately.

Comparison of the mean, median and maximum eight-hour-average concentrations during the second and third episodes shows that the third episode had the highest concentrations, e.g., the peak concentration at AQ3 during Episode 2 was 6.13 ppm compared to 7.25 ppm during Episode 3; the peak at HS2 in Episode 2 was 14.8 ppm and in Episode 3 was 20.4 ppm. A similar relationship held at most of the other sites. Generally speaking, the third episode was more severe than the second. However, some of the sites, such as HS12, showed an averaged CO concentration in Episode 2 that was higher than the average concentration in Episode 3.

During both the second and third episodes, stations in the Lynwood area showed higher concentrations than stations in other areas; again see Tables 2-2 and 2-3. We will discuss this spatial variation of the CO in Section 3.

Table 2-4 lists CO data capture rates for each station. As it shows, some of the stations did not have a high data capture rate. Equipment problems, mainly faulty timers, caused these losses of data. The data information for tracers will be shown in Section 4.

2.2 DATA QUALITY

Data from the AQMD's continuous monitors have been compared with those obtained from the collocated or nearby integrated samples over the same averaging periods. Figures 2-1a, 2-1b and 2-1c show scatterplots comparing integrated samples in the third episode from AQ2, AQ3 and HS3 with continuous one-hour averaged data from CTY2, CTY3, CTY1, respectively. The correlation coefficients have been calculated and are shown on each plot. The correlation coefficient for AQ3 and CTY3 is 0.95 in the third episode; a similar high degree of correlation, 0.96, also exists between HS3 and CTY1; however, as is

Table 2-1. List of Integrated Air Sampling Locations

Stations	Sample Location	Other Name
CO Monitoring Site		
AQ2	Hawthorne Air Quality Station	AQ2
AQ3	Los Angeles Air Quality Station	AQ3
CC1	1420 Lake St. Glendale	C1
CC2	1065 Armade Dr., Pasadena	C2
CC3	738 E. Oakdale, Monrovia	C3
CC4	1405 N. Edgemon, Los Angeles	C4
CC5	305 N. Lincon Ave # 5 Monterey Park	C5
CC6	12645 Fineview, El Monte	C6
CC7	12070 Beatrice Street, Culver City	C7
CC8	3678 Fairland Blvd., Los Angeles	C8
CC10	2349 Strong Ave., City of Commence	C10
CC11	7274 Canyon Crest Dr., Whittier	C11
CC12	700 W. Pine Ave., El Segundo	C12
CC13	13133 S. Hoover St. Gardena	C13
CC14	11914 Lyndora, Norwalk	C14
CC15	1703 Ford Ave., Redonda Beach	C15
CC16	17513 Broadwell Ave., Gardena	C16
CC17	203 W. Artesia Bl. Long Beach	C17
CC18	10012 Ramona St., Bellflower	C18
CC19	6940 Walker, Cudahy	C19
CC20	2300 Dorris Pl., Los Angeles	C20
CC21	2635 Lancaster Ave., East Los Angeles	C21
HS1	3351 E. Imperial Hwy., Lynwood	HS1
HS2	3301 Beechwood Ave., Lynwood	HS2
HS3	11220 Long Beach Blvd., Lynwood	HS3
HS4	11220 Long Beach Blvd., Lynwood	HS4
HS5	3367 Beechwood Ave., Lynwood	HS5
HS6	3340 Sanborn Ave., Lynwood	HS6
HS7a	Sheriff's Station, Lynwood, 50 ft. elevation	HS7a
HS7b	Sheriff's Station, Lynwood, 100 ft. elevation	HS7b
HS7c	Sheriff's Station, Lynwood, 150 ft. elevation	HS7c

Table 2-1. Continued

HS8	3366 E. Imperial Hwy., Lynwood	HS8
HS9	10821 Capistrano Ave., Lynwood	HS9
HS10	10700 San Luis Ave. Lynwood	HS10
HS11	11817 State St., Lynwood	HS11
HS12	3801 Cortland St., Lynwood	HS12
HS13	9603 Croesus Ave., Lynwood	HS13
HS14	9329 Hildreth Ave., South Gate	HS14
HS15	5300 Clark St., Lynwood	HS15
HS16	13824 N. Pausen Ave., Compton	HS16
AQMD Continuous Monitors		
CTY1 (HS3)	11220 Long Beach Blvd., Lynwood	COCTY1
CTY2 (AQ2)	Hawthorne Air Quality Station	COCTY2
CTY3 (AQ3)	Los Angeles Air Quality Station	COCTY3
Tracer Release Site		
TR01	Washington and Freeway 5	Ta (PMCP)
TR02	Firestone and Freeway 605	Tb (PMCH)
TR03	Central Ave., and Freeway 91	Tc (PDCH)
TR04	Century Blvd. & Freeway 110	Td (PTCH)
Tethersonde Site		
TETH-1	3300 Century Blvd., Lynwood	Lynwood
TETH-2	Vernon Fire Station, Vernon	Vernon
Traffic Counting		
Newport Traffic Study Site		
TC-1	La Cienega and 120th, Hawthorne	TRANS1
TC-2	Firestone Blvd and John Ave., Florence	TRANS2
TC-3	Atlantic Ave. and Firestone Blvd, South Gate	TRANS3
TC-4	Lynwood Air Quality Site	TRANS4
TC-5	Long Beach Blvd and Imperial Hwy, Lynwood	TRANS5
TC-6	Long Beach Blvd and Rosecrans Ave., Compton	TRANS6
CALTRANS Site		
	Freeway 210 and La Crescenta Ave.	210-LC
	Freeway 210 and Santa Anita	210-STA
	Freeway 405 and Venice Blvd.,	405-VENI
	Freeway 405 and Freeway 10	405-10
	Freeway 405 and Compton Blvd.	405-CMP
	Freeway 605 and San Gabriel River	605-SGR
	Freeway 10 and Freeway 5	No. 5-10

Table 2-2. CO Data Analysis For Each Station
Episode 2: Dec 19-20, 1989

SITE	MEAN	MEDIAN	70TH	90TH	PEAK	HR	2ND PEAK	HR	Highest 8HR AVG	HR
AQ3	4.16	4.38	4.81	5.57	6.13	8	5.63	6	4.97	0-8,1-9
CC1	4.63	4.56	5.10	6.95	7.25	6	7.13	8	5.97	0-8,1-9
CC3	2.82	2.75	2.94	3.55	4.00	18	3.50	16	3.41	14-22,15-23
CC4	4.72	4.63	4.71	6.54	6.88	6	6.63	20	5.47	16-0,17-1
CC7	5.18	5.94	6.21	7.18	9.88	4	7.19	20	7.27	22-6,23-7
CC8	3.51	3.63	4.20	5.05	7.56	8	5.13	0	5.03	2-10,3-11
CC10	3.75	3.63	4.30	4.95	7.50	22	5.00	0	5.22	18-2,19-3
CC12	3.89	2.94	4.97	7.73	8.38	8	7.88	6	7.29	0-8,1-9
CC13	1.87	1.83	1.88	1.98	2.50	2	2.00	18	1.99	18-2,19-3
CC14	6.59	7.19	7.53	8.83	9.13	20	8.63	16	8.04	14-22,15-23
CC15	3.00	2.29	4.20	5.50	5.75	0	5.63	6	4.97	22-6,23-7
CC16	5.67	5.69	7.50	9.44	10.25	6	9.63	4	9.28	22-6,23-7
CC17	8.76	10.00	10.34	11.62	12.75	18	11.13	12	10.94	11-19
CC18	5.73	6.38	7.38	8.98	9.38	8	9.25	6	8.19	0-8,1-9
CC19	4.74	4.50	5.15	7.64	10.00	22	7.38	20	7.56	2-10,3-11
CC20	4.66	4.63	5.00	6.12	7.63	6	6.13	20	5.63	0-8,1-9
HS1	2.88	2.75	2.80	3.10	3.25	12	2.75	16		
HS2	6.93	6.38	8.00	11.81	14.75	22	14.13	23	10.40	17-1
HS5	7.46	7.00	8.89	12.93	14.13	22	14.00	23	11.18	17-1
HS7A	7.14	7.00	8.13	9.04	9.13	12	9.00	20	7.50	11-19
HS7B	5.59	5.63	5.96	6.55	7.25	4	6.25	10	6.04	20-421-5
HS7C	4.57	4.38	5.15	5.73	6.13	6	5.63	22	5.07	22-6,23-7
HS9	7.30	6.51	7.63	14.50	16.38	11	15.25	19	9.28	11-19
HS10	6.80	6.94	8.73	11.00	14.25	18	13.50	17	8.97	11-19
HS12	7.71	7.32	9.55	12.45	20.63	19	16.75	18	12.90	12-20
HS13	5.44	2.63	4.65	13.80	16.25	14	14.50	16	12.00	12-20,13-21
HS14	4.57	3.75	4.98	6.92	7.25	12	6.88	14	6.06	11-19
HS15	6.64	6.19	8.10	11.70	15.50	20	11.88	18	11.75	14-22,15-23

Table 2-3. CO Data Analysis For Each Station
Episode 3: Jan 8-10, 1990

SITE	MEAN	MEDIAN	70TH	90TH	PEAK	HR	2ND PEAK	HR	Highest 8HR AVG	HR
AQ2	7.58	7.00	8.63	13.51	17.00	12	15.88	10	15.13	6-14,7-15
AQ3	4.90	4.88	6.23	6.48	7.25	22	6.50	0	6.35	18-2,19-3
CC1	5.71	6.14	6.25	6.75	8.35	8	6.75	0	6.91	2-10,3-11
CC4	5.78	5.51	5.95	7.39	9.75	8	7.45	6	7.12	2-10,3-11
CC5	5.65	5.25	6.82	7.80	8.75	20	7.70	22	7.55	18-2,19-3
CC6	5.33	5.29	6.30	7.20	7.38	0	7.20	22	6.96	18-2,19-3
CC8	5.34	5.66	6.58	7.55	9.90	22	7.75	8	7.51	18-2
CC10	5.69	5.44	6.48	9.38	11.63	20	9.38	6	8.68	14-22,15-23
CC13	7.11	7.19	7.65	11.15	12.25	22	11.25	8	9.35	0-8,1-9
CC14	5.94	5.91	6.58	7.60	10.38	6	7.68	4	8.09	22-6,23-7
CC16	6.45	6.63	7.63	10.03	12.88	8	12.05	6	10.89	4-12,5-13
CC17	5.62	6.72	7.21	7.69	8.50	12	7.75	10	7.89	6-14,7-15
CC18	6.01	6.32	7.13	9.03	10.13	8	9.38	6	8.66	0-8,1-9
CC19	7.04	6.94	7.45	12.55	12.75	22	12.75	6	10.03	16-0,17-1
CC21	5.50	5.19	5.62	8.25	9.08	6	8.50	8	6.72	0-8,1-9
HS1	8.95	7.63	8.75	14.76	18.55	6	15.63	8	14.00	17-1,18-2
HS2	9.05	7.50	11.88	14.30	20.43	7	16.25	23	13.05	18-2
HS3	9.51	7.63	11.91	15.60	20.13	8	16.63	7	13.31	1-9
HS5	8.90	7.50	11.20	14.98	16.68	8	15.63	22	12.86	18-2
HS6	9.29	7.65	13.50	15.00	21.50	7	20.70	6	13.73	0-8
HS7A	8.57	7.38	8.16	14.49	17.50	8	15.75	22	11.97	18-2
HS7B	6.38	6.38	7.20	8.15	9.13	12	8.38	22	7.97	16-0,17-1
HS7C	5.80	5.57	5.90	7.55	10.75	8	10.25	22	7.20	0-8
HS8	10.54	8.75	12.23	17.54	25.00	7	21.88	8	15.84	1-9
HS10	7.44	5.88	7.20	12.44	22.25	15	18.75	16	12.54	11-19
HS12	6.52	6.05	7.37	9.85	17.13	18	16.88	17	7.41	5-13
HS13	6.11	6.07	6.83	9.03	15.00	14	9.50	16	6.84	18-2
HS14	5.56	5.50	6.01	7.44	8.63	14	7.50	12	6.54	6-14,7-15
HS15	8.96	8.38	10.73	13.73	15.95	18	14.63	20	14.57	16-0,17-1
HS16	8.60	5.94	8.70	15.75	19.00	20	16.88	18	15.94	16-0,17-1

Table 2-4. CO Data Information For Each Station

	Episode 2: Dec. 19 - 20				Episode 3: Jan. 8 - 10				Capture
SITE	Record	Missing	Time periods of missing records	Remarks	Record	Missing	Time periods of missing records	Remarks	rate
AQ2	0	12	12:00,12/19 - 12:00,12/20	No samples	17	3	12:00,1/8 ,0:00,14:00,1/9 (2hr avg.)	empty bags	0.53
AQ3	0	12	12:00,12/19 - 12:00,12/20	No samples	12	8	12:00,1/8, 14:00,1/9-2:00,1/10 (2hr avg.)	empty bags	0.38
CC1	11	1	22:00, 12/19 (2 hr avg.)	empty bags	10	10	12:00, 1/8, 2:00, 10:001,14:00 1/9 - 2:00, 1/10	empty bags	0.66
CC3	9	3	14:00 - 16:00, 12/19 (2 hr avg.)	empty bags	9	11	12:00, 1/8, 8:00, 1/9 - 2:00 , 1/10(2hr avg.)	empty bags	0.56
CC4	11	1	8:00, 12/19 (2hr avg.)	empty bags	12	8	12:00, 1/8, 14:00, 1/9 - 2:00, 1/10 (2hr avg.)	empty bags	0.72
CC5	0	12	12:00, 12/19 - 12:00, 12/20	No samples	9	11	12:00-14:00, 1/8, 6:00-8:00, 1/9, 14:00, 1/9-2:00, 1/10	empty bags	0.28
CC6	0	12	12:00, 12/19 - 12:00, 12/20	No samples	10	10	12:00, 20:00, 1/8, 10:00,14:00, 1/9-2:00, 1/10(2hr avg.)	empty bags	0.31
CC7	11	1	10:00, 12/20 (2hr avg.)	operation failed	0	20	12:00,1/8, - 2:00,1/10	empty bags	0.34
CC8	12	0			18	2	12:00, 1/8, 14:00, 1/9 (2hr avg.)	late operation	0.94
CC10	12	0			18	2	12:00, 1/8, 14:00, 1/9 (2hr avg.)	late operation	0.94
CC12	12	0			0	20	12:00,1/8, - 2:00,1/10	no samples	0.38
CC13	12	0			18	2	12:00, 1/8, 14:00, 1/9 (2hr avg.)	late operation	0.94
CC14	6	6	0:00 - 10:00, 12/20 (2hr avg.)	empty bags	12	8	12:00, 1//8, 14:00,1/9 - 2:00, 1/10 (2hr avg.)	empty bags	0.56
CC15	12	0			0	20	12:00,1/8, - 2:00,1/10	no samples	0.38
CC16	12	0			15	5	12:00, 1/8,12:00, 14:00, 20:00, 1/9, 2:00, 1/10(2hr avg.)	empty bags	0.84
CC17	7	5	2:00 - 10:00, 12/20 (2hr avg.)	empty bags	12	8	12:00, 1/8,14:00, 1/9 - 2:00, 1/10 (2hr avg.)	empty bags	0.59
CC18	12	0			12	8	12:00, 1/8, 14:00, 1/9 - 2:00, 1/10 (2hr avg)	empty bags	0.75
CC19	9	3	0:00 - 4:00, 12/20 (2hr avg.)	empty bags	18	2	12:00, 1/8, 14:00, 1/9(2hr avg.)	late operation	0.84
CC20	11	1	14:00,12/19 (2hr avg.)	empty bags	0	20	12:00,1/8, - 2:00,1/10	empty bags	0.34
CC21	0	12	12:00, 12/19 - 12:00, 12/20	no samples	12	8	12:00, 1/8, 14:00, 1/9 - 2:00, 1/10 (2hr avg.)	empty bags	0.38
HS1	3	9	18:00,12/19 - 10:00, 12/20 (2hr avg.)	empty bags	17	3	12:00,1/8,14:00,20:00,1/9 (2hr avg.)	empty bags	0.63
HS2	23	1	00:00, 12/20 (2hr avg.)	empty bags	32	7	12:00 -13:00, 22:00, 1/8, 1:00, 13:00-15:00, 1/9 (1hr avg.)	empty bags	0.87
HS3	0	24	12:00, 12/19 - 12:00, 12/20	no samples	33	6	12:00-13:00, 1/8, 1:00 ,4:00, 14:00 - 15:00,1/9 (1hr avg.)	empty bags	0.52
HS5	23	1	18:00, 12/19 (1hr avg.)	empty bags	33	6	12:00,13:00,21:00, 1/8, 7:00, 14:00,15:00, 1/9 (1hr avg.)	empty bags	0.89
HS6	0	24	12:00, 12/19 - 12:00, 12/20	empty bags	32	7	12:00 -13:00, 1/8, 4:00 13:00-16:00, 1/9 (1hr avg.)	empty bags	0.51
HS8	0	24	12:00, 12/19 - 12:00, 12/20	no samples	34	5	12:00 -13:00, 1/8, 3:00,14:00,15:00, 1/9 (1hr avg.)	empty bags	0.54
HS9	20	4	6:00 -8:00, 10:00-11:00 12/20(1hr avg.)	sampler failed	0	20	12:00, 1/8 - 2:00, 1/10	sampler failed	0.45
HS10	24	0			29	10	12:00-13:00,1/8, 0:00,7:00,9:00,11:00,12:00,14:00,15:00 1/9,2:00,1/10	empty bags	0.84
HS12	22	2	14:00 - 16:00, 12/19 (2hr avg.)	empty bags	27	12	12:00,13:00,16:00, 19:00-23:00,1/8,3:00,12:00,14:00,15:00,1/9	empty bags	0.78
HS13	11	1	20:00, 12/19 (2hr avg.)	empty bags	12	8	12:00,18:00,20:00,1/8,4:00,8:00,10:00,14:00,22:00,1/9 (2hr avg)	empty bags	0.72
HS14	9	3	22:00 - 2:00, 12/19 (2hr avg.)	empty bags	15	5	12:00,20:00,1/8,14:00,22:00,1/9,2:00,1/10 (2hr avg.)	empty bags	0.75
HS15	12	0			16	4	12:00,1/8, 0:00-6:00,14:00,1/9 (2hr avg.)	empty bags	0.88
HS16	0	12	12:00, 12/19 - 12:00, 12/20 (2hr avg.)	no sample	16	4	12:00,1/8,8:00,14:00,1/9,2:00,1/10 (2hr avg.)	empty bags	0.50
HS7A	7	5	2:00 - 10:00, 12/20 (2hr avg.)	empty bags	18	2	12:00,1/8,14:00,1/9 (2hr avg.)	late operation	0.78
HS7B	7	5	12:00 - 18:00, 22:00, 12/19 (2hr avg.)	empty bags	16	4	12:00,16:00,18:00,1/8, 14:00,1/9 (2hr avg.)	empty bags	0.72
HS7C	8	4	12:00 - 18:00, 12/19 (2hr avg.)	empty bags	18	2	12:00, 1/8, 14:00,1/9 (2hr avg.)	late operation	0.81

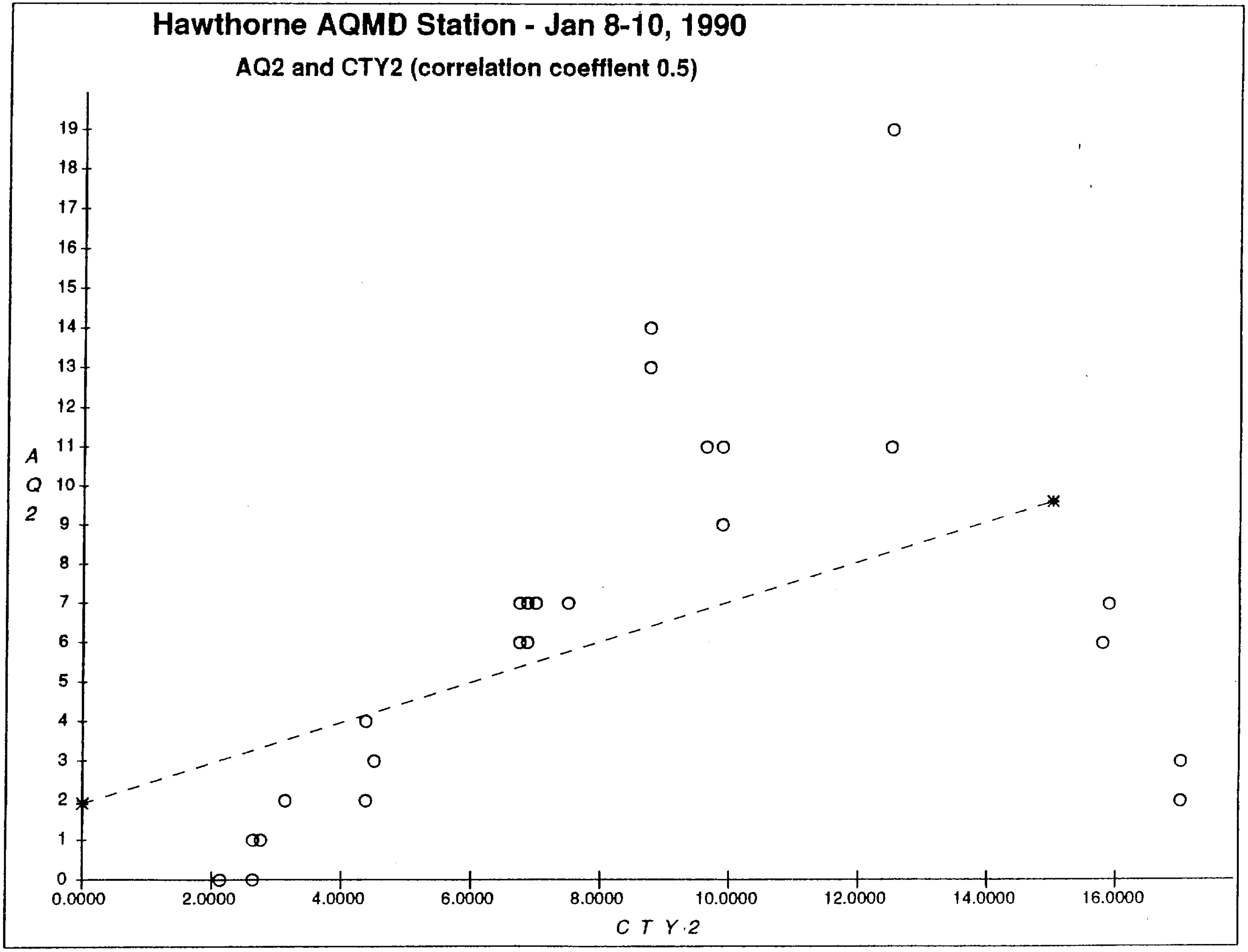

Hawthorne AQMD Station - Jan 8-10, 1990
AQ2 and CTY2 (correlation coeffient 0.5)
AQ2
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
0.0000
2.0000
4.0000
6.0000
8.0000
10.0000
12.0000
14.0000
16.0000
CTY2

FIGURE 2–1a.

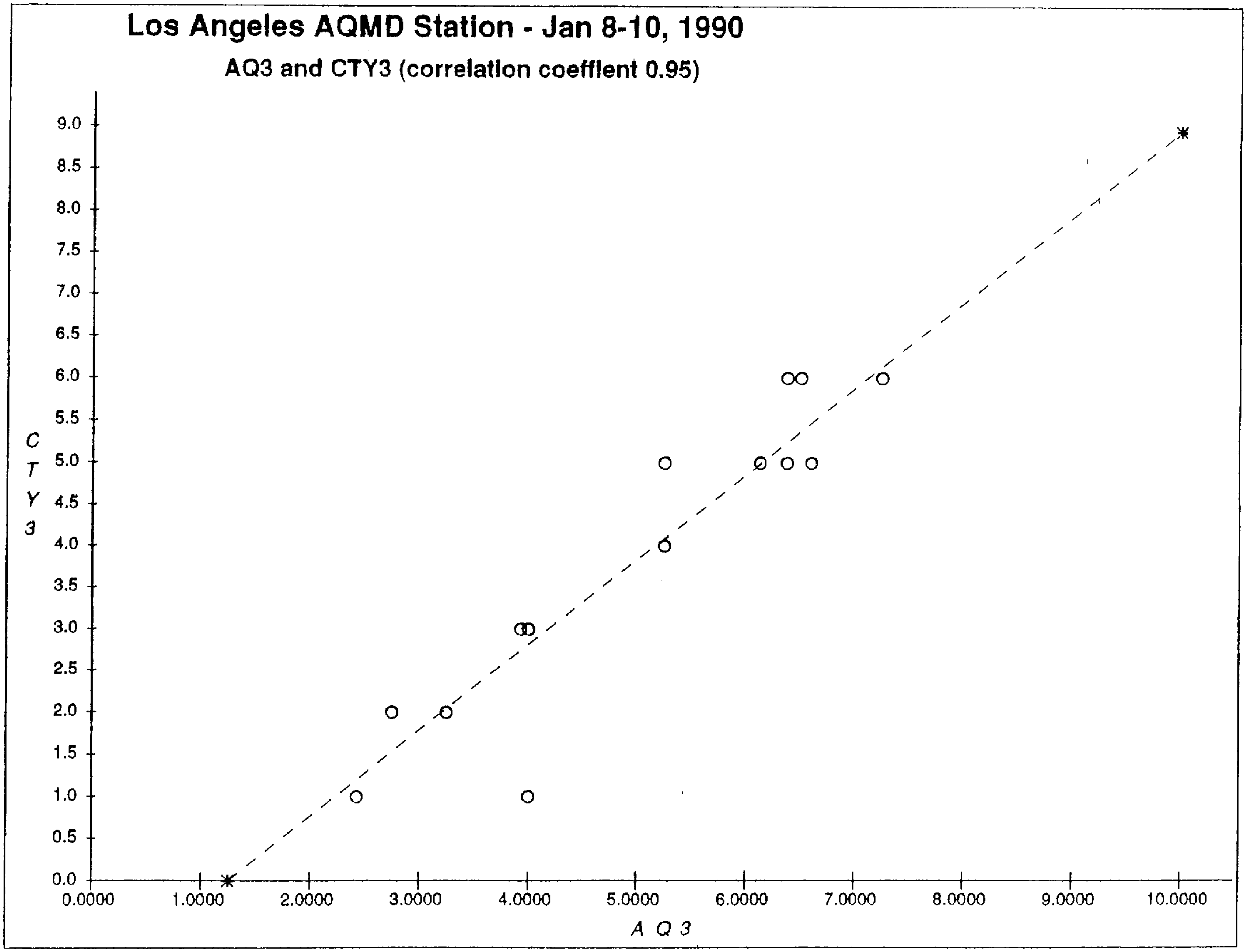

Los Angeles AQMD Station - Jan 8-10, 1990
AQ3 and CTY3 (correlation coeffient 0.95)
C T Y 3
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0000
1.0000
2.0000
3.0000
4.0000
5.0000
6.0000
7.0000
8.0000
9.0000
10.0000
A Q 3

FIGURE 2–1b.

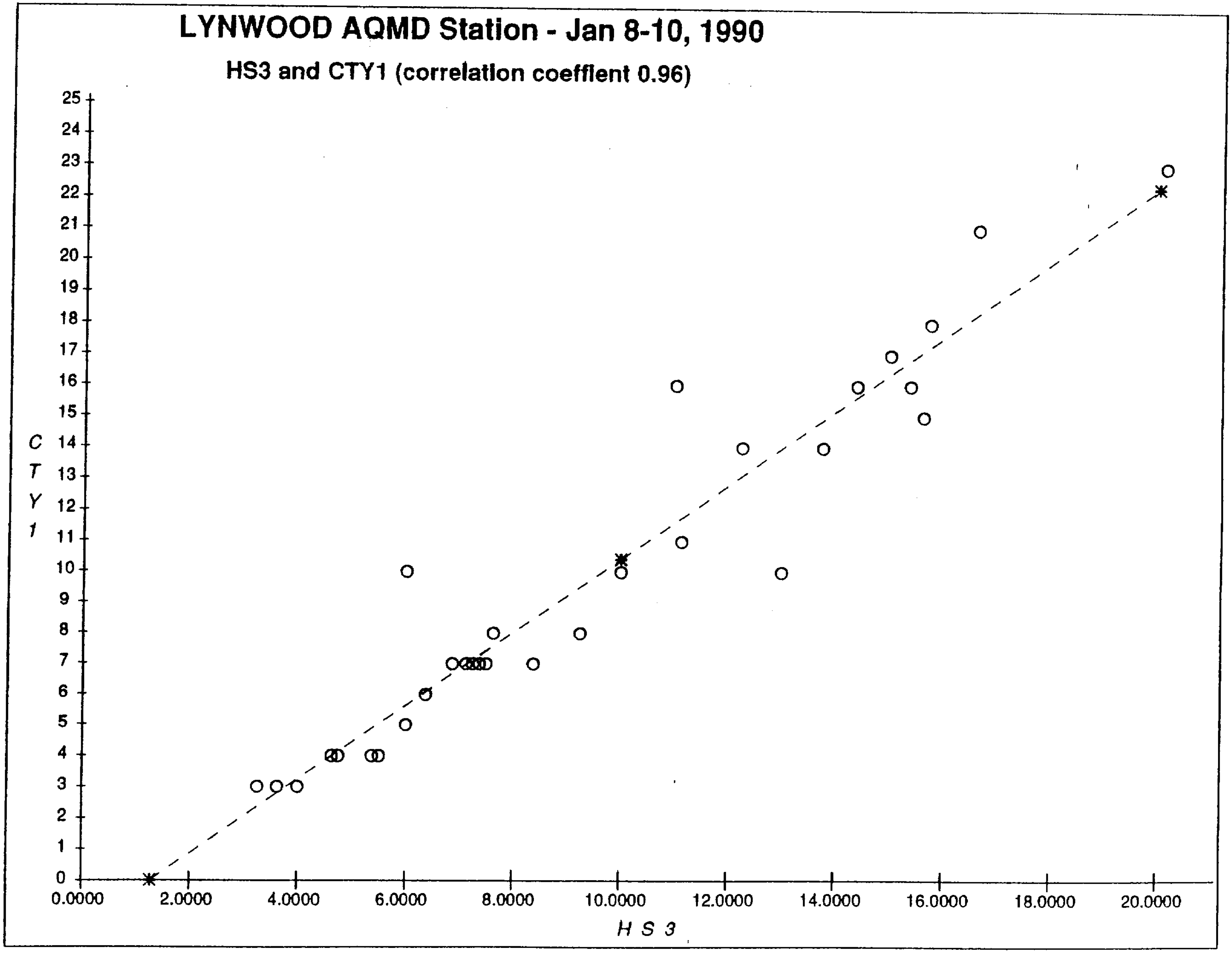

LYNWOOD AQMD Station - Jan 8-10, 1990
HS3 and CTY1 (correlation coeffient 0.96)
C T Y 1
H S 3
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
0.0000
2.0000
4.0000
6.0000
8.0000
10.0000
12.0000
14.0000
16.0000
18.0000
20.0000

FIGURE 2–1c.

FIGURE 3–3a. December 19 – 20, 1989.

FIGURE 3–3a. December 19 – 20, 1989.

FIGURE 3–3b. January 8 – 10, 1990.

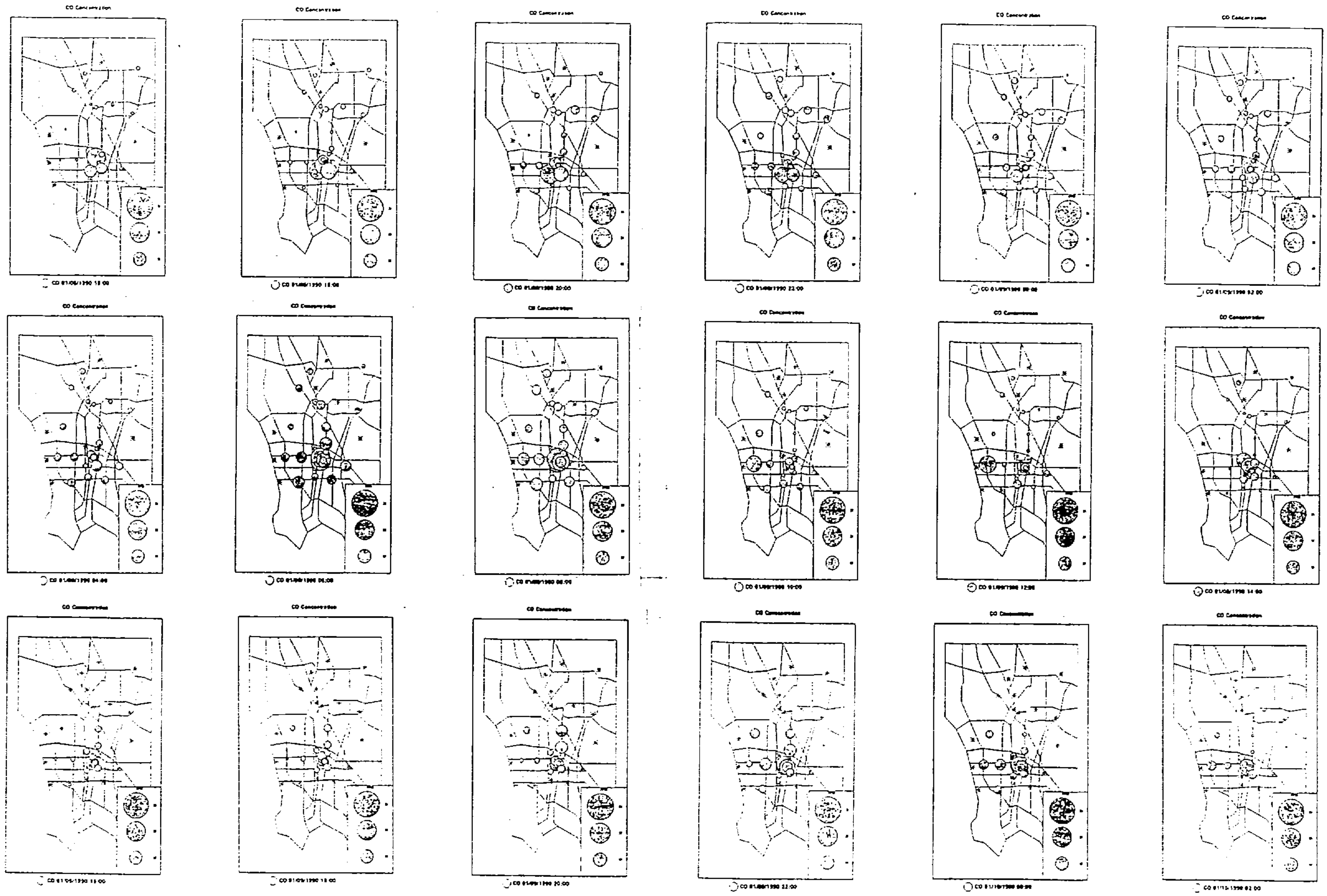


FIGURE 3–3b. January 8 – 10, 1990.

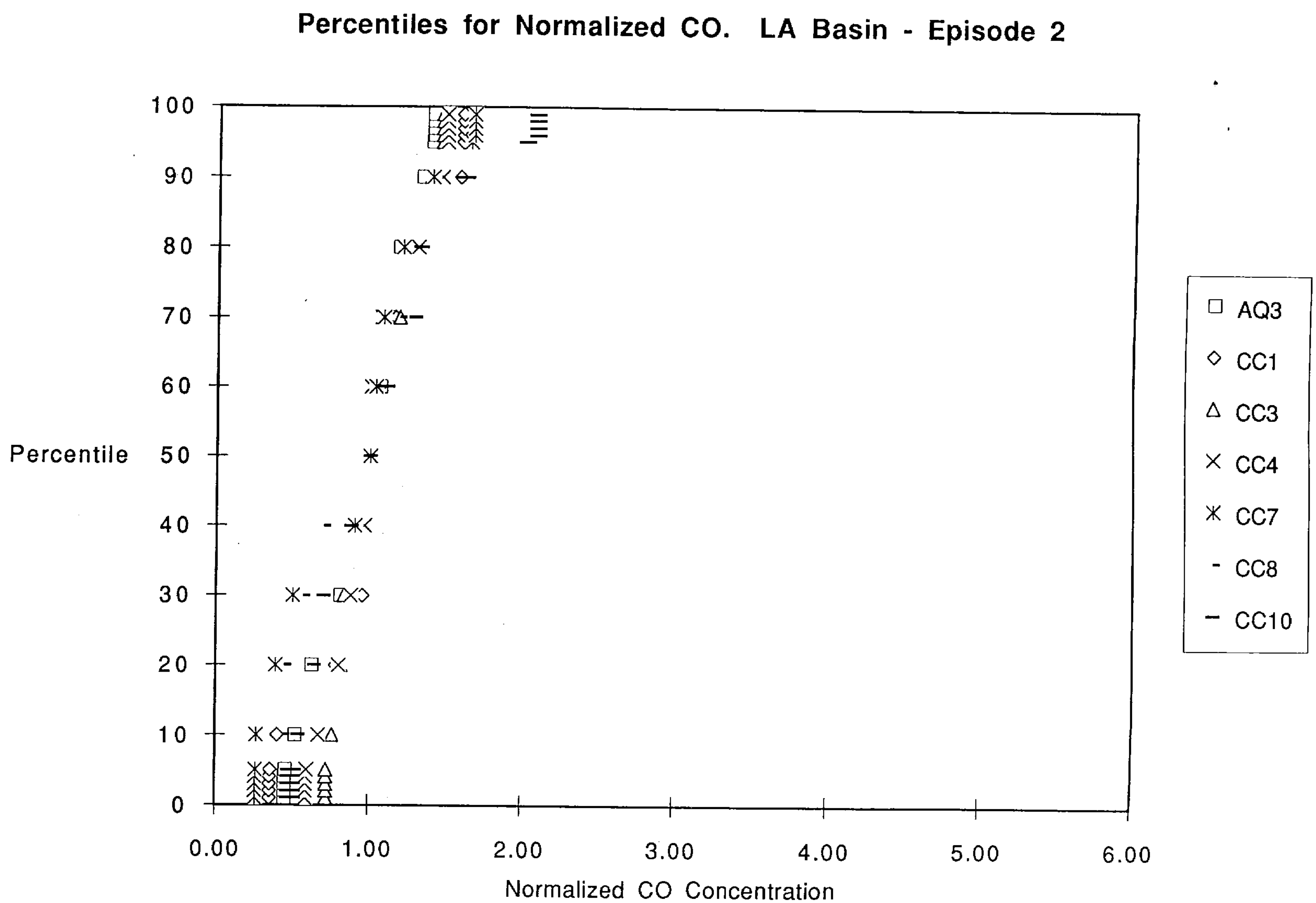


FIGURE 3–4a. All stations in this cluster show similar distributions.

Fig. 3-4b. Percentiles for Normalized CO. LA Basin - Episode 2

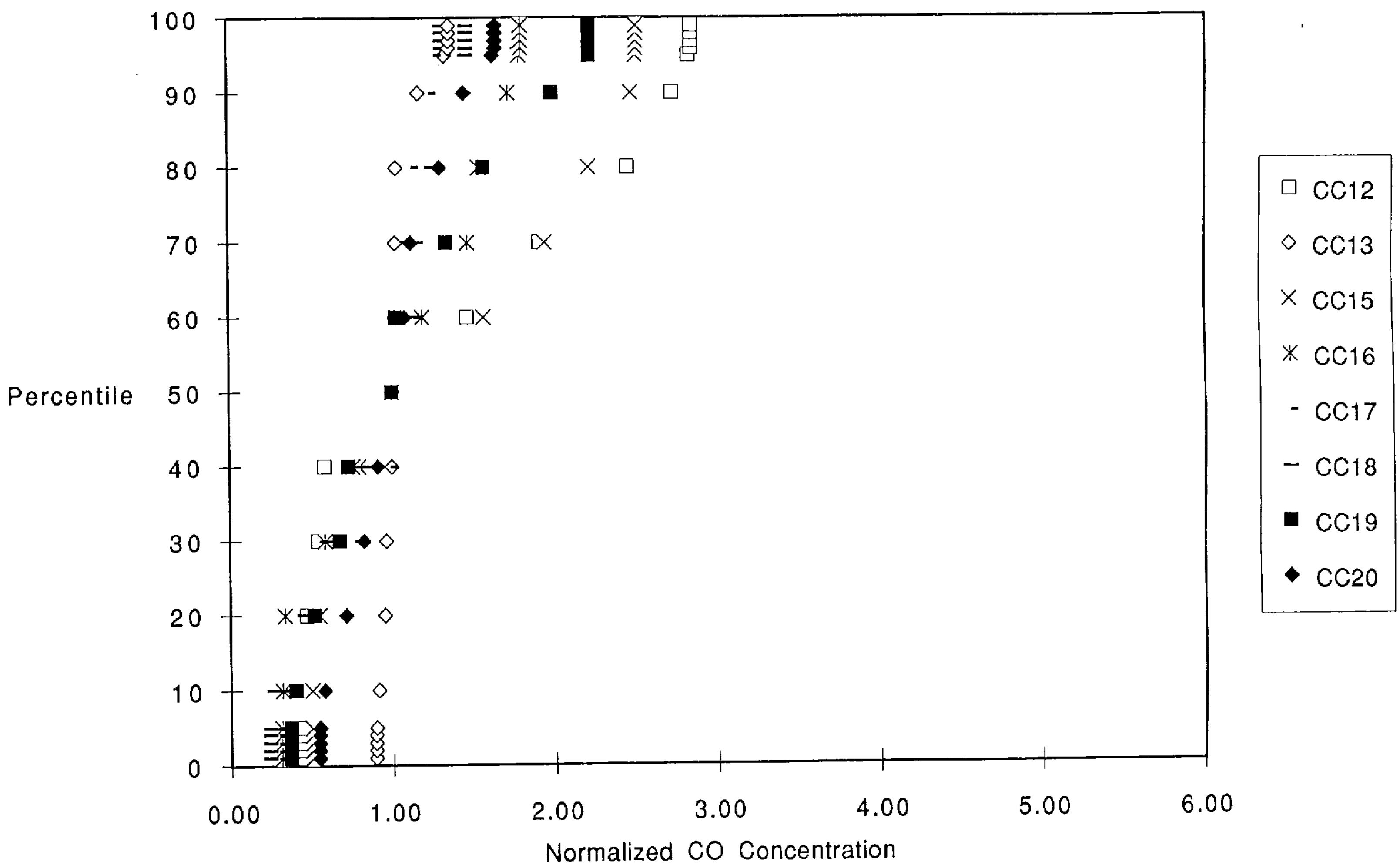


FIGURE 3–4b. Stations CC12, CC15 and CC19 show unusually high increases in CO during the peak episodes.

Fig. 3-4c. Percentiles for Normalized CO. LA Basin - Episode 2

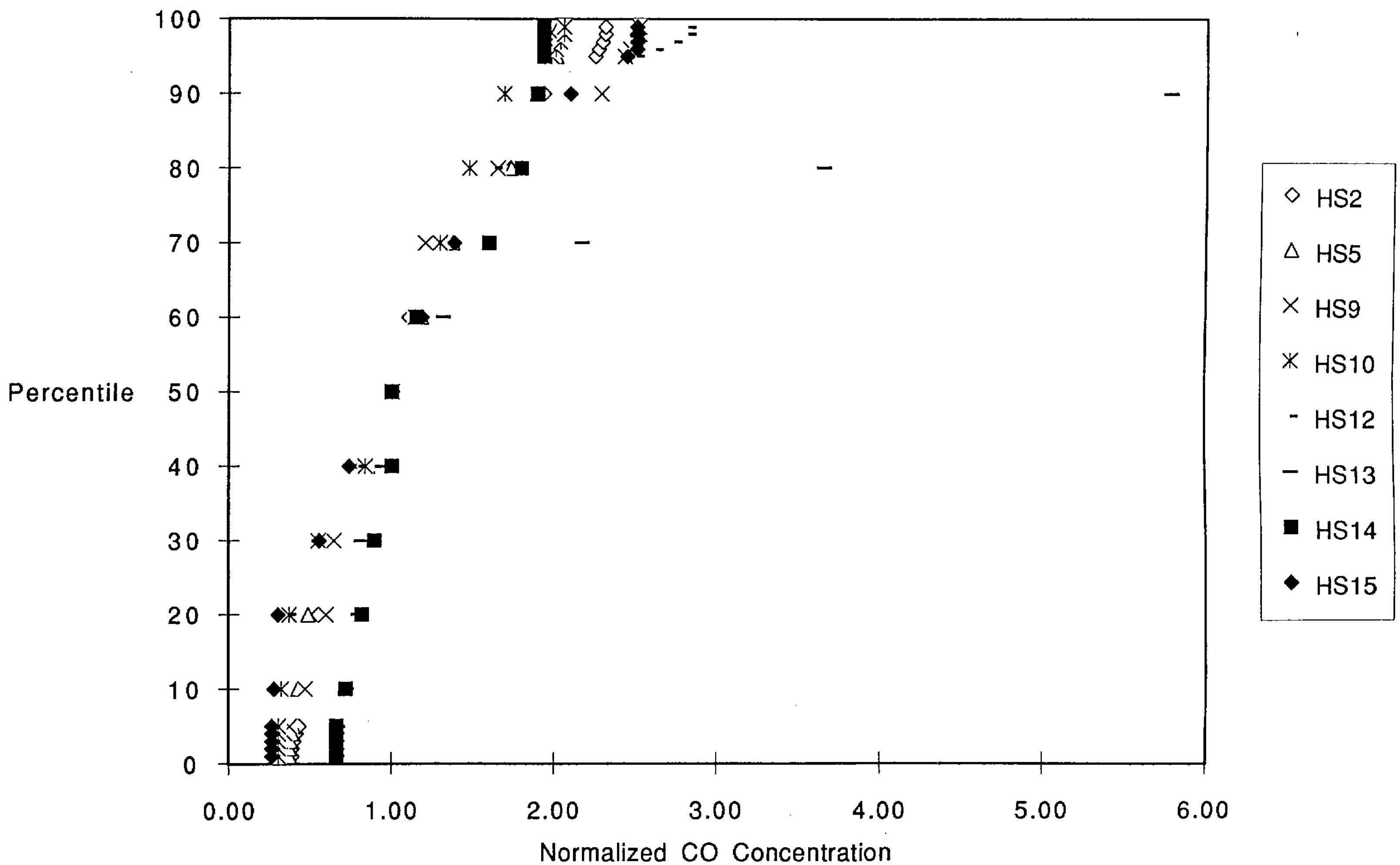


FIGURE 3–4c.

Table 3-1. Cumulative Frequency Distribution Normalized by the Median

Episode 2: Dec. 19-20, 1989

SITE	AQ3	CC1	CC3	CC4	CC7	CC8	CC10	CC12	CC13	CC15	CC16	CC17	CC18	CC19
MEAN	0.95	1.02	1.03	1.02	0.87	0.97	1.03	1.32	1.02	1.31	1.00	0.88	0.90	1.05
70TH	1.10	1.12	1.07	1.02	1.04	1.16	1.18	1.69	1.03	1.84	1.32	1.04	1.16	1.15
90TH	1.27	1.52	1.29	1.41	1.21	1.40	1.37	2.63	1.09	2.41	1.66	1.16	1.41	1.70

SITE	CC20	HS2	HS5	HS7A	HS7B	HS7C	HS9	HS10	HS12	HS13	HS14	HS15
MEAN	1.01	1.09	1.07	1.02	1.00	1.04	1.12	0.98	1.05	2.08	1.22	1.07
70TH	1.08	1.25	1.27	1.16	1.06	1.18	1.17	1.26	1.31	1.77	1.33	1.31
90TH	1.33	1.85	1.85	1.29	1.16	1.31	2.23	1.59	1.70	5.26	1.84	1.89

Episode 3: Jan. 8-10, 1990

SITE	AQ2	AQ3	CC1	CC4	CC5	CC6	CC8	CC10	CC13	CC14	CC16	CC17	CC18	CC19
MEAN	1.08	1.00	0.93	1.05	1.08	1.01	0.94	1.05	0.99	1.00	0.97	0.84	0.95	1.01
70TH	1.23	1.28	1.02	1.08	1.30	1.19	1.16	1.19	1.06	1.11	1.15	1.08	1.13	1.07
90TH	1.93	1.33	1.10	1.34	1.49	1.36	1.33	1.73	1.55	1.29	1.52	1.14	1.43	1.81

SITE	CC21	HS1	HS2	HS3	HS5	HS6	HS7A	HS7B	HS7C	HS8	HS10	HS12	HS13	HS14
MEAN	1.06	1.18	1.17	1.27	1.19	1.20	1.16	1.00	1.04	1.20	1.26	1.08	1.01	1.01
70TH	1.08	1.15	1.54	1.58	1.49	1.74	1.11	1.13	1.06	1.40	1.23	1.22	1.13	1.09
90TH	1.59	1.94	1.86	2.08	2.00	1.93	1.96	1.27	1.36	2.00	2.12	1.62	1.49	1.35

SITE	HS15	HS16
MEAN	1.07	1.45
70 TH	1.28	1.46
90 TH	1.64	2.65

(Figures 3-4d through 3-4g). These plots can be interpreted as representing the characteristics of the peak intensity relative to the standard median condition during the episodic period. This visual representation was intended to show any areas where the peaks are not characteristic of the rest of the network. Figures 3-5a through 3-5h are maps representing these normalized concentration profiles in the network during the peak episodes. Without the distraction of the actual concentration, we are able to see the CO buildup characteristics across the region in these maps. We note that several of the stations in the network show anomalous behavior, demonstrated by their divergence from the typical frequency distribution.

These maps and the statistics of Table 3-1 provide interesting insight into the CO problem. The normalized distributions in Hawthorne and Lynwood appear skewed compared to other sampling locations in the region; this suggests that the Hawthorne and Lynwood areas have either strong local source influences anomalous local meteorological/geographical factors that influence the CO accumulation. We also note in the Lynwood bar-charted maps of the distributions several places where the relative change between median and 90th percentile is exceptionally large. This local sensitivity of the concentration during episodes may be evidence of significant local sources that do not extend their influence far into the area. Data from the GM "rover" vehicle, presented later in this report, show a similar trend. One station near Hawthorne shows similar heightened sensitivity at the 90th-percentile level.

3.4 VERTICAL CHARACTERISTICS OF THE CO DISTRIBUTIONS IN LYNWOOD

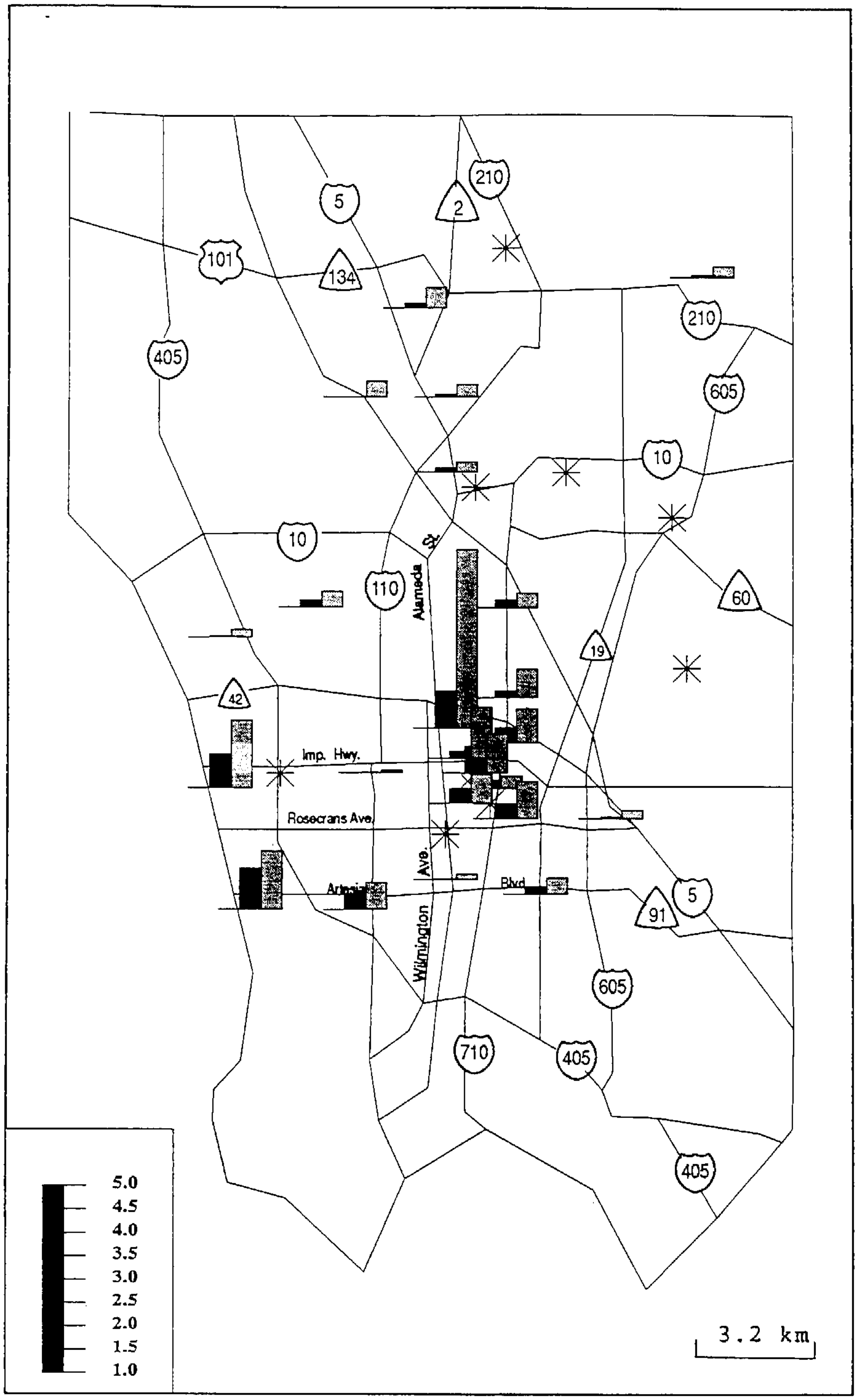
Integrated ambient air sampling was performed at several different elevations at Station 7a, 7b, and 7c in Lynwood (Lynwood Sheriff's Station). Tethersonde soundings were performed at the same location. The samples were collected at approximately 15, 30 and 45 meters (50, 100 and 150 feet, respectively) throughout each intensive period. The measured CO concentrations have been used to characterize the vertical distribution of CO in this area where the highest local CO concentrations exist.

o **Episode 2: 19–20 December 1989**

During the second episode, CO samples were not collected successfully at all three elevations (15, 30 and 45 meters). The nearby surface station at the AQMD station (CTY1) was used for comparison to represent corresponding surface concentrations of CO during this episode. The plot from the 19–20 December study period, Figure 3-6a, shows that the elevated concentrations at the 45-meter level follow the surface concentrations. Concentrations at the 45-meter level were sometimes higher than those at the 30-meter level. Concentrations at 30-meter level were higher than the surface concentration when the surface was low during the early morning. The 15-meter concentration was high at the beginning of the Episode-2 monitoring period, four times higher than the surface concentration. This may be a

Pencentiles of Normalized CO

Episode 2 - Dec. 19 - 20, 1989



70TH 11/27/1 90TH 11/27/1

FIGURE 3–4d.

Pencentiles of Normalized CO

Episode 3 - Jan. 8 - 10, 1990

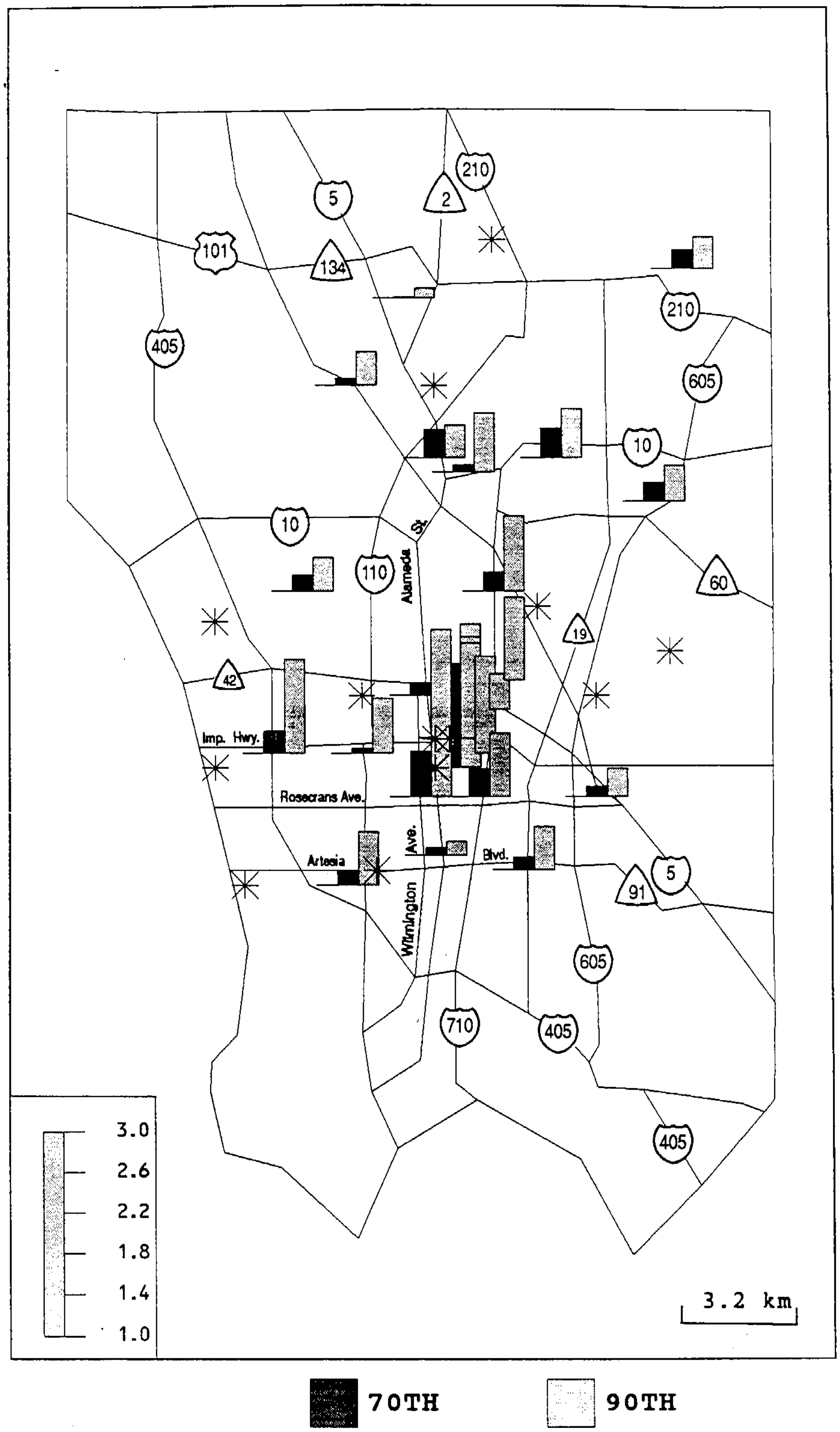


FIGURE 3–4e.

Pencentiles of Normalized CO in Lynwood

Episode 2 - Dec. 19-20, 1989

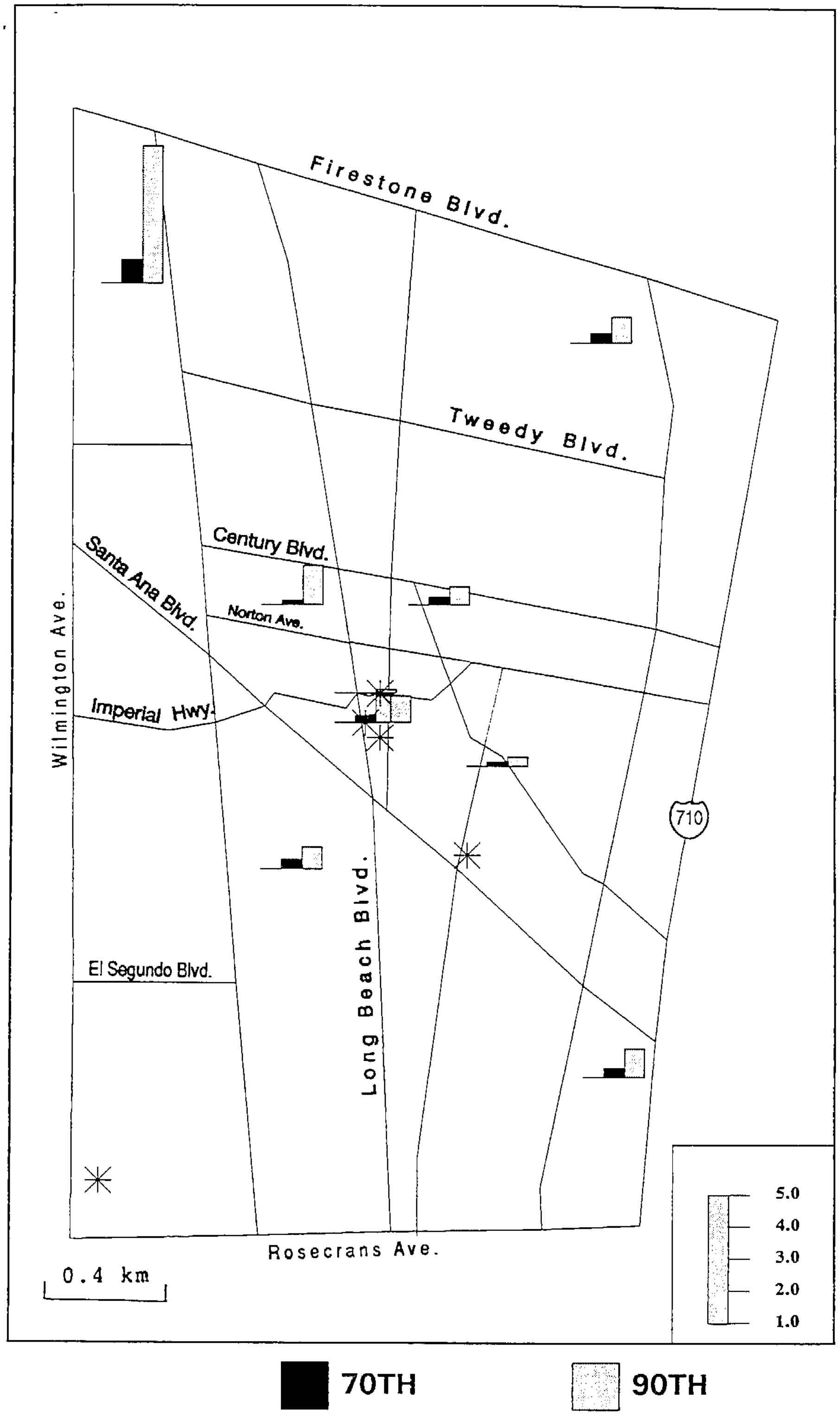


FIGURE 3–4f.

Pencentiles of Normalized CO in Lynwood

Episode 3 - Jan. 8 - 10, 1990

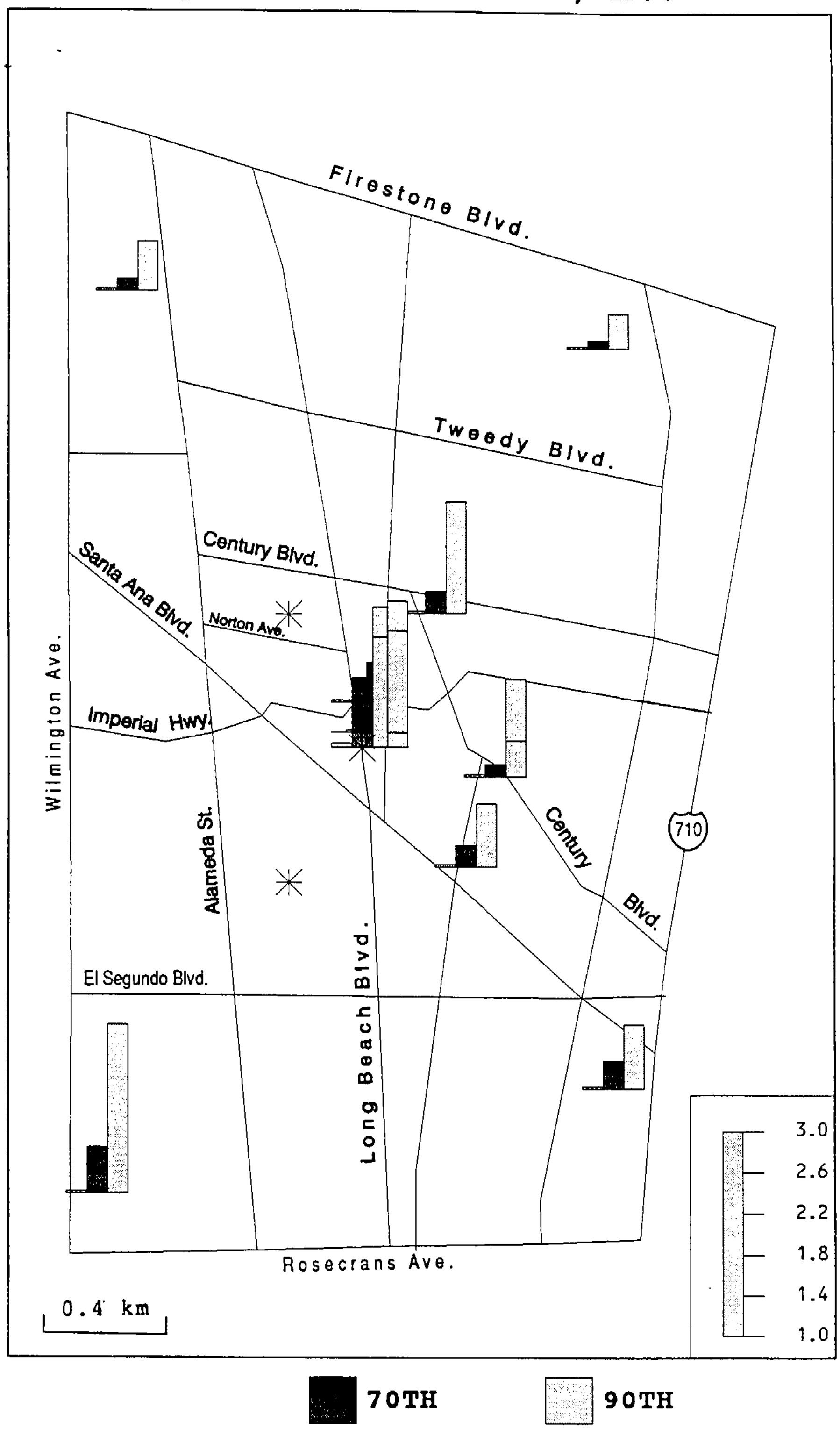


FIGURE 3–4g.

CO Concentration Normalized by Median

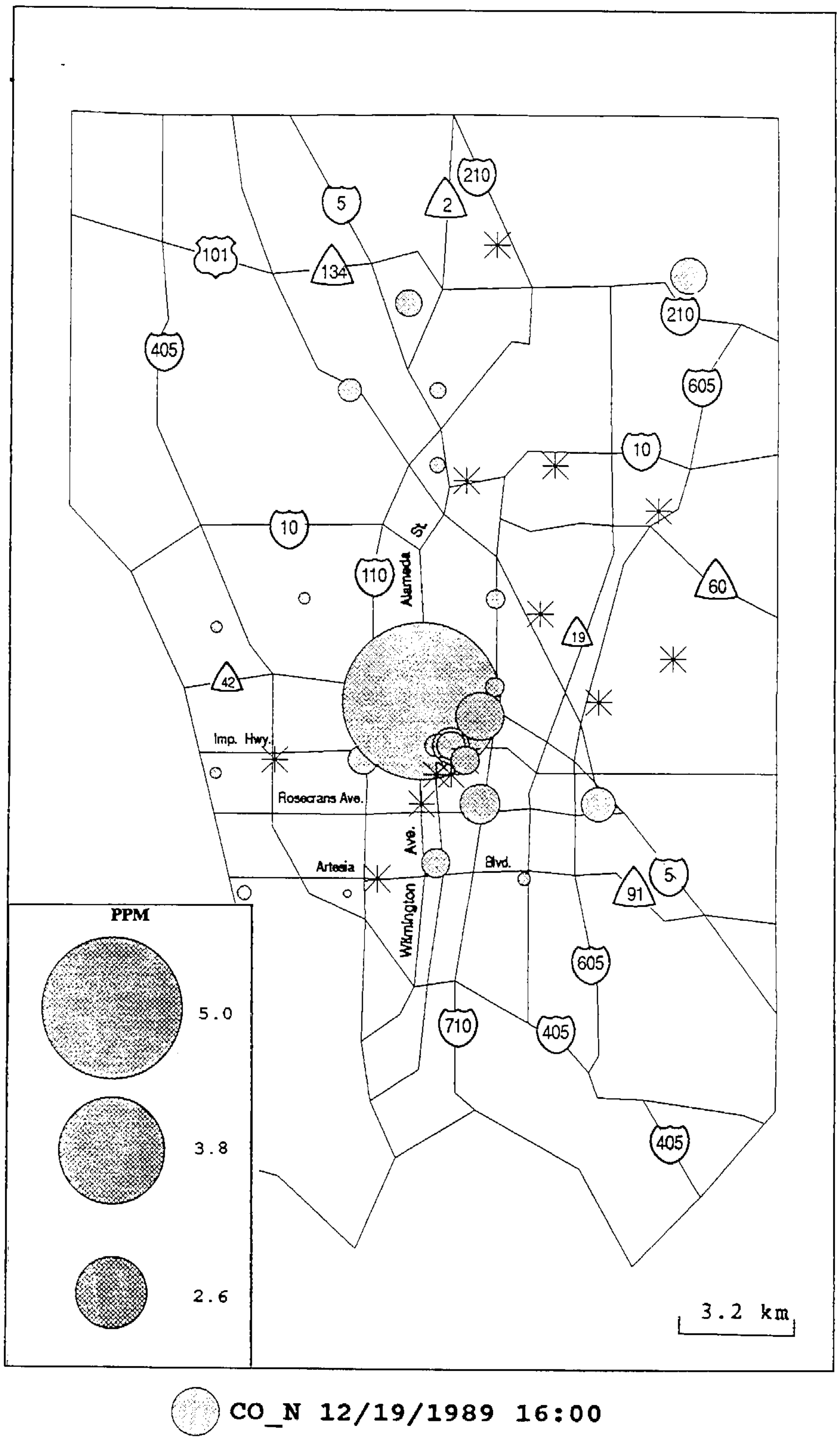


FIGURE 3–5a.

CO Concentration Normalized by Median

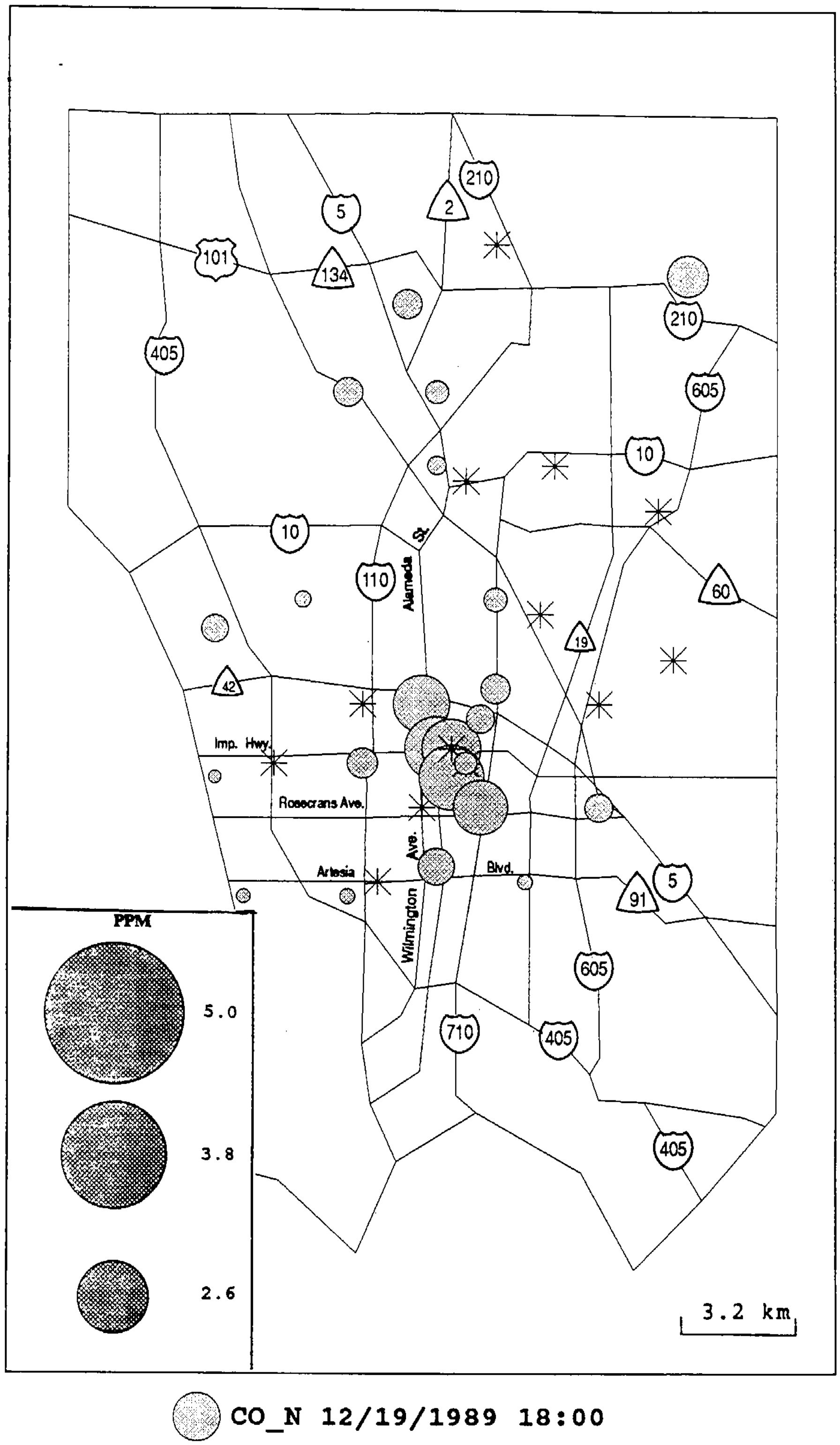


FIGURE 3–5b.

CO Concentrations Normalized by Medians

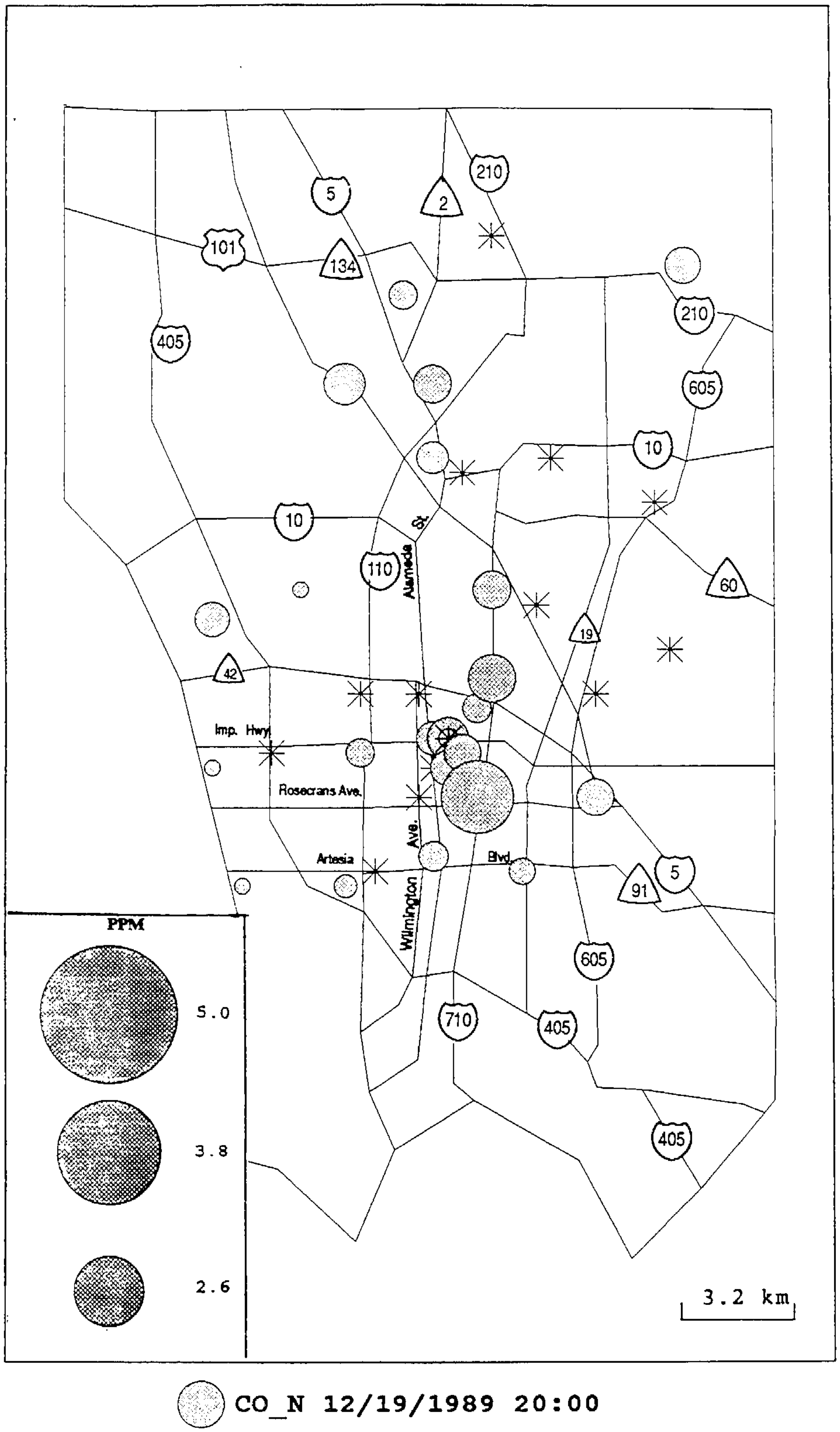


FIGURE 3–5c.

