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NEW JERSEY STATE DEPARTMENT OF TRANSPORTATION

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ENVIRONMENTAL ANALYSIS AND REPORT
FOR
ROUTE 18 FREEWAY EXTENSION
CITY OF NEW BRUNSWICK AND PISCATAWAY TOWNSHIP
MIDDLESEX COUNTY, NEW JERSEY

VOLUME II - APPENDIX

SECTION 4 - FINAL REPORT

ROUTE 18 EXTENSION

AIR POLLUTION IMPACT STUDY

JULY 1972

PREPARED BY

GENERAL ELECTRIC COMPANY

FOR

KING & GAVARIS
CONSULTING ENGINEERS

C. 2

GENERAL ELECTRIC

Re-entry & Environmental Systems Division

PHILADELPHIA, PENNSYLVANIA

[redacted]

FINAL REPORT

ROUTE 18 EXTENSION

AIR POLLUTION IMPACT STUDY

July 1972

Submitted to

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By The

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3198 Chestnut St.
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Under Contract Agreement dated 6 March 1972

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1.0 INTRODUCTION

The proposed NJSDOT alignment for the extension of Route 18 Freeway through New Brunswick, N.J. proposes that the four lane divided highway pass the George Street dormitories of Rutgers University. The proposed alignment at this point, follows the bed of the existing Delaware and Raritan Canal, as shown in Figure 1-1. The NJSDOT has estimated the average daily traffic on the extended Route 18 Freeway behind the dormitories. This traffic projection indicates that the peak hourly volume behind the dormitories in 1975 will be 2700 vehicles per hour and will be 4300 vehicles per hour in 1995. This report is part of an environmental impact study to evaluate the air pollution impact of the proposed Route 18 Extension.

1.1 Study Objectives

The air pollution impact study conducted was structured to achieve two specific objectives, namely,

a) To estimate the carbon monoxide (CO) level that the Frelinghuysen Dormitory would be subjected to as a result of vehicular traffic along the Route 18 extension as proposed by the NJSDOT.

b) To determine the effect, on the estimated carbon monoxide level at the Frelinghuysen Dormitory if a deck were to be added over the roadway near the dormitory.

1.2 Study Implementation

The study objectives were achieved by a combination of carbon monoxide measurements and analytical evaluation. The

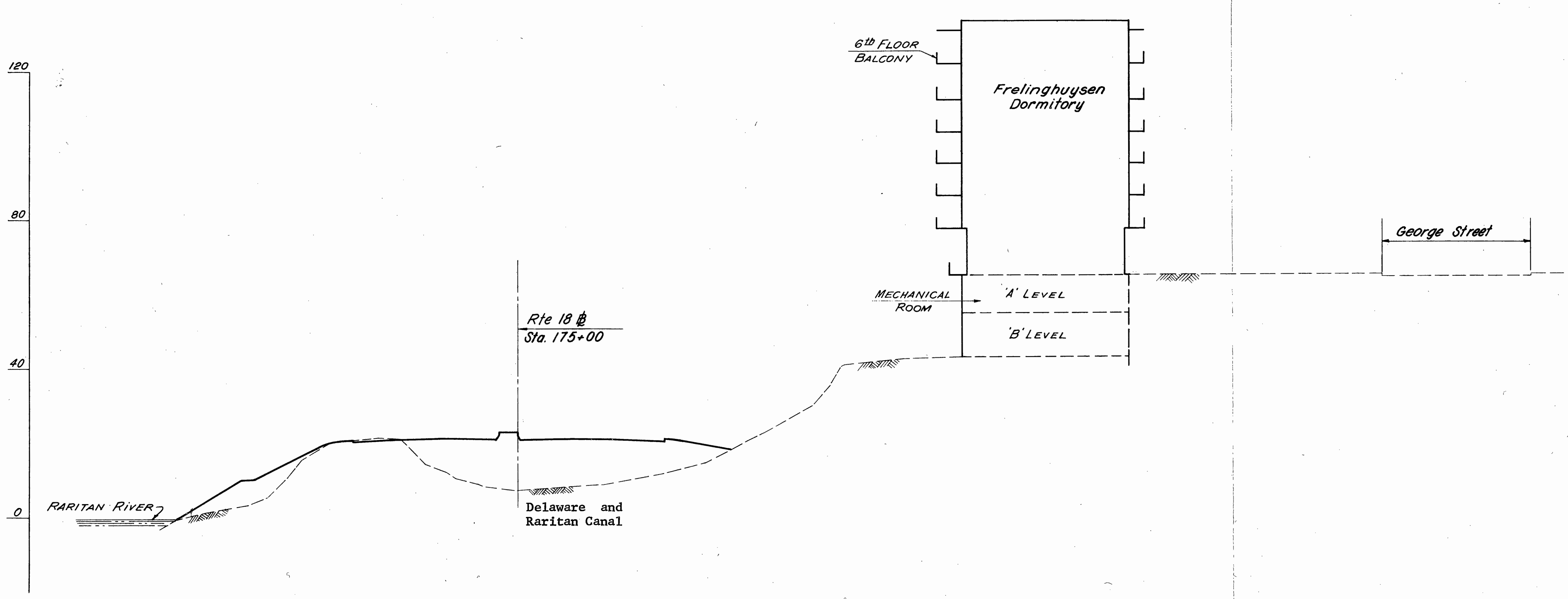

120
80
40
0
6th FLOOR
BALCONY
Frelinghuysen
Dormitory
MECHANICAL
ROOM
'A' LEVEL
'B' LEVEL
George Street
Rte 18 ℄
Sta. 175+00
RARITAN RIVER
Delaware and
Raritan Canal

Figure 1-1

first objective was accomplished by measuring traffic generated CO at the Rutgers University Music Building adjacent to an existing section of New Jersey Route 18 and then translating the results of this measured CO to the Frelinghuysen Dormitory.

The second objective was reached by mathematically modelling traffic/CO data associated with a decked roadway for various meterological conditions possible at the dormitory site.

1.3 Study Participants

The field work and data analysis for this study were performed by the General Electric Company under a subcontract to King and Gavaris, Consulting Engineers. Traffic data was collected by the New Jersey State Department of Transportation. Data on wind speed and direction used in the analysis were obtained by GE conducted on-site measurements.

1.4 Study Report

This report describes the study, summarizes the results and presents carbon monoxide concentration projections and conclusions based upon the results. Section 2.0 consists of the Summary and Conclusions. The Study Program and the results obtained are described in Section 3.0. Instrumentation and calibration techniques used are included in Section 4.0. Test data obtained is included in Section 5.0. The derivation of the math models used in this report are described in Section 6.0. Photographs pertinent to this study are grouped in Section 7.0.

2.0 STUDY FINDINGS

2.1 Summary

2.1.1 Existing Carbon Monoxide Level at Frelinghuysen Dormitory

The average carbon monoxide concentration level at the Frelinghuysen Dormitory was 1.6 ppm for the two week monitoring period. As shown in the tabulation below, no significant difference in average concentration levels was discernable between low and high elevation locations. Average hourly concentrations indoors at all locations lagged outdoor average hourly carbon monoxide levels by approximately 1 hour. Outdoor concentrations exhibited a larger average hourly variation than indoor concentrations. Average carbon monoxide levels were equal on both sides of the dormitory.

LOCATION	CO CONCENTRATION - ppm				
	PERIOD	WEEKDAY			
	AVE.	Ave.	Min.	Max.	Range
6th Floor-Out-Front	1.1	1.2	.6	2.9	2.3
6th Floor-In-Front	1.1	1.2	.7	2.0	1.3
1st Floor-Out-Front	1.4	1.6	1.0	2.6	1.6
1st Floor-In-Front	1.3	1.5	1.0	2.2	1.2
Mech. Rm.-Out-Rear	1.6	1.6	1.0	2.8	1.8
Mech. Rm.-In-Rear	1.7	1.7	1.1	2.8	1.7
6th Floor-Out-Rear	1.4	1.6	.9	2.7	1.8
6th Floor-In-Rear	1.5	1.6	.9	2.4	1.5
George St.-Front	2.9	3.5	2.9	4.8	1.9
Parking Lot-Rear	2.3	2.4	1.8	3.1	1.3

The carbon monoxide concentration levels at each location monitored varied throughout the day from day to day. While the diurnal variations in CO level show indications of being traffic related, the correspondence with George Street traffic is unusually weak. The data strongly suggests that motorcycle and automotive traffic in and out of the parking lot, which is excluded from the traffic count, significantly influenced the carbon monoxide level. Variations in the CO level from day to day in general can be related to daily traffic volumes. These daily relationships, however, are strongly determined by meteorological conditions, i.e. wind direction and wind speed as shown in Figure 2.1-1.

Comparison of the upper plot, daily vehicular volume, with the bottom two plots, CO Concentration at probe locations 1A & 5B will show an apparent lack of correlation. However, consideration of the meteorological conditions, shown on the middle two plots, provides a clear relationship. (Location 1A was on the George Street side of the Dormitory while location 5B was on the parking lot side.) Carbon monoxide levels on 4/20 and 4/22 are higher on the George Street side than expected for the traffic recorded on those days. Conversely, the parking lot concentration levels are lower. High winds blow from the river on 4/20 and 4/22. The prevailing wind on the other three days blew from George Street towards the Dormitory.

As shown in Figure 2.1-2 which displays diurnal data for 20 April, the hourly changes in George Street traffic affect CO concentrations for the three probes shown (Probe 1B is indoors on the George Street side) during the morning rush hour period. The CO/traffic relationship, however, does not hold for the evening

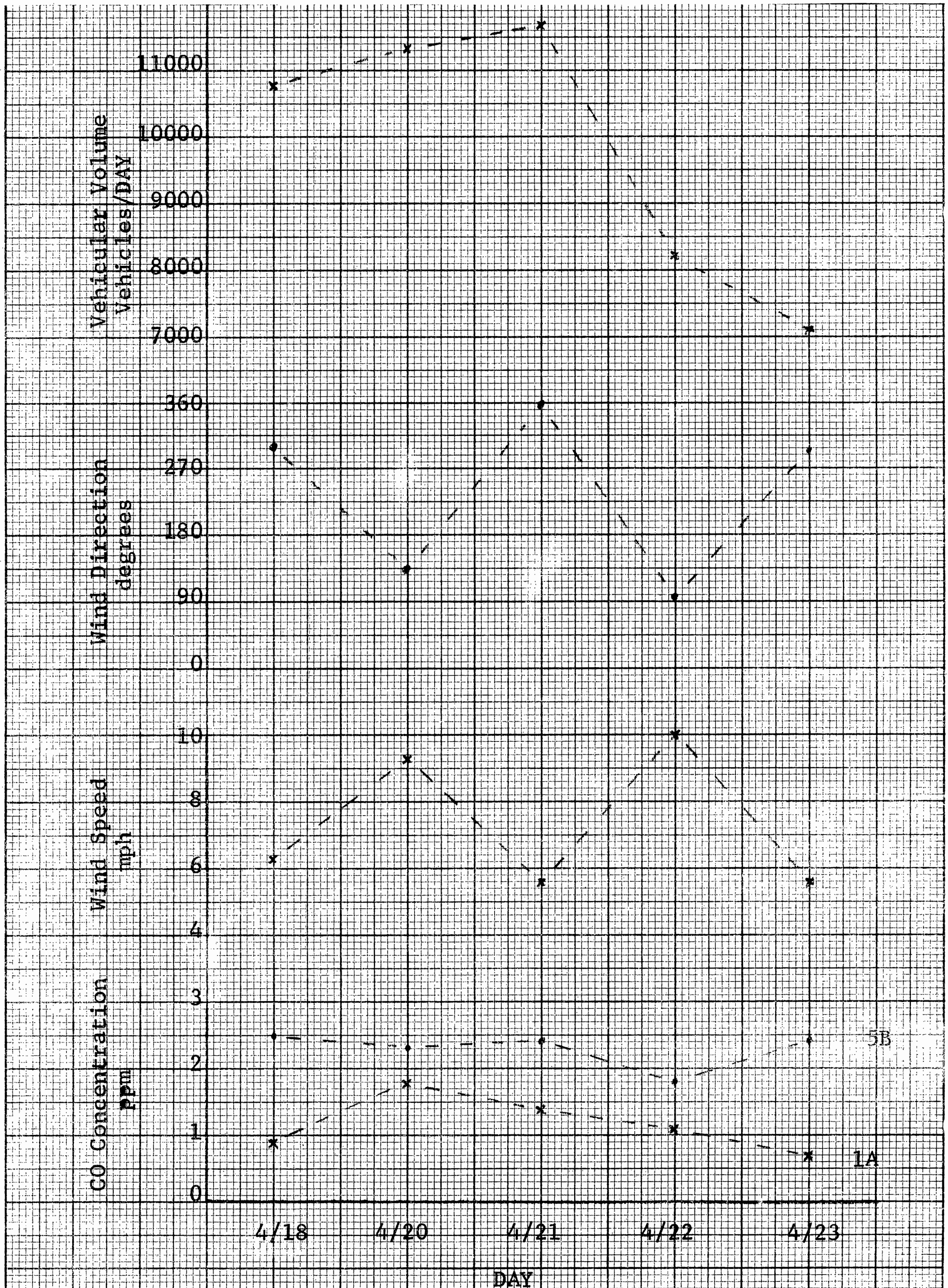


Figure 2.1-1 Daily Characteristics • Frelinghuysen Dormitory

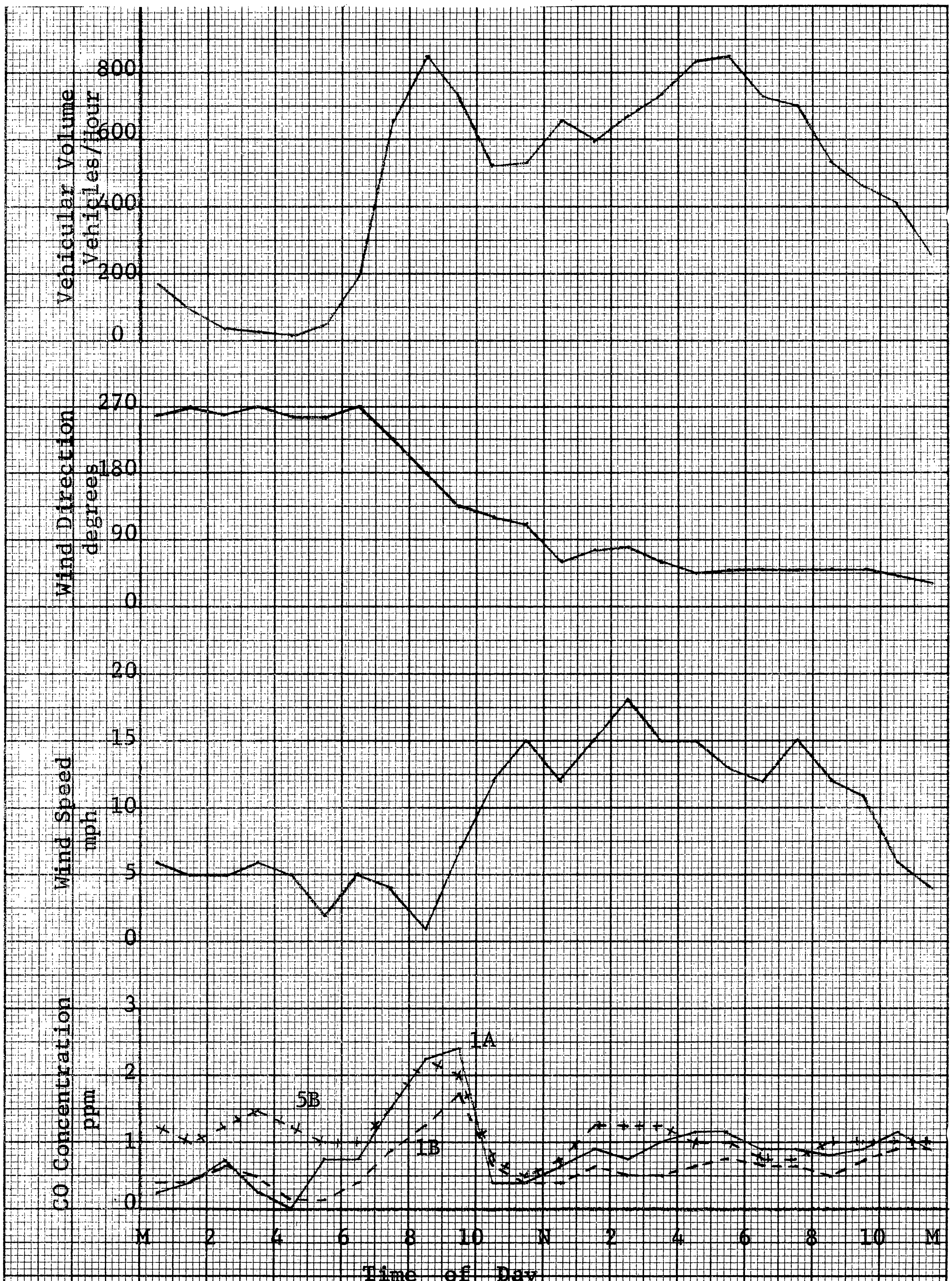


Figure 2.1-2 Diurnal Characteristics - Frelinghuysen - 4/10

rush hour peak. Examination of the concentrations for Probe 5B will show that the CO level was higher during the early AM hours when the wind was from the west and traffic was at its lowest than when high traffic and easterly winds occured in the late afternoon and evening.