CO Concentrations Normalized by Medians

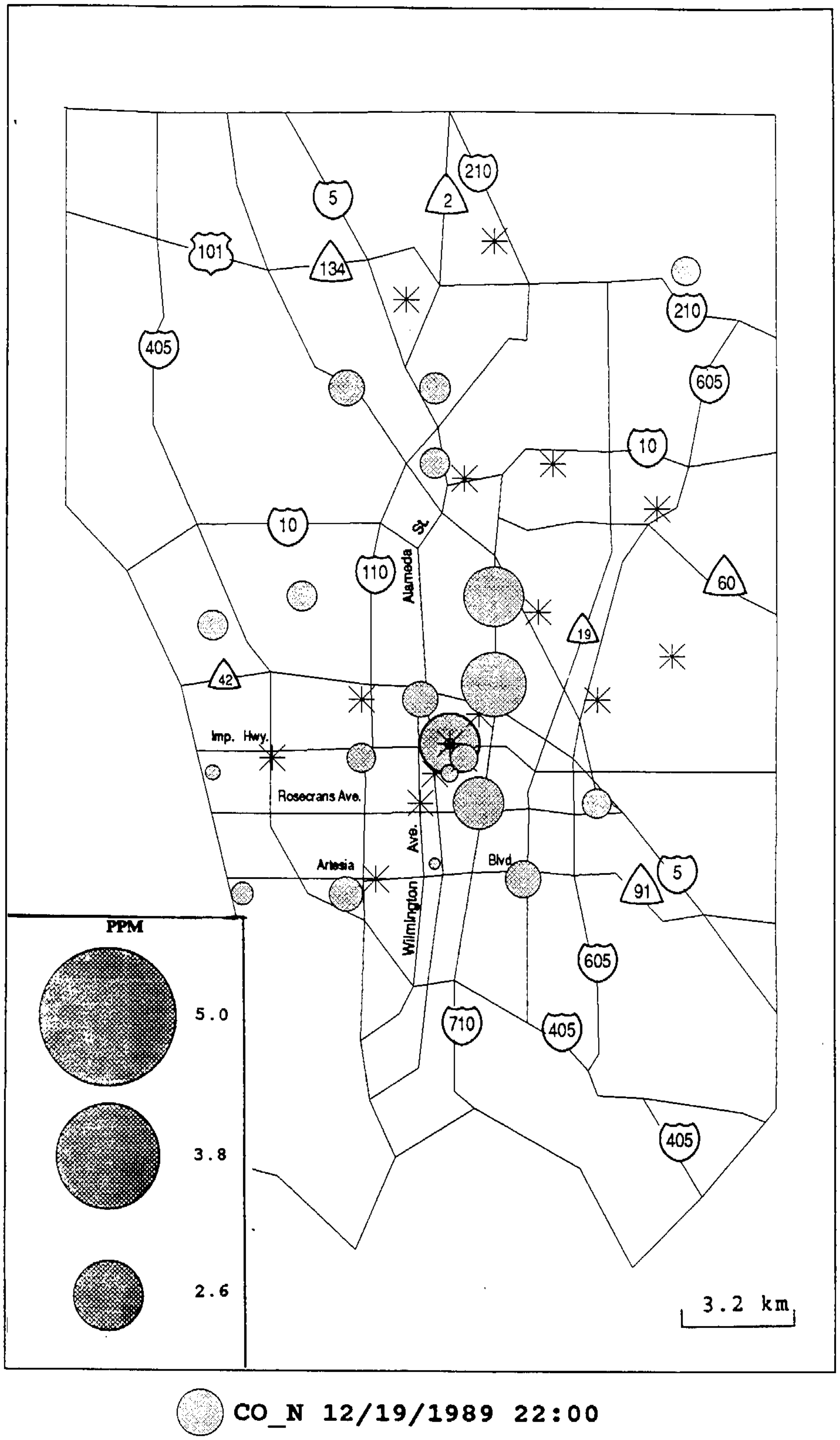


FIGURE 3–5d.

CO Concentrations Normalized by Medians

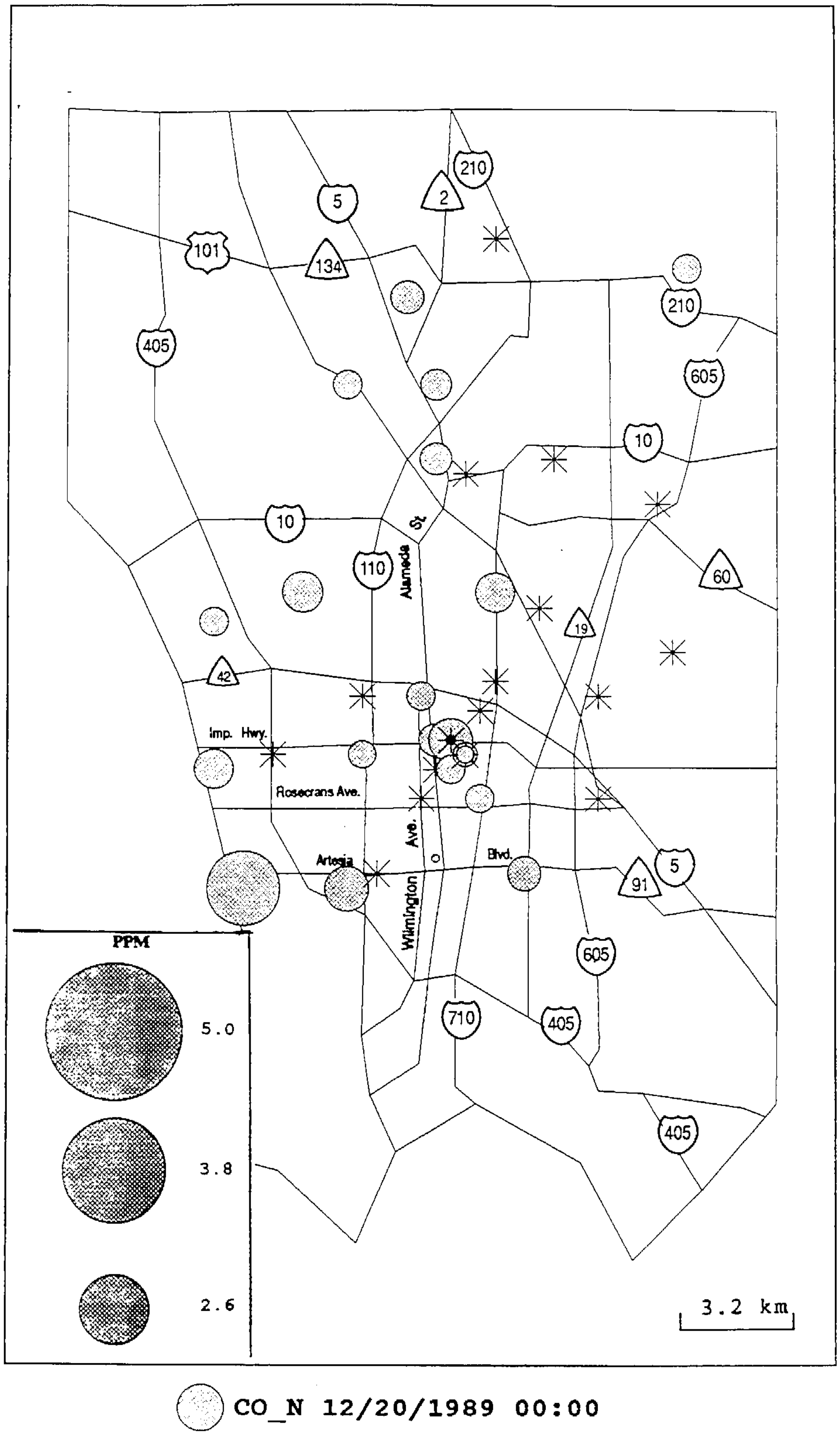


FIGURE 3–5e.

CO Concentrations Normalized by Medians

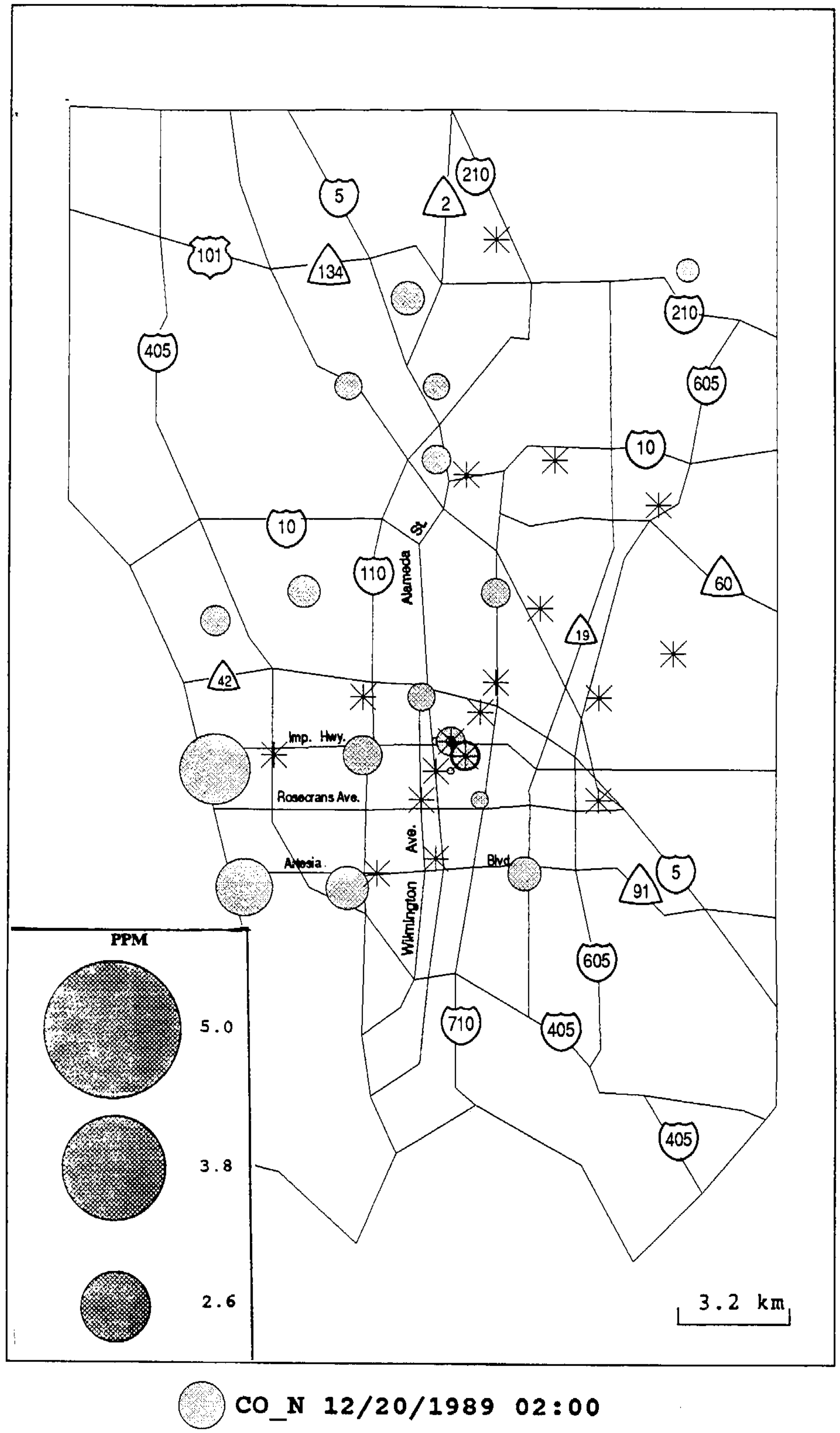


FIGURE 3–5f.

CO Concentrations Normalized by Medians

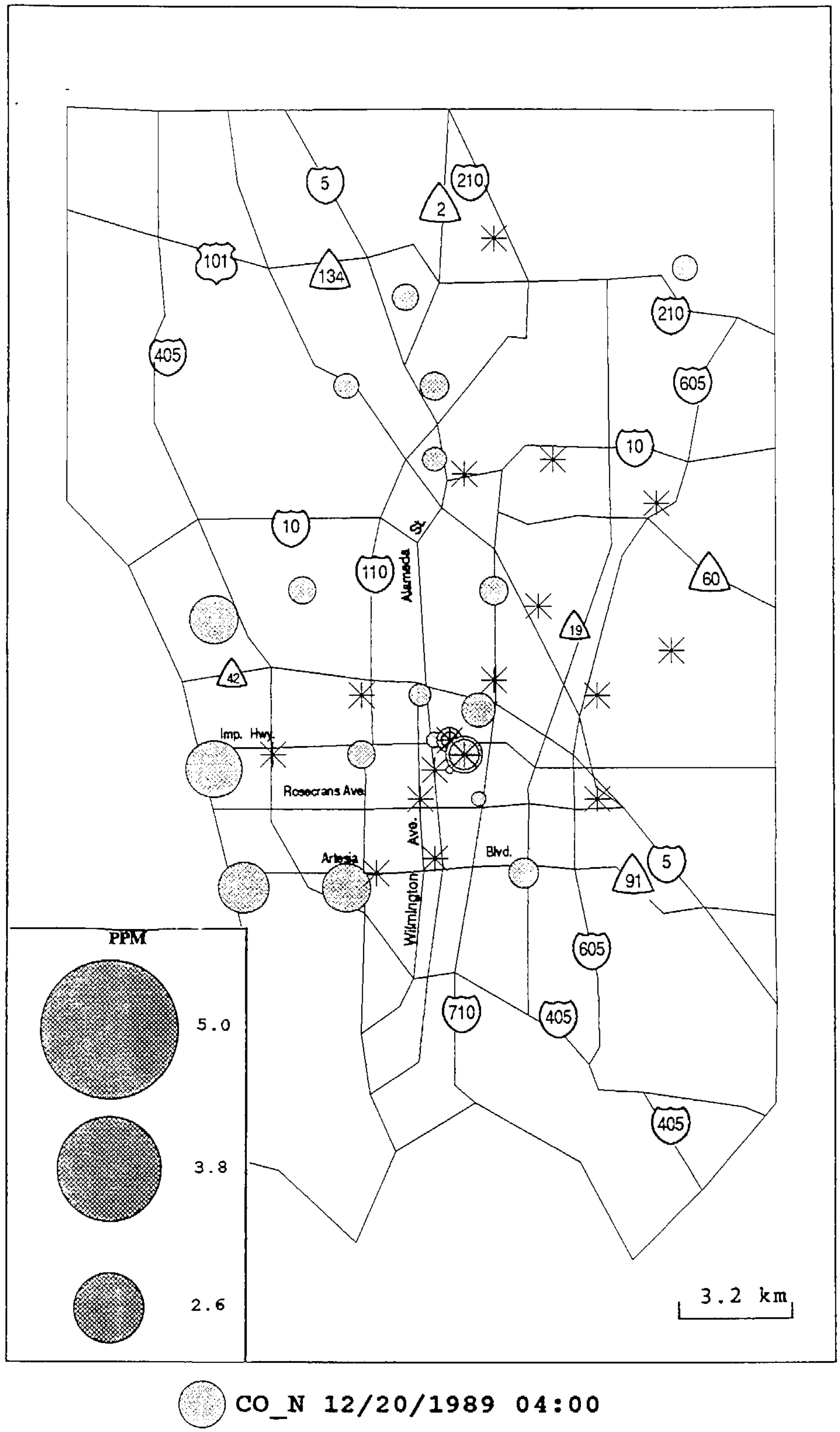


FIGURE 3–5g.

CO Concentrations Normalized by Medians

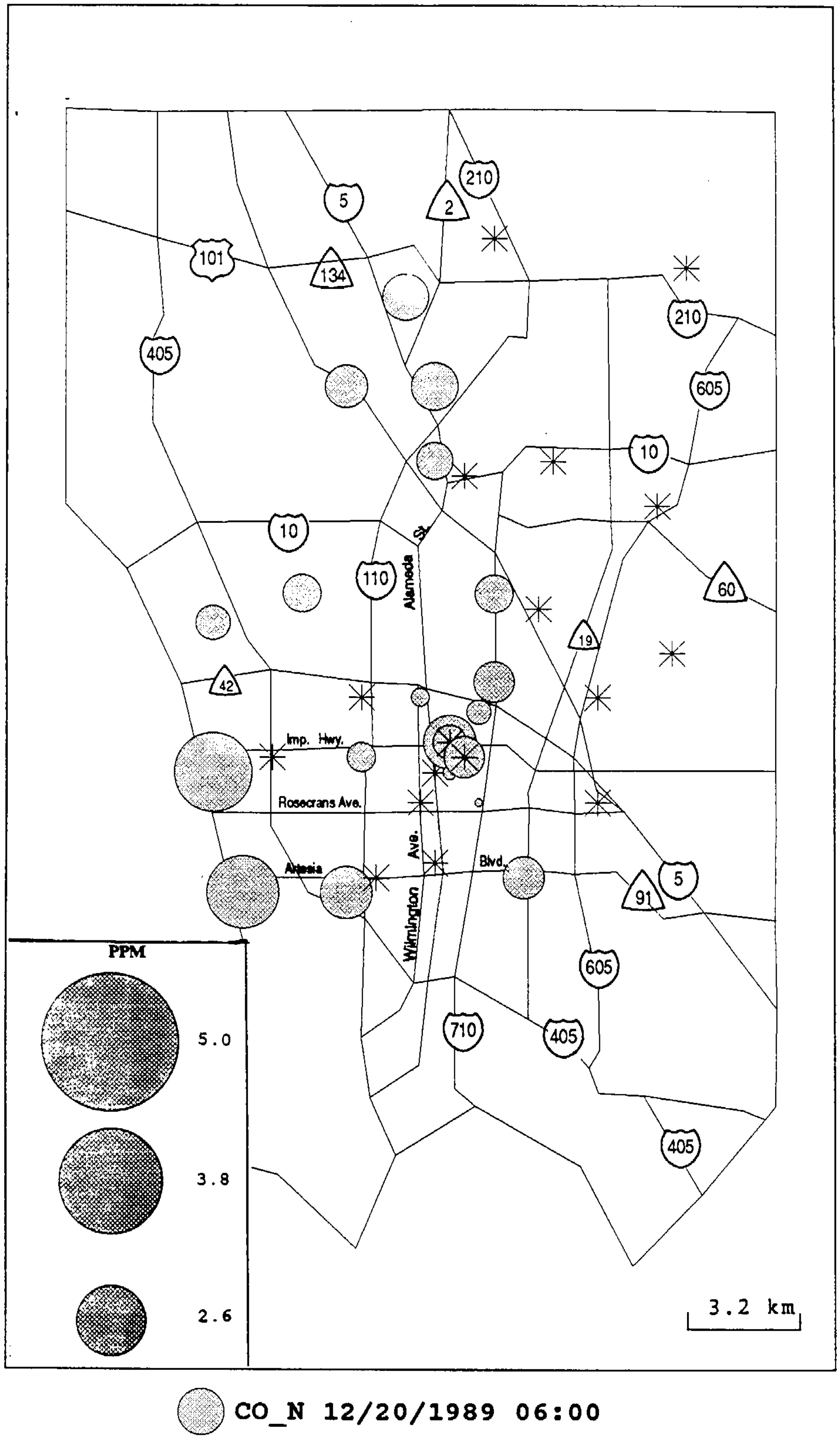


FIGURE 3–5h.

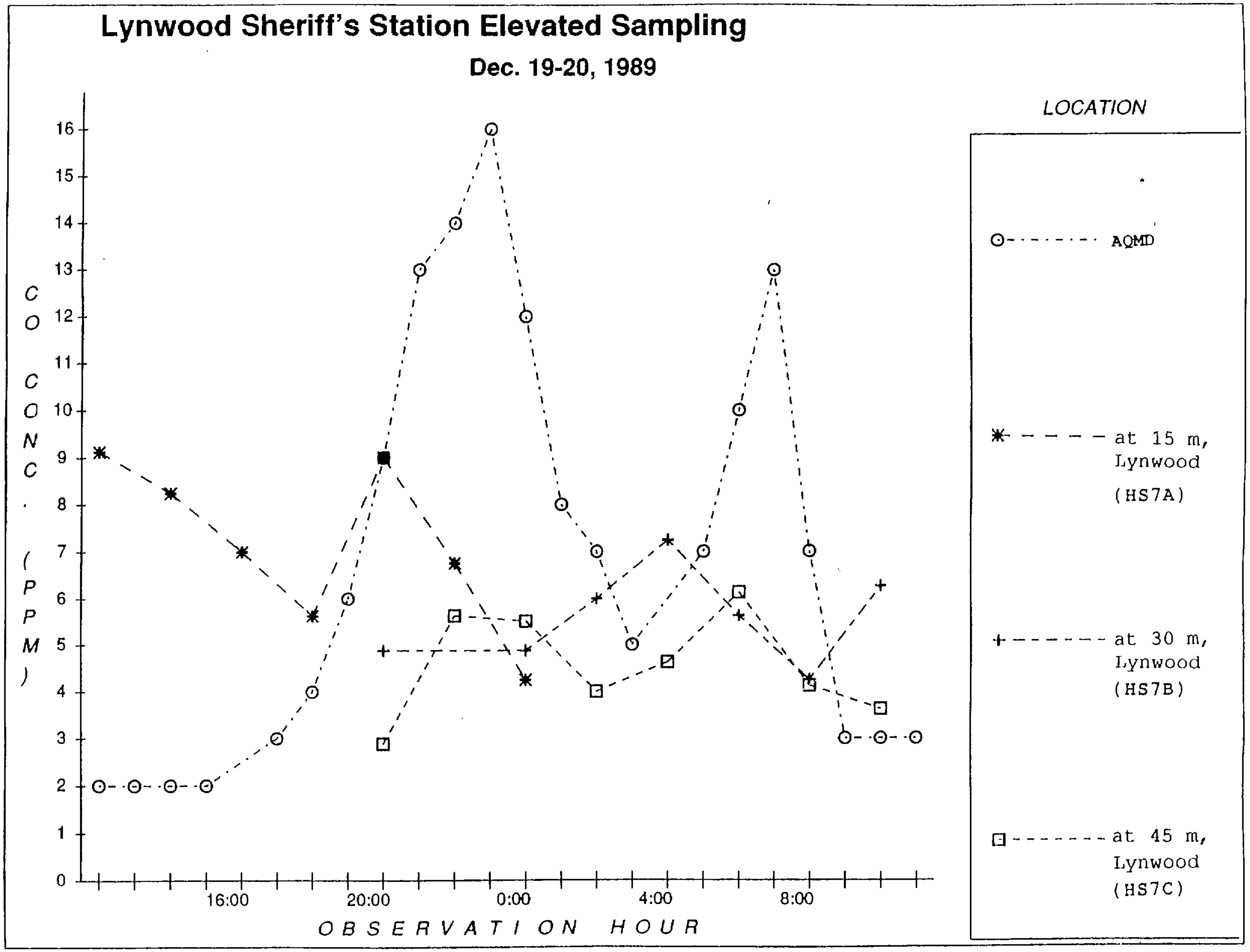

Lynwood Sheriff's Station Elevated Sampling
Dec. 19-20, 1989
CO CONC. (PPM)
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
16:00
20:00
0:00
4:00
8:00
OBSERVATION HOUR
LOCATION
AQMD
at 15 m, Lynwood (HS7A)
at 30 m, Lynwood (HS7B)
at 45 m, Lynwood (HS7C)

FIGURE 3-6a.

consequence of the previous day's episodic behavior, in which the maximum concentration at the Lynwood AQMD station had a morning peak of 12 ppm at 0700 hours, but we have no way of confirming this.

- **Episode 3: 8–10 January 1990**

During the third episode, CO samples were successfully collected at all three elevations. Figure 3-6b shows the time-series plots of the CO concentrations at the surface station and at the three elevations during the CO episodes of 8–10 January 1990. As is shown in the figure, concentrations at 15, 30 and 45 meters almost follow the pattern of the surface concentrations. The concentrations at 15 meters are a little bit lower than those on the surface. Concentrations at the 30-meter level show a relatively smooth curve, which may indicate the influences of the diffusion. Concentrations at the 30-meter level sometimes appeared to be higher than the surface concentrations. The behavior at 45-meter level again showed a strong pattern that is similar to that of the surface concentrations, but about two times lower. Concentrations at the 45-meter level occasionally showed higher concentrations than at the 30-meter level.

- **Conclusions from Observations of the Vertical Distribution of CO**

The data collected during the third episode from the elevated sampling probes show that the CO concentrations at 15, 30 and 45 meters generally follow the peak of the surface concentrations. This seems to be consistent with the supposition that local surface-based sources are responsible for maintaining the CO levels. The CO concentrations between 15 and 30 meters appear strongly influenced by the same sources that influence the surface concentration; however, the higher peaking of the concentration at 30 and 45 meters during the 8–10 January episode may indicate that CO concentrations can be influenced by transported carbon monoxide as well. Since the wind speeds were low at surface and the inversion was stronger at Lynwood, wind at higher elevations may have transported the CO from sources at other locations that had less strong inversion.

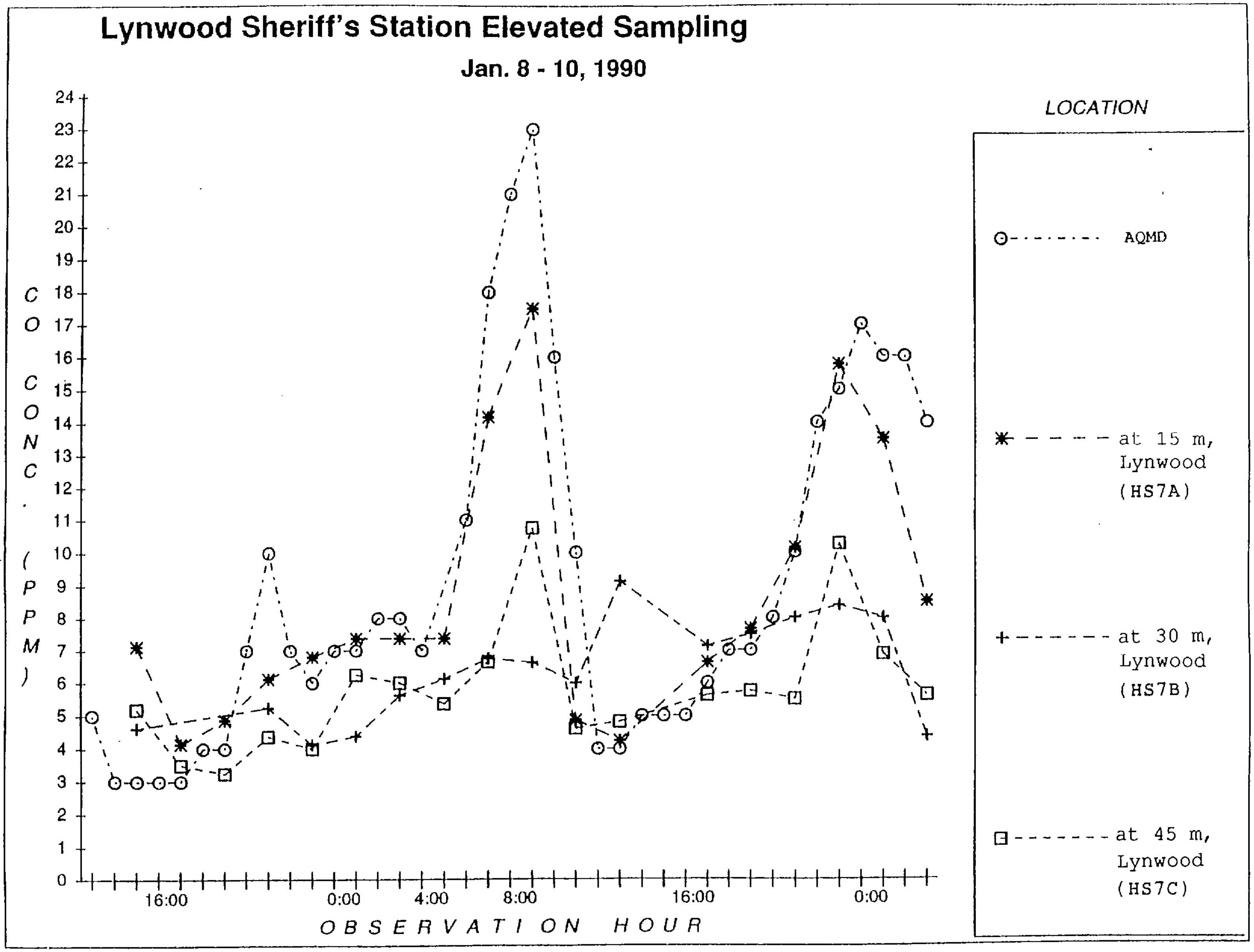

Lynwood Sheriff's Station Elevated Sampling
Jan. 8 - 10, 1990
CO CONC. (PPM)
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
16:00
0:00
4:00
8:00
16:00
0:00
OBSERVATION HOUR
LOCATION
AQMD
at 15 m, Lynwood (HS7A)
at 30 m, Lynwood (HS7B)
at 45 m, Lynwood (HS7C)

FIGURE 3-6b.

Section 4

TRACER DATA: AIR FLOW PATTERNS IN THE BASIN

At four locations centered about the AQMD's air monitoring stations in Lynwood (see Figure 4-1a), tracer gases were released continuously during each intensive period between 1700 and 2300 hours. Four perfluorocarbon tracers—Perfluoromethylcyclopentane (PMCP), Perfluoromethylcyclohexane (PMCH), Perfluoro-1, 1-Dimethylcyclohexane (PDCH), and Perfluorotrimethylcyclohexane (PTCH) represented by Ta, Tb, Tc and Td in our tabulations and displays—were tracked in the network by analyzing the bag samples collected at each integrating ambient air site. (Certain of these tracer data are missing from the 19–20 December episode; bags were used for carbon isotope analysis instead of tracer analysis.) These data were used to infer air flow patterns at the surface and the duration of stagnation events in the basin during the intensive study periods.

Table 4-1 presents the schedule and the locations for tracer release during the study periods. On 19 December 1989, PMCP, PMCH, PDCH and PTCH were released at the rate of 235, 237, 310, and 189 gms/hr, respectively. On 8 January 1990, PMCP, PMCH, PDCH and PTCH were released at the rate of 250, 265, 227, and 219 gms/hr, respectively. Tracer time-series plots and maps showing the release point and impact concentrations of each tracer at each sampling site are shown throughout the following text. (See Appendix D for the full compilation of these time series plots.)

o **Episode 2: 19–20 December 1989**

The PMCP plots from 19 December 1989, 1400 to 1800 hours (Figures 4-1b through 4-1d), are intended to simulate the air movement during the daytime of this intensive period. Unlike the CO concentration plots, however, they do not show a clearly defined moving pattern. Later evening observations from 19 December at 2200 hours to 20 December at 0600 hours (Figures 4-1e through 4-1i) seem to show a moving pattern that represents flow from the inland areas to the coast. The plots for the other tracers, shown in Appendix D-1, do not show the moving tracer pattern as clearly, apparently because of the less dense sampler distribution over the paths taken by these tracers.

Several stations, namely C14, C15, C17 and HS14, show high tracer concentrations at the beginning of this second intensive period, prior to the scheduled release of any of the tracers. Since this high perfluorocarbon level cannot be residual gas from the 5 December release, we must assume that the extremely high concentration, like the PMCP at HS14, was caused by some form of contamination, by some unidentified source, or by some artifact of the sampling.

An analysis of the time of arrival at each site of the peak concentration for each tracer, as well as the records collected and missing during the study periods have been listed in Tables 4-2a through 4-2d. As was mentioned before, some of the stations showed their peak concentrations before the tracers were scheduled for release during the episode. The earliest hours with tracer after the tracers were released are

Tracer Release Points

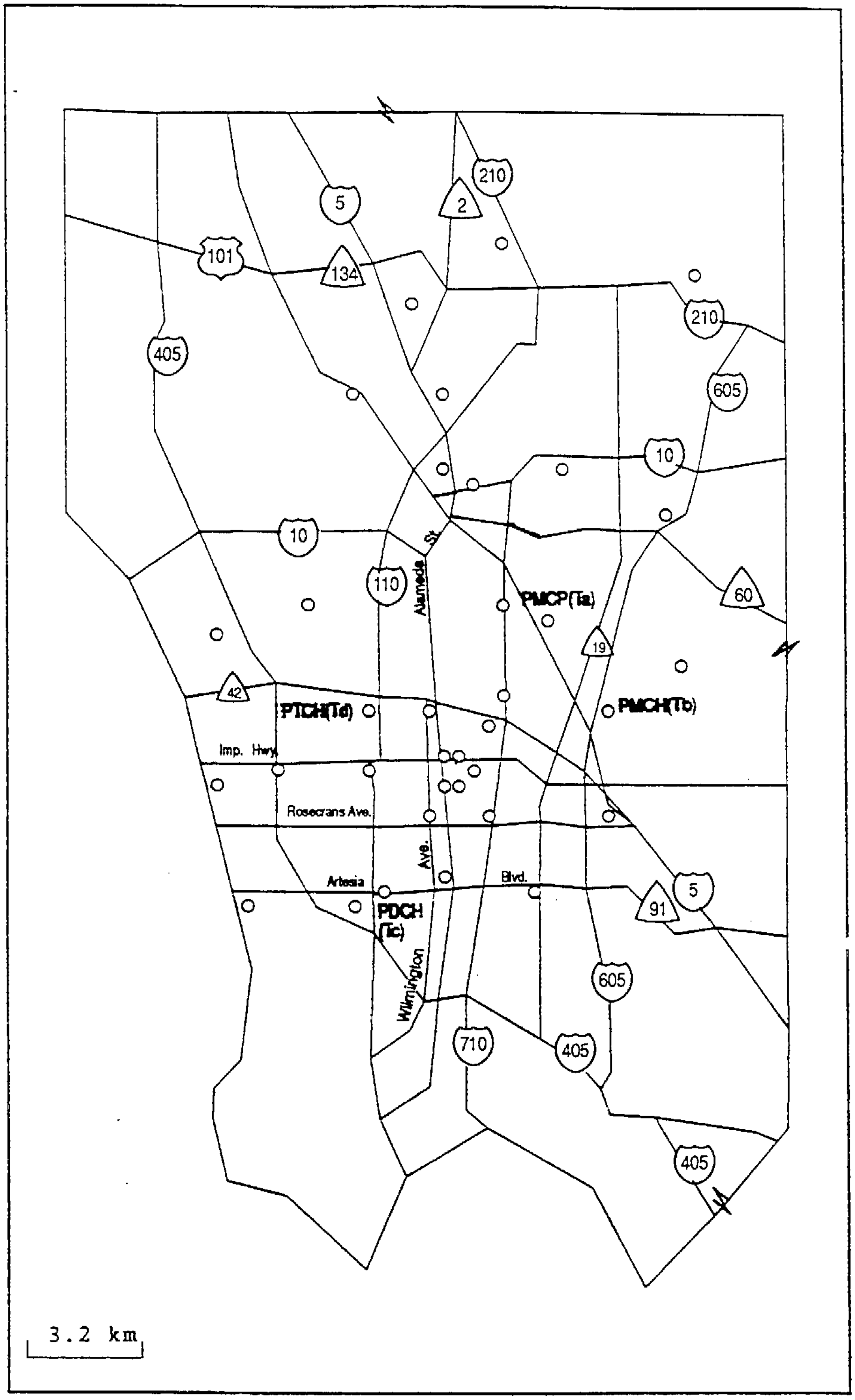
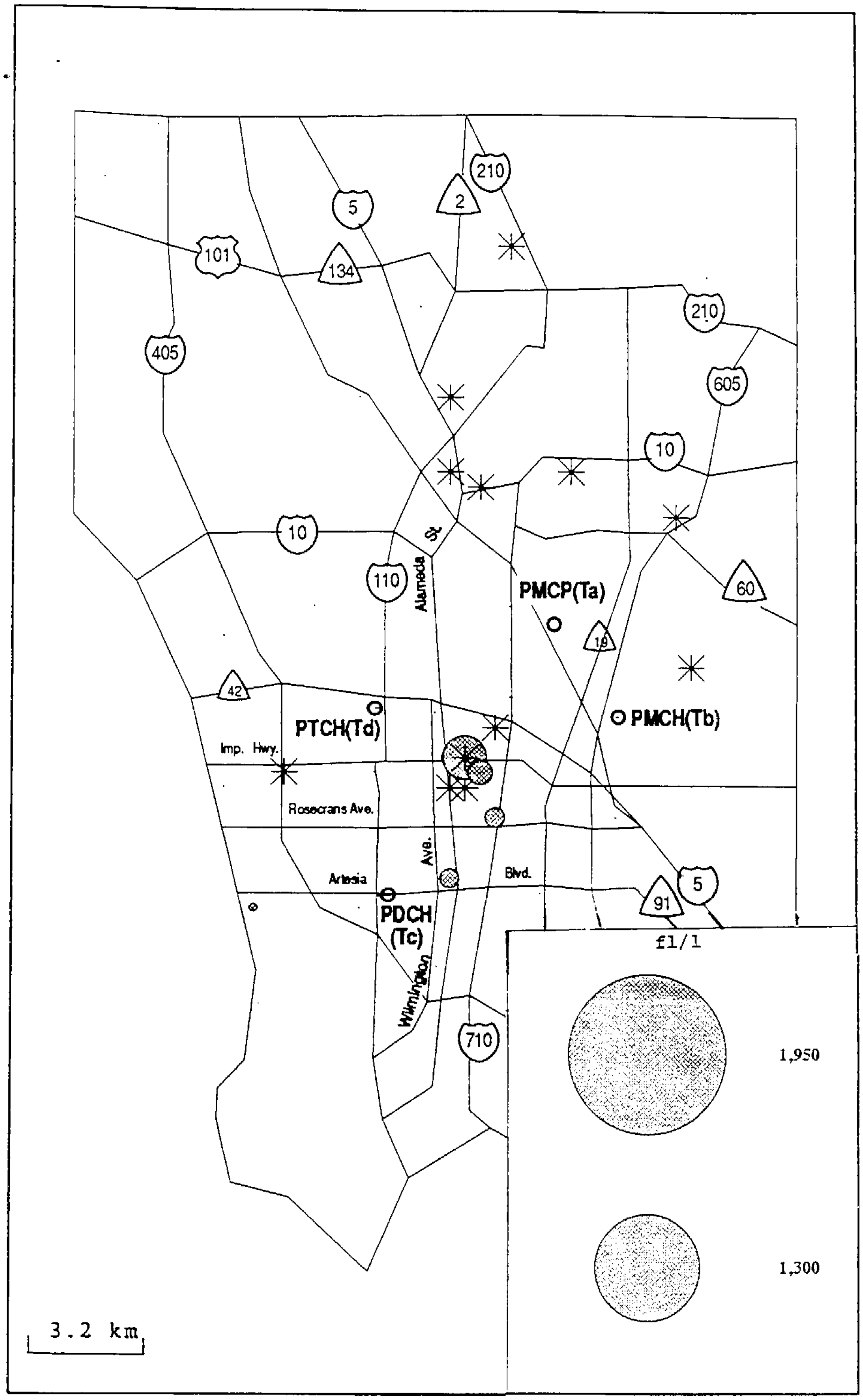


FIGURE 4–1a.

Table 4-1. Schedule and Locations of Tracers Releases

Tracer	Date	Location	Release Period
PMCP	12/19/90	Hwy 5 & Washington St.	1700 - 2300
PMCH	12/19/89	Hwy 605 & Firestone	1700 - 2300
PDCH	12/19/89	Hwy 91 & Central Ave.	1700 - 2300
PTCH	12/19/89	Hwy 110 & Century Blvd.	1700 - 2300
PMCP	1/8/90	Hwy 5 & Washington st.	1700 - 2300
PMCH	1/8/90	Hwy 605 & firestone	1700 - 2300
PDCH	1/8/90	Hwy 91 & Central Ave.	1700 - 2300
PTCH	1/8/90	Hwy 110 & Century Blvd.	1700 - 2300

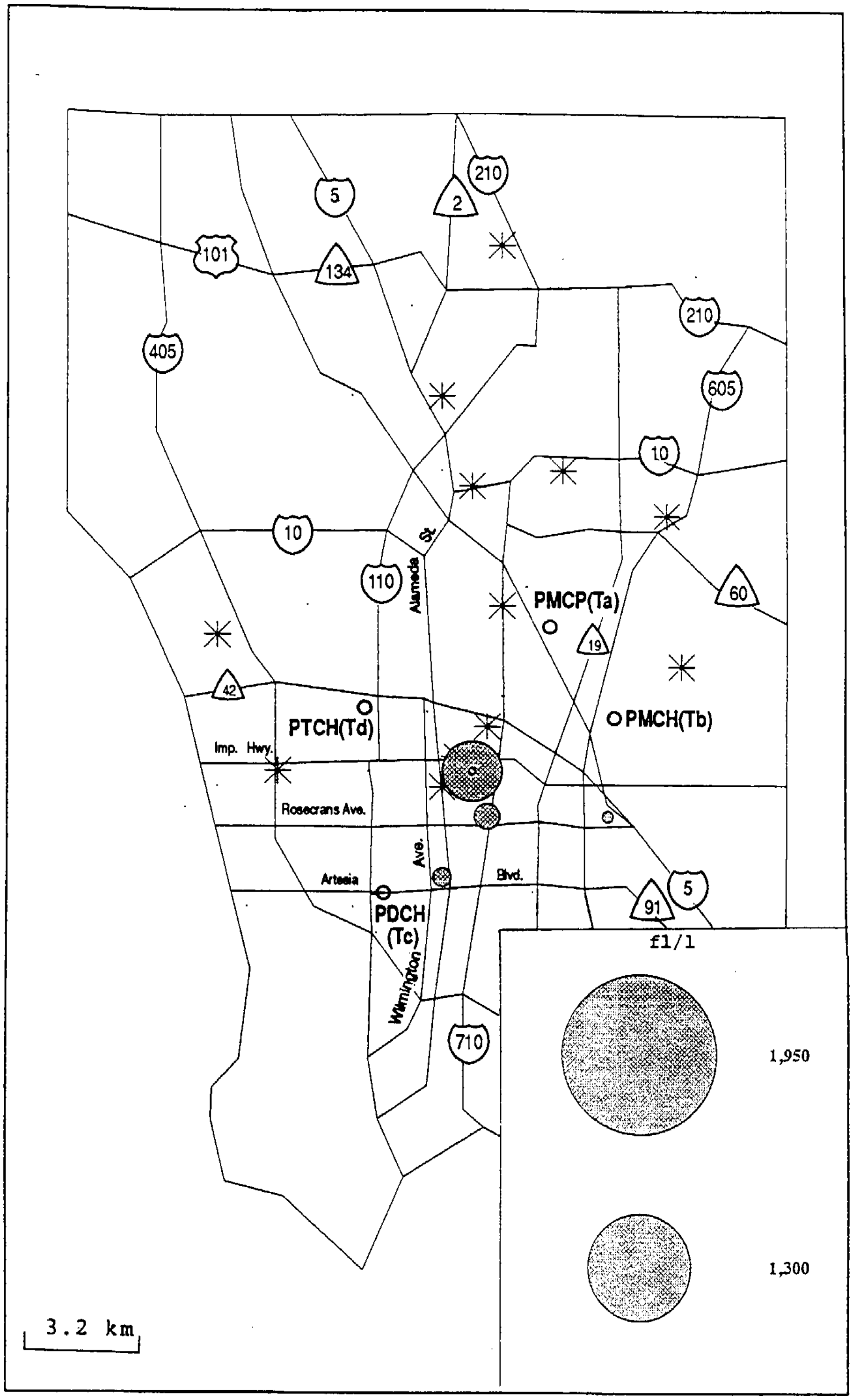
Tracer PMCP



TA 12/19/1989 14:00

FIGURE 4–1b.

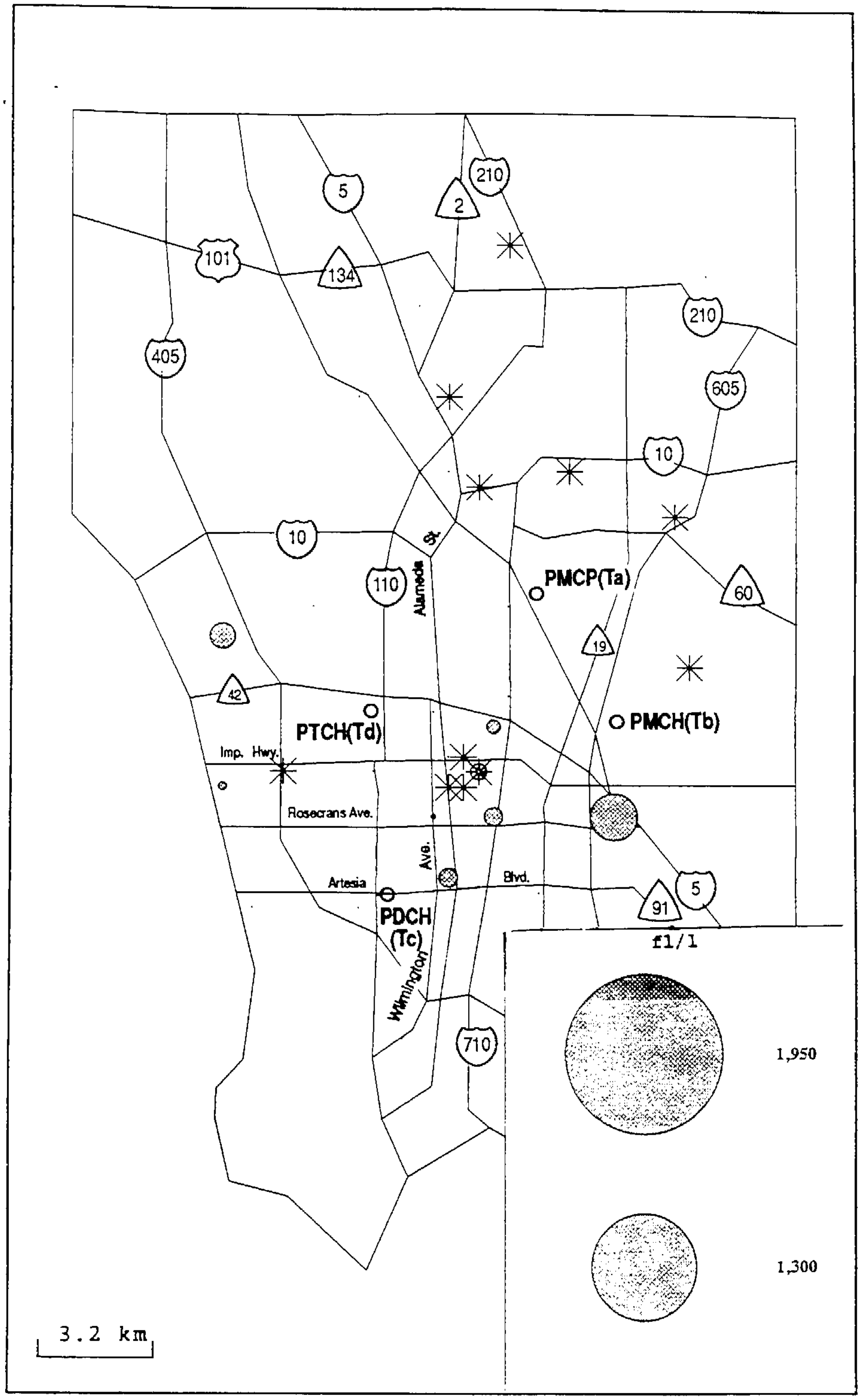
Tracer PMCP



TA 12/19/1989 16:00

FIGURE 4–1c.

Tracer PMCP



TA 12/19/1989 18:00

FIGURE 4–1d.

Tracer PMCP

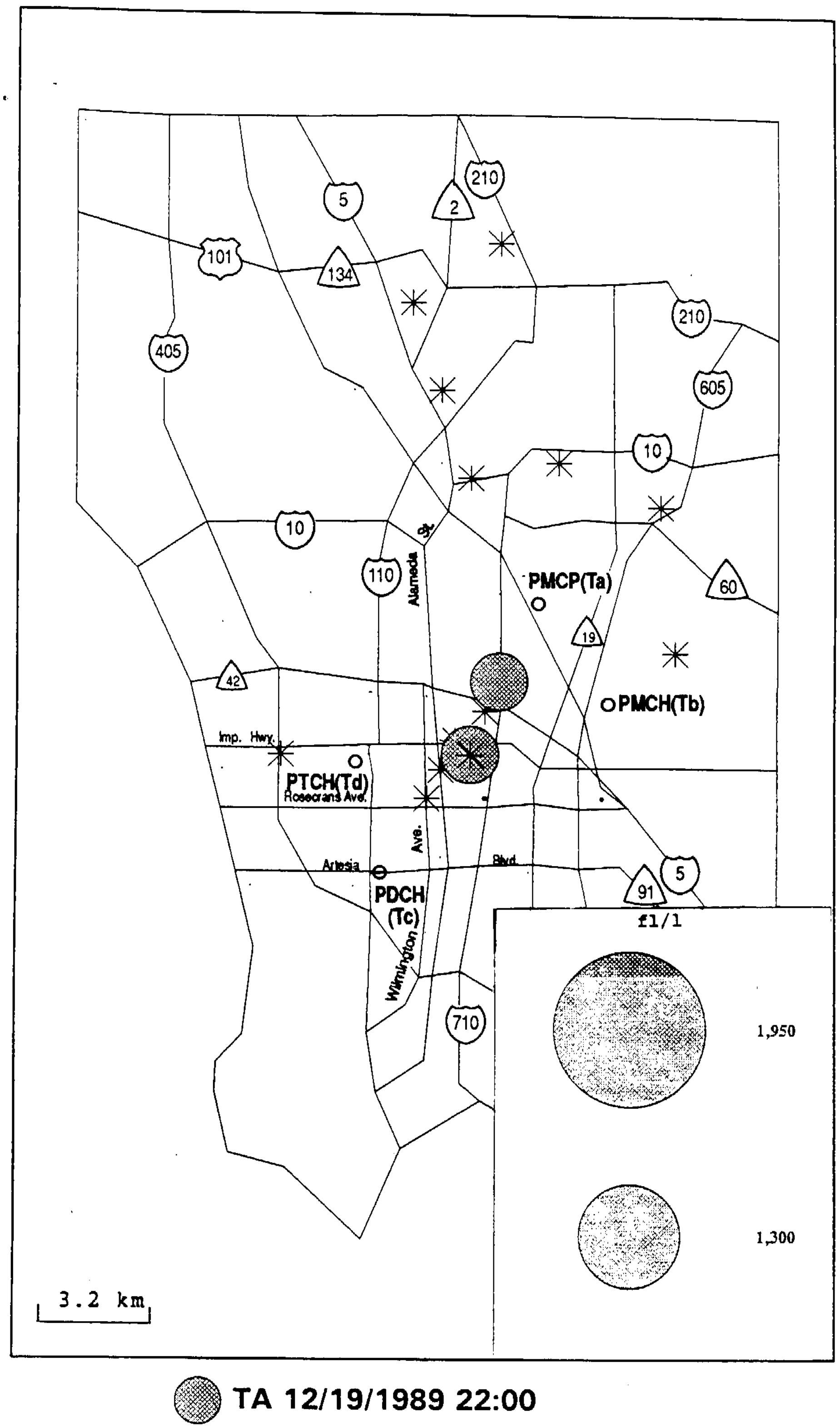
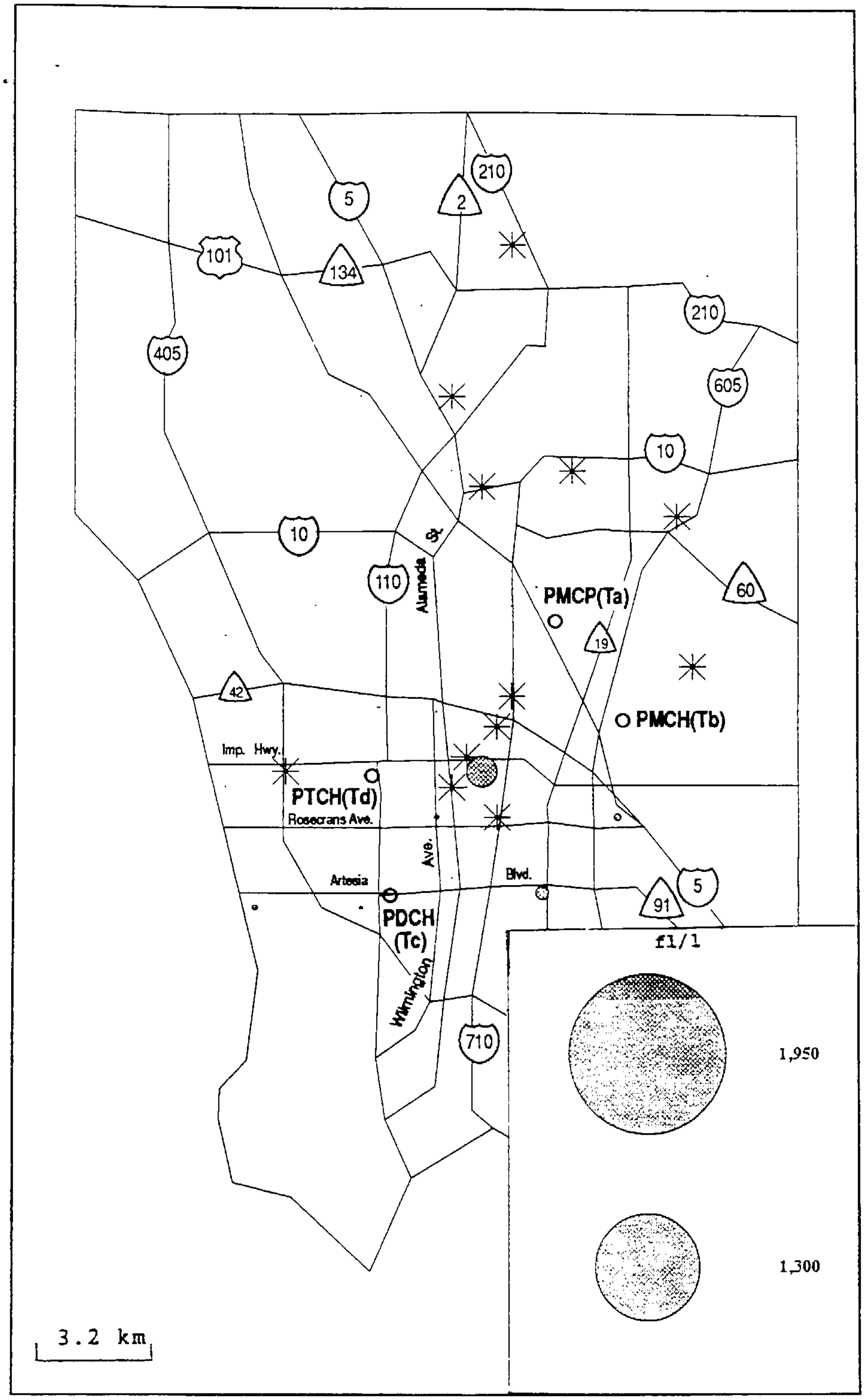


FIGURE 4–1e.

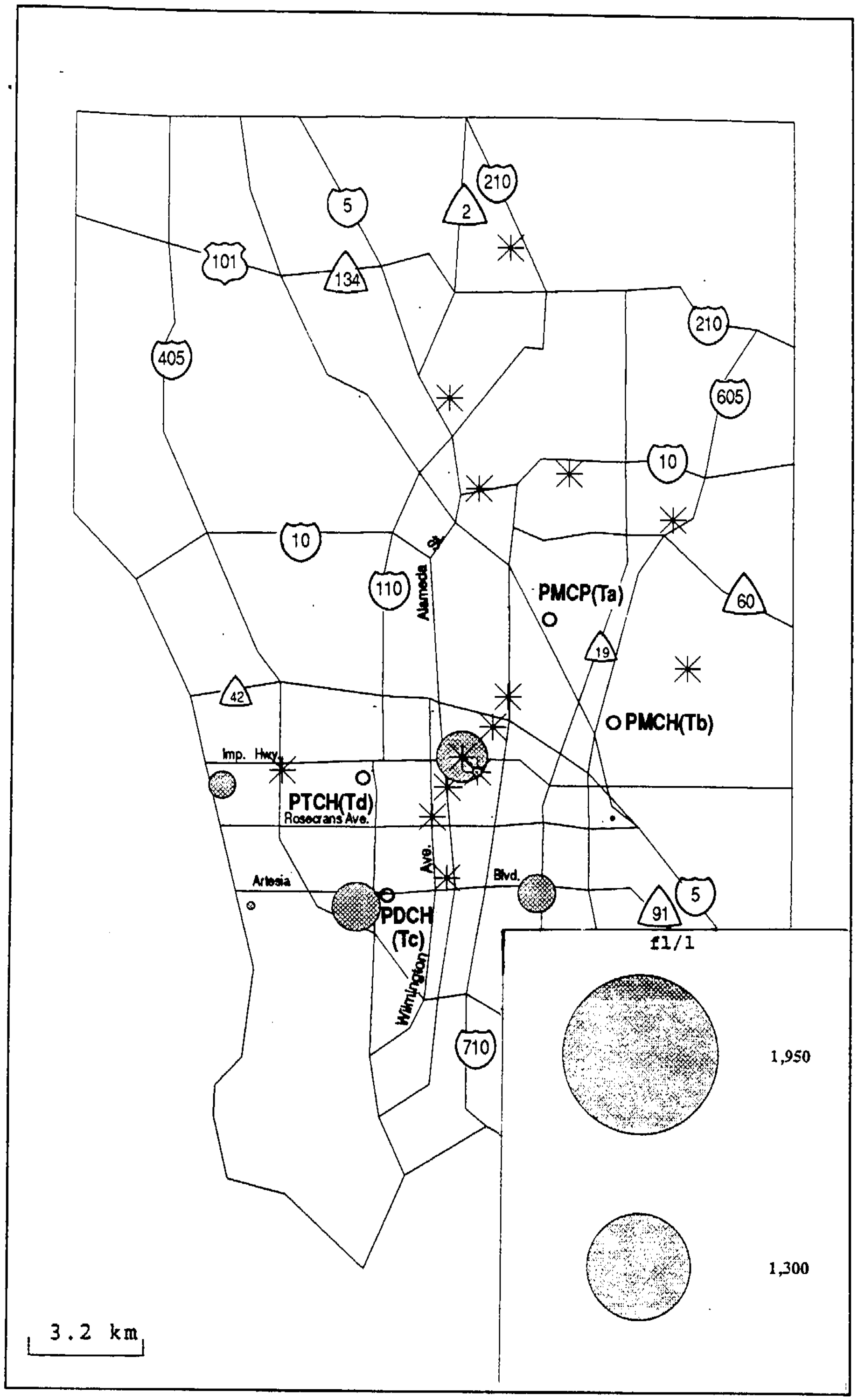
Tracer PMCP



TA 12/20/1989 00:00

FIGURE 4–1f.

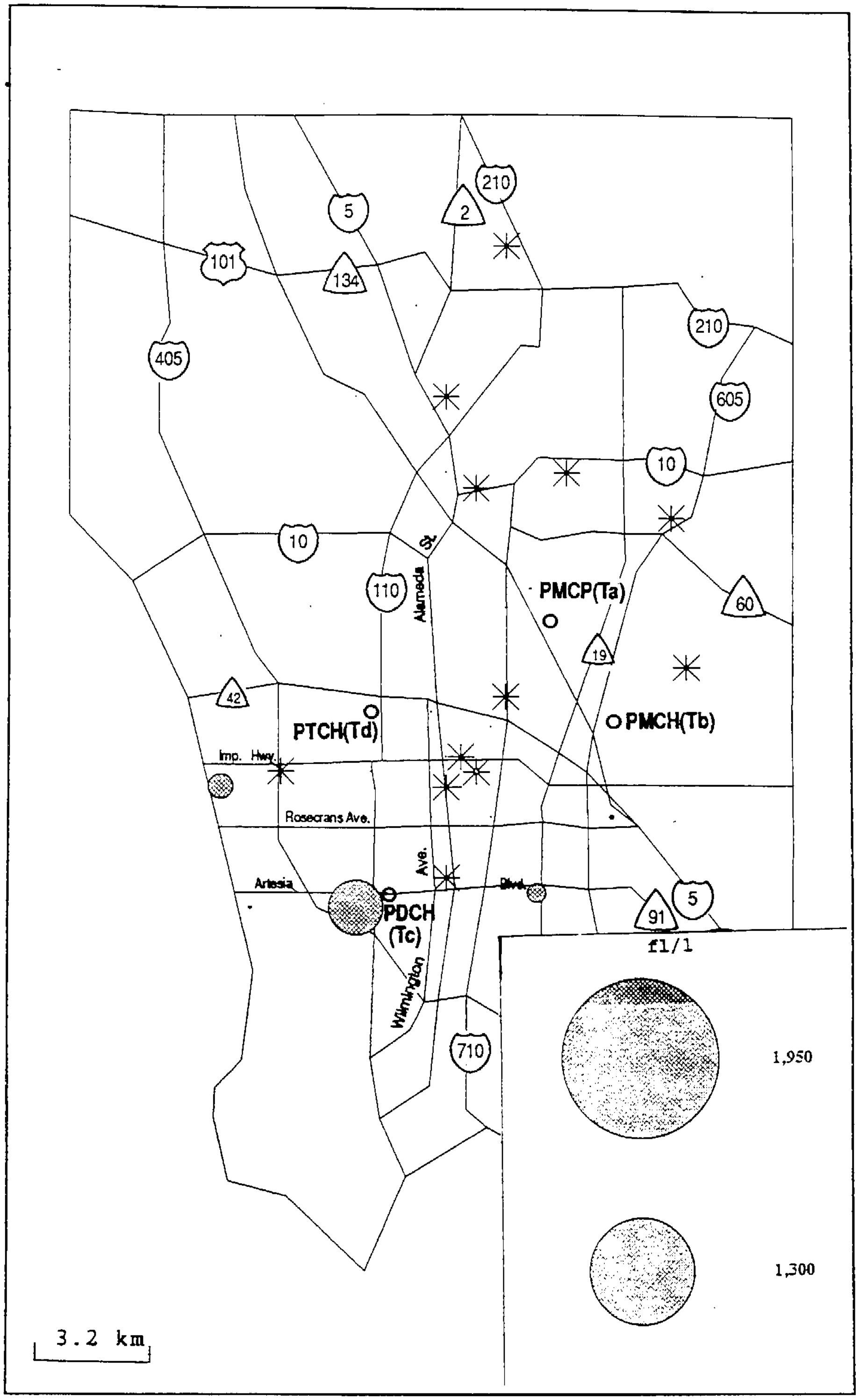
Tracer PMCP



TA 12/20/1989 02:00

FIGURE 4–1g.

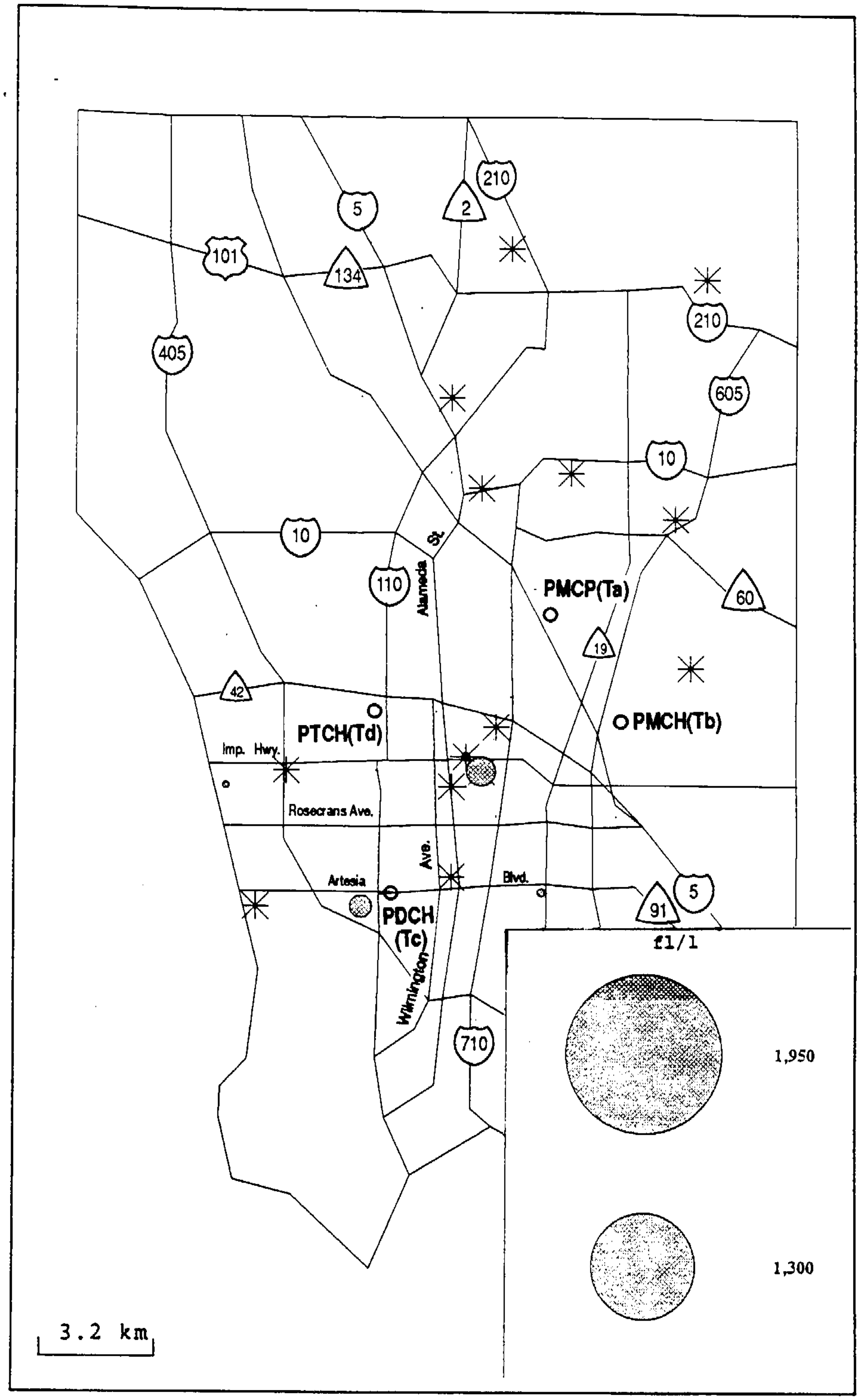
Tracer PMCP



TA 12/20/1989 04:00

FIGURE 4–1h.

Tracer PMCP



TA 12/20/1989 06:00

FIGURE 4–1i.

Table 4-2a. Tracer Data Information For Each Station (PMCP)

SITE	NUM	MISS	PEAK	HR	DATE	Start Conc.	NUM	MISS	PEAK	HR	DATE	Start Conc.
	Episode 2: Dec. 19 - 20, 1989						Episode 3: Jan. 8 - 10, 1990					
AQ2	0	12	-99	-	-	-	11	9	549	6	09JAN	-
AQ3	11	1	0		19DEC-20DEC	-	12	8	0		08JAN-10JAN	0
CC1	11	1	0		19DEC-20DEC	-	9	11	0		08JAN-10JAN	0
CC10	11	1	0		19DEC-20DEC	0	18	2	1949	20	08JAN	0
CC12	12	0	353	2	20DEC	113	0	20	-99	-	-	-
CC13	12	0	0		19DEC-20DEC	0	18	2	628	2	09JAN	0
CC14	12	0	610	18	19DEC	610	12	8	125	20	08JAN	0
CC15	9	3	235	12	19DEC	0	0	20	-99	-	-	-
CC16	12	0	713	4	20DEC	0	17	3	339	6	09JAN	0
CC17	7	5	256	14	19DEC	248	12	8	186	12	09JAN	0
CC18	12	0	494	2	20DEC	0	12	8	226	0	09JAN	0
CC19	8	4	768	22	19DEC	0	16	4	1221	2	09JAN	0
CC20	0	12	-99	-	-	-	0	20	-99	-	-	-
CC21	0	12	-99	-	-	-	7	23	0		08JAN-10JAN	-
CC3	9	3	0		19DEC-20DEC	0	9	11	0		08JAN-10JAN	0
CC4	10	2	0		19DEC-20DEC	0	12	8	0		08JAN-10JAN	-
CC5	0	12	-99	-	-	-	5	15	0		08JAN-10JAN	-
CC6	0	12	-99	-	-	-	10	10	196	22	08JAN	-
CC7	11	1	337	18	19DEC	337	0	20	-99	-	-	-
CC8	12	0	0		19DEC	0	17	3	1971	0	09JAN	0
HS1	3	9	88	16	19DEC	-	18	2	1181	4	09JAN	0
HS10	21	3	577	14	19DEC	0	5	15	76	19	09JAN	-
HS12	20	4	1143	15	19DEC	-	14	16	733	15	08JAN	-
HS13	11	1	201	10	20DEC	0	6	14	183	8	09JAN	-
HS14	5	7	2019	12	19DEC	187	13	7	149	0	09JAN	0
HS15	10	2	341	16	19DEC	256	12	8	382	16	08JAN	328
HS16	9	3	69	18	19DEC	69	16	4	1264	14	08JAN	889
HS2	22	2	2417	1	20DEC	0	0	39	-99	-	-	-
HS3	0	24	-99	-	-	-	15	24	1024	3	09JAN	-
HS5	0	24	-99	-	-	-	0	39	-99	-	-	-
HS6	0	12	-99	-	-	-	7	32	360	7	09JAN	-
HS7A	7	5	779	16	19DEC	221	17	3	0		08JAN-10JAN	0
HS7B	10	2	385	6	20DEC	66	0	20	-99	-	-	-
HS7C	10	2	765	22	19DEC	-	17	3	1087	0	09JAN	0
HS8	0	24	-99	-	-	-	0	39	-99	-	-	-
HS9	18	6	594	13	19DEC	0	0	39	-99	-	-	-

Table 4-2b. Tracer Data Information for Each Station (PMCH)

SITE	NUM	MISS	PEAK	HR	DATE	Start Conc.	NUM	MISS	PEAK	HR	DATE	Start Conc.
	Episode 2: Dec. 19 -20, 1989						Episode 3: Jan. 8 -10, 1990					
AQ2	0	12	-99	-	-	-	11	9	998	2	09JAN	-
AQ3	11	1	0		19DEC-20DEC	0	12	8	0		08JAN-10JAN	0
CC1	11	1	0		19DEC-20DEC	0	9	11	0		08JAN-10JAN	0
CC10	11	1	0		19DEC-20DEC	0	18	2	1072	8	09JAN	226
CC12	12	0	256	2	20DEC	0	0	20	-99	-	-	-
CC13	12	0	0		19DEC-20DEC	0	18	2	1169	22	08JAN	0
CC14	12	0	4389	14	19DEC	0	12	8	153	2	09JAN	0
CC15	9	3	148	12	19DEC	0	0	20	-99	-	-	-
CC16	12	0	1641	2	20DEC	0	17	3	1122	2	09JAN	0
CC17	7	5	2648	14	19DEC	281	12	8	1685	8	09JAN	0
CC18	12	0	9824	2	20DEC	0	12	8	6897	2	09JAN	0
CC19	8	4	0		19DEC-20DEC	0	16	4	824	20	08JAN	0
CC20	0	12	-99	-	-	-	0	20	-99	-	-	-
CC21	0	12	-99	-	-	-	7	13	0		08JAN-10JAN	-
CC3	9	3	0	12	19DEC-20DEC	0	9	11	0		08JAN-10JAN	0
CC4	10	2	0	12	19DEC-20DEC	-	12	8	0		08JAN-10JAN	-
CC5	0	12	-99	-	-	-	5	15	0		08JAN-10JAN	-
CC6	0	12	-99	-	-	-	10	10	248	22	08JAN	135
CC7	11	1	107	18	19DEC	107	0	20	-99	-	-	-
CC8	12	0	0		19DEC-20DEC	0	17	3	129	10	09JAN	0
HS1	3	9	256	16	19DEC	-	18	2	1894	22	08JAN	0
HS10	21	3	125	11	20DEC	0	5	34	0		08JAN-10JAN	-
HS12	20	4	1743	13	19DEC	-	14	26	2460	9	09JAN	0
HS13	11	1	0		19DEC-20DEC	0	6	14	345	8	09JAN	0
HS14	5	7	0		19DEC-20DEC	0	13	7	125	0	09JAN	0
HS15	10	2	183	14	19DEC	0	12	8	312	2	09JAN	56
HS16	9	3	118	18	19DEC	118	16	4	2455	18	08JAN	2445
HS2	22	2	239	8	20DEC	0	0	39	-99	-	-	-
HS3	0	24	-99	-	-	-	15	24	72	3	09JAN	-
HS5	0	24	-99	-	-	-	0	39	-99	-	-	-
HS6	0	24	-99	-	-	-	7	32	850	1	09JAN	-
HS7A	7	5	1032	14	19DEC	0	17	3	0		08JAN-10JAN	0
HS7B	10	2	328	2	20DEC	200	0	20	-99	-	-	-
HS7C	10	2	1145	22	19DEC	-	17	3	1033	10	09JAN	0
HS8	0	24	-99	-	-	-	0	39	-99	-	-	-
HS9	18	6	186	12	19DEC	0	0	39	-99	-	-	-

Table 4-2c. Tracer Data Information For Each Station (PDCH)

SITE	NUM	MISS	PEAK	HR	DATE	Start Conc.	NUM	MISS	PEAK	HR	DATE	Start Conc.
	Episode 2: Dec. 19 - 20, 1989						Episode 3: Jan. 8 - 10, 1990					
AQ2	0	12	-99	-	-	-	11	9	55	10	09JAN	-
AQ3	11	1	0		19DEC-20DEC	0	12	8	0		08JAN-10JAN	0
CC1	11	1	0		19DEC-20DEC	0	9	11	0		08JAN-10JAN	0
CC10	11	1	0		19DEC-20DEC	0	18	2	868	8	09JAN	145
CC12	12	0	665	0	20DEC	0	0	20	-99	-	-	-
CC13	12	0	0	12	19DEC-20DEC	0	18	2	0		08JAN-10JAN	0
CC14	12	0	100	16	19DEC	0	12	8	55	0	09JAN	0
CC15	9	3	72	12	19DEC	0	0	20	-99	-	-	-
CC16	12	0	868	0	20DEC	0	17	3	1596	20	08JAN	0
CC17	7	5	44	16	19DEC	0	12	8	271	0	09JAN	0
CC18	12	0	0		19DEC-20DEC	0	12	8	580	0	09JAN	0
CC19	8	4	0		19DEC-20DEC	0	16	4	154	6	09JAN	0
CC20	0	12	-99	-	-	-	0	20	-99	-	-	-
CC21	0	12	-99	-	-	-	7	13	0		08JAN-10JAN	-
CC3	9	3	0		19DEC-20DEC	0	9	11	0		08JAN-10JAN	0
CC4	10	2	0		19DEC-20DEC	-	12	8	0		08JAN-10JAN	-
CC5	0	12	-99	-	-	-	5	15	0		08JAN-10JAN	-
CC6	0	12	-99	-	-	-	10	10	0		08JAN-10JAN	-
CC7	11	1	63	18	19DEC	63	0	20	-99	-	-	-
CC8	12	0	0		19DEC-20DEC	0	17	3	0		08JAN-10JAN	0
HS1	3	9	101	16	19DEC	-	18	2	0		08JAN-10JAN	-
HS10	21	3	0		19DEC-20DEC	0	5	34	0		08JAN-10JAN	-
HS12	20	4	0		19DEC-20DEC	-	14	25	0		08JAN-10JAN	-
HS13	11	1	0		19DEC-20DEC	0	6	14	0		08JAN-10JAN	-
HS14	5	7	0		19DEC-20DEC	0	13	7	0		08JAN-10JAN	0
HS15	10	2	0		19DEC-20DEC	0	12	8	0		08JAN-10JAN	0
HS16	9	3	0		19DEC-20DEC	0	16	4	1193	18	08JAN	1193
HS2	22	2	95	8	20DEC	0	0	39	-99	-	-	-
HS3	0	24	-99	-	-	-	15	24	0		08JAN-10JAN	-
HS5	0	24	-99	-	-	-	0	39	-99	-	-	-
HS6	0	24	-99	-	-	-	7	32	0		08JAN-10JAN	-
HS7A	7	5	0		19DEC-20DEC	0	17	3	0		08JAN-10JAN	0
HS7B	10	2	78	18	19DEC	78	0	20	-99	-	-	-
HS7C	10	2	0		19DEC-20DEC	-	17	3	628	10	09JAN	0
HS8	0	24	-99	-	-	-	0	39	-99	-	-	-
HS9	18	6	0		19DEC-20DEC	0	0	39	-99	-	-	0

Table 4-2d. Tracer Data Information for Each Station (PTCH)

SITE	NUM	MISS	PEAK	HR	DATE	Start Conc	NUM	MISS	PEAK	HR	DATE	Start Conc.
	Episode 2: Dec. 19 - 20, 1989						Episode 3: Jan. 8 - 10, 1990					
AQ2	0	12	-99	-	-	-	11	9	1159	2	09JAN	-
AQ3	11	1	0		19DEC-20DEC	0	12	8	0		08JAN-10JAN	0
CC1	11	1	0		19DEC-20DEC	0	9	11	0		08JAN-10JAN	0
CC10	11	1	0		19DEC-20DEC	0	18	2	58	16	09JAN	0
CC12	12	0	266	0	20DEC	-	0	20	-99	-	-	-
CC13	12	0	0		19DEC-20DEC	-	18	2	1913	20	08JAN	-
CC14	12	0	37	16	19DEC	0	12	8	0		08JAN-10JAN	0
CC15	9	3	1088	0	20DEC	0	0	20	-99	-	-	-
CC16	12	0	114	2	20DEC	-	17	3	79	8	09JAN	-
CC17	7	5	213	12	19DEC	-	12	8	0		08JAN-10JAN	-
CC18	12	0	0		19DEC-20DEC	-	12	8	0		08JAN-10JAN	-
CC19	8	4	0		19DEC-20DEC	0	16	4	0		08JAN-10JAN	0
CC20	0	12	-99	-	-	-	0	20	-99	-	-	-
CC21	0	2	-99	-	-	-	7	13	0		08JAN-10JAN	-
CC3	9	3	0		19DEC-20DEC	0	9	11	0		08JAN-10JAN	0
CC4	10	2	0		19DEC-20DEC	-	12	8	0		08JAN-10JAN	-
CC5	0	12	-99	-	-	-	5	15	0		08JAN-10JAN	-
CC6	0	12	-99	-	-	-	10	10	0		08JAN-10JAN	-
CC7	11	1	0		19DEC-20DEC	0	0	20	-99	-	-	-
CC8	12	0	0		19DEC-20DEC	0	17	3	0		08JAN-10JAN	0
HS1	3	9	0		19DEC-20DEC	-	18	6	83	20	09JAN	0
HS10	21	3	1673	6	20DEC	0	5	34	0		08JAN-10JAN	-
HS12	20	4	1999	8	20DEC	-	14	25	168	17	08JAN	-
HS13	11	1	0		19DEC-20DEC	0	6	14	0		08JAN-10JAN	0
HS14	5	7	0		19DEC-20DEC	0	7	26	0		08JAN-10JAN	0
HS15	10	2	0		19DEC-20DEC	0	12	8	0		08JAN-10JAN	0
HS16	9	3	1586	8	20DEC	0	16	4	1946	20	08JAN	766
HS2	22	2	734	20	19DEC	0	0	39	-99	-	-	0
HS3	0	24	-99	-	-	0	15	24	74	19	09JAN	0
HS5	0	24	-99	-	-	-	0	39	-99	-	-	-
HS6	0	24	-99	-	-	-	7	32	59	19	09JAN	-
HS7A	7	5	151	12	19DEC	0	17	3	0		08JAN-10JAN	0
HS7B	10	5	151	0	19DEC	0	0	20	-99	-	-	-
HS7C	10	5	138	20	19DEC	-	17	3	0		08JAN-10JAN	0
HS8	0	24	-99	-	-	-	0	39	-99	-	-	-
HS9	18	6	561	8	20DEC	0	0	39	-99	-	-	-

also listed in the table for reference to observe the transport pattern (for two-hour average data the earliest concentration is the concentration at 18:00; for one-hour average data the earliest concentration is the concentration at 17:00).

A dynamic Gaussian model (AVACTA, Version 3.1) has been run to simulate the trajectory of the tracers during their release period in the second episode (17:00–23:00). Wind observations from seven AQMD stations were uses as input for the simulation. Figure 4-2 shows the trajectories of the four tracers. As we can observe from the figure, the simulated tracers describe rather well the tracers' movement during their release period, more clearly than do Figures 4-1c through 4-1e.

- **Episode 3: 8–10 January 1990**

The movement of the tracers PMCP and PMCH from the 9 January 0000 to 0600 period (Figures 4-3a through 4-3d for PMCH, for example; others are shown in Appendix D-2) showed an offshore wind pattern similar to that observed during the second episode. Like the plots shown in the second episode, the plots of tracers PMCP and PMCH do not show the apparently characteristic daytime wind pattern. Again, that might be in part caused by less dense sampling distribution in the regions where these tracers might have been found.

At the start of the third episode, as in the second, tracers were detected in the samples from some stations; e.g., PMCH was detected at C18 and C19, PTCH was detected at C17, before these tracers were scheduled for release.