2.1.2 Existing Carbon Monoxide Level at Music Building

The average carbon monoxide concentration levels at the Music Building indoor and outdoor locations were less than 3.0 ppm throughout the two week monitoring period. No significant difference in average concentration was noticed between the two locations at the Music Building and the George Street access ramp measurement point. As expected higher CO levels were recorded at both the edge of the east bound lanes and the median strip of Route 18. The total period average concentrations, and those for the weekdays only, are shown below.

CO Concentrations - ppm

	Music Bldg.		Access Ramp	Route 18	
	In	Out	Edge	Edge	Median
Total Ave.	2.1	2.0	2.1	4.6	6.3
Weekday Ave.	1.9	1.9	1.9	4.6	6.1
Weeday Min	1.4	1.3	.9	1.6	2.3
Weekday Max	2.2	2.4	2.8	9.0	9.4
Weekday Range	.8	1.1	1.9	7.4	7.1

Concentration levels indoors lagged outdoor levels generally by about 1 hour and showed a smaller average hourly variation. As shown in Figure 2.1-3, the carbon monoxide level at the two Music Building locations appeared to be more responsive to the ramp edge concentrations than to Route 18 concentrations. While both the road edge and median strip CO levels show good corelation with Route 18 traffic, the divergence of the median strip concentrations during the 7 - 9 PM period suggests that this monitoring location is affected by traffic on the access ramp. It will be noted that the concentrations at the ramp edge and both Music Building monitoring locations followed this short term peak. Conversely, the P.M. traffic peak at 4 PM was not recognized at the Music Building.

Figure 2.1-4 portrays the daily characteristics measured at the Music Building site. (It should be noted that differing quantities of data was obtained for the three sets of CO concentrations presented. While the indoor/outdoor data can be compared, rigid comparison with road and ramp edge should be avoided. Similarly road and ramp edge may be compared as a pair, but not with other CO Data.) These plots clearly depict the interrelation of traffic volume, wind direction, wind speed on the CO concentration at the five monitoring locations. Examination of the median strip plot will show that daily CO levels appear more responsive

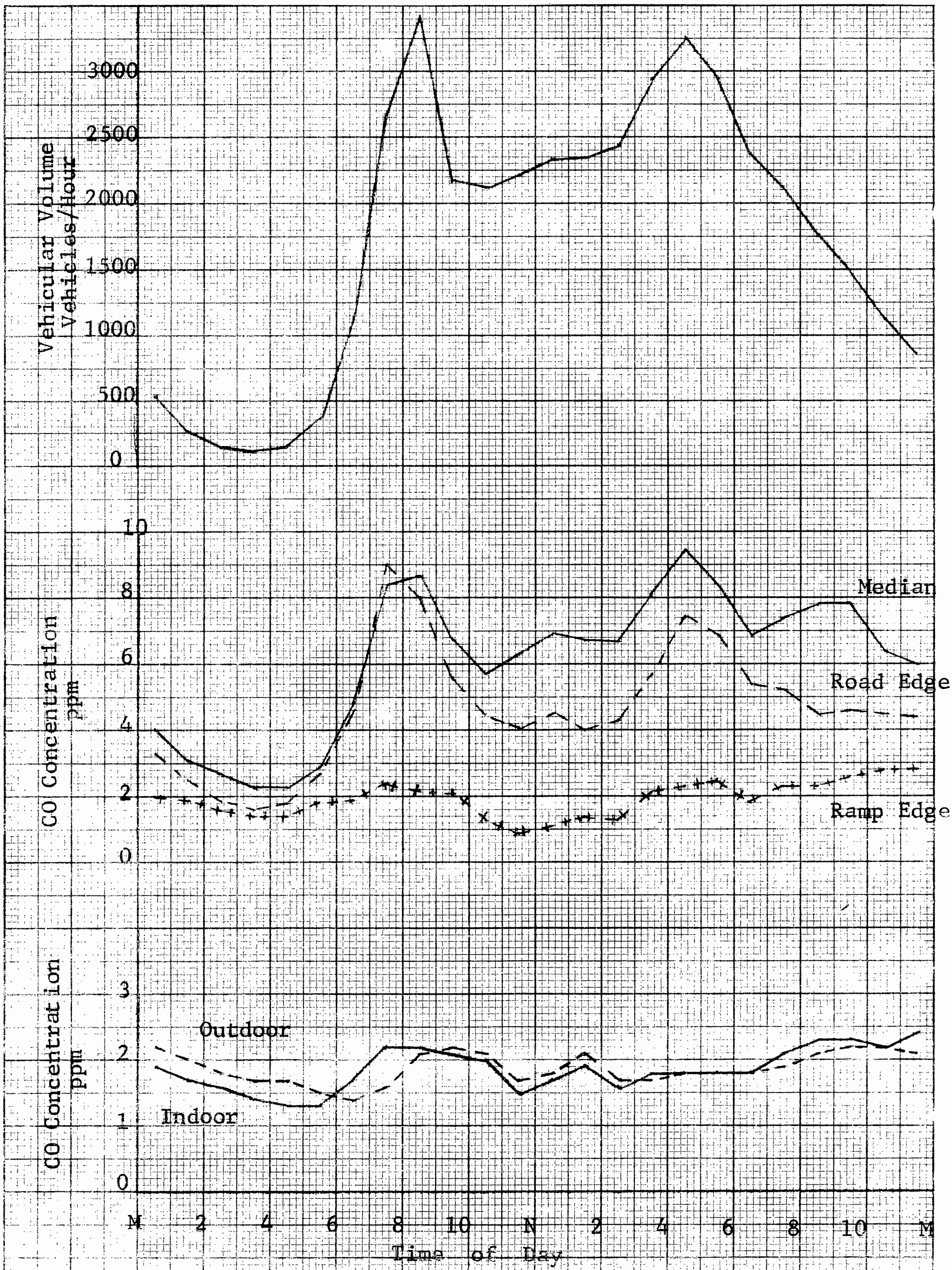


Figure 2.1-3 Diurnal Characteristics - Music Building

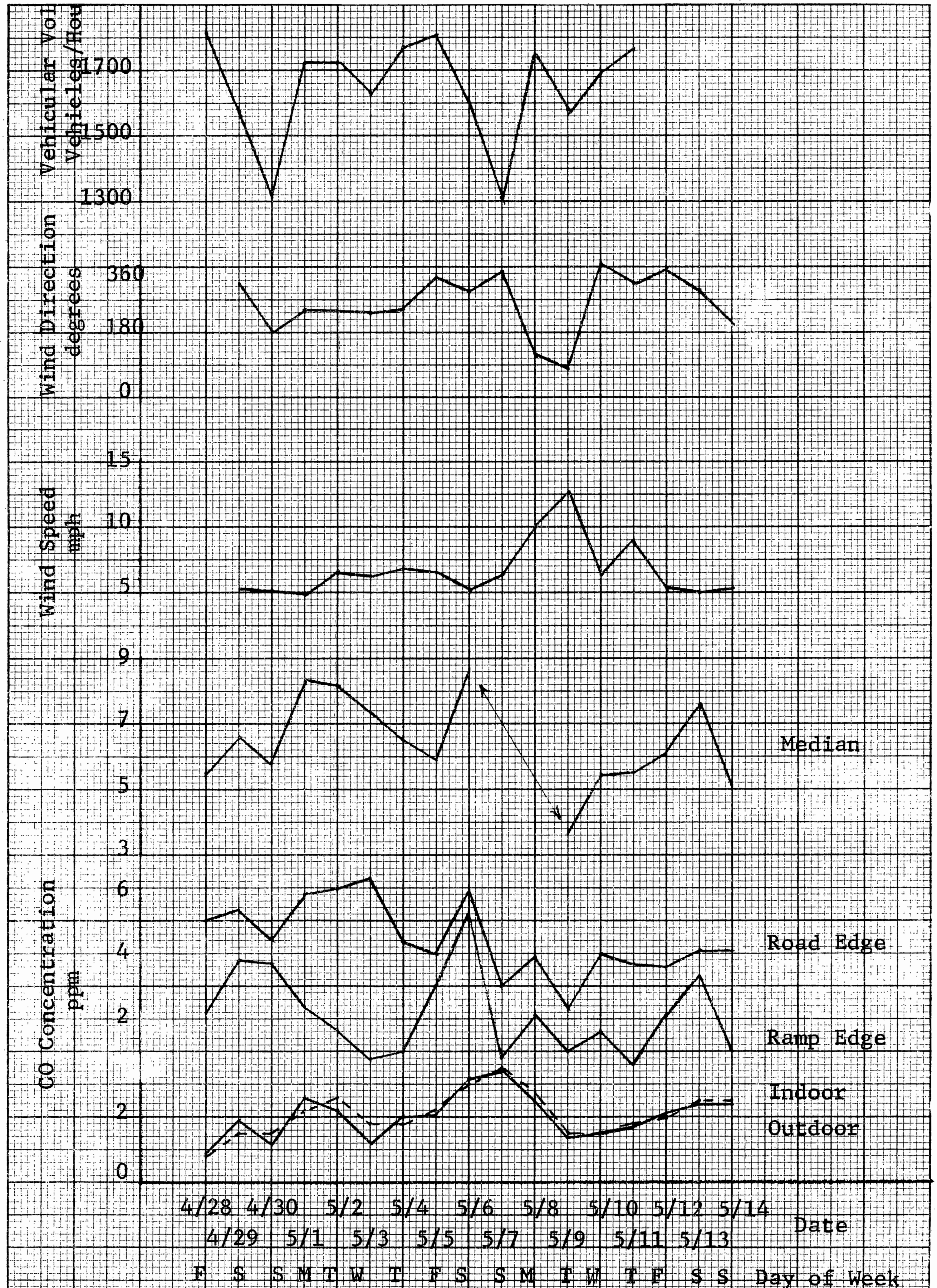


Figure 2.1-4 Daily Characteristics - Music Building

to meteorological conditions than vehicular volume. The ramp edge levels show peaks on the three Saturdays, but the road edge conditions for those days do not fluctuate to the same degree. This strongly suggests that Route 18 has little direct impact on ramp edge CO concentration and that ramp traffic varies differently than Route 18 traffic. The indoor/outdoor plots again show the delay of indoor levels with respect to outdoor concentrations.

The diurnal variations in carbon monoxide concentrations recorded at the five monitoring locations at the Music Building site are clearly traffic related. Each location displays typical hysterisis type curves of CO level versus traffic. Figure 2.1-5, for the Route 18 median strip location, is representative of all locations. The starting hour for the diurnal CO/traffic readings are indicated on the plot. It will be noticed that under continuous decreasing traffic volume conditions, the CO level decreases more slowly than average. For continuous increasing traffic volume conditions, the CO level increases more slowly. During periods of relatively steady traffic conditions, the carbon monoxide concentrations approach a more representative CO/traffic relationship.

The average carbon monoxide traffic relationship of a roadway configuration can be described in terms of the site vehicular pollution factor, ie the hourly average concentration produced

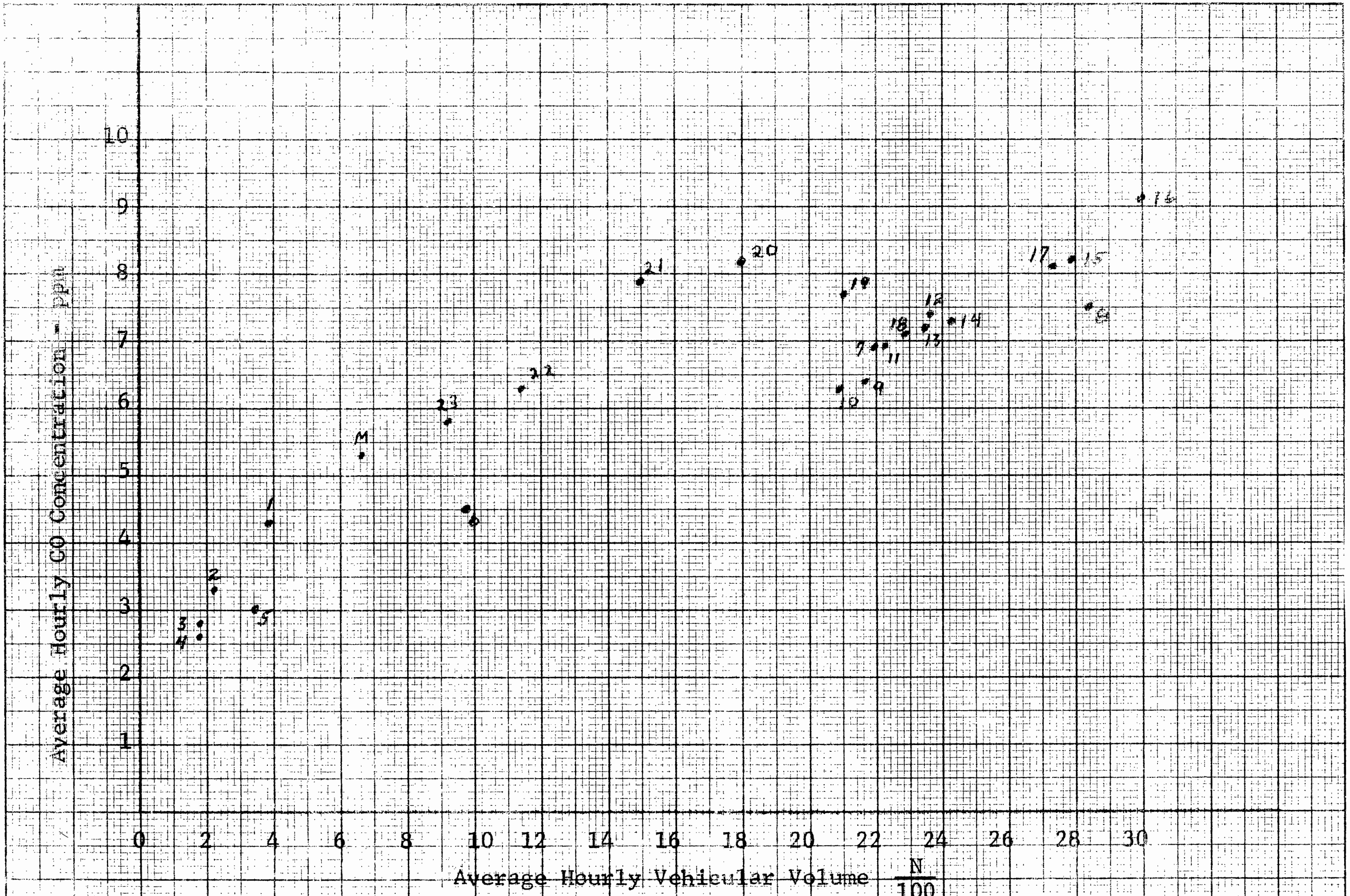


Figure 2.1-3 CO/Traffic Relationship - Median Strip Rte 18 - Music Building

per vehicle. Route 18, as seen at the median strip, was determined to have a vehicle pollution factor of 3.8×10^{-3} (ppm - hr/veh). The combination of Route 18 and ramp traffic produced a vehicle pollution factor of 1.2×10^{-3} as seen outside the Music Building on the basis of only Route 18 traffic.

2.1.3 <u>Anticipated Carbon Monoxide Level at Frelinghuyser Dormitory</u>

The average carbon monoxide level at the Frelinghuysen dormitory subsequent to the opening of the proposed Route 18 Extension (undecked roadway) will be increased by 2.2 ppm in 1975 and by 3.5 ppm in 1995. Assuming the non Route 18 traffic generated carbon monoxide level at the dormitory site does not change from its 1972 level, the average CO concentration at the dormitory will be approximately 3.8 ppm in 1975 and 5.1 ppm in 1995.

The anticipated carbon monoxide level will vary from these estimated levels from day to day and throughout each day. The daily CO level will be influenced by the day of the week and the prevailing meteorological conditions. Weekday concentrations will be slightly higher than concentrations on Saturdays and Sundays as a result of greater weekday traffic. The quantity of Route 18 traffic generated CO seen along the parking lot face of Frelinghuysen will be highest when the wind is stable and blowing at 1 to 3 mph.

During a typical day, concentrations at the dormitory will vary directly with diurnal changes in traffic volume and indirectly with diurnal changes in wind speed. As previously shown on Figure 2.1-2, which displays diurnal data at Frelinghuysen for 20 April, the morning traffic rush hour peak produced a peak in measured carbon monoxide. However, the carbon monoxide level did not rise proportionately during the evening rush hour. This phenomenon is partially the result of the 180° shift in wind from the morning to evening periods and partly to the higher wind speed during the evening rush hour. Since peak traffic conditions on the extension of Route 18 will occur at different times on weekdays and Saturdays and Sundays, the peak CO conditions for those days will vary both in magnitude and time of day. For the purpose of this report the exact effect of the diurnal traffic and wind peaks per day could not be explored. It should be noted that the change from Standard to Daylight Time will affect the relative time of peaking of wind speed with traffic.

Under worst case conditions, i.e. peak traffic and stable winds blowing from 230° at 1 to 3 mph, the carbon monoxide level along the parking lot face of Frelinghuysen will increase approximately 5.0 ppm over 1972 levels in 1975 and about 7.0 ppm in 1995. An in-depth study of meteorological data would be required to predict the frequency of occurency of the worst case conditions.