- **Discussion of Tracer Results**

The results of the tracer experiment show that the tracer transport during the night mimics the apparent movement of the CO cloud. However, because of possible contamination, missing data, and a relatively sparse sampling network along the paths taken by several of the tracer gases, the transport patterns have not been documented in great detail over the entire study area, nor are the patterns clearly defined during the daytime hours.

One important observation can be made from these data, however. The tracer gases were not observed in the network at any of the sites for long periods of time. This seems to indicate that the episodes cannot be due simply to stagnation and pooling of local contaminants. Were that the case, the tracers would have been trapped in these same pools and observed in a localized set of receptors for an extended period of time.

TRACER TRAJETORY
DECEMBER 19, 1989

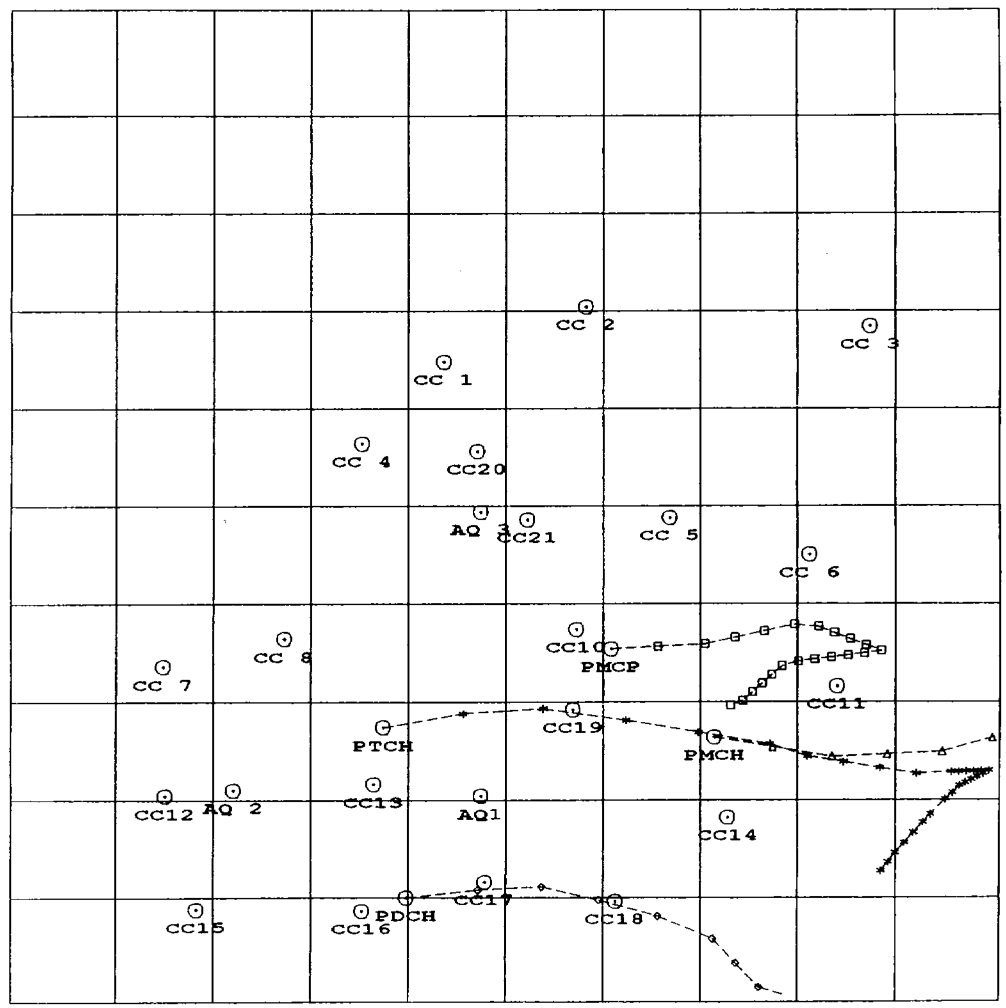
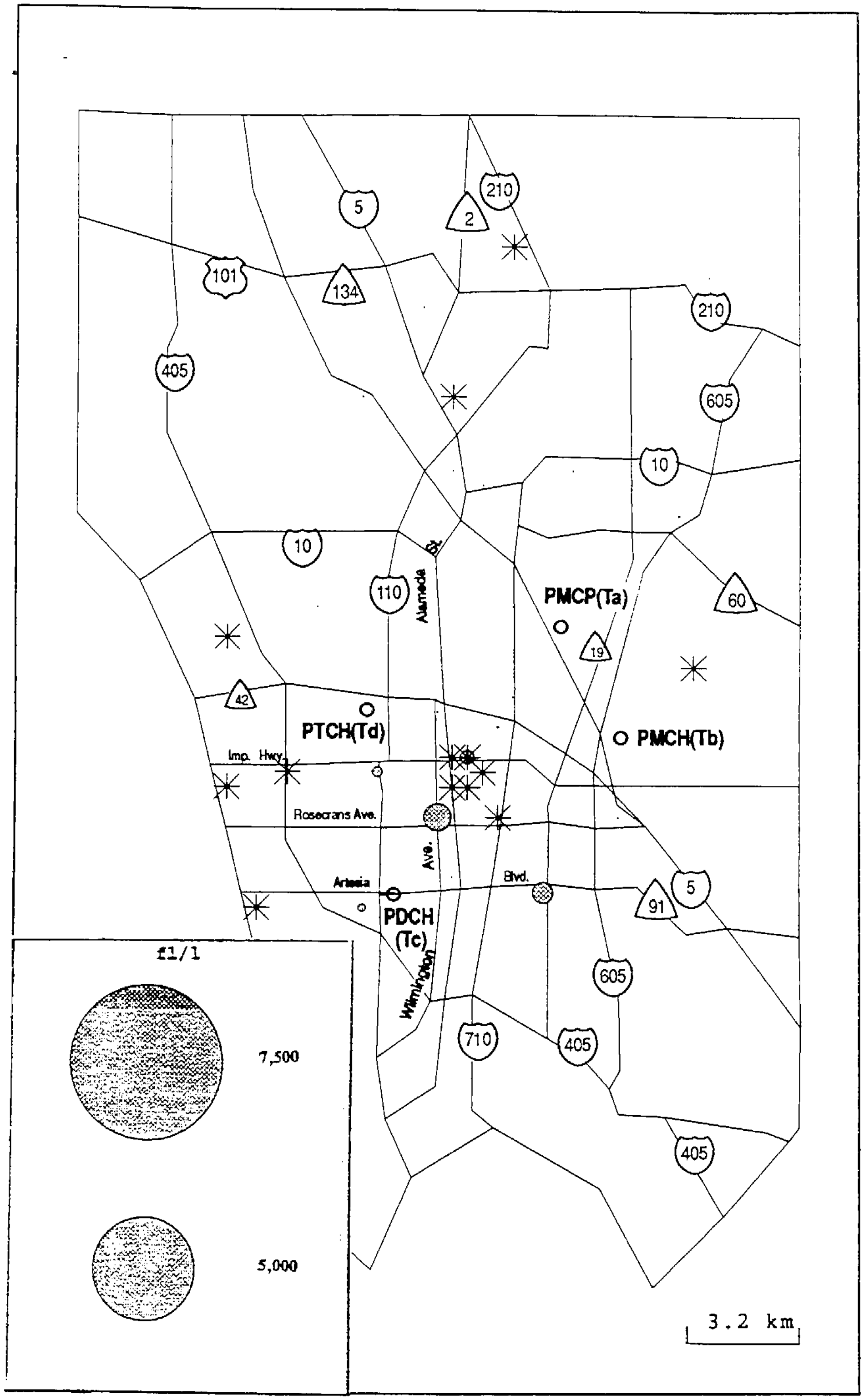


FIGURE 4-2

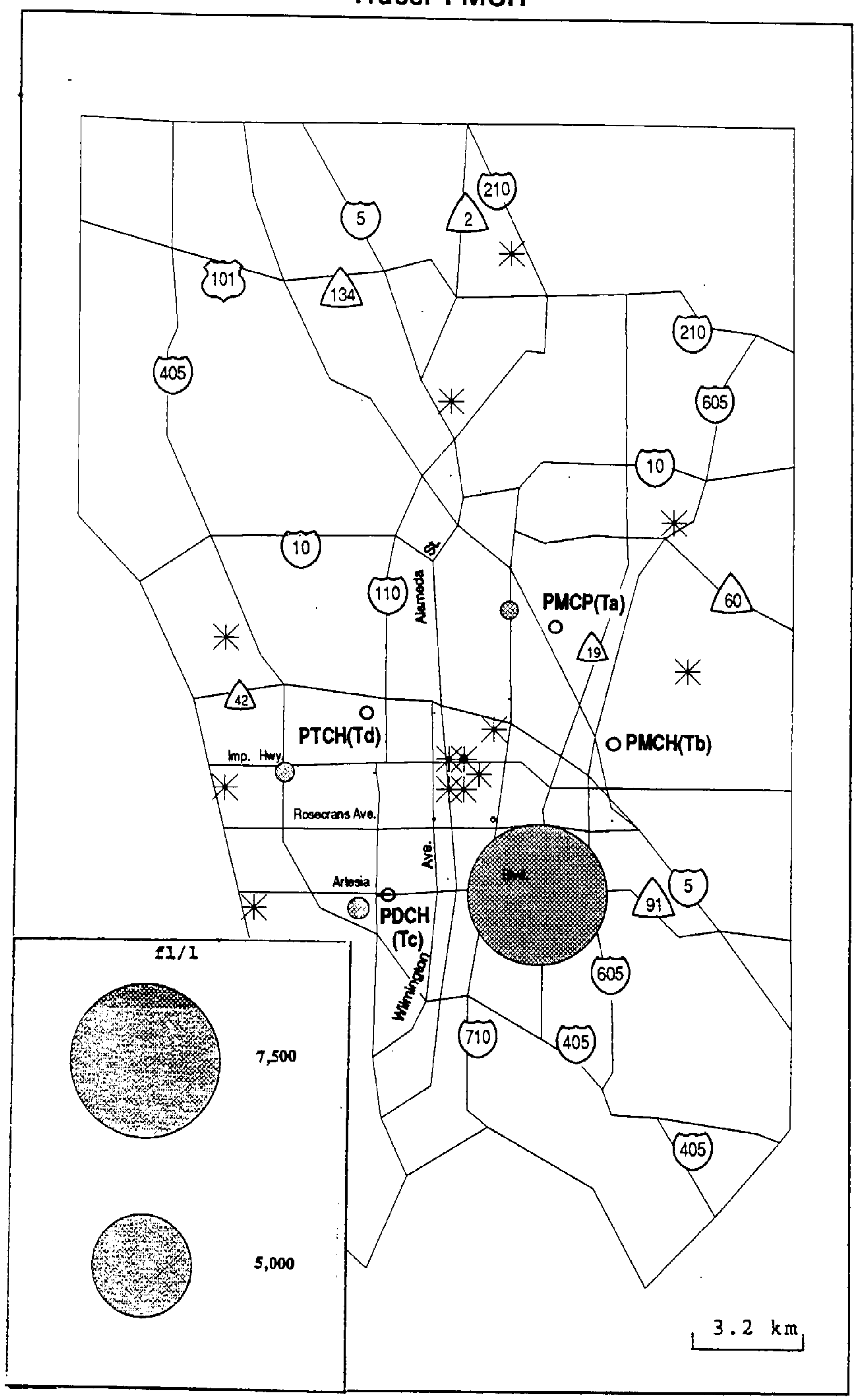
Tracer PMCH



TB 01/09/1990 00:00

FIGURE 4-3a.

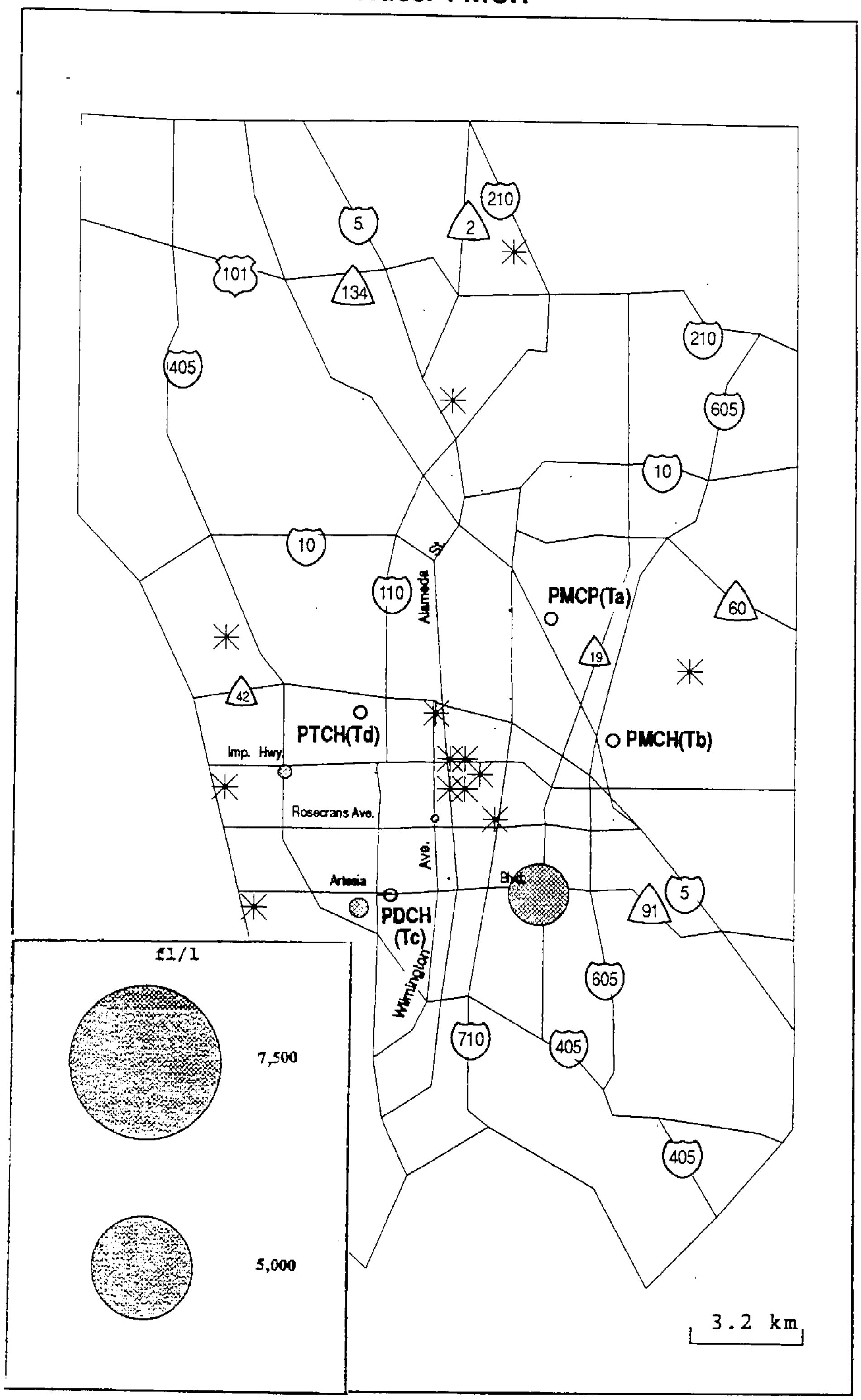
Tracer PMCH



TB 01/09/1990 02:00

FIGURE 4-3b.

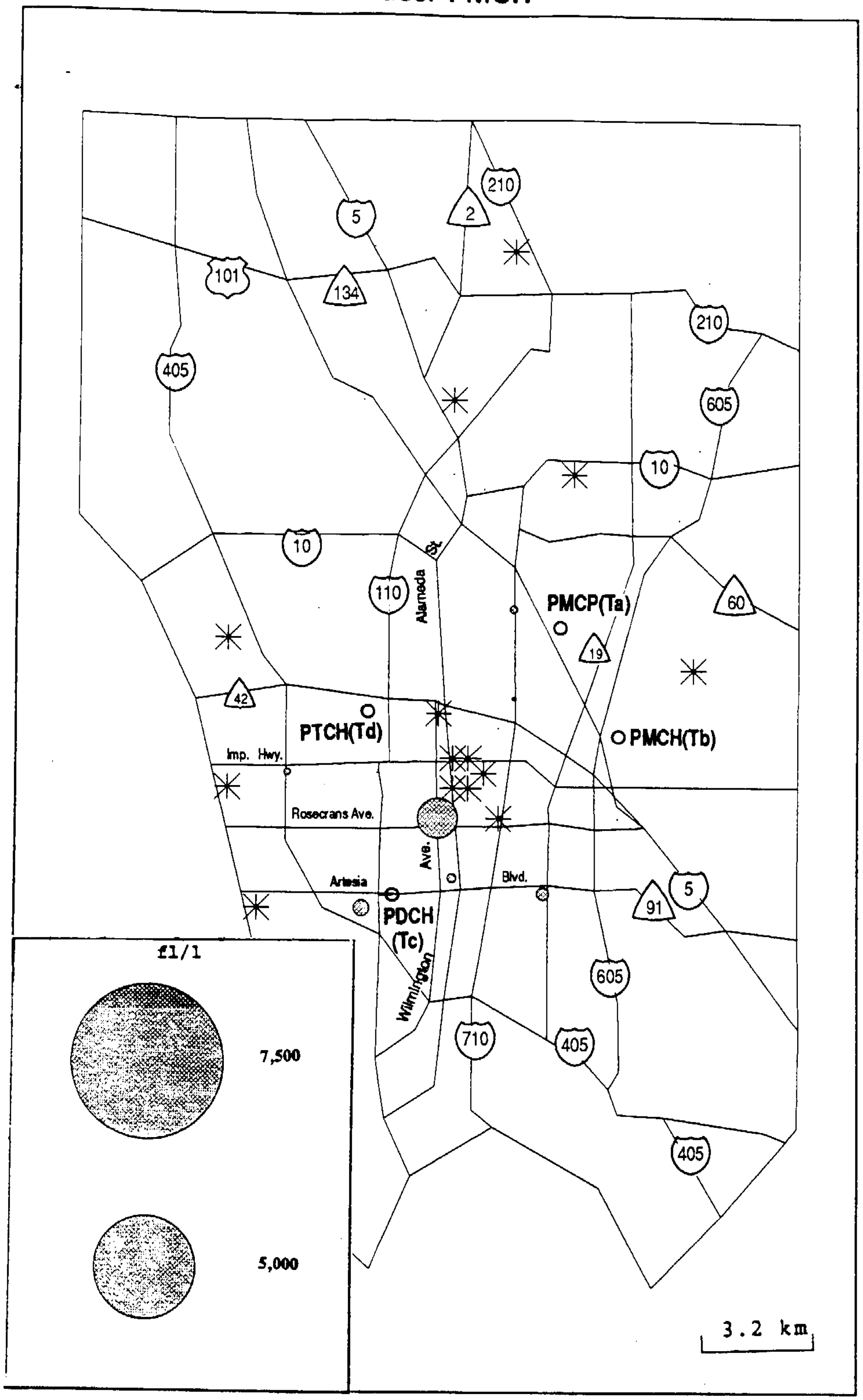
Tracer PMCH



TB 01/09/1990 04:00

FIGURE 4-3c.

Tracer PMCH



TB 01/09/1990 06:00

FIGURE 4-3d.

Section 5

METEOROLOGICAL DATA

At two sites, one north of Lynwood in Vernon and the other in Lynwood, east of the AQMD station, tethersondes were set up to monitor the meteorological conditions throughout a vertical air column from 2 to 60 meters. (Operations were limited to 60 meters due to restrictions imposed by the FAA for tethered balloon flights near controlled airspace. These same restrictions limited our choices for tethersonde flight locations; one preferred location would have been in Hawthorne, nearer the coast.) The wind speed and direction, and dry- and wet-bulb ambient temperatures were also monitored. These data have been used to estimate wind speed and direction and mixing height at these two locations and have been compared to generalize the conditions in this part of the LA Basin.

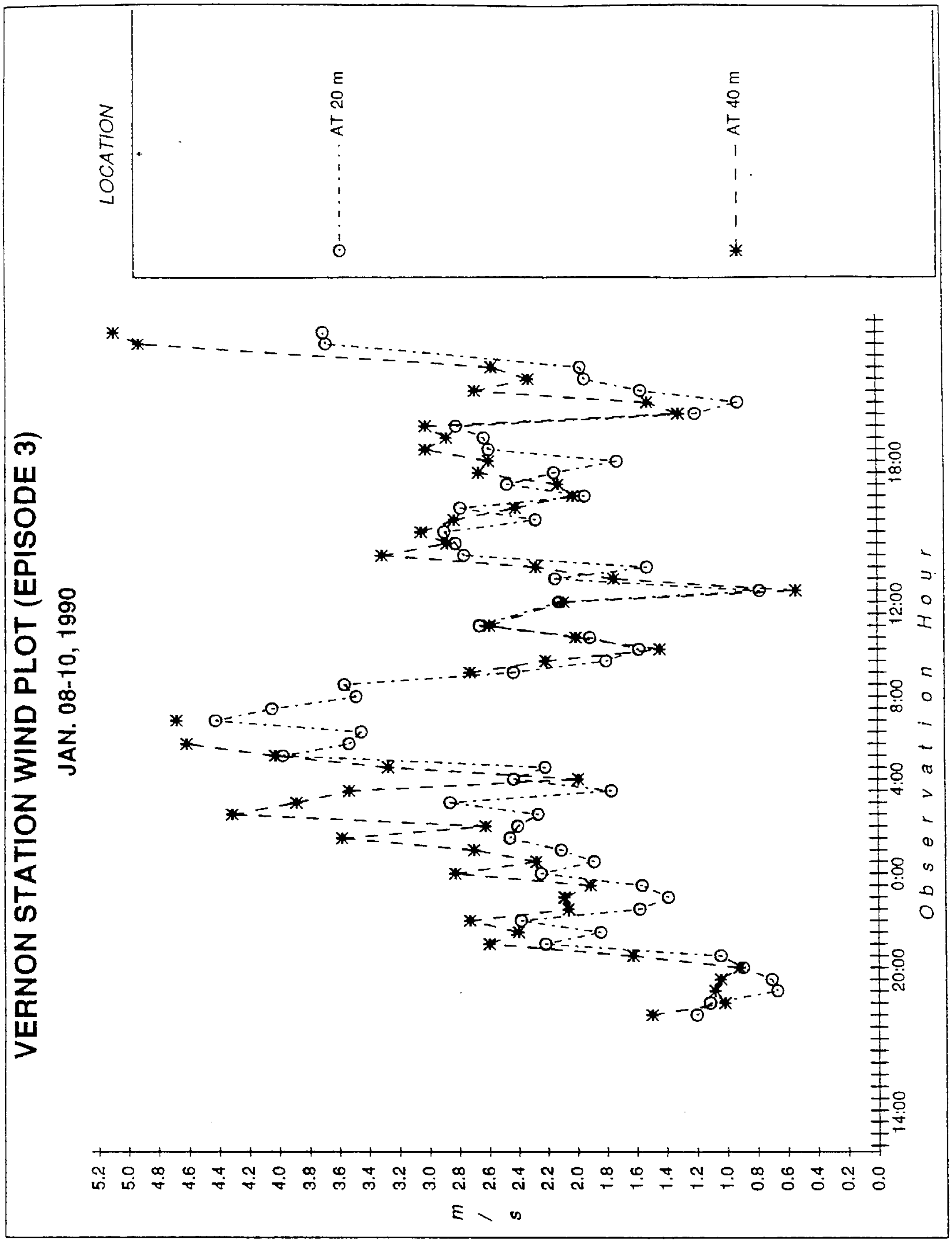
5.1 WIND INFORMATION

o Wind Speed

Time-series plots of tethersonde wind speeds, shown in Figures 5-1a through 5-1d, have been produced for each episode from the Lynwood and Vernon soundings. Wind speeds at the 20-meter and 40-meter elevations have been plotted to show how the air flows may differ at several altitudes around the area. The wind speed patterns at 20 and 40 meters are similar, with higher speeds at the 40-meter level. At Vernon, average wind speed at 20 meters is 2.2 meters per second (m/s), somewhat lower than the 2.8 m/s that was observed at 40 meters in the third episode. At Lynwood, the average wind speeds were 1.5 m/s and 2.1 m/s at 20 and 40 meters, respectively, in the third episode. Comparing the wind speeds at the Lynwood and Vernon stations, the average wind speed at Vernon appears to be higher than that at Lynwood. The differences are about 0.7 m/s and 0.6 m/s at 20 and 40 meters in the second and third episodes. See Figures 5-1a through 5-1d for a complete accounting of this behavior.

Of more importance than maximum wind speeds to our understanding of the episodes, however, is the comparison of low-wind-speed occurrences at the two locations. In Vernon, minimum wind speeds around 0.8 m/s were observed during the 2200-hour sounding. In Lynwood, in contrast, minimum winds for the same hour were around 0.2 m/s at 20 meters and were not measured above 1 m/s for a period of about four hours at that elevation. Vernon winds were consistently above 1 m/s for all soundings except the one at 2200 hours. Again, see Figures 5-1a through 5-1d.

The Lynwood and Central Los Angeles surface wind observations from the SCAQMD have been compared with our observations at 20 m in Lynwood and Vernon during the study period (see Figures 5-1e and 5-1f). The AQMD surface wind observations at Lynwood are compared with the



VERNON STATION WIND PLOT (EPISODE 3)
JAN. 08-10, 1990
m / s
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
3.2
3.4
3.6
3.8
4.0
4.2
4.4
4.6
4.8
5.0
5.2
14:00
20:00
0:00
4:00
8:00
12:00
18:00
O b s e r v a t i o n H o u r
LOCATION
AT 20 m
AT 40 m

FIGURE 5–1a.

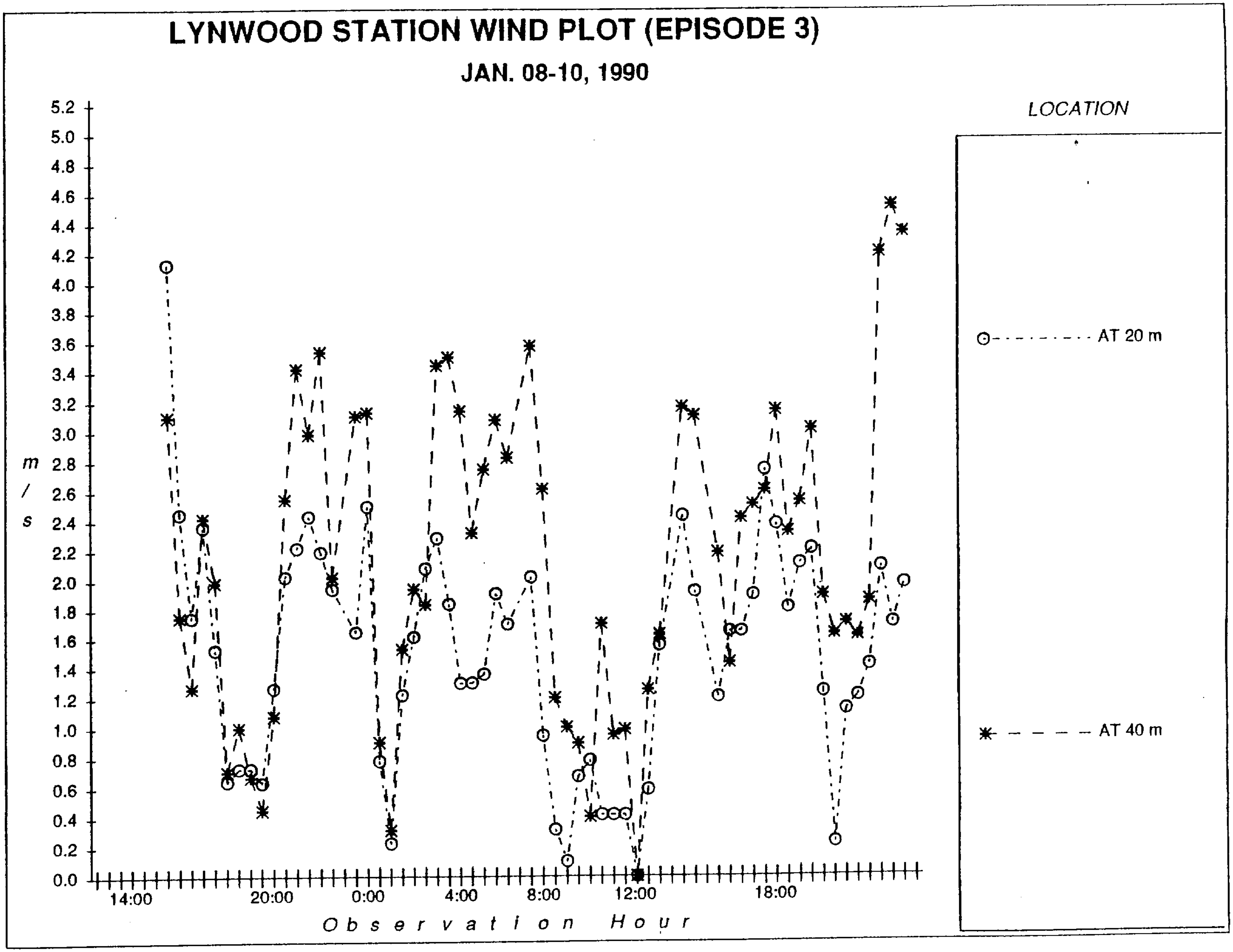

LYNWOOD STATION WIND PLOT (EPISODE 3)
JAN. 08-10, 1990
m / s
5.2
5.0
4.8
4.6
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
14:00
20:00
0:00
4:00
8:00
12:00
18:00
Observation Hour
LOCATION
AT 20 m
AT 40 m

FIGURE 5–1b.

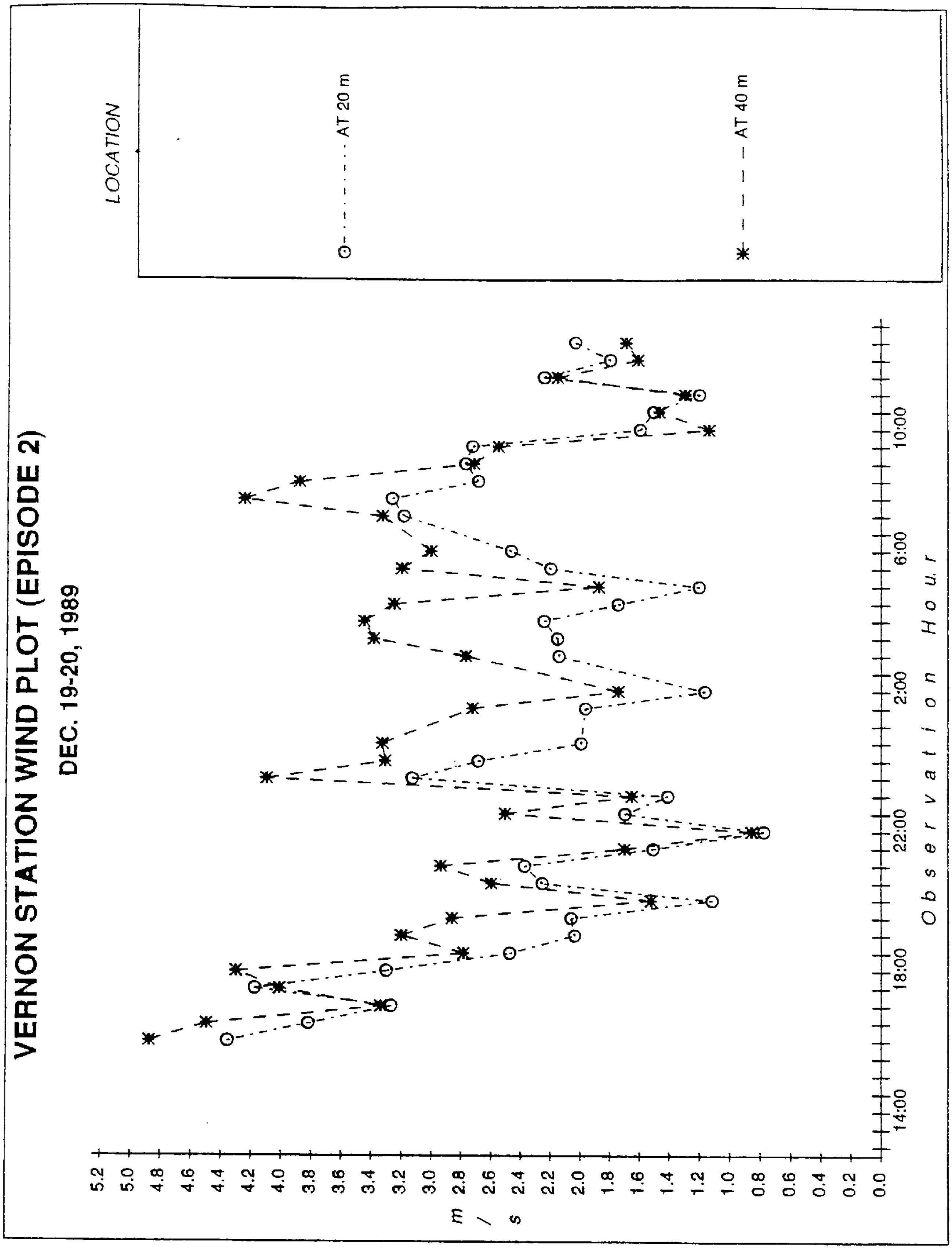

VERNON STATION WIND PLOT (EPISODE 2)
DEC. 19-20, 1989
LOCATION
AT 20 m
AT 40 m
m/s
5.2
5.0
4.8
4.6
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
14:00
18:00
22:00
2:00
6:00
10:00
Observation Hour

FIGURE 5–1c.

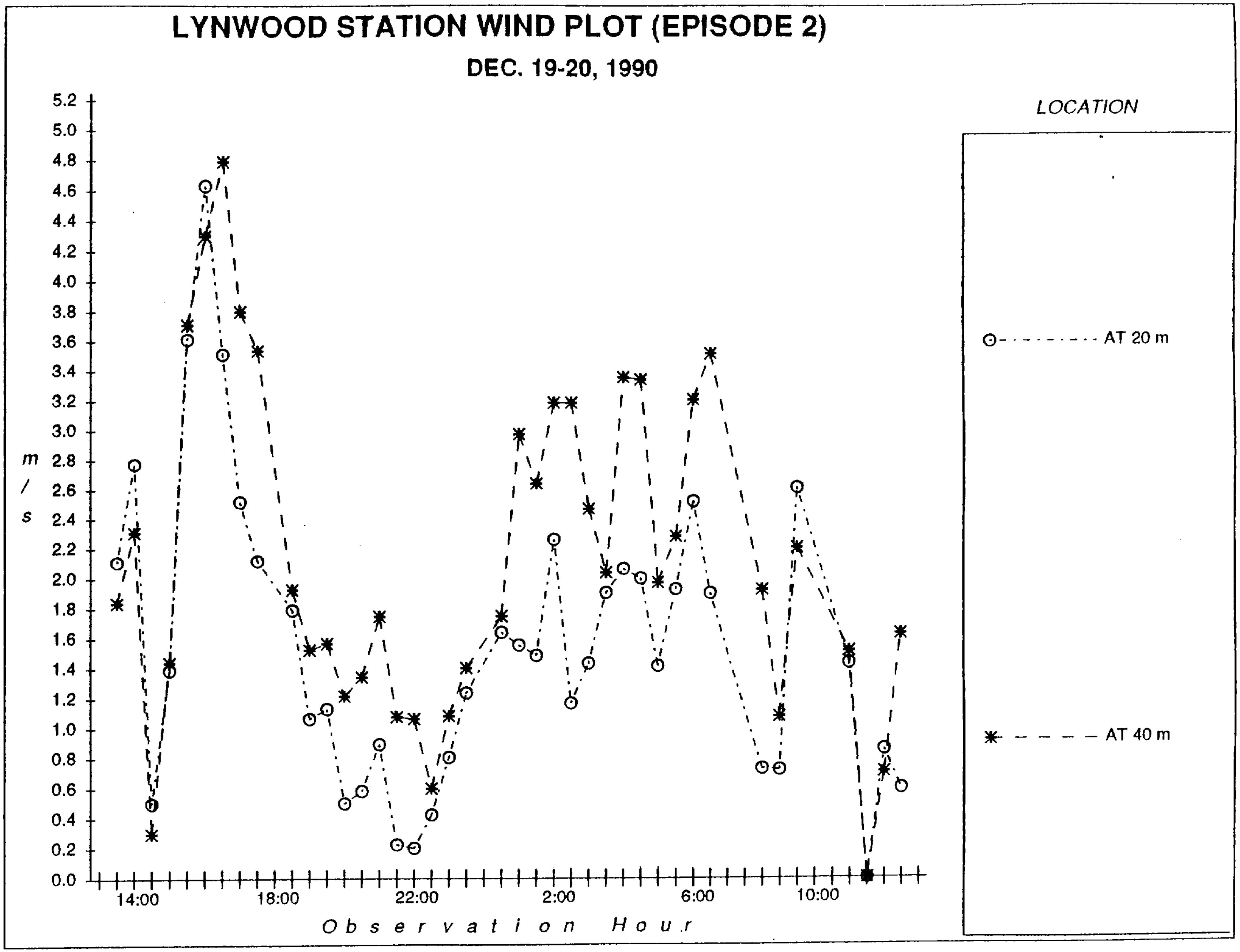

LYNWOOD STATION WIND PLOT (EPISODE 2)
DEC. 19-20, 1990
m / s
5.2
5.0
4.8
4.6
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
14:00
18:00
22:00
2:00
6:00
10:00
Observation Hour
LOCATION
AT 20 m
AT 40 m

FIGURE 5–1d.

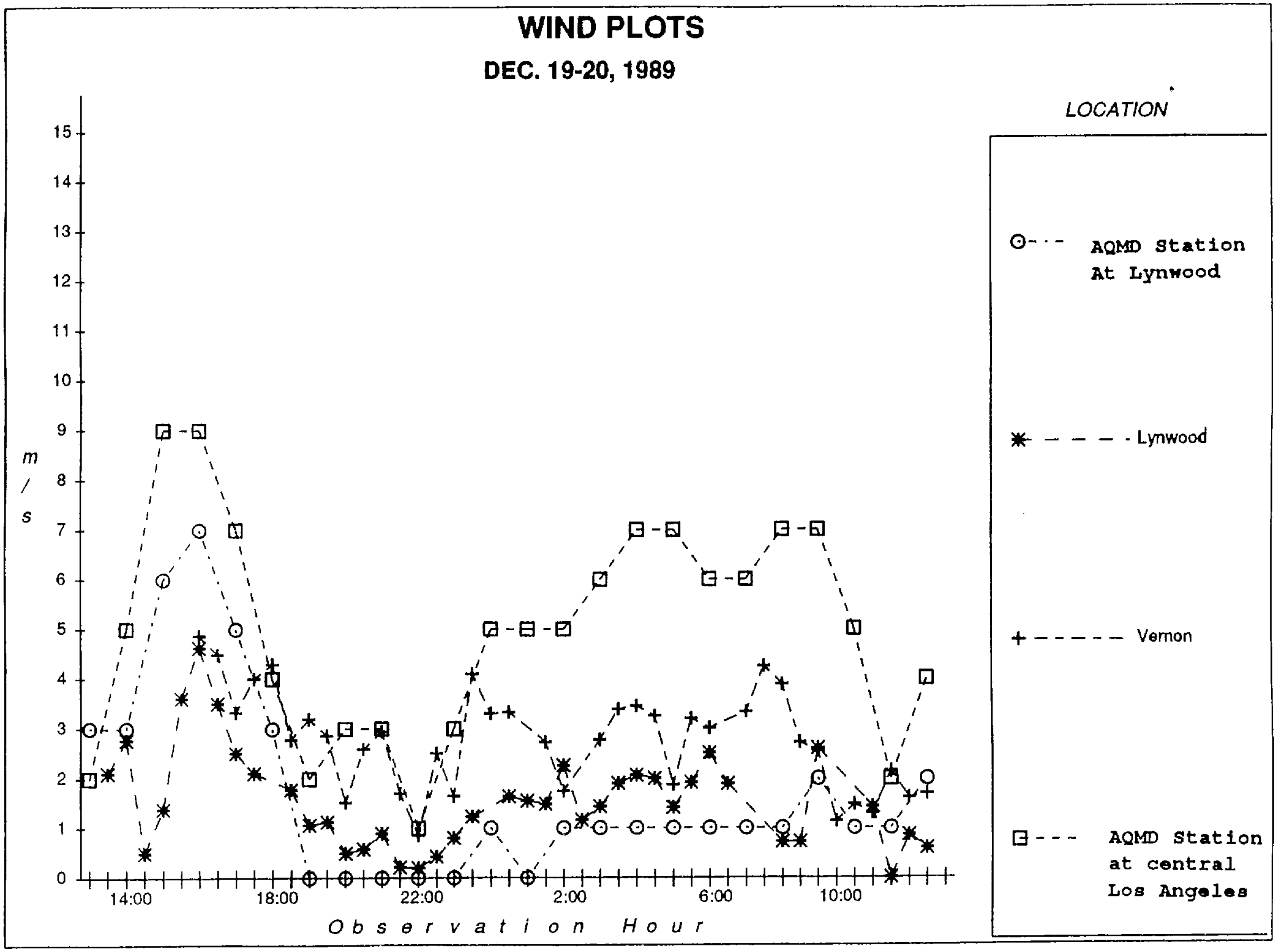
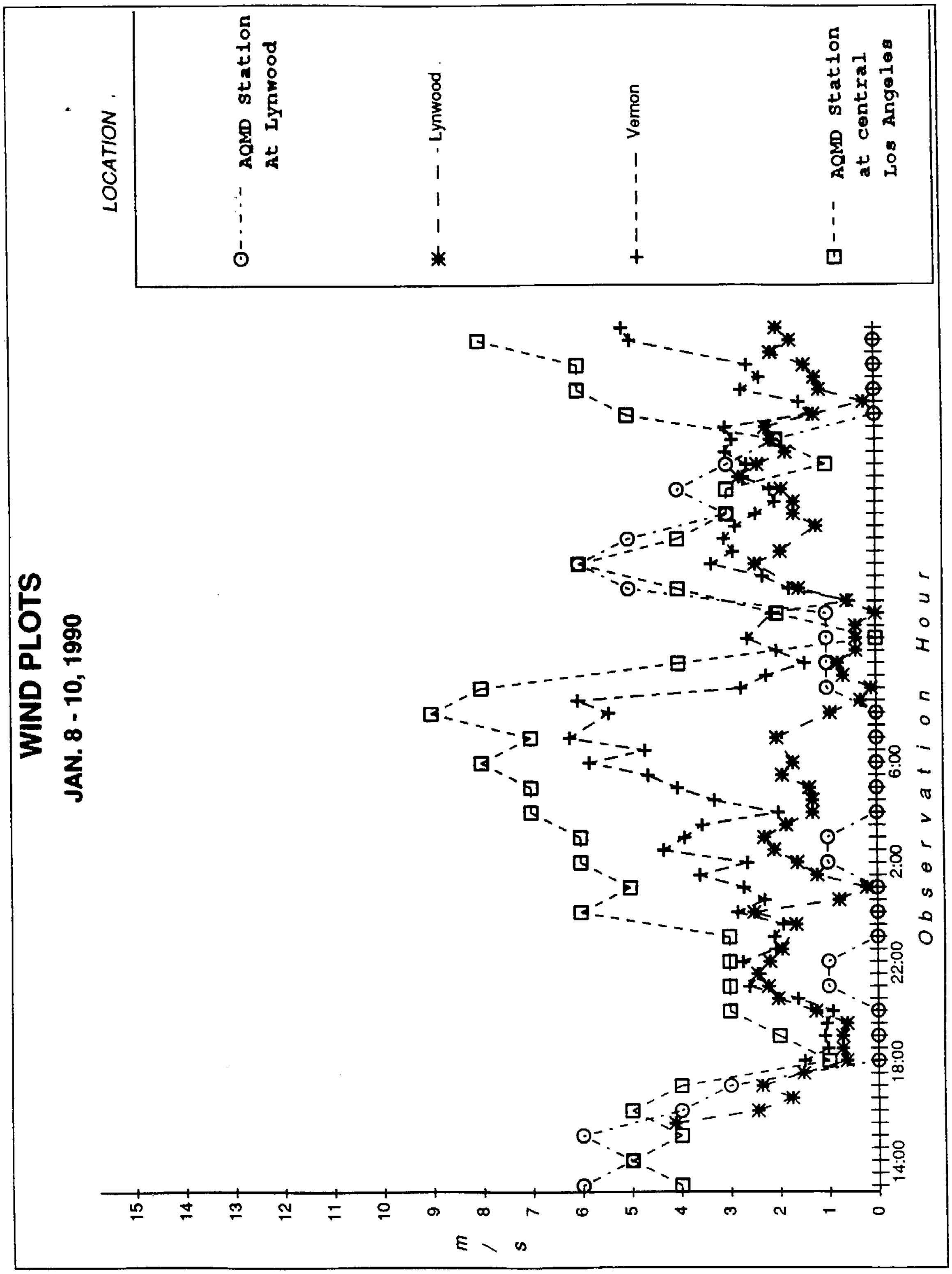

WIND PLOTS
DEC. 19-20, 1989
m / s
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
14:00
18:00
22:00
2:00
6:00
10:00
Observation Hour
LOCATION
AQMD Station At Lynwood
Lynwood
Vernon
AQMD Station at central Los Angeles

FIGURE 5-1e.



WIND PLOTS
JAN. 8 - 10, 1990
m / s
Observation Hour
14:00
18:00
22:00
2:00
6:00
LOCATION
AQMD Station At Lynwood
Lynwood
Vernon
AQMD Station at central Los Angeles

FIGURE 5-1f.

observations at other locations in the basin to get a basinwide wind picture. Figures 5-1g through 5-1j presents the observations from seven stations in the basin during the second and third episode. These stations are Burbank, Whittier, Central Los Angeles, Pasadena, Hawthorne, Anaheim and Lynwood. During the second episode, Burbank, Whittier, Lynwood, Pasadena and Hawthorne showed continuous low wind speed during some time periods; the same thing happened during the third episode.

The CO and wind time-series plots (Figure 5-1k and 5-1l) observed together show that when the CO concentration reached its peak during the night in the second episode, the wind speeds were extremely low, less than 1 m/s. The same thing happened on the evening of 8 January; however, on the evening of 9 January, the wind speeds were not extremely low. Generally speaking, the wind speeds were low during the whole study period. The lower wind speed at Lynwood is consistent with a greater potential for high CO concentrations there.

o **Wind Direction**

Figures 5-2a through 5-2h display the wind directions measured in Lynwood and Vernon at the 20- and 40-meter levels during the intensive study periods. In the second episode, the soundings at the 20-meter level at the Lynwood Sheriff's Station showed that from about 1400 to 1800 hours the dominant wind direction was southwest; from about 2200 to 0530 hours, the dominant wind direction was northeast. The measurements at the 40-meter level showed that from about 1400 to 1800, the dominant wind direction was southwest; from about 2200 to 1130, it was northeast; and at about 1200 it shifted to southwest again (see Figures 5-2a and 5-2b).

In the third episode, at the 20-meter level in Lynwood, the strong southwest wind pattern appeared between 1530 and 1900 on 8 January and between 1130 and 2000 on 9 January. The dominant northeast wind direction appeared between 0000 and 1100 on 9 January and 2200 and 0400 on 9–10 January. Wind at the 40-meter level at this station showed a similar pattern (see Figures 5-2c and 5-2d).

Because of the actual start time of the sampling, the time period we use to indicate the wind direction may not be the entire time period during which the wind was oriented in this direction, e.g., during Episode 3, we find from the plot that the wind direction was southwest at about 1530–2000 hours on 8 January, but we do not have a measurement before that time period that can tell us at what time the wind changed to this direction. Based on the information we do have, we can infer a rather consistent wind pattern during both the second and third episodes at the Lynwood station. Similar wind patterns were also shown at the Vernon station in both the second and third episodes (see Figures 5-2e and 5-2h).

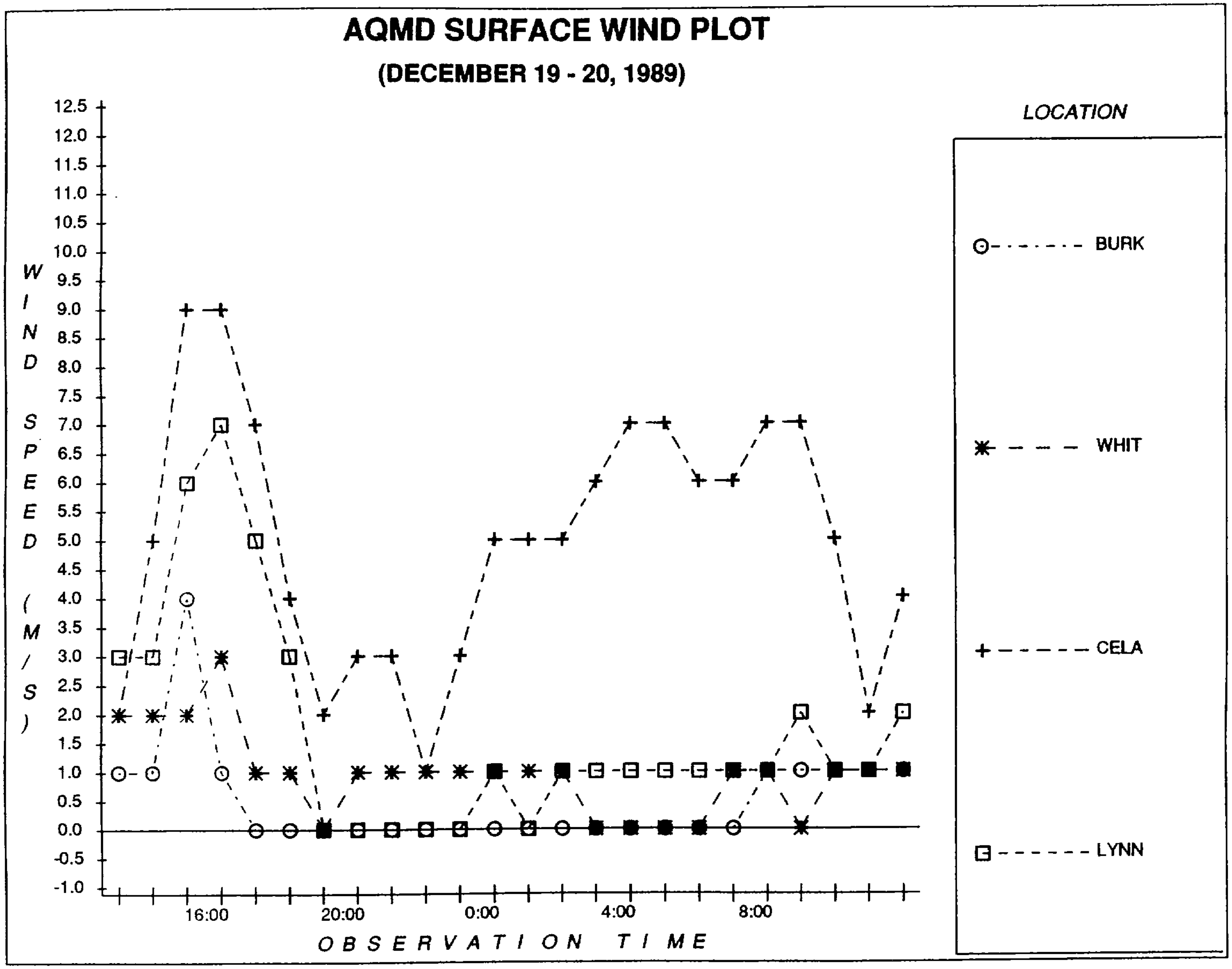

AQMD SURFACE WIND PLOT
(DECEMBER 19 - 20, 1989)
WIND SPEED (M/S)
12.5
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
16:00
20:00
0:00
4:00
8:00
OBSERVATION TIME
LOCATION
BURK
WHIT
CELA
LYNN

FIGURE 5-1g.

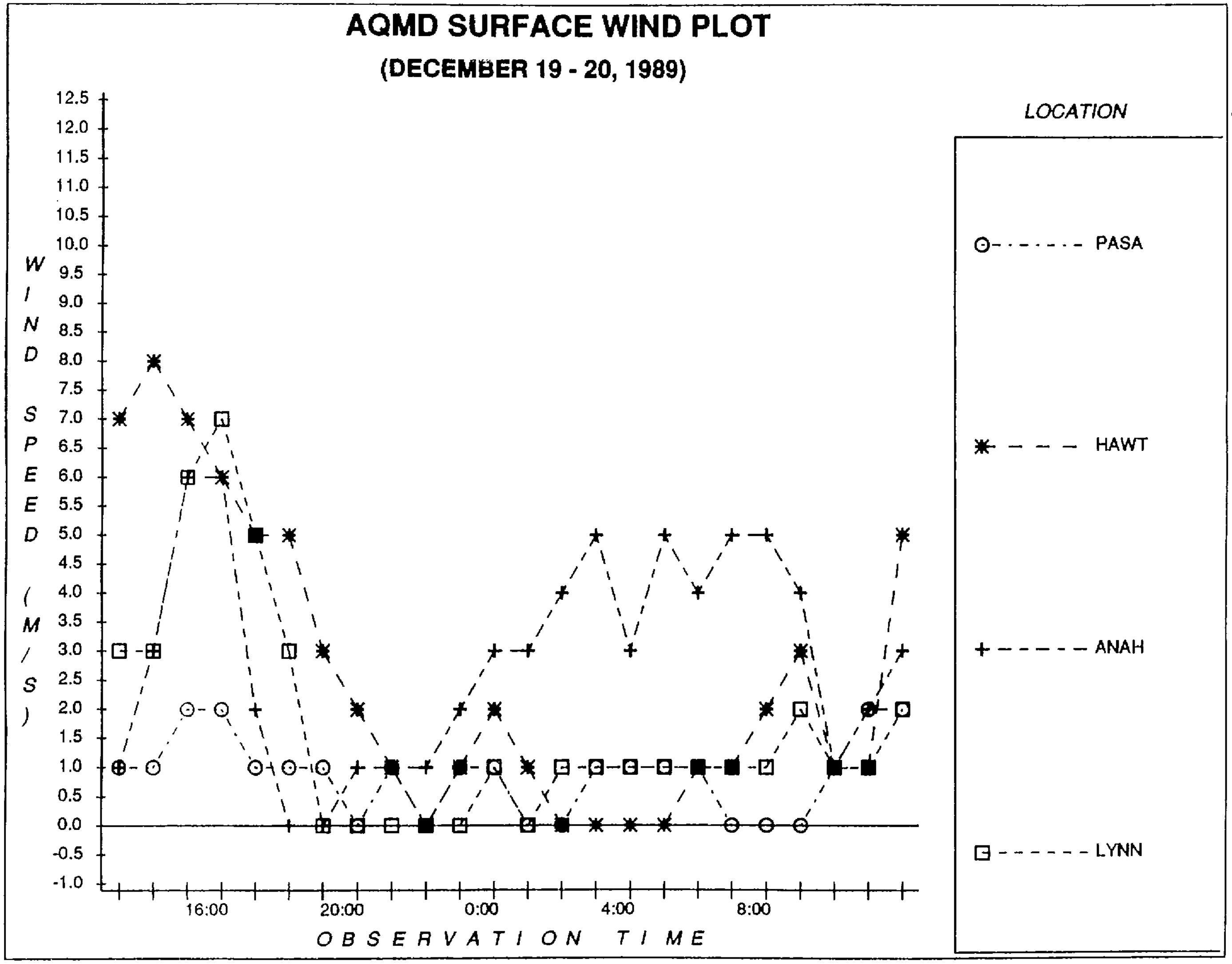

AQMD SURFACE WIND PLOT
(DECEMBER 19 - 20, 1989)
WIND SPEED (M/S)
12.5
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
16:00
20:00
0:00
4:00
8:00
OBSERVATION TIME
LOCATION
PASA
HAWT
ANAH
LYNN

FIGURE 5-1h.

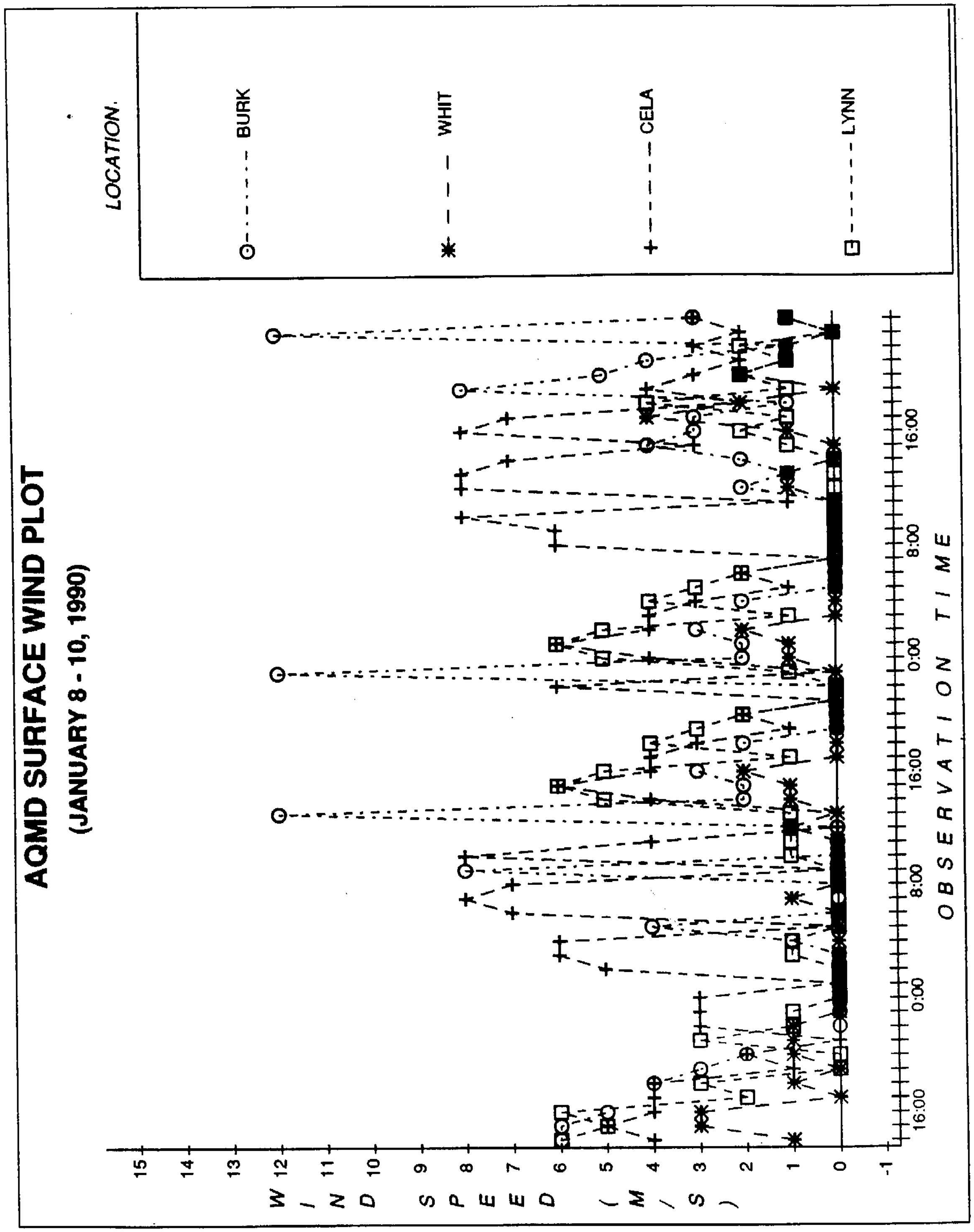

AQMD SURFACE WIND PLOT
(JANUARY 8 - 10, 1990)
LOCATION.
BURK
WHIT
CELA
LYNN
WIND SPEED (M/S)
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
16:00
0:00
8:00
16:00
0:00
8:00
16:00
OBSERVATION TIME

FIGURE 5-1i.

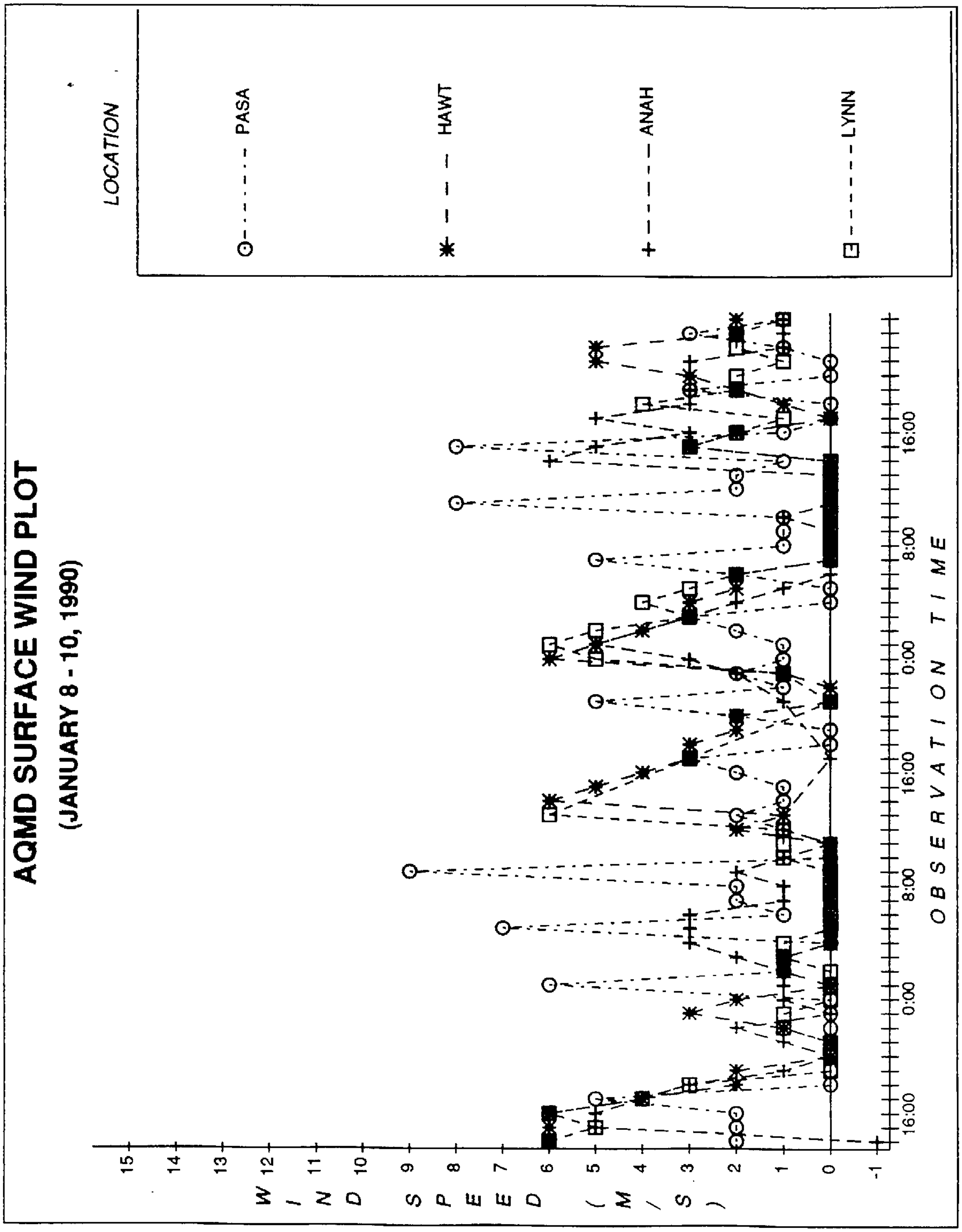

AQMD SURFACE WIND PLOT
(JANUARY 8 - 10, 1990)
LOCATION
PASA
HAWT
ANAH
LYNN
WIND SPEED (M/S)
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
16:00
0:00
8:00
16:00
0:00
8:00
16:00
OBSERVATION TIME

FIGURE 5-1j.

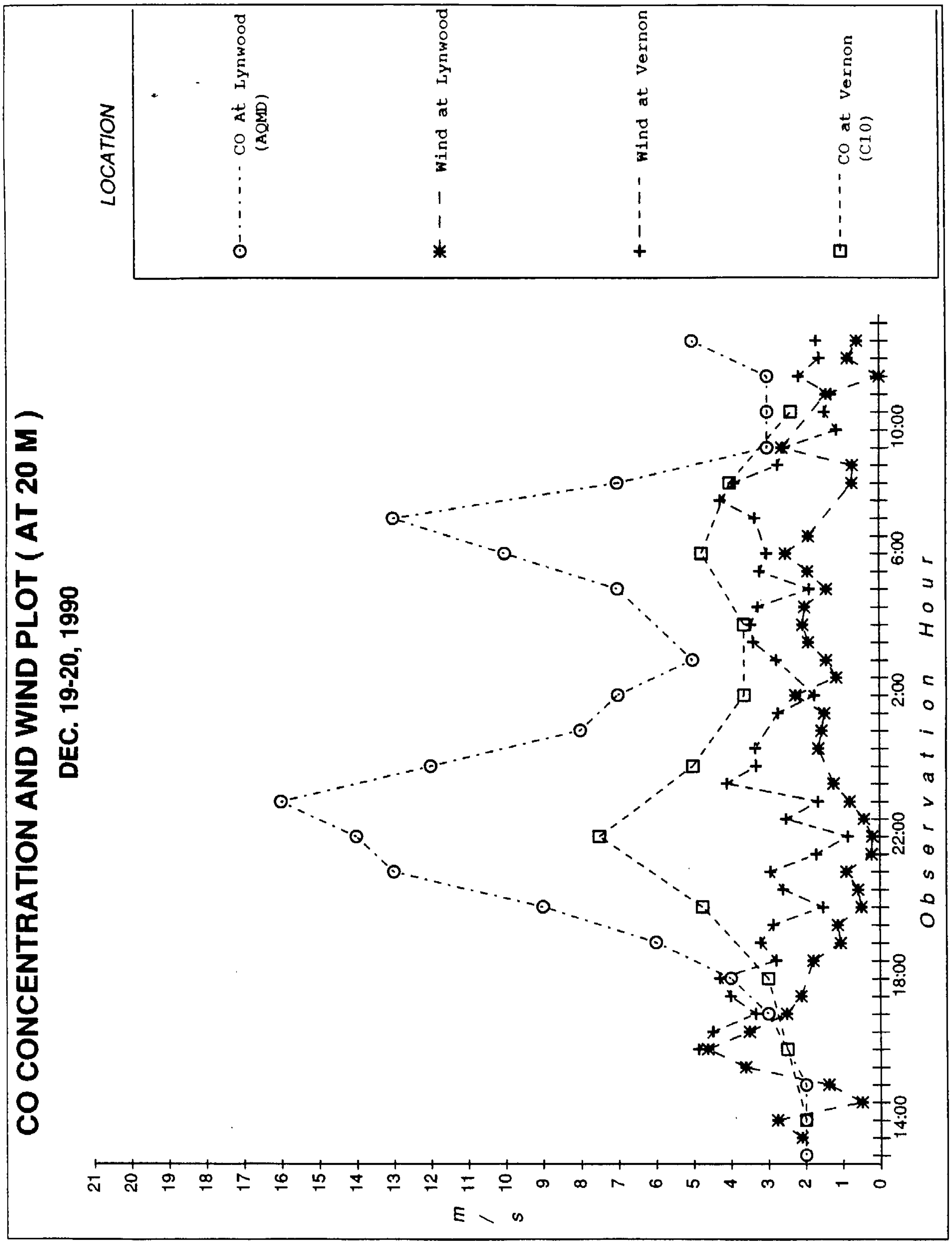

CO CONCENTRATION AND WIND PLOT (AT 20 M)
DEC. 19-20, 1990
m / s
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
14:00
18:00
22:00
2:00
6:00
10:00
Observation Hour
LOCATION
CO At Lynwood (AQMD)
Wind at Lynwood
Wind at Vernon
CO at Vernon (C10)

FIGURE 5-1k.

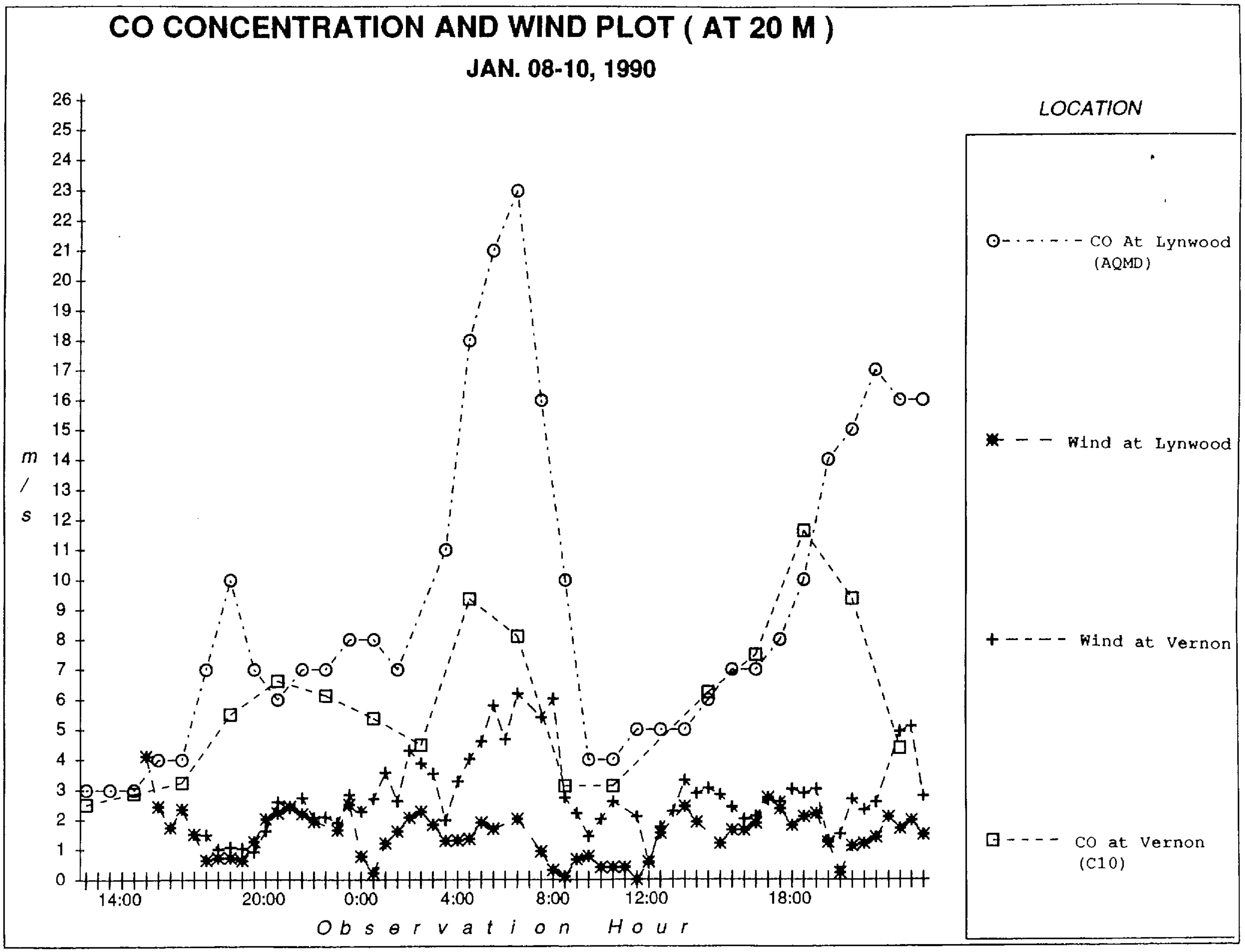
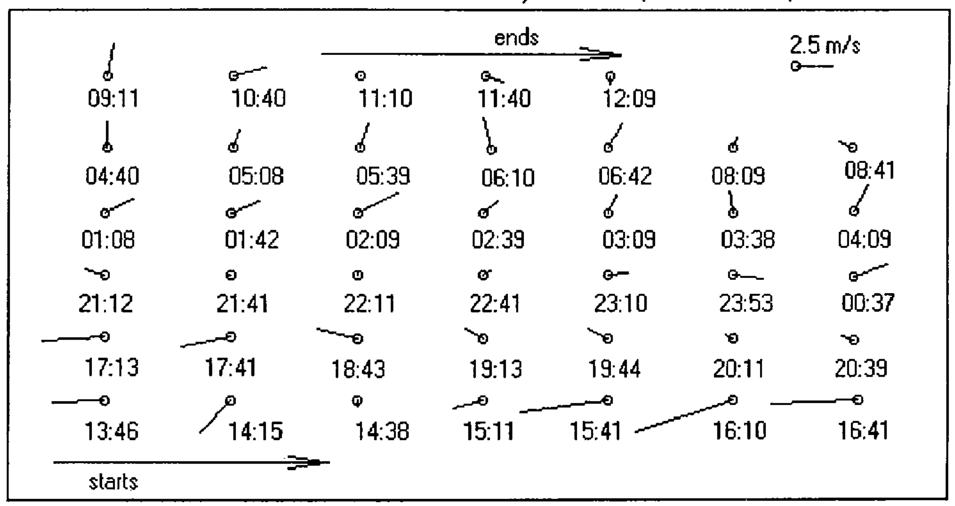

CO CONCENTRATION AND WIND PLOT (AT 20 M)
JAN. 08-10, 1990
m / s
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
14:00
20:00
0:00
4:00
8:00
12:00
18:00
Observation Hour
LOCATION
CO At Lynwood (AQMD)
Wind at Lynwood
Wind at Vernon
CO at Vernon (C10)

FIGURE 5-11.

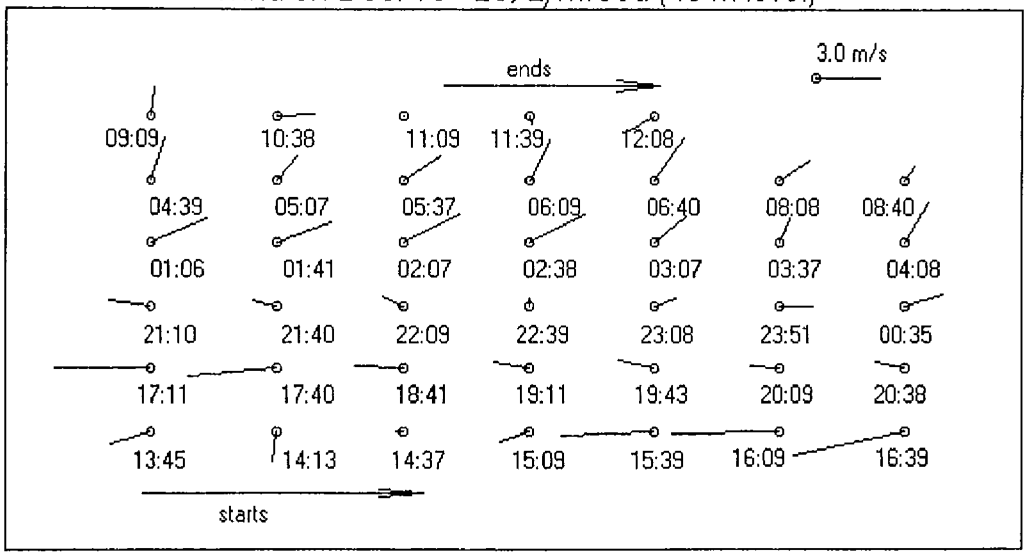
Wind on Dec. 19-20, Lynwood (20 m level)



The wind barb starts at 13:46 on Dec. 19 and ends at 12:09 on Dec. 20.

FIGURE 5–2a.

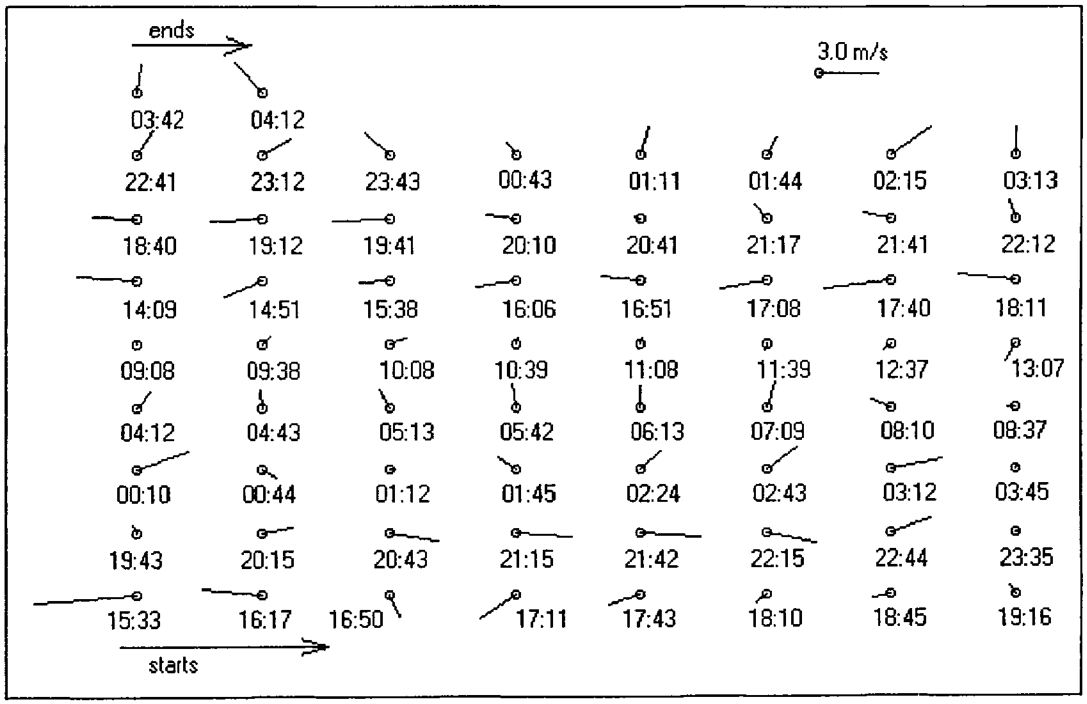
Wind on Dec. 19 - 20, Lynwood (40 m level)



The wind barb starts at 13:45 on Dec. 19 and ends at 12:08 on Dec. 20.

FIGURE 5–2b.

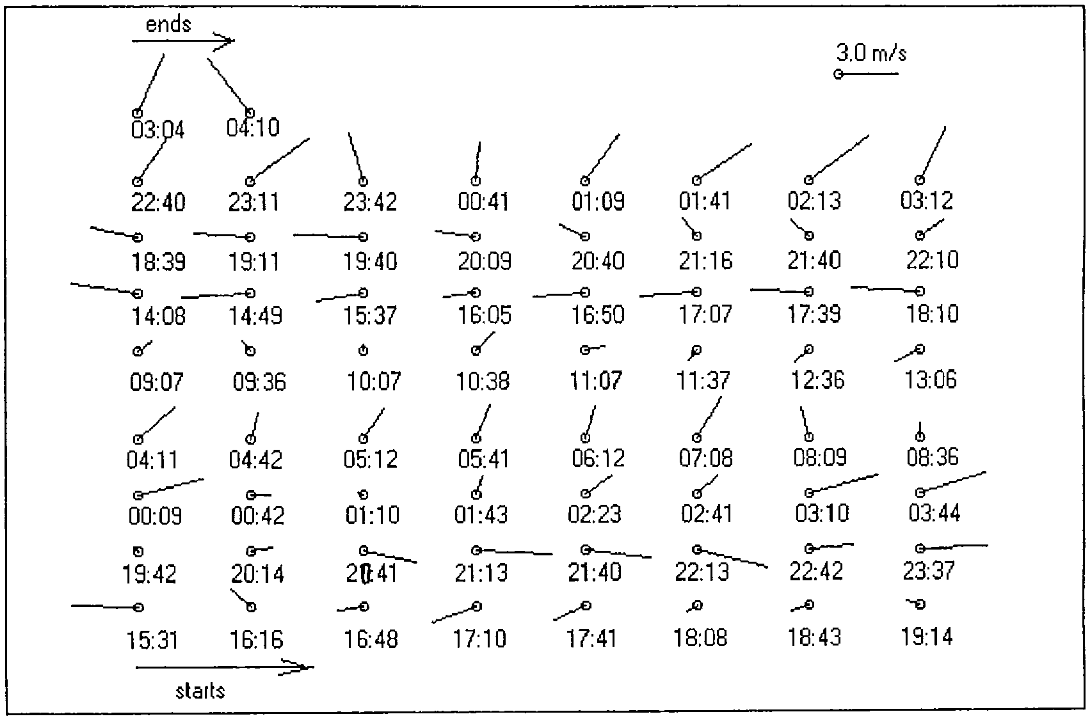
Wind on Jan. 8 - 10, Lynwood (20 m level)



The wind barb starts at 15:33 on Jan. 8 and ends at 04:12 on Jan. 10.