Concentrations at the dormitory site should not be significantly different for average and worst case conditions if a deck were to be added over the roadway. The carbon monoxide generated beneath the deck will build up during periods of high traffic. This concentration will escape from beneath the deck along the open side towards the Raritan River rather than by the typical cross roadway diffusion for an open highway. Since the buildup in CO beneath the deck will lag slightly behind the increase in traffic volume, the basic effect will be to shift peaking CO conditions to a later time of the day. Likewise beneath deck concentrations will remain high for a longer period than for an open highway, extending the period of time of high concentrations at the deck edge. Since wind speeds normally are higher during the daytime, the net effect of the deck should be negligible on the carbon monoxide level at Frelinghuysen.

2.2 CONCLUSIONS

The conclusions drawn from this study of the effect on the air pollution in the vicinity of the Frelinghuysen Dormitory resulting from anticipated 1975 and 1995 traffic volumes on the Route 18 Extension are divided into two groups. The first group includes the estimated effect based upon the small sample of data gathered during the study. Because the data sample is small, certain qualifications that should be more fully explored are presented in the second group.

On the basis of the gathered data, the following conclusions are reached.

1 - Carbon monoxide levels are essentially equal inside and outside Frelinghuysen and front and back.

2 - The existing CO level is small, less than 4.0 ppm, and is generated by George Street traffic and localized traffic off of George Street.

3 - Short term CO peaks of 6 to 10 ppm occur under present traffic conditions. These peaks dissapate rapidly and do not significantly influence the carbon monoxide level.

4 - Meteorological conditions at the dormitory significantly influence the carbon monoxide level.

5 - The average carbon monoxide level on the parking lot side of the dormitory will be increased by 2.2 ppm in 1975 and by 3.5 ppm in 1995 as a result of the Route 18 Extension.

6 - The impact of the Route 18 Extension on the carbon monoxide level will be essentially the same for an open highway as for a decked highway.

7 - The topography of the Frelinghuysen site is such that extended periods of stable winds of low velocity perpendicular to Route 18 will increase the concentrations at the back of the dormitory by 5.0 ppm in 1975 and 7.0 ppm in 1995 during the day-time when average hourly traffic of 2700 and 4300 vehicle per hour occur.

It may be desirable to obtain further information on two points:

1 - The minor differences between the Music Building and Frelinghuysen sites.

2 - The degree to which the measured meteorological conditions are representative of annual conditions at the Frelinghuysen site.

With reference to the similarity of the two sites, for all practical purposes the geometric relationship of the highway/access ramp with respect to Music Building and the proposed features at the Frelinghuysen Dormitory is the same. Two differences are noted, however. First is the difference in traffic flow on the access ramps. At the Music Building, the roadway past the front of the building continues for much longer distance than that which will occur at Frelinghuysen. Traffic on the Music Building access ramp will travel at a higher speed than probably will occur at the dormitory. Since vehicle velocity is a contributing factor to carbon monoxide emissions, a higher vehicle pollution factor will result at Frelinghuysen from the accelerating/decelerating traffic pattern. It has been assumed herein that the traffic volume on the access ramp at the Music Building is greater than that which will occur on the Frelinghuysen ramp and that the lower traffic volume at Frelinghuysen will offset the accelerating/decelerating traffic. The difference in traffic volume on the two ramps should be checked to verify this assumption.

The wind recirculation patterns at the two sites may be different, resulting in different carbon monoxide flow paths from Route 18 to the building involved. While the relative dimensions of highway to building are essentially the same, the topography on the river side of the highway is different between the two sites At the Music Building, Route 18 is higher above and further from the river. This difference was not explored.

With reference to meteorological conditions, consideration should be given to obtaining a more complete annual profile of wind speed and wind direction. This study was conducted during the springtime. Diurnal conditions may be appreciably different during the winter months.

3.0 STUDY PROGRAM

The impact study of the proposed Route 18 Extension on the air pollution level at the George Street dormitories of Rutgers University was conducted to achieve two objectives. These were:

a. To estimate the carbon monxide level that would be received inside and outside the Frelinghuysen dormitory as a result of vehicular traffic along the Route 18 Extension if the highway is constructed as proposed.

b. To determine the effect on the estimated CO level, at the Frelinghuysen dormitory if a deck were to be added over the roadway near the dormitory.

The first objective was achieved by the following carbon monoxide measurement and analytical steps.

a. Measuring the existing carbon monoxide concentrations inside and outside the Frelinghuysen dormitory, both on the George Street and canal sides of the building.

b. Measuring the traffic generated carbon monoxide on and adjacent to an existing portion of Route 18 and adjacent to an exit ramp passing the Rutgers Music Building at the Douglas Campus and both inside and outside the Music Building on the Route 18 side.

c. Extrapolating the carbon monoxide concentrations found at the Music Building to the Frelinghuysen dormitory site.

d. Comparing the George Street and extrapolated Route 18 traffic generated carbon monoxide levels.

The second objective was achieved by the following analytical steps.

a. Developing mathematical models to describe the effect of various meteorological conditions possible at the dormitory site upon traffic generated carbon monoxide levels released from a decked roadway.

b. Determining the "worst case" carbon monoxide levels that would occur at the dormitory for anticipated traffic conditions on the proposed Route 18 Extension for 1975 and 1995.

The air pollution measurement and analytical steps outlined above were performed in three groups broadly categorized as follows:

1. Existing Carbon Monoxide at Frelinghuysen Dormitory
2. Carbon Monoxide at Music Building
3. Anticipated Carbon Monoxide at Frelinghuysen Dormitory

The detailed description of each site and the data obtained during the field work are presented and discussed in Sections 3.1, 3.2 and 3.3

3.1 Existing Carbon Monoxide at Frelinghuysen

3.1.1 Site Description and Data

3.1.1.1 Carbon Monoxide Data

Carbon monoxide measurements were made at the Frelinghuysen dormitory to define the carbon monoxide concentrations inside and outside the dormitory resulting from traffic on George Street. The concentrations were monitored from 10 to 17 April simultaneously at two levels on the parking lot side. Similarly the bi-level concentrations on the George Street side of the dormitory were measured between 17 and 24 April 1972. Inside concentrations in the rooms on the George Street side and at the 6th floor on the parking lot side were taken with the windows closed. The windows in the mechanical equipment room, however, were open during the test period.

The carbon monoxide concentrations were obtained by mounting four sampling probes on each side of the building under study. The measurement locations for the two monitoring periods are shown on Figures 3.1-1 and 3.1-2. The pollution level at each height was determined by two Bendix carbon monoxide analyzers. Each analyzer alternately determined the carbon monoxide concentration sampled by a pair of probes. A fifth set of CO data was obtained during both monitoring periods on the opposite side of the building under study each week, using an Intertech carbon monoxide analyzer. As shown in the diagrams, the readings taken on the George Street side during the first

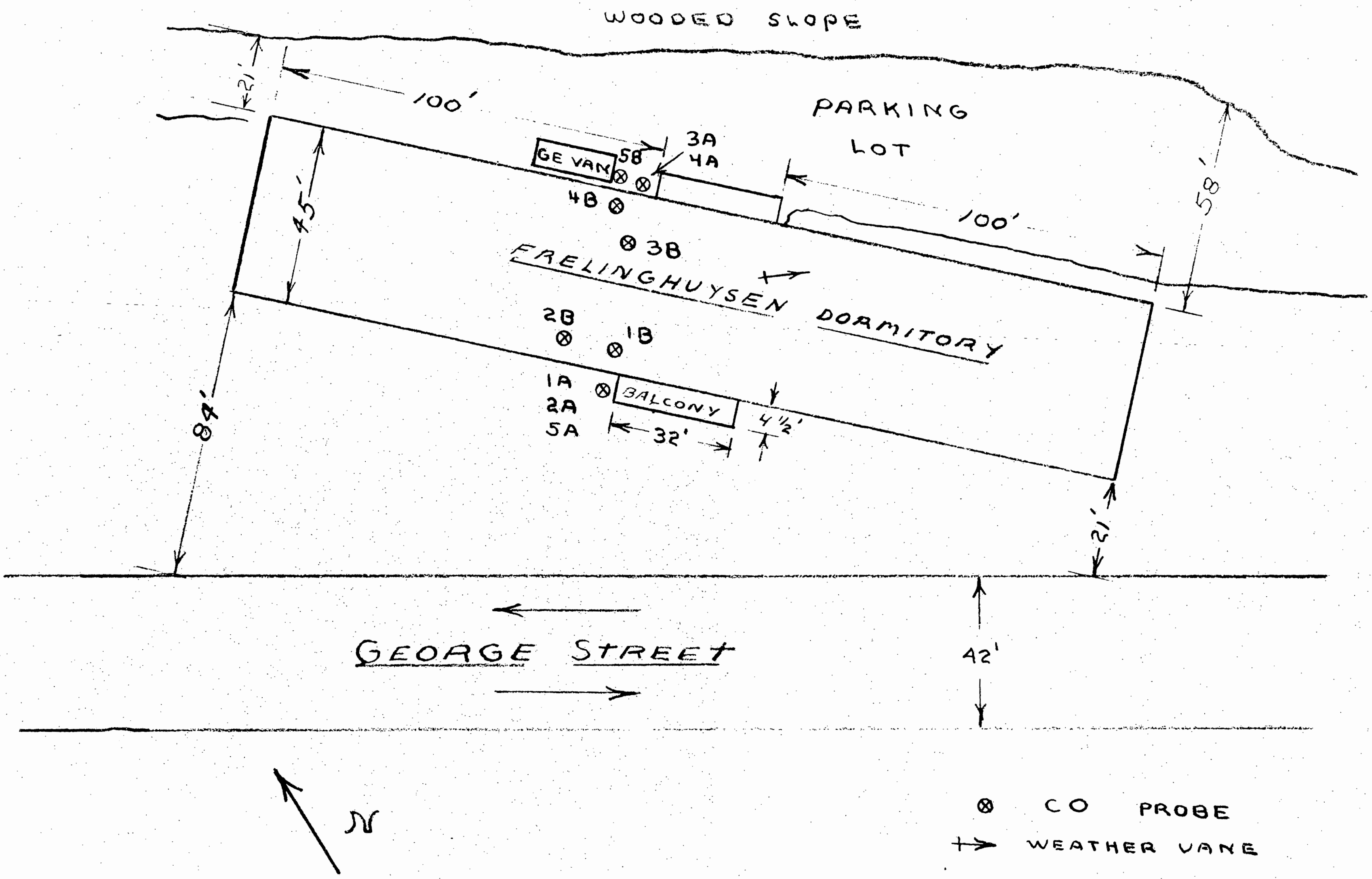


FIG. 3.1-1 FRELINGHUYSEN DORMITORY—PLAN VIEW

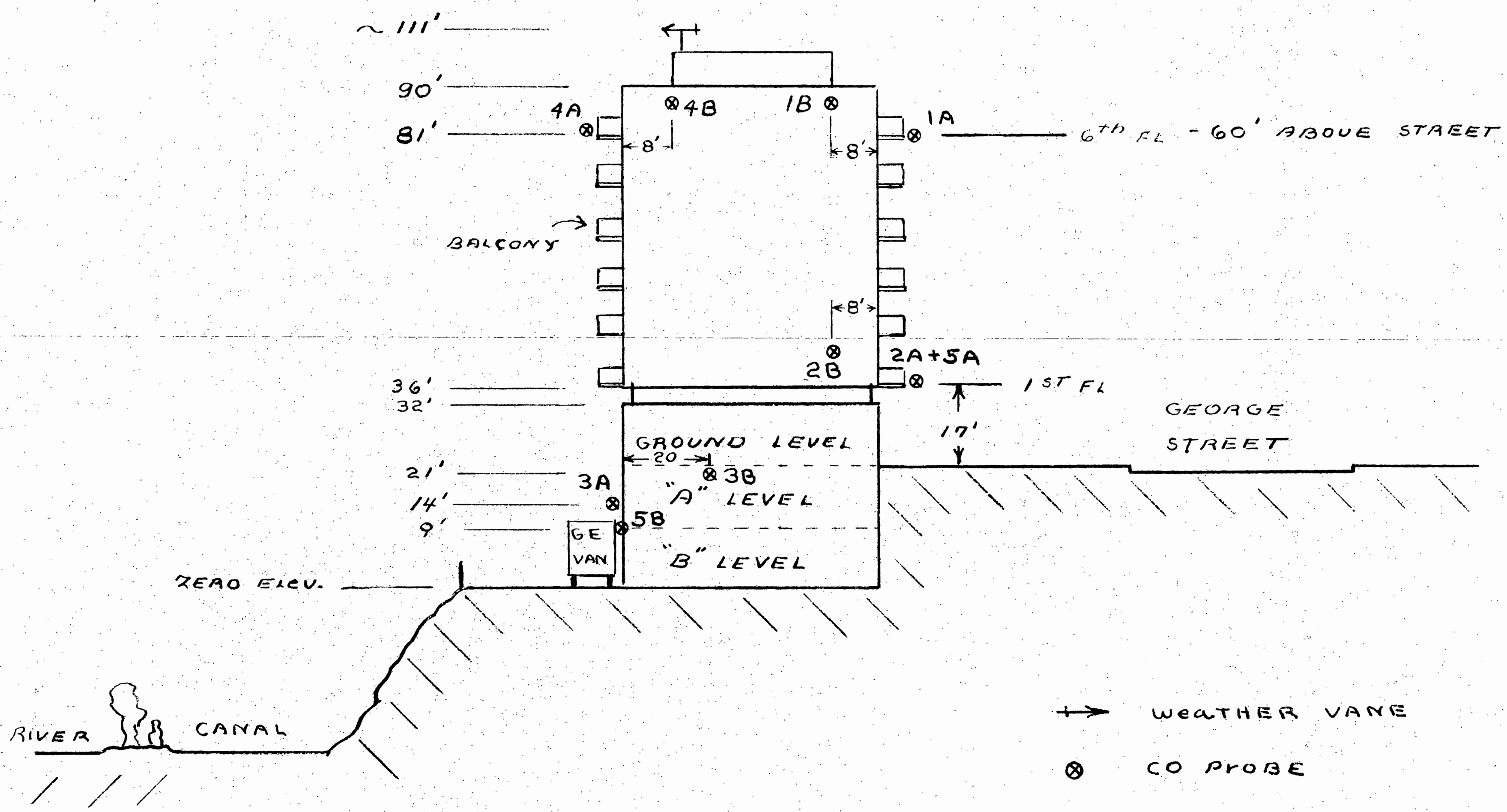


FIG. 3.1-2 FRELINGHUYSEN DORMITORY—ELEVATION VIEW

measurement period were at the same location as probe 2A during the second week monitoring. The fifth reading during the second measurement period was just outside the contractors equipment van. Instrumentation and calibration techniques used to obtain all data are described in Section 4.0.

Carbon monoxide concentration levels on both sides of the dormitory generally were quite low. Short term peaks were recorded by the probes at the lower elevation locations. These short term peaks were directly traceable to vehicular traffic, including motorcycles, in the near vicinity of the dormitory.

It should be noted that no readings were obtained for probe locations 3A and 3B from 10 PM on Friday 14 April to 8 AM on Monday 17 April. Since the weekend data for these probes is not available, no direct comparison of their average hourly concentration levels for the total measurement period should be made with total period averages for the other eight probes. Similarly, caution should be exercised in comparing the daily averages shown for all probes. Since the carbon monoxide concentration levels vary throughout a day, approximately 20 hours of data should be available to provide a suitable definition of the daily average concentration. The average hourly carbon monoxide concentrations for the 5 probes sampled during the total monitoring period each week are presented on Tables 3.1-1 and -2. (The hourly CO readings for all probe locations are tabulated in Section 5.0.) The standard deviations for these CO readings are given in Tables 3.1-3 and 3.1-4. Probe pairs 1A - 1B, 2A-2B, 3A-3B and 4A-4B may be compared on a daily average basis however. It should be noted that an apparent difference in the results from the two types of equipment used (Bendix versus Intertech) did exist. (Probes 5A-5B were always higher and Probe 5A was much higher than Probe 2A.) This is not unusual at the low concentration levels which were experienced.

3.1.1.2 Meteorological Data

Measurements of the wind azimuth direction and wind speed, as seen approximately 9 feet above the top of the dormitory, were made during the second week of carbon monoxide monitoring at the dormitory site. (It should be noted that these measurements indicate prevailing conditions above the dormitory and are not necessarily indicative of ground level air currents). The hourly average wind azimuth and wind speed data obtained is documented in Section 5.0.

During the week of monitoring, the wind blew primarily from the West, North and East directions. Southerly winds occurred only three times during the week. Each period was for less than three hours. Generally the roof wind was quite stable over a several hour period and slowly shifted direction. There is no consistant diurnal profile of wind direction. The average wind azimuth

TABLE 3.1 - 1

Frelinghuysen Dormitory
CO Concentration - ppm
10 to 17 April 1972

HOUR	PROBE NUMBER 3A	3B	4A	4B	5A
2400-100	2.5	2.5	1.7	1.9	3.0
100-200	2.3	2.4	1.7	1.9	3.2
200-300	1.4	1.5	1.2	1.7	2.4
300-400	1.2	1.2	1.1	1.3	2.3
400-500	1.1	1.1	1.2	1.2	2.3
500-600	1.6	1.6	1.3	1.3	2.3
600-700	1.4	1.6	1.3	1.4	2.5
700-800	1.5	1.5	1.4	1.5	2.8
800-900	1.4	1.9	1.7	1.7	3.0
900-1000	1.4	1.8	1.3	1.4	2.9
1000-1100	1.0	1.1	1.2	1.4	2.7
1100-1200	1.2	1.2	1.1	1.2	2.8
1200-1300	1.0	1.2	1.1	1.2	3.1
1300-1400	1.2	1.3	1.2	1.1	3.4
1400-1500	1.5	1.5	1.2	1.2	3.1
1500-1600	1.4	1.5	1.1	1.1	3.1
1600-1700	1.4	1.5	1.3	1.2	2.7
1700-1800	1.3	1.6	1.4	1.4	2.8
1800-1900	1.2	1.2	1.3	1.3	2.7
1900-2000	2.4	2.6	1.6	1.4	3.0
2000-2100	2.0	2.3	1.8	1.7	3.0
2100-2200	2.8	2.8	1.9	1.9	3.4
2200-2300	2.1	2.5	2.2	2.1	3.9
2300-2400	2.2	2.2	1.8	2.0	3.4
AVE.	1.6	1.7	1.4	1.5	2.9

TABLE 3.1 - 2

Frelinghuysen Dormitory
CO Concentration - ppm
17 to 24 April 1972

HOUR	PROBE NUMBER 1A	1B	2A	2B	5B
2400-100	1.2	1.1	1.7	1.5	2.4
100-200	1.0	1.2	1.6	1.5	2.3
200-300	1.2	1.4	1.7	1.6	2.5
300-400	.9	1.2	1.3	1.4	2.3
400-500	.6	1.1	1.1	1.2	2.3
500-600	.7	.7	1.1	1.1	2.1
600-700	.8	.7	1.3	1.3	2.5
700-800	1.0	.7	1.6	1.3	2.7
800-900	2.2	1.3	1.8	1.4	2.4
900-1000	1.8	1.4	1.7	1.6	2.3
1000-1100	.7	.8	1.1	1.5	1.8
1100-1200	.9	.9	1.3	1.2	2.0
1200-1300	.8	.9	1.4	1.4	2.1
1300-1400	.8	1.0	1.1	1.1	2.0
1400-1500	.8	.7	1.1	1.1	2.2
1500-1600	1.1	.8	1.2	1.2	2.2
1600-1700	1.0	.9	1.2	1.1	2.3
1700-1800	1.1	1.0	1.2	1.2	2.1
1800-1900	1.2	1.0	1.0	1.0	2.1
1900-2000	1.4	1.2	1.4	1.0	2.4
1000-2100	1.8	1.3	1.9	1.6	2.7
2100-2200	1.3	1.5	1.3	1.5	2.6
2200-2300	1.3	1.5	1.3	1.6	2.4
2300-2400	1.1	1.3	1.4	1.2	2.4
AVE.	1.1	1.1	1.4	1.3	2.3

Table 3.1 - 3
Frelinghuysen Dormitory
CO Concentration
Standard Deviation
10 to 17 April 1972

HOUR	Probe Number 3A	3B	4A	4B	5A
2400-100	.8	.9	1.0	1.3	2.0
100-200	1.5	1.3	1.4	1.4	1.8
200-300	.6	.5	.6	1.2	1.0
300-400	.6	.5	.8	.8	1.1
400-500	.6	.7	.8	.8	1.1
500-600	.4	.4	.9	.9	1.2
600-700	.7	.6	.8	.9	1.2
700-800	.7	.7	.6	.8	1.5
800-900	.5	.3	.9	1.0	1.6
900-1000	.8	.8	.5	.5	1.5
1000-1100	0.0	.3	.4	.6	.7
1100-1200	.7	.7	.5	.5	.6
1200-1300	.5	.5	.6	.6	1.1
1300-1400	.7	.7	.6	.7	1.6
1400-1500	.7	.7	.6	.6	1.1
1500-1600	1.3	1.3	.7	.6	1.1
1600-1700	1.1	1.2	.7	.7	1.2
1700-1800	.8	1.1	.6	.7	1.0
1800-1900	.7	.6	.5	.6	.8
1900-2000	1.7	1.4	1.0	.7	2.0
2000-2100	.8	1.1	.9	1.0	1.7
2100-2200	1.0	.9	1.0	1.0	1.9
2200-2300	.4	.6	1.7	1.3	3.0
2300-2400	.6	.7	1.6	1.6	2.1

Table 3.1 - 4
Frelinghuysen Dormitory
CO Concentration
Standard Deviation
17 to 24 April 1972

HOUR	Probe Number 1A	1B	2A	2B	5B
2400-100	1.1	.6	1.4	.7	.3
100-200	1.0	.6	1.0	.9	.4
200-300	.8	.7	.6	.6	.5
300-400	.5	.6	.6	.6	.5
400-500	.5	.8	.8	.8	.2
500-600	.5	.5	.8	.8	.3
600-700	.5	.5	.9	.9	1.5
700-800	1.1	.6	1.3	1.0	1.2
800-900	1.6	.8	1.5	1.1	1.0
900-1000	1.6	1.1	1.7	1.7	1.0
1000-1100	.3	.4	.7	1.2	.4
1100-1200	.4	.4	.7	.7	.8
1200-1300	.3	.4	.6	.7	.6
1300-1400	.5	.3	.3	.4	.5
1400-1500	.4	.3	.3	.3	.7
1500-1600	.6	.5	.5	.5	.7
1600-1700	.6	.4	.8	.7	.6
1700-1800	.6	.4	.5	.5	.4
1800-1900	.4	.4	.4	.5	.6
1900-2000	.6	.2	.4	.5	.6
2000-2100	1.5	.7	1.7	1.2	1.2
2100-2200	.3	.7	.4	.7	.5
2200-2300	.6	.7	.2	.3	.3
2300-2400	.5	.5	.3	.2	.4

angle was 357°. (Note that the Frelinghuysen dormitory lies along a line with a northerly heading of 319°). The winds blew from the parking lot side of Frelinghuysen towards the dormitory about 53% of the time (47% of the time the winds blew from the George St. side

Wind speed appears to be independent of wind azimuth angle. There is some suggestion, however, that north and east winds from the Raritan River, are slightly higher. Winds ranged from 1 to 18 mph. The diurnal profile, shown in Figure 3.1-3, exhibits the characteristics rise in wind speed during the day and early morning lull. The average wind speed was 7.3 mph.

3.1.1.3 Traffic Data

Vehicular traffic flow on George Street was recorded in hourly increments by the New Jersey State Department of Transportation during the two week carbon monoxide monitoring period. The hourly average traffic flow rate data obtained is included in Section 5.0. Examination of this data will show that traffic volume was essentially constant on weekdays and successively lower on Saturdays and Sundays. Tables 3.1-5 and 3.1-6 present the average hourly data for the weekday and weekend periods for the two monitoring periods. Figures 3.1-4 and 3.1-5 are plots of the diurnal traffic for each week. The upper plots show the average hourly vehicle volume for the total week in each direction and for both directions. The lower plots present the weekday and weekend segments of total traffic on George Street.

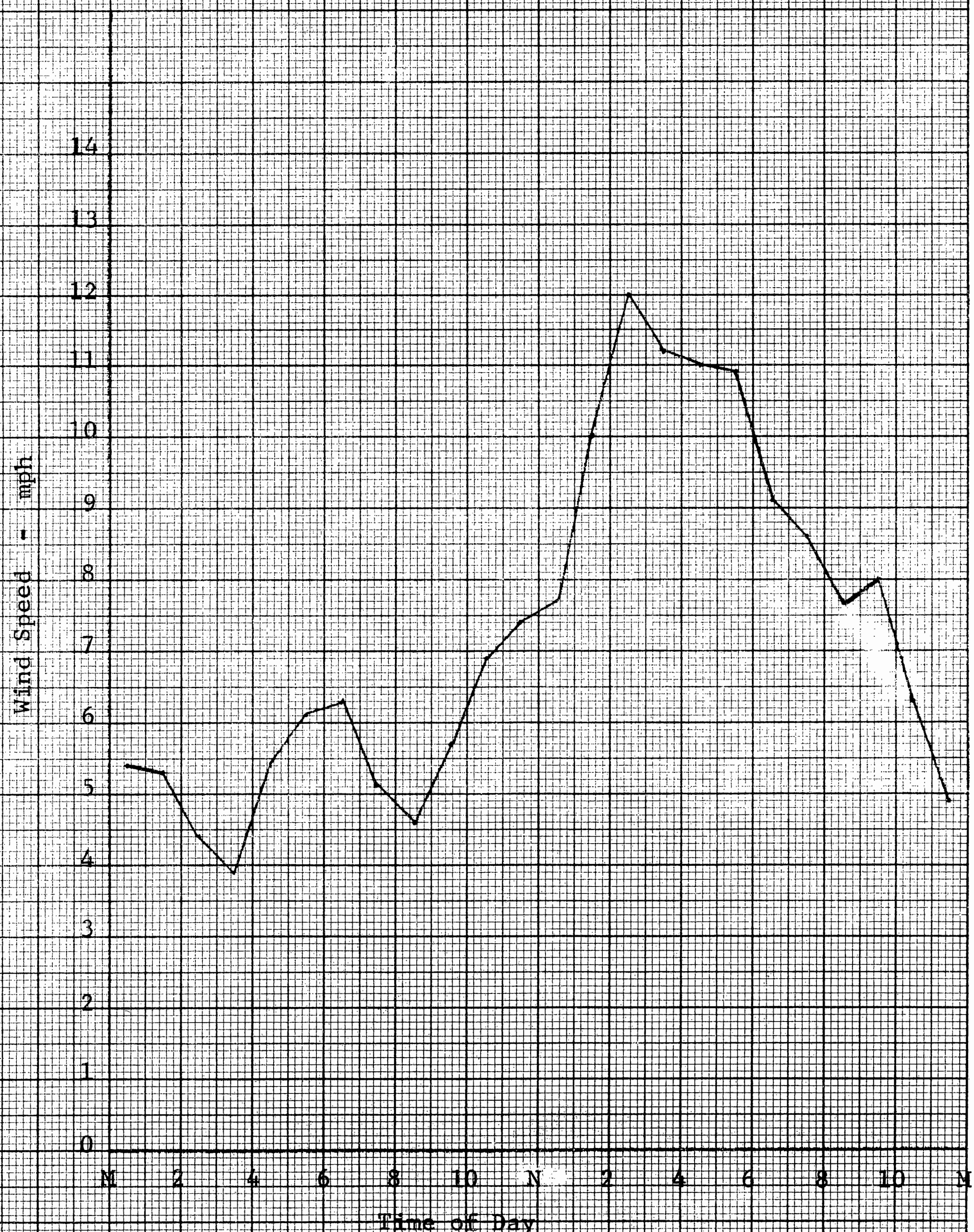


Figure 3.1-3 Diurnal Wind Speed - Frelinghuysen

TABLE 3.1-5
Frelinghuysen Dormitory
Average Vehicular Volume
10-16 April 1972

HOUR	Northbound W.D.	Northbound W.E.	Southbound W.D.	Southbound W.E.	Total W.D.	Total W.E.
2400-100	74	169	52	117	126	286
100-200	38	122	22	96	60	217
200-300	18	80	16	59	34	139
300-400	14	40	4	22	18	62
400-500	9	15	8	12	17	27
500-600	18	17	31	22	49	39
600-700	63	27	148	40	210	66
700-800	226	52	473	83	699	134
800-900	290	97	576	141	866	238
900-1000	271	129	376	233	647	362
1000-1100	246	163	281	242	527	405
1100-1200	267	240	306	257	573	497
1200-1300	334	271	355	257	690	527
1300-1400	307	260	325	276	632	535
1400-1500	328	275	322	253	650	528
1500-1600	360	270	398	253	758	523
1600-1700	414	300	420	246	834	546
1700-1800	509	245	357	211	866	456
1800-1900	356	236	366	109	722	345
1900-2000	302	252	329	163	635	415
2000-2100	257	250	200	127	458	377
2100-2200	266	192	164	78	450	270
2200-2300	202	187	141	89	343	271
2300-2400	145	164	94	113	240	277
TOTAL	5314	4053	5764	3499	11104	7542

W.D. = Weekdays

W.E. = Weekends

TABLE 3.1-6
Frelinghuysen Dormitory
Average Vehicular Volume
17-24 April 1972

HOUR	Northbound W.D.	Northbound W.E.	Southbound W.D.	Southbound W.E.	TOTAL W.D.	TOTAL W.E.
2400-100	84	-	62	133	142	-
100-200	39	71	30	112	70	183
200-300	21	89	15	52	36	139
300-400	15	35	5	25	19	60
400-500	7	19	8	13	16	32
500-600	15	19	32	17	47	36
600-700	61	28	152	37	212	64
700-800	225	60	457	68	673	148
800-900	280	84	571	115	833	249
900-1000	274	120	391	224	675	344
1000-1100	234	142	282	238	516	380
1100-1200	271	229	289	277	561	506
1200-1300	346	295	340	269	687	514
1300-1400	284	265	318	258	603	522
1400-1500	324	261	337	246	661	507
1500-1600	333	287	392	280	725	567
1600-1700	406	284	384	266	790	549
1700-1800	491	263	361	235	852	498
1800-1900	363	238	354	196	717	434
1900-2000	334	208	334	236	669	444
2000-2100	272	196	209	175	481	371
2100-2200	275	190	196	146	475	336
2200-2300	226	148	167	124	399	271
2300-2400	130	150	138	102	268	252
TOTAL	5310	-	5824	3844	11127	-