FIGURE 5–2c.

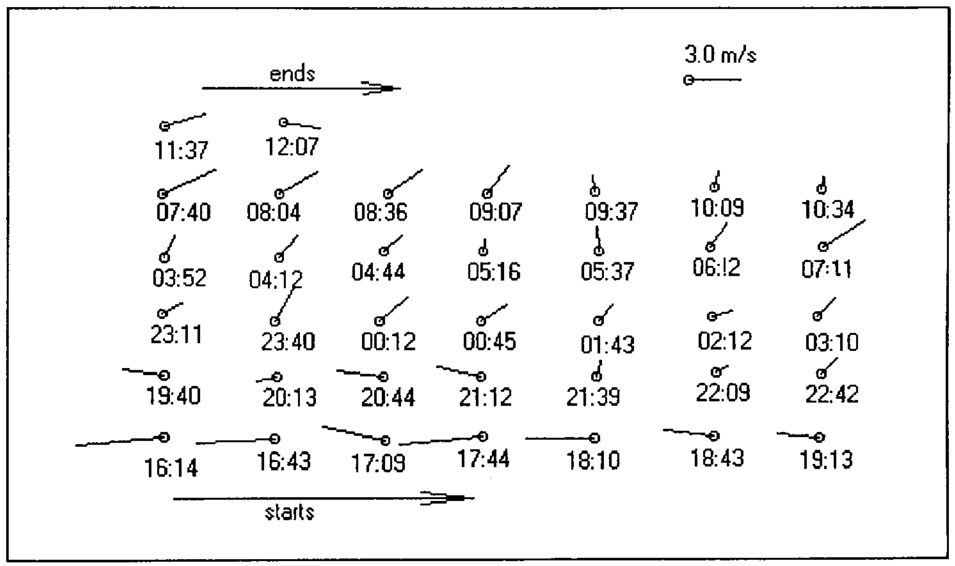
Wind on Jan. 8 - 10, Lynwood (40 m level)



The wind barb starts at 15:31 on Jan. 8 and ends at 04:10 on Jan. 10.

FIGURE 5–2d.

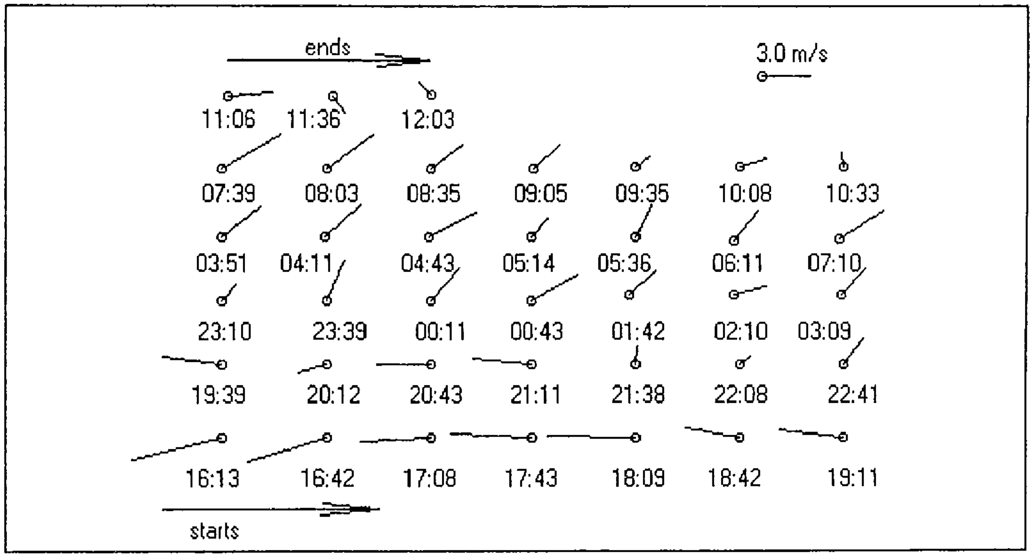
Wind on Dec. 19 - 20, Vernon (20 m level)



The wind barb starts at 16:14 on Dec. 19 and ends at 12:07 on Dec. 20.

FIGURE 5–2e.

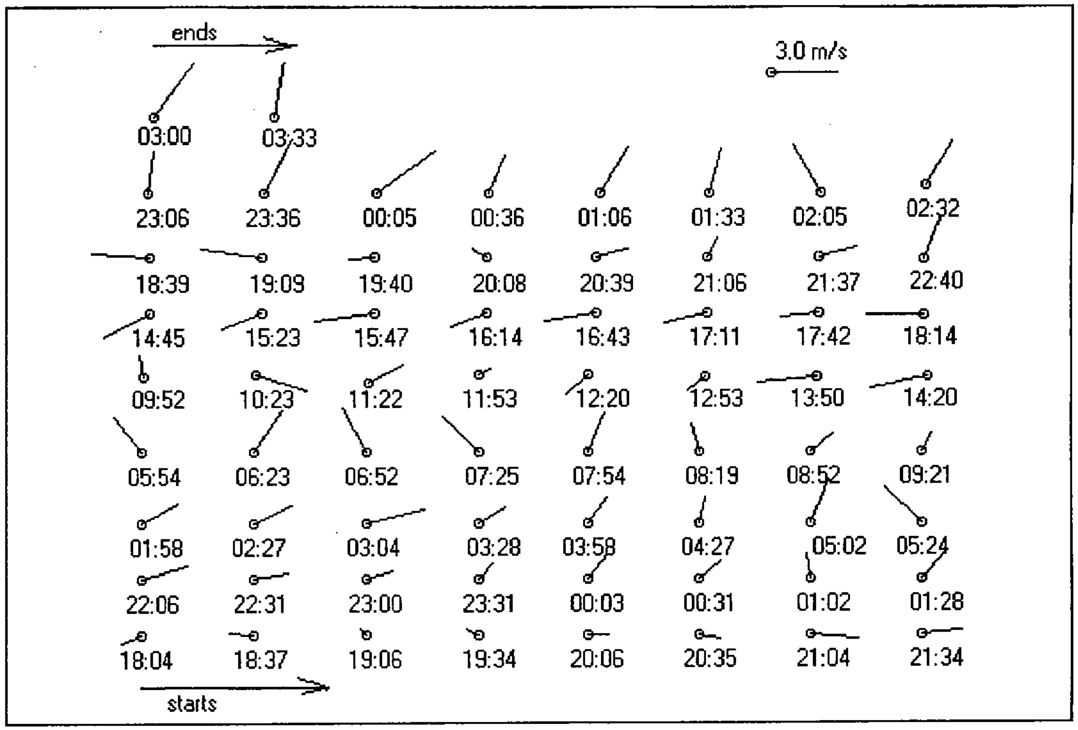
Wind on Dec. 19-20, Vernon (40 m level)



The wind barb starts at 16:13 on Dec. 19 and ends at 12:03 on Dec. 20.

FIGURE 5–2f.

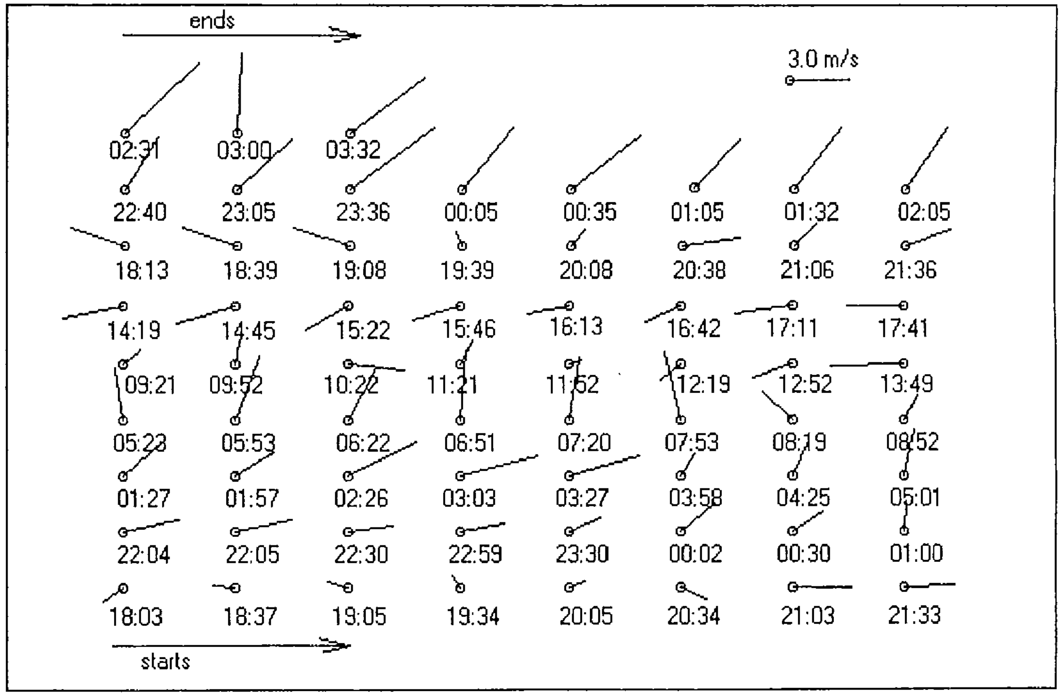
Wind on Jan. 8 -10, Vernon (20 m level)



The wind barb starts at 18:04 on Jan. 8 and ends at 03:33 on Jan. 10.

FIGURE 5–2g.

Wind on Jan. 8 - 10, Vernon (40 m level)



The wind barb starts at 18:03 on Jan. 8 and ends at 03:32 on Jan. 10.

FIGURE 5–2h.

Figures 5-2i through 5-2k present the interpolated wind flow at 18:00, 20:00 and 22:00 on 19 December 1989, from the seven SCAQMD stations mentioned before. The grid is the same as the grid in Figure 4-2. These wind fields are presented for reference to compare with wind flow observations from Lynwood and Vernon from this study (see Figures 5-2a and 5-2e).

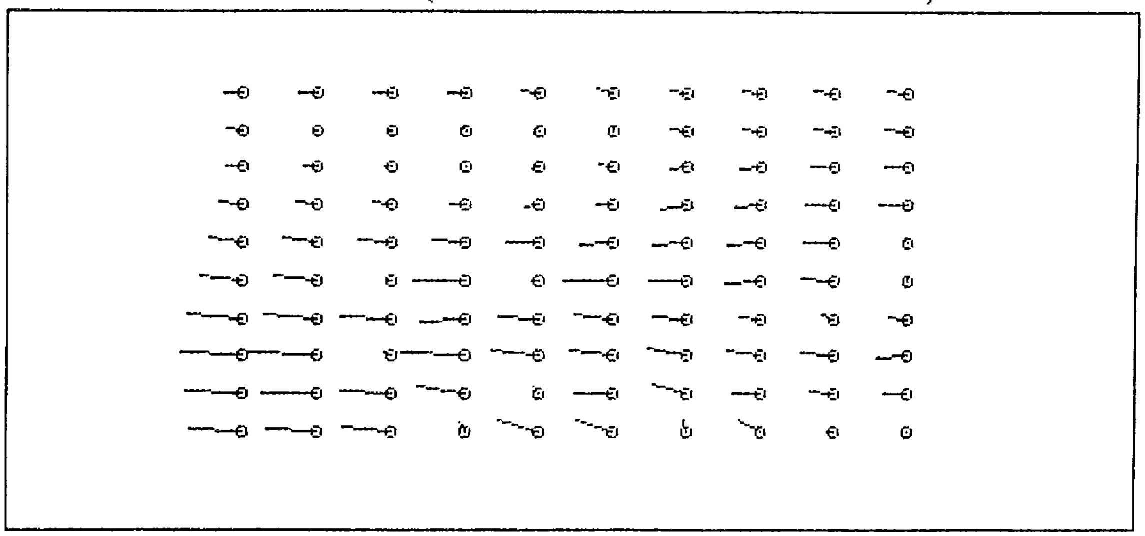
As we have discussed before, in the afternoon, the observed CO movement is onshore, e.g., 19 December, 1200 to 1800 hours; late in the night it is offshore, e.g., from 19 December, 2000 hours, to 20 December, 0400 hours. These phenomena are consistent with the wind pattern described above; we infer again that what we are observing is the movement of wind-transported CO.

5.2 MIXING HEIGHT

Mixing height is an important factor in the potential for pollutant buildup. We have examined the tethersonde data to determine to the extent possible the mixing height or strength of inversion that occurs during the two intensive study periods studied in this project. Temperature profiles have been plotted for both the Lynwood and Vernon stations. A series of these profiles are presented in Appendix E. Comparing the temperature profiles from the two sounding locations around 0000 to 0100 or 0200 during the second episode (see Figures 5-3a through 5-3d), we observe that the Vernon data suggest better mixing conditions than are suggested by the Lynwood data. Also, at around 1200, the profiles in Figures 5-3e and 5-3f show evidence that the atmosphere around the Lynwood station still has less mixing potential than that around the Vernon station, due to the apparent low inversion starting at around 35 meters. The same phenomenon was observed during Episode 3. Table 5-1 lists the inversion heights and intensities estimated from the temperature soundings. Inversion intensities are described in terms of the temperature gradient: dry adiabatic rate, $-1^{o}C$ per 100 meters, is considered to be a neutral condition; temperature gradients less than the dry adiabatic rate are considered to be unstable; temperature gradients larger than dry adiabatic rate are considered to be stable. Most of the time, the Lynwood station showed higher inversion intensities than the Vernon station, which means that the Lynwood station had a relatively stronger inversion than the Vernon station. Low inversion heights also create one of the conditions for CO buildup.

Figures 5-4a through 5-4d show some observations from LMU. Figures 5-4e and 5-4f are the tethersonde data from the Lynwood station. The data from LMU have much larger scale and less resolution than the tethersonde data from this study. Though we could not directly compare these two sets of observations, the observations appear to be consistent at about 14:00 on 19 December 1989. However, at about 14:00 on 9 January 1990, the two observations are not consistent.

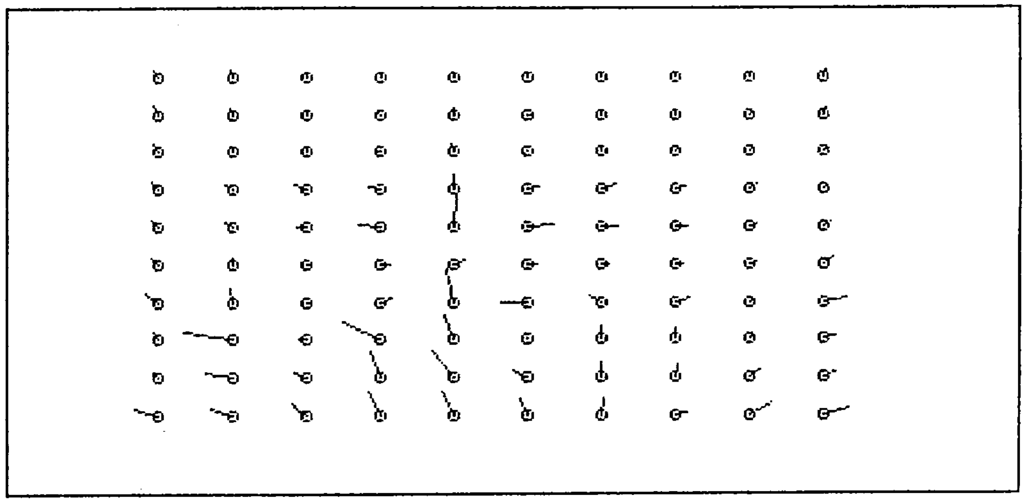
Wind Field Plot (18:00 on December 19, 1989)



10 x 10 grid is the same as the grid in Figure 4 - 2

FIGURE 5-2i.

Wind Field Plot (20:00 on December 19, 1989)



10 x 10 grid is the same as the grid in Figure 4 - 2.

FIGURE 5-2j.

Wind Field Plot (22:00 on December 19, 1989)

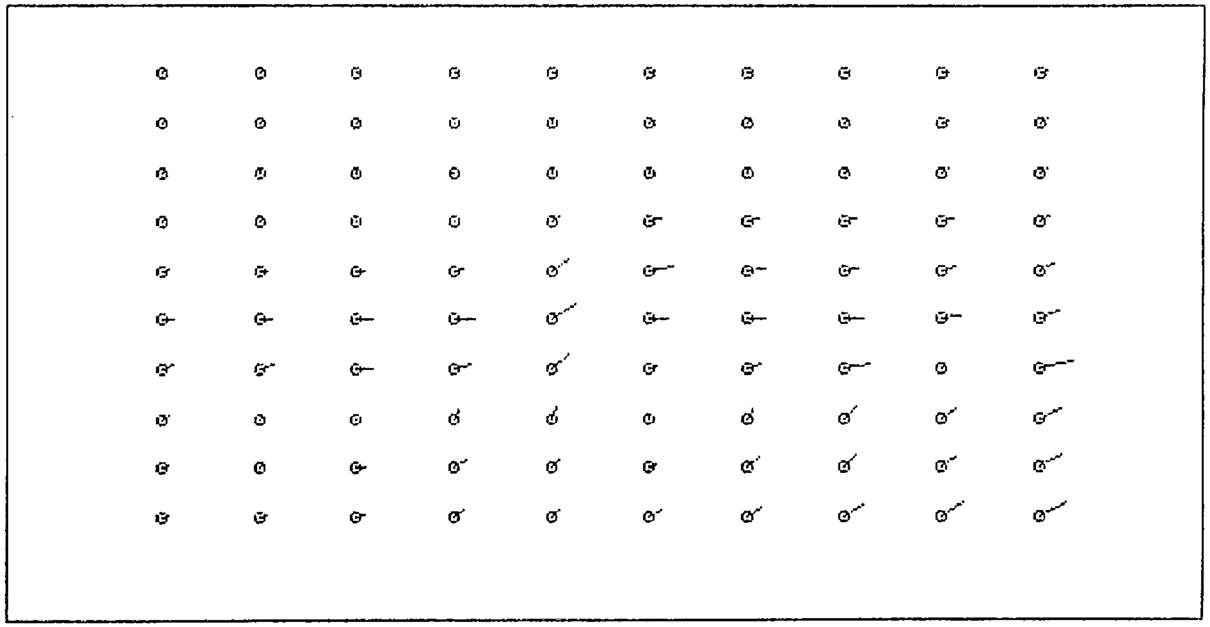


FIGURE 5-2k.

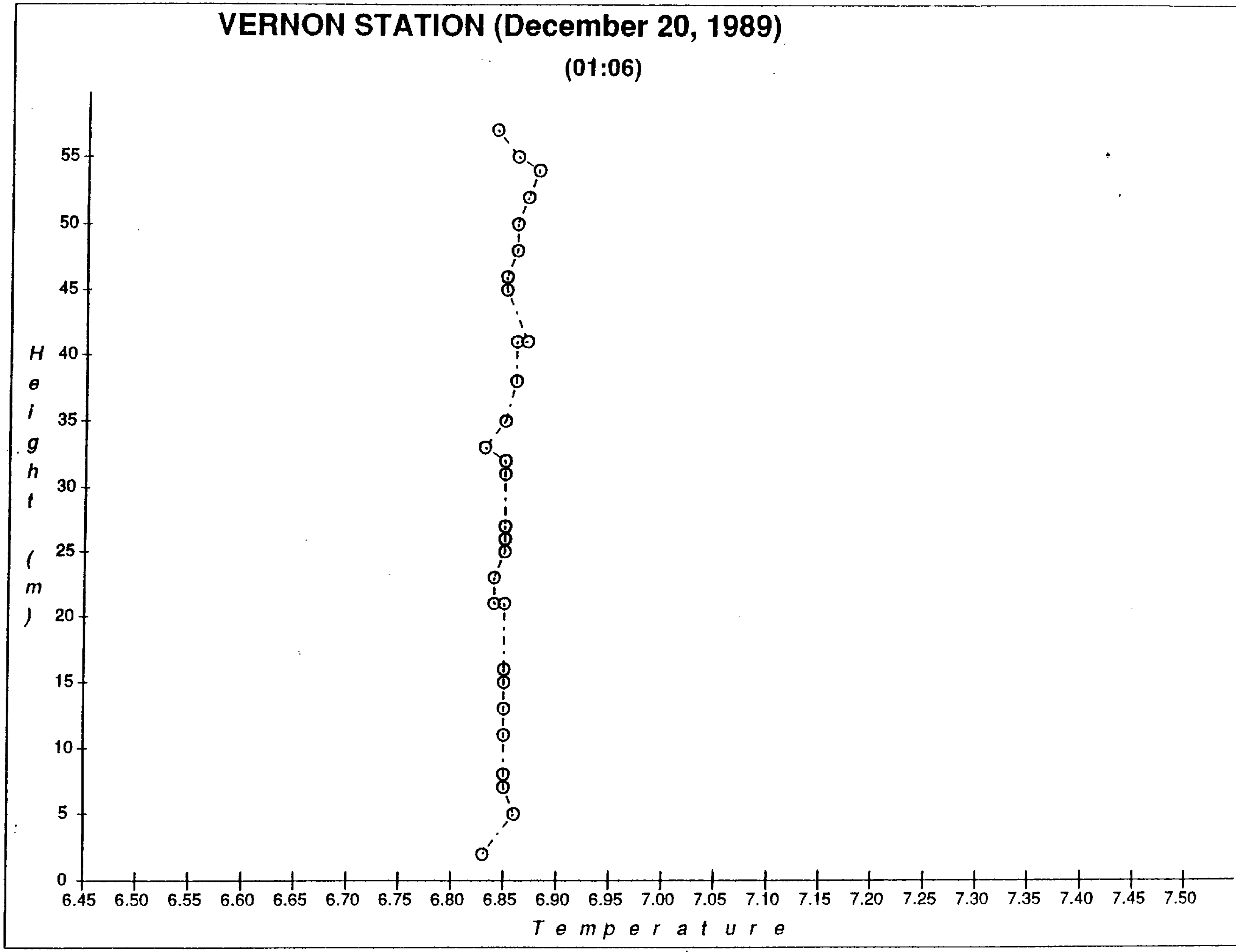

VERNON STATION (December 20, 1989)
(01:06)
Height (m)
0
5
10
15
20
25
30
35
40
45
50
55
6.45
6.50
6.55
6.60
6.65
6.70
6.75
6.80
6.85
6.90
6.95
7.00
7.05
7.10
7.15
7.20
7.25
7.30
7.35
7.40
7.45
7.50
Temperature

FIGURE 5–3a.

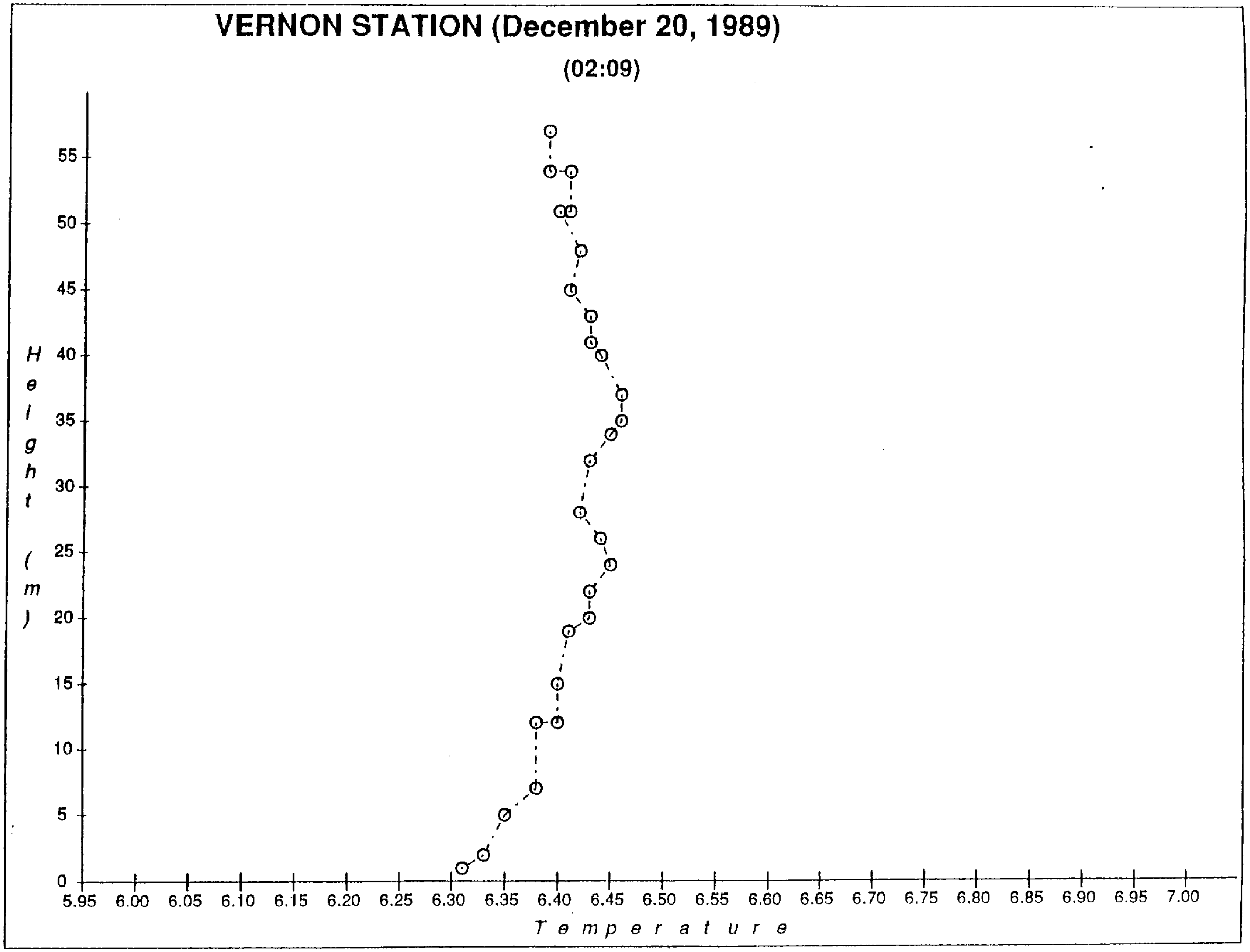
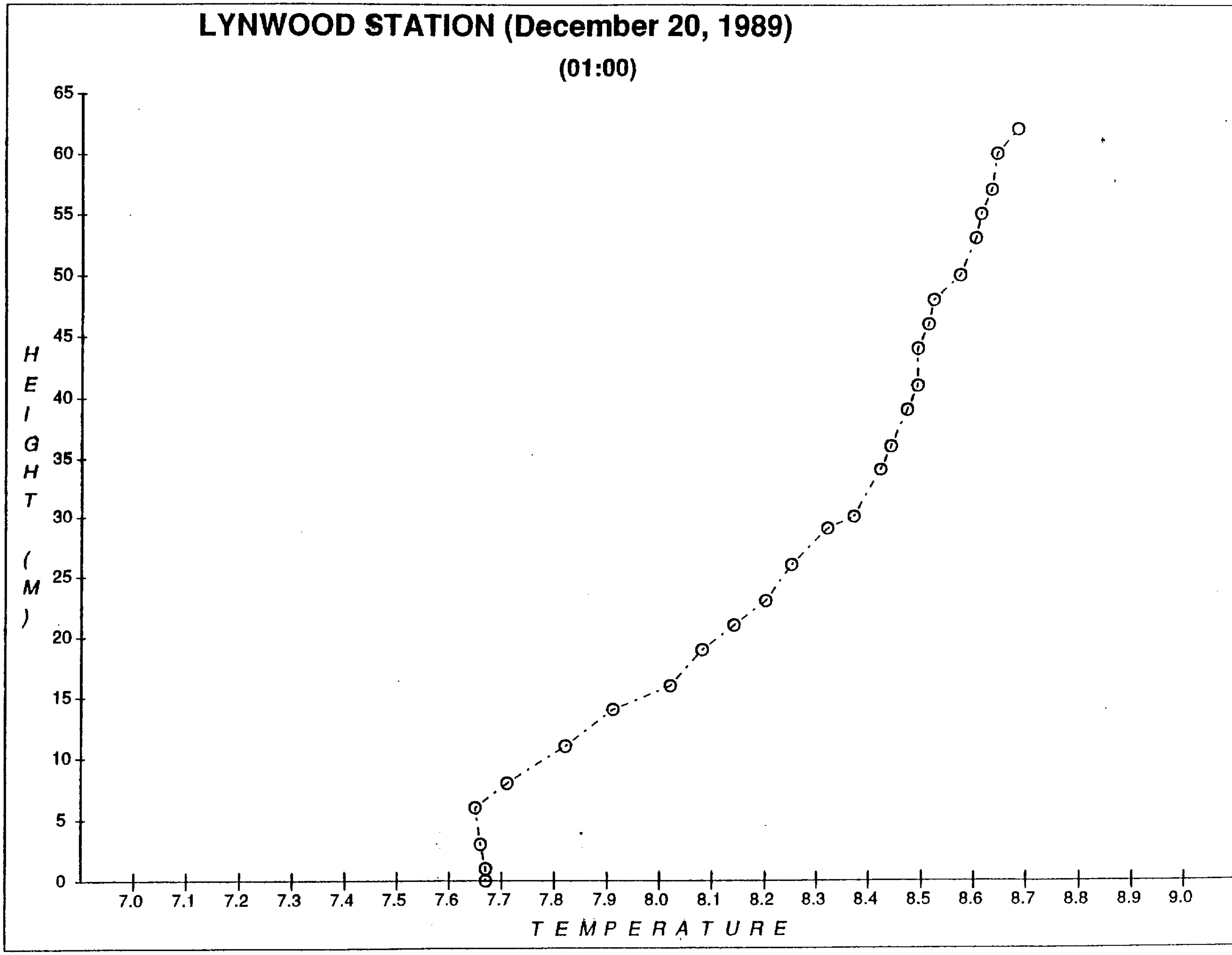

VERNON STATION (December 20, 1989)
(02:09)
Height (m)
55
50
45
40
35
30
25
20
15
10
5
0
5.95
6.00
6.05
6.10
6.15
6.20
6.25
6.30
6.35
6.40
6.45
6.50
6.55
6.60
6.65
6.70
6.75
6.80
6.85
6.90
6.95
7.00
Temperature

FIGURE 5–3b.



LYNWOOD STATION (December 20, 1989)
(01:00)
HEIGHT (M)
TEMPERATURE
65
60
55
50
45
40
35
30
25
20
15
10
5
0
7.0
7.1
7.2
7.3
7.4
7.5
7.6
7.7
7.8
7.9
8.0
8.1
8.2
8.3
8.4
8.5
8.6
8.7
8.8
8.9
9.0

FIGURE 5–3c.

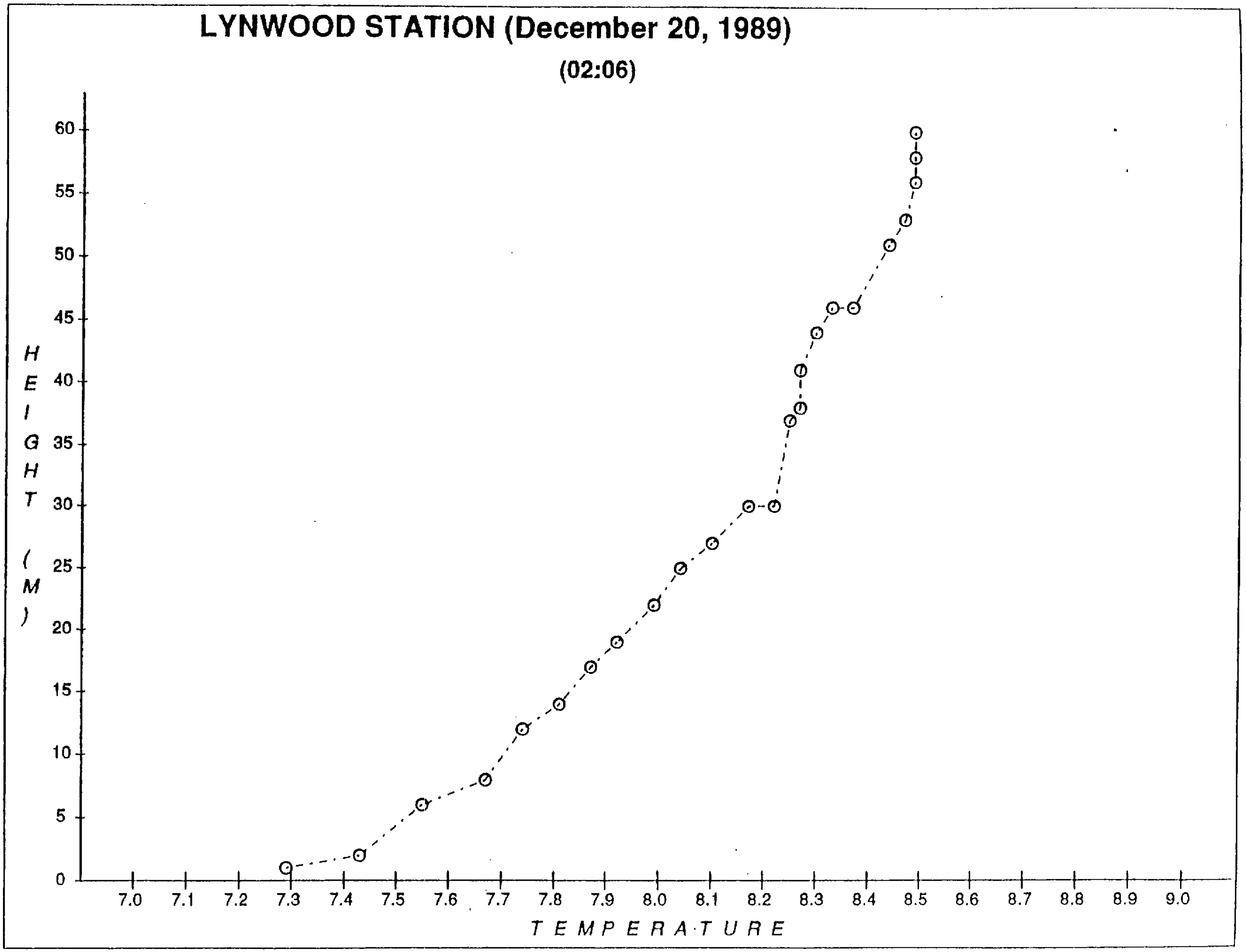

LYNWOOD STATION (December 20, 1989)
(02:06)
HEIGHT (M)
0
5
10
15
20
25
30
35
40
45
50
55
60
7.0
7.1
7.2
7.3
7.4
7.5
7.6
7.7
7.8
7.9
8.0
8.1
8.2
8.3
8.4
8.5
8.6
8.7
8.8
8.9
9.0
TEMPERATURE

FIGURE 5–3d.

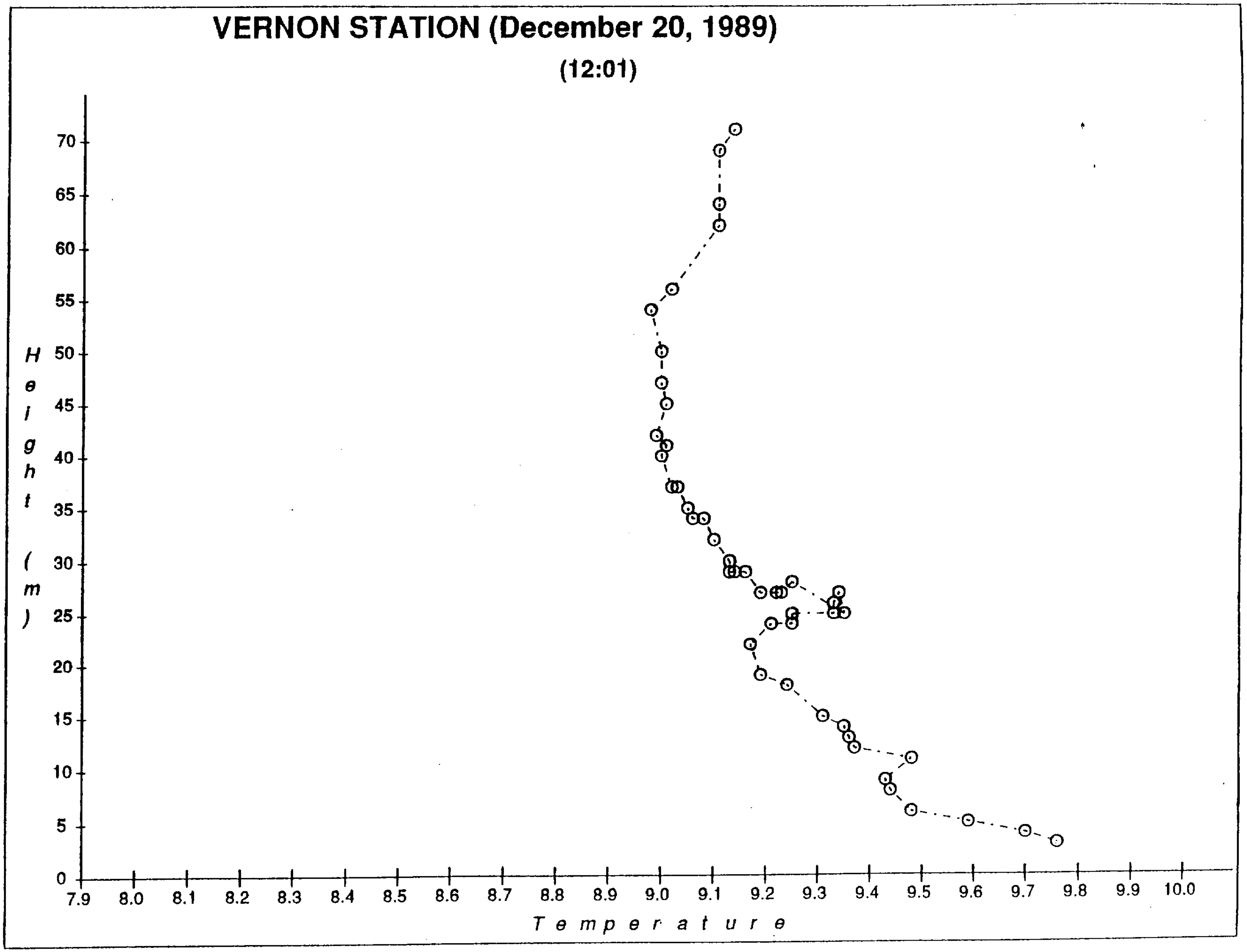

VERNON STATION (December 20, 1989)
(12:01)
Height (m)
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
7.9
8.0
8.1
8.2
8.3
8.4
8.5
8.6
8.7
8.8
8.9
9.0
9.1
9.2
9.3
9.4
9.5
9.6
9.7
9.8
9.9
10.0
Temperature

FIGURE 5–3e.

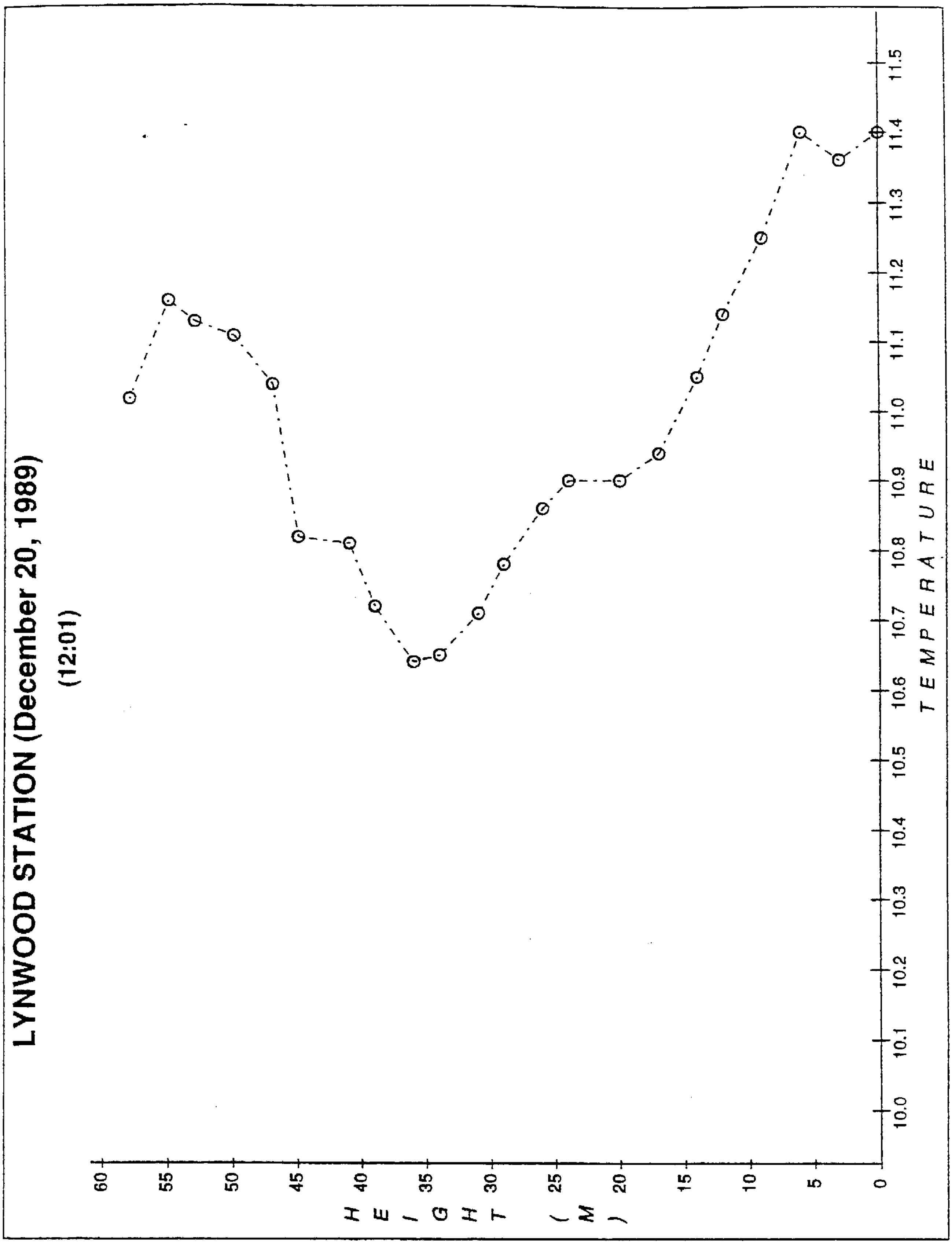

LYNWOOD STATION (December 20, 1989)
(12:01)
HEIGHT (M)
TEMPERATURE
0
5
10
15
20
25
30
35
40
45
50
55
60
10.0
10.1
10.2
10.3
10.4
10.5
10.6
10.7
10.8
10.9
11.0
11.1
11.2
11.3
11.4
11.5

FIGURE 5–3f.

Table 5-1. Inversion Height and Inversion Intensity

		Lynwood			Vernon		
Date	Time	Inversion Height	Inversion Intensity		Inversion Height	Inversion Intensity	
		(m)	°C/100		(m)	°C/100	
12/19/89	16:00				>65	-4.35	
	18:00	>65	-0.46		>65	-3.30	
	20:00	0	1.00		>65	-2.03	
	22:00	10	-2.14	1.95	0	0.00	
	0:00	0	4.20		0	0.88	
	2:00	0	2.00		0	0.79	
	4:00	0	2.77		0	0.33	
	6:00	0	4.00		0	0.46	
	8:00	0	0.00	0.40	60	-0.62	
	10:00	>65	-1.25		>65	-2.00	
12/20/89	12:00	35	-2.13		>65	-1.55	
1/8/90	16:00	>65	-0.92				
	18:00	>65	-0.46		>65	-0.38	
	20:00	0	6.67		0	0.31	
	22:00	0	2.86		0	0.55	
1/9/90	0:00	0	6.60		0	0.84	
	2:00	0	7.20		11	-0.50	0.60
	4:00	0	4.00		0	0.73	
	6:00	5	-4.60	3.00	0	0.55	
	8:00	1	-0.05	2.22	15	-0.55	1.33
	10:00	>65	-0.40		40	-0.89	
	12:00	>65	-0.65		>65	-0.70	
	14:00	>65	-1.64		>65	-0.83	
	16:00	>65	-0.73		>65	-0.50	
	18:00	0	0.33		15	-0.10	
	20:00	0	1.60		0	2.29	
	22:00	0	3.45		0	3.00	
1/10/90	0:00	0	4.00		0	3.50	
	2:00	0	5.60		0	2.60	
	4:00	0	6.67		0	2.30	

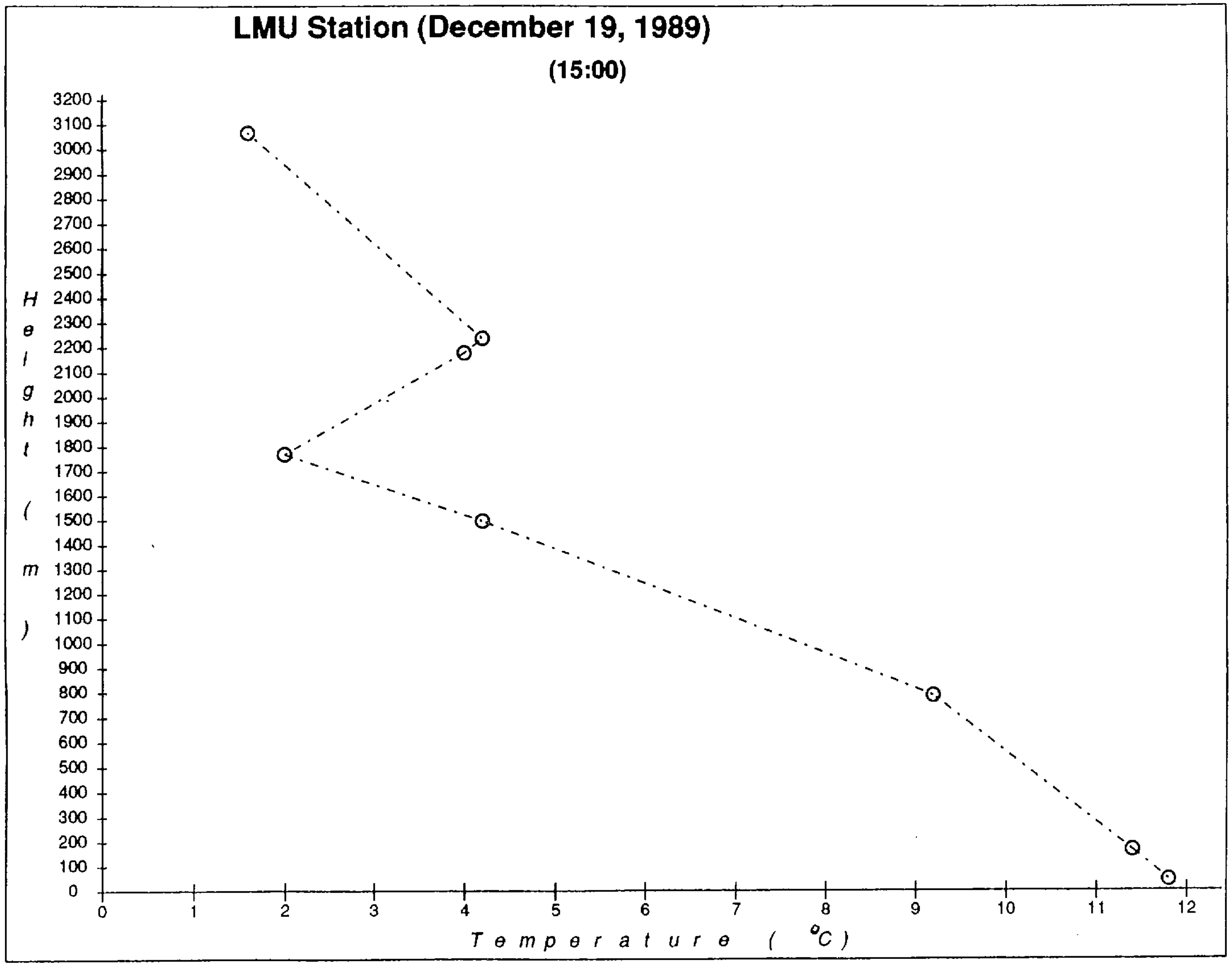

LMU Station (December 19, 1989)
(15:00)
Height (m)
3200
3100
3000
2900
2800
2700
2600
2500
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
0 1 2 3 4 5 6 7 8 9 10 11 12
Temperature (°C)

FIGURE 5-4a.

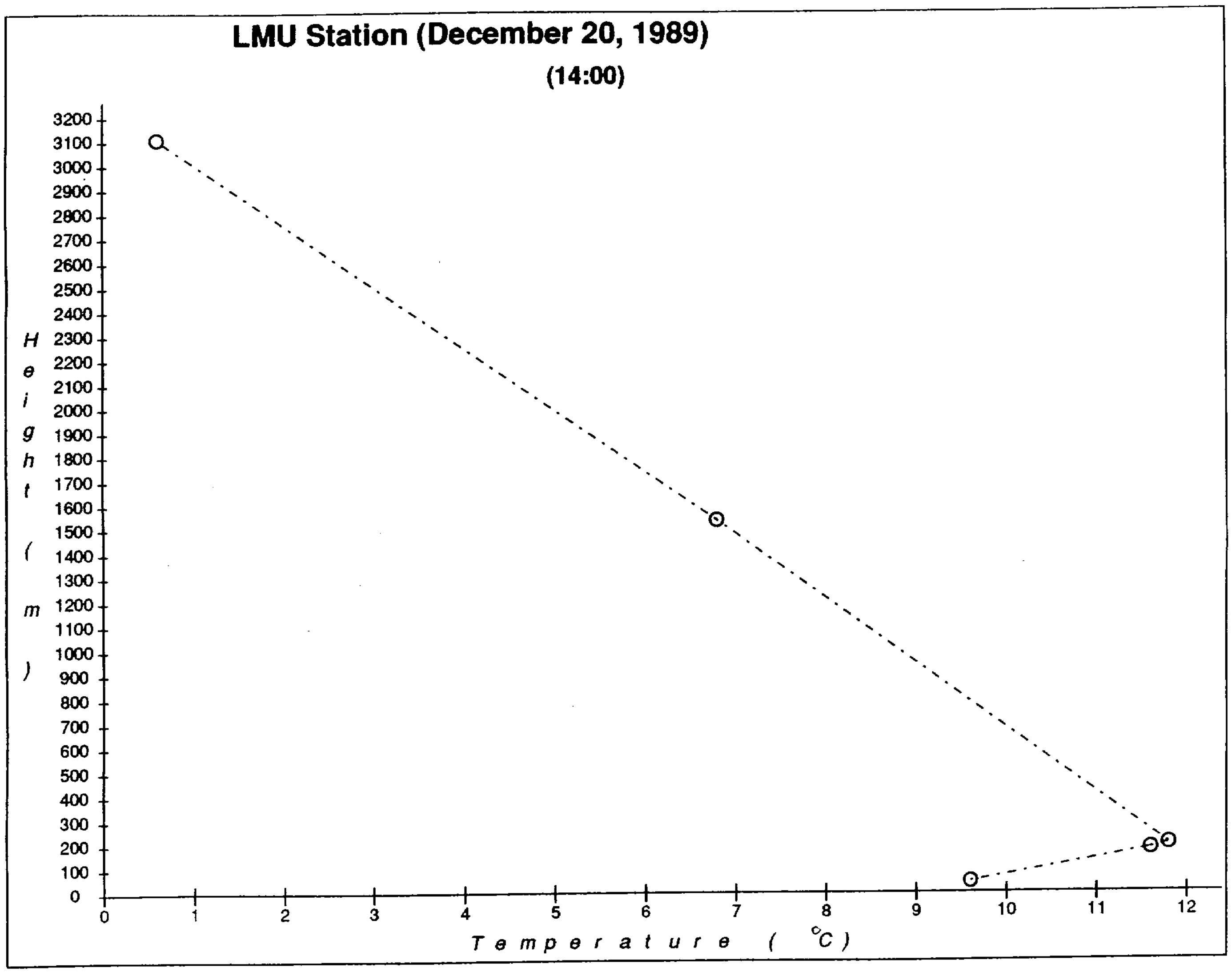
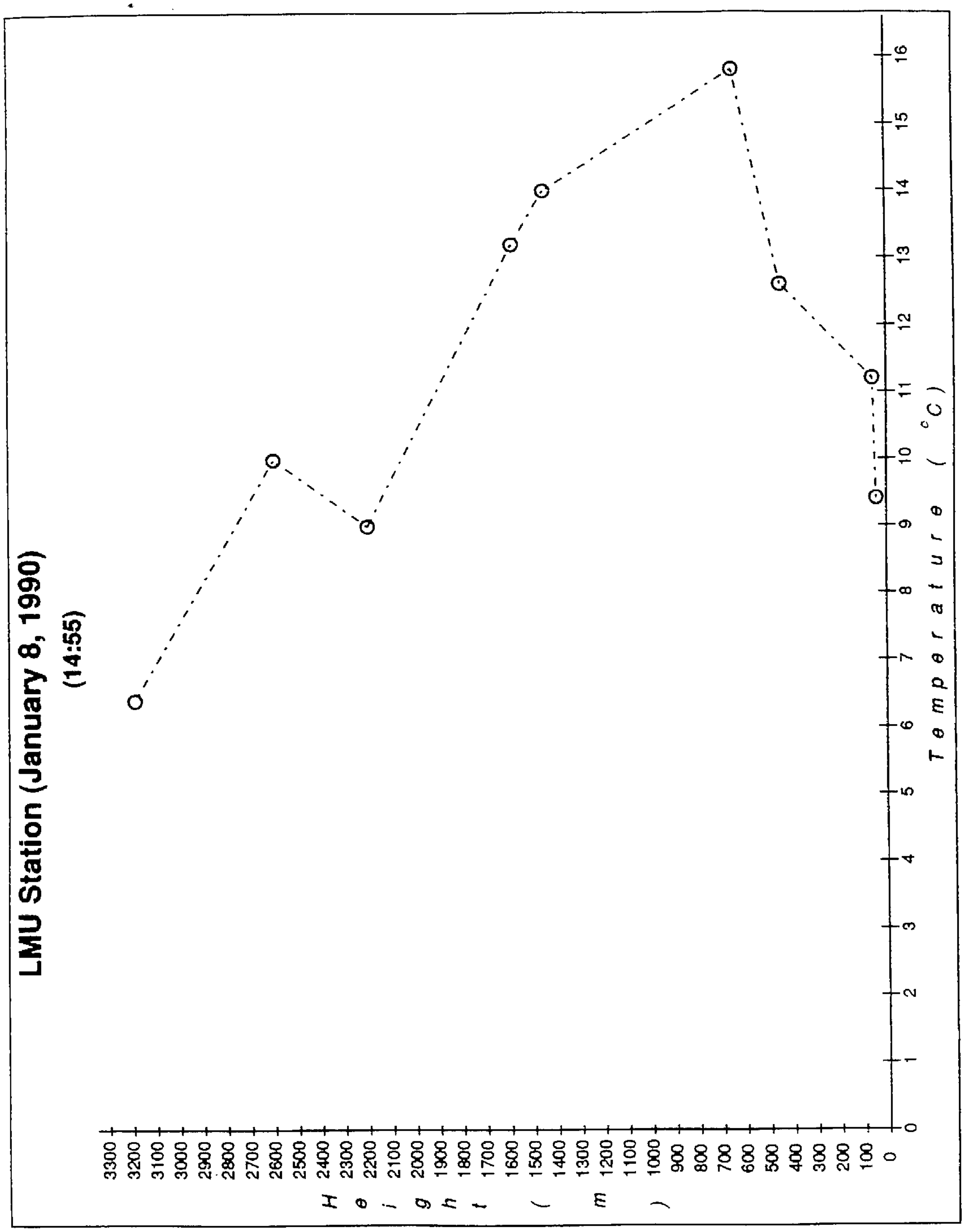

LMU Station (December 20, 1989)
(14:00)
Height (m)
3200
3100
3000
2900
2800
2700
2600
2500
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Temperature (°C)

FIGURE 5-4b.



LMU Station (January 8, 1990)
(14:55)
Height (m)
3300
3200
3100
3000
2900
2800
2700
2600
2500
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Temperature (°C)

FIGURE 5-4c.

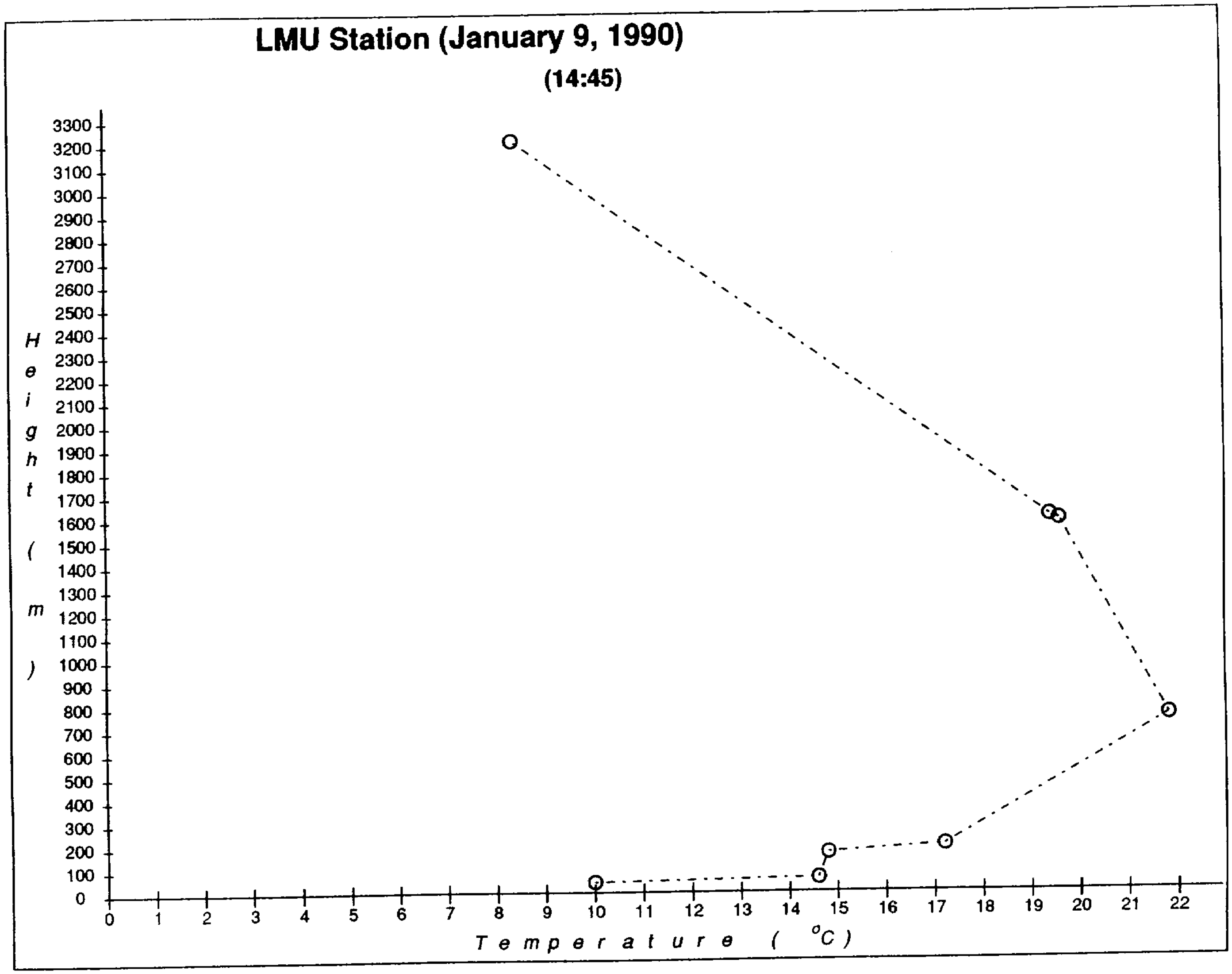

LMU Station (January 9, 1990)
(14:45)
Height (m)
Temperature (°C)
3300
3200
3100
3000
2900
2800
2700
2600
2500
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22

FIGURE 5-4d.

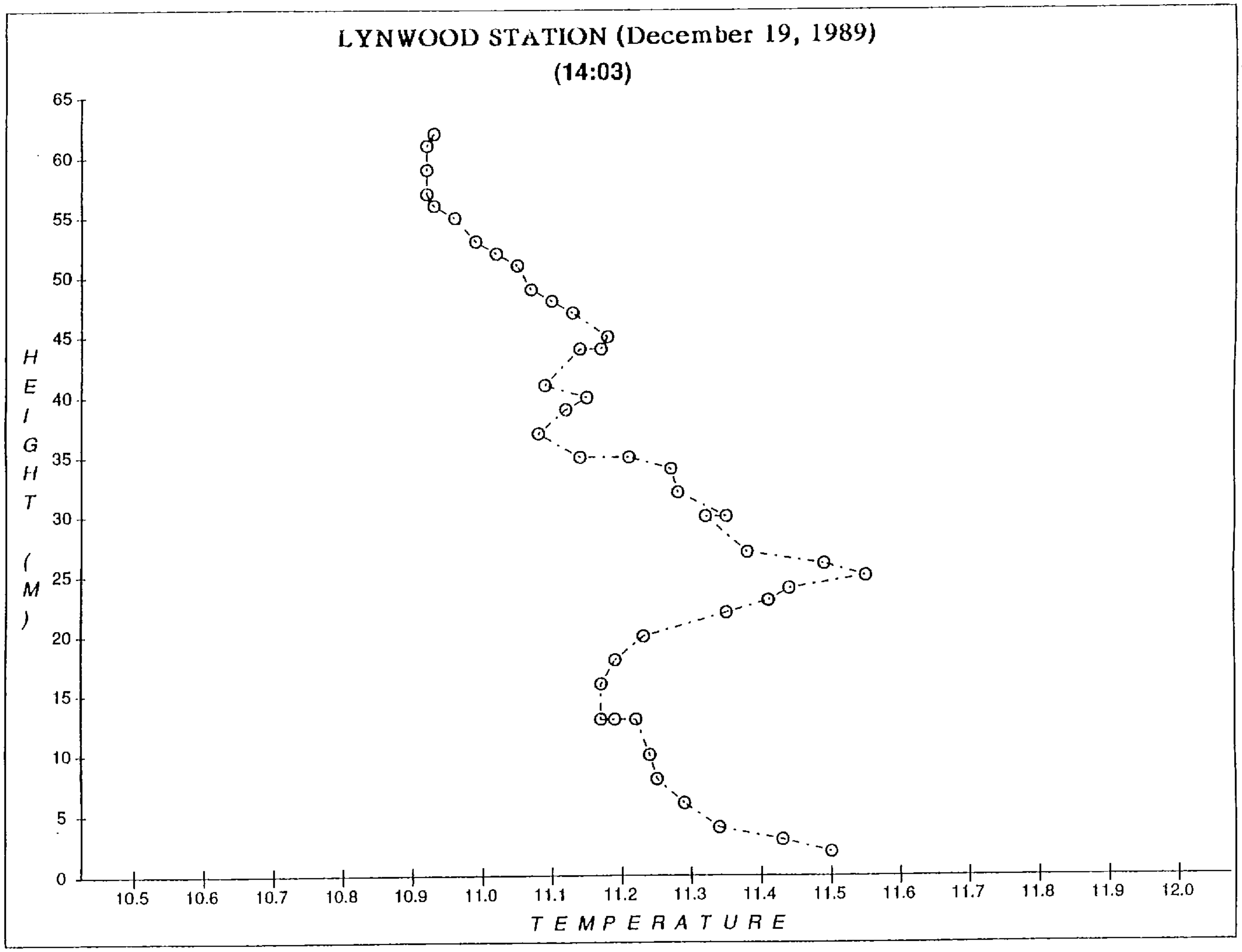
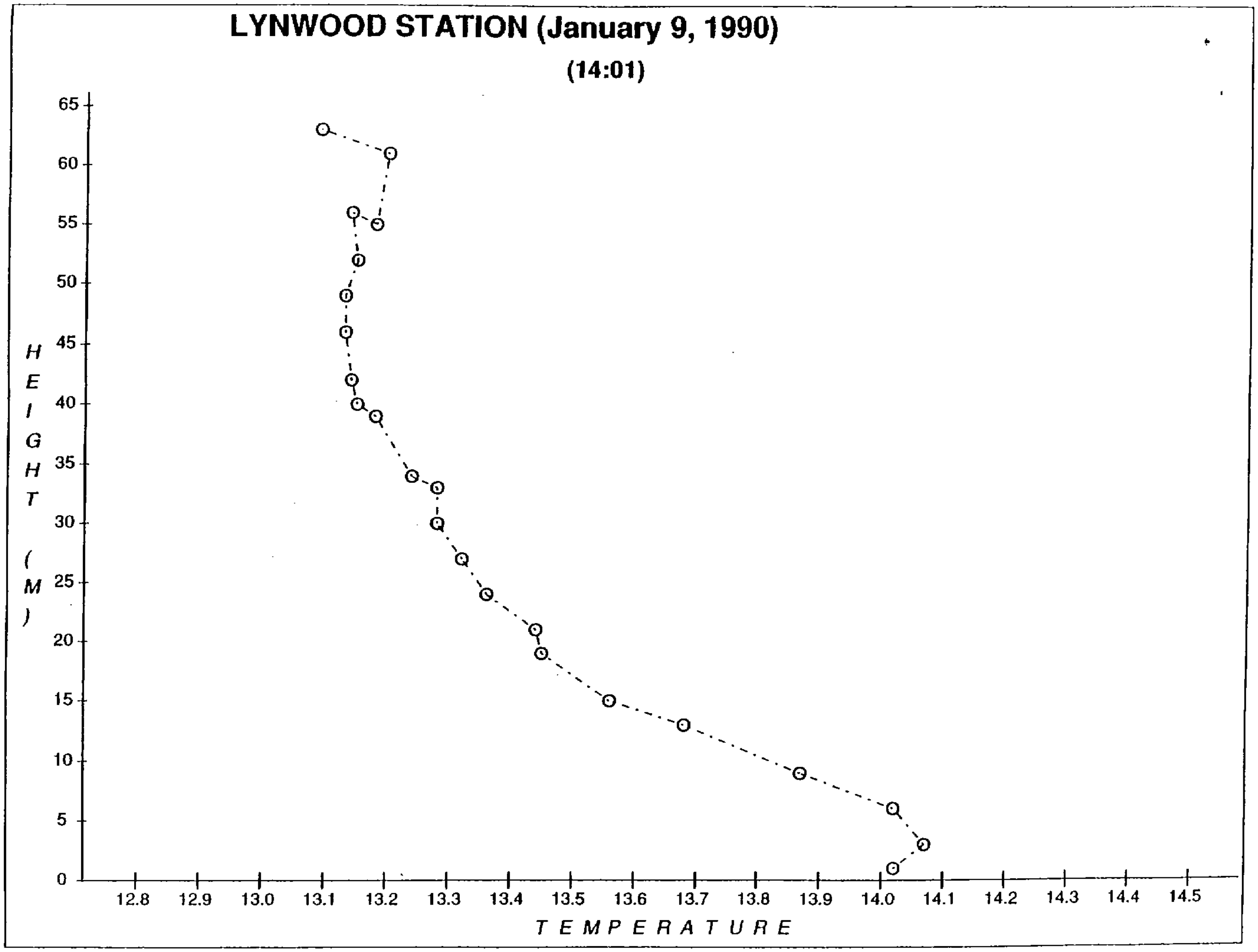

LYNWOOD STATION (December 19, 1989)
(14:03)
HEIGHT (M)
65
60
55
50
45
40
35
30
25
20
15
10
5
0
10.5
10.6
10.7
10.8
10.9
11.0
11.1
11.2
11.3
11.4
11.5
11.6
11.7
11.8
11.9
12.0
TEMPERATURE

FIGURE 5-4e.



LYNWOOD STATION (January 9, 1990)
(14:01)
HEIGHT (M)
65
60
55
50
45
40
35
30
25
20
15
10
5
0
12.8
12.9
13.0
13.1
13.2
13.3
13.4
13.5
13.6
13.7
13.8
13.9
14.0
14.1
14.2
14.3
14.4
14.5
TEMPERATURE

FIGURE 5-4f.

Section 6

TRAFFIC DATA: OBSERVATIONAL RELATIONSHIPS WITH CO EPISODES

Traffic counts from CalTrans and Newport Traffic have been plotted for periods coincident with Episodes 2 and 3. This information can be used to determine how much and when the traffic influences can be correlated with the local CO buildup. See Appendix F for a complete set of time-series plots.

6.1 TRAFFIC VOLUME

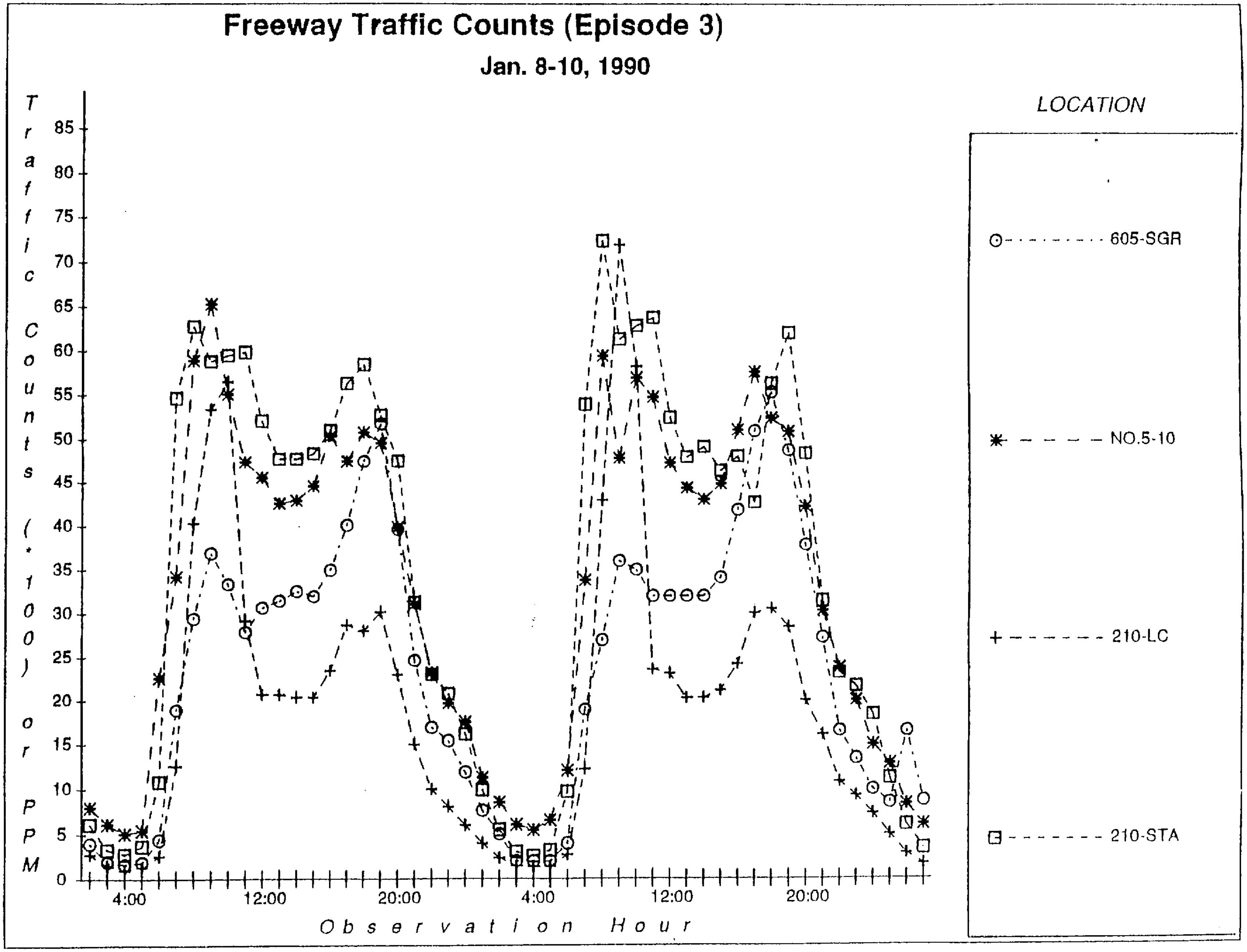
The freeway traffic counts from both episodes show the peak traffic hours occur around 0800 hours and around 1600 to 1700 hours. This feature of the data is illustrated in Figures 6-1a and 6-1b for Episode 3. Freeway 405 at the Compton Boulevard ramp (405-CMP) appears to reach its peak volume earlier than does Freeway 10 at the interchange between the 405 Freeway and the 10 (405-10).

Surface traffic counts near the Lynwood area have also been examined. Six intersections have been listed in Table 2-1. The local peak traffic hours are 0800 and 1700 hours, in agreement with the traffic counts from CALTRANS for the nearby freeways.

6.2 CO CONCENTRATION RELATED TO TRAFFIC VOLUME

Averaged CO concentrations have been considered in conjunction with both the nearby freeway traffic counts and local traffic counts. As illustrated in Figures 6-2a and 6-2b, at most monitoring locations, CO builds up during the morning peak traffic period and again around midnight, several hours after the typical evening traffic peak. For example, considering the CO concentration in the Hawthorne area together with traffic counts nearby, at 405-CMP or at the intersection of La Cienega and 120th Street (TRANS1), the CO concentration built up to a peak around midnight and in the early-to-mid morning. As well as we can infer from our temperature soundings, the mixing height during the night appears to be extremely low during both episodes. This may prevent the dispersion of CO from the evening traffic peak period and result in an apparent "pseudo source" for the CO to build up at midnight. During the morning, the CO concentration appears to build up under the influence of both the high traffic volume and the residual low mixing height (see Appendix F-1, F-2).

The actual mechanism for pollutants moving into Lynwood and building up is not characterized by our data, but appears to be a combination of the poor mixing conditions in the area and some sort of pollutant trapping between the dense traffic corridors that surround the area. The traffic flowing through these corridors is probably due largely to commuters in transit, many neither originating nor terminating in that area; under slow, high density traffic conditions; this type of traffic may contribute more CO than does



Freeway Traffic Counts (Episode 3)
Jan. 8-10, 1990
Traffic Counts (*100) or PPM
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
4:00
12:00
20:00
4:00
12:00
20:00
Observation Hour
LOCATION
605-SGR
NO.5-10
210-LC
210-STA

FIGURE 6–1a.

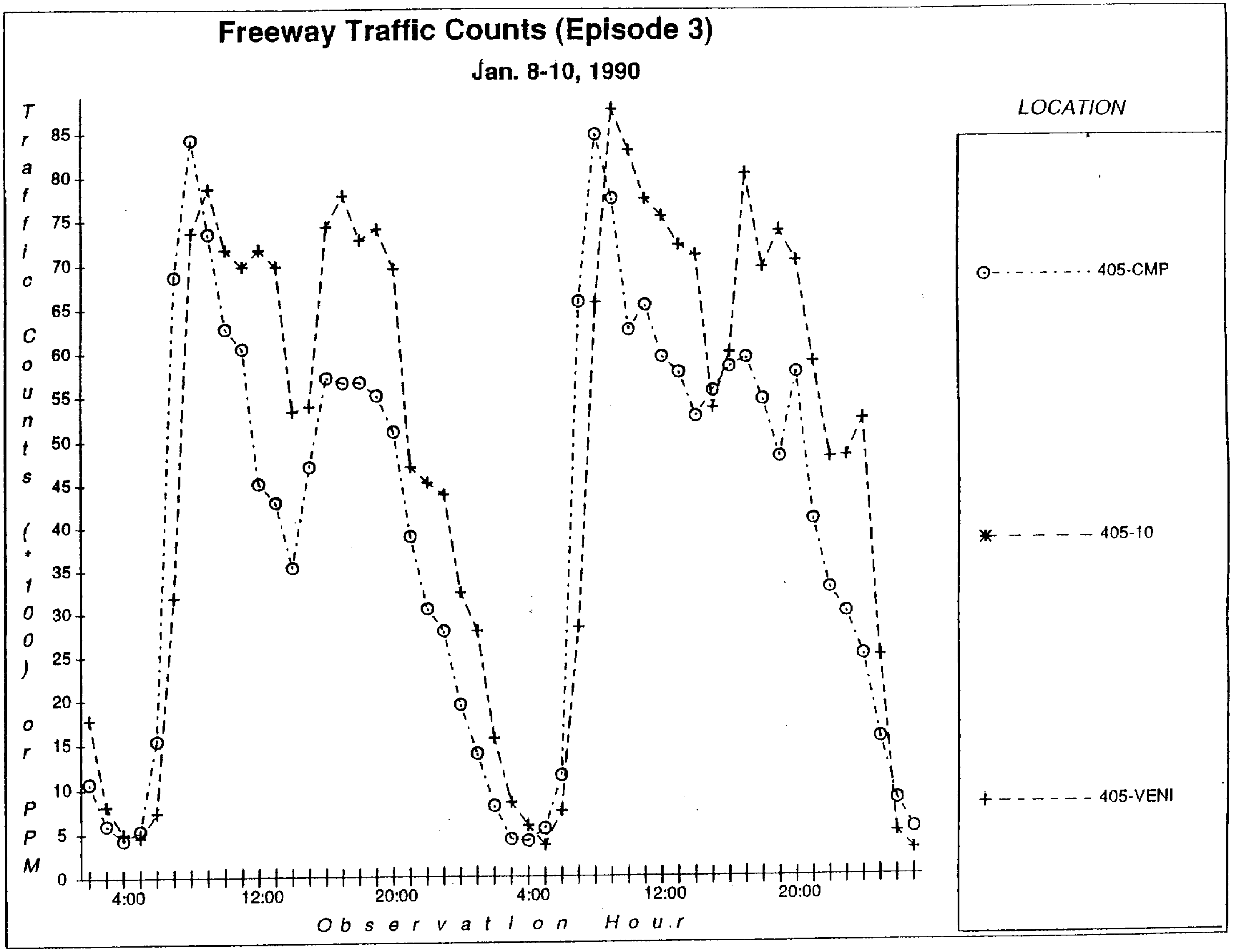

Freeway Traffic Counts (Episode 3)
Jan. 8-10, 1990
Traffic Counts (*100) or PPM
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
4:00
12:00
20:00
4:00
12:00
20:00
Observation Hour
LOCATION
405-CMP
405-10
405-VENI

FIGURE 6–1b.

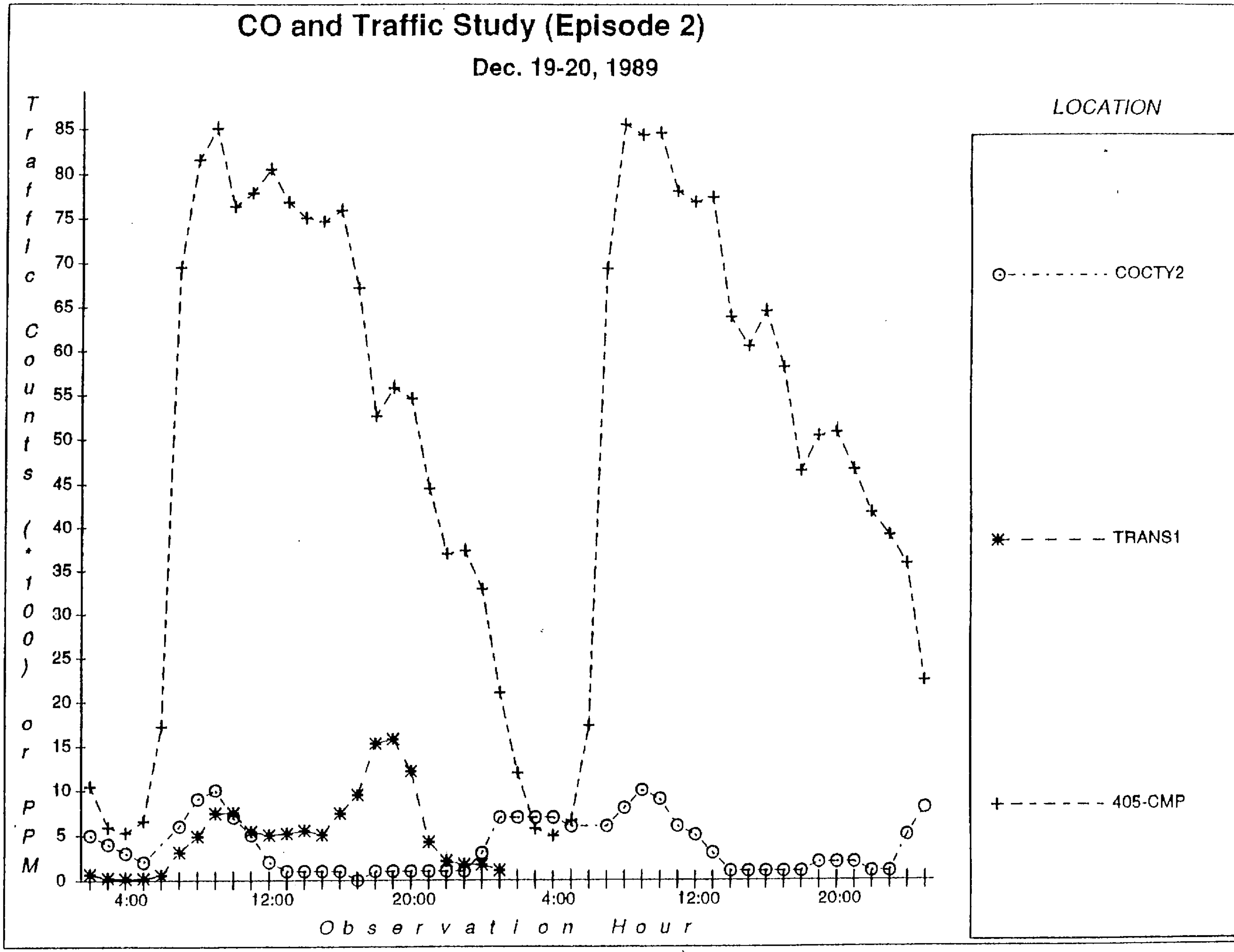

CO and Traffic Study (Episode 2)
Dec. 19-20, 1989
Traffic Counts (*100) or PPM
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
4:00
12:00
20:00
4:00
12:00
20:00
Observation Hour
LOCATION
COCTY2
TRANS1
405-CMP

FIGURE 6–2a.

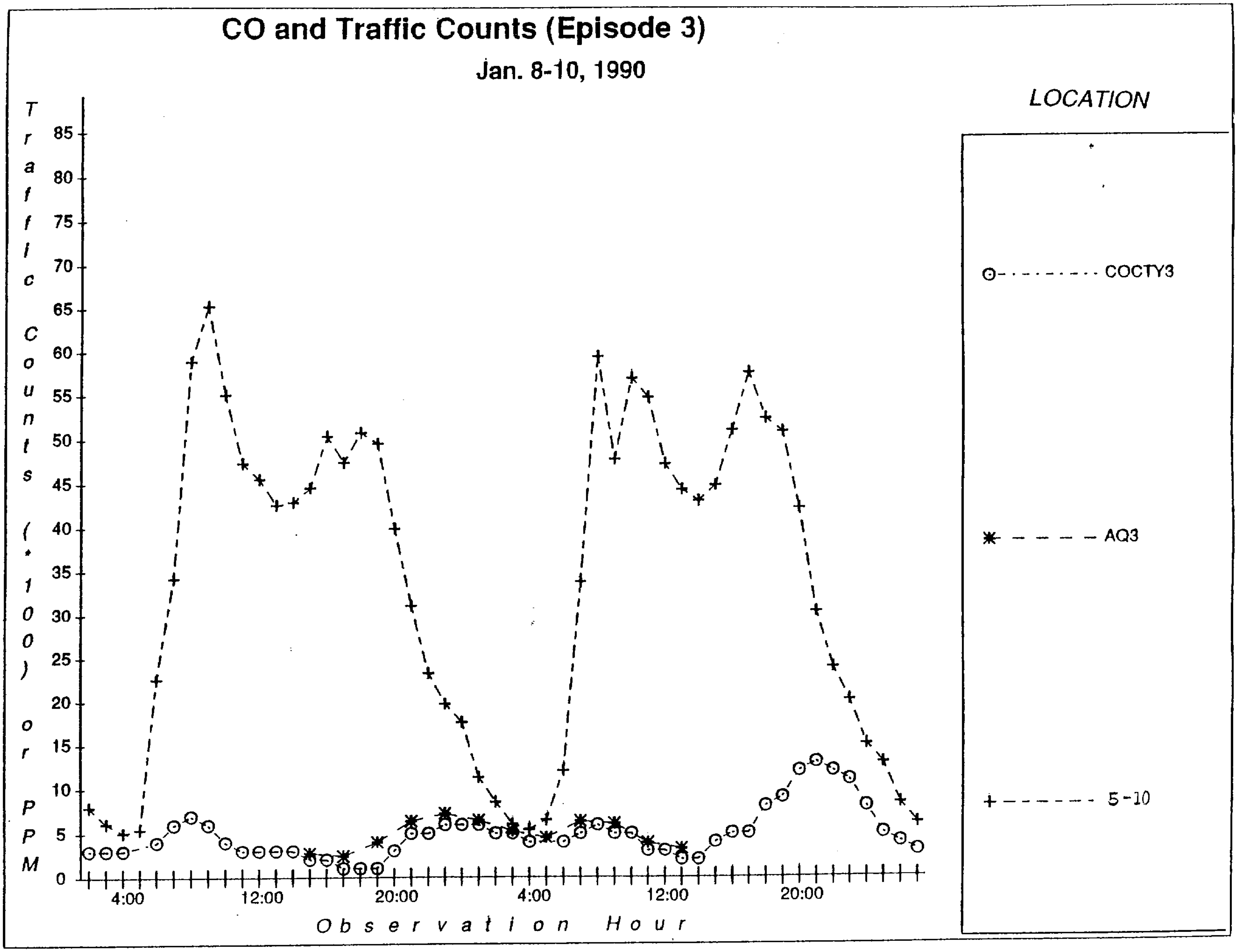

CO and Traffic Counts (Episode 3)
Jan. 8-10, 1990
Traffic Counts (*100) or PPM
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
4:00
12:00
20:00
4:00
12:00
20:00
Observation Hour
LOCATION
COCTY3
AQ3
5-10

FIGURE 6–2b.

traffic in areas where many of the vehicles are terminating their trips (due to lower resultant volume).

The data show that CO concentrations are not very high during the afternoon even though traffic volumes may be as high as their morning counterparts. This again points to the importance of mixing to the occurrence of CO exceedances. This is of course consistent with many other observations that meteorological conditions are a major determining factor for the increase not only of CO concentrations but of other pollutants as well.

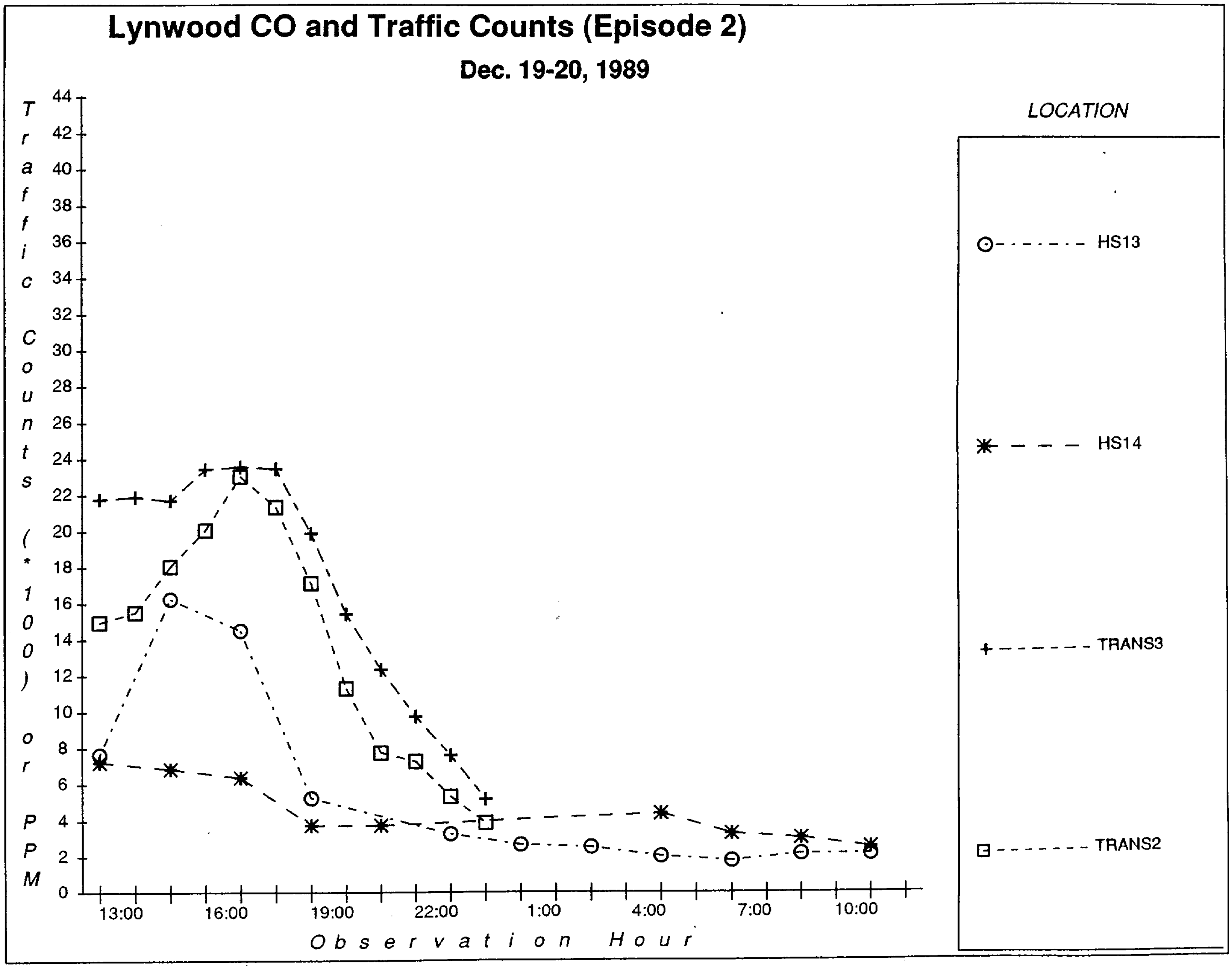
Two plots for stations near the Lynwood area show dramatically the strong correlation between traffic volume and CO concentrations on the one hand and the lack of correlation between traffic conditions and CO on the other. In Figure 6-3a, CO appears to be driven up by the traffic volume (traffic source dominated) and in Figure 6-3b, possibly by poor meteorology conditions (volume is very low). The traffic counts for stations identified as TRANS2, TRANS3, TRANS4, and TRANS5 in Table 2-1 are much the same in the time period studied. The difference between these two plots is the location of the stations relative to possible major sources: Stations HS13 and HS14 are close to and just south of a major freeway; Stations AQMD, HS2 and HS5 are somewhat distant, in a more or less commercial/residential area. From the plots, we can see that carbon monoxide concentration and the traffic counts increased almost simultaneously for HS13 and, to some extent, for HS14. For the same episode, the CO concentrations at Stations HS1 through HS8 built up several hours after the traffic peak hour. Correlating the wind speed, inversion height, inversion intensities, and traffic counts with the late evening peak of CO concentration, strong inversions as well as the extremely low wind speed in Lynwood seem be the dominant factor at that time (see Figure 5-1i). Figure 6-3a and 6-3b may characterize the phenomenological differences between localized and disperse traffic influences on the CO concentrations.

In summary, we have observed strong correlation between the morning CO episodes and the traffic counts. In the evening, no such correlation is observed, except to note that the traffic peak and CO peak appear to be similar in form to the morning peaks, but offset in time. Meteorological and geographic factors appear to more strongly influence the occurrence of the evening episodes.

6.3 MOBILE ON-ROAD CO MONITORING

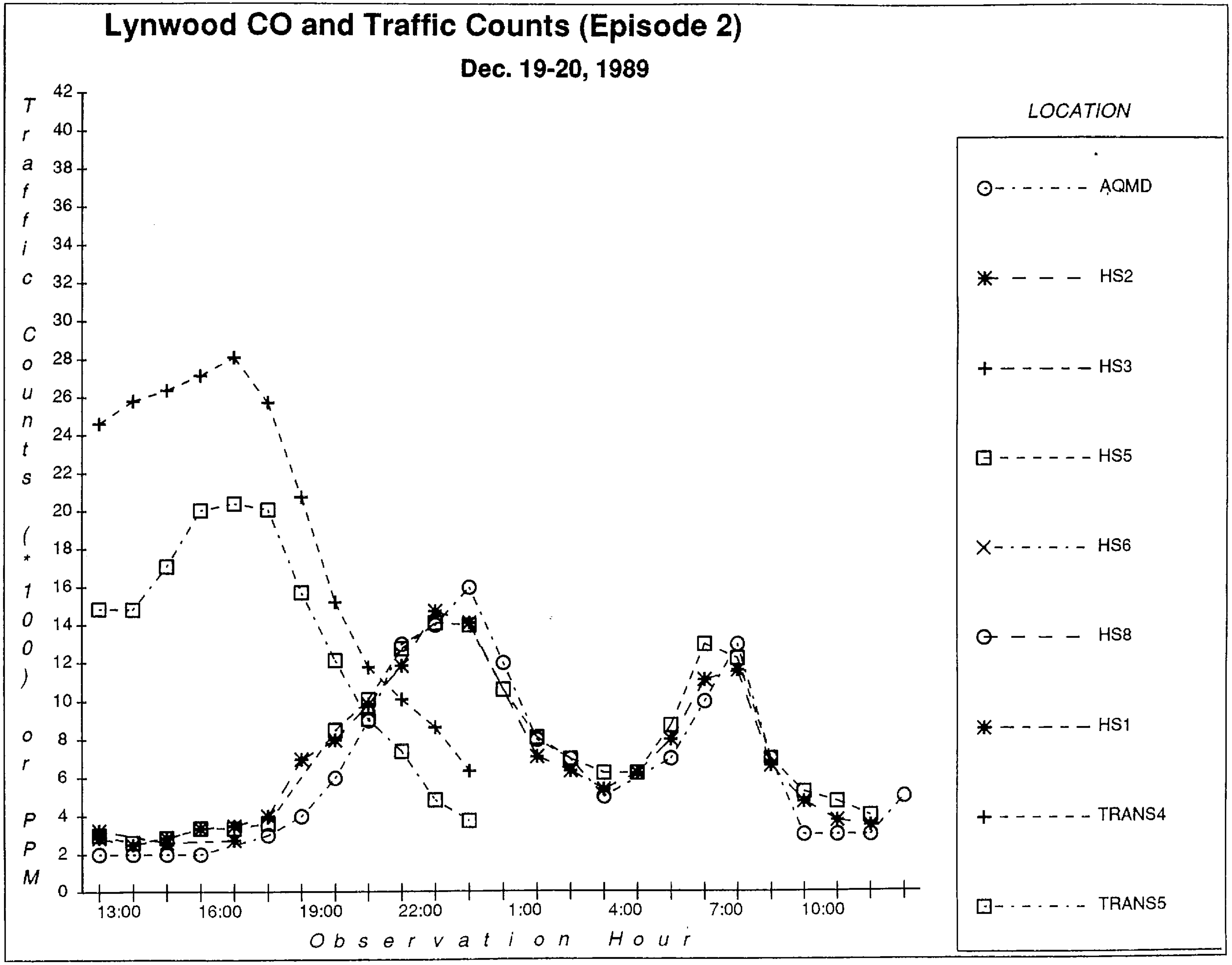
Data from the GM monitoring vehicle have been analyzed and compared against the concentrations from the fixed-site monitors located near the vehicle's sampling path.

The CO data reported here have been taken during the second intensive period from 19:59:00 on 19 December 1989 to 02:41:50 on 20 December 1990 in Lynwood. The routes were six loops starting at the parking lot next to the Lynwood AQMD station and are described as follows: North East Loop: Long



Lynwood CO and Traffic Counts (Episode 2)
Dec. 19-20, 1989
Traffic Counts (*100) or PPM
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
13:00
16:00
19:00
22:00
1:00
4:00
7:00
10:00
Observation Hour
LOCATION
HS13
HS14
TRANS3
TRANS2

FIGURE 6-3a.



Lynwood CO and Traffic Counts (Episode 2)
Dec. 19-20, 1989
Traffic Counts (*100) or PPM
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
13:00
16:00
19:00
22:00
1:00
4:00
7:00
10:00
Observation Hour
LOCATION
AQMD
HS2
HS3
HS5
HS6
HS8
HS1
TRANS4
TRANS5

FIGURE 6-3b.

Beach North, Firestone East, 710 South, Imperial West; South West Loop: Long Beach South, Rosecrans West, Wilmington North, Imperial East; North West Loop: Long Beach North, Firestone West, Central South, Imperial East; 1st Big Loop: Imperial East, 710 South, Alondra West, Central North, Firestone East, 710 South, Imperial West and Parking Lot; 2nd Big Loop: Imperial East, 710 South, Alondra west, Central North, Firestone East, 710 South, Imperial East, U-turn to Imperial West and Parking Lot. The major landmarks in these loops are shown on Figure 6-4, Figure 6-5a through Figure 6-5l.

Figure 6-5a and Figure 6-5l show the same route but for travel in opposite directions and different time periods. As is observed, Figure 6-5l shows lower concentrations and less fluctuation than Figure 6-5a, this behavior is very likely caused by the absence of much traffic around midnight. The peaks shown on Figure 6-5a, e.g., at Imperial and La Cienega, Imperial and San Pedro are consistent with impacts from the Freeway 405 and 110 nearby. The two figures would not necessarily show exactly the same peak pattern because on-road monitoring is more easily influenced by short-term transients due to such factors as nearby vehicles' exhaust, or localized traffic buildups. This is discussed more later.

As is observed from the figures, CO concentrations increased at most of the major intersections, e.g., Figure 6-5b shows that CO concentration increased when the monitoring vehicle turned onto Firestone; Figure 6-5d shows that the concentration increased when the vehicle turned onto Long Beach, and reached a peak at Rosecrans; Figure 6-5h shows at both Bullis and Imperial, and Central and 108th, that the CO concentrations again increased. At most of the freeway onramps, concentrations are higher than the concentrations measured at offramps, e.g., Figures 6-5b, 6-5f and 6-5h displayed the phenomenon. This phenomenon could be related to the acceleration condition of the cars and to traffic volumes at the entrance. Also, when the monitoring vehicle was under the freeway at 605 and 5, we observed increases in CO concentration, showing the reduced dilution that results there. Interestingly, also, most of the parking lot observations were elevated relative to their surrounding observations.

Concentrations have been calculated from the on-road data to compare with the nearby fixed monitoring stations. The results are plotted from Figures 6-6a through 6-6c. Roadway CO observations (2 seconds intervals) have been integrated during the time when the monitoring vehicle drove in the vicinity of certain fixed monitoring stations and has been compared with the hourly data from those fixed stations, e.g., when the monitoring vehicle departed or arrived at the parking lot, we integrated the concentrations monitored along the path close to the stations HS1 through HS6 and HS8 (see Figure 6-4). The thick lines on Figure 6-4 represent the paths on which we integrated the on-road CO data. We note here that data from stations HS11 and HS16 were missing during the study period and HS13 did not sample over the time periods that could be compared. Figures 6-6a through 6-6c display the concentrations calculated

On-road Sampling Paths in Lynwood

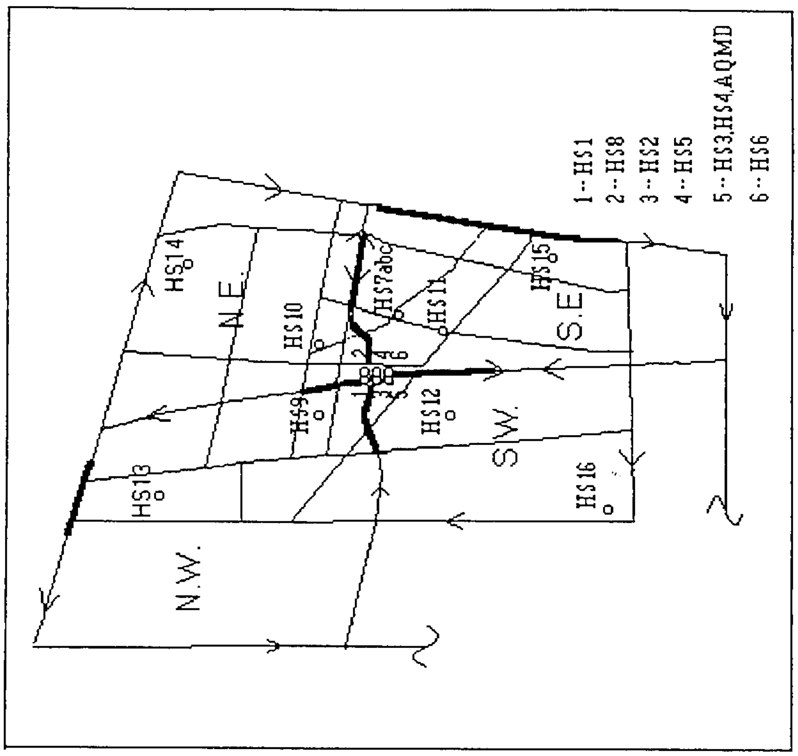


FIGURE 6-4.

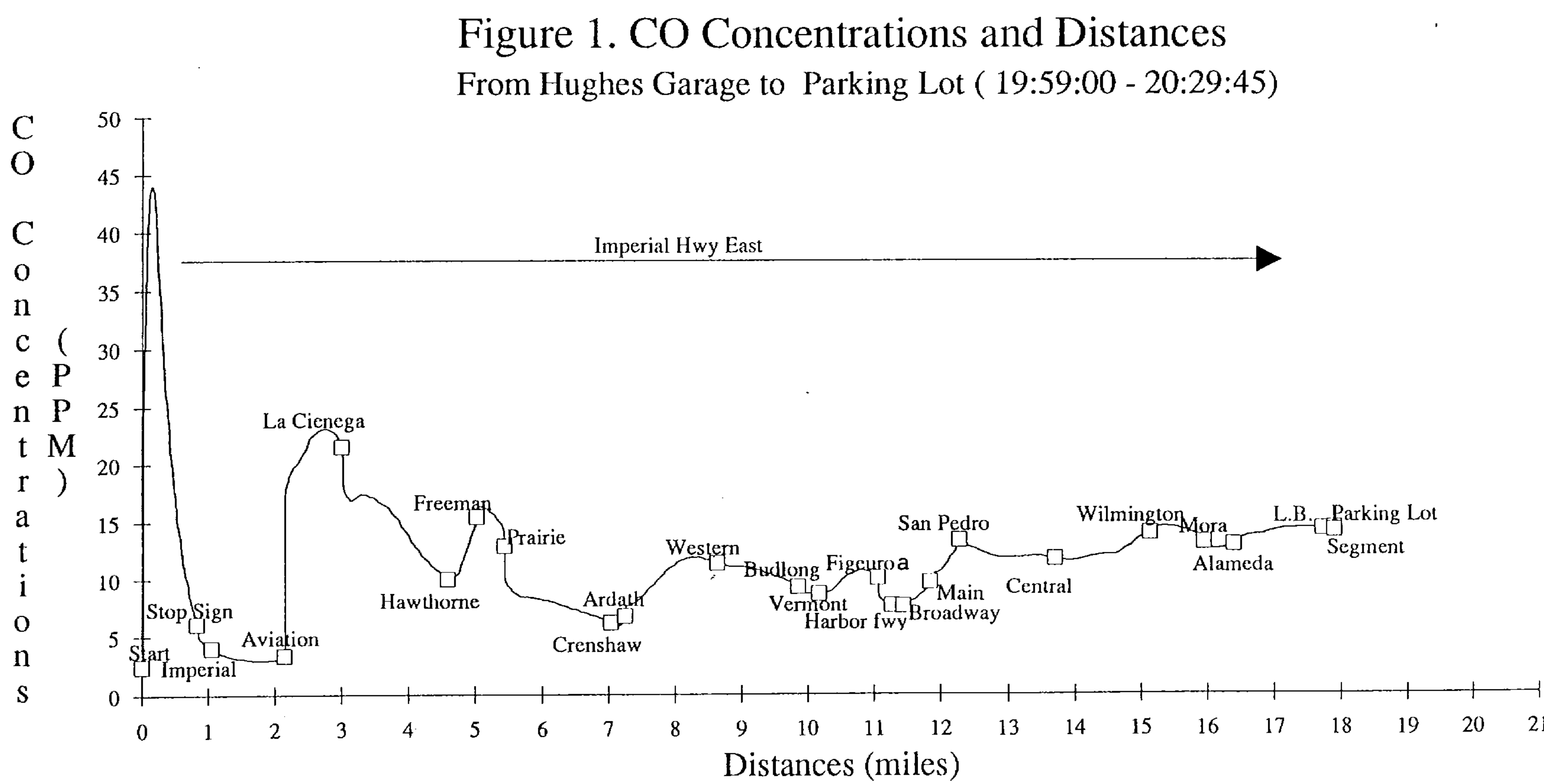


Figure 1. CO Concentrations and Distances
From Hughes Garage to Parking Lot (19:59:00 - 20:29:45)
CO Concentrations (PPM)
Distances (miles)
Imperial Hwy East
Start
Stop Sign
Imperial
Aviation
La Cienega
Freeman
Hawthorne
Prairie
Ardath
Crenshaw
Western
Budlong
Vermont
Figeuroa
Harbor fwy
Broadway
Main
San Pedro
Central
Wilmington
Mora
Alameda
L.B.
Parking Lot
Segment

FIGURE 6-5a.

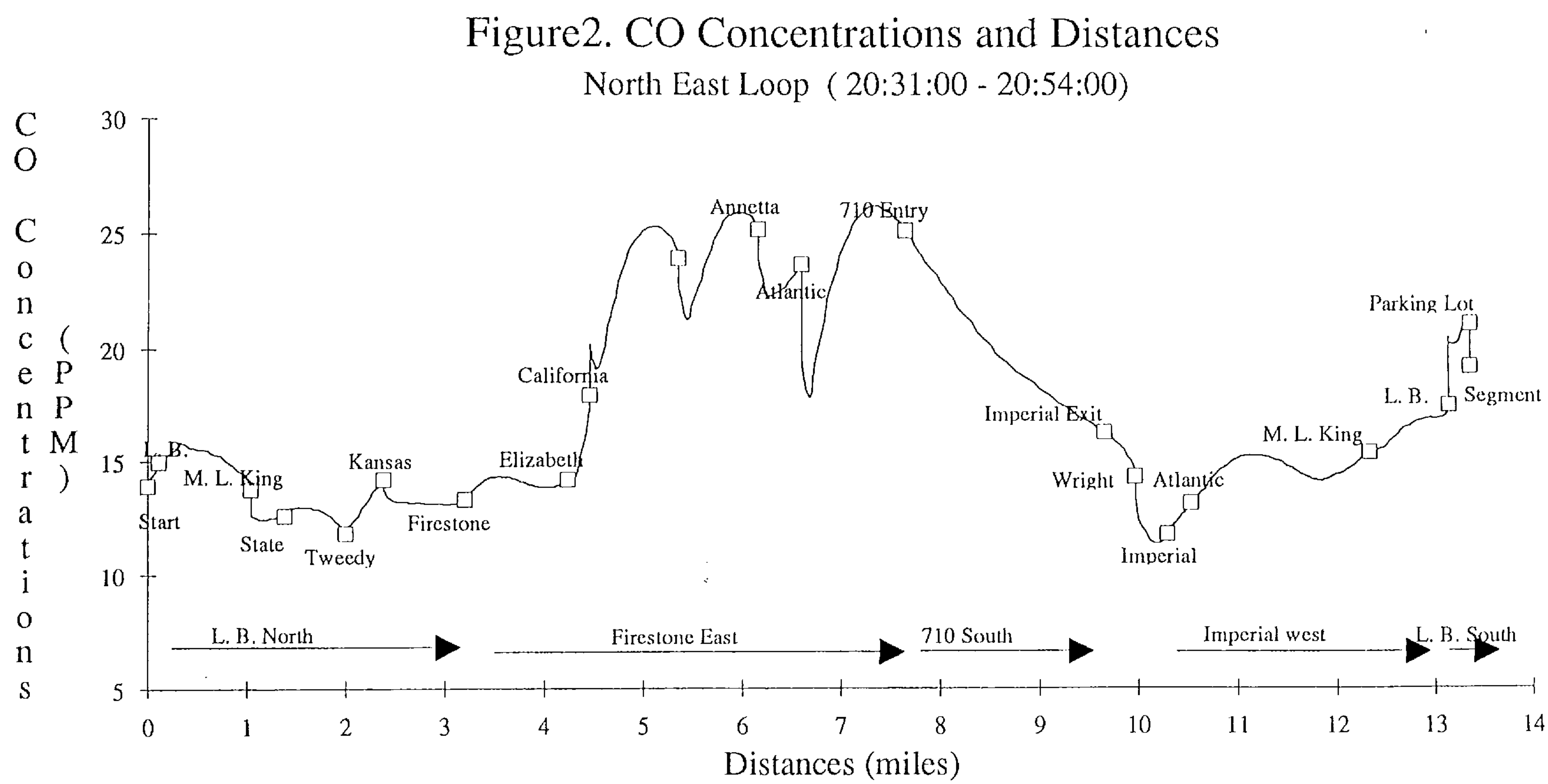


Figure2. CO Concentrations and Distances
North East Loop (20:31:00 - 20:54:00)
CO Concentrations (PPM)
30
25
20
15
10
5
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Distances (miles)
Start
L. B.
M. L. King
State
Tweedy
Kansas
Firestone
Elizabeth
California
Annetta
Atlantic
710 Entry
Imperial Exit
Wright
Imperial
Atlantic
M. L. King
L. B.
Parking Lot
Segment
L. B. North
Firestone East
710 South
Imperial west
L. B. South

FIGURE 6-5b.

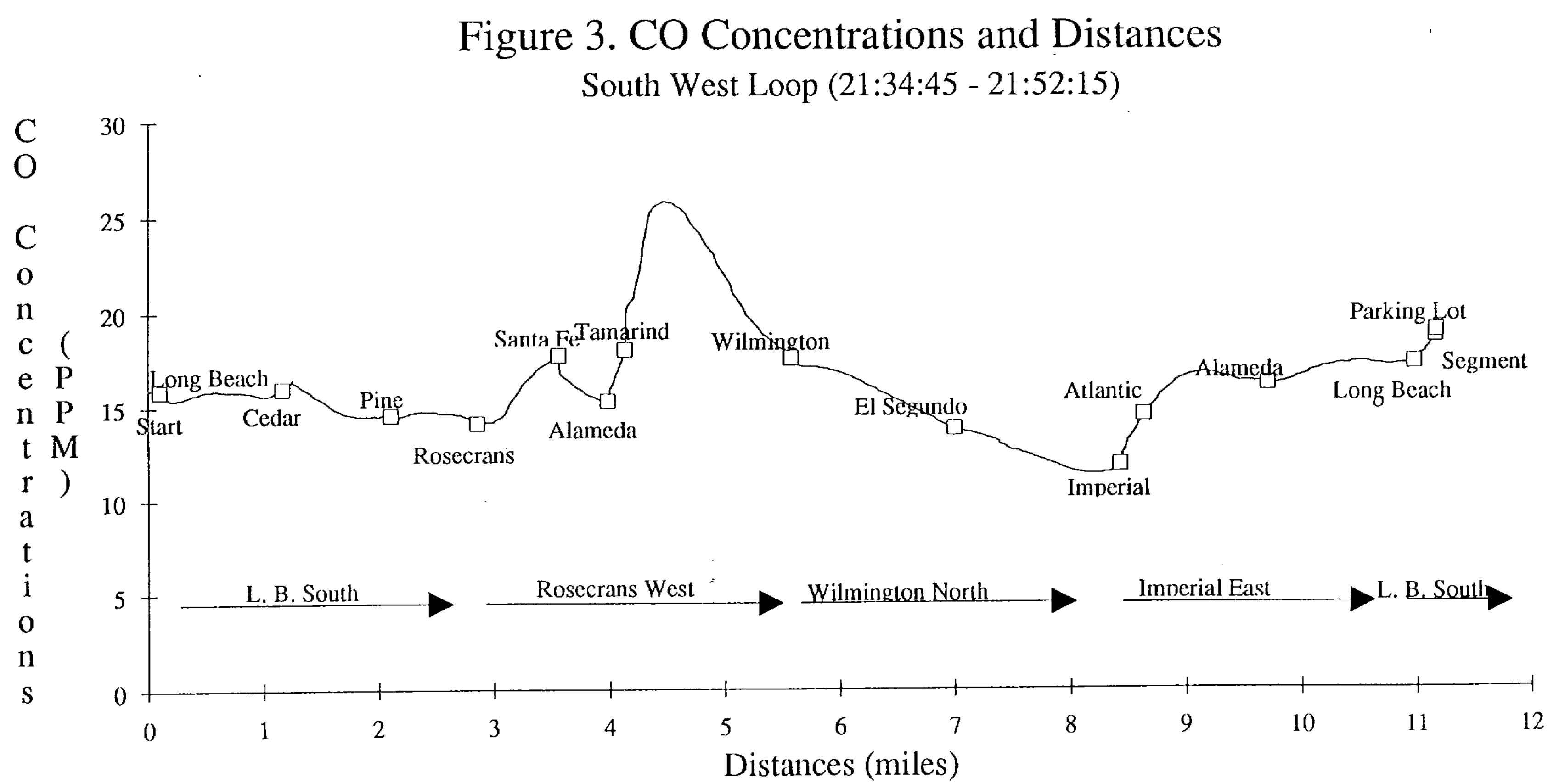
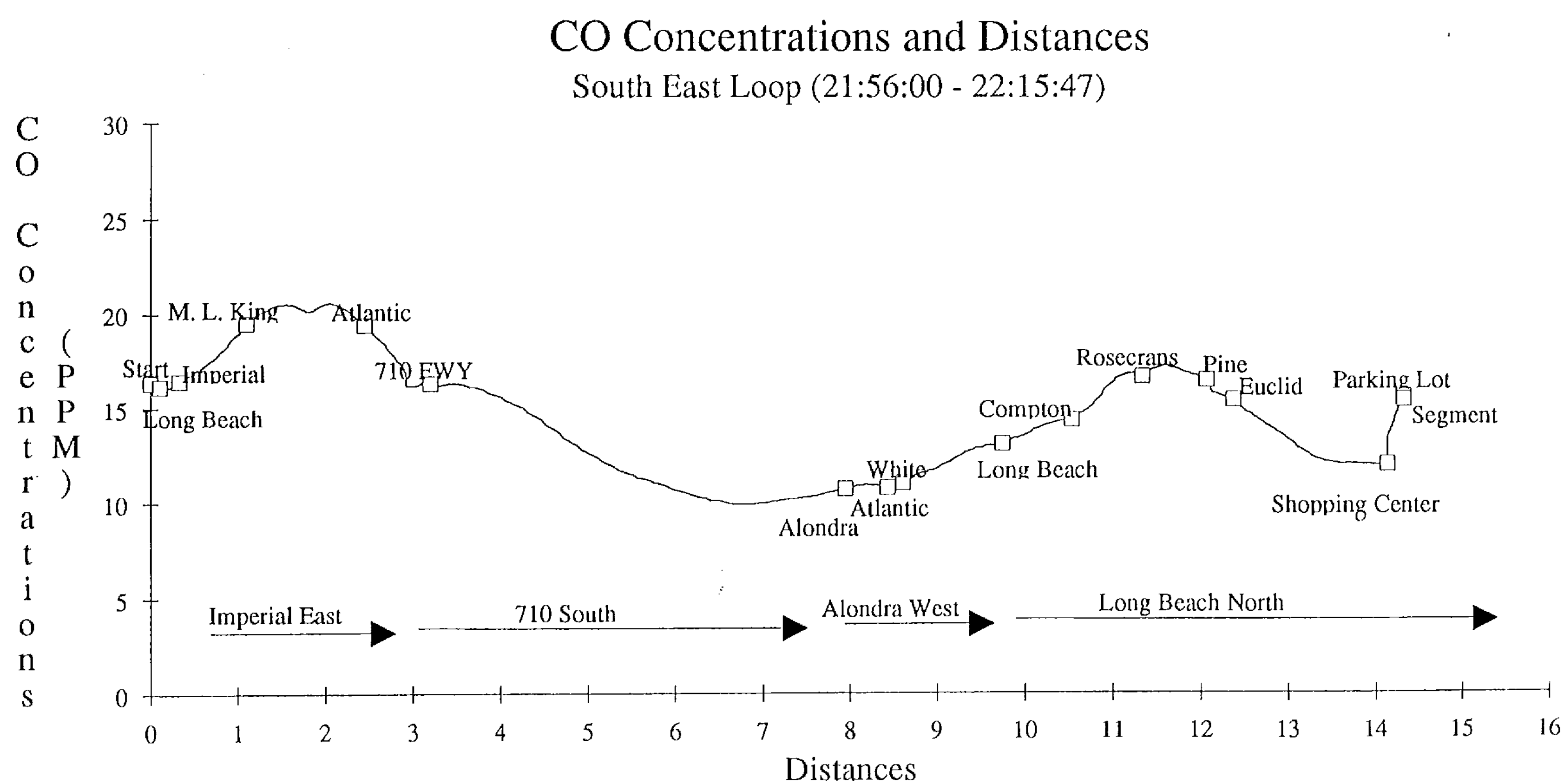


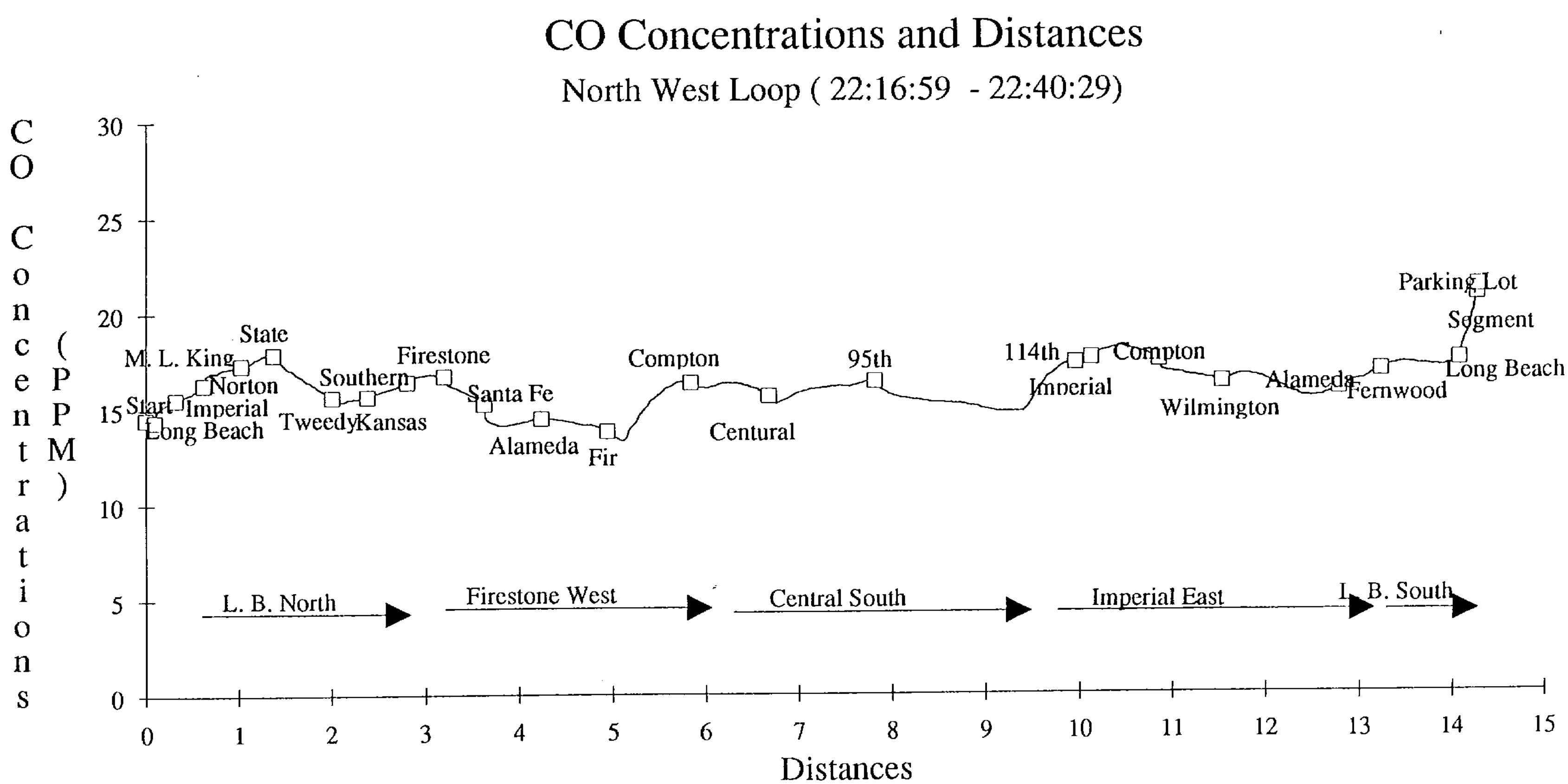
Figure 3. CO Concentrations and Distances
South West Loop (21:34:45 - 21:52:15)
CO Concentrations (PPM)
30
25
20
15
10
5
0
Distances (miles)
0
1
2
3
4
5
6
7
8
9
10
11
12
Start
Long Beach
Cedar
Pine
Rosecrans
Santa Fe
Tamarind
Alameda
Wilmington
El Segundo
Imperial
Atlantic
Alameda
Long Beach
Segment
Parking Lot
L. B. South
Rosecrans West
Wilmington North
Imperial East
L. B. South

FIGURE 6-5c.



CO Concentrations and Distances
South East Loop (21:56:00 - 22:15:47)
CO Concentrations (PPM)
0
5
10
15
20
25
30
Start
Long Beach
Imperial
M. L. King
Atlantic
710 FWY
Alondra
Atlantic
White
Long Beach
Compton
Rosecrans
Pine
Euclid
Parking Lot
Segment
Shopping Center
Imperial East
710 South
Alondra West
Long Beach North
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Distances

FIGURE 6-5d.



CO Concentrations and Distances
North West Loop (22:16:59 - 22:40:29)
CO Concentrations (PPM)
30
25
20
15
10
5
0
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Distances
Start
Long Beach
Imperial
Norton
M. L. King
State
Tweedy
Kansas
Southern
Firestone
Santa Fe
Alameda
Fir
Compton
Centural
95th
114th
Imperial
Compton
Wilmington
Alameda
Fernwood
Long Beach
Segment
Parking Lot
L. B. North
Firestone West
Central South
Imperial East
L. B. South

FIGURE 6-5e.

Figure 6. CO Concentrations and Distances

1st Big Loop (22:44:00 - 23:14:33)

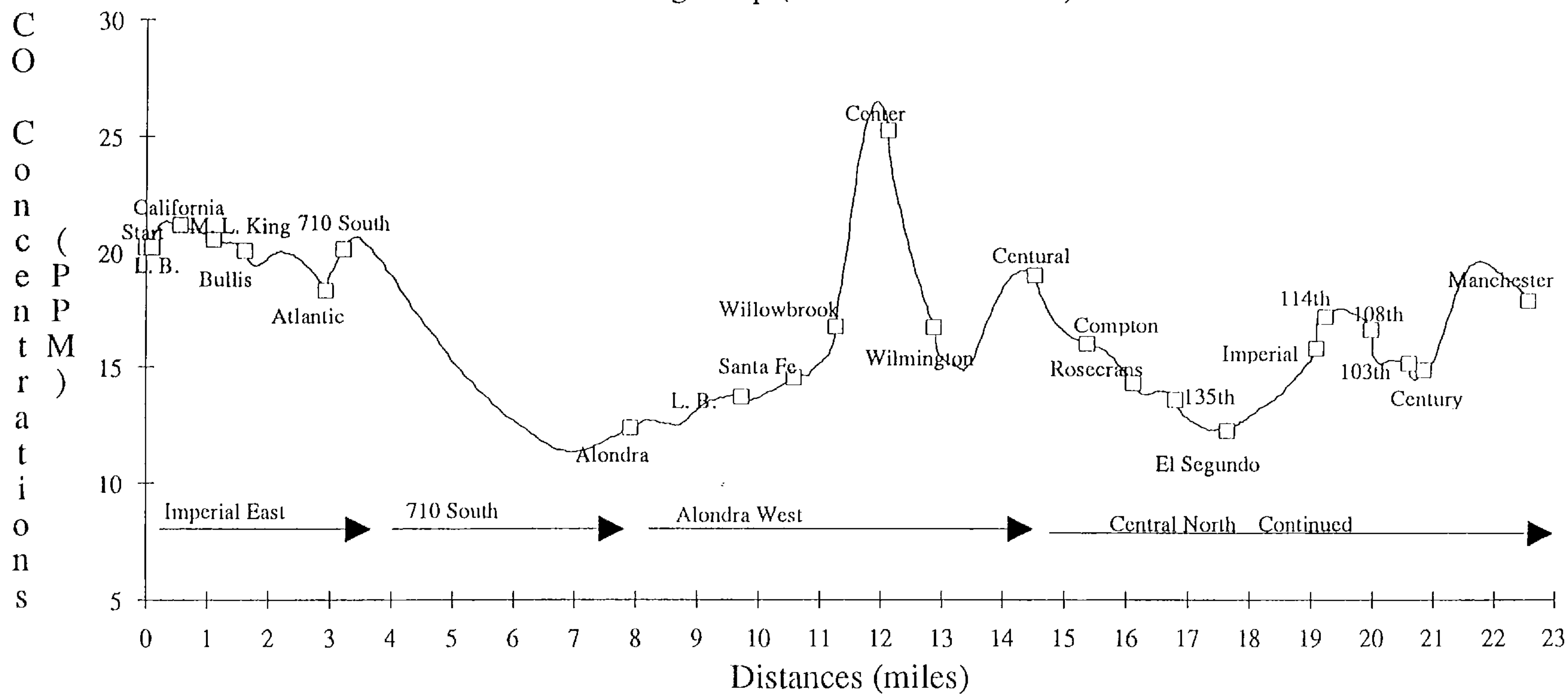


FIGURE 6-5f.

Figure 7. CO Concentrations and Distances

1st Big Loop (23:14:33 - 23:36:59)

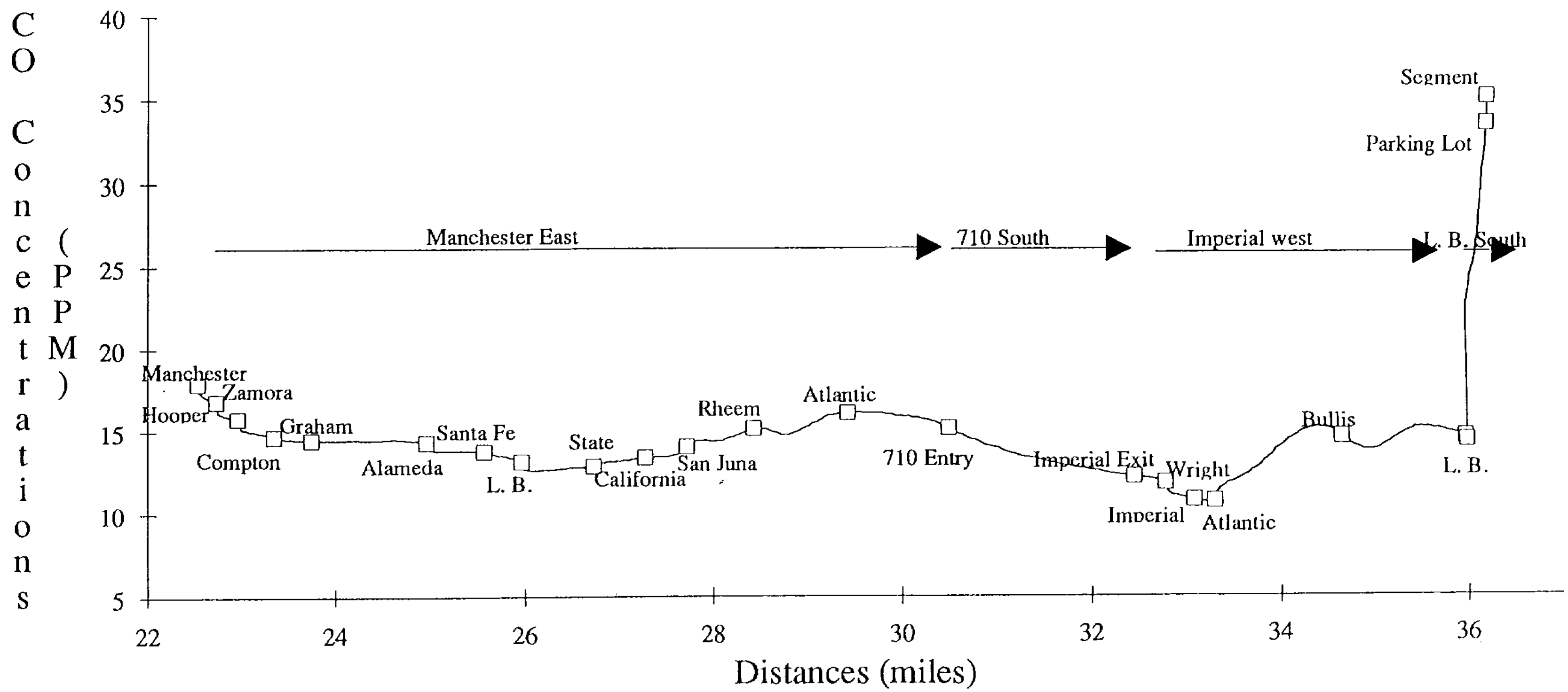
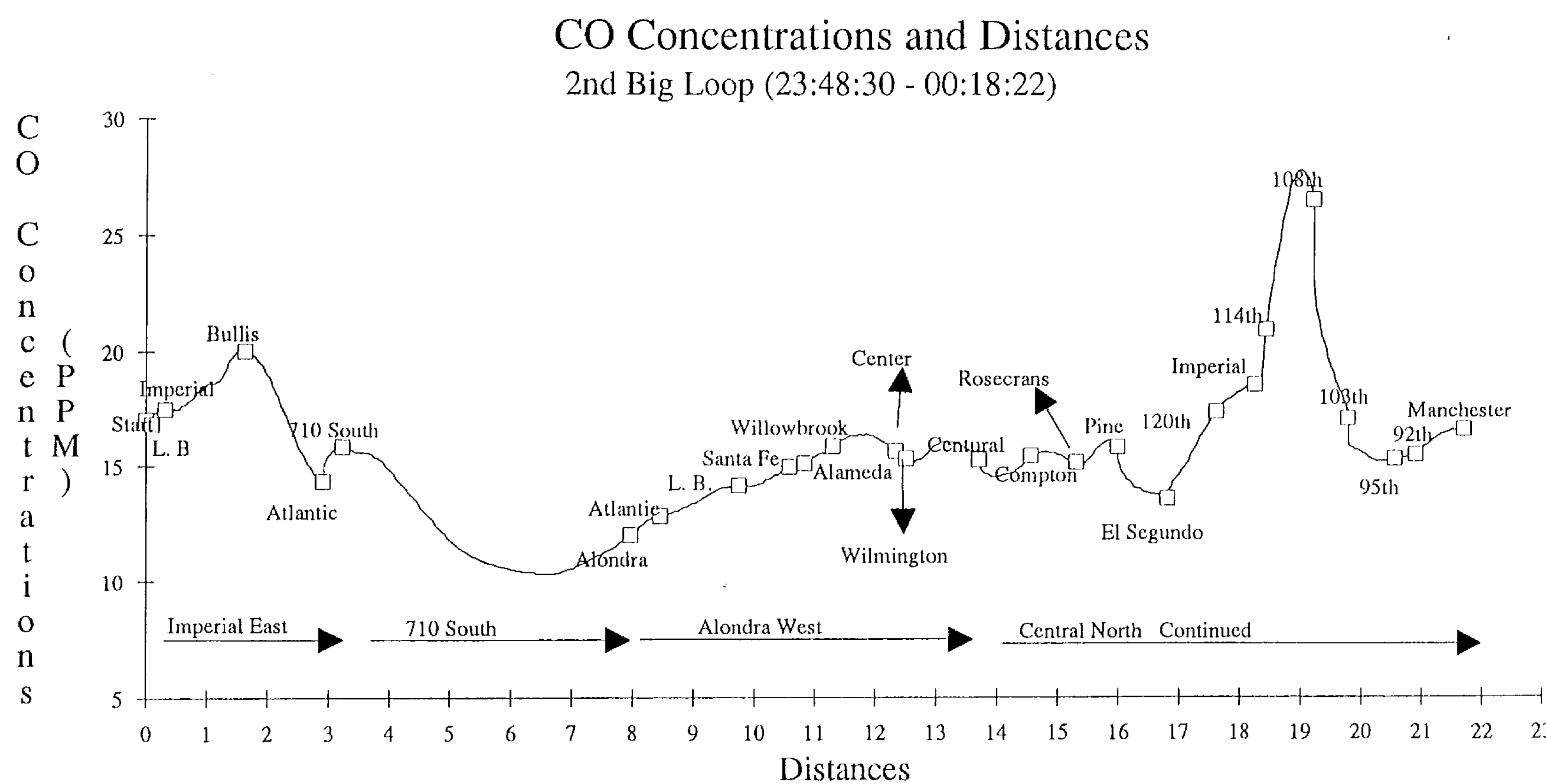


FIGURE 6-5g.



CO Concentrations and Distances
2nd Big Loop (23:48:30 - 00:18:22)
CO Concentrations (PPM)
30
25
20
15
10
5
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Distances
Start
Imperial
L. B
Bullis
710 South
Atlantic
Alondra
Atlantic
L. B.
Santa Fe
Willowbrook
Alameda
Center
Wilmington
Centural
Compton
Rosecrans
Pine
El Segundo
120th
Imperial
114th
108th
103th
95th
92th
Manchester
Imperial East
710 South
Alondra West
Central North Continued

FIGURE 6-5h.

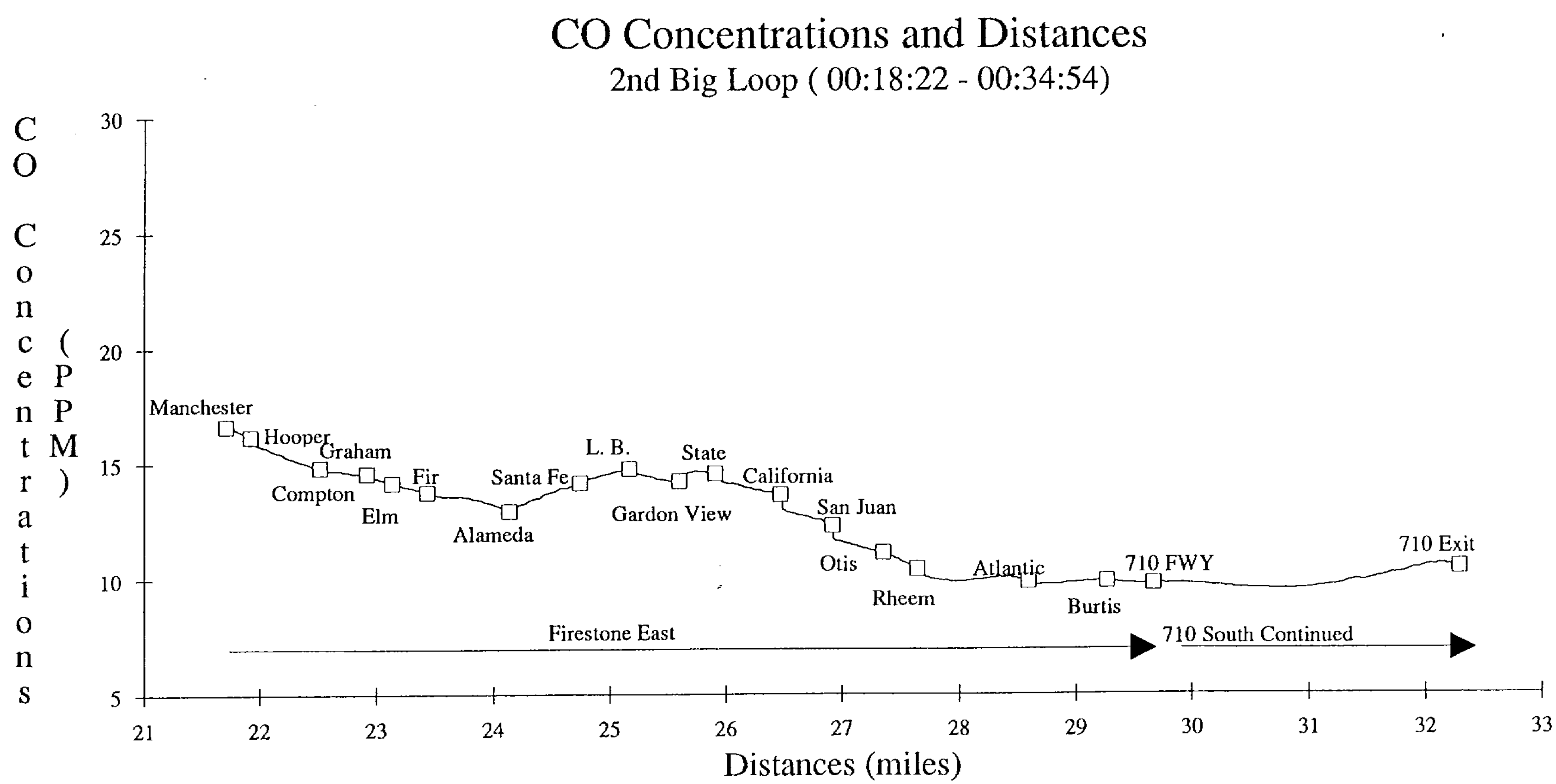

CO Concentrations and Distances
2nd Big Loop (00:18:22 - 00:34:54)
CO Concentrations (PPM)
30
25
20
15
10
5
21
22
23
24
25
26
27
28
29
30
31
32
33
Distances (miles)
Manchester
Hooper
Graham
Compton
Elm
Fir
Alameda
Santa Fe
L. B.
Gardon View
State
California
San Juan
Otis
Rheem
Atlantic
Burtis
710 FWY
710 Exit
Firestone East
710 South Continued

FIGURE 6-5i.

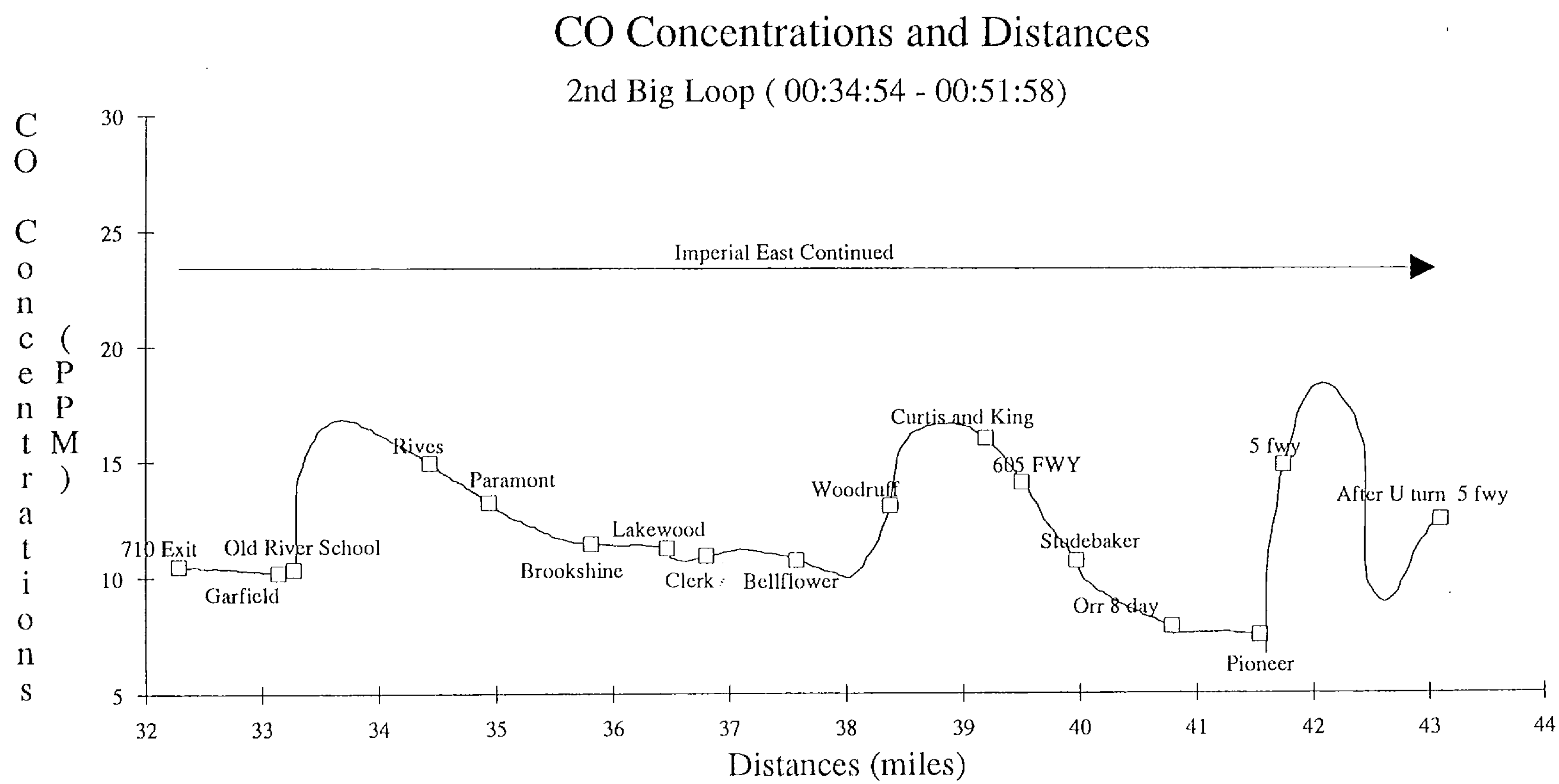

CO Concentrations and Distances
2nd Big Loop (00:34:54 - 00:51:58)
CO Concentrations (PPM)
Distances (miles)
Imperial East Continued
710 Exit
Garfield
Old River School
Rives
Paramont
Brookshine
Lakewood
Clerk
Bellflower
Woodruff
Curtis and King
605 FWY
Studebaker
Orr 8 day
Pioneer
5 fwy
After U turn 5 fwy
30
25
20
15
10
5
32
33
34
35
36
37
38
39
40
41
42
43
44

FIGURE 6-5j.

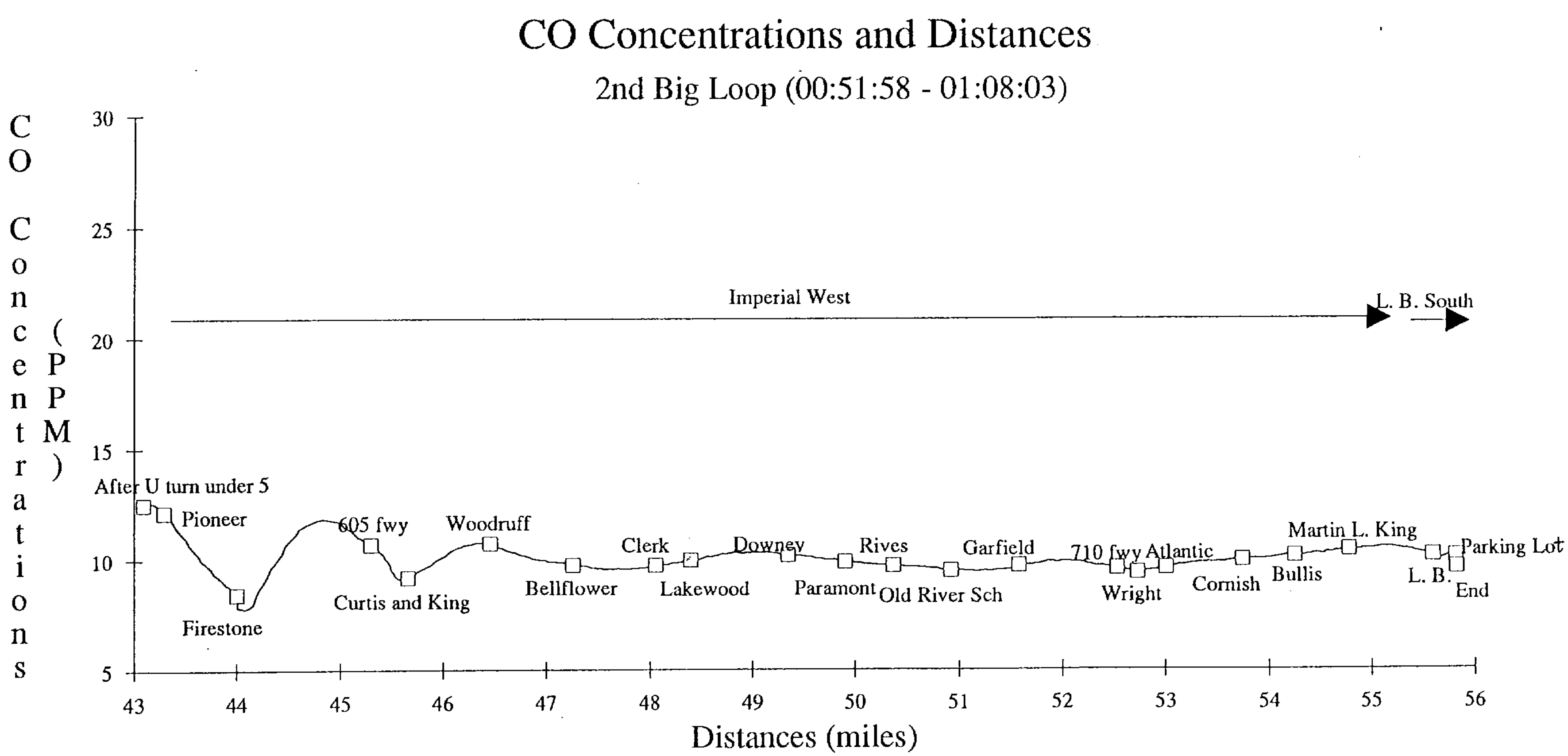

CO Concentrations and Distances
2nd Big Loop (00:51:58 - 01:08:03)
CO Concentrations (PPM)
30
25
20
15
10
5
Imperial West
L. B. South
After U turn under 5
Pioneer
Firestone
605 fwy
Curtis and King
Woodruff
Bellflower
Clerk
Lakewood
Downey
Paramont
Rives
Old River Sch
Garfield
710 fwy
Atlantic
Wright
Cornish
Bullis
Martin L. King
L. B.
Parking Lot
End
43
44
45
46
47
48
49
50
51
52
53
54
55
56
Distances (miles)

FIGURE 6-5k.

Figure 12. CO Concentrations and Distances

From Parking Lot to Hughes Garage (02:15:30 - 02:41:50)

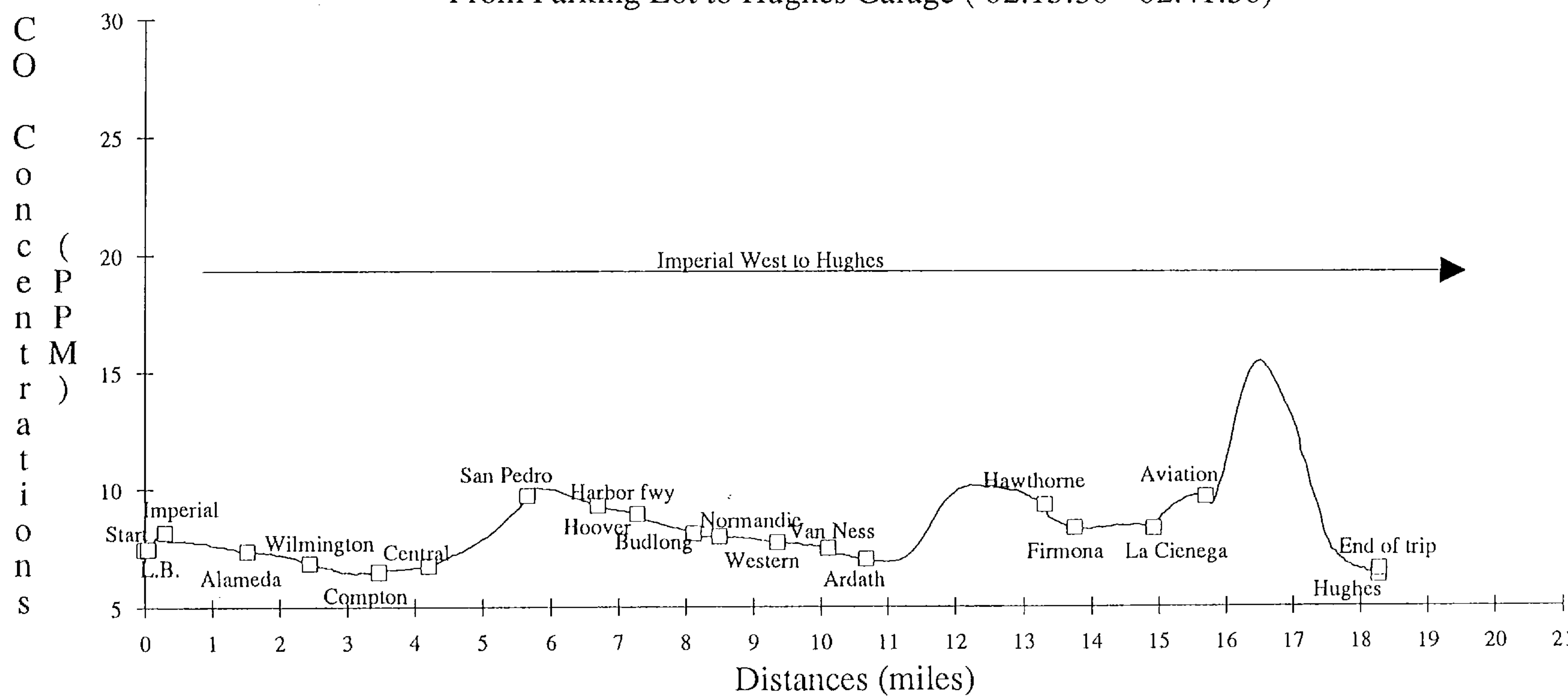


FIGURE 6-51.

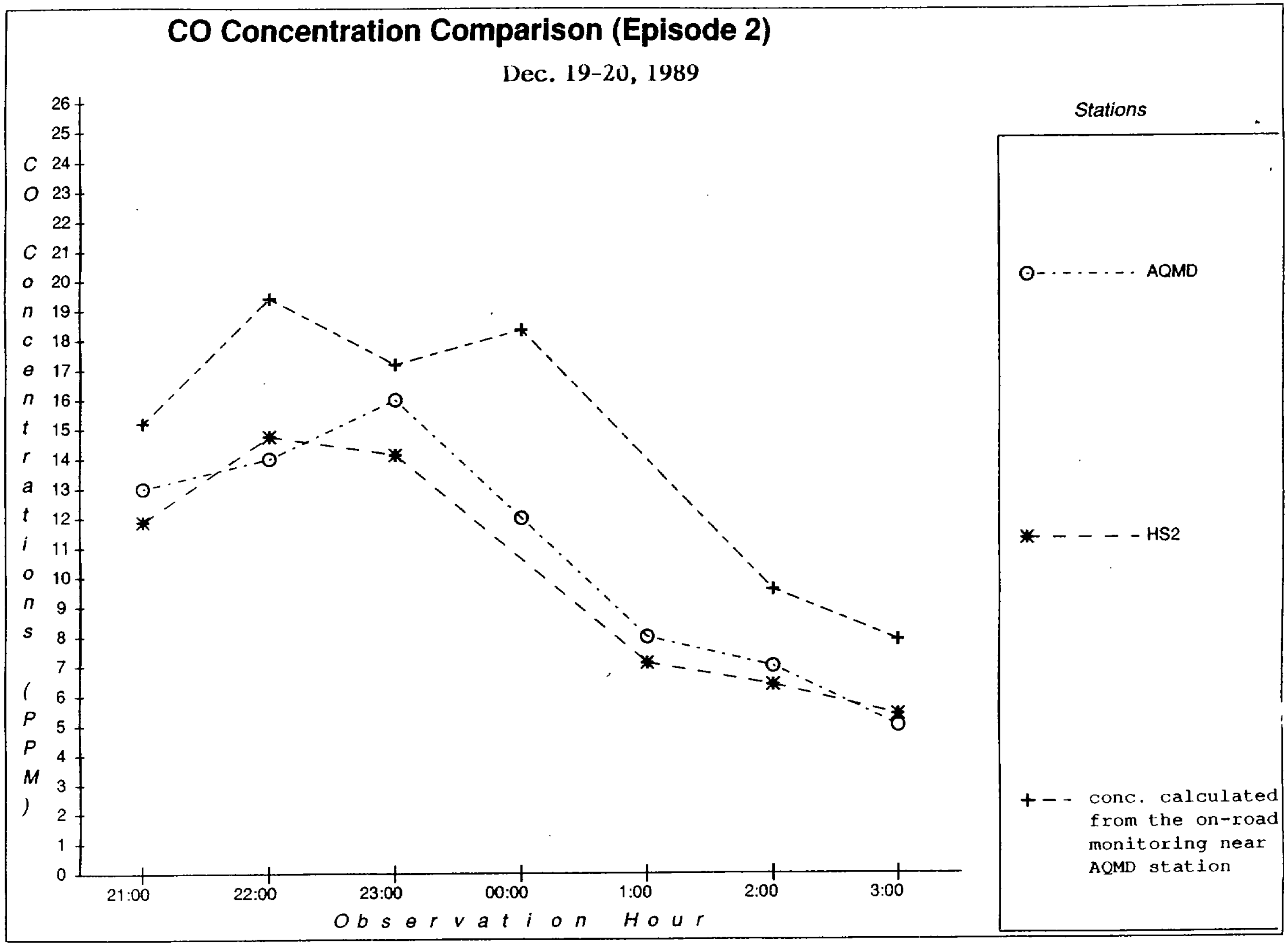
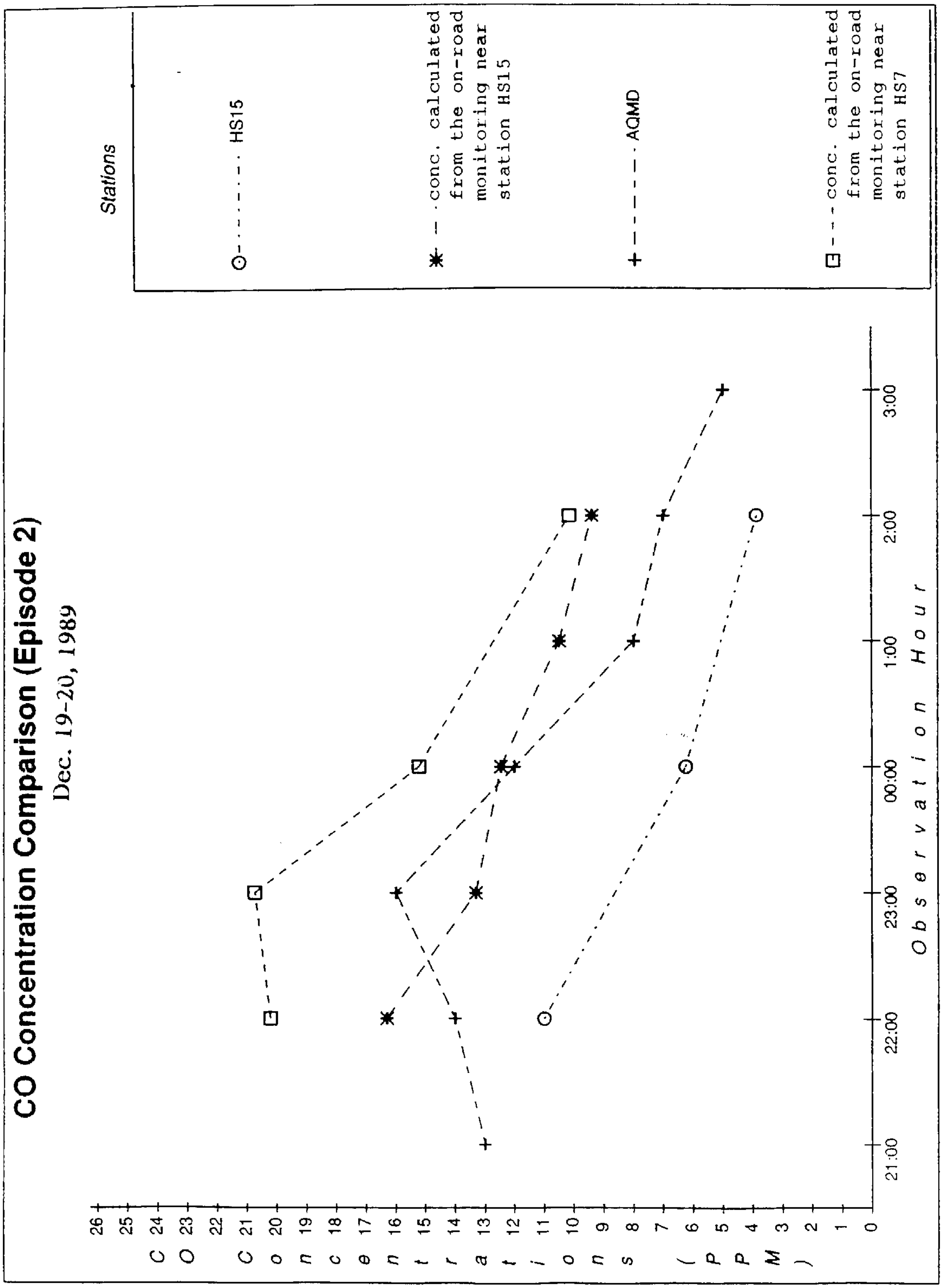

CO Concentration Comparison (Episode 2)
Dec. 19-20, 1989
CO Concentrations (PPM)
Observation Hour
21:00
22:00
23:00
00:00
1:00
2:00
3:00
Stations
AQMD
HS2
conc. calculated from the on-road monitoring near AQMD station

FIGURE 6-6a.



CO Concentration Comparison (Episode 2)
Dec. 19-20, 1989
CO Concentrations (PPM)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
21:00 22:00 23:00 00:00 1:00 2:00 3:00
Observation Hour
Stations
HS15
conc. calculated from the on-road monitoring near station HS15
AQMD
conc. calculated from the on-road monitoring near station HS7

FIGURE 6-6b.