W.D. = Weekdays

W.E. = Weekends

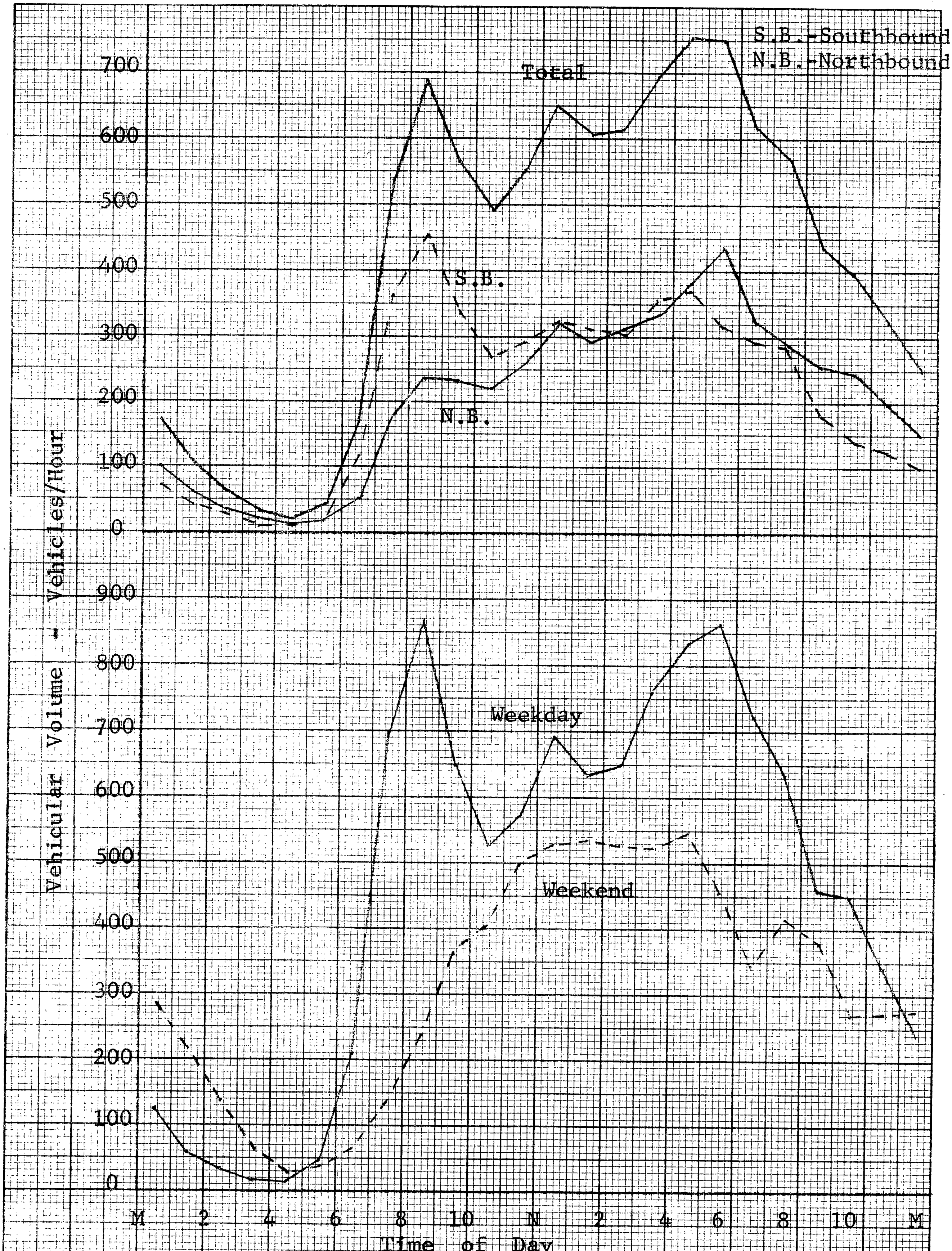


Figure 3.1-4 Diurnal Traffic - 1st week - George Street

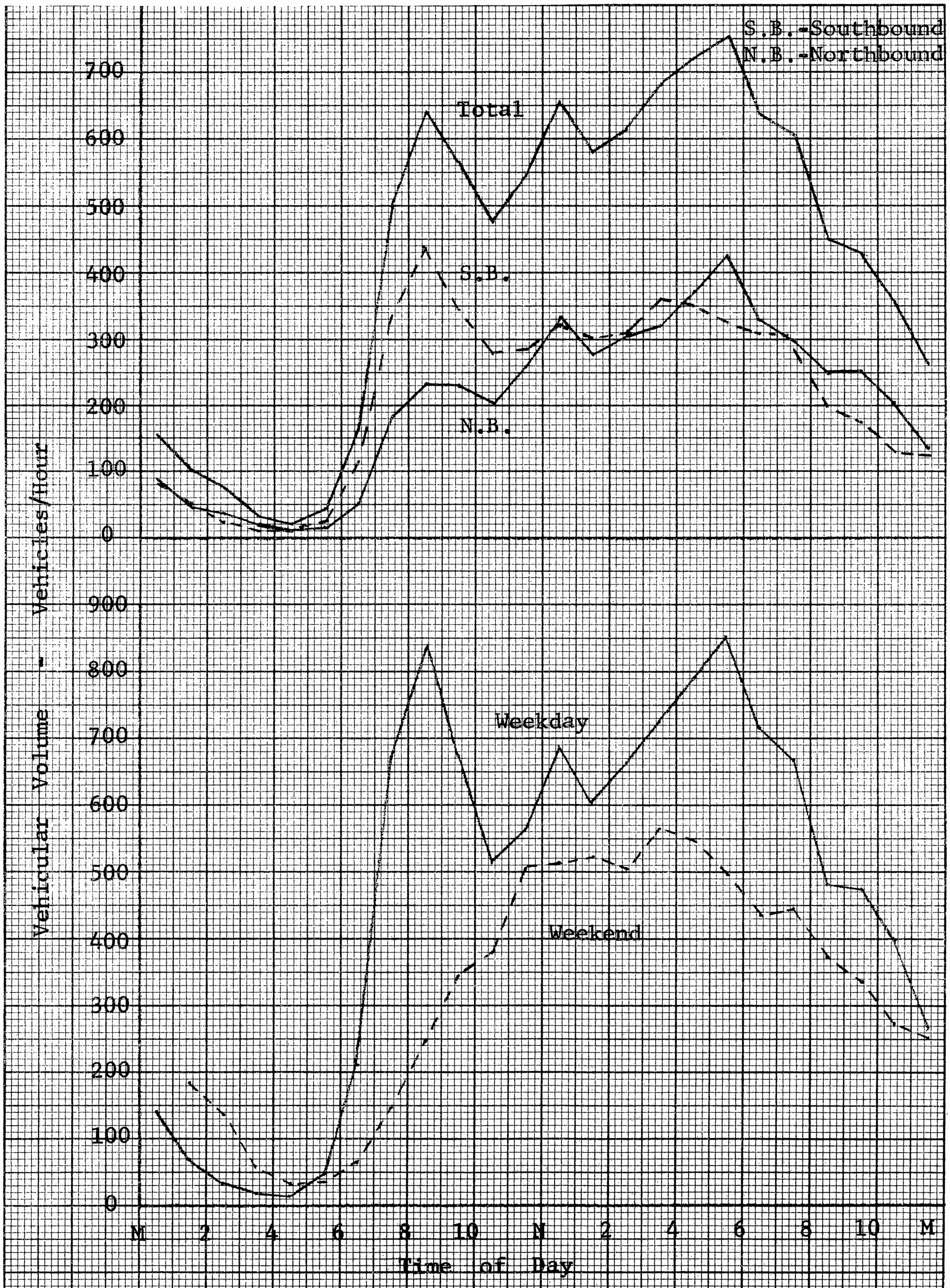


Figure 3.1-5 Diurnal Traffic - 2nd week - George Street

3.1.2 Carbon Monoxide Diurnal Characteristics

The hourly carbon monoxide concentration levels recorded at the dormitory as measured by probes 1A through 4B ranged, as presented in Section 5.0, from 0 to 6 ppm during the two week monitoring period. The average levels for these probes, however, only varied between 1.1 and 1.7 ppm for that period. The carbon monoxide levels measured by the Intertech analyzer at probe locations 5A and 5B were somewhat higher, varying from 0.5 to 10.5 ppm. The average concentrations for these two probes were 2.9 and 2.3 ppm respectively.

The peak concentration levels occured on 10 April during the first monitoring week between 10 and 11 P.M. and were recorded on both sides of the dormitory. During the second monitoring period, another peak occured on both dormitory sides between 8 and 9 P.M. on 21 April. In general, variations in carbon monoxide seen at one side of the dormitory were also noticed on the opposite side throughout the two week period.

The hourly data for each probe was averaged on the basis of weekdays and weekends, as tabulated on Tables 3.1-7 through 3.1-9. Figures 3.1-6 through 3.1-8 show the weekday diurnal patterns. As expected, two high periods and two low periods of carbon monoxide concentrations occured. Characteristic morning peaks are noted about 8:00 A.M. The second

TABLE 3.1-7
Frelinghuysen Dormitory
CO Concentration - ppm

17 to 24 April 1972

HOUR	PROBE NUMBER 1A W.D.	1A W.E.	1B W.D.	1B W.E.	2A W.D.	2A W.E.	2B W.D.	2B W.E.
2400-100	.8	1.9	1.1	1.2	1.2	2.4	1.3	1.8
100-200	.9	1.4	1.2	1.2	1.4	1.9	1.4	1.8
200-300	1.0	1.4	1.4	1.3	1.8	1.4	1.8	1.4
300-400	.8	.9	1.2	1.3	1.6	.8	1.7	1.0
400-500	.6	.7	.9	1.4	1.5	.5	1.6	.5
500-600	.9	.4	.7	.8	1.5	.4	1.5	.4
600-700	1.0	.4	.8	.4	2.0	.3	1.9	.3
700-800	1.3	.6	.9	.4	2.5	.2	2.1	.2
800-900	2.9	.4	1.9	.5	2.6	.6	2.0	.4
900-1000	2.5	.8	2.0	.4	2.3	.4	2.2	.4
1000-1100	.7	.4	1.0	.3	1.3	.3	1.6	.8
1100-1200	1.0	.9	1.0	.5	1.6	.8	1.5	.7
1200-1300	.8	.9	1.0	.8	1.6	.9	1.6	.8
1300-1400	.8	.8	1.1	.7	1.3	.7	1.2	.7
1400-1500	.9	.8	.8	.7	1.2	.9	1.2	.9
1500-1600	1.3	.7	1.0	.5	1.4	.9	1.3	.9
1600-1700	1.2	.8	1.0	.7	1.4	.8	1.3	.8
1700-1800	1.2	.9	1.0	.8	1.3	1.1	1.2	1.1
1800-1900	1.2	1.2	1.0	.8	1.0	1.0	1.0	1.0
1900-2000	1.4	1.2	1.1	1.3	1.4	1.4	1.0	1.2
2000-2100	2.0	1.4	1.4	1.1	2.1	1.5	1.7	1.4
2100-2200	1.4	1.3	1.7	1.2	1.2	1.5	1.5	1.4
2200-2300	1.5	.7	1.8	.7	1.3	1.2	1.3	1.3
2300-2400	1.2	.9	1.6	.7	1.2	1.7	1.1	1.4
AVE.	1.2	.9	1.2	.8	1.6	1.0	1.5	.9

WD = Weekdays

WE = Weekends

TABLE 3.1-8
Frelinghuysen Dormitory
CO Concentration - ppm
10 to 17 April 1972

	PROBE NUMBER							
	3A		3B		4A		4B	
HOUR	W.D.	W.E.	W.D.	W.E.	W.D.	W.E.	W.D.	W.E.
2400-100	2.5	-	2.5	-	2.1	.8	2.3	.9
100-200	2.3	-	2.4	-	2.1	.9	2.3	.9
200-300	1.4	-	1.5	-	1.4	.8	2.0	.9
300-400	1.2	-	1.2	-	1.4	.6	1.5	.8
400-500	1.1	-	1.1	-	1.4	.6	1.4	.7
500-600	1.6	-	1.6	-	1.5	.7	1.5	.7
600-700	1.4	-	1.6	-	1.6	.7	1.7	.7
700-800	1.5	-	1.5	-	2.0	.8	1.7	.9
800-900	1.4	-	1.9	-	2.1	.9	2.2	.8
900-1000	1.4	-	1.8	-	1.6	.8	1.8	.9
1000-1100	1.0	-	1.1	-	1.2	1.3	1.4	1.2
1100-1200	1.2	-	1.2	-	.9	1.6	1.1	1.4
1200-1300	1.0	-	1.2	-	.9	1.7	1.0	1.8
1300-1400	1.2	-	1.3	-	.9	1.9	.9	1.7
1400-1500	1.5	-	1.5	-	.9	1.8	1.0	1.8
1500-1600	1.4	-	1.5	-	1.1	1.2	1.0	1.5
1600-1700	1.4	-	1.5	-	1.3	1.3	1.2	1.2
1700-1800	1.3	-	1.6	-	1.4	1.3	1.5	1.3
1800-1900	1.2	-	1.2	-	1.3	1.2	1.3	1.2
1900-2000	2.4	-	2.6	-	1.8	1.0	1.6	1.0
2000-2100	2.0	-	2.3	-	2.1	1.0	2.0	1.0
2100-2200	2.8	-	2.8	-	2.2	1.1	2.1	1.2
2200-2300	2.1	-	2.5	-	2.7	1.2	2.4	1.3
2300-2400	2.2	-	2.2	-	2.2	.9	2.3	1.2
AVE.	1.6	-	1.7	-	1.6	1.1	1.6	1.1

W.D. = Weekdays

W.E. = Weekends

TABLE 3.1-9
Frelinghuysen Dormitory
CO Concentration - ppm

HOUR	10 to 17 April 1972 5A W.D.	W.E.	17 to 24 April 1972 5B W.D.	W.E.
2400-100	3.6	1.5	2.4	2.5
100-200	4.0	1.5	2.2	2.5
200-300	2.9	1.5	2.4	2.8
300-400	2.9	1.0	2.4	2.0
400-500	2.9	1.0	2.4	2.0
500-600	3.0	1.0	2.2	1.8
600-700	3.1	1.3	2.9	1.5
700-800	3.8	1.3	3.1	1.5
800-900	3.8	1.5	2.8	1.5
900-1000	3.8	1.3	2.5	1.8
1000-1100	3.0	2.0	1.8	1.8
1100-1200	3.0	2.3	1.9	2.3
1200-1300	3.5	2.3	2.2	2.0
1300-1400	3.8	2.3	2.1	1.8
1400-1500	3.5	2.3	2.3	2.0
1500-1600	3.5	2.0	2.3	2.0
1600-1700	3.2	1.5	2.3	2.3
1700-1800	3.0	2.3	2.1	2.0
1800-1900	2.9	2.3	2.0	2.3
1900-2000	3.5	1.8	2.4	2.5
2000-2100	3.6	1.5	2.8	2.5
2100-2200	4.0	1.8	2.6	2.5
2200-2300	4.8	1.5	2.4	2.3
2300-2400	4.1	1.8	2.4	2.5
AVE.	3.5	1.7	2.4	2.1