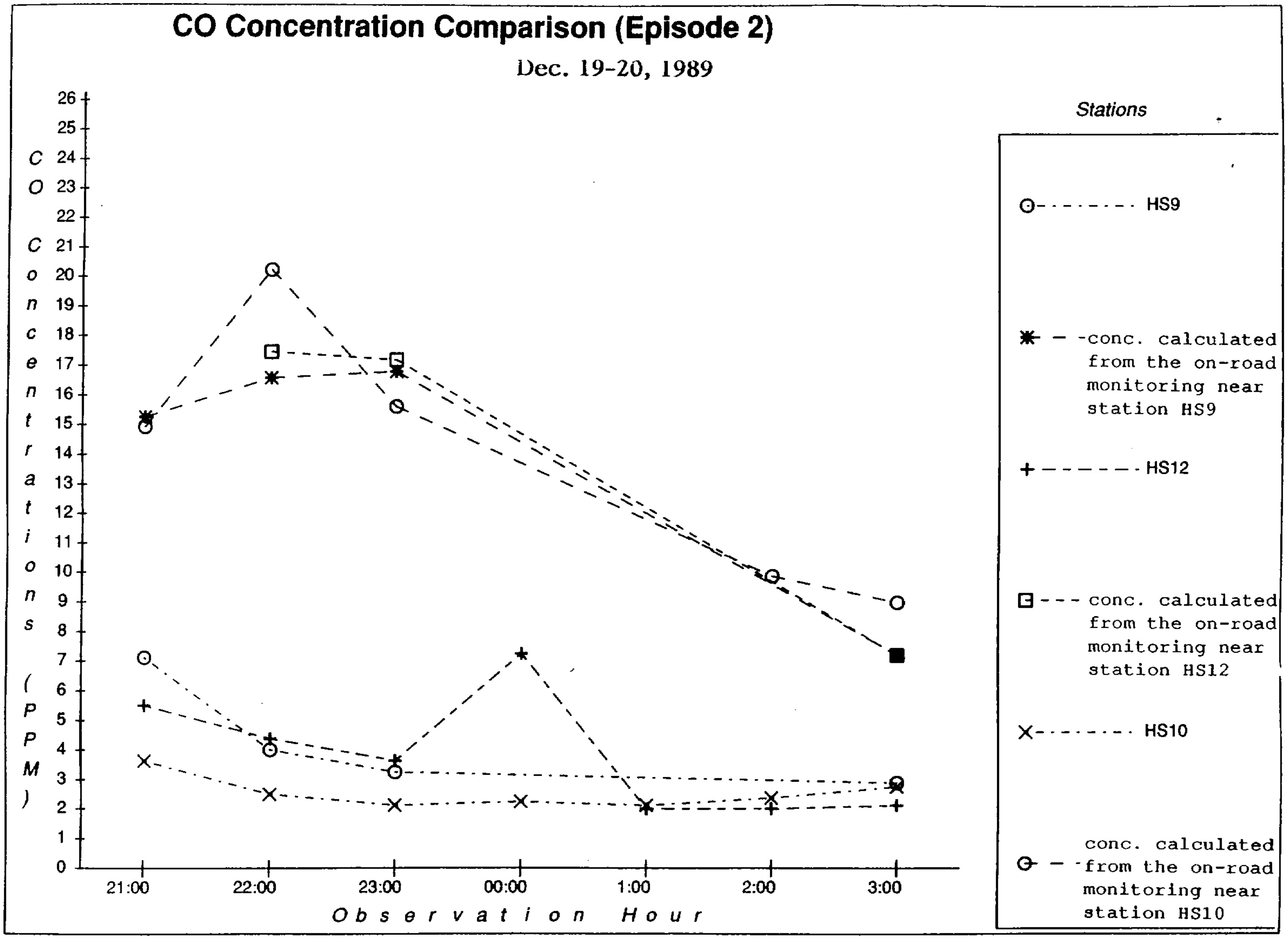

CO Concentration Comparison (Episode 2)
Dec. 19-20, 1989
CO Concentrations (PPM)
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
21:00
22:00
23:00
00:00
1:00
2:00
3:00
Observation Hour
Stations
HS9
conc. calculated from the on-road monitoring near station HS9
HS12
conc. calculated from the on-road monitoring near station HS12
HS10
conc. calculated from the on-road monitoring near station HS10

FIGURE 6-6c.

from both on-road monitoring near the fixed sites and the fixed site monitoring stations. As can be seen from the figures, some of the results are comparable, e.g., the integrated concentration calculated near the parking lot show a similar pattern to those for stations HS2 and HS5 at 21:00 19 December 1989 to 3:00 20 December 19899 (see Figure 6-6a). As has been shown on Figure 3-1, stations HS2 and HS5 are consistent with the entire group of stations in the area nearby HS1 to HS8; thus the on-road monitoring near the parking lot adequately represents the pattern in that limited area. HS15 and HS7 almost match the on-road sampling pattern from streets nearby (see Figure 6-6b). All of these stations, however, show that the concentration calculated from the on-road monitoring data is higher than the fixed site integrated sampling data. This could be caused by the self-pollution from the monitoring vehicle itself, it could be caused by the proximity of the vehicle to the major source corridor.

Some of the results from the on-road monitoring do not correlate well with the fixed monitoring stations nearby. Figure 6-6c shows that HS9, HS10 and HS12 have different patterns than those of the mobile monitoring station. However, the mobile monitor does have a similar pattern and magnitude when compared to the HS1 through HS8 stations. The peak shown in station HS12 at 00:00 20 December 1989 may indicate there were some other local source or meteorological influence during that sampling period.

We should note that on-road monitoring data provide an instantaneous description of a potentially rapidly varying situation which will differ considerably over any given time period. This is illustrated by the differences between Figures 6-5j and 6-5k, which display the CO concentrations at approximately the same points along the same route but in opposite directions observed within an interval of no more than 30 minutes of each other. These figures suggest that the on-road sampling may be very much dominated by the observation-specific information, things like kind of vehicles nearby, their conditions, how many of them, driving speed, etc, while the fixed hourly-integrated monitoring data reflects the combined influences of both sources and meteorological conditions in the source/sampling region because the meteorological dilution and also physical absorption and dry deposition can take place with sufficient time to average out all of these variations. Once again, since the on-roadway monitoring shows instantaneous individual observations which are not observable in the hourly integrated samples taken nearby, these two sets of data will not be always comparable, depending on the sampling periods, the path and locations of the monitoring, the uniformity of the vehicle traffic, and the variability of the meteorology.

In this study, the comparison period was too short to justify a rigorous statistical analysis.

Appendix A

WORK PLAN

(AV-R-89/6153R)

AV-R-89/6153R
AV Project 91199

WORK PLAN

OPERATION AND MAINTENANCE OF FORTY-TWO CARBON MONOXIDE SAMPLERS IN THE LOS ANGELES AREA BETWEEN NOVEMBER 15, 1989 TO JANUARY 15, 1990

Prepared for

California Air Resources Board
1102 Q Street
P.O.Box 2815
Sacramento, CA 95812

November 1989

AV-R-89/6153R
AV Project 91199

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By

AeroVironment Inc.
825 Myrtle Avenue
Monrovia, CA 91016

November 1989

TABLE OF CONTENTS

Section 1

INTRODUCTION

1.1 PROJECT ORIGIN

Monitoring stations in seven of California's air basins have reported carbon monoxide (CO) concentrations above state and federal ambient air quality standards during 1986 or 1987. The most frequent violations have been reported from the Lynwood, Hawthorne, and Burbank stations located in the South Coast Air Basin. The highest CO concentrations in California have been measured at the Lynwood station, in west-central Los Angeles. In 1987, the maximum eight-hour average CO concentration was exceeded at that site on 40 days.

The existence of localized areas with elevated CO concentrations within urban areas has been well documented. Roadway traffic is usually the dominant CO source in most communities, with the greatest emission densities occurring near intersections and congested roadway locations. Generally, CO concentrations are proportional to traffic volume. Meteorological conditions control the rate at which CO concentrations decrease with distance from the emission source.

In order to develop measures to reduce regional and local CO concentrations and meet the air quality standards, the spatial distribution of CO must be characterized and the contribution of local sources such as vehicle emissions to areawide levels must be understood.

1.2 PROJECT OBJECTIVES

The objective of the California Air Resources Board's (ARB's) monitoring program is to determine the contribution of local sources to ambient CO concentrations in areas of Los Angeles where unusually high CO levels exist. To accomplish this objective, the ARB contracted AV Projects, Inc. (AV), a wholly owned subsidiary of AeroVironment Inc., to conduct an ambient air monitoring study to do the following:

- evaluate the spatial variation of CO levels near local agency maintained monitoring sites during periods of high CO concentrations, with the contribution of local and areawide emissions being estimated separately

- identify major CO emissions sources and quantify their relative contribution to the elevated local CO concentrations.

1.3 THE WORK PLAN

The following document is the work plan AV developed for conducting the ARB CO monitoring study. Section 2 of the plan states the project scope of work and describes the monitoring site locations, measurement parameters, project schedule, and organization. Section 3 discusses the sample collection and analysis procedures, including sample custody and documentation protocols. Section 4 contains the standard operating procedures. Sections 5 and 6 describe quality assurance and data validation procedures for the project, respectively.

Section 2

PROJECT DESCRIPTION

2.1 PROJECT SCOPE

Between 15 November 1989 and 15 January 1990, three days of intensive CO monitoring will be conducted at 39 locations within the South Coast Air Basin. The study includes low density ambient air sampling along a large grid throughout the Los Angeles area (Figure 2-1) and high density sampling in the City of Lynwood (Figure 2-2) where frequent violations of federal and state CO standards have been reported. During the intensive, several sampling and measurement tasks will be conducted simultaneously. Each task is described below.

Task 1: Areal Integrated Ambient Air Sampling. At each monitoring site along the areawide sampling grid and in the City of Lynwood, one- or two-hour integrated ambient air samples will be collected throughout each 24-hour intensive. The samples will be analyzed for CO by AV's laboratory in Monrovia and for tracer gases by Tracer Technologies of San Diego. The results will be used to evaluate the spatial distribution of CO areawide and in the Lynwood area where locally high levels exist. The data will also be used to assess the contribution of local emissions to the regional CO levels.

Task 2: Vertical Integrated Ambient Air Sampling. At Station 7a,b,c, in Lynwood (Figure 2-2), two-hour integrated ambient air samples will be collected from 0, 50, 100, and 150 feet above the ground surface throughout each 24-hour intensive. The samples will be analyzed for CO by AV's laboratory in Monrovia, and the results will be used to determine the vertical distribution of CO in an area where locally high levels exist.

Task 3: Tracer Releasing. At four locations near the South Coast Air Quality Management District air monitoring station in Lynwood (Figure 2-1), tracer gas will be released at the start of each intensive and every six hours thereafter for the duration of the test. Four perfluorocarbon tracers will be tracked by analyzing the samples collected at each areal integrated ambient air site. The purpose of tracer releasing is to determine the regional air flow during the sampling period. Tracer Technologies of San Diego will release the tracers and perform the sample analysis.

FIGURE 2–1. Integrated ambient air sampling locations – Los Angeles area.

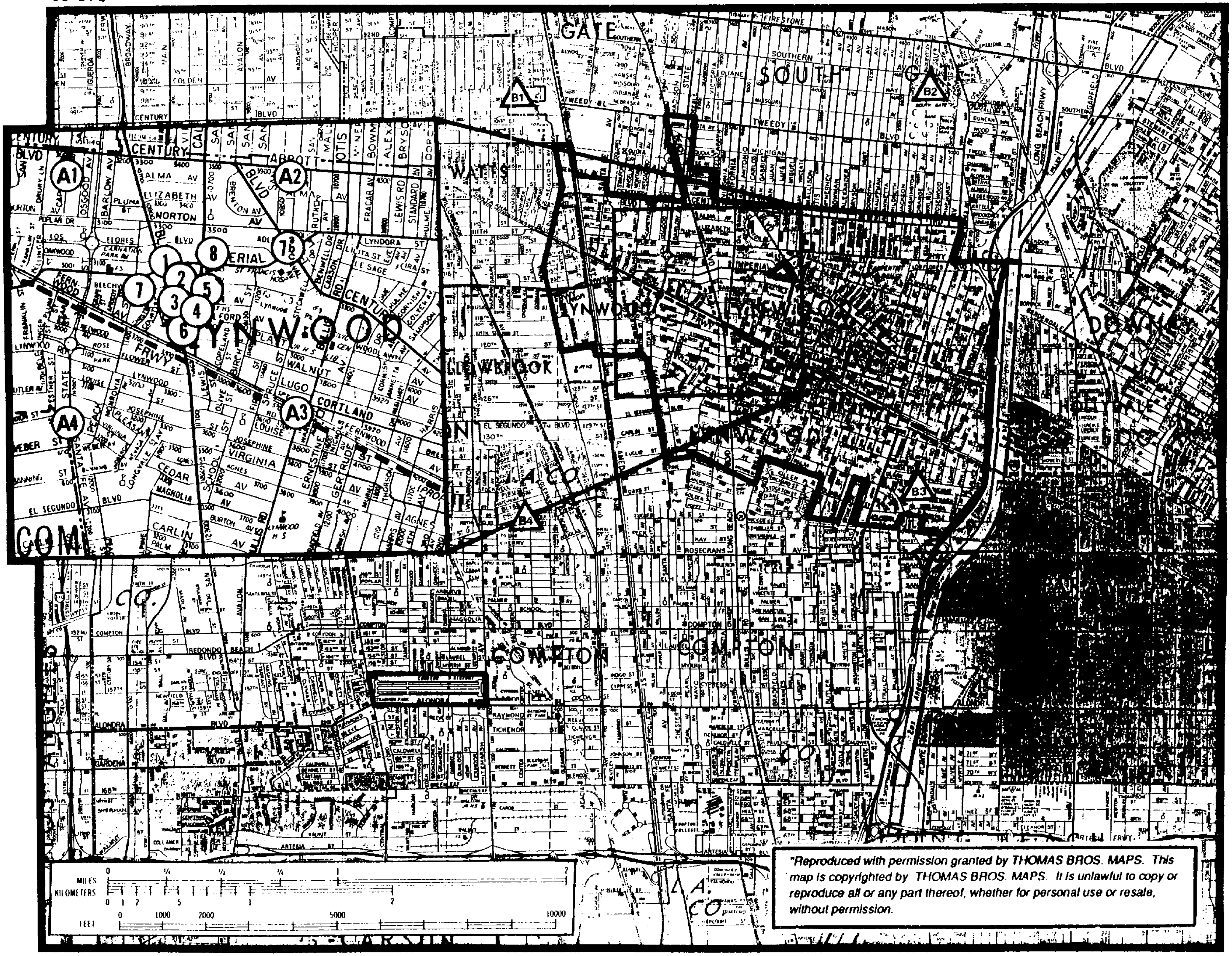

FIGURE 2–2. Integrated ambient air sampling locations – City of Lynwood.

Task 4: Fixed Height Meteorological Data Measurement. Throughout the intensives, a 10-meter meteorological station will be operated at Station 7a,b,c, in Lynwood (Figure 2-2). The station will monitor wind conditions and air temperature. The meteorological data will be used in the evaluation of the CO spatial distribution.

Task 5: Multiple Height Meteorological Data Measurement. At two sites north and south of Lynwood (Figure 2-1), tethersondes will be used to monitor the meteorological conditions throughout the vertical air column. The tethersondes will be operated up to 200 feet above the ground and will monitor wind conditions and dry and wet bulb ambient temperatures. The meteorological data will be used in the evaluation the CO spatial distribution.

Task 6: Exhaust Emissions Monitoring. At two locations in Lynwood and one in Hawthorne, exhaust emissions monitoring for CO will be conducted by the University of Denver Research Group. The results will be used to evaluate whether differences in vehicle characteristics have contributed to the elevated CO concentrations in Lynwood and to quantify their impact.

Task 7: Videotaping. At the same two Lynwood and one Hawthorne locations, the University of Denver Research Group will conduct a statistical survey of vehicles travelling on adjacent roadways. They will videotape license plates and later match vehicle registration information such as location of registration, vehicle age, and other data. They will also compare California State emissions testing results to the results obtained in Task 6.

Task 8: Traffic Counts and Speed Profiles. Average daily traffic counts and speed profiles will be performed by Newport Traffic Studies, Inc., at six locations in and near Lynwood. The traffic data will provide information for the evaluation of mobile CO sources.

2.2 MONITORING SITE LOCATIONS

The ambient air sampling sites include 2 existing air quality stations, 21 cloud characterization sites and 16 hot spot characterization sites. The site locations are listed in Table 2-1 and shown on Figures 2-1 and 2-2. The ARB has given each location a priority rating so that in the event of equipment failure the most critical locations will be sampled.

The sites designated for tracer release, meteorological data measurement, and traffic studies are listed in Table 2-2 and shown on Figures 2-1 and 2-2. If only one tethersonde monitoring location is operational, the southern site is preferred.

TABLE 2-1. Integrated air sampling locations.

Sampler Number	Site Designation	Sample Type	Sample Location	Site Priority
01	AQ02	IA	Hawthorne AQ Station	medium
02	AQ03	IA	Los Angeles AQ Station	medium
03	CC01	IA	1420 Lake St., Glendale	medium
04	CC02	IA	1065 Armade Dr., Pasadena	medium
05	CC03	IA	738 E. Oakdale, Monrovia	medium
06	CC04	IA	1405 N. Edgemont, Los Angeles	low
07	CC05	IA	305 N. Lincoln Ave, #5, Monterey Pk.	medium
08	CC06	IA	12645 Fineview, El Monte	medium
09	CC07	IA	Monterey Park	medium
10	CC08	IA	3678 Fairland Blvd., L.A.	high
11	CC10	IA	2349 Strong Ave., City of Commerce	high
12	CC11	IA	7274 Canyon Crest Dr., Whittier	high
13	CC12	IA	700W Pine Ave., El Segundo	medium
14	CC13	IA	13133 S. Hoover St., Gardena	high
15	CC14	IA	11914 Lyndora, Norwalk	high
16	CC15	IA	1703 Ford Ave., Redondo Beach	low
17	CC16	IA	17513 Broadwell Ave., Gardena	high
18	CC17	IA	203 W. Artesia Blvd., Long Beach	high
19	CC18	IA	10012 Ramona St., Bellflower	high
20	CC19	IA	6940 Walker, Cudahy	high
21	CC20	IA	2300 Dorris Pl., Los Angeles	high
22	CC21	IA	2635 Lancaster Ave., Los Angeles	high

TABLE 2-1. (continued)

Sampler Number	Site Designation	Sample Type	Sample Location	Site Priority
23	HS01	IA	3351 E. Imperial Hwy.	high
24	HS02	IA	3301 Beechwood Ave.	high
25	HS03	IA	11220 Long Beach Blvd.	high
26	HS04	IA	11220 Long Beach Blvd.	high
27	HS05	IA	3367 Beechwood Ave.	high
28	HS06	IA	3340 Sanborn Ave.	high
29	HS07	IA	11330 Bullis Ave.	high
30	HS07a	IA	3300 Century Blvd.	high
31	HS07b	IA	3300 Century Blvd.	high
32	HS07c	IA	3300 Century Blvd.	high
33	HS08	IA	3366 E. Imperial Hwy	high
34	HS09(A1)	IA	10821 Capistrano Ave.	high
35	HS10(A2)	IA	10700 San Luis Ave.	high
36	HS11(A3)	IA	3801 Cortland St.	high
37	HS12(A4)	IA	11817 State St.	high
38	HS13(B1)	IA	9603 Croesus Ave.	high
39	HS14(B2)	IA	9329 Hildreth Ave., South Gate	high
40	HS15(B3)	IA	5300 Clark St.	high
41	HS16(B4)	IA	1324 N. Pausen Ave., Compton	high

FOOTNOTES

AQ02 = Air Quality Station
CC01 = Cloud Characterization Site
HS01 = "Hot Spot" (City of Lynwood) Site
A1 = Site is within 1 km of the "Hot spot" area
B1 = Site is within 3 km of the "Hot spot" area
IA = Integrated Ambient Air Sample

TABLE 2-2. Tracer release and data collection locations.

Instrument Number	Site Designation	Data Type	Sample Location	Site Priority
01	TR01	Tracer Rel.	Century Blvd. & Freeway 110	high
02	TR02	Tracer Rel.	Washington and Freeway 5	high
03	TR03	Tracer Rel.	Firestone and Freeway 605	high
04	TR04	Tracer Rel.	Central Ave., and Freeway 91	high
01	MT01	WV, Temp.	3300 Century Blvd., Lynwood	medium
01	TETH-1	WS, WD, Temp.	3300 Century Blvd., Lynwood	high
02	TETH-2	WS, WD, Temp.	Vernon Fire Station, Vernon	medium
01	EEM-1	EEM	Lynwood	
02	EEM-2	EEM	Lynwood	
01	TC-1	TC	Long Beach Blvd and Imperial Hwy, Lynwood	
02	TC-2	TC	La Cienega and 120th, Hawthorne	
03	TC-3	TC	Lynwood Air Quality Site	
04	TC-4	TC	Firestone Blvd and John Ave., Florence	
05	TC-5	TC	Atlantic Ave. and Firestone Blvd, South Gate	
06	TC-6	TC	Long Beach Blvd and Rosecrans Ave., Compton	
01	VT-1	VT	Long Beach Blvd. and Imperial Hwy, Lynwood	
02	VT-2	VT	La Cienega and 120th, Hawthorne	
03	VT-3	VT	Lynwood Air Quality Site	
04	VT-4	VT	Variable Locations - TC-4, 710 & Clara St. Overpass, Bell Gardens, and TC-6	

FOOTNOTES

TR01 = Tracer Release Site
MT01 = Meteorological Tower Site
TETH-1 = Tethersonde Site
EEM-1 = Exhaust Emissions Monitoring Site
TC-1 = Traffic Study Site
VT-1 = Videotaping Site
WS = Wind Speed
WD = Wind Direction
WV = Wind Vectors

The integrated ambient air sample analysis will be conducted at AV's laboratory in Monrovia and the perfluorocarbon tracer analysis will be performed by Tracer Technologies at their laboratory in San Diego.

2.3 SAMPLE COLLECTION AND DATA MEASUREMENT REQUIREMENTS

The sample collection and data measurement requirements of the study are summarized in Table 2-3 for each monitoring site. Three integrated air samplers will be used during the study, Air Quality Samplers I, II, and III. The type of sampler selected for each site depends on the required length of sample integration. Air Quality Samplers II and III are capable of integrating samples over two hours, whereas Sampler I is capable of sampling only over one-hour periods.

The integrated air samples will be analyzed for CO by nondispersive infrared spectroscopy using a 1 part per million by volume (ppm_v) method detection limit (MDL) and for the perfluorocarbon tracers by gas chromatography with electron capture detection (GC-ECD) using 20 and 30 femtoliter per liter (fL/L) or 10^{-15} L/L MDLs. The samples will be analyzed for CO within 72 hours and for the tracer gases within 240 hours.

Meteorological data, including wind conditions and dry bulb and wet bulb ambient temperature, will be collected continuously throughout the intensives using a three-axis meteorological station and two tethersondes. The minimum threshold levels for the meteorological measurements are determined by the equipment specifications.

Traffic studies, including traffic counts, speed profiles, videotaping and exhaust emissions monitoring, will be conducted during the intensives. The traffic counts compiled during the study will be reduced to 24-hour averages or average daily traffic measurements. The exhaust emissions will be analyzed for CO and carbon dioxide (CO_2) using portable, real-time analysis equipment.

Sample collection and analysis procedures, including sample custody and documentation protocols are discussed in Section 3 of this work plan. Section 4 describes the instrument specifications and standard operating procedures.

2.4 PROJECT SCHEDULE

Three 24-hour CO monitoring intensives will take place between 15 November 1989 and 15 January 1990. The intensive periods will be determined by the ARB and will be selected based on meteorological forecasts. Optimally, the intensives will take place during stagnant weather conditions when maximum CO levels occur.

TABLE 2-3

SAMPLE COLLECTION AND DATA MEASUREMENT REQUIREMENTS

Sampler Number	Site Designation	Sample or Data Type	Sampling Interval (hours)	Total No. of Samples (per intensive)	Measurement or Analytical Parameter	Analytical Method	Analytical Detection Limit	Sample Holding Time (hours)	Tracer Analysis Priority
01	AQ02	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	medium
02	AQ03	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	medium
03	CC01	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	
04	CC02	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	
05	CC03	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	
06	CC04	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	low
07	CC05	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	
08	CC06	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	
09	CC07	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	low
10	CC08	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	high
11	CC09	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	

TABLE 2-3. continued

Sampler Number	Site Designation	Sample or Data Type	Sampling Interval (hours)	Total No. of Samples (per intensive)	Measurement or Analytical Parameter	Analytical Method	Analytical Detection Limit	Sample Holding Time (hours)	Tracer Analysis Priority
12	CC10	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	high
13	CC11	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	
14	CC12	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	low
15	CC13	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	high
16	CC14	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	high
17	CC15	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	medium
18	CC16	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	high
19	CC17	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	high
20	CC18	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	high
21	CC19	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	high
22	CC20	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	low
23	CC21	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	medium
24	HS01	IA	1	24	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	high
25	HS02	IA	1	24	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	medium

TABLE 2-3. continued

Sampler Number	Site Designation	Sample or Data Type	Sampling Interval (hours)	Total No. of Samples (per intensive)	Measurement or Analytical Parameter	Analytical Method	Analytical Detection Limit	Sample Holding Time (hours)	Tracer Analysis Priority
26	HS03	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	high
27	HS04	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	medium
28	HS05	IA	1	24	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	medium
29	HS06	IA	1	24	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	medium
30	HS07	IA	1	24	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	medium
31	HS07	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	high
32	HS07	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	high
33	HS07	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	high
34	HS08	IA	1	24	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	medium
35	HS09 (A1)	IA	1	24	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	high
36	HS10 (A2)	IA	1	24	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	high
37	HS11 (A3)	IA	1	24	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	high
38	HS12 (A4)	IA	1	24	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	high

TABLE 2-3. continued

Sampler Number	Site Designation	Sample or Data Type	Sampling Interval (hours)	Total No. of Samples (per intensive)	Measurement or Analytical Parameter	Analytical Method	Analytical Detection Limit	Sample Holding Time (hours)	Tracer Analysis Priority
39	HS13 (B1)	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	high
40	HS14 (B2)	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	high
41	HS15 (B3)	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	high
42	HS16 (B4)	IA	2	12	CO	IR	1 ppm_v	72	
					tracers	GC-ECD	20 to 30 fL/L	240	high
01	MT01	Met Data	continuous	na	WV	UVW Anemometer		na	na na
					Air Temp.	Thermistor		na	na na
01	TETH-1	Met Data	continuous	na	WS	Cup Anemometer	na	na	na
					WD	Magnetic Compass	na	na	na
					Dry Bulb	Thermistor	na	na	na
					Wet Bulb	Thermistor with Water Jacket	na	na	na
02	TETH-2	Met Data	continuous	na	WS	Cup Anemometer	na	na	na
					WD	Magnetic Compass	na	na	na
					Dry Bulb	Thermistor	na	na	na
					Wet Bulb	Thermistor with Water Jacket	na	na	na
01	EEM-1	Exhaust	24	variable	CO	IR	real time	na	na
02	EEM-2	Exhaust	24	variable	CO	IR	real time	na	na

TABLE 2-3. continued

Sampler Number	Site Designation	Sample or Data Type	Sampling Interval (hours)	Total No. of Samples (per intensive)	Measurement or Analytical Parameter	Analytical Method	Analytical Detection Limit	Sample Holding Time (hours)	Tracer Analysis Priority
01	TC-1	Vehicle Data	24	variable	TC, SP		real time	na	na
02	TC-2	Vehicle Data	24	variable	TC, SP		real time	na	na
03	TC-3	Vehicle Data	24	variable	TC, SP		real time	na	na
04	TC-4	Vehicle Data	24	variable	TC, SP		real time	na	na
05	TC-5	Vehicle Data	24	variable	TC, SP		real time	na	na
06	TC-6	Vehicle Data	24	variable	TC, SP		real time	na	na
01	VT-1	Vehicle Data	24	variable	VT	video cam	real time	na	na
02	VT-2	Vehicle Data	24	variable	VT	video cam	real time	na	na
03	VT-3	Vehicle Data	24	variable	VT	video cam	real time	na	na
04	VT-4	Vehicle Data	24	variable	VT	video cam	real time	na	na

FOOTNOTES

WS = Wind Speed
WD = Wind Direction
CO = Carbon Monoxide
CC01 = Cloud Characterization Site
TC = Traffic Counts
SP = Speed Profiles
MT01 = Meteorological Tower Site
WV = Wind Vectors

VT = Videotaping
IR = Nondispersive Infrared Spectroscopy
GC-ECD = Gas Chromatography with Electron Capture Detection
HS01 = "Hot Spot" (City of Lynwood) Site
ppm_v = parts per million by volume
TETH-1 = Tethersonde Site
IA = Integrated Ambient Air Sample

na = not applicable
AQ02 = Air Quality Station
VT-1 = Videotaping Site
TC-1 = Traffic Study Site
EEM-1 = Vehicle Exhaust Emissions Site
A1 = Site is within 1 meter of Lynwood
fL/L = femtoliters per Liter (10^{-15}L/L)
B1 = Site is within 3 meters of Lynwood

A progress report will be completed within one month after the end of the testing program. The final report will be submitted within two months.

2.5 PROJECT ORGANIZATION AND RESPONSIBILITY

The project management structure is shown in Figure 2-3. The project director for the CO monitoring study is Dr. Robert Nininger. He is responsible for allocating the company resources and for ensuring that the project manager has the equipment and manpower to accomplish all aspects of the project. He is the direct contact between the ARB and AV. The project manager for the program is Dr. K.C. Moon. He is responsible for the technical and financial management of the project. He is ultimately responsible for all phases of the project, including field investigations, chemical analyses, quality control sample collection, data processing, and reports.

The field operations manager is Mr. Don Christopherson. He is responsible for coordinating the field activities and making sure that AV personnel, subcontractors, and operational equipment are in place during the intensives. He is also responsible for the quality of the samples and field measurements. He will manage the field team and make sure that correct standard operating procedures and sample handling and custody procedures are used throughout the field program. He is responsible for reporting any deficiencies in the operation of field equipment or in the recording and documentation of field data. If a problem arises that may compromise the integrity of the results, he will take whatever corrective actions are deemed necessary by the project manager to mitigate or rectify the problem, including halting the field effort until the problem is corrected. The senior instrumentation supervisor is Mr. Kurt Bumiller. He is responsible for the quality of the CO analytical measurements. He will make sure that the meteorological instruments and CO analyzers are operational and calibrated correctly. He will make sure that instruments damaged or broken during the program are repaired or replaced and that routine instrument maintenance is conducted. He is responsible for verifying that the fixed height meteorological station is sited appropriately. The senior instrument operator is Mr. David Cordell. He is responsible for ensuring that the ambient air samplers are operational and programmed correctly. He will make sure that sampling systems damaged or broken during the program are repaired or replaced and that routine equipment maintenance is conducted. He is responsible for training the field teams to use correct standard operating procedures and sample handling, documenting and custody procedures.

The data processing manager is Ms. Sheryl Thurston. She will make sure that the entry of field measurements and analytical data into a computer data base management system are checked against original reports using data entry verification routines and visual inspection of hard copies of data files. She

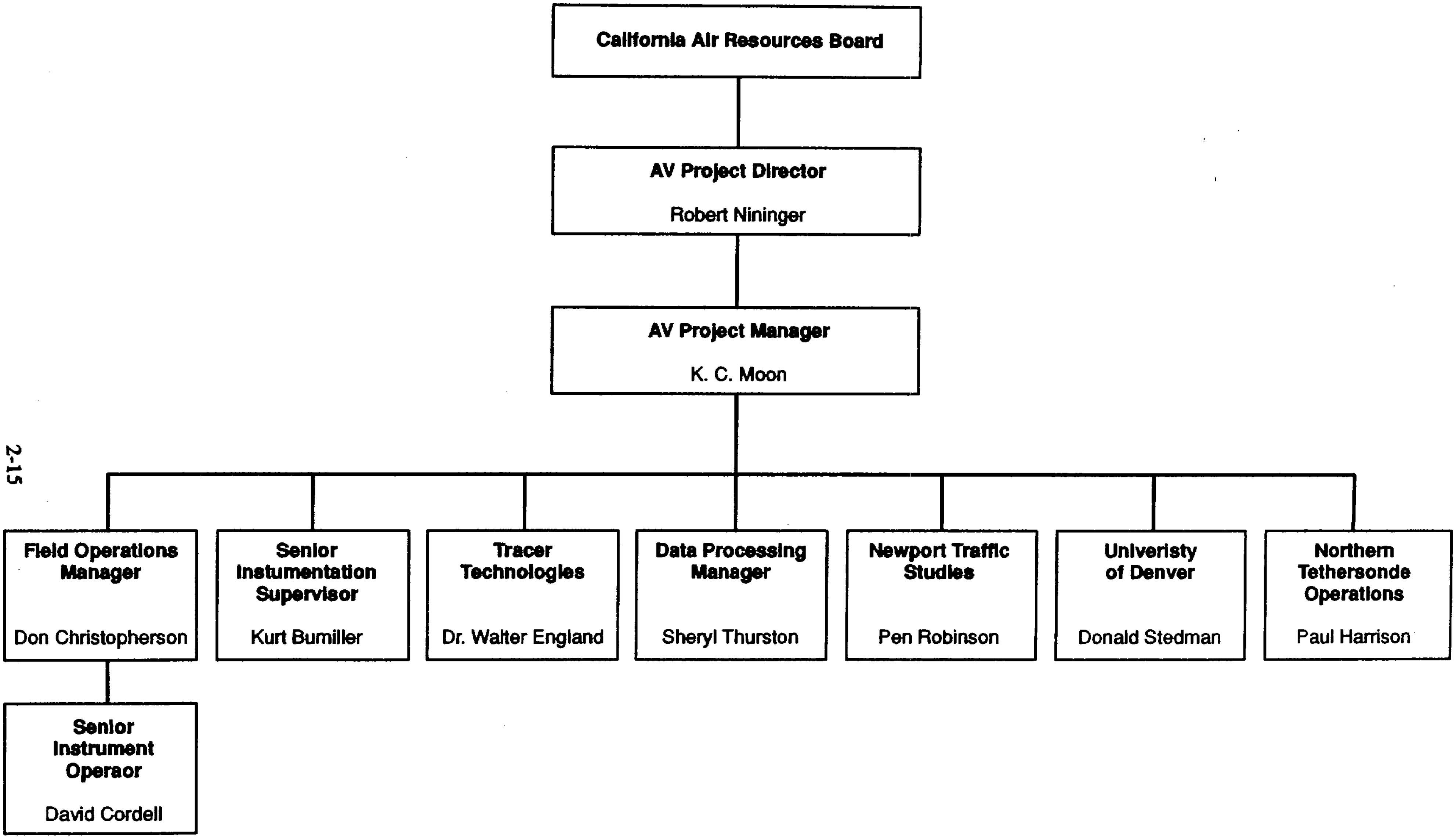

FIGURE 2–3. AeroVironment project management structure.

is responsible for keeping original data and data files from becoming lost, destroyed, discarded, or incorrectly altered.

The people in charge of managing the project for our subcontractors are

Tracer Technologies	Dr. Walter England
Newport Traffic Studies	Ms. Pen Robinson
University of Denver Research Group	Mr. Donald Stedman
Northern Tethersonde Operation	Dr. Paul Harrison

Section 3

SAMPLE COLLECTION AND ANALYSIS PROCEDURES

3.1 SAMPLE COLLECTION

3.1.1 Intensive CO Measurement Call-Up Procedures

Every Monday, Tuesday, and Wednesday, at 1500 hours local time, the AV project manager will call the ARB control center to find out if CO monitoring will be conducted the following day. If a "GO" message is received, the intensive sampling period will begin at 1200 hours (noon) the following day. Following receipt of a "GO" message, the project manager will contact the field operations manager and the senior instrument operator and instruct them to start preparations. In addition, he will notify the subcontractors, property owners of each sampling site, and Federal Aviation Administration personnel, as described in the correspondence contained in Appendix H.

At 0900 hours local time the following day, before final deployment, the AV project manager will call the ARB control center to confirm the "GO" status and to report the readiness of the field operations. Unexpected changes in the meteorological conditions or equipment problems may cause the intensive to be postponed.

The "GO" message will be transmitted at the direction of the project manager to our subcontractors, Tracer Technologies, Newport Traffic Studies, the University of Denver Research Group, and Dr. Paul Harrison, before 1600 hours on the day that the message is received. Confirmation of "GO" status will be communicated as soon as it is received at about 0900 hours the day of the intensive.

During and after each intensive, the AV project manager will inform the ARB control center about the state of the intensive. After 48 hours following an intensive, the AV project manager will contact the control center about the timing of the next intensive.

If a "NO GO" message is received, then the time frame for a "GO" day will be discussed, and the project manager will continue daily communication with the control center.

3.1.2 Sampler Preparation and Transport

At the start of the program, the integrated air samplers will be assembled and the necessary sample bags, batteries, and spare parts will be stocked. The aluminized mylar bags that will be used during the program will be labeled, leak tested, and blank tested. Immediately following receipt of "GO" status, the final sampler preparations will take place. First, the sampler batteries will be tested, the samplers will be activated, and the sample bags will be attached to the sampler manifolds. Next, the sampler clocks will be set at local time (PST) and the systems will be programmed.

Before confirmation of "GO" status at 0900 on the day of the intensive, the samplers will be loaded into vehicles and transported to the sampling sites. One field team will be dedicated to each of five geographic areas (Figure 3-1). The field teams will leave AV by 0630 and set up the stations by 1200 hours. At the end of the intensive the following day, the field team will check each sampler, close off the sample bags and transport the samplers with the samples still connected to the manifold to AV. Any vandalism or theft of samplers will be reported to the project manager and field operations manager or senior instrument operator.

3.1.3 Sample Collection

The samplers will be positioned at the locations shown in Appendix A. No adjustments will be made to the systems once they are in the field. If a sampler appears to be damaged, the field team member will contact the project manager and field operations manager, senior instrument operator or other project personnel immediately for instruction.

3.1.4 Communication

Throughout each intensive, the field team members, project manager, field operations manager, and senior instrument operator will carry pagers for communication. When a field team member's pager sounds, he or she will telephone AV immediately before proceeding with any other activity, including the deployment of samplers. During each intensive, project personnel will be headquartered in a control room to expedite communication.

3.1.5 Site Visits

AV field team members will not visit the tracer release sites at any time during the monitoring program. ARB and AV management personnel may visit either the sample collection sites or the tracer release sites without notification. However, no person will visit a sample collection site after visiting a tracer release site during a given intensive, nor will any vehicle be used for both purposes.

If, during a site visit, unusual circumstances or problems are observed, the visitor will report his findings to the AV project manager and field operations manager or senior instrument operator.

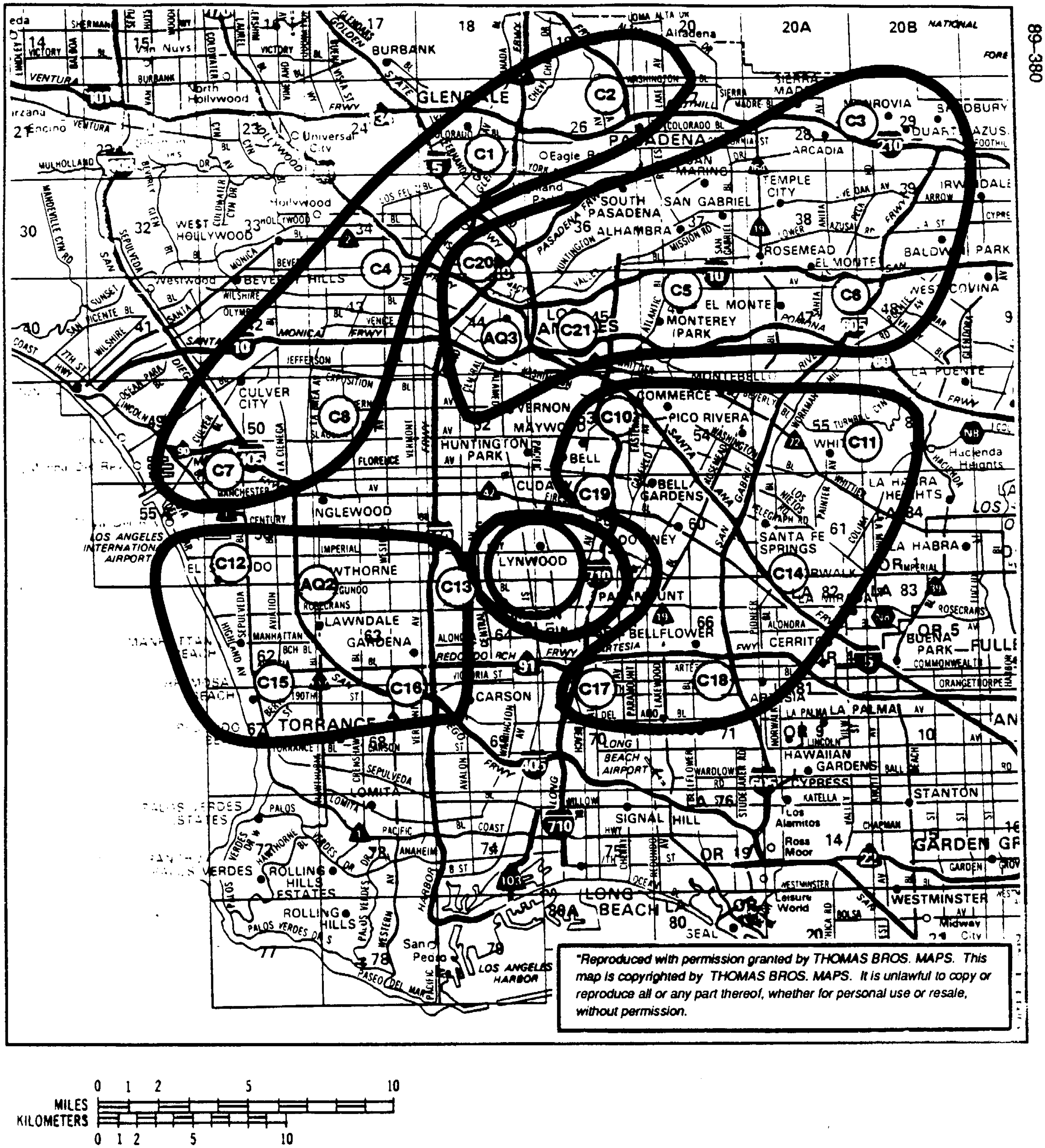

FIGURE 3–1. Designated areas for sampler distribution.

3.2 SAMPLE DOCUMENTATION

3.2.1 Sample Identification

All samples collected during the monitoring program will be given a master identification number and eleven-digit code for rapid identification. The sample bags will be labeled before leak testing and blank collection. The master identification number will appear in the upper right corner of each bag. The eleven-digit code will have five components that identify the sample type, location, sampler number, sampling round, and bag number. The first two digits, IA, will identify the sample type as an integrated ambient air sample.

The next four digits will identify the sample location:

AQ02	Air Quality Station Number 2
CC15	Cloud Characterization Station Number 15
HS08	Hot Spot Site Number 8

The third component will indicate the sampler number, 01 through 42. The fourth component will be the sampling round, 1, 2 or 3, and the last will be the bag number, 1 through 24.

The following examples will help clarify the sample identification scheme:

IA-CC21-23-2-05	The integrated air sample collected in Bag No. 5 at Cloud Characterization Site No. 21 using Sampler No. 23 during the second intensive.
IA-AQ03-02-1-16	The integrated air sample collected in Bag No. 16 at Air Quality Station No. 3 using Sampler No. 2 during the first intensive.

3.2.2 Sampler Labels

The integrated ambient air samplers will be labeled at the time of sample collection. When the samplers are deployed, the sampler number, sampling location, date and time of sampling, and the signature of the field team member will be recorded on the labels. The information will be written clearly in water proof ink. Figure 3-2 shows several sample labels.

3.2.3 Station Log

A hardbound field log book with prenumbered pages will be used to record observations, field data, and activities as they relate to the progress of the investigation. The field team member will carry the log book with him whenever he is in the field. Every site entry and exit by any person for any purpose will be

Bag No. : ____________
Sampler ID : ____________
Sampler setup : 1 hr 2 hr
Sample date : ____________
Sample time : ____________
Port No. : ____________
Site : ____________

Comments :

Bag No. : ____________
Sampler ID : ____________
Sampler setup : 1 hr 2 hr
Sample Date : ____________
Sample time : ____________
Port No. : ____________
Site : ____________

Comments :

Bag No. : ____________
Sampler ID : ____________
Sampler setup : 1 hr 2 hr
Sample date : ____________
Sample time : ____________
Port No. : ____________
Site : ____________

Comments :

Bag No. : ____________
Sampler ID : ____________
Sampler setup : 1 hr 2 hr
Sample Date : ____________
Sample time : ____________
Port No. : ____________
Site : ____________

Comments :

Bag No. : ____________
Sampler ID : ____________
Sampler setup : 1 hr 2 hr
Sample date : ____________
Sample time : ____________
Port No. : ____________
Site : ____________

Comments :

Bag No. : ____________
Sampler ID : ____________
Sampler setup : 1 hr 2 hr
Sample Date : ____________
Sample time : ____________
Port No. : ____________
Site : ____________

Comments :

FIGURE 3-2. Integrated air sample labels.

clearly recorded. Any occurrence that might affect the operating status of the station or help in future data interpretation will be documented. Such occurrences include instrument or sampler malfunctions or suspected malfunctions, power failures, unusual data points or unusual atmospheric phenomena such as severe weather. All equipment maintenance, repairs and calibrations will also be recorded thoroughly.

Entries in the log book will be written in waterproof ink. They will include the name of the author, date and time of entry, location of the activity, names and affiliations of personnel on site, sample collection or measurement methods, and identification numbers of samples collected, field observations and any comments.

The field operations manager will review the log book documentation for accuracy and completeness and either sign the log book verifying the quality of the entry or direct the author to amend or complete the entry.

3.2.4 Checklist

When the samplers are prepared for the field, a check list will be filled out by the person conducting the preparations (Figure 3-3). The checklist will document the sampler number, date and time of preparation, sample bag numbers and associated sampler ports, and the author's signature. The checklist will remain with the sampler at all times during the intensive. When the sampler is deployed, the field team member will record the sampling site location, date, time, and his signature on the checklist. Similarly, when the sampler is recovered, the field team member will record the date, time, and his signature.

3.2.5 Calibration Forms

The calibration forms for the meteorological instruments and CO analyzer are contained in the specific standard operating procedures manuals appended to this work plan. Instrument calibrations will be made according to the manufacturer's instruction, as described in the manuals. The calibration forms that will be used by Tracer Technologies are shown and described in Section 6 of their quality assurance plan. The plan is included as Appendix B.

3.2.6 Corrections to Documentation

Original data recorded in field notebooks, chain-of-custody records, and other forms will be written in waterproof ink. None of these documents will be altered, destroyed or discarded even if they are illegible or contain inaccuracies that require correction. If an error is made, the document will be corrected by the individual who made the entry by drawing a single line through the incorrect information and entering the correct information. All corrections will be initialed and dated.

AeroVironment Inc.

Bag sampler record

Monrovia check out :			Port No.	Time	Bag No.
Date :	________		1	____	________
Time :	________		2	____	________
Tech. :	________		3	____	________
Sampler Id. :	________		4	____	________
Sampler setup :	1 hr 2 hr		5	____	________
Sampler Pumps :	________		6	____	________
Sampler clock :	________		7	____	________
Batt voltage :	________		8	____	________
			9	____	________
Sampler deployment :			10	____	________
			11	____	________
Date :	________		12	____	________
Time :	________		13	____	________
Tech. :	________		14	____	________
Site :	________		15	____	________
Clock :	________		16	____	________
Bags open :	________		17	____	________
			18	____	________
			19	____	________
Sampler pick-up :			20	____	________
			21	____	________
Date :	________		22	____	________
Time :	________		23	____	________
Tech. :	________		24	____	________
Clock :	________				
Bags closed :	________				

Comments :

FIGURE 3-3. Bag sampler checklist and chain-of-custody form.

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3.3 SAMPLE CUSTODY

The purpose of sample custody procedures is to document the history of sample collection from the time of sample container preparation, through sample collection, shipment, and sample analysis. An item is considered to be in custody when any of the following apply:

- it is in the physical possession or view of the responsible party
- it is secured by the responsible party to prevent tampering
- it is secured by the responsible party in a restricted area

The checklist described in Section 3.2.4 will function as a field chain-of-custody form. One checklist will be filled out for each sampler. It will document sample possession from the time of collection to the time of receipt by AV. It will include complete sample collection information.

The collected samples will always be accompanied by the chain-of-custody record. The field team will maintain sample custody until the samples are transported to AV for CO analysis. Following CO analysis, the samples will be shipped to Tracer Technologies for perfluorocarbon analysis. At the time the samples are transferred to Tracer Technologies, the individuals relinquishing and receiving the samples will sign and date a sample inventory form.

The analytical laboratories will receive samples in a designated area of the laboratory. A sample custodian will check to make sure that the custody seal on the shipping container has not been broken. He will unpack the samples and verify the arrival of all samples against the inventory form. If there are any problems that may affect the sample integrity or any discrepancies between the samples and inventory record, the sample custodian will notify the AV project manager immediately.

3.4 SAMPLE SHIPPING

The sample bags will be packed into boxes and picked up by Tracer Technologies. Samples from only one sampler will be included in each box. AV's name and address will appear on each box.

3.5 SAMPLE ANALYSIS

The integrated ambient air samples will be analyzed for CO and the tracer gases. The CO analysis will be conducted by AV at their laboratory in Monrovia. The sample analysis will be completed within 72 hours of sample collection. The tracer analysis will be conducted by Tracer Technologies at their laboratory in San Diego. It will be completed within 240 hours (ten days) of sample collection.

3.5.1 CO Analysis

CO analysis will be performed using a Beckman 866 ambient CO monitoring system. The system measures differences in the absorption of nondispersed infrared energy to quantify the concentration of CO. Approximately three liters of sample will be drawn through the monitoring system by its internal pump. The sample will pass through a cell where it is exposed to infrared radiation (IR). A portion of the IR will be absorbed by the CO in the sample, with the percentage of IR absorbed being proportional to the CO concentration.

During the analysis, the IR beam will pass through two flow-through cells, the sample cell and a reference cell receiving a continuous flow of CO-free air. The difference in IR absorption between the sample and reference cells will be quantified.

3.5.2 Tracer Analysis

The samples will be prepared for tracer analysis using an absorption/adsorption process. One liter of each ambient air sample will be absorbed onto a carbon sorbent trap. Following loading, the sample will undergo flash thermal desorption, with the off-gas flowing to a catalytic reactor followed by a low-volume permeation dryer. From the dryer, the sample will be passed to a secondary carbon sorbent trap and through a short pre-column to remove potential high molecular weight compounds that may interfere with the analysis.

Following preparation, the samples will be analyzed using gas chromatography with electron capture detection (ECD). Analytical compound separation will be achieved with a silicon OV101 column operated at 50°C. The compounds of interest will be quantified by a Valco ECD. The output signal will be recorded by a Baseline data acquisition system for subsequent reporting.

Section 4

STANDARD OPERATING PROCEDURES

4.1 AIR QUALITY SAMPLERS

Three different types of air quality samplers will be used during the monitoring study. The samplers are designed to collect integrated ambient air samples through a single inlet into sample bags for later analysis. They are multiple-bag air collection systems that fill the bags sequentially over specified sampling periods. The sample collection is controlled by built-in electronic time clocks that are easily programmed. Once a sample has been collected, the sampler seals it off by a one-way valve. A pinch clamp is then used to close the sample container before the bag is removed from the sampler. The samplers are powered by batteries. The air quality sampler operations manuals are contained in Appendices C, D, and E.

4.1.1 Air Quality Sampler I - Instrument Description

Air Quality Sampler I was designed and constructed by the Washington State Department of Ecology specifically for CO studies. It is a sequential sampler capable of unattended collection of one- or two-hour integrated ambient air samples. The sampler consists of a cabinet housing a control assembly and a pump assembly. The sample intake port and battery power connector are located on the top of the cabinet. Three rows of bulkhead sample port fittings for connection to the sample bags are located on the back panel of the sampler extending to the outside.

4.1.2 Operating Procedure

The operating procedures for Air Quality Sampler I are listed in the operations manual contained in Appendix C.

4.1.3 Air Quality Sampler II-Instrument Description

Air Quality Sampler II was developed and patented by Environmental Measurement, Inc. (EMI). In 1982, AV purchased the sampler line. It is also a sequential sampler capable of unattended collection of one- or two-hour integrated ambient air samples. The sampler consists of two units, a drum bag chamber and a lid assembly. The drum bag chamber serves as a protective shell for the samples, battery, and control assembly. The battery pack is located inside and at the bottom of the drum. The lid assembly houses the timer controller and air pumps. It holds the locking ring designed to open and close the apparatus. The whole system is covered by a rain shelter cap.

4.1.4 Operating Procedure

The operating procedures for Air Quality Sampler II are discussed in Section 3 of the operations manual, which is contained in Appendix D.

4.1.5 Air Quality Sampler III-Instrument Description

Air Quality Sampler III was also designed by EMI. It is capable of collecting sequential ambient air samples integrated over one or two hours. It consists of four modules: the electronic time controller; the pump assembly, including the sample cane and inlet manifold; the sample bag box; and the power supply. All four modules fit into a four-cubic-foot rectangular enclosure.

4.1.6 Operating Procedure

The operating procedures for Air Quality Sampler III are discussed in Section 3 of the operations manual, which is contained in Appendix E.

4.1.7 Air Quality Sampler Calibration

No calibration of the controller electronics is necessary. Similarly, the sample flow rates have been calibrated by the manufacturer and should not require further adjustment under normal operating conditions.

4.1.8 Air Quality Sampler Maintenance

Only two items require periodic maintenance. They are the batteries and the pumps.

o **Pump Maintenance**

The pump chamber should be periodically opened and cleaned to avoid excessive dust and small debris accumulation. The pump chamber is not filtered; therefore, cleaning is required for continued good pump operation. Pumps are best cleaned by blowing them out with low pressure compressed air, such as an aerosol can of dry air.

o **Battery Maintenance**

The batteries should be checked each time the sampler is to be used or at least every 100 hours to insure adequate battery power for reliable operation. Check the batteries by disconnecting the battery pack connector and test with a voltmeter. Across the two terminals inside the female socket the voltage should be 9.0 volts or greater. If not, remove battery pack and change the batteries.

NOTE: Disconnect the battery pack from the controller when the station is not used for more than a week.

4.2 CO ANALYZER

4.2.1 Instrument Description

The Beckman ambient CO monitoring system automatically and continuously analyzes ambient air for CO by nondispersive infrared spectroscopy. The system consists of four interconnected units: the pump/sample-handling module, gas-control panel, analyzer unit, and automatic zero/span standardizer. The pump/sample-handling module consists of a diaphragm pump with associated inlet and outlet filters and pressure relief valve. It intakes ambient air and supplies a constant stream to the gas control panel. The gas-control panel routes gases to the sample and reference cells of the analyzer unit. Electronic circuitry within the analyzer unit measures the difference between the amount of infrared energy absorbed in the sample and reference cells. The automatic zero/span standardizer provides periodic standardization of the system every 5 minutes and 30 seconds.

4.2.2 Operating Procedure

The operating procedures for the ambient CO monitoring system are contained in Sections 3 and 4 of the operations manual, which is included as Appendix F.

4.2.3 Calibration

The calibration procedures for the system are contained in Section 3 of the operations manual (Appendix F).

4.2.4 Maintenance

The maintenance procedures for the system are contained in Section 6 of the operations manual (Appendix F).

4.3 METEOROLOGICAL INSTRUMENTATION

4.3.1 Fixed Height Measurement-Instrument Description

The fixed-height meteorological data will be collected using a 10-meter meteorological tower with a Gill UVW propeller anemometer, capable of measuring wind vectors in three directions, and an ambient temperature sensor. The UVW anemometer is designed for maximum sensitivity at low wind speeds and has a working range between 0 and 25 meters per second. Each propeller measures the component of wind that is parallel with its axis of rotation. The propellers have a starting threshold of 0.6 miles per hour. Air temperature will be measured by a thermistor with at least +/-0.5°C accuracy.

The meteorological tower will use a Campbell CR20 electronic data logger to read and record data from the wind monitor. The datalogger will either be programmed manually or with a laptop computer. The data will be downloaded in the field to a laptop computer.

4.3.2 Operating Procedure

The operating procedure for the fixed height meteorological instrumentation is contained in Appendix G.

4.3.3 Multiple Height Measurement - Instrument Description

The multiple height meteorological data will be collected by two tethersonde systems. The systems will measure wind speed and direction and dry-bulb and wet-bulb temperatures. Each system consists of an airborne sensor package or tethersonde, a blimp-shaped 2.25-cubic-meter or larger balloon, a winch, and an atmospheric data acquisition system (ADAS). The system requires 110 or 220V ac power. Meteorological profiles from the ground surface to up to 800 meters and back may be made in 20 to 30 minutes.

The tethersonde will consist of five sensor systems. Dry-bulb and wet-bulb temperatures will be sensed by precision-matched thermistors. Wind speed and direction will be measured by a three-cup anemometer and magnetic compass, respectively.

4.3.4 Operating Procedure

The operating procedure for the multiple height meteorological instrumentation is contained in Appendix H.

4.3.5 Meteorological Instrumentation Calibration

The meteorological weather station and the tethersonde systems will be calibrated according to manufacturers' recommendations before the start of the field program.

4.3.6 Meteorological Instrumentation Maintenance

The stationary meteorological instruments will be checked for integrity and response to winds every two weeks or on the morning of equipment deployment, as appropriate, for the duration of the study.

Section 5

QUALITY ASSURANCE

The following section defines the data quality goals of the project in terms of accuracy, precision, and completeness and presents, in specific terms, the quality control activities required to obtain them.

5.1 QUALITY ASSURANCE OBJECTIVES

Table 5-1 contains the quality assurance (QA) objectives for each measurement parameter, including all field and laboratory investigations that generate data.

5.1.1 Analytical Detection Limits

The minimum detection limit (MDL) of a substance is the minimum concentration of that substance that can be measured and reported with 99 percent confidence that the true value is greater than zero. The MDL objective for CO analysis is 1 ppm_V. The MDL objectives for the tracer analyses are 20 fL/L for perfluoromethylcyclopentane (PP1/2) and perfluoromethylcyclohexane (PP2) and 30 fL/L for perfluorodimethylcyclohexane (PP3a) and perfluorotrimethylcyclohexane (PP4).

5.1.2 Accuracy

Accuracy is the degree of agreement between the measurement of the average of measurements for a parameter and the accepted reference or true value. It is a combination of the bias and precision in a measurement system.

To ensure accurate sample collection and field data acquisition, operating procedures for sample collection and handling, and data documentation have been established (Section 4). Experienced field personnel will train and manage the field teams in use of the correct protocols. The field equipment that will be used was designed specifically for the purpose for which it will be used. It is constructed of materials that prevent contaminant adsorption and offgassing and minimize the potential for cross contamination.

Before the program, all of the samplers will be tested over at least one 24-hour trial period to verify that they are operational and fill the sample bags to the appropriate fullness. Blank testing will be conducted on at least two bags from each lot (a total of 76 bags) by filling them with zero air, leaving them overnight, and analyzing them for CO, tracer gases, and any interfering compounds. If any contamination is detected, the bags will be flushed with CO-free air for three cycles and reanalyzed.

TABLE 5-1. Quality assurance objectives.

Sample Collection Precision	Sample Collection Completeness	Analytical Parameter	Analytical Detection Limit	Sample Analysis Accuracy	Sample Analysis Precision	Sample Analysis Completeness
80 %	80 %	CO	1 ppm_V	90-110 %	80 %	90 %
		Tracers	20-30 fL/L	90-110 %	80 %	90 %

Meaurement Parameter	Data Collection Accuracy	Data Collection Precision	Data Collection Completeness
Wind Speed	+/- 1 m/s	+/- 0.5 m/s	80%
Wind Direction	+/- 15^o	+/- 5^o	80%
Air Temp.	+/- 1^oC	+/- 0.5^oC	80%
Rel. Humidity	+/- 10%	+/- 5%	80%

% = Percent
CO = Carbon monoxide
ppm_V = parts per million by volume
fl/L = femtoliters per liter (10^{-15}L/L)
m/s = meters per second
^{o} = degrees
^oC = degrees Centigrade

Stability tests will also be conducted by filling two sets of two sample bags from each lot with 10 and 45 ppm_v tracer gases, respectively. The bags will be analyzed immediately after filling and three days and six days later.

Analytical accuracy is monitored in the laboratory by running a reference standard approximately every ten analyses. The integrated air analytical check standard results must be between 90 and 110 percent of the true value.

The following objectives have been set for the meteorological data accuracy:

Wind speed	±1 meter per second (m/s)
Wind direction	±15 degrees (^{o})
Temperature	±1 degree Centigrade (^{o}C)
Relative Humidity	±10 percent (%)

5.1.3 Precision

Precision is a measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is expressed in terms of the relative percent difference (RPD). The RPD is calculated as the difference divided by the mean, multiplied by 100.

To ensure precise sample collection, uniform sampling containers that were cleaned and prepared using the same protocol will be used throughout the sampling program. In addition, similar sample collection, handling, and transportation procedures will be followed. Sampling precision will be determined by evaluating the RPD between primary and collocated sample results at two sites.

Analytical precision is determined from duplicate analysis. Both laboratories will analyze approximately one out of every twenty samples in duplicate. The integrated air duplicate results are expected to be within 20 percent.

The following objectives have been set for the meteorological data precision:

Wind speed	±0.5 m/s
Wind direction	±5^{o}
Temperature	±0.5^{o}C
Relative Humidity	±5%

5.1.4 Completeness

Completeness is a measure of the amount of valid data obtained for a measurement system compared to the amount that was expected to be obtained under correct normal conditions.

The completeness objective for the sample collection and analysis is 80 percent and for the meteorological data collection is 80 percent.

5.2 SYSTEMS AUDITS

The ARB will conduct a systems audit and a performance audit during the monitoring study. The systems audit will include on-site inspection of instrument and measurement systems operation and maintenance, and sample collection, handling and custody protocols. The performance audit will entail challenging the CO analysis instrumentation with standards to verify measurement accuracy.

Internal performance and systems audits will be conducted by Tracer Technologies laboratory to verify that proper procedures are followed. Their quality assurance manager will conduct the audits and will be responsible for providing the spikes and blanks that are used to validate system performance.

Tracer Technologies' program manager will audit the tracer releases to ensure that proper procedures are followed by the release engineer.

5.3 CORRECTIVE ACTION

Corrective action will be initiated whenever accuracy, precision, or completeness deviates from its objective value. Problems will be identified by field or management personnel or through audits. Corrective action will begin by identifying the source of the problem. Potential problem sources include failure to adhere to prescribed procedures, equipment malfunction, or systematic contamination. Examples of remedies for these problems include more intensive training programs, equipment repair followed by more intensive maintenance programs, and elimination of the contaminant source.

The ultimate responsibility for quality assurance of all project activities resides with the manager of AV's quality assurance department. The project manager is responsible for the quality control activities of the project. Consequently, the project manager will initiate corrective actions and the QA manager will monitor their progress and ensure that they proceed in a timely manner.

5.4 QUALITY ASSURANCE REPORTS TO MANAGEMENT

The ARB will report the results of their systems and performance audits to the project manager within one month of the audits.

Any suspected or documented field quality control problems, including the use of incorrect standard operating procedures and sample handling and custody procedures, improper operation of field equipment, or deficiencies in the recording of field data will be documented by the field operations manager in a written report and submitted to the project manager immediately after they are identified.

Any suspected or documented laboratory quality control problems, including the use of incorrect standard operating procedures and sample handling and custody procedures, improper operation of instrumentation or deficiencies in the recording of analytical data will be prepared by the senior instrumentation supervisor and submitted to the project manager immediately after they are identified.

Section 6

DATA VALIDATION

6.1 SAMPLE COLLECTION DATA

The sample collection data will be recorded by the field teams during each intensive. The field operations manager is responsible for reviewing the data for accuracy and completeness. If problems are discovered, he will direct the field team member to complete or amend the entry. All raw field data, including sample data forms, chain-of-custody documentation, and log books will be kept by AV's data management group.

The integrated ambient air samples will be flagged if the duration of sample collection cannot be verified or if the sample is damaged or deteriorated during collection or transport.

6.2 METEOROLOGICAL DATA

Meteorological data will be reduced and tabulated by AV's data management group. It will be reviewed by the senior instrumentation supervisor for completeness and consistency. All raw data, including strip charts, will be kept by the data management group.

6.3 LABORATORY DATA

CO analysis data will be recorded on data forms by the analyst. The senior instrumentation supervisor is responsible for reviewing the data daily to ascertain that it is consistent and reasonable and that the quality assurance objectives are being met. He is also responsible for preparing the data report summarizing the analysis results and procedures, and submitting it to the project manager in a timely manner. All raw data, including calibration curves, data forms, and laboratory notebooks, will be kept by AV's data management group.

Data received from Tracer Technologies will be reviewed by AV personnel for consistency. The analysis results will be reviewed considering the meteorological conditions to determine whether the data are reasonable. Inconsistencies and unusual results will be examined further to determine whether they reflect actual site conditions or are the result of field or laboratory procedural errors.

Sampler Number	Site Designation	Sample Type	Sample Location	Site Priority
01	AQ02	IA	Hawthorne AQ Station	medium
02	AQ03	IA	Los Angeles AQ Station	medium
03	CC01	IA	1420 Lake St., Glendale	medium
04	CC02	IA	1065 Armade Dr., Pasadena	medium
05	CC03	IA	738 E. Oakdale, Monrovia	medium
06	CC04	IA	1405 N. Edgemont, Los Angeles	low
07	CC05	IA	305 N. Lincoln Ave, #5, Monterey Pk.	medium
08	CC06	IA	12645 Fineview, El Monte	medium
09	CC07	IA	Monterey Park	medium
10	CC08	IA	3678 Fairland Blvd., L.A.	high
11	CC10	IA	2349 Strong Ave., City of Commerce	high
12	CC11	IA	7274 Canyon Crest Dr., Whittier	high
13	CC12	IA	700W Pine Ave., El Segundo	medium
14	CC13	IA	13133 S. Hoover St., Gardena	high
15	CC14	IA	11914 Lyndora, Norwalk	high
16	CC15	IA	1703 Ford Ave., Redondo Beach	low
17	CC16	IA	17513 Broadwell Ave., Gardena	high
18	CC17	IA	203 W. Artesia Blvd., Long Beach	high
19	CC18	IA	10012 Ramona St., Bellflower	high
20	CC19	IA	6940 Walker, Cudahy	high
21	CC20	IA	2300 Dorris Pl., Los Angeles	high
22	CC21	IA	2635 Lancaster Ave., Los Angeles	high

Sampler Number	Site Designation	Sample Type	Sample Location	Site Priority
23	HS01	IA	3351 E. Imperial Hwy.	high
24	HS02	IA	3301 Beechwood Ave.	high
25	HS03	IA	11220 Long Beach Blvd.	high
26	HS04	IA	11220 Long Beach Blvd.	high
27	HS05	IA	3367 Beechwood Ave.	high
28	HS06	IA	3340 Sanborn Ave.	high
29	HS07	IA	11330 Bullis Ave.	high
30	HS07a	IA	3300 Century Blvd.	high
31	HS07b	IA	3300 Century Blvd.	high
32	HS07c	IA	3300 Century Blvd.	high
33	HS08	IA	3366 E. Imperial Hwy	high
34	HS09(A1)	IA	10821 Capistrano Ave.	high
35	HS10(A2)	IA	10700 San Luis Ave.	high
36	HS11(A3)	IA	3801 Cortland St.	high
37	HS12(A4)	IA	11817 State St.	high
38	HS13(B1)	IA	9603 Croesus Ave.	high
39	HS14(B2)	IA	9329 Hildreth Ave., South Gate	high
40	HS15(B3)	IA	5300 Clark St.	high
41	HS16(B4)	IA	1324 N. Pausen Ave., Compton	high

FOOTNOTES

AQ02 = Air Quality Station
CC01 = Cloud Characterization Site
HS01 = "Hot Spot" (City of Lynwood) Site
A1 = Site is within 1 km of the "Hot spot" area
B1 = Site is within 3 km of the "Hot spot" area
IA = Integrated Ambient Air Sample

APPENDIX B

Tracer Technologies' Quality Assurance Plan

CALIFORNIA AIR RESOURCE BOARD
LOS ANGELES CARBON MONOXIDE PROJECT

TRACER STUDY
QUALITY ASSURANCE PLAN

Prepared for:

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825 Myrtle Ave
Monrovia, CA

Prepared By:

Tracer Technologies
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October 1989

<u>CONCURRENCES</u>

Name: Ms. Patricia Hobson | Phone: (619) 480-8988
Title: Quality Assurance Manager

Signature: ______________________ Date: ______________

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Title: Project Manager

Signature: ______________________ Date: ______________

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LIST OF FIGURES

1.0 INTRODUCTION AND SUMMARY

The California Air Resources Board (CARB) is sponsoring tracer study experiments as a contribution to the CARB Los Angeles Carbon Monoxide (CO) Project.

This document represents the Quality Assurance Plan relative to the tracer release and sample analysis procedures that will be imposed upon these specific project activities. All the other quality assurance / quality control (QA/QC) activities associated with the tracer experiments will be developed and implemented by Aerovironment (AV) and will be provided in a separate document.

2.0 PROJECT ORGANIZATION

The QA project organization and the direct responsibilities of the named individuals for these tests are summarized in Table 2-1. Mr. Steve Quon will serve as Project Manager and will interface directly with Aerovironment (AV). He will be responsible for the field activities relating to the release of the tracer. He will also be responsible for implementing the QA/QC program associated with the tracer release system during the field tests. Mr Stephen Kerrin will serve as Senior Chemist. His responsibilities will be to supervise the analytical laboratory including the supervision of all analyses performed and will implement the QA/QC program in the laboratory.

As Project Manager, Mr. Quon also will be responsible for organizing all the data for the final report. Ms. Patricia Hobson will serve as the project QA officer. Her responsibilities will be to oversee the QA/QC program outlined herein. She will monitor all QA/QC activities and will be responsible for performing independent performance audits.

Program Manager - Steve Quon

Manage overall program
Interact and coordinate activities with AV Project Manager
Implement QA/QC program in field

Program QA Manager - Patricia Hobson

Oversee QA/QC program
Provide QA/QC reports
Monitor QA/QC activities
Perform QA performance audits
Review QA/QC data

Senior Chemist - Stephen Kerrin

Supervise analytical laboratory
Establish analysis procedures
Train staff in analytical techniques
Review analyses data
Implement QA/QC procedures in laboratory

Project Engineer - Richard Crema

Design tracer release system.
Supervise tracer release
Assist project manager in field

Data Manager - Steve Quon

Gather test data
Perform data reductions
Generate test report

TABLE 2-1 - SPECIFIC RESPONSIBILITIES

3.0 QA OBJECTIVES

Project QA objectives for precision, accuracy, and completeness are presented in Table 3-1. Precision will be determined as the percent relative standard deviation or relative percent difference of replicate samples or analyses (relative percent difference for two values). Collocated samples used to assess precision. Accuracy will be measured by use of reference standards for gas analysis. Completeness will be measured as a percentage of the number of analytical results obtained versus the number of results generated.

QA objectives for method detection limits are presented in Table 3-2. These limits represent values above the best obtainable method detection limits of the instruments.

The data and the data reduction sequence that are critical to achieving the project goals are those linking the amount of released tracer to the concentration of the tracer measured at different locations in the sample grid. This linkage involves the desired sample concentration and the detection limit of the gas chromatograph for the perfluorocarbons. In order to ensure that enough tracer is released to be able to measure the tracer at the farthest point in the grid, the release rate was chosen so that the concentration at the farthest point be ten times the background concentration. An analysis using traditional modeling estimates of dilution and simple mass balance estimates will be used to estimate the proper tracer release rate.

TABLE 3-1 - PRECISION, ACCURACY, AND COMPLETENESS OBJECTIVES

MEASUREMENT PARAMETER	MEASUREMENT METHOD	PRECISION (%)	ACCURACY (%)	COMPLETENESS (%)
PP 1/2	GC/ECD	20	10	90
PP 2	GC/ECD	20	10	90
PP 3A	GC/ECD	20	10	90
PP 4	GC/ECD	20	10	90

TABLE 3-2 - QA OBJECTIVES FOR METHOD DETECTION LIMITS

(NOTE: fL is 10^{-15} liters)

MEASUREMENT	METHOD DETECTION LIMIT OBJECTIVE
PP 1/2	20 fL/L
PP 2	20 fL/L
PP 3A	30 fL/L
PP 4	30 fl/L

4.0 RELEASE PROCEDURES

The objectives of the tracer release are to release a known amount of tracer in the atmosphere at a constant rate. Great care must be taken to ensure that the release rate is constant and that the tracer is properly atomized.

Tracer Technologies has chosen four unique tracer compounds for this study: perfluoromethylcyclopentane (PMCP), (PP-1/2);perfluoromethylcyclohexane (PMCH), (PP-2) and per-fluoro-1-1,2-dimethylcyclohexane (PDCH-A), (PP-3A); per-fluorotrimethylcyclohexane (PTCH), (PP-4). The attractive qualities of these compounds are that they have extremely low global backgrounds and that they can be measured in concentrations as low as 20 femtoliters (10^{-15} liters/liter). However, this sensitivity greatly increases the chances of contamination so great care must be taken to ensure that tracer is not inadvertently released at any time in the test frame window.

Three steps are taken to ensure that the tracer cannot contaminate the test grid or the collected samples. First, a storage place in San Diego will be used to store the tracers when they are not in use. This will ensure that if there is a tracer leak, the leak will not likely affect the sampling grid, since the predominant winds are from the west. Secondly, the pressure drums used to store the tracer will be filled with tracer at least 3 days prior to any test at the storage location to ensure that any spillage occurring during fill-up will not affect the sampling grid. Thirdly, great care will be taken to ensure that the pressure drum is leak free during transport and storage.

During the actual test, it it important that the release system be leak-free so that a second plume is not generated to contaminate the test grid. High vapor pressures and the requirement for quantitative releases of two unique tracer materials place additional constraints on the integrity of the release system. Any fugitive tracer emissions from the ground level or aerial release system could significantly bias the observed downwind concentrations, especially in the near field. To verify that no accidental releases have occurred, the drums containing the perfluorocarbons will be weighed before and after each release as a check on the release systems performance.

4.1 RELEASE SYSTEM

To minimize the potential for accidental release, Tracer Technologies will use the release system shown schematically in Figure 4-1. The system will be capable of atomizing one tracer liquid for ground release. There will be two of these systems available for use.

To insure a closed system from tracer reservoir to actual release point, sufficient tracer will be loaded into metal drums with shut-off valves on the inlet and outlet connections. The drums will be connected to a source of compressed air which will be used, rather than a liquid pump, to establish liquid flow. The use of compressed air eliminates the need for a pump and a vacuum breaker on the drum, thus reducing the possibility of unwanted tracer emission.

Tracer Technologies intends to use a Nupro fine-metering valve in series with an Omega slow-flow Rotameter to monitor and control the flow of the tracer. Meter readings will be visually checked and recorded in a log every 10 minutes to monitor and correct any fluctuations in the flow rates. A platform scale will be used to weigh the drums before and after the release as a check on release system performance.

The releases require immediate and thorough vaporization of the liquid material into a non-buoyant plume. To achieve this, the liquid will be aspirated with a spray nozzle. The same compressed air source used to pressurize the reservoir will be used to atomize the liquid.

4.2 TRACER RELEASE PROCEDURES

The tracer release engineers accompanied by the field test manager will operate the release system. One engineer will be able to control the release of both tracers for the first test from a centrally located release station. Since the release locations for the second test are apart, two engineers will be needed to perform the releases. Specific responsibilities of the tracer release engineers are as follows:

- On the designated test day, he will arrive at the release location 3 hours before the scheduled release time to set up the system as pictured in Figure 4-1.

- o All system components will be checked for proper operation and leak-proof connections and the tracer drums weighed.

- o After the release system is in place, he will inform the field test manager that the system is ready for tracer release.

- o At tracer release initiation the tracer release engineer will check-in with the field test manager.

- o Maintain the tracer release rate at the desired levels.

- o Record all operating data in a bound notebook.

- o At the end of the tracer release, the engineer will dismantle the release system and weigh the tracer drum. He will ensure that all shut-off valves are off on the pressure vessel and that there are no obvious leaks.

- o The tracer release engineer will then leave the release site and drive to the storage location using a route that is at least five miles away from any sampler. He will inform the Field Manager when he is leaving the site.

- o He will shower and change clothes before he returns to the Escondido Laboratory. The vehicle he has used will be declared off limits for all samples and sample equipment.

4.3 FIELD MEASUREMENT OF TRACER RELEASE

During the actual tracer release, the release engineer will record the rotameter readings every five minutes. In addition, he will weigh the tracer drum prior to and after the tracer release period using a platform scale. The form he will use to record the readings and weights is shown in Figure 4-2.

TRACER RELEASE SYSTEM SCHEMATIC

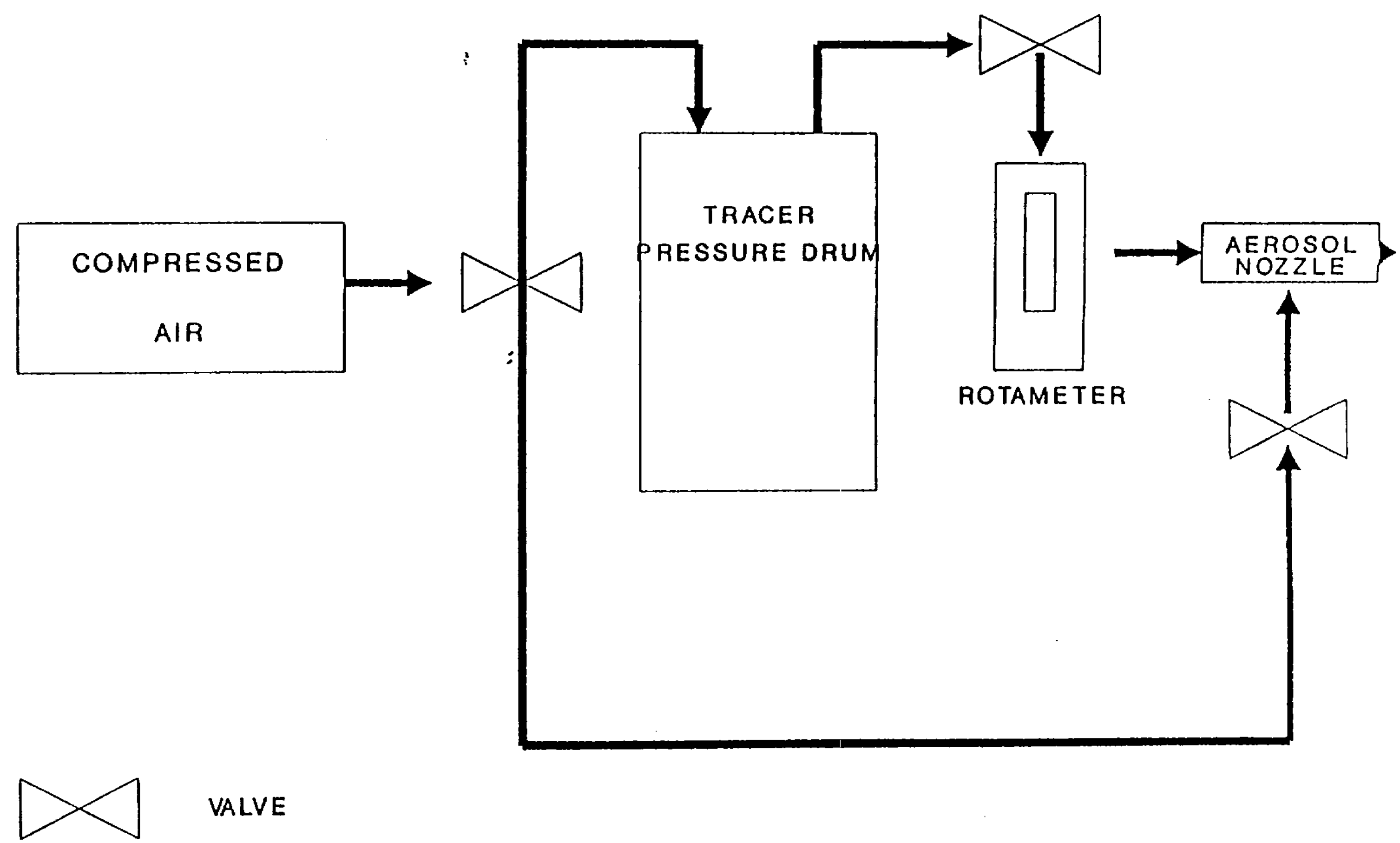


Figure 4-1 Tracer Release System

SUBJECT: TRACER RELEASE MEASUREMENT	TRACER TECHNOLOGIES QUALITY ASSURANCE

TECHNICIAN:		DATE:
TRACER:	TIME START:	TIME END:
INITIAL MASS:	FINAL MASS:	MASS RELEASED:

TIME	ROTAMETER READING	EQUIVALENT FLOW RATE

FIGURE 4-2 - TRACER RELEASE FORM

5.0 LABORATORY ANALYSIS

The following section includes the process by which the samples are returned to the laboratory and analyzed by gas chromatography.