W.D. = Weekdays

W.E. = Weekends

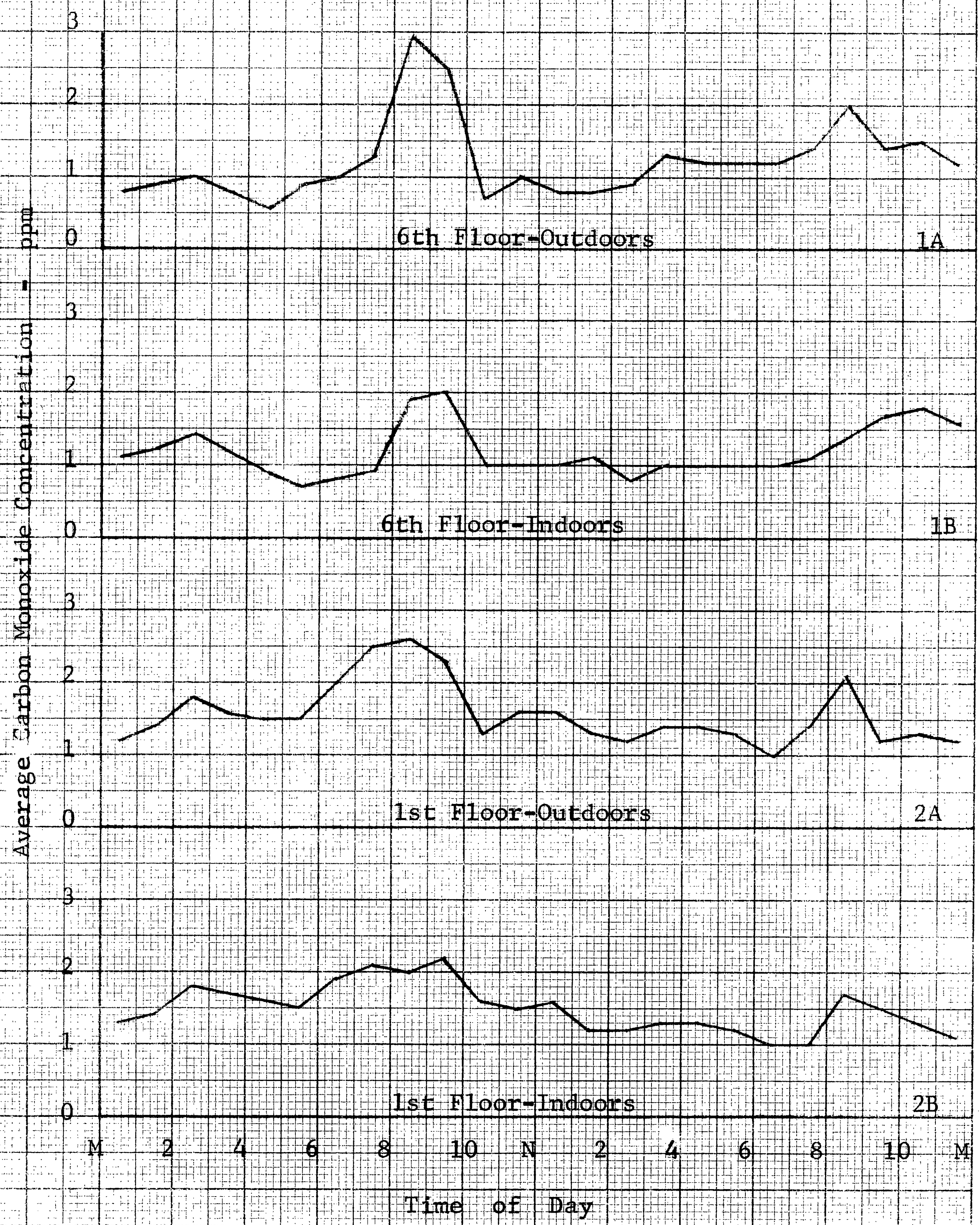


Figure 3.1-6 Carbon Monoxide - Frelinghuysen - Front

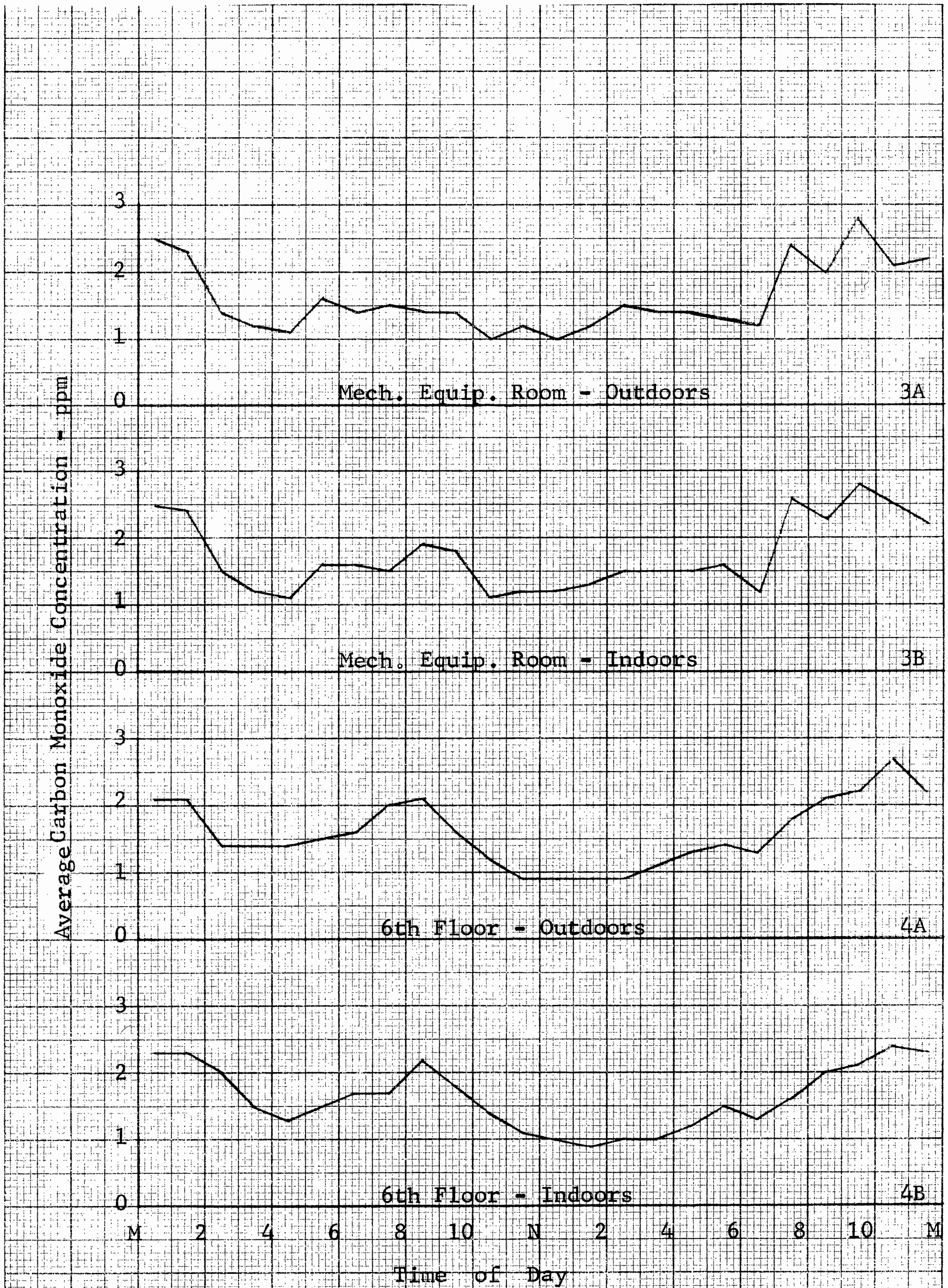


Figure 3.1-7 Carbon Monoxide - Frelinghuysen - Rear

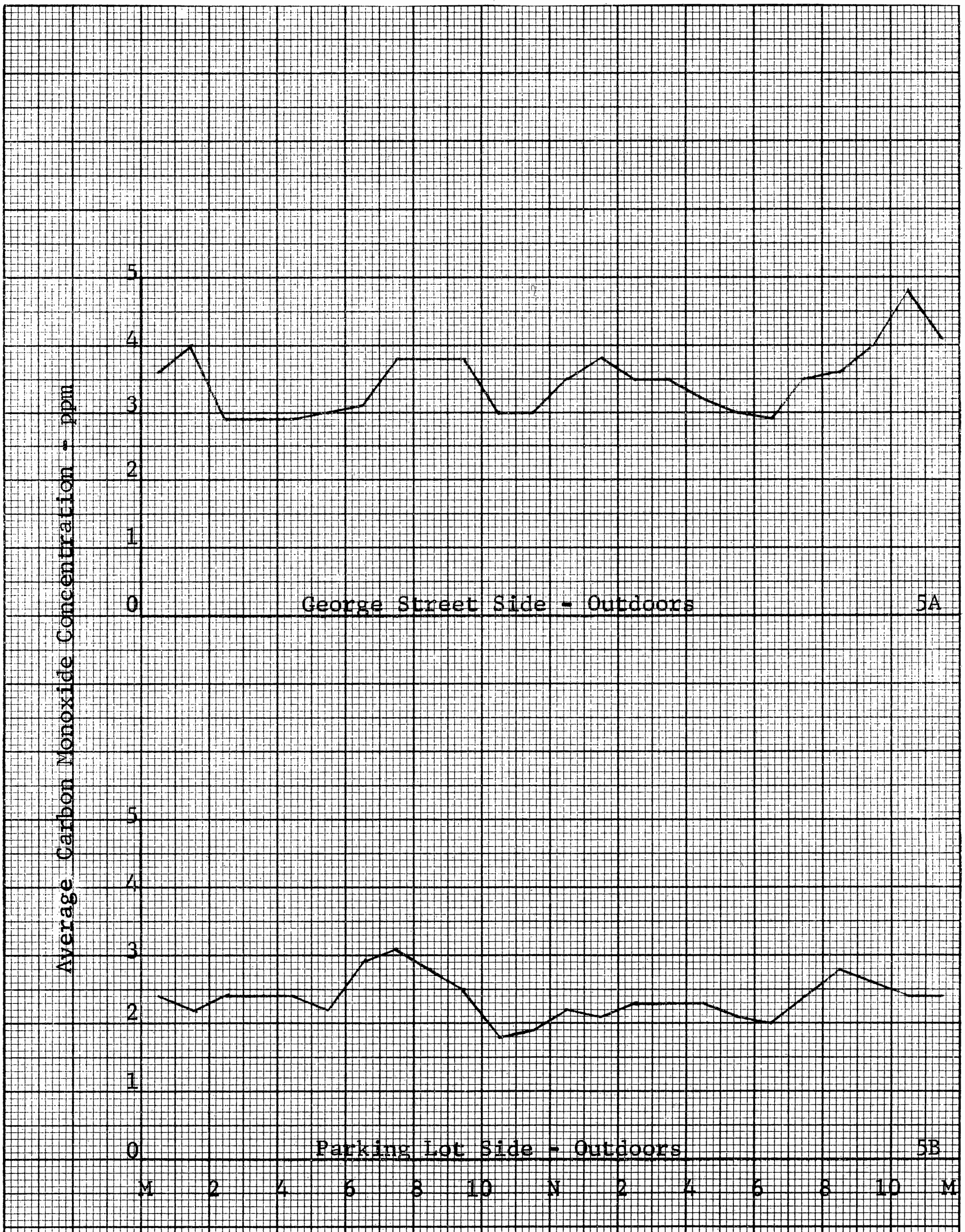


Figure 3.1-8 Carbon Monoxide - Frelinghuysen - Opposite Sides

peak, however, is considerably later in the day, from 8 P.M. to midnight, than typically is seen on an urban roadway.

3.1.3 Carbon Monoxide Spatial Profile

Examination of the daily average data, shown in Tables 3.1-7 thru 3.1-9 reveals that in general, weekend concentrations were lower than concentrations during the weekday periods. The weekday and weekend average concentrations in ppm for the eight probes used to monitor the spatial profile of the carbon monoxide levels at the dormitory are tabulated below:

Probe No.	Weekday	Weekend
1A	1.2	0.9
1B	1.2	0.8
2A	1.6	1.0
2B	1.5	0.9
3A	1.6	-
3B	1.7	-
4A	1.6	1.1
4B	1.6	1.1

It will be noted that the high elevation probes 1A and 1B measured a slightly lower concentration level at the front of the dormitory than the low elevation probes on the same side (2A & 2B). The carbon monoxide levels on the parking lot side do not show a similar vertical differential. The slightly lower average concentration at the 6th floor front location suggests that wind effects the concentration level more at this location than at the other three locations. This is supported by the observation that the outside probe 1A showed the largest diurnal variation in average hourly readings (from 0.6 to 2.9 ppm). (The effect of meteorological variations on carbon monoxide levels is discussed in paragraph 3.1.5.

3.1.4 Indoor/Outdoor Relationship

The average carbon monoxide levels indoors and outdoors at the dormitory are within 0.1 ppm at each of the four locations monitored. A comparison of individual hourly averages, shown in Section 5.0 data sheets, reveals that the indoor/outdoor differential did vary greater than the 0.1 ppm average. However, there is no consistent pattern to the differentials. Accordingly, it is concluded that there is no measureable difference in average indoor and outdoor carbon monoxide levels at the dormitory.

There is strong indication that the indoor carbon monoxide levels are the result of external CO sources. As seen on Figures 3.1-4 thru 3.1-6, indoor peaks occured simultaneously with or later than outdoor peaks. Generally outdoor peaks are higher than indoor peaks. Conversely indoor levels decrease more slowly.

The diurnal variations in average hourly readings at each of the four locations always was larger at the outside position (A probes) as seen in the table below.

Probe No.	CO Concentration - ppm Diurnal Range	Diff	I/O Diff
1A	.6 - 2.9	2.3	1.0
1B	.7 - 2.0	1.3	
2A	1.0 - 2.6	1.6	.4
2B	1.0 - 2.2	1.2	
3A	1.0 - 2.8	1.8	.1
3B	1.1 - 2.8	1.7	
4A	.9 - 2.7	1.8	.3
4B	.9 - 2.4	1.5	

The variation between the indoor and outdoor ranges is smallest at the mechanical equipment room (windows open). This indicates that, while open windows will permit outside CO to enter a particular room faster, the indoor level will decrease more rapidly with open windows when the outside concentration level decreases.

3.1.5 Carbon Monoxide/Wind Relationship

The carbon monoxide level measured outside the Frelinghuysen dormitory varied as a function of both wind direction and wind speed. The effect of these meteorological factors is seen by examination of the concentration levels on both sides of the dormitory for several hours at a time. Table 3.1-10 shows the average values of the data obtained for each half day period for the wind conditions and for CO probes 1A and 5B. Figure 3.1-9 shows these average CO levels plotted against wind direction. (The data on the right side represents time periods when the prevailing wind direction blew from George Street towards the dormitory. The left side plots show conditions when the wind blew from the

TABLE 3.1-10
Frelinghuysen Dormitory
Averaged Wind & CO Data
17 to 24 April 1972

TIME PERIOD		Wind		CO - ppm	
		ANGLE-DEGREES	SPEED-MPH	PROBE 1A	PROBE 5B
4/17	PM	7	13.1	.7	2.1
4/18	AM	346	5.2	.7	2.5
4/18	PM	253	7.1	1.2	2.6
4/19	AM	274	5.3	-	2.3
4/19	PM	268	6.3	1.3	2.4
4/20	AM	218	6.1	1.7	2.5
4/20	PM	53	12.3	1.9	2.0
4/21	AM	341	5.8	-	2.4
4/21	PM	19	5.5	1.5	2.4
4/22	AM	108	8.9	1.4	1.9
4/22	PM	88	11.2	.8	1.7
4/23	AM	333	4.6	.3	2.1
4/23	PM	256	6.7	1.1	2.8
4/24	AM	353	3.2	.7	2.6

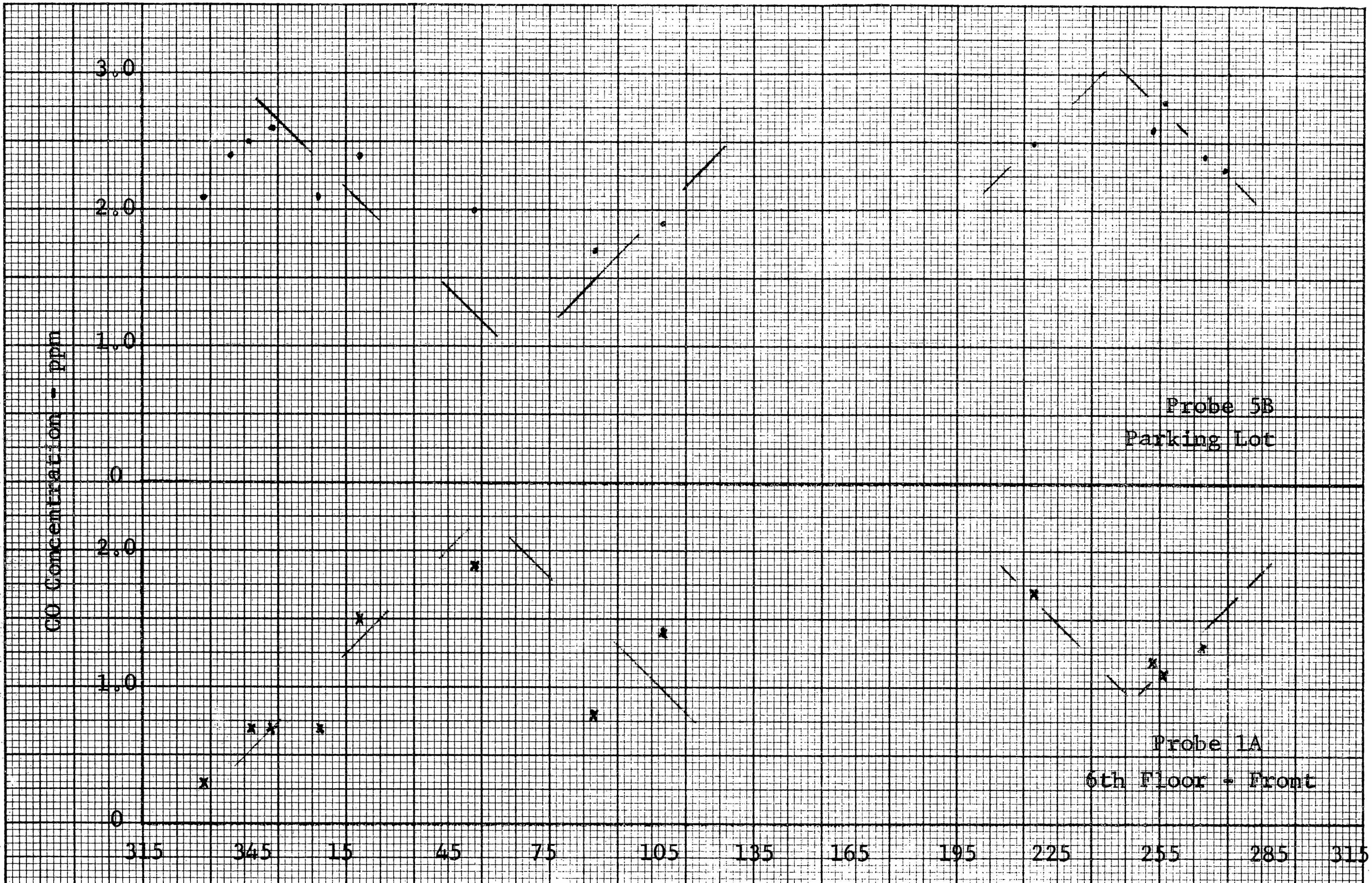


Figure 3.1-9 Average Carbon Monoxide - Wind Direction - Frelinghuysen

parking lot side.)

It can be seen that when winds blew from George Street, CO concentrations in the parking lot peaked as the wind angle approached 240°. CO concentrations on the George Street side, however, approached a low level with the same wind variation. This phenomena is apparent, in reverse, when winds neared 60° (blowing from the opposite side of the dormitory). Thus the anticipated reduction in CO concentration outside a building as the wind blows perpendicular to its face did occur.

Examination of the data plotted in Figure 3.1-9 will show that three high northeasterly wind conditions (over 10.0 mph) occurred. The CO levels at probe 1A (on the sheltered side of the dormitory) fall beneath the suggested curve. This indicates the higher winds create more turbuance on the sheltered side and disburse the CO faster and prevent the normal diffusion from George Street towards the dormitory. Conversely, these high roof level winds do not reduce the CO concentrations on the parking lot side as rapidly.

This effect of wind speed can be seen from Figures 3.1-10and 3.1-11. The first figure shows the diurnal profile for Apr 21 to the extent available for wind speed and selected CO probe locations. (Prevailing winds throughout the day were from the north at 359°) It will be noticed, in the lower curve,

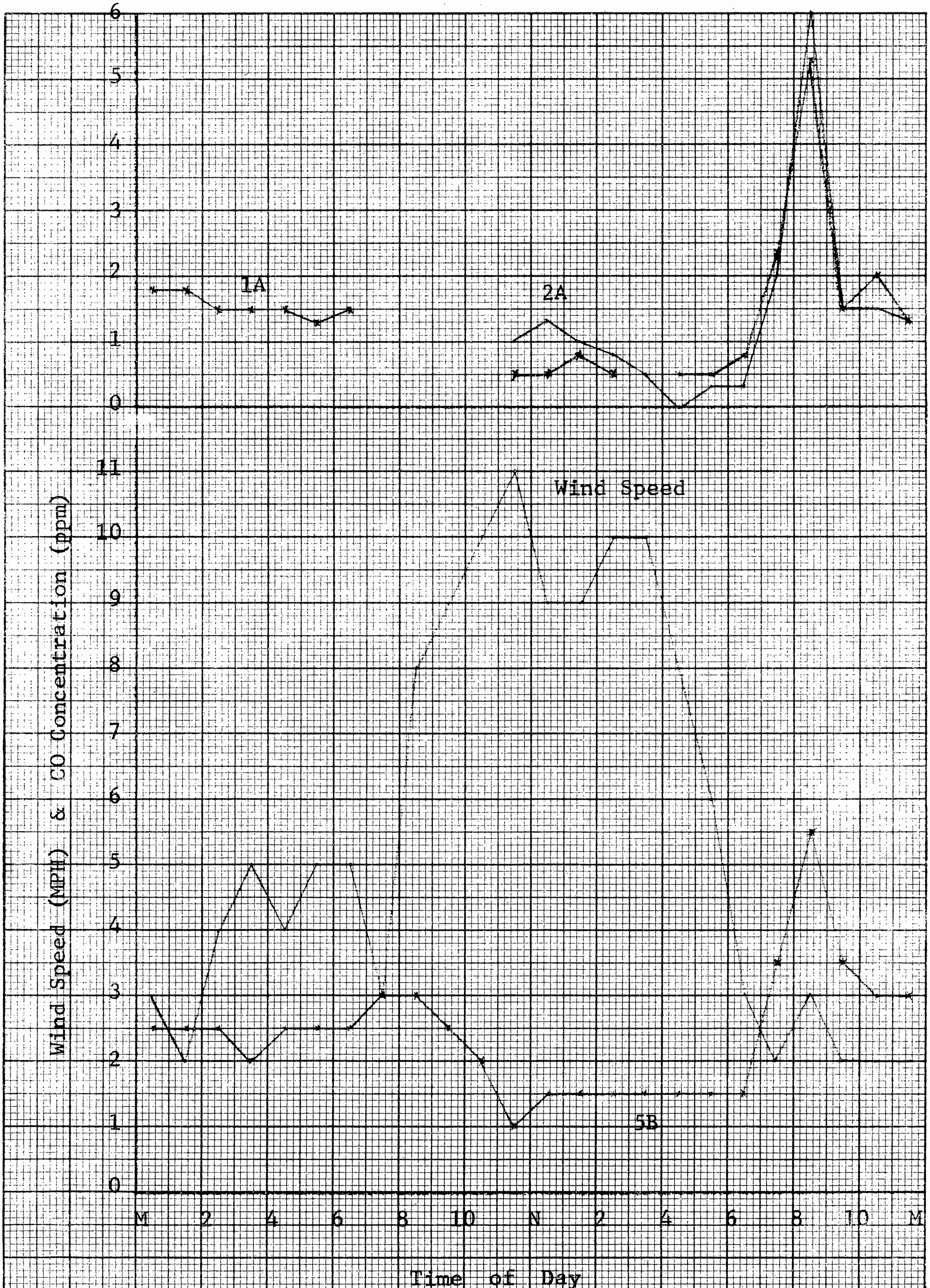


Figure 3.1-10 Diurnal Characteristics - Apr 21 - Frelinghuysen

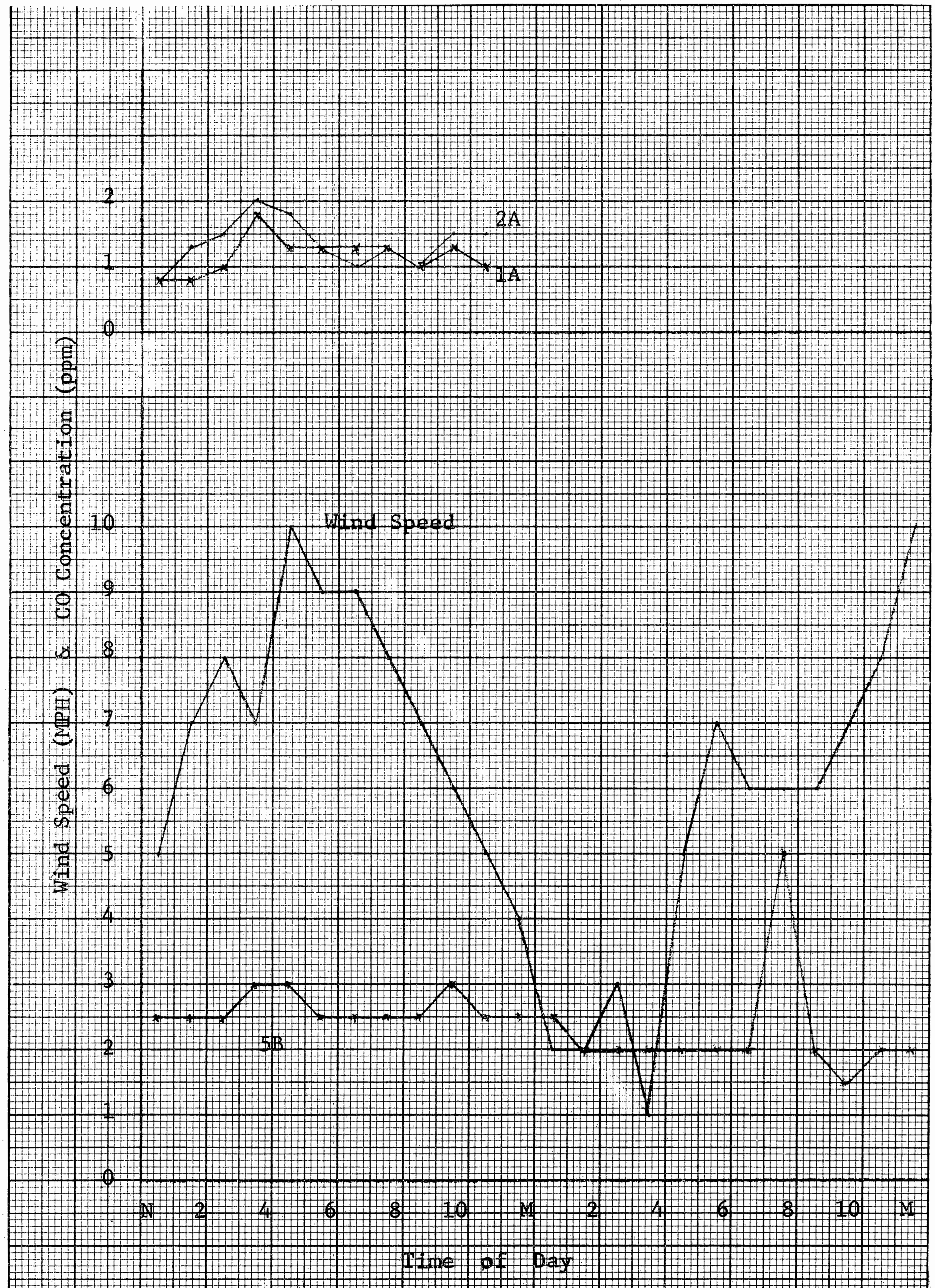


Figure 3.1-11- Diurnal Characteristics - Apr. 18&19 - Frelinghuysen

that the concentration level seen at probe 5B decreases as the wind speed increases above 6 mph between 8 and 9 A.M. and then increases late at night when wind speed return to 2-3 mph. (The CO peak between 8 and 9 P.M. is not wind related. As shown in the upper plots, probes 1A and 2A also peaked at the same time.) Figure 3.1-11 for the 24 hour period from noon on Apr 18 to noon on Apr 19 when the winds were from the west at 263°, shows that there is little or no wind effect seen in the parking lot at probe 5B location. The 3 and 9 P.M. peaks on Apr 18 in the parking lot also occurred on the George Street side, as shown in the upper plot of CO concentrations at probe locations 1A and 2A.

The influence of meteorological variations is apparent at all elevations of the dormitory. Daily average data for wind direction and speed and CO concentration levels for the five probe locations being monitored on Saturday, April 22 and Sunday, April 23 are tabulated below:

	WIND		CO - PPM				
DATE	ANGLE-DEGREES	SPEED MPH	1A	1B	2A	2B	5B
4/22	98	10.0	1.1	.9	1.2	1.1	1.8
4/23	294	5.6	.7	.7	.8	.7	2.4

On 4/22 with high easterly winds (from river) the CO concentrations for probes 1A, 1B, 2A & 2B are higher than for 4/23 when the wind is from George Street. Conversely the carbon monoxide level at probe 5B is lower for easterly winds than for northwesterly winds.

3.1.6 Carbon Monoxide/Traffic Relationship

Comparison of the diurnal curves of carbon monoxide and traffic, presented in paragraph 3.1.1 and 3.1.2, will show that the daily profiles are substantially different. While the George Street traffic curves are typical, the diurnal carbon monoxide curves are much flatter than normal. Figure 3.1-12 shows the carbon monoxide/traffic relationship, using the weekday average hourly data, for probes 3A and 5A for the first week and probes 2A and 5B for the second week. From these plots it must be concluded that George Street traffic per se does not determine the carbon monoxide level at the Frelinghuysen Dormitory. The general tendency for carbon monoxide to peak in the 8 - 10 PM hours, see figures 3.1-6, -7, and -8, while traffic is decreasing rapidly suggest that there is a second source of carbon monoxide in the vicinity of the dormitory. Very possible this is traffic into and out of the parking lots which did not cross the traffic counters in George Street.

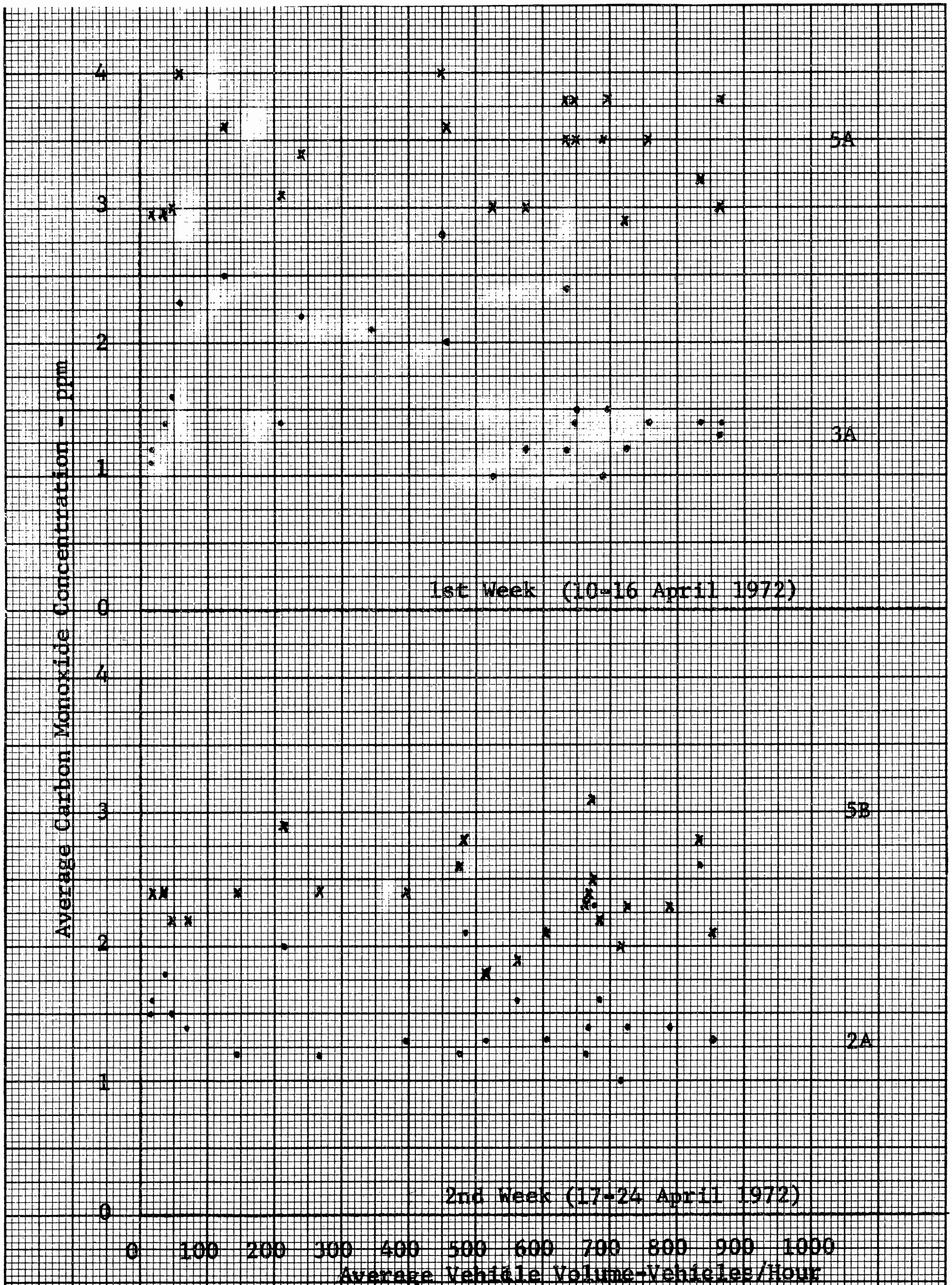


Figure 3.1-12 Carbon Monoxide/Traffic Relationship-Frelinghuysen

3.2 CARBON MONOXIDE AT MUSIC BUILDING

3.2.1 Site Description and Data

3.2.1.1 Carbon Monoxide Data

Carbon monoxide measurements were made at the Music Building located on the Douglas Campus to define the carbon monoxide concentrations resulting from traffic on an existing section of Route 18. The concentration profile about the Music Building was obtained by monitoring the carbon monoxide on the median strip of the highway, adjacent to the highway and an exit ramp passing in front of the Music Building, and simultaneously at two locations inside and outside the second floor of the Music Building. The inside concentrations were measured with the windows in the hall facing Route 18 closed during the study. The carbon monoxide concentration levels were monitored from 27 April to 15 May 1972. (It should be noted that Daylight Savings Time went into affect at 2 AM on 30 April, during the monitoring period.)

The concentration levels were obtained by mounting five sampling probes at the measurement locations as shown in figures 3.2-1 and 3.2-2. The pollution level on the median strip was determined by an Intertech carbon monoxide analyzer. The carbon monoxide concentrations at the other four locations were measured using two Bendix carbon monoxide analyzers. Instrumentation and calibration techniques used are described in Section 4.0