5.1 SAMPLE LOG-IN

The samples will be transported by ground to the analytical facility in Escondido. The analytical facility is physically separated from the normal Tracer Technologies laboratory area where routine handling and storage of perfluorocarbons occurs in order to prevent the chance of contamination. All sample bags will be stored in an impound area of this facility until the project is completed. The bags will be stored by sampler location to facilitate the analysis of a particular sample.

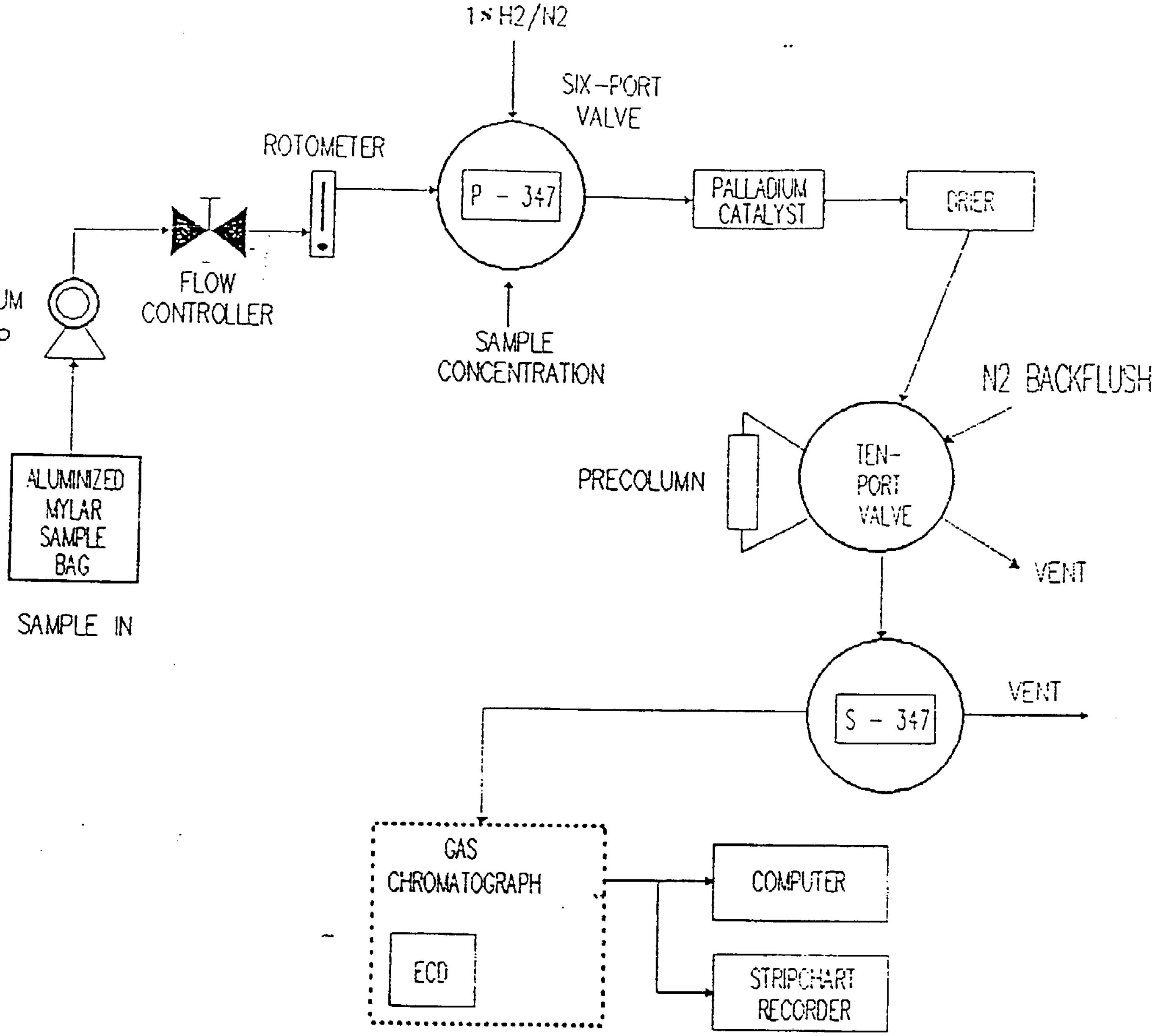
When an instrument operator requires a sampler bag for analysis, the supervisor removes one from the impound area, enters analysis path data into the computer, and transfers the bag to the operator.

5.2 SAMPLE ANALYSIS

The analysis methodology is described in the following sections. The sample is prepared for analysis through an absorption/adsorption process while all interfering compounds are removed. The sample is then analyzed by GC/ECD. Operation of the analysis system is fairly simple since all the valve switching, heating and sample injection is computer controlled by the Baseline™ control and data acquisition system. All the operator has to do is enter the sample number into the system and attach the sample onto the sampling port and the rest is computer controlled.

5.2.1 Sample Preparation

Once the operator initiates the analysis process, the sample is then subjected to an established sample preparation/analysis protocol (Dietz et. al., 1981; Dietz and Senum, 1986; Ferber et. al., 1981; and Ferber, 1985). As shown in Figure 5-1, the sampling bag will be downloaded (1 liter of analyte) through a dry test meter onto the carbon based sorbent trap. Once loaded, the sample will



P 347 PRIMARY AMBERSORB 347 TRAP
S 347 SECONDARY AMBERSORB 347 TRAP

Figure 5-1 - GC ANALYSIS CONFIGURATION

undergo flash thermal desorption with the off-gas flowing to the catalytic reactor. This reactor is packed with 20 mesh molecular sieve which has been coated with palladium, 5% by weight; reactor temperature is maintained at 160 C. Any non-perfluorinated compounds such as the chlorofluorocarbons desorbed from the primary carbon based sorbant trap will be destroyed in this reactor. In addition, the presence of hydrogen in the reactor carrier gas will reduce any residual traces of oxygen to water.

Subsequently, the sample passes from the reactor through a low volume permeation dryer. From the dryer the gas stream is passed to a secondary carbon based sorbent trap through a short pre-column which holds up potential high molecular weight compounds that may interfere with the analysis.

Upon completion of this preparation cycle, both sorbent traps are heated and back-flushed with dry nitrogen to regenerate the ambersorb resin.

5.2.2 Gas Chromatographic Analysis

Once the sample is processed through the preparation cycle, the sample is introduced into the GC. A silicon OV101 column, operated at 50 C is used for separation. A Valco ECD detector is used to quantify the tracer compounds. The output signal is then recorded by the Baseline™ data acquisition system. A stripchart recorder is also used to back-up the chromatograph. The operator will transfer a sticker from the bag sample to the stripchart chromatogram labeled with the appropriate sample number.

6.0 INSTRUMENT CALIBRATION

This section describes the measurement system calibration procedures used to ensure quality data. Field measurement and laboratory measurement calibration procedures are addressed in turn.

6.1 PERFLUOROCARBON ANALYSES

Calibration of the GC system will be performed daily. Prior to any analysis, a three point calibration curve will be obtained and response factors will be calculated from this curve. In addition, every 8 hours of analyses, a reference standard in the middle range of the response curve will be run to check instrument performance. If there is more than a 10% variation in the response of the reference sample from the calibration curve, a new calibration will be performed. The documentation form used for the calibrations is shown in Figure 6-1. All calibration runs will be performed using the same procedures as a normal analysis run.

All standards were prepared by the Scott-Marrin Company. Arrangements have been made with Brookhaven National Laboratories to audit the standards to be used in this test. Samples of these Scott-Marrin standards will be analyzed by Brookhaven to certify their final concentrations.

6.2 ROTAMETER CALIBRATION

Prior to in-field use, the tracer release engineer will be responsible for calibrating the rotameter used to monitor the tracer release rates. The rotameter will be calibrated as follows:

- The release set-up will be the same as that used for a tracer release except that instead of aspirating the tracer, the tracer will be collected from the rotameter into a closed container.
- The container will be weighed prior to and after each calibration run to determine the weight of tracer released, M_t .
- The tracer drum will be pressurized to 30 PSI during each run.

CALIBRATION SHEET

Day/Month:____________ 19_____

Operator:____________

Test #:____________

Sheet #:____________

DATE/TIME	INPUT CONCENTRATION	PEAK HEIGHT				Comments/Init.
		PP-1/2	PP-2	PP-3A	PP-4	

Figure 6-1 GC Calibration Data Sheet

- During each run the engineer will use a stop-watch to time the length of the run, t_r.
- A minimum of 3 test runs will be run for each rotameter reading.
- A minimum of 5 different rotameter readings will be used for the calibration curve.
- In plotting the curve, the engineer will use the average of the three masses and times to calculate an equivalent flow-rate.
- A sample rotameter calibration form is presented in Figure 6-2.

Figure 6-2

ROTAMETER CALIBRATION FORM

SUBJECT: ROTAMETER CALIBRATION	TRACER TECHNOLOGIES QUALITY ASSURANCE
TECHNICIAN: MANUFACTURER:	DATE: MODEL #:

ROTAMETER READING	TIME	INITIAL MASS	FINAL MASS

7.0 DATA VALIDATION, AND REPORTING

The flow of data and the data reduction and reporting scheme is illustrated in Figure 7-1. Indicated in the figure are the three forms of data that become integrated into a test report: tracer release, sample time and location, and sample concentration.

Tracer release data is recorded by the release engineer performing the release. The data sheet is shown in Figure 4-2. This data is presented to the project manager for verification.

Data regarding the sample time and location are recorded by the Technicians. The data sheet is shown in Figure 5-4. The sampling team leader reviews these data for completeness and consistency.

Tracer analysis data are collected via stripchart recorder and the data acquisition system. The data acquisition system automatically calculates the response factors and integrates the sample concentrations to eliminate possible computation errors. The Senior Chemist is responsible for viewing the data daily to ascertain that the data is correct. He shall calculate the daily response factor and use several chromatograms during the day to verify that the acquisition system is performing correctly. The Senior Chemist is also responsible for preparing a data report from the data acquisition system. This report provides a summary of the analysis results concentrations for each sample number. All concentrations will be reported in femtoliters/liter (10^{-15} liters/liter). Raw analysis data, in the form of laboratory notebook, chromatograms, and strip charts are kept indefinitely in the laboratory file.

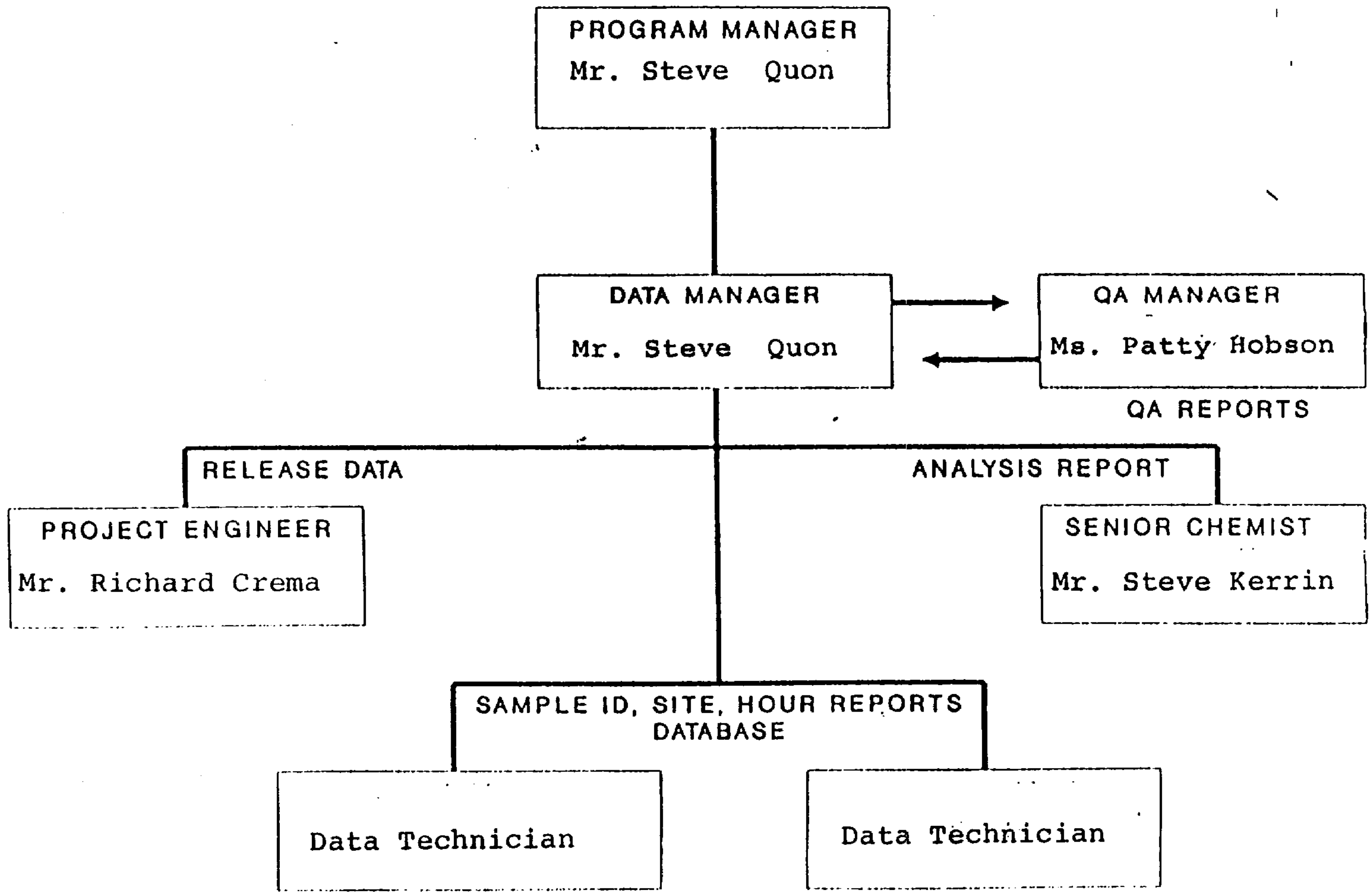
The data manager will accumulate the data and draft the test report, presenting measurement results and procedures. This report is reviewed by the program manager for completeness, accuracy by the program manager before submittal to AV.

7.1 DATA VALIDATION

Data validation and data reduction auditing are performed at several levels as shown in Figure 7-1. At the lowest level, the sampling team leaders and the Senior Chemist review and audit the measurement reports from individual technicians and analysts. In addition, a computer database is used to

Figure 7-1

DATA FLOW SCHEMATIC



log in the samples and provides another audit check to ensure that there are no gross labeling errors.

The senior chemist audits all laboratory analysis reports for completeness. Data validation is checked by comparing results obtained by the data acquisition system to the raw strip charts and qualitative expectations. In addition, data validity is checked by reviewing reported results obtained on blanks and spike samples submitted for analysis.

The project QA manager also performs selected data audits. In these, the QA manager reviews the entire analysis file for randomly selected samples, checking for completeness of documentation, use of correct procedures, and appropriateness of data interpretation and reduction.

Finally, the project manager, in the review of the test report, performs the final level of data validation. The program manager compares findings reported to expectations or to findings reported in other efforts and verifies selected calculations using independent algorithms.

7.2 DATA REPORTING

Tracer Technologies will submit the data base to AV package which presents the raw data and statistical and graphical summaries of the database. The package will be in two forms; i.e., (1) the data base in IBM-PC format with user oriented statistical/graphics package; and (2) hardcopy report.

The following paragraphs discuss the various aspects of the data reporting that will be performed.

<u>Raw Data Listings.</u>

IBM-PC floppy diskettes and printed hard copy medium of the data base medium will be submitted to AV at the conclusion of the experimental program. The raw data listings will include the following information

o Concentration of tracers by time interval, date and location.

o Tracer release data by time, date and location.

The combination of these raw data bases can be studied and presented to better understand the data of the tracer field experiments.

8.0 PERFORMANCE AUDITS

The Quality Assurance Manager will conduct a quality assurance audit of the laboratory analysis activities to verify that proper procedures are followed. She will also be responsible for providing the spikes and blanks that will be used to validate system performance.

The program manager will audit the tracer releases to ensure that proper procedures are followed by the release engineer.

9.0 CORRECTIVE ACTION

Corrective actions are initiated whenever measurement precision, accuracy or completeness deviate from the objectives established in Section 2.0. In addition, corrective actions are initiated whenever problems are identified through the internal or external auditing procedures described in Section 8.0.

The release engineer is responsible for corrective action on the release systems. The senior chemist is responsible for initiating and and completing corrective actions for laboratory measurement systems.

The project QA manager monitors the progress of major corrective actions and ensures they proceed in a timely manner. The program manager approves all corrective actions.

10.0 REFERENCES

Dietz, R.N. et. al. (1981), "An Inexpensive Perfluorocarbon Tracer technique for Wide-Scale Infiltration Measurements in Homes", BNL 30032, Brookhaven National Laboratory, Upton, N.Y.

Dietz, R.N. and G.I. Senum (1986), " Capabilities, Needs and Applications of Gaseous Tracers," in Atmospheric Tracer Technology and Applications, J.H. Heiken (Ed.), Noyes Publications, Park Ridge, N.J.

Ferber, G. J. et. al. (1981), "Demonstration of a Long-Range Atmospheric Tracer System Using Perfluorocarbon Tracer Techniques", ERL ARL-138, Silver Springs, MD.

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USEPA (1983), "Guideline on the Meaning and Use of Precision and Accuracy Data Required by 40CFR5, Appendices A and B", EPA- 600/14-83-023, Research Triangle Park, NC.

APPENDIX C

Air Quality Sampler I Operations Manual

CONTENTS

Operating Procedures

PROGRAMMABLE BAG SAMPLER

The State Department of Ecology designed and locally constructed the programmable bag sampler for carbon monoxide studies. It is a sequential sampler capable of unattended collection of one-hour samples of ambient air. Eight one-hour samples may be sequenced up to three days in advance. Two additional segments of eight one-hour samples may be programmed.

These procedures are intended to assist the operator in the installation and programming of the sampler. Monitoring procedures (probe installation, siting, etc.) are protocals of the Air Monitoring Section, (206) 885-1900. Contact George Benson at (206) 459-6241 for maintenance assistance.

Contained herein are the control descriptions, specifications, installation and programming instructions for the samplers. Diagrams have been added to visually assist in understanding the descriptions.

Control Descriptions

Door Control Assembly (See Diagram 1): The Program Control Panel contains the timesetting and Group Program Switches necessary to preset the sampler

Solenoid/Pump Assembly (See Diagram 1): The System Power Switch controls the main power OFF/ON. The Solenoid/Pump Switch is used to disable the pump and solenoid when programming the timer.

Sample Air Intake Port (See Diagram 2): Outside ambient air inlet

Sample Port Fittings (See Diagram 2): Three rows of bulkhead fittings for connection to the sample bags.

Battery Power Connector (See Diagram 2)

Specifications:

Absolute Supply Voltage: Range of 11.0 to 13.5 Volts DC

Current Requirements: Solenoid Pump "ON" 300 ma
" " "OFF" 5 ma

Pump Flow Set: 0.1 liters/minute

Temperature Range: 0 to 120 degrees farenheit (Internal)

Intake Particulate Filter: 5 microns

Dimensions (with ports): 14" x 11.5" x 5.5"

Timing Accuracy: ± 1 minute/week

Installation:

1. Sampler may be mounted horizontally or vertically on the top shelf of the bag sampler shelter.

2. Connect the power cord to the 12 volt DC (automotive type) battery. (INSURE CORRECT POLARITY)

3. Connect ambient air probe to the Sample Air Intake Port.

4. Connect sample bags to Sample Port Fittings. Sample Port Fittings are numbered within the eight hour sequenced rows.

5. Operation Set-Up Test:

   a. Set the three Group Program Switches to position 1
   b. Turn System Power Switch to "ON"
   c. Turn Solenoid/Pump Switch to "ON"
   d. In sequence, press "8HRS", "HRS", and "SEC" Reset buttons
   e. Press and hold "HRS" Set button
   f. After eight seconds the first LED should light, pump should turn on and first solenoid will click on
   g. Continuing to hold "HRS" Set button down, LED's and solenoids should sequentially operate through the LED series

Operation:

1. Turn System Power Switch to "ON"
2. Turn Solenoid/Pump Switch to "OFF"
3. Turn all Group Switches to "OFF"
4. Determine operation requirements

   a. Determine desired start time (day and hour) for first eight one-hour samples
   b. Calculate the hours differential from the present or set time (round to the next whole hours).

      For Example: Today is Monday morning at 8 am and it is desired to run the samples every other day starting each day at the same time. Desired start time is 10 am. (It is advisable to be at the site before 8 or you will need to wait till 9 am to set the sampler.)

5. Set Group 1 Switch to enable ("EN").
6. Press, in sequence: "8HRS", "HRS" and "SEC" Reset buttons
7. In the eample, set the number of hours before the start time, in this case 2, by pressing the "HRS" Set button until the LED (1st group) runs down to the 7th position. This means that 2 hours are available before the instrument starts.
8. Press Reset buttons "SEC" and "8HRS"
9. Reset Group 1 Switch to the number of eight hour segments, in this case position 1.
10. Set Group 2 Switch. See Option Table, Option #3.
11. For setting Group 3 Switch, see Option Table, Option #3.

    *At this point, programming is completed.

12. Turn Solenoid/Pump Switch to "ON".
13. Push "SEC" Reset button on the hour to synchronize counter to the time-of-day.

OPTIONS TABLE

Option #1: To run a 24 hour set with all three sets of bags, all three Group Switches must be at the same setting.

Option #2: To run consecutive days starting at the same hour, set Group 2 Switch 2 positions beyond that of the Group 1 Switch, and the Group 3 switch 2 positions beyond the Group 2 setting.

Option #3: To run every-other day starting at the same hour, set the Group 2 Switch to 5 positions beyond the Group 1 setting and the Group 3 Switch 5 positions beyond the Group 2 setting.

Figure 1

	Bag #	LED	Remaining Hours
GROUP 1	1	0	8 Hrs
	2	0	7 Hrs
	3	0	6 Hrs
	4	0	5 Hrs
	5	0	4 Hrs
	6	0	3 Hrs
	7	0	2 Hrs
	8	0	1 Hr

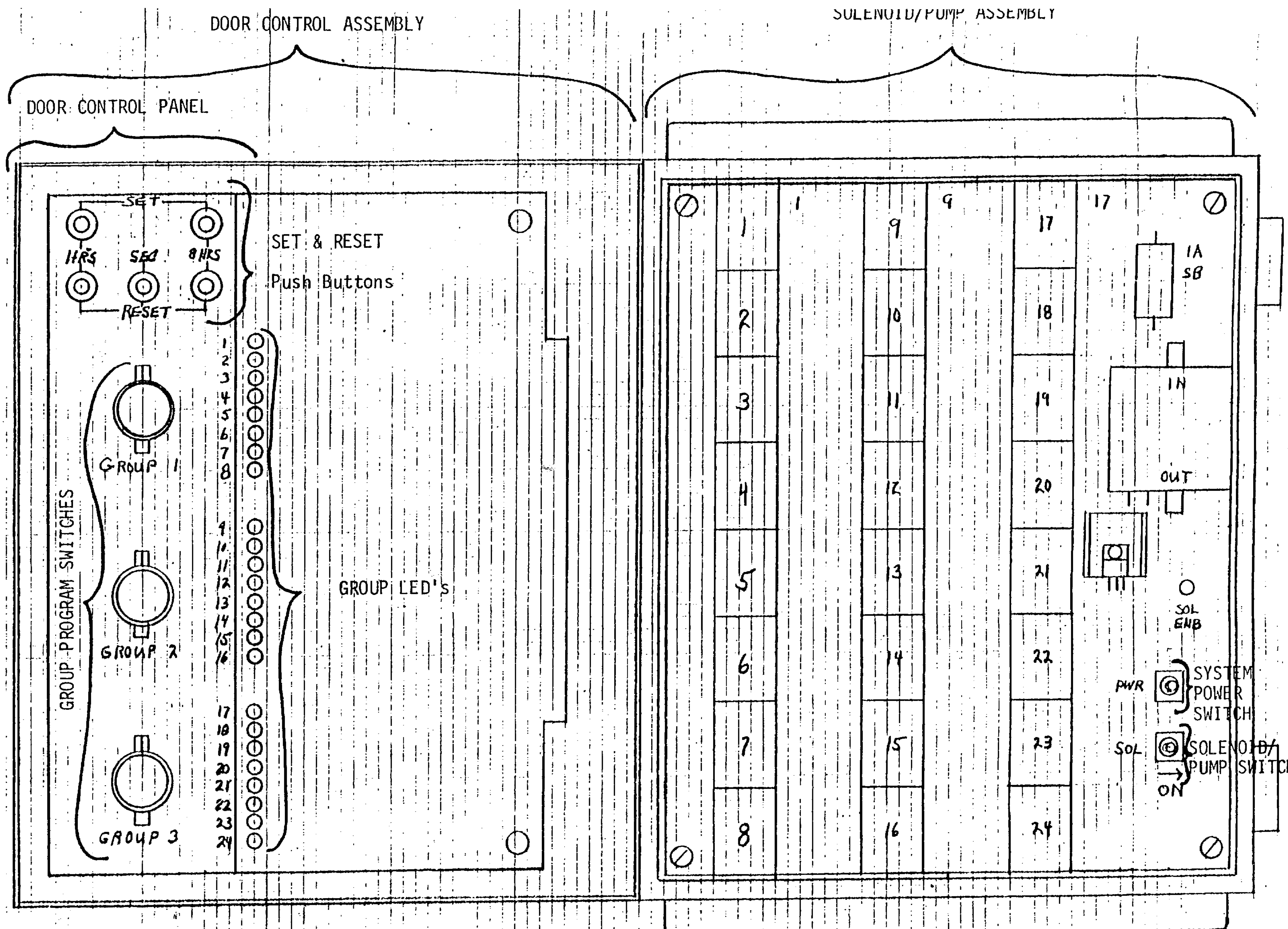
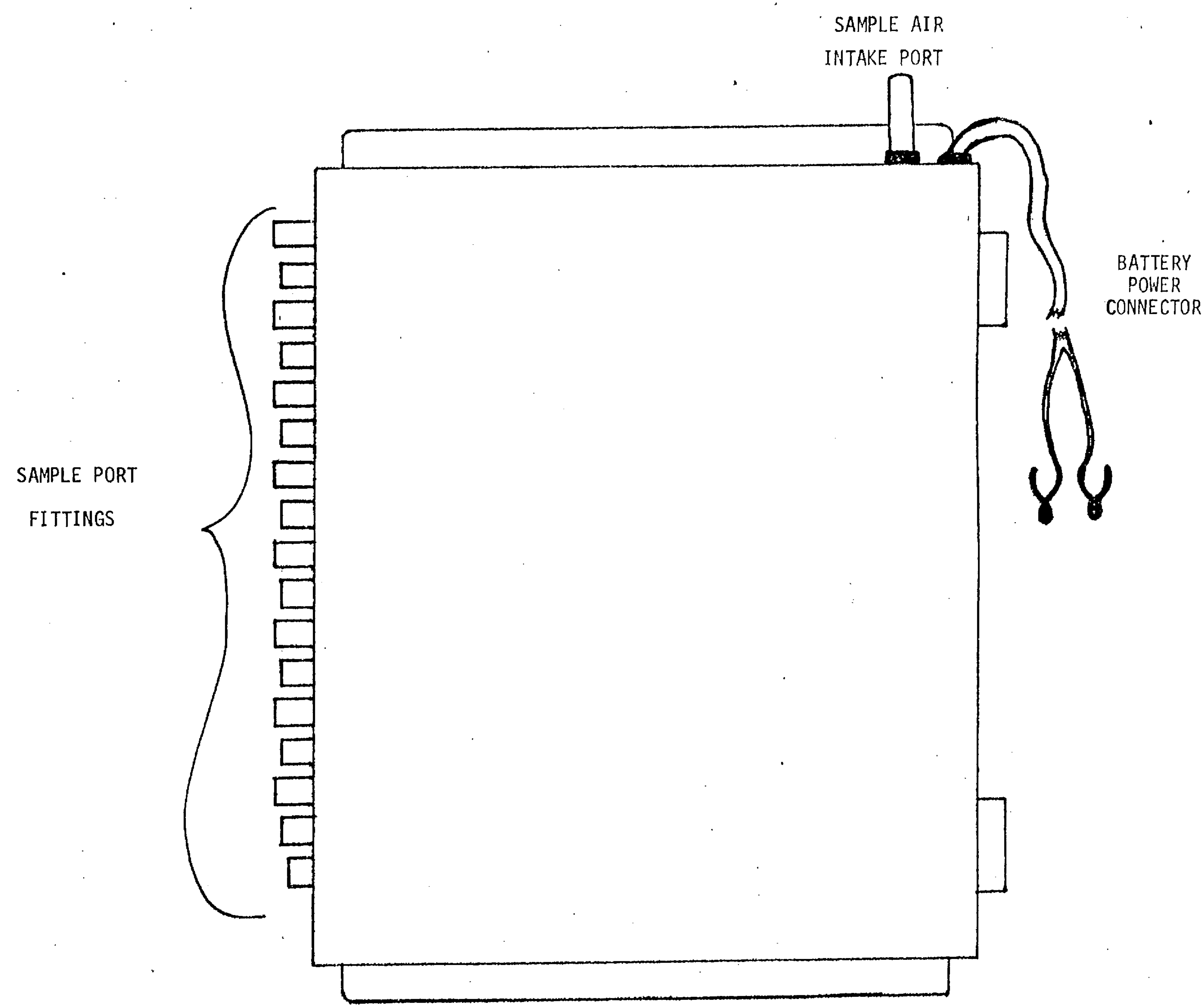

DOOR CONTROL ASSEMBLY
SOLENOID/PUMP ASSEMBLY
DOOR CONTROL PANEL
SET
HRS
SEQ
8HRS
RESET
SET & RESET
Push Buttons
GROUP 1
GROUP 2
GROUP 3
GROUP PROGRAM SWITCHES
GROUP LED's
1A
SB
IN
OUT
SOL
ENB
PWR
SYSTEM
POWER
SWITCH
SOL
SOLENOID/
PUMP SWITCH
ON

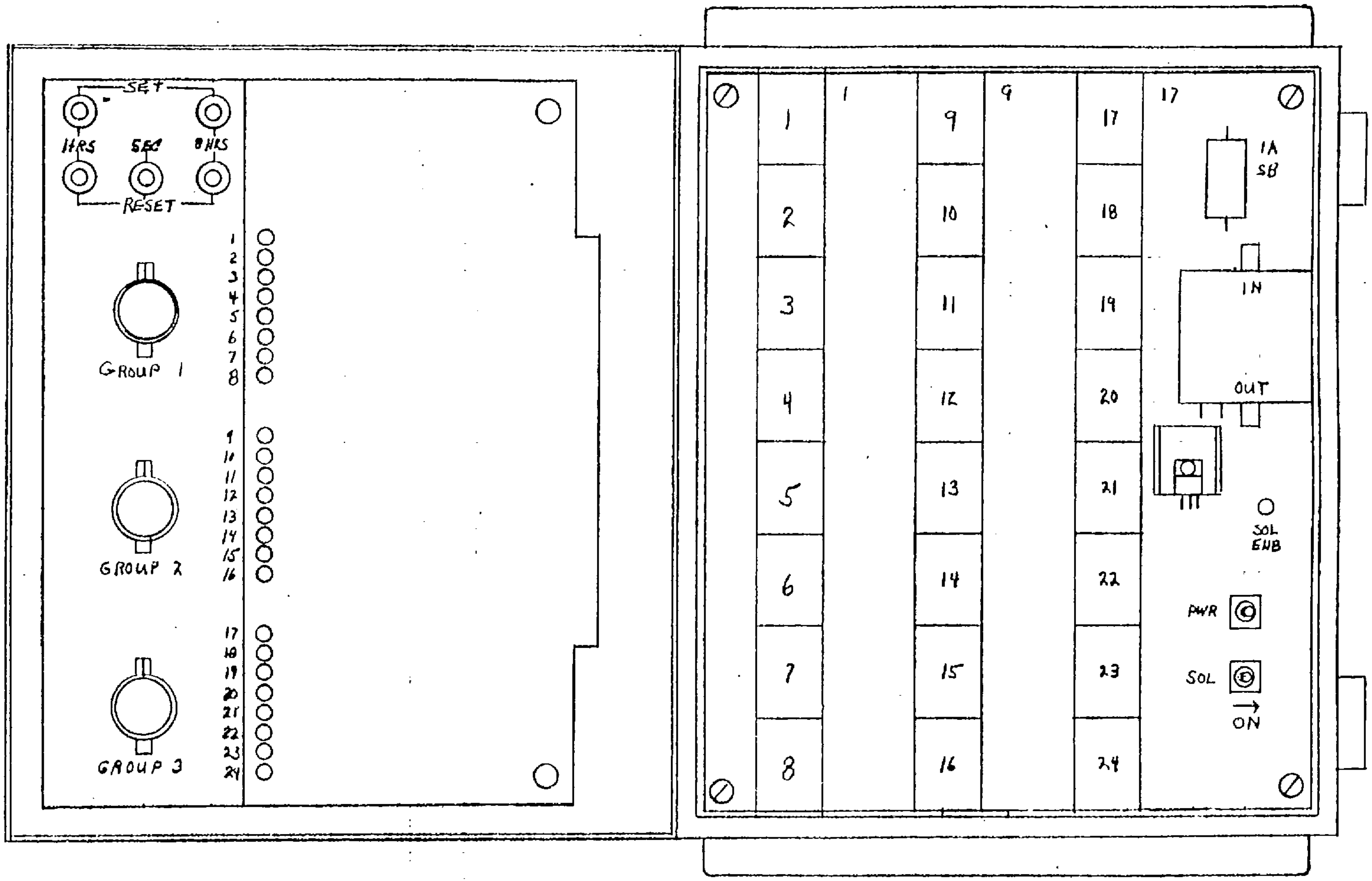
Diagram 1


SAMPLE AIR
INTAKE PORT
BATTERY
POWER
CONNECTOR
SAMPLE PORT
FITTINGS

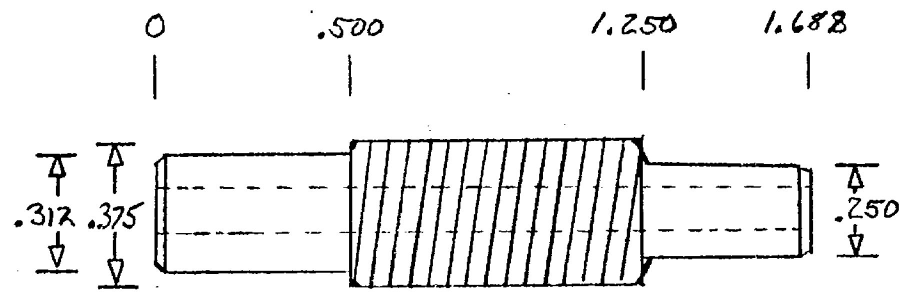
Parts List

CABINET ASSEMBLY

Item	Qty	Part Number	Manufacturer	Source
Enclosure	1	1414PHK	Hoffman	JNB Specialties
Bulk Head Fittings	25	884-102	JNB	JNB Specialties
Power Cable	1	884-103	WDOE	
Bushing	1			Newark Electronics
Bumper	2	#2198	HH Smith	
Stand Off	2	HEX,6-32 x ½"		
Screws	2	6-32 x 1" RH		
Nuts	2	6-32		
Lock Washer	2	#6 Star		
Screws	4	6-32 x 3/8" TH		

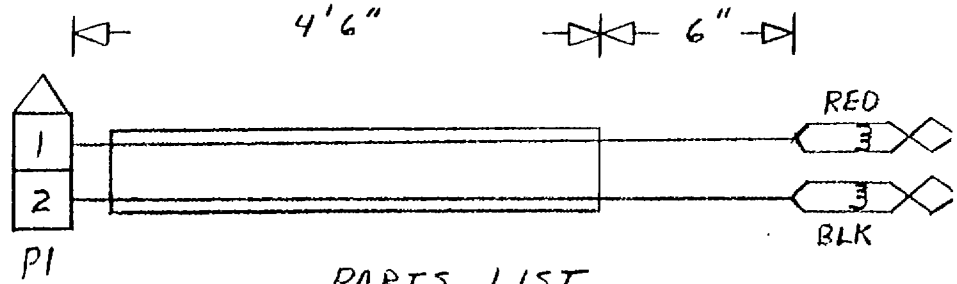


7-30-84	G. Benson
TOP ASSEMBLY BAG SAMPLER CONTROLLER	
WDOE	894-101



1. MATERIAL BLACK DELRIN 3/8" ROD
2. FABRICATE TO ABOVE DIMENTIONS
3. DRILL .125 HOLE TROUGH CENTER OF PART
4. THREAD FOR 3/8" X 24 NUT
5. SUPPLY WITH (2) PLATED NUTS 3/8" X 24
6. SCALE 2:1

11-14-84	G. Benson
BULK HEAD FITTINGS BAG SAMPLER	
WDOE	884-102



PARTS LIST

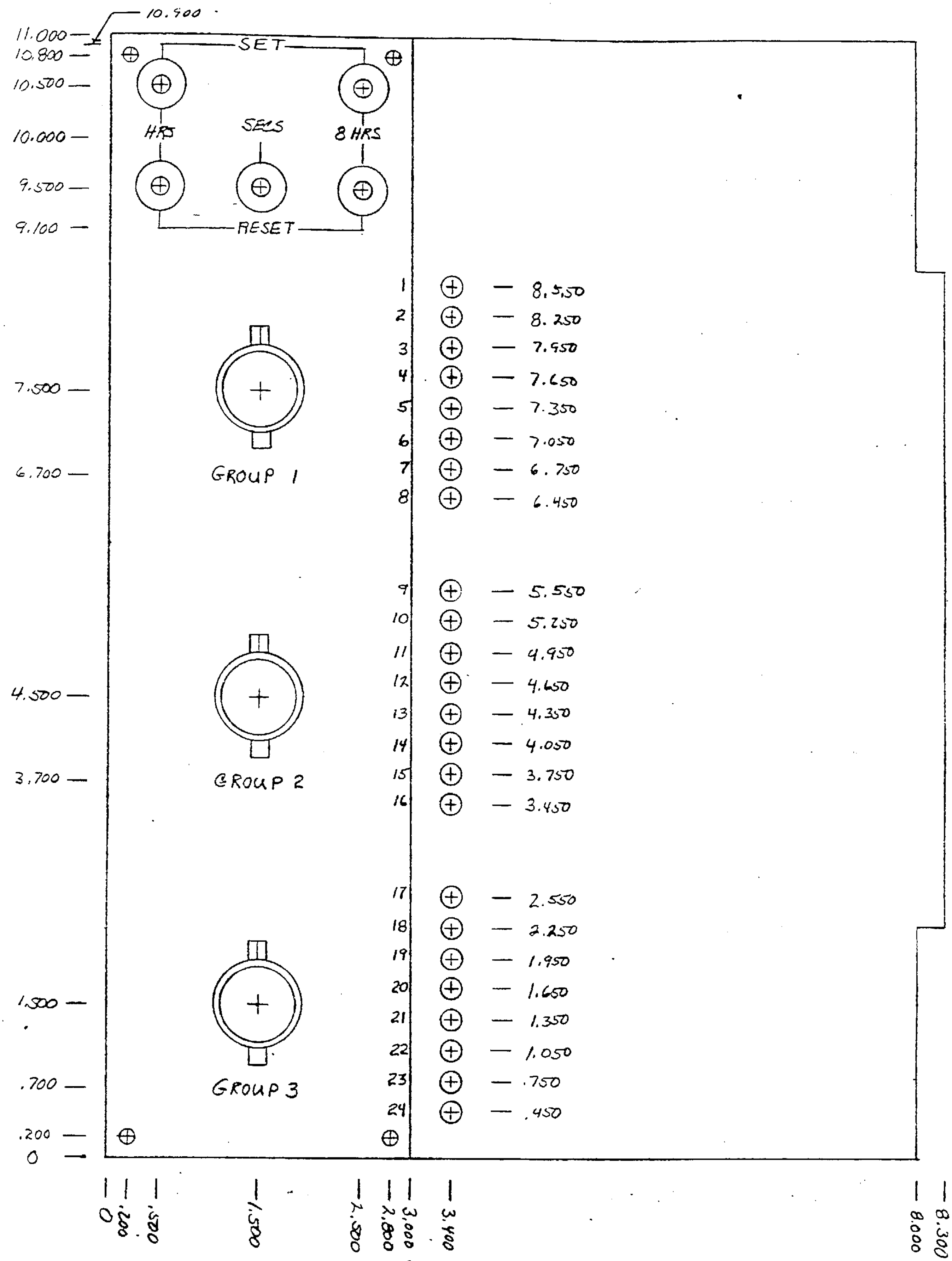
1. CONNECTOR P1 MOLEX 03-09-1022 W/02-09-1103 PINS
2. CABLE BELDEN 8461
3. BATTERY CLIPS 24 A NEWARK 28F616
4. RED BOOT #26 NEWARK 28F-482
5. BLACK BOOT #26 NEWARK 28F-483
6. HEAT SHRINK 1/4" POLYOLEFIN

12-14-84	G. Benson
POWER CABLE	

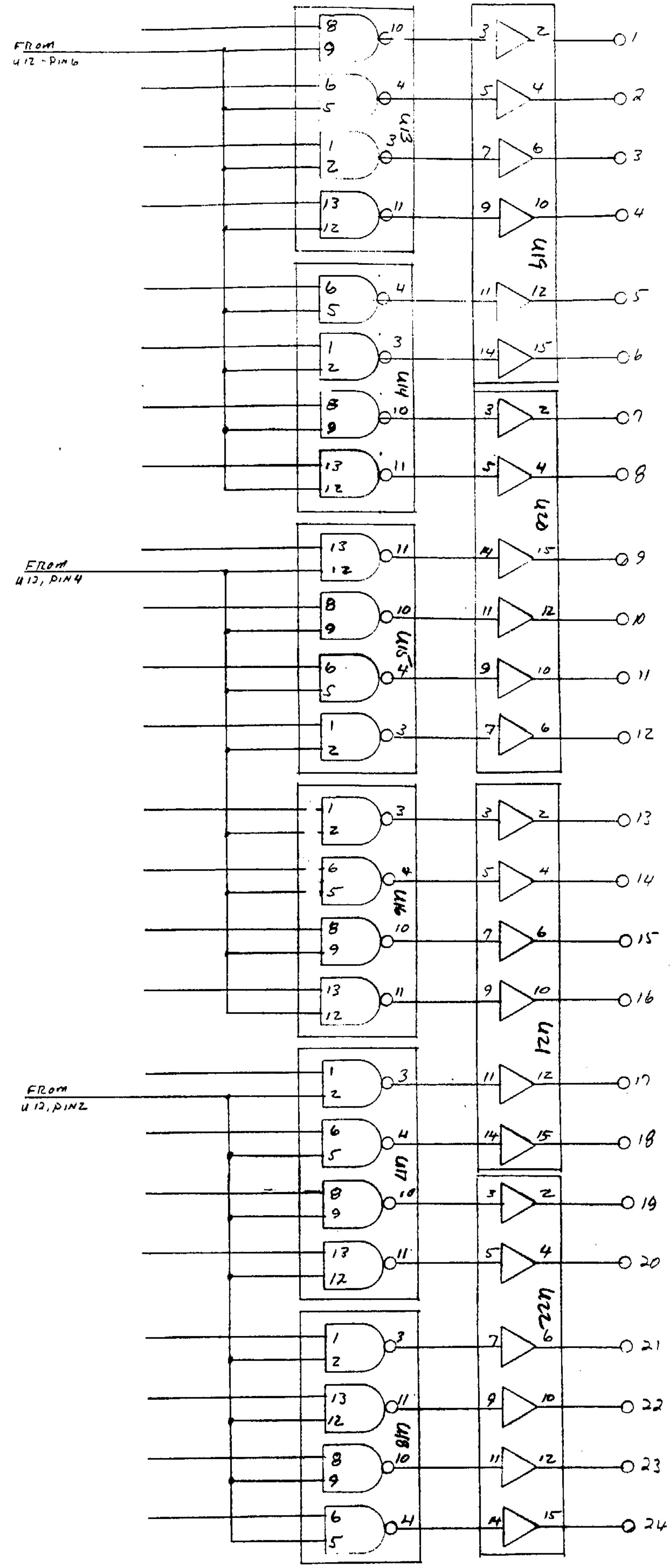
Parts List

COUNTER/CONTROL ASSEMBLY

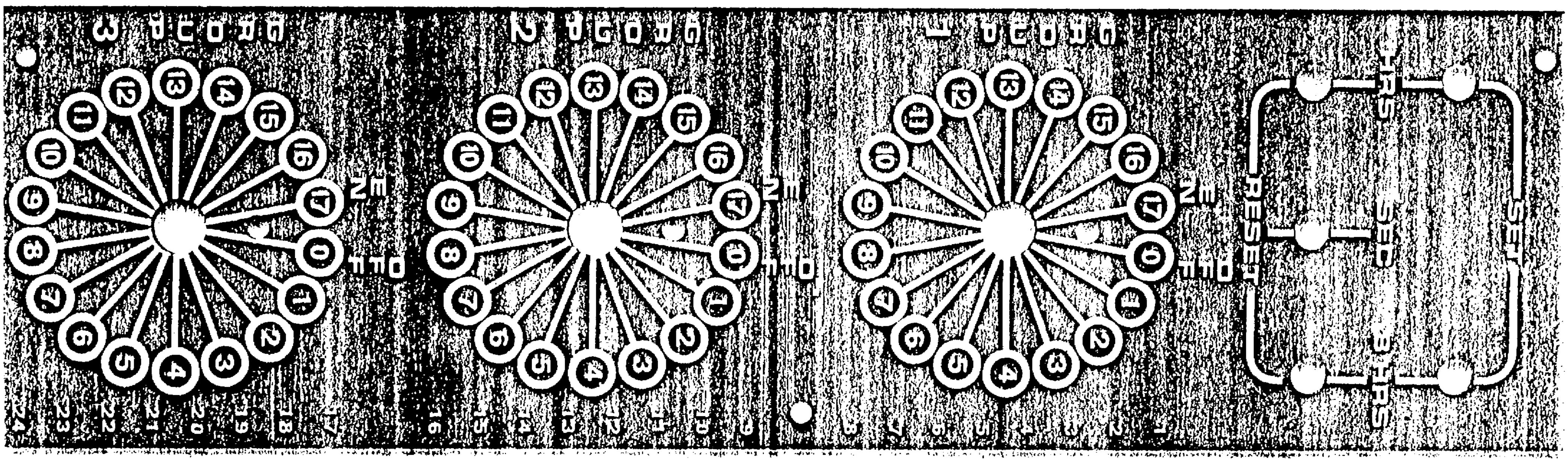
Circuit Reference	Part Name	Qty	Manufacturer	Part Number	Source
S1,S2,S3	Switch	3	Centralab	PA-3001	Newark
S4	Switch	1	ALCO	MSP-103C	Newark
S5-S8	Switch	4	ALCO	MSP-103B	Newark
Y1	Crystal	1	Micronium	MPC-33-0209	Newark
C1,C2	Capacitor	2		19F303(Newark)	Newark
C3	Capacitor	1		272-1016	Radio Shack
C4,C5	Capacitor	2		272-1434	Radio Shack
(U11)	Socket	1	T.I.	C931402	Newark
(U12)	Socket	1	T.I.	C931602	Newark
Q1 to Q24	Transistor	24		2N2222	Newark
Q25	Transistor	1		MPS-A13	Radio Shack
L1 to L24	LED	24	Leecraft	L111DR	Newark
U1	I.C.	1	RCA	CD4045B	Newark
U2	I.C.	1	RCA	CD4040BE	Newark
U3	I.C.	1	RCA	CD4022BE	Newark
U4,U5	I.C.	2	RCA	CD4017BE	Newark
U6	I.C.	1	RCA	CD4012BE	Newark
U7,U13-U18	I.C.	7	RCA	CD4011B	Newark
U8,U19-U22	I.C.	5	RCA	CD4049UB	Newark
U9	I.C.	1	RCA	CD4013BE	Newark
U11	I.C.	1	RCA	CD4025BE	Newark
U12	I.C.	1	RCA	CD4050BE	Newark
CR1	Diode	1		1N4005	
R1 to R25	Resistor	25		¼W,5%,3K	
R26,27,28	Resistor	3		¼W,5%,1M	
R29-R33	Resistor	5		¼W,5%,10K	
R34	Resistor	1		¼W,5%,10M	
	Buss Bar	6 Ft		22 ga Copper Tinned	
	Tubing	2 Ft		22 ga, Thin wall	
	Wire	1 Ft		26 ga, Stranded	
	Screws	3		6-32 x ¼", FH	
	Screws	1		6-32 x 3/8", BH	
	Screws	1		6-32 x ½, RH	
	Stand Off	6		HEX,6-32 x 3/8"	
	Stand Off	2		HEX,6-32 x ½"	
	Bumper	1	HH Smith	#2198	
	PC Board	1	JNB	101584	JNB Specialties
	Switch Panel	1	JNB	884-130	JNB Specialties
	Knobs	3	ALCO	PKGP-90B-¼	Newark



9-19-84	G. BENSON	
DRILL DRAWING COUNTER/CONTROLLER		
WDOE	884-110	



12-14-84	JNB	
SCHEMATIC COUNTER/CONTROL SOLENOID DRIVERS		
WDOE	884 - 120	SH 2



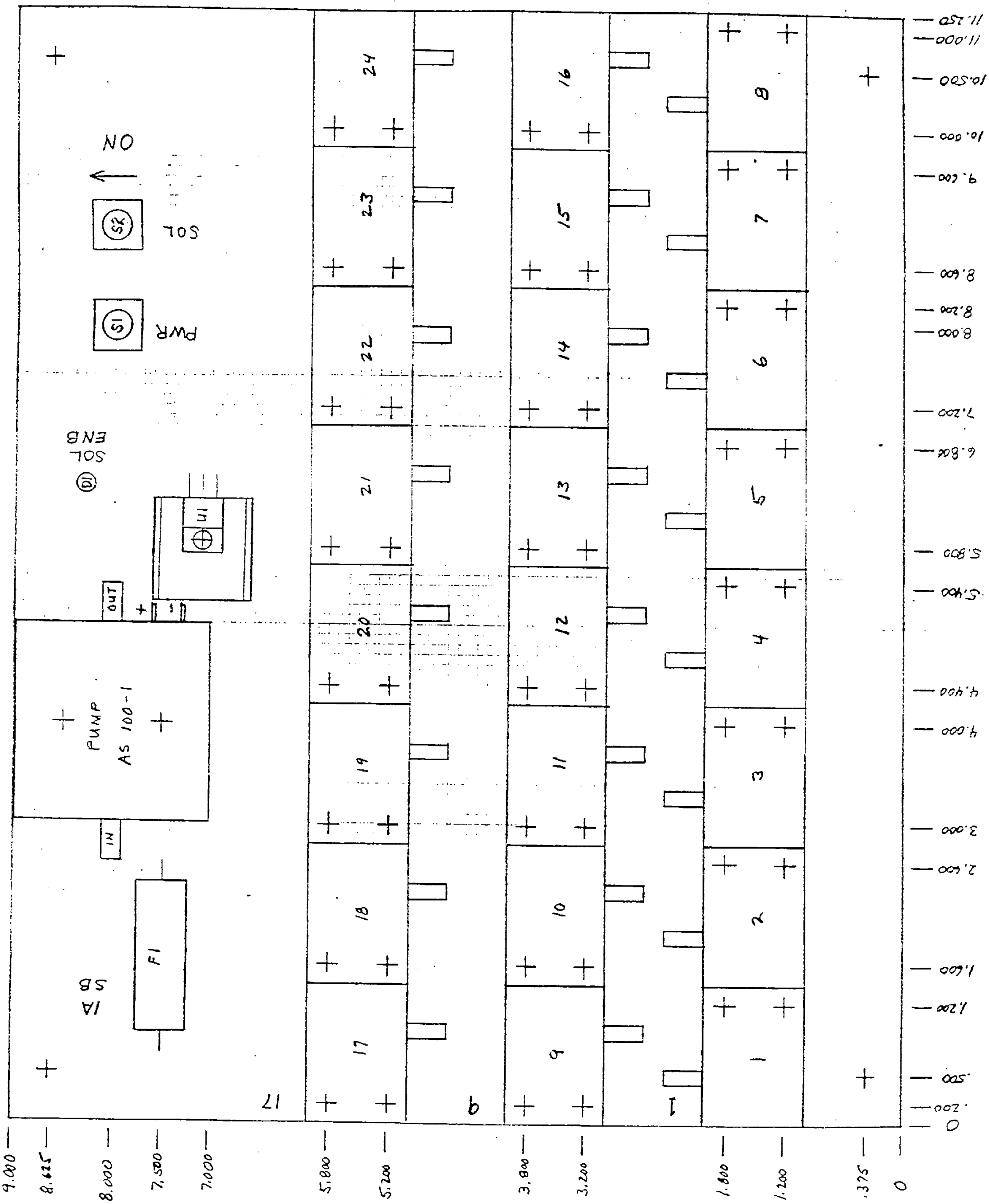
Supplier: J.N.B. SPECIALTIES
3830 80th Ave. S.E.
Olympia, Wa. 98503
206-491-4193

12-14-84	G. Benson
SWITCH PANEL	

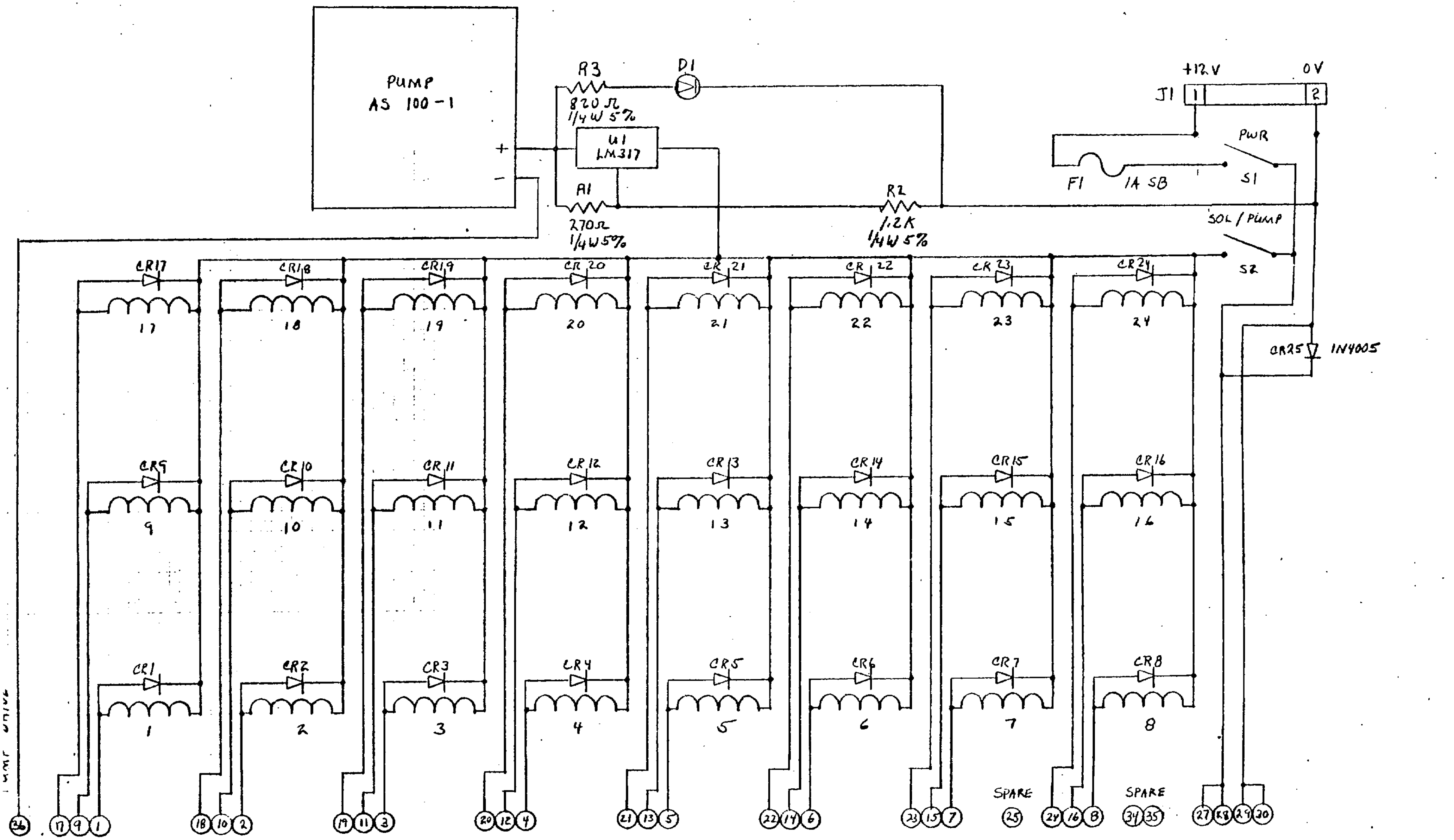
Parts List

SOLENOID/PUMP ASSEMBLY

Circuit Reference	Part Name	Qty	Manufacturer	Part Number	Source
	Cable Assem.	1	WDOE	884-160	WDOE
	Pump	1	Spectrex	A5-100-1	WDOT
SV1-24	Solenoid Valves	24		SV7904	C & H Sales
S1,S2	Switch	2	ALCO	MTA-206N-PC	Newark
U1	I.C. Regulator	1	T.I.	LM317	Radio Shack
(U1)	Heat Sink	1		276-1778	Radio Shack
D1	LED	1	Leecraft	L111DR	Newark
F1	Fuse	1	Buss	MDL1	Newark
(F1)	Fuse Holder	1		170-739	Radio Shack
CR1-24	Diode	24		1N914	Newark
CR25	Diode	1	1N4005	1N4005	
R1	Resistor	1		¼W,5%,820	
R2	Resistor	1		¼W,5%,1.2K	
R3	Resistor	1		¼W,5%,270	
	Bus Bar	6 Ft		22 ga tinned Copper	
	Wire	1 Ft		22 ga, stranded	
J1	Connector	1	Molex		Newark
(J1)	Pins	2	Molex		Newark
	T Fittings	23		64031	U.S. Plastic
	Tubing	20 Ft	TYGON	R-3603	Universal Plastic
	Tie Straps	48		805-1106	Allied Electronics
	Screws	4		6-32 x ½"	
	Nuts	2		#6-32	
	Washers	4		#6 Star	
	Foam Pad	2		1" x 2 1/8"	Radio Shack
	PC Board	1	JNB	082784	JNB Specialties

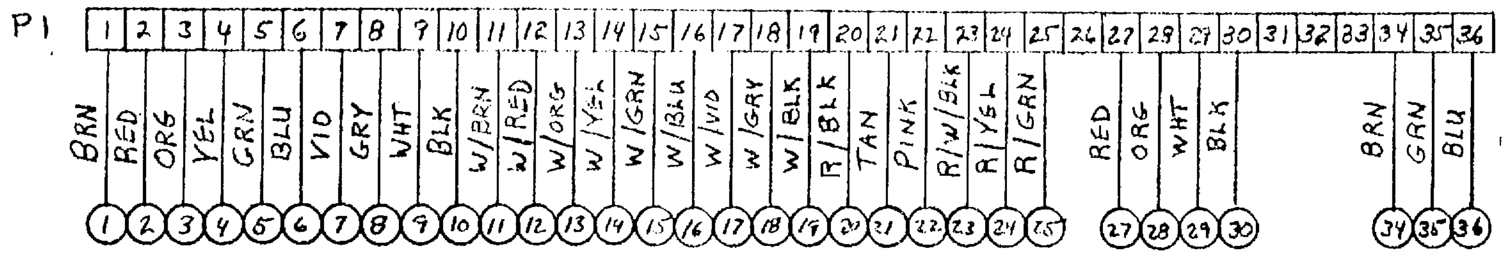


7-27-84	G. Benson
DRILL DRAWING PUMP/SOLENOID ASSEMBLY	
WDOE	884-140



1. Solenoid Valve SV7904 C+H SALES - 1 to 24
2. PUMP AS 100-1
3. PC CARD JNB SPECIALTIES
4. SWITCHES ALCO MTA-206N-PC NEWARK (61F795) - S1 & S2
5. Regulator MOTOROLA LM317 Newark - U1
6. Resistors 1/4W 5% - R1 + R2
7. DIODES 1N914 CR1 to CR24

7-27-84	G. Benson
SCHEMATIC PUMP/SOLENOID ASSEMBLY	
WDOE	884 - 150



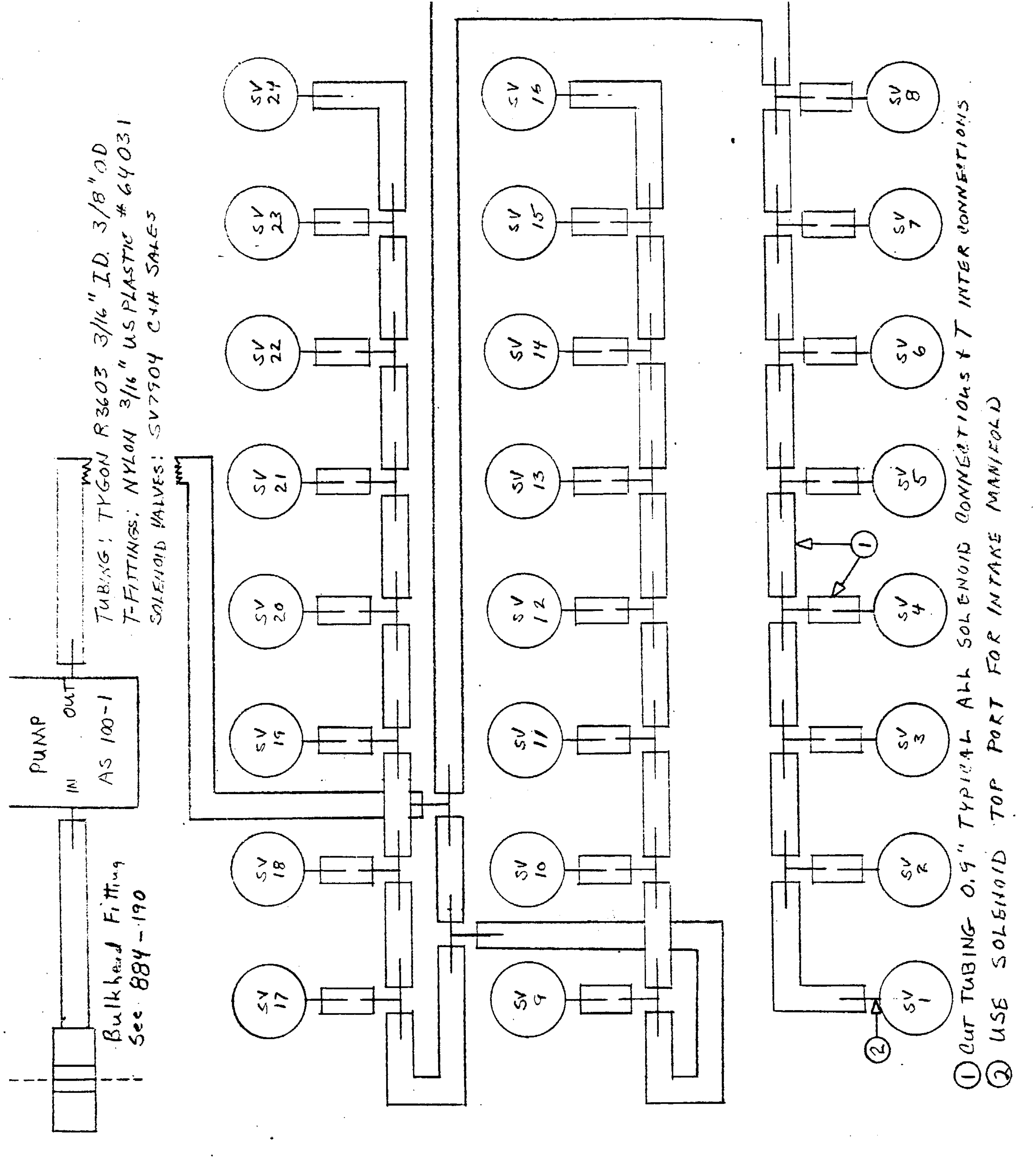
25 COND. 22 Ga Stranded

7 COND 22 Ga Stranded

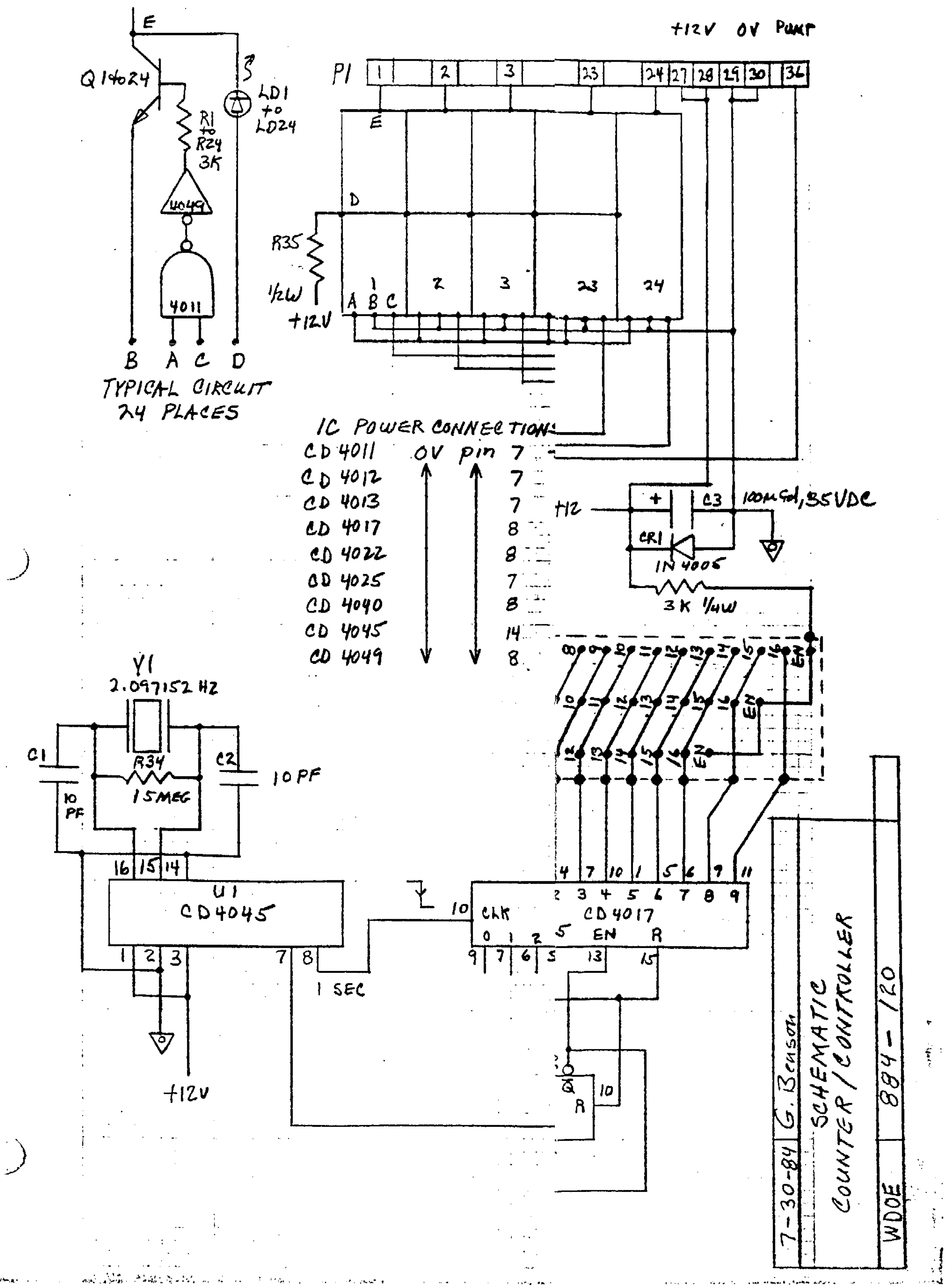
SOLDER TO SOLENOID/PUMP PC

Notes: Connector – ELCO 6007-036-940-012
CABLE LENGTH – 18 in. – 25 COND 22ga
– 7 COND 22ga
Heat Shrink 2 in ½"
2 in ⅜"

7-30-84	G. Benson
CABLE ASSEM. CTR./CONT. TO SOL./PUMP	



8-13-84	G. Benson
INTAKE MANIFOLD BAG SAMPLER	
WDOE	884-170



E
Q1 to Q24
LD1 to LD24
R1 to R24 3K
4049
4011
B A C D
TYPICAL CIRCUIT 24 PLACES
+12V 0V PUMP
P1
1 2 3 23 24 27 28 29 30 36
E
D
R35 1/2W
+12V
A B C
1 2 3 23 24
IC POWER CONNECTIONS
CD 4011 0V pin 7
CD 4012 7
CD 4013 7
CD 4017 8
CD 4022 8
CD 4025 7
CD 4040 8
CD 4045 14
CD 4049 8
+12
C3 100μfd, 35VDC
CR1 1N 4005
3K 1/4W
Y1 2.097152 HZ
C1 10 PF
R34 15MEG
C2 10 PF
U1 CD4045
16 15 14
1 2 3 7 8
1 SEC
+12V
CLK CD4017
EN R
Q R
7-30-84
G. Benson
SCHEMATIC COUNTER/CONTROLLER
WDOE 884-120

APPENDIX D

Air Quality Sampler II Operations Manual

AIR QUALITY SAMPLER II

Operating and Maintenance Manual

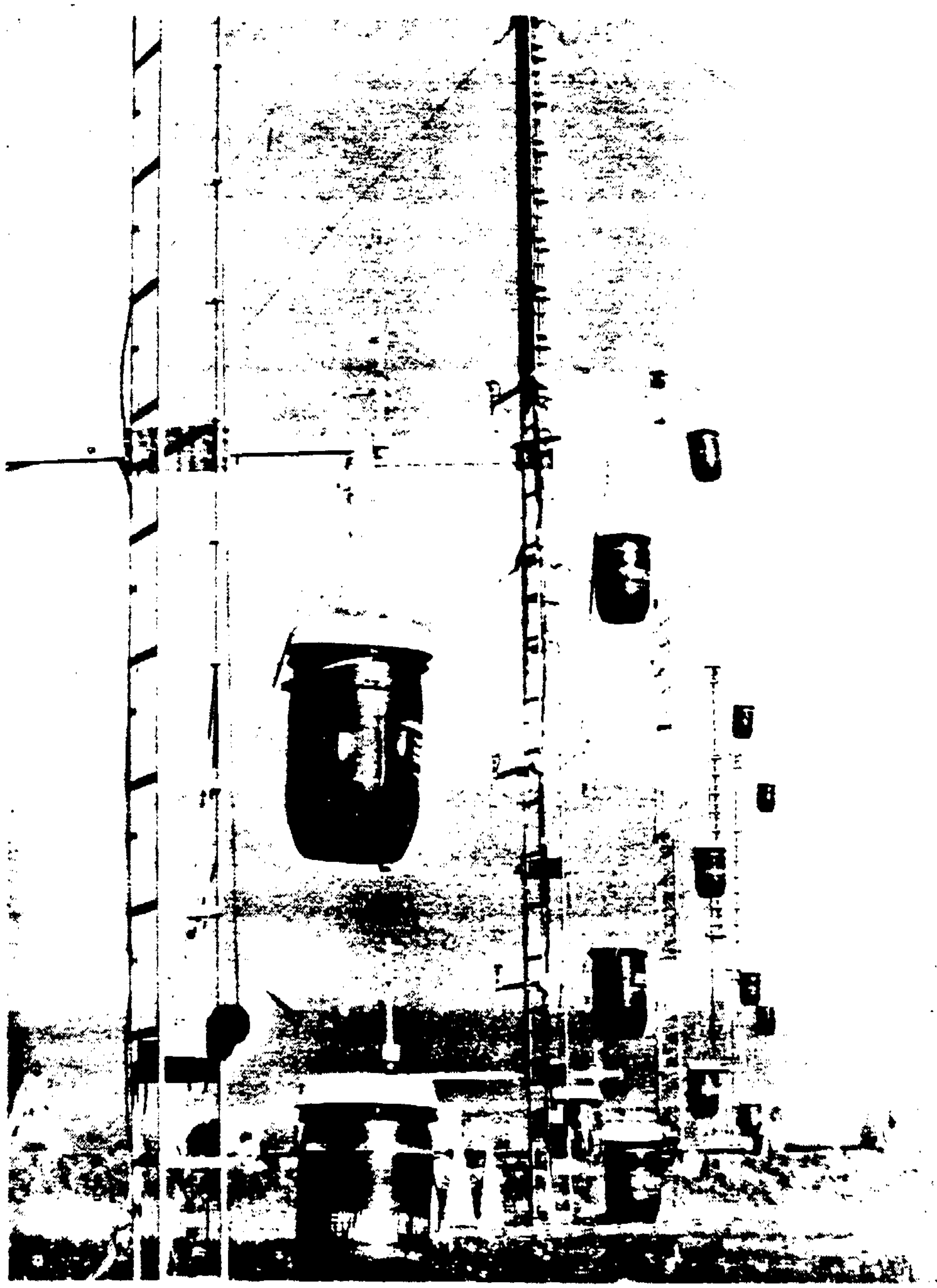
AeroVironment Inc.
825 Myrtle Avenue • Monrovia, California 91016-3424 • USA
Telephone 818/357-9983

AIR QUALITY SAMPLER II

Operating and Maintenance Manual

by

AeroVironment, Inc.
825 Myrtle Ave.
Monrovia, CA 91016



AIR QUALITY SAMPLERS IN THE FIELD

CONTENTS

Figures

Tables

Section 1

INTRODUCTION AND DESCRIPTION

INTRODUCTION

The collection of historical air samples in plastic bags has been employed by air pollution specialists for two decades. But only in the past few years has the methodology become widely used. One reason for the increased use of bag sampling is the availability of sequential bag sampling equipment. In addition the economy and flexibility of the technique make it desirable for new uses.

As the number of applications broadens the design of the equipment is changed to meet the requirements of new and more sophisticated air sampling programs.

The Air Quality Sampler (AQS) was originally developed and patented* by Environmental Measurements, Inc. (EMI). In 1982 the AQS sampler line was purchased by AeroVironment, Inc.

GENERAL DESCRIPTION

Description of the AQS

The AQS consists of two basic units: (see Figure 1)

- The Drum acts as a bag chamber and as an overall protective shell with the battery pack located at the bottom.

*U.S. Patent No. 3,921,456

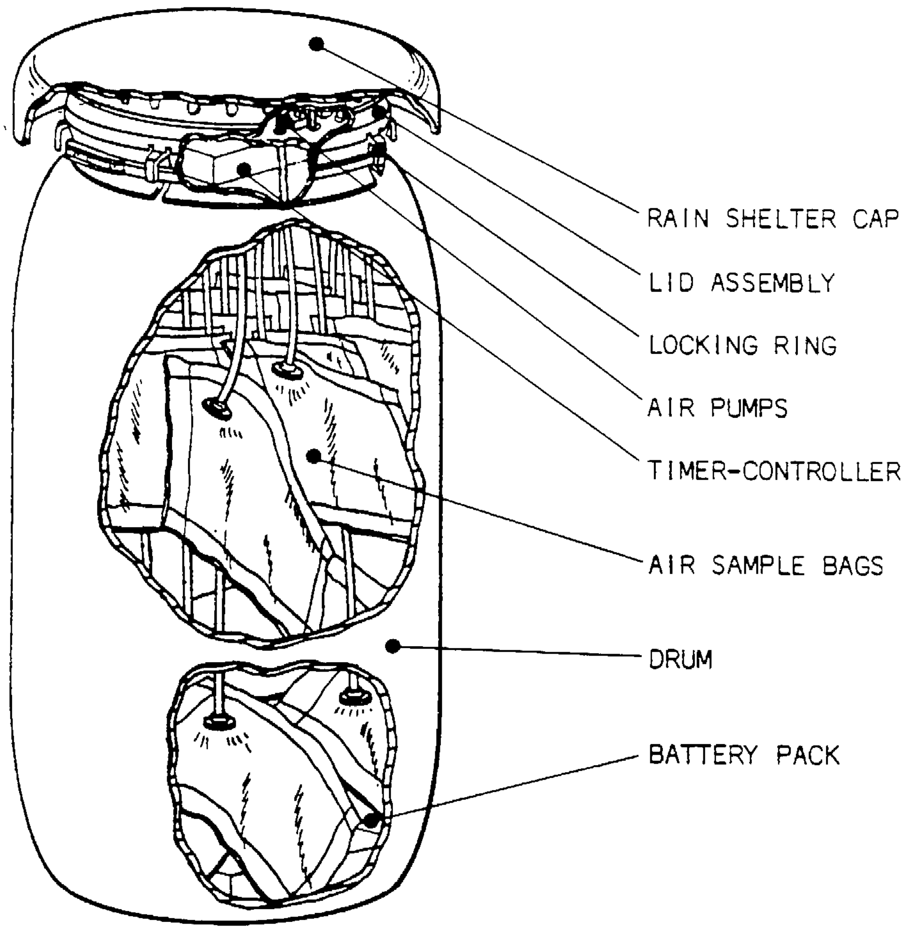


Figure 1. Sketch of the AQS.

- The Lid Assembly houses the Timer Controller and the Air Pumps; it holds the Locking Ring designed to open and close the apparatus.

The whole system is covered by the Rain Shelter Cap.

Description of the Method

The AQS provides a time programmable means for gathering air samples for later analysis. Each AQS contains a very stable 24-hour clocking reference which may be set to time of day. Operating from internal battery power the system is programmed for time sampling, as desired, then left unattended to gather hourly air samples in bags located in the Drum. When the programmable sampling sequence is completed the AQS automatically terminates the sample-taking process.

Once a sample has been gathered in a bag (see Figure 2), the latter remains full, sealed off by a one-way valve. A pinch clamp is provided on the bag tubing to seal off the samples upon their removal from the AQS. Removal is achieved by separating the quick-disconnect fitting (see Figure 3). Placed in a container the bags are transported to a central facility for analysis. A set of empty bags is installed in the AQS and sampling may continue.

The full bags are emptied into one or more air analyzers. The gas concentrations measured represent hourly averages since the AQS samples are time-integrated over preset 60-minute periods (or multiples of 60-minutes).

When all air is removed and they have been optionally flushed with an inert gas, the bags are ready to be used again. The low power integrated circuit enables the system to reliably operate for *at least* 600 hours before requiring battery replacement.

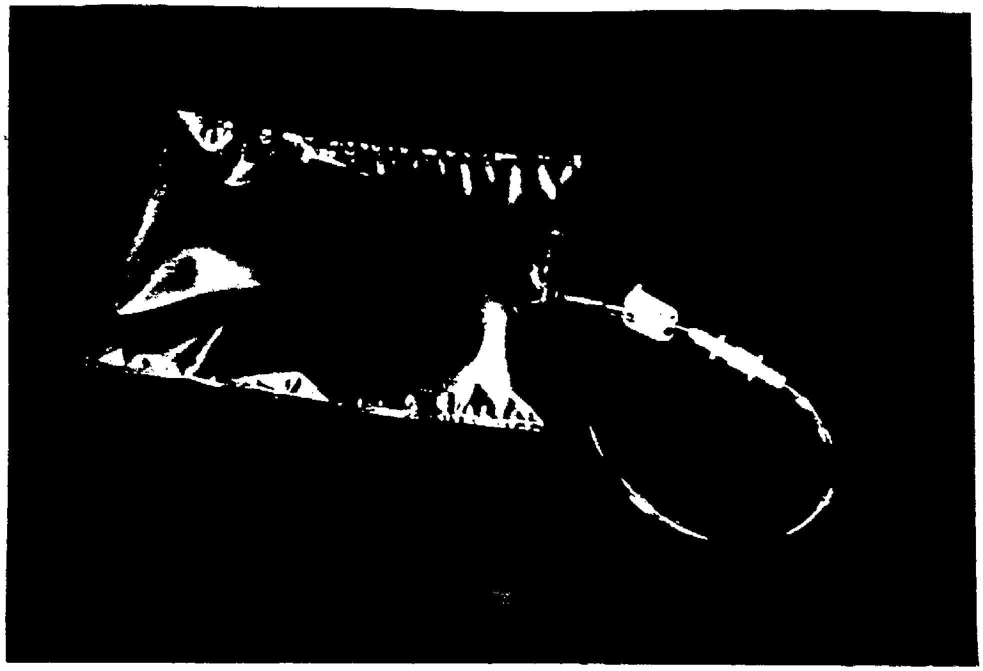


Figure 2. AV Air Sampling Bag

Figure 3. Tubing with Pinch Clamp and Quick Disconnect

Section 2

SPECIFICATIONS

AIR QUALITY SAMPLER

DRUM:	Enclosure:	High molecular weight polyethylene with UV stabilizers
	Dimensions:	225 liter 60 cm OD x 117 cm H (23.6 in. x 46.1 in.) or 120 liter 60 cm x OD x 76 cm H (23.6 in. x 29.9 in.)
WEIGHT:		11-14 kg (24.2-30.8 lbs)
SAMPLING MEDIUM:		Ambient Air
METHOD OF SAMPLING:		Time-averaged air flow into inflatable bags for delayed analysis.
PUMP UNIT:		Single action piston, dc motor driven
NUMBER OF PUMPS:		1-24, typically 8, 12, 16 or 24
NUMBER OF BAGS:		One per pump
DRUM CAPACITY:		225-liter: 24 2-liter, 12 5-liter or 6 10-liter bags 120-liter: 12 2-liter or 8 5-liter bags
CONTROLS:		ON-OFF; hour and minute TIME SET, push to DISPLAY time, FLOW-RATE selector.
FLOW RATE:		see below
TIME DISPLAY:		Light emitting diodes (LED) hours and minutes
POWER:		Dry cell batteries - four 12 VDC (NEDA 926) 600 Hours (5 L/HR, 16 HR/Day) continuous operation

FLOW RATE:

Flow rate	(L/HR)	2	5	10
ON Time	(msec)	250	250	250
Period	(sec)	10	5	2

PROGRAMMING PERIOD:	Standard AQS 24 Hrs. Cycle Option AQS 96 Hrs.
ENVIRONMENTAL:	-10°C to +50°C (14°F to 122°F)

Section 3

METHOD OF OPERATION

The AQS has been designed for field handling and transportation. It will provide good reliable results if the user carefully conforms to the operating steps described in this section.

OPENING THE AQS

The system is opened by releasing the clamp which secures the Locking Ring holding the Lid Assembly in place. The clamp and ring are located slightly beneath the bottom edge of the Rain Shelter Cap. Release by pulling outward on the free end of the clamp. Once released, the cover can be removed by pulling the black scalloped edges which protrude from beneath the Rain Shelter Cap (see Figure 4).

> When removing the Lid Assembly have the clamp facing you. In this way, when it is raised and pivoted away, the Controller (connected to the Lid) will come to the upright, readable position. All pump-to-bag tubing and the battery cable will be at the far side of the cover opening. This precaution allows opening and pivoting of the Lid without putting excessive strain on the tubing or cable.

Figure 4. Opening the Air Quality Sampler.

The cover can be placed upside down on top of the open drum, to program the controller and to connect bags to pump fittings. Upon initial receipt of the AQS the sample tubing and battery cable will not be attached. The Battery Pack is located at the bottom of the drum; the battery cable is clamped near the drum top. A second cable extends from the controller. Attach the mating connectors to provide power to the controller.

PRELIMINARY CHECKS

After connecting the battery cable to the Timer Controller cable place the power switch in the ON position. Depress the TIME button to observe the time. While still holding down this button, depress the HOUR SET button. If the hours advance at one hour per second the clock is operating properly. Depress the MIN SET button: the minutes will advance at one minute per second.

Advance the time to 10 hours 00 minutes. Set the flow rate selector to the 10 L/HR position. Using a single jumper cable, plug one end into the 10 HOUR socket, then touch the other end to the pump sockets, one at a time, to verify that each pump operates. At the 10-liter flow rate each pump will turn on for a short period of time (¼ second) then turn off and remain off for two seconds before briefly turning on again.

Patch the STOP HR socket into the 10 HOUR socket. Manipulate the HOUR and MIN SET buttons to bring the indicated time to 09 hours 59 minutes. Allow the clock to advance normally until it shows 10 hours 00 minutes. Using a volt meter or oscilloscope check the voltage at the 10 HOUR socket (ground to controller case). If it is 11.5 volt or higher the AQS controller has terminated the sampling sequence. If the voltage is 1.0 volt or lower the stopping sequence is inoperative (out of order).

> Depressing either of the TIME SET switches initializes the system, clearing the sequence stopping action,provided the existing hour is not the same as the chosen STOP hour. In this way, when time is being set, the STOP is overriden.

PROGRAMMING PRINCIPLES

Sample pump programming is accomplished by using the supplied jumper cables to connect the selected 60-minute interval, represented by the HOUR Sockets (00, 01 ... 22, 23), to the selected PUMP input socket (1 to N, N = 8, 12, 16, 24).

For the AQS with the "Cycle Option" the day is also selected during which each 60-minute sample is to be drawn (Cycle 1, 2, 3, 4).

If more than one connection is to be made to a single socket, the jumper cables may be stacked one on top of the other.

> The same HOUR output socket CANNOT be connected to more than one PUMP input socket (e.g. two pumps cannot operate simultaneously)! This combination would cause overload of the switching regulator.

Each pump outlet to a bag is numbered (e.g. 1 to N, N = 8, 12, 16, 24) in agreement with the Timer Controller PUMP input sockets. Great care should be taken in reproducing these numbers on the corresponding Air Sampling Bag. Thus identified, the samples are coded to the time and day the sample was taken.

Care is required when inserting and removing the programming jumper cables. To prevent damaging the sockets the recommended procedure is to:

- Insert or remove each jump plug individually.
- Hold jumper by the plug not by the wire.

The timing system is based on the twenty-four-hour clock, where midnight is 0000 hours, 6 a.m. is 0600 hours, noon is 1200 hours, 11 p.m. 2300 hours, etc. Hours and minutes are displayed and can be set.

All of the 24-hour time intervals are available outputs on the controller front panel sockets. All sampling pump inputs are also available sockets. The sequence can be terminated by connecting the STOP HR socket to the desired HOUR socket.

STANDARD PROGRAMMING

Connect the HOUR socket to the PUMP socket to prescribe the hour intervals during which samples are to be taken. Connect the STOP HR socket to the desired HOUR socket in order to prescribe the time at which the sampling sequence is to be completed.

> The STOP HR corresponds to the complete interval (beginning to end) of the hour it is patched to. Do not patch the STOP HR in the middle of the sampling sequence. This would cause sampling to be disabled at the start of the prescribed hour.

> If no STOP HR is connected, the 24-hour cycle repeats itself until the AQS is switched off or until the battery voltage falls below usable level. This causes improper sample gathering and may cause the bags to burst.

After all patch cords are in place (see Figure 5) attach each bag to a pump fitting by means of the quick-disconnect (see Figure 6) and place it into the drum.

- When installing the bags, make sure the pinch clamps are loosened to allow sampled air to flow freely through the tubing into the bag.
- Do not place more than 12 2-liter bags at the same level in the barrel. Stagger 24 2-liter bags at two different levels.
- Make sure sampling time is recorded on the corresponding bag.

Turn the power on, set the time by depressing the DISPLAY and the TIME SET buttons.

To close the AQS apply slight pressure to the top of the Lid Assembly to insure it is snugly fitted onto the Drum. Close the ring clamp. The clamp is slotted to lock the lid to the drum once the clamp has been closed. The clamping ring insures a very tight fit and some force may be required to secure it into the clamped position.

Figure 5. Programming the Air Quality Sampler

Figure 6. Bags Attached to the Pump Outlets

When closing the AQS check carefully to insure none of the bags or tubes are inadvertently trapped between the Drum rim and the Lid Assembly.

Example 1

Example 1 (see Figure 7) illustrates a simple case of programming of the Standard AQS. Note that no pump can be activated after HOUR 11. The existing time must be after HOUR 11 and before HOUR 06.

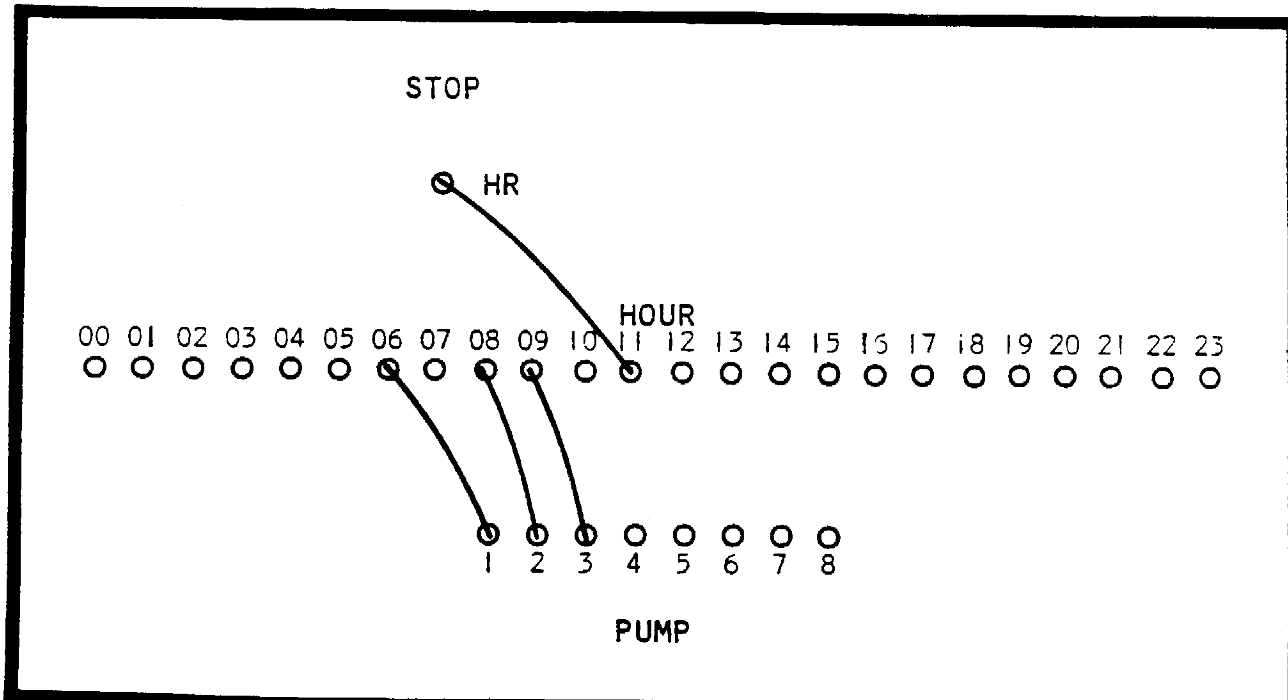


Figure 7. Example 1 (Standard AQS).

- At HOUR 06 PUMP 1 is activated; from 0600 to 0700 Bag 1 is filled.
- From 0700 to 0800 no pump is active.
- At HOUR 08 PUMP 2 is activated; from 0800 to 0900 Bag 2 is filled.
- At HOUR 09 PUMP 3 is activated; from 0900 to 1000 Bag 3 is filled.
- At HOUR 11 the sampling sequence is disabled until the AQS is attended and the STOP mode cleared by momentarily depressing the TIME SET, minutes switch.

CYCLE OPTION PROGRAMMING

The Cycle Option AQS

The "Cycle Option" enables programming over a 96-hour period divided into four 24-hour periods (four cycles). Both cycle and hour of sampling can be selected for a particular pump (bag). Furthermore the Cycle Option is designed with 4 pump Groups which enable pumps (bags) belonging to one Group and only those to be activated during a predetermined cycle. A single Group, more than one, or all Groups can be gang patched to operate in any one cycle. Table I gives the standard pump groupings in the AQS; special order groupings are listed also.

The additional features on the Control Panel of the Cycle Option AQS compared to that of the standard AQS are from right to left (see Figure 8 and Figure 9):

- The four GROUP sockets (pumps are grouped as described in Table I). Each AQS has a provided grouping chart in the pocket at the back of this of this manual.
- The four CYCLE sockets, labeled 1, 2, 3 and 4.
- The Light Emitting Diode (LED) indicator shows which cycle is in operation.
- START HR socket and STOP CY socket located immediately above the STOP HR socket.

TABLE I

AQS PUMP GROUPING

CYCLE OPTION

Total number of pumps	Standard pump groupings	Special order groupings
8	4, 4	
	2, 2, 2, 2	
12	2, 4, 4, 2	3, 3, 3, 3
16	2, 6, 6, 2	
	4, 4, 4, 4	4, 4, 6, 2
24	6, 6, 6, 6	8, 4, 4, 8
		6, 6, 4, 8
		12, 4, 2, 6
		8, 8, 2, 6

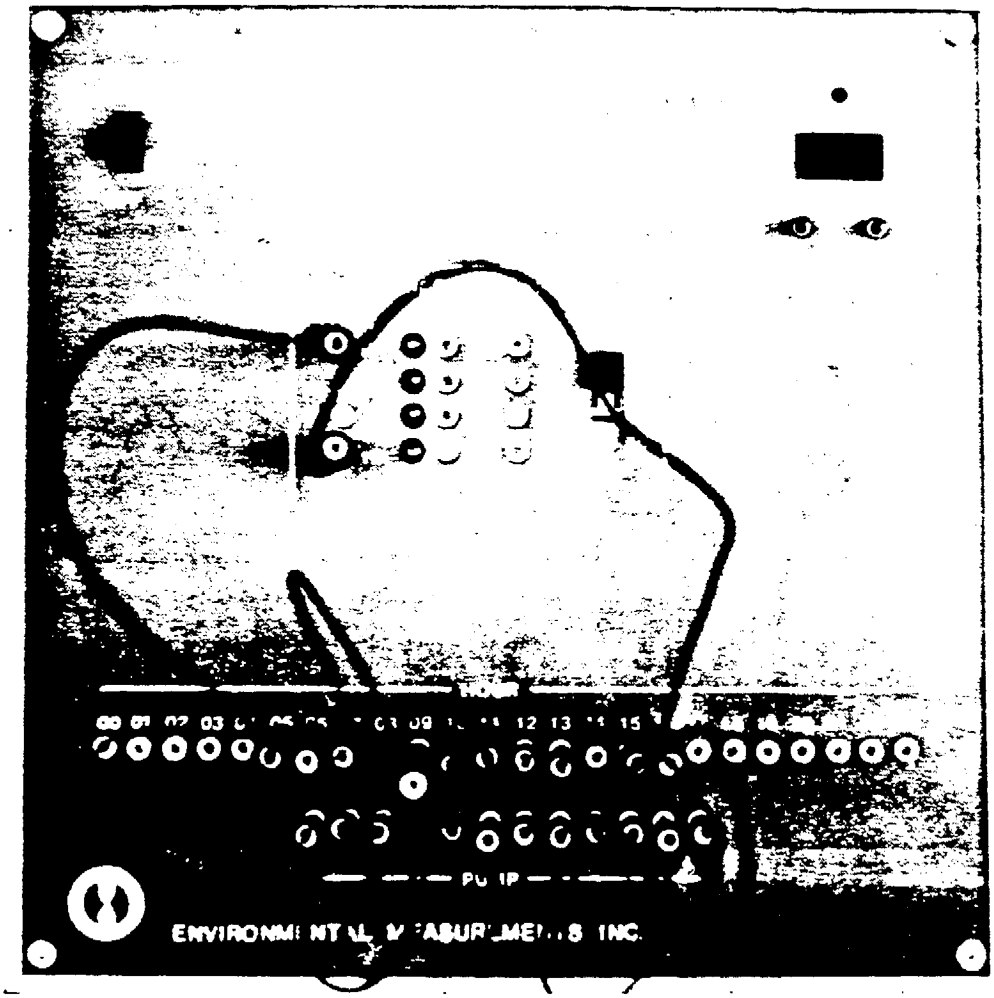


Figure 8. Controller Front Panel (12-pump Cycle-Option)

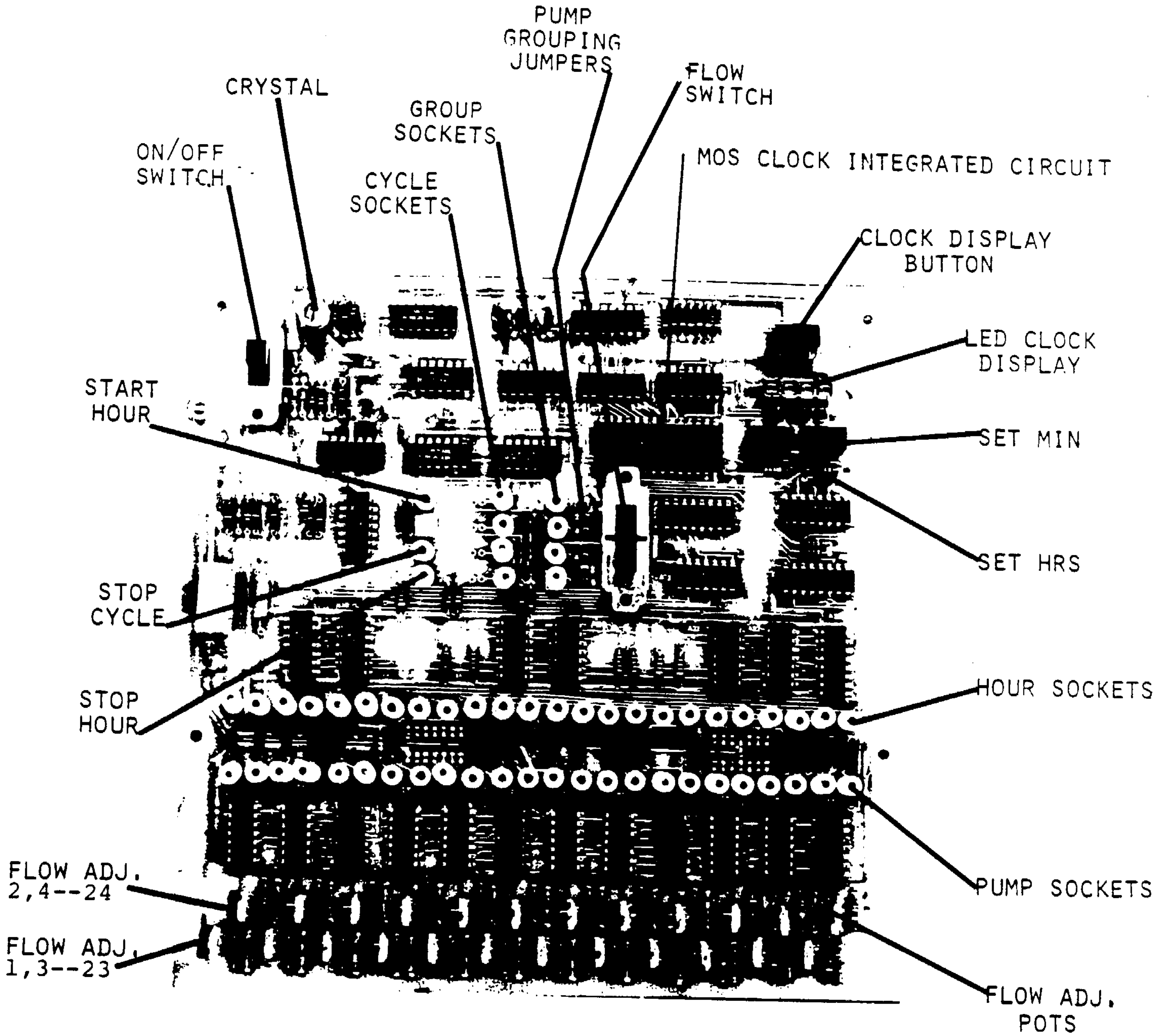


Figure 9. Printed Circuit Board
(24-pump Cycle Option)

PROGRAMMING STEPS

Example 2 (see Figure 10)

This example illustrates step by step all normal programming operations for an AQS with Cycle Option. Simpler examples follow.

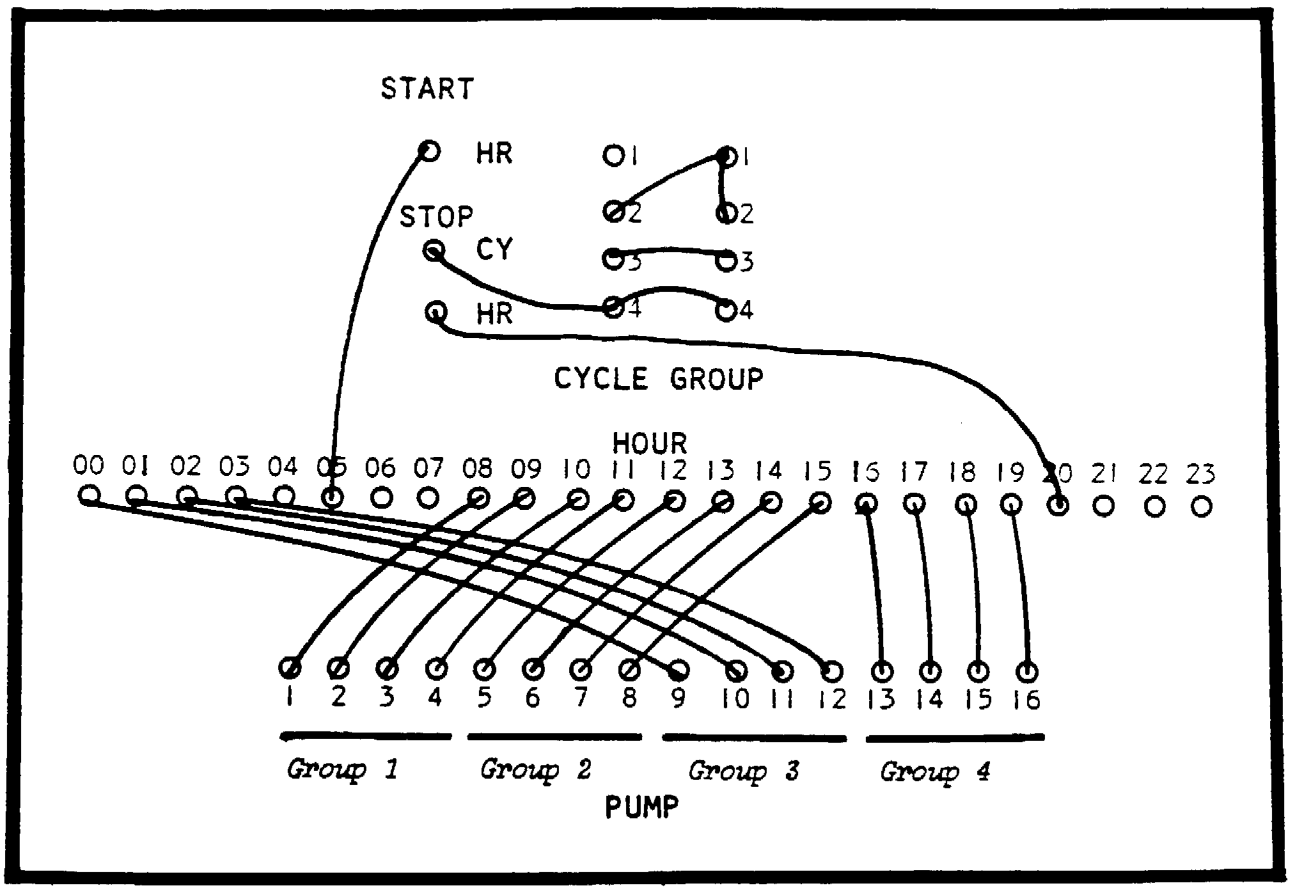


Figure 10. Example 2 (Cycle Option AQS)

In Example 2

HOURS 08 through 15 are patched to PUMP 1 through 8 respectively, which will cause:

- bag 1 to be filled on Thursday between 0800 and 0900
- o bag 2 is filled between 0900 and 1000 and so on until
- bag 8 is filled between 1500 and 1600.

Step 6 and Step 7 can be repeated to use up the remaining Cycles and the remaining bags. (next page)

In Example 2, Cycle 3 is connected to GROUP 3 HOURS 00 through 04 are connected to pumps 9 through 12 respectively:

At 0500 on Friday morning Cycle 3 is activated

at HOUR 00 (Saturday midnight) pump 9 is enabled and fills bag number 9 between midnight and 0100 then,

between 0100 and 0200 bag 10 is filled

between 0200 and 0300 bag 11 is filled

between 0300 and 0400 bag 12 is filled

Cycle 4 being connected to GROUP 4 during the fourth Cycle, beginning on Saturday at HOUR 05, bags of the group 4: 13, 14, 15 and 16, are filled successively between 1600-1700, 1700-1800, 1800-1900 and 1900-2000 hrs.

Step 1 Turn the AQS on.

Step 2. Set the flow to desired flow rate (2,5 or 10 L/HR).

Step 3 Momentarily depress either of the TIME SET buttons, this causes the cycle counter to be initialized to Cycle 1 (LED of Cycle 1 lights up).

Step 4 Set the time on the display to the time of the day.

Step 5 Connect START HR to the desired HOUR socket (0500 in Example 2). This will cause the cycle counter to advance one cycle increment each time the START HR is reached.

In the example assuming the AQS was initialized on Thursday at 0000 or any time Wednesday after 0600 hours, at 0500 on Thursday the cycle counter will advance from 1 to 2.

Step 6 Connect the desired Cycle to the Group or Groups which are to be operating during this particular Cycle. In Example 2 the pumps are equally divided into the four Groups (four pumps each). Cycle 2 is patched to Groups 1 and 2; this means that only pumps 1 through 8 may be enabled during Cycle 2 extending from 0500 on Thursday till 0500 on Friday.

Step 7 The next step consists of patching HOUR sockets of the selected Cycle to PUMP sockets of the selected Groups.

Step 8 Patching the STOP CY socket to a Cycle socket and the STOP HR socket to an HOUR socket terminates all operation (except for the clock) during this cycle, at the HOUR indicated.

In Example 2 all pumps are disabled on the 4th day at HOUR 20 (or Saturday at 8 p.m.). The sampling is over, the bags can be removed as described in Section 1 and a set of fresh bags can be installed if the experiment is to be repeated. The cycle timer is reset to Cycle 1 by momentarily depressing the time setting minutes push button.

If sampling is over do not forget to return the power switch to its OFF position.

MORE EXAMPLES

The following examples (3 through 9) are offered as guides to programming the AQS with and without the Cycle Option (see Figures 11 through 17).

Example 3 (see Figure 11)

Any number of Groups may be connected to one Cycle socket. All the Groups can be connected to the same Cycle as illustrated in the following example.

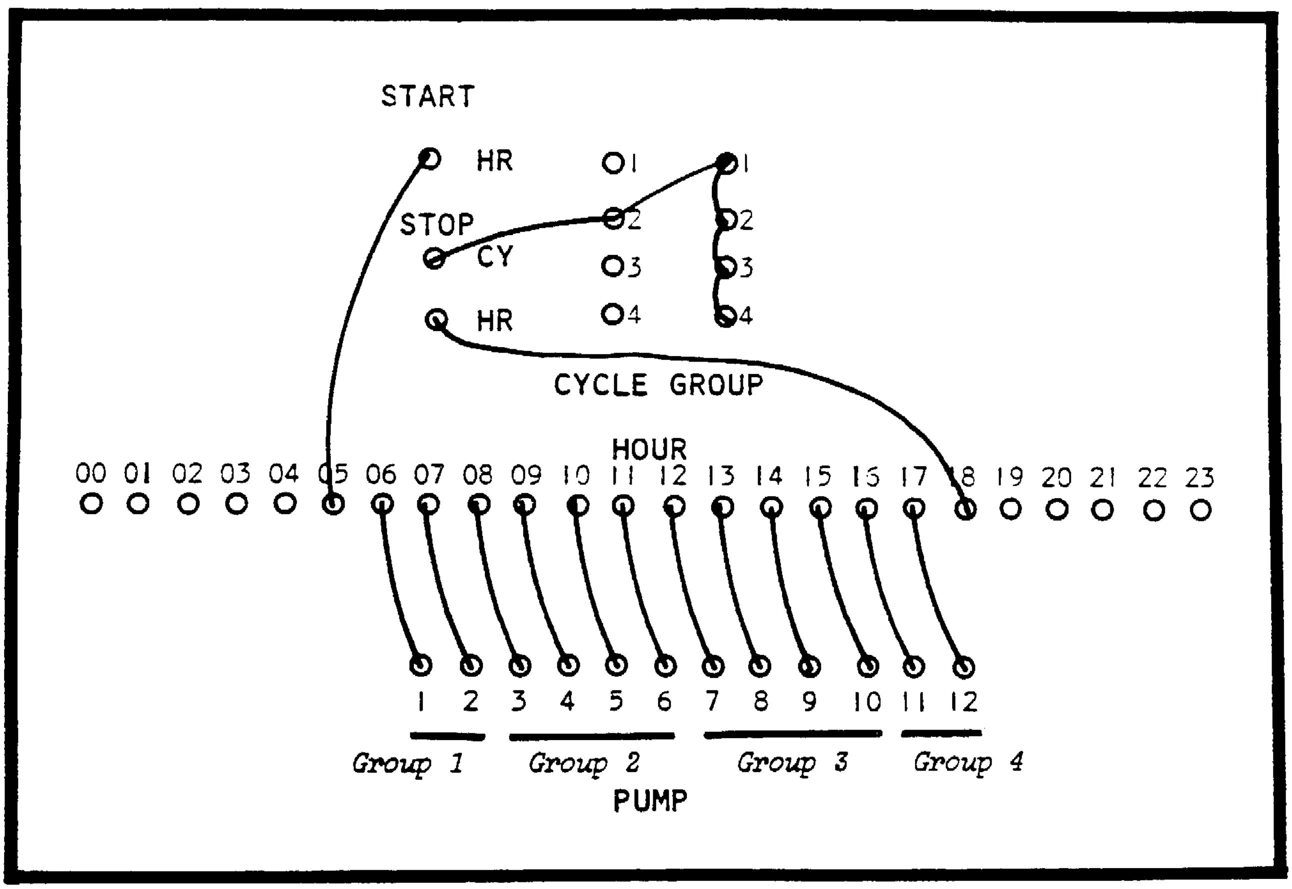


Figure 11. Example 3 (Cycle Option AQS).

- Groups 1, 2, 3 and 4 are all connected to Cycle 2; they will all operate in this Cycle.
- START HR is patched to HOUR 05; when the clock reaches 0500, Cycle 2 is activated. From 0600 on through 1700, Bags 1 through 12 are successively filled for a 60-minute period each.
- STOP CY is patched to Cycle 2 and STOP HR to HOUR 18; the sequence stops at 1800 of Cycle 2.
- Assuming a 225-liter drum the maximum flow rate acceptable is 5 L/HR with 12 5-liter bags. The only other alternative for a 225 or 120-liter drum is 12 2-liter bags with a 2 L/HR flow rate.

Example 4 (see Figure 12)

This is a repeat of Example 3 with a 24 pump AQS (instead of 12) where the 24 pumps are successively activated during the 24 hourly intervals of Cycle 2.

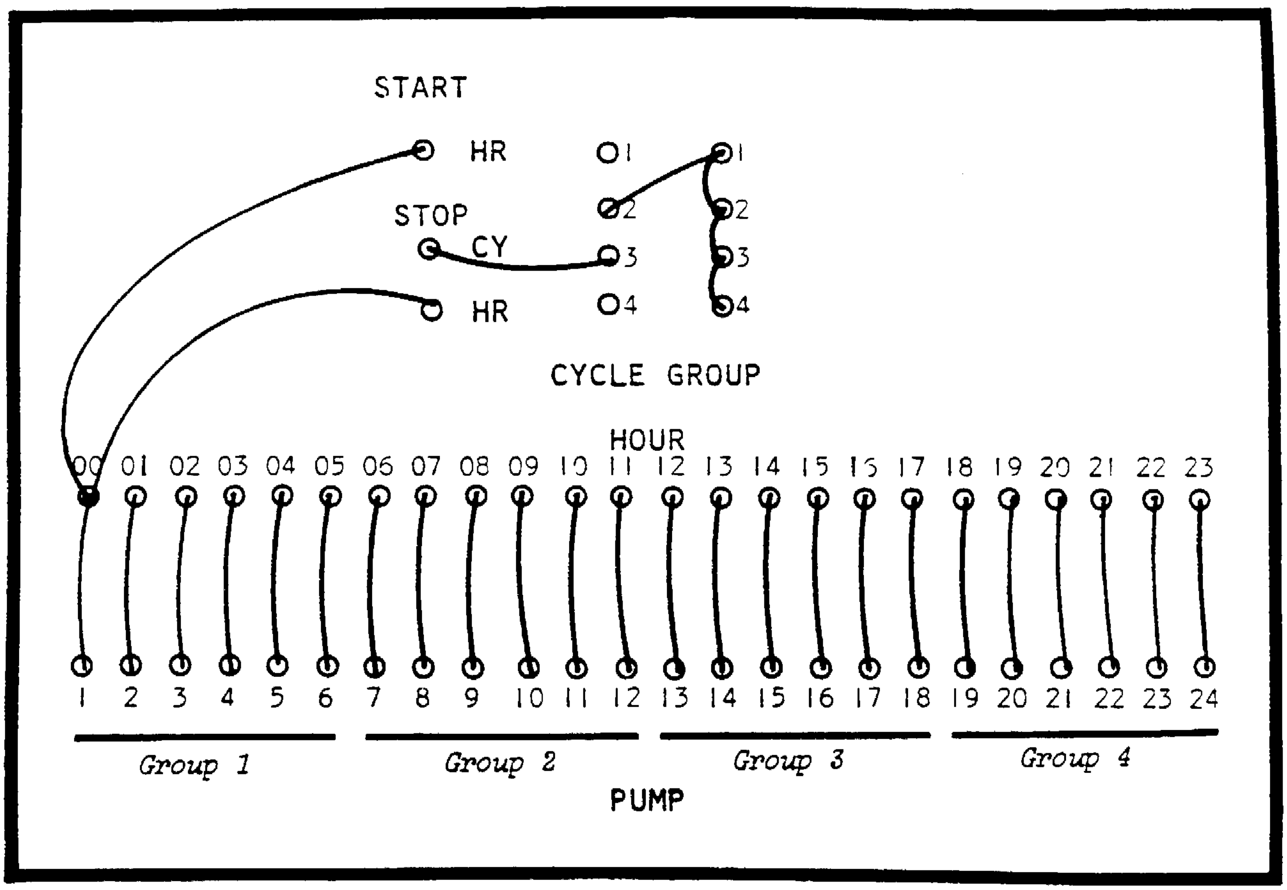


Figure 12. Example 4 (Cycle Option AQS).

- Groups 1, 2, 3 and 4 are all connected to Cycle 2; they will all operate in this Cycle.
- START HR is patched to HOUR 00; when the clock reaches 0000 Cycle 2 is activated from 0000 throught to 2300 inclusively. Bags 1 through 24 are each successively filled for a 60-minute period.
- At 2359 Cycle 2 enters its last minute of operation; at HOUR 00 Cycle 3 is activated but the sequence stops because STOP CY is patched to Cycle 3 at STOP HR 00.
- In this case the drum must be 225-liters with 24 2-liter bags; only acceptable flow rate 2 L/HR.

- **STOP HR and START HR can be stacked one on top of the other.**
- **Jumper cables linking successive Group sockets can be stacked to chain connect multiple sockets. In Examples 3 and 4 the jumper cables would be made to patch Groups 1, 2, 3 and 4.**

Example 5 and Example 6 (see Figure 13 and Figure 14)

One can leave all the Group sockets and Cycle sockets unconnected which in effect allows the Cycle Option AQS to operate as a Standard AQS as illustrated in Examples 5 and 6, where the end results are identical for the two programmings.

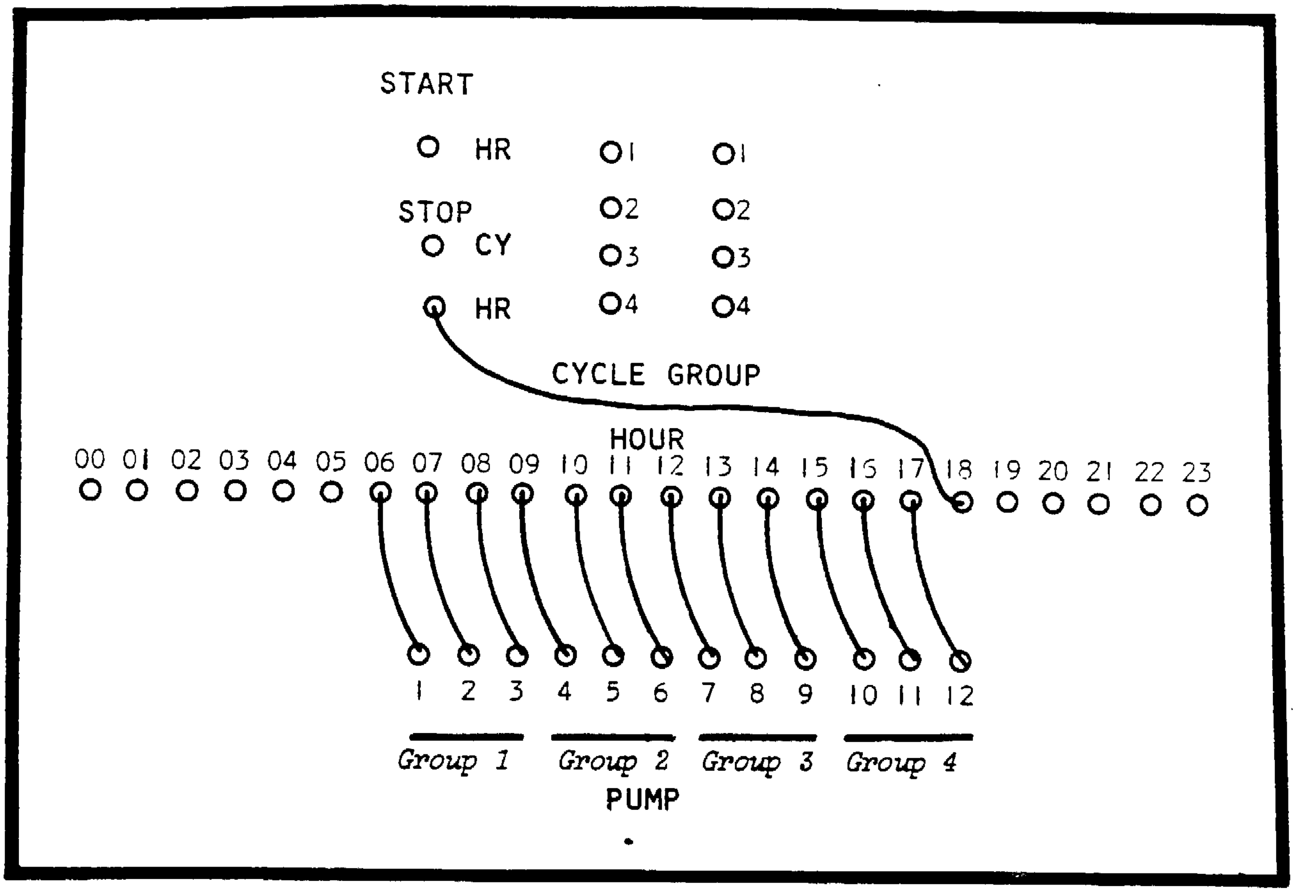


Figure 13. Example 5 (Cycle Option AQS).

The programming comes to the same end result as in Example 3. The Cycle and Group sockets being entirely bypassed,the starting sampling time on the LED Display must be prior to 0600. This restriction does not apply to Example 3.

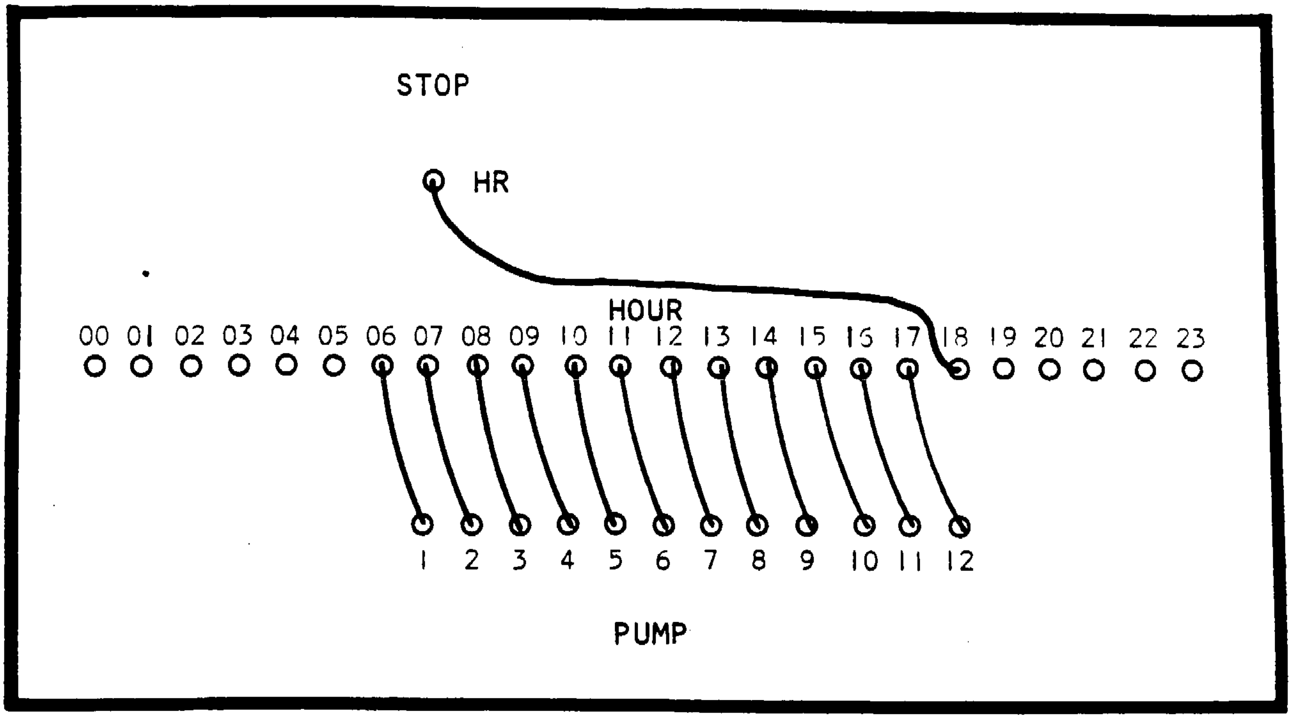


Figure 14. Example 6 (Standard AQS).

The same remarks apply to the programming of this standard AQS and the Cycle Option AQS of Examples 3 and 5.

Whether the Cycle Option is used or not, the STOP HR connection must be made for stopping.

Example 7 (see Figure 15)

Unattended identical sampling pattern repeated for four consecutive days.

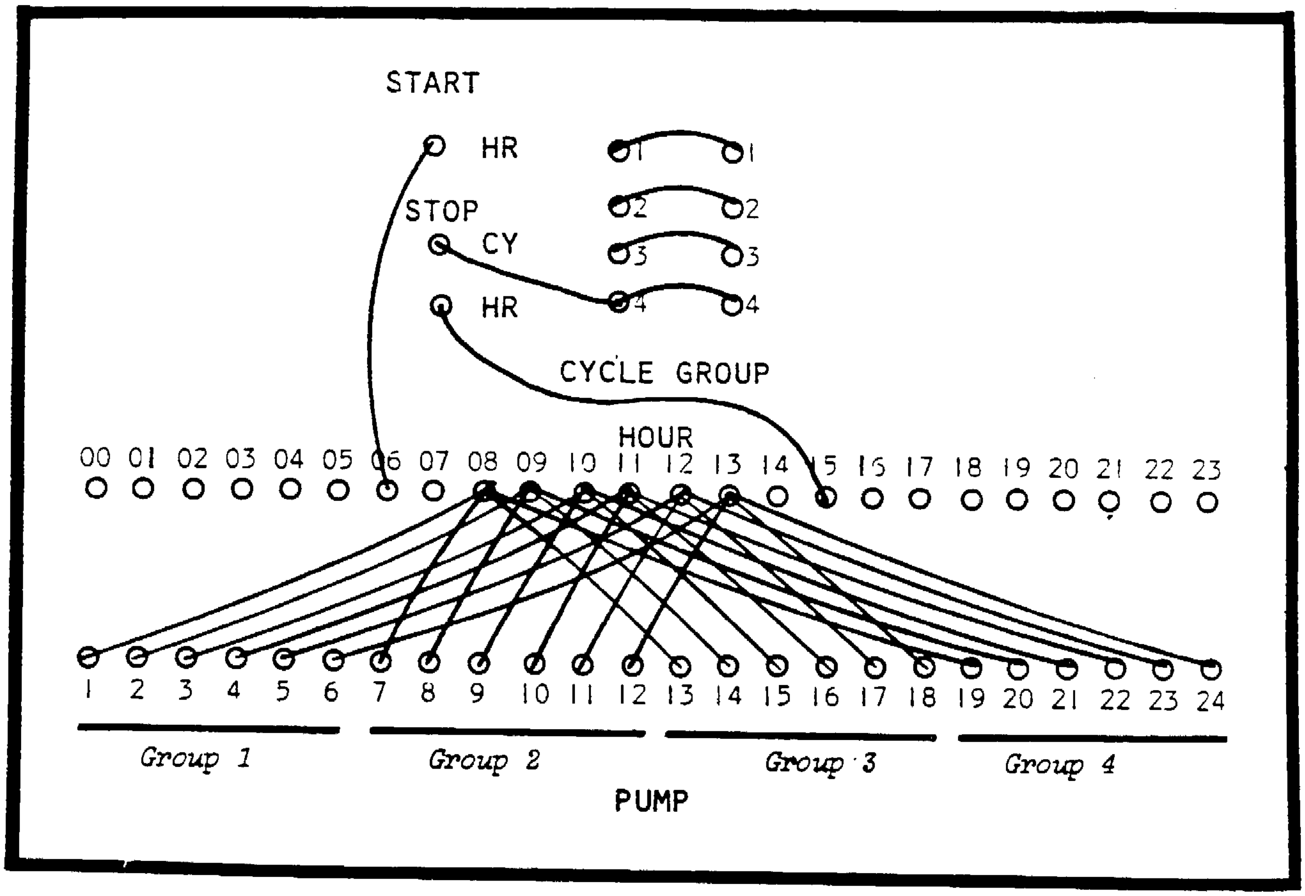


Figure 15. Example 7 (Cycle Option AQS).

- For four consecutive days, the AQS samples during the same 60-minute intervals from 0800 through 1400.
- At 0600 each day the Cycle Counter advances one notch.
- On the 4th day (4th Cycle) at 1500 all the pumps are disabled.
- Assuming the Clock is set to the time of the day the operation can start only between 0600 and 0800.
- The drum size must be 225-liters with 24 2-liter Bags and a 2 L/HR flow rate.

> In Example 7 Step 4 (setting the time on the LED display) is particularly important since the AQS is used in Cycle 1. If the time on the display was set before HOUR 06 this would cause the Cycle counter to advance from 1 to 2 at HOUR 06 and Cycle 1 would be skipped altogether; Group 1 would never be activated.
> In the particular experiment proposed in Example 7 the time can only be set between 0600 and 0800 (corresponding to HOUR 06 and 08). As an alternative, the START and STOP HR could both be set to 1400 then the initial set up time could be any time between 1500 and 0700.

Example 8 (see Figure 16) and Example 9 (see Figure 17)

Both examples depict programming patterns where one bag is filled during more than one 60-minute period. The flow rate and the size of the bags must be carefully adjusted to accommodate all the air intake.

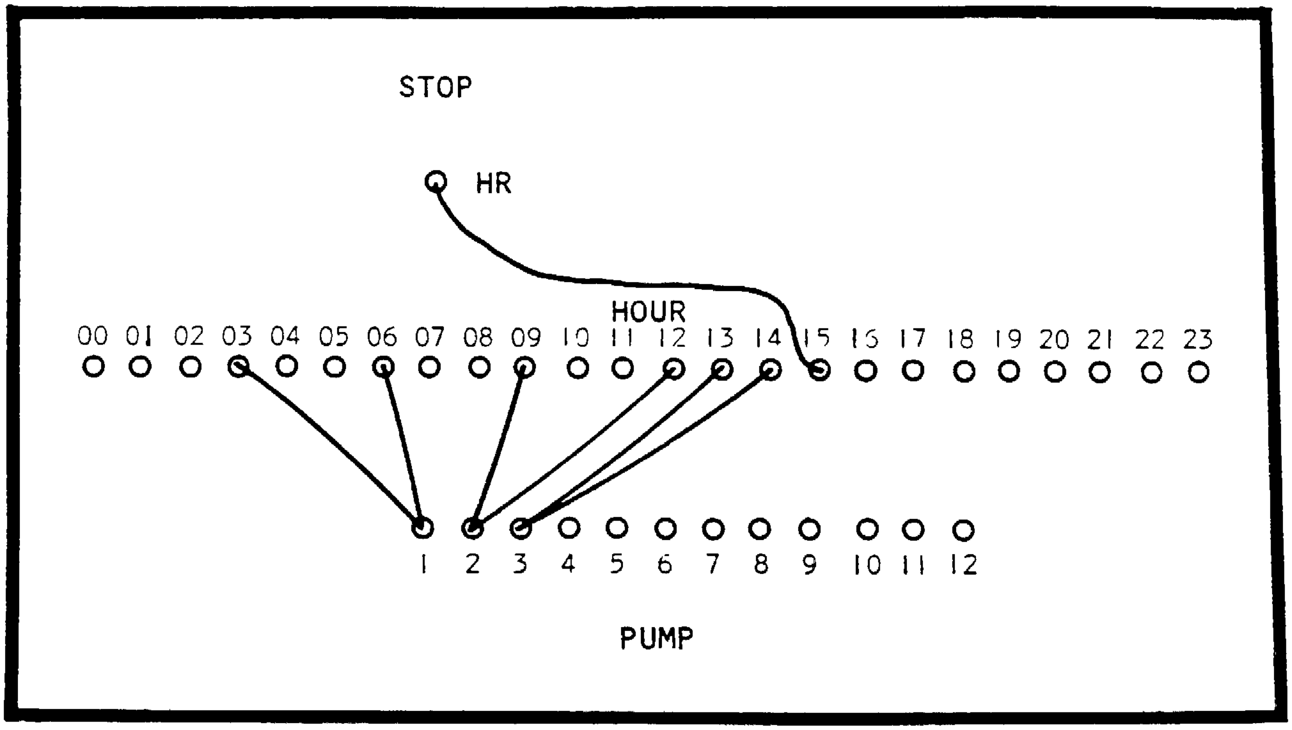


Figure 16. Example 8 (Standard AQS).

If multi-hour operation of a single pump is required, as shown in Examples 8 & 9, contact the factory. The hour ports are not designed to be hard-wired together. To do so may damage the AQS Controller. Contact the AV factory by calling (818) 357-9983.

- When the AQS is switched on, the time on the LED display must be set prior to 0300.
- In the time intervals (0300 to 0400) and (0600 to 0700) Bag 1 is filled.
- In the intervals (0900-1000) and 1200-1300) Bag 2 is filled.
- In interval 1300 to 1500 Bag 3 is filled.
- At 1500 all the pumps are disabled.
- Assuming that the drum has a 225-liter capacity and that only Pumps 1, 2, and 3 will be used for this particular sampling, three 20-liter Bags can be used and the flow rate set at 10 L/HR.

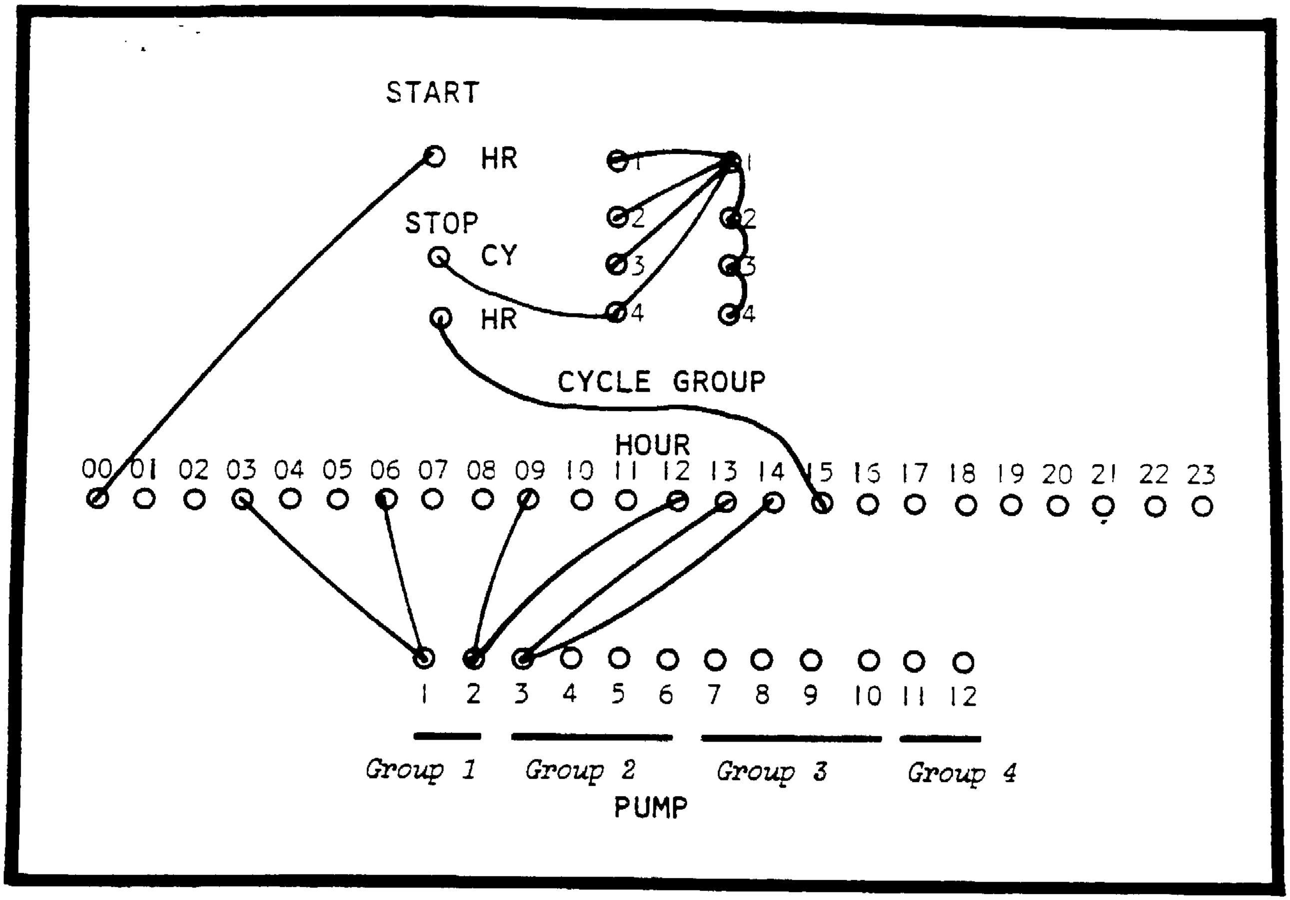


Figure 17. Example 9 (Cycle Option AQS).

> If multi-hour operation of a single pump is required, as shown in Examples 8 & 9, contact the factory. The hour ports are not designed to be hard-wired together. To do so may damage the AQS Controller. Contact the AV factory by calling (818) 357-9983.

This case is a repeat of Example 8 on four consecutive days.

- The starting time for sampling on the LED display must be between 0000 and 0300.
- Since all the Groups are connected they can all be operating during the same Cycle; all the Groups being connected to each Cycle, can all be operating during all the Cycles.
- At HOUR 00 each day the cycle counter advances one notch. During each Cycle:
    - Bag 1 is filled in the time intervals (0300-0400) and (0600-0700).
    - Bag 2 is filled in the time intervals (0900-1000) and (1200-1300).
    - Bag 3 is filled in the time interval 1300-1500.
- Each bag is now filled for a total of 8 hours. The only acceptable flow rate is 2 L/HR and the three bags must have a capacity of 16-liters.

Section 4

TECHNICAL DESCRIPTION

ELECTRONIC

All timing originates from a 15.36KHz crystal oscillator. This is divided to 60 hz, input to an MOS (integrated circuit using monolithic oxides of silicon) device providing time division multiplexes (TDM) outputs in a binary-coded decimal (BCD)format and seven segment outputs for driving the light-emitting diode (LED) numerals for time display.

The selected BCD outputs, tens and units of hours, are latched to get out of the TDM "time" base. They are then decoded to provide 24 one-hour timing sockets which are in phase with the *hour's* display of the visible clock.

When an active one-hour timing socket is connected to a pump socket, the pump is driven for the hourly interval by a separate timing device. The operating period of this duty-cycle timing device establishes the average flow rate the pump will provide for the one hour of operation.

A standard AQS is programmable by patch cords (jumper cables, see Figure 18) to establish the hour-to-pump interface and the selection of a stopping time. An AQS with the Cycle Option may be further programmed to provide selected day, as well as hour for pump operation.

Reference to Figure 18, the Controller Block Diagram, and Appendix A showing the printed circuit schematic will be of assistance.

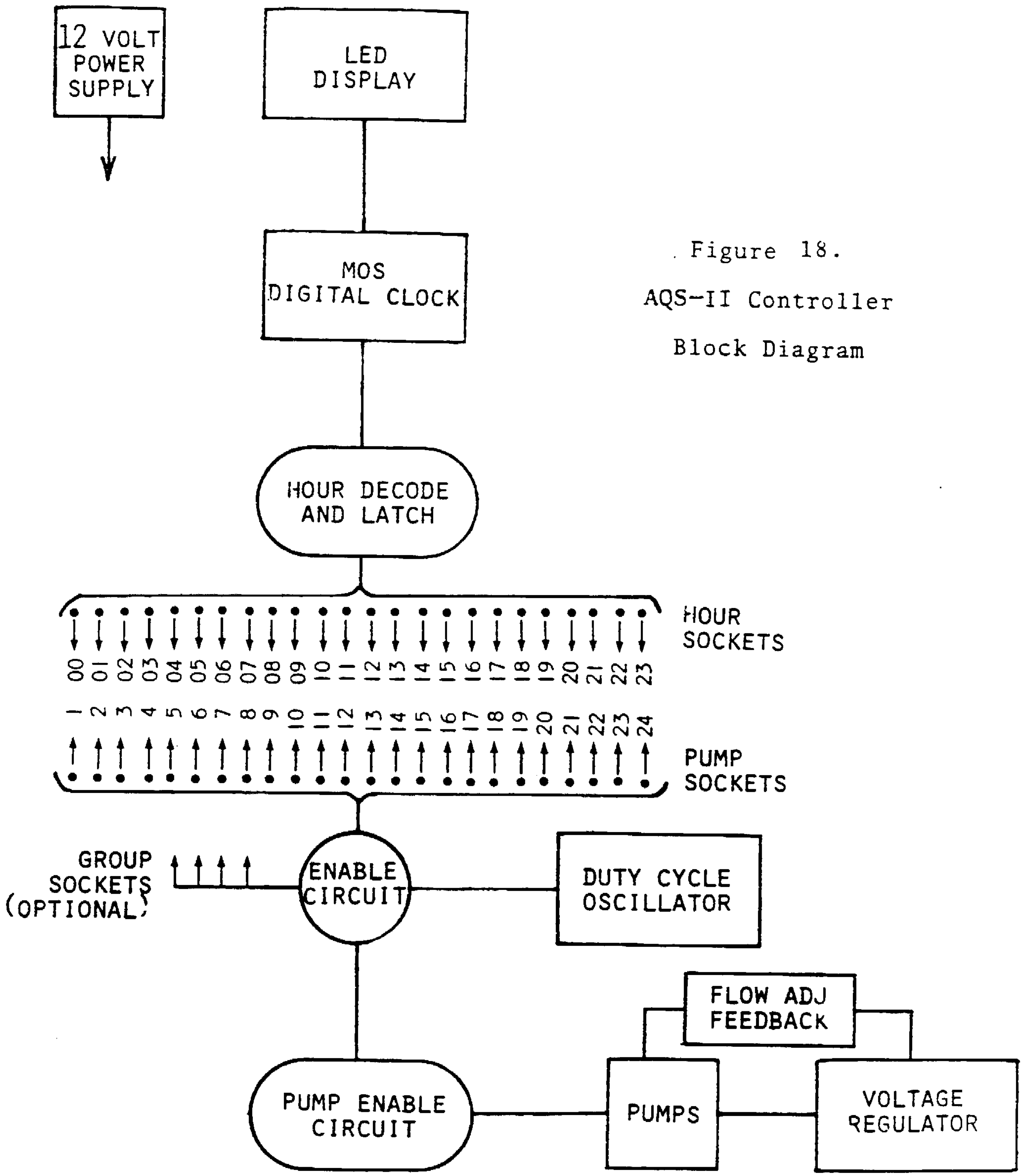


Figure 18.

AQS-II Controller

Block Diagram

Timing. Crystal X1 oscillates at 15.36KHz providing a signal for CMOS Divider A-1 (CD 4060).

A-1 divides the 15.36KHz by 256 giving a 60Hz square wave as input frequency for A-11. A-11(MM5313) is a 24-hour digital clock MOS device providing time division multiplexed BCD outputs and decoded seven segment numeral outputs, synchronous with timing, to identify tens and units of hours and minutes.

A momentary push switch (S2) is included to turn on the LED display when the AQS is being programmed. Switches S3 and S4, momentary push ON, provide the means for rapidly advancing the clock outputs for time setting. S3 sets the hours, advancing the clock at the rate of one hour per second. S4 sets the minutes, advancing the minutes at the rate of one minute per second. Components R4 and C3, connected to pin 27 of A-11, provide the frequency for time division multiplexing. The seven segment outputs are input to MOS-to-LED drivers A5 and A6 (LM 75491). The digit enable outputs from A-11 are input to the Clock display A7 (DL-34M) through non-inverting buffers A2 (CMOS CD 4050). The segment outputs from A5 and A6 are also input to A7 resulting in a time division multiplexed real time on the LED display.

Digit enable outputs for tens of hours and units of hours, from A-11, are differentiated and delayed by A4 (MM74C04), components C4, C5, C6, C7, R120, and R121 and input to quad latches A13 and A16 (MC 14042) as latch commands. Negative true BCD data from A11 corresponding to each digit in multiplexed sequence is input to A16 and A13 through A14 inverter (CD 4049). The outputs from A16 correspond to a BCD equivalent to the Clock unit of hours. Outputs from A13 correspond to the BCD equivalent of the tens of hours shown on the display. The units of hours BCD data is input to A23 BCD to one of ten decoder (MC 14028), while the tens of hours BCD is input to A15 (C0 4073) AND gates for use as an enable for 0-9 hour output group, 10-19 hour output group and 20-23 hour output group. The final decoding is done by A17, A18, A19, A20, A21, and A22 (CD4011 NAND gates), producing a negative true (low voltage) signal at the active hour socket.

Pump Operation. The pump ring contains up to 24 D.C. motor pumps with one side of all the motors connected together and brought into the controller via J-2-pin 4 and 11. The remaining side of each pump motor is brought into the controller and is taken to an output of current drivers A26, A29, A32, and A35 (LM 75492 Inverting Hex (6 per pack) Buffers). Whenever any input to the pump drivers is high, their output is low, providing a ground for a pump motor. Voltage regulator circuit A8, Q2, Q3, L1, CR3 and C8, delivers a D.C. voltage to the common side of the motors. More specifically, Q2 used as a zener diode delivers a precise voltage to A8 comparitor circuit depending on the voltage division that occurs between R13 and the resistance in the circuit to the grounded pump driver. This resistance can be varied by adjusting individual potentiometers, thereby causing the pump voltage to change. This feature assures consistent sample volumes from pump to pump.

Pump Duty Cycle Timing. The pump drivers A26, A29, A32, and A35 (75492) are connected to pump enabling circuits which have three inputs. One input is the programmable pump socket. Another input is the GROUP Socket (pull down resistors provide this when a STANDARD MODEL is purchased). The third input is a signal that provides the adjustable duty cycle. A8 (LM 324 Quad Op Amp) used as an astable multivibrator oscillates at a frequency depending on FLOW RATE SWITCH (S1). Placing S1 in the 2 LITER/HR position selects a duty cycle nominally 250 milliseconds ON for a 10second period. When S1 is placed in the 5 LITER/HR position, the duty cycle is nominally 250 milliseconds ON for a 5 second period and in the 10 LITER/HR position, 250 milliseconds ON for a 2 second period. This signal along with the other two discussed earlier must all be present for a pump to become active.

Stop Sequence. In the standard AQS stopping the pump sampling sequence is accomplished by programming the SEQUENCE STOP HR socket to the desired hour. When the pre-programmed hour is reached, the A12 "flip flop" is set, disabling the 0-9, 10-19, and 20-23 hour groups. In the AQS with

CYCLE OPTION, stopping the sequence can be achieved in two ways. The STOP HR socket is patched to the correct hour and either no GROUP sockets are patched into CYCLE sockets or a GROUP socket can be connected to a cycle socket. The desired stopping cycle socket is thus patched to the stop cycle socket.

Cycle Option. "Flip-flops" A12 are cleared when the time setting switches S3 or S4 are depressed. This also initializes the cycle sequence to No. 1 by clearing "0" flip-flops A9 (MC14013). When the START CYCLE HR socket is patched to an hour socket and that socket goes active it toggles (by trigger input) A9, LED #2 lights showing the AQS is now in its 2nd day of operation. Only those pumps in the GROUP which is programmed into CYCLE #2 socket will be enabled. After the time advances to the programmed START HR again, A9 toggles and LED #3 lights. This occurs again the following day and LED #4 lights. If the STOP CYCLE SOCKET is programmed to the fourth CYCLE the AQS will stop during this CYCLE.

Battery Power Pack. The battery pack, located in the bottom of the AQS drum, contains four 12-volt batteries in parallel (Burgess TW2-X or equivalent). The batteries are NEDA 926 type which when parallel connected as a set of four will give at least 600 hours of operation before requiring replacement.

Controller PC Card Removal. Remove the four screws on the controller end panel facing the pump nipples. Remove the two Phillips screws near the corners of the controller top panel (near the ON/OFF switch and near the TIME PUSH-TO-READ switch). The controller P.C. board is attached to the top panel and it should be free to slide out of the remaining three sides. Slide them forward about five inches, spread the chassis sides, lift out the panel and controller card. Turn the panel/card sandwich over and disconnect J1 and J2 from the controller P.C. board. Note that J1 and J2 are dot color coded. Next, loosen and remove the seven screws holding the P.C. board to the standoffs. Reassemble in the reverse manner. First attach panel to the P.C. board and slide part way into the controller sides. Attach J1 and J2 and slide the sandwich (P.C. board and panel) all the way in. Make certain J1 and J2 are secured to the panel board with string or tie-wraps. Attach two Phillips screws, and attach the end panel.

When the panel and P.C. card are unattached be very careful to avoid changing the potentiometer settings; potentiometers are located near the lower side of the card. Each potentiometer adjusts the flow rate for a particular pump.

MECHANICAL

The exterior of the AQS is constructed of high density polyethylene which has been treated with ultra-violet inhibitors to provide long life under outdoor exposure conditions.

Removal of Pumps: The pumps are located within the chamber covered by the AQS lid. Six Nylatch fasteners have been used. To remove the white cover the Nylatch fasteners are loosened by pulling upward on the protruding cap centered in each of the fasteners. When all six center plugs have been "snapped" up, the cover is removable by applying upward pressure at each of the Nylatch points. This provides a separating force between cover and remaining lower portion of top assembly at each of the Nylatch points.

Removing the top dome exposes the pumps. Each output port (to the bag hoses) is associated with an individual pump. Each pump is removable by unsoldering the two wiring points then removing the screw which holds the pump in place.

Pump removal will possibly be easier if the pump holder assembly is removed from the black lid which holds the controller unit on its underside. This is done by removing the six screws which penetrated the black lid to clamp the pump holder in place. The wiring cable from the pumps to the controller will remain attached so do not attempt to remove the pump holder unit from the lid totally.

Removal of Controller Unit: After removing the pump chamber cover you will observe four screw heads symmetrically located on the lid at the bottom of the pump chamber. Removing these will free the electronic controller from the lid.

Section 5

PERIODIC MAINTENANCE

Only two items require periodic maintenance. They are the batteries and the pumps.

PUMP MAINTENANCE

The pump chamber should be periodically opened and cleaned to avoid excessive dust and small debris accumulation. The pump chamber is not filtered; therefore, cleaning is required for continued good pump operation. Pumps are best cleaned by blowing them out with low pressure compressed air, such as an aerosol can of dry air.

BATTERY MAINTENANCE

The batteries should be checked each time the AQS is to be used or at least every 100 hours to insure adequate battery power for reliable operation. Check the batteries by disconnecting the battery pack connector and test with a voltmeter. Across the two terminals inside the female socket the voltage should be 9.0 volts or greater. If not, remove battery pack and change the batteries.

Disconnect the battery pack from the controller when the AQS is not used for more than a week.

BATTERY REPLACEMENT

To replace the four 12-volt batteries in the AQS it is necessary that the battery pack be removed from the barrel, the old batteries discarded and four fresh 12-volt lantern batteries (NEDA type 926) be installed, following the procedure below. A pair of pliers and standard blade screw-driver are adequate tools.

REMOVAL OF BATTERY PACKS:

1. Loosen all the turnbuckles which secure the battery pack to the barrel. Note that the turnbuckle screw through the barrel wall is a standard 10-24 thread (right hand thread), the screw-hook from the turnbuckle attached to the battery pack is a reverse standard 10-24 thread (left hand thread).
2. Remove the battery cable clamp located near the top of the barrel.
3. Free the battery pack of all turnbuckle hooks which are seated through holes in the top of the battery pack.
4. Remove the battery pack and place on a convenient working surface with turnbuckle hook holes facing down.
5. Remove four sheet metal screws from the now top surface allowing the top cover to be removed exposing the four batteries.

Installing New Batteries

1. Note that the *terminal side* of each battery is positioned *toward* the outside of the battery pack. Remove the four batteries, one at a time by pulling up on the bottom end (opposite the terminal end). Leave the wires connected until all batteries have been removed from the battery pack.
2. Note that all batteries' positive terminals (+) are interconnected by a common wire having red colored insulation. All negative terminals (-) are interconnected by a common wire having black colored insulation.
3. Position the new batteries next to the still interconnected old batteries.
4. Transfer the red wire from the old batteries to the new batteries, one battery at a time. Leave all the black wire connections to the old batteries in place.
5. When all red wire connections have been transferred then transfer, one at a time, the black wire connections from old to new batteries.
6. Set the old batteries aside. Place the new batteries back into the battery pack (terminals to outside). Take care to prevent any of the red or black wires from

Section 6

Warranty

AeroVironment Inc. (AV) warrants instrumentation and accessories which it manufactures to be free from defective material or workmanship for a period of 90 days from the date of shipment to the original purchaser.

The warranty or subsystems manufactured by others shall be that of the original manufacturer.

Notification of Claims

Requests for warranty adjustments must include model and serial numbers together with details of the difficulty encountered. To expedite handling, telephone requests will be honored but must be documented subsequently. No returned components will be accepted without prior authorization from AV. A Returned Material Authorization (RMA) number can be obtained by calling AeroVironment, Inc. (818) 357-9983 and contacting the Products Group.

Liability

Liability under this warranty is limited to the replacement of defective components, or to the servicing and adjusting of defective instruments or subsystems.

AV will not be liable for collateral or any incidental or consequential damages caused by, or resulting from, defective material, workmanship, or other equipment failure.

Transportation charges for warranty replacements and repairs shall be paid by the customer. Transportation charges to the factory - AeroVironment, Inc., 825 Myrtle Ave., Monrovia, California 91016 - shall be prepaid by the customer. Transportation charges for the return of the equipment shall be billed by AV to the customer.

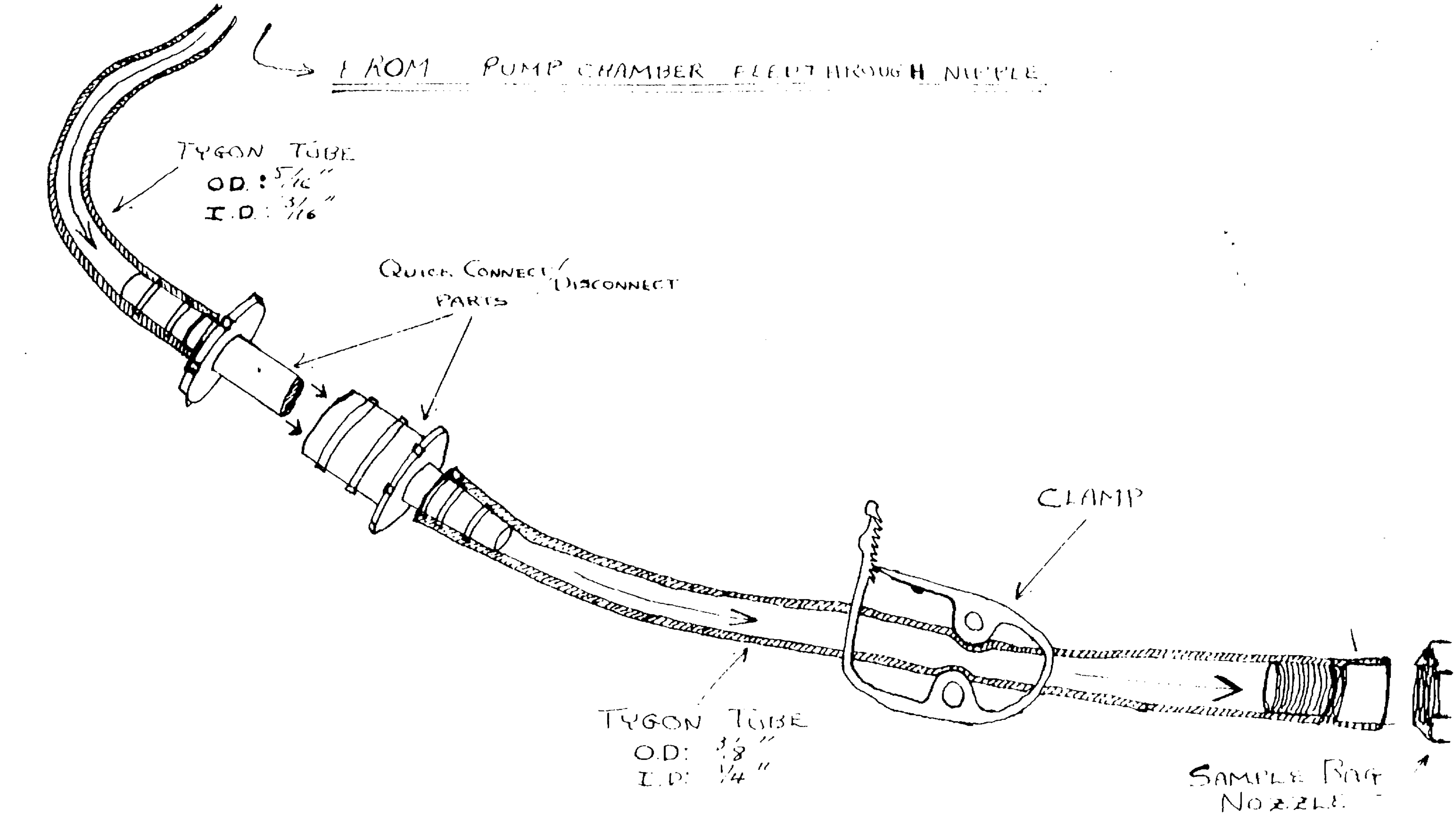
Note: Shipping documents on equipment returned to AV from outside the U.S.A. must state: "This instrumentation was manufactured in the United States of America".

Warranty Violations

This warranty does not extend to AV equipment which has been subject to misuse, accident, neglect, vandalism, improper application, installation and operation, or failure to comply with normal maintenance procedures. AV will not accept responsibility for, or resulting from, improper or unauthorized alterations or repairs.

Repair

Repairs and/or replacement parts provided under the warranty shall carry a 90 day warranty. The warranty for any repair work or parts sold beyond the original warranty is for 90 days.



ENVIRONMENTAL MEASUREMENTS INC.			TITLE: AQS SAMPLE BAG AND HOSE ASSEMBLY		
SCALE: ~	BY PHIL SCHUG		APP:		
DATE:	CHK.		APP:		
material:			finish:		
tolerance unless otherwise specified			size	drawing no.	rev.
.xx = + .01	.xxx = ± .005		A	~~23-030~~	A

Appendix A

PUMP GROUPING

AQS II Serial Number __________ .

The sampling pumps of this AQS II have been grouped as follows;

GROUP	PUMPS
1	________
2	________
3	________
4	________

This is a factory setting which can be modified in the field by a qualified technician. Consult the schematic diagram or the factory to answer any questions concerning pump grouping changes.

AQS PROGRAMMING WORKSHEET

NO. 1 8 PUMPS

START

O HR

STOP

O CY

O HR

O1	O1
O2	O2
O3	O3
O4	O4

CYCLE GROUP

HOUR

00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O

O	O	O	O	O	O	O	O
1	2	3	4	5	6	7	8

PUMP

AQS PROGRAMMING WORKSHEET

NO. 2 12 PUMPS

START

O HR   O1   O1

STOP   O2   O2

O CY   O3   O3

O HR   O4   O4

CYCLE GROUP

HOUR

00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O

O	O	O	O	O	O	O	O	O	O	O	O
1	2	3	4	5	6	7	8	9	10	11	12

PUMP

AQS PROGRAMMING WORKSHEET

NO. 3 16 PUMPS

START

O HR

STOP

O CY

O HR

O1	O1
O2	O2
O3	O3
O4	O4

CYCLE GROUP

HOUR

00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O

O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

PUMP

AQS PROGRAMMING WORKSHEET

NO. 4 24 PUMPS

START

O HR | O1 | O1

STOP

O CY | O2 | O2

O HR | O3 | O3

| O4 | O4

CYCLE GROUP

HOUR

00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O

O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

PUMP

APPENDIX E

Air Quality Sampler III Operations Manual