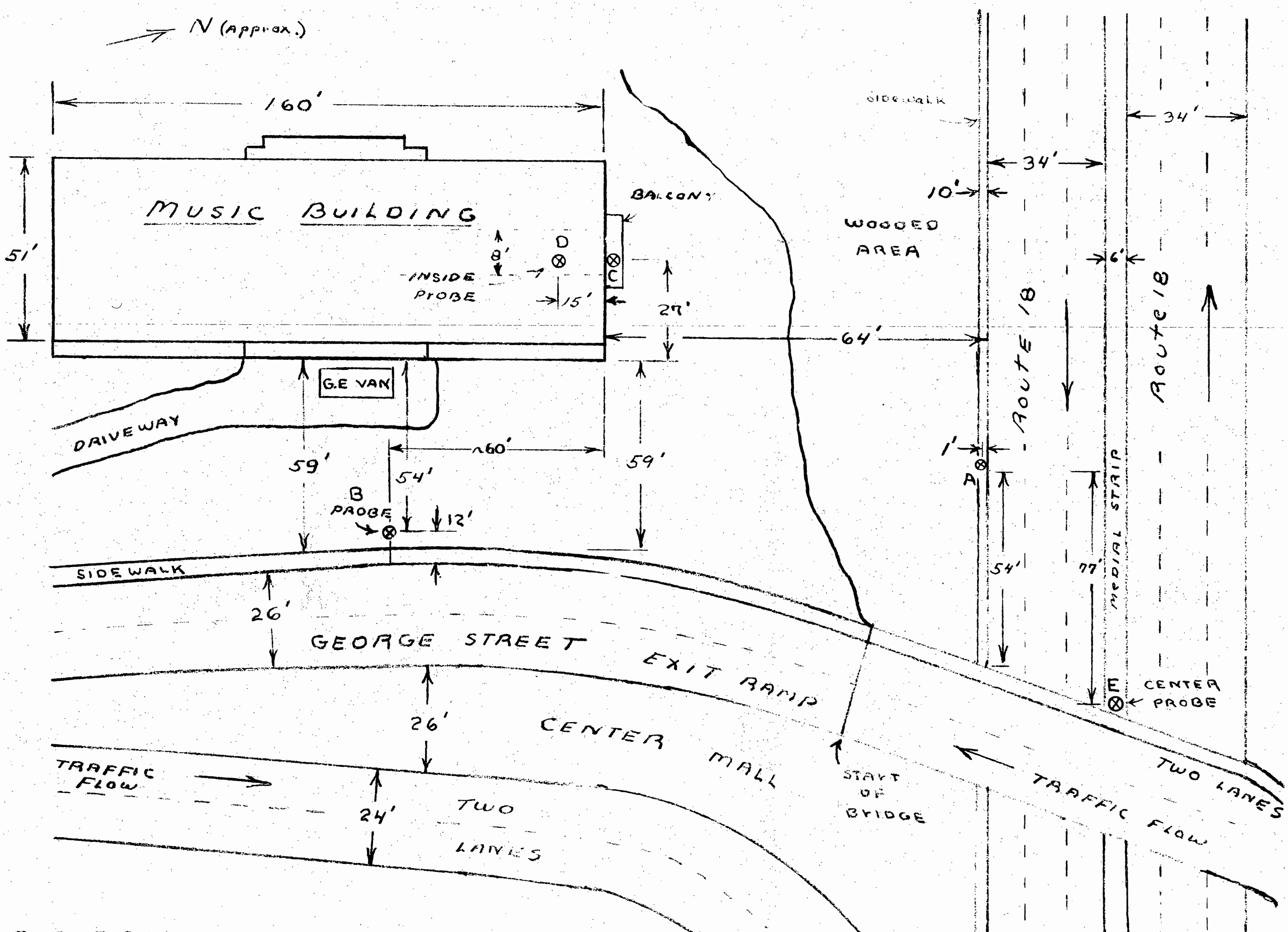


FIG. 3.2-1 MUSIC BUILDING-PLAN VIEW

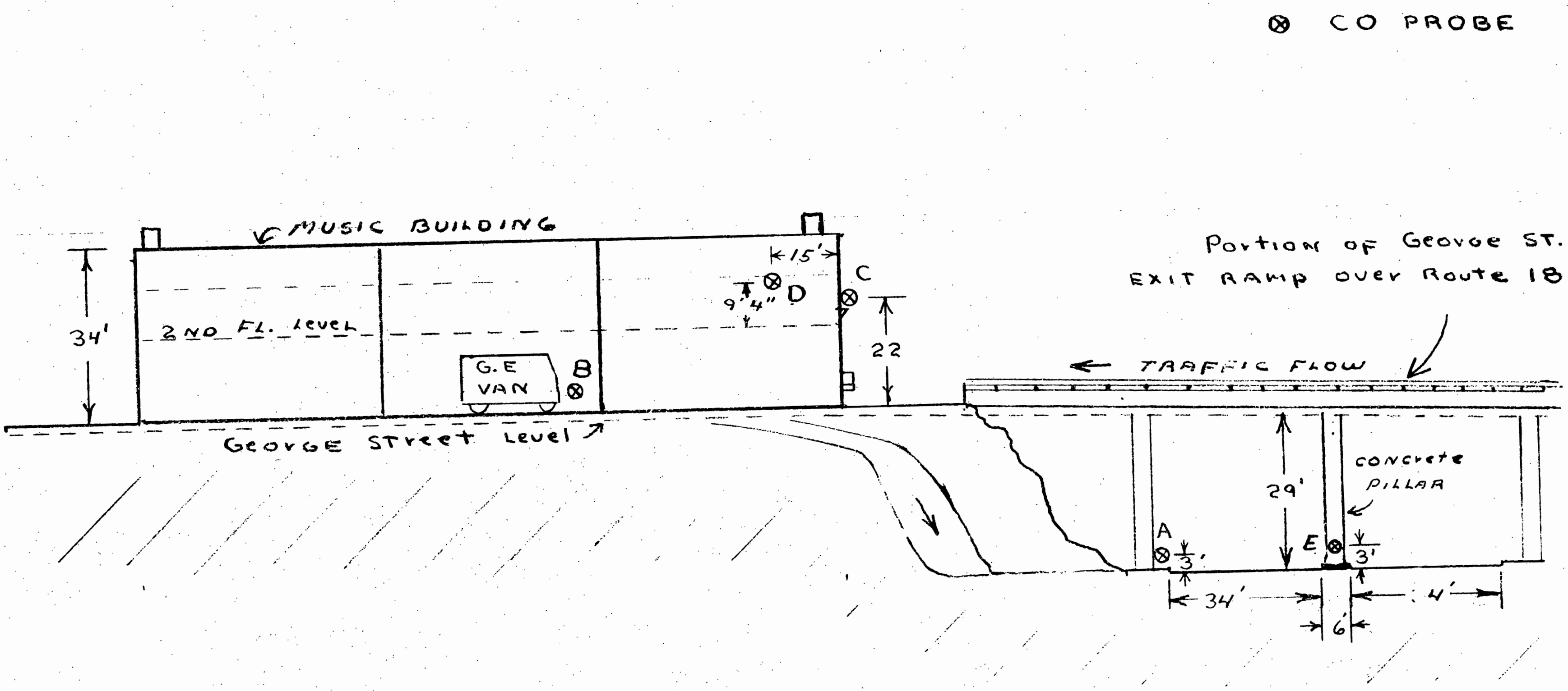


FIG. 3.2-2 MUSIC BUILDING–ELEVATION VIEW

The hourly carbon monoxide readings for all probe locations for the data collection period are presented in Section 5.0. The average hourly concentrations and the daily average concentrations are shown on those data sheets. It should be noted that the number of valid hourly readings obtained are different for the three analyzers used. Caution must be observed in comparing daily average readings from probe to probe.

Examination of the CO data in Section 5.0 will show that the concentration levels recorded at a given probe location varied from day to day and for the same hours each day. The standard deviations for the average hourly concentrations for all probes is shown in Table 3.2-1. It will be noted that the locations close to traffic, probes A&E, evidenced the largest deviations. The deviations at the ramp edge, outdoor and indoor locations showed progressively lower deviations in average hourly concentrations.

The average hourly CO concentrations recorded for the total monitoring period for the 5 probes at the Music Building are presented in Table 3.2-2. As expected, the median strip of Route 18, Probe E showed the highest average concentration, 6.3 ppm. The average concentration alongside Route 18, Probe A was significantly lower at 4.6 ppm. Average concentrations adjacent to the exit ramp and at the indoor and outdoor locations at the Music Building are the lowest.

Table 3.2-1
Music Building
CO Concentration
Standard Deviation

Total Period

27 April to 15 May 1972

HOUR	PROBE A	B	C	D	E
2400-100	2.1	2.2	1.7	.9	2.9
100-200	1.9	1.9	1.1	.9	2.5
200-300	1.3	1.3	.8	1.0	1.5
300-400	1.2	1.1	.7	.9	1.2
400-500	1.1	1.0	.6	.9	1.1
500-600	1.1	1.2	.6	.8	1.0
600-700	1.2	1.3	.6	.7	1.3
700-800	2.2	1.5	.6	.6	2.6
800-900	2.5	1.1	1.1	.7	3.1
900-1000	1.7	.7	1.1	1.0	2.3
1000-1100	1.4	.5	1.1	1.2	2.0
1100-1200	1.7	.2	1.0	1.1	2.2
1200-1300	1.9	.5	.9	1.0	2.1
1300-1400	1.8	.6	1.0	1.1	2.2
1400-1500	1.9	.7	.9	.9	2.5
1500-1600	2.7	.8	1.0	.9	2.5
1600-1700	3.4	1.1	.9	.9	2.8
1700-1800	3.3	1.3	.8	.8	2.6
1800-1900	1.9	1.1	.8	.8	2.1
1900-2000	1.9	1.8	1.3	.9	2.0
2000-2100	1.8	1.8	1.4	1.1	2.3
2100-2200	1.8	1.9	1.2	1.0	2.6
2200-2300	1.6	1.6	1.2	.9	2.3
2300-2400	2.1	2.0	1.3	.8	2.6

Table 3.2-2
Music Building
CO Concentration - ppm

Total Period
27 April to 15 May 1972

HOUR	PROBE A	B	C	D	E
2400-100	4.1	2.8	2.5	2.3	5.3
100-200	3.4	2.6	1.9	2.2	4.3
200-300	2.6	2.1	1.6	2.0	3.3
300-400	2.3	2.0	1.5	1.9	2.8
400-500	2.3	1.9	1.4	1.8	2.6
500-600	3.1	2.3	1.3	1.5	3.0
600-700	4.7	2.5	1.7	1.4	4.5
700-800	6.8	2.7	2.1	1.6	6.9
800-900	6.3	2.1	2.5	2.2	7.5
900-1000	5.4	2.0	2.5	2.6	6.4
1000-1100	4.5	1.3	2.3	2.5	6.3
1100-1200	4.2	.9	2.0	2.3	6.9
1200-1300	4.7	1.1	2.0	2.1	7.4
1300-1400	4.3	1.4	2.0	2.2	7.2
1400-1500	4.4	1.2	1.8	1.9	7.3
1500-1600	5.6	2.0	2.0	1.9	8.2
1600-1700	6.7	2.0	2.0	2.0	9.1
1700-1800	6.3	2.3	2.0	2.0	8.1
1800-1900	5.1	1.8	1.9	2.0	7.1
1900-2000	5.4	2.5	2.4	2.1	7.7
2000-2100	4.8	2.6	2.6	2.3	8.2
2100-2200	5.0	2.9	2.6	2.4	7.9
2200-2300	4.6	2.9	2.2	2.4	6.3
2300-2400	4.4	2.8	2.3	2.2	5.8
AVE.	4.6	2.1	2.0	2.1	6.3

The daily average carbon monoxide concentrations measured on Route 18 at the median and road edge locations and at the ramp edge location are shown on Figure 3.2-3. As expected, CO concentrations were always highest at the median strip. (Since several hours of data is not available on 7 & 8 May for the median strip, Probe E, the points plotted are concentration levels assuming the missing data is equal to the average CO level for the respective hours. Data is also unavailable for Probes A & B for short periods on most days. Since the corresponding hours of data for these two probes is equal, their daily average concentrations may be compared. Rigid comparison of probes A & B with the dashed portion of the Probe E data is not advisable.) In general, the daily carbon monoxide levels at these three locations follow the same pattern, except for the ramp edge on May 1 through 4.

3.2.1.2 Traffic Data

Vehicular traffic flow on both the East and West bound lanes of Route 18 passing under the George Street ramp was recorded in hourly increments by the New Jersey Department of Transportation. This data is presented in Section 5.0. No measurements were made of the traffic using the access ramp. Figure 3.2-4 shows the daily average vehicular volume traversing Route 18 at the Music Building. Eastbound traffic always was

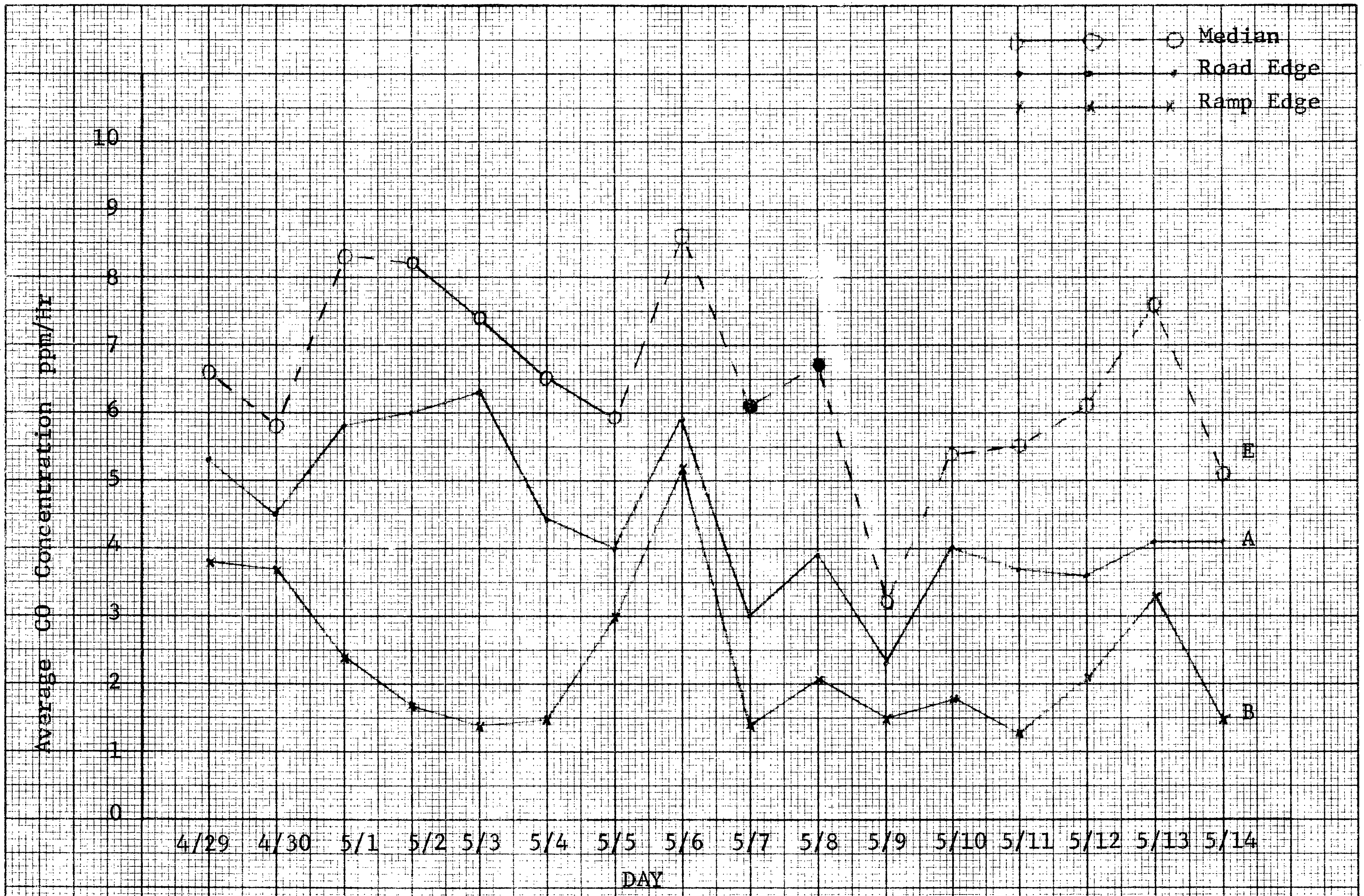


Figure 3.2-3 Daily Average CO Concentrations - Music Building

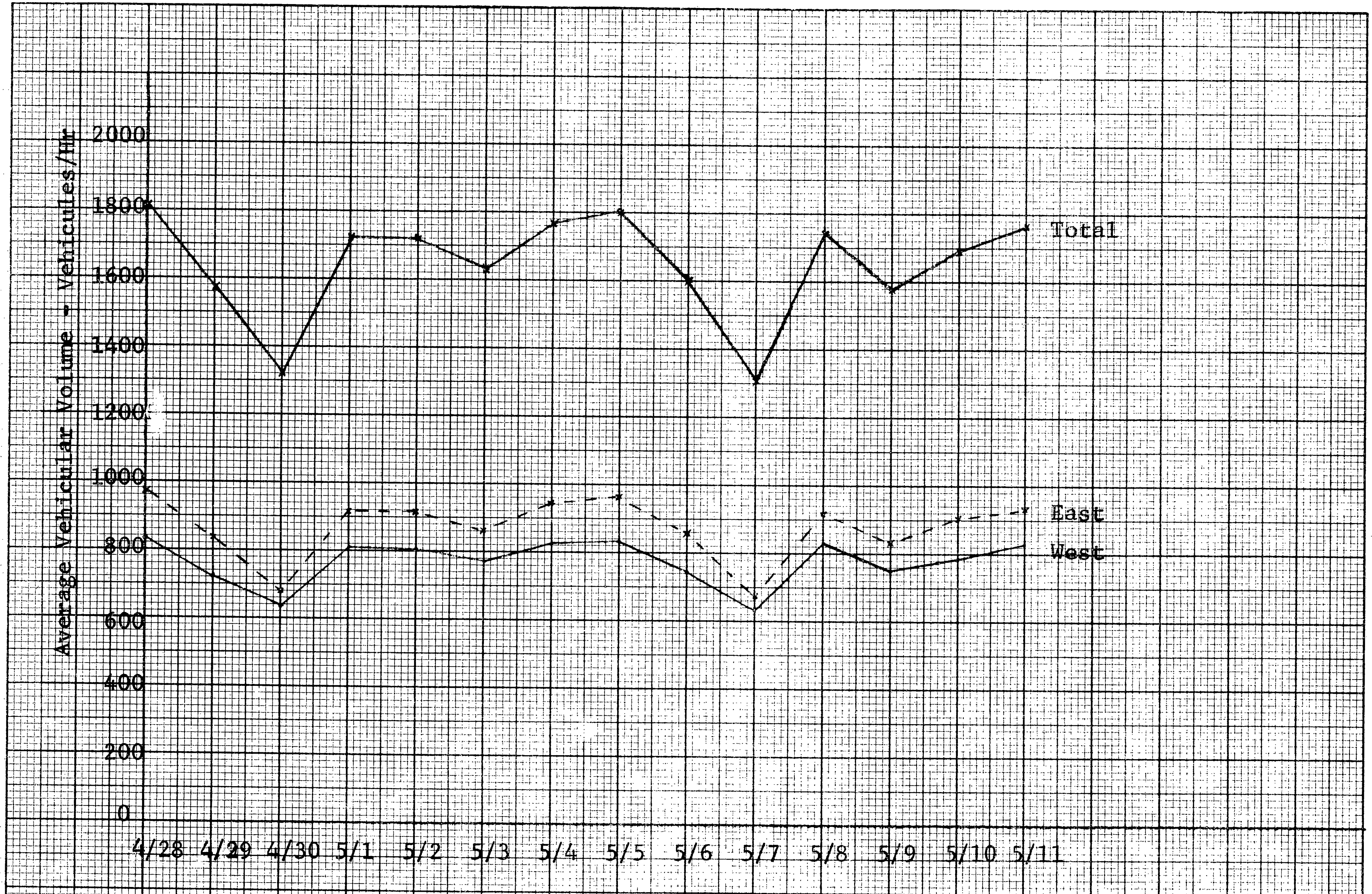


Figure 3.2-4 Daily Average Vehicular Volume - Music Building

larger than westbound traffic west of the George Street exit ramp. Volume on either side of the highway varied uniformly from day to day. The lowest traffic periods occured on the two Sundays, 30 April and 7 May. Saturday traffic was the next lowest. While the Sunday traffic lows appear to relate to CO concentration levels for Probes A & E on figure 3.2-3, the relationships do not hold on 4 & 5 May nor on 9 & 10 May. A comparison of Route 18 traffic and CO at the ramp edge, Probe B, again shows lack of correlation for 1 through 4 May.

The diurnal traffic flow on Route 18, shown in figure 3.2-5, exhibited characteristic peaking condition during the morning and evening rush hours. The AM peak is due to westbound traffic while the evening is the result of eastbound vehicular flow. Westbound traffic exceeded eastbound traffic only during the morning rush hour period. Volume on either side of the highway varied uniformly during the early morning and late night hours. The 8 AM to 8 PM period showed a fluctuating traffic flow on both sides.

As previously mentioned, weekend traffic was lower than traffic on weekdays. The diurnal traffic patterns differ appreciably, as shown on figure 3.2-6, for the significant divisions of a week, as is characteristic for an urban expressway. Traffic related pollutants accordingly will differ as a function of the time of the week.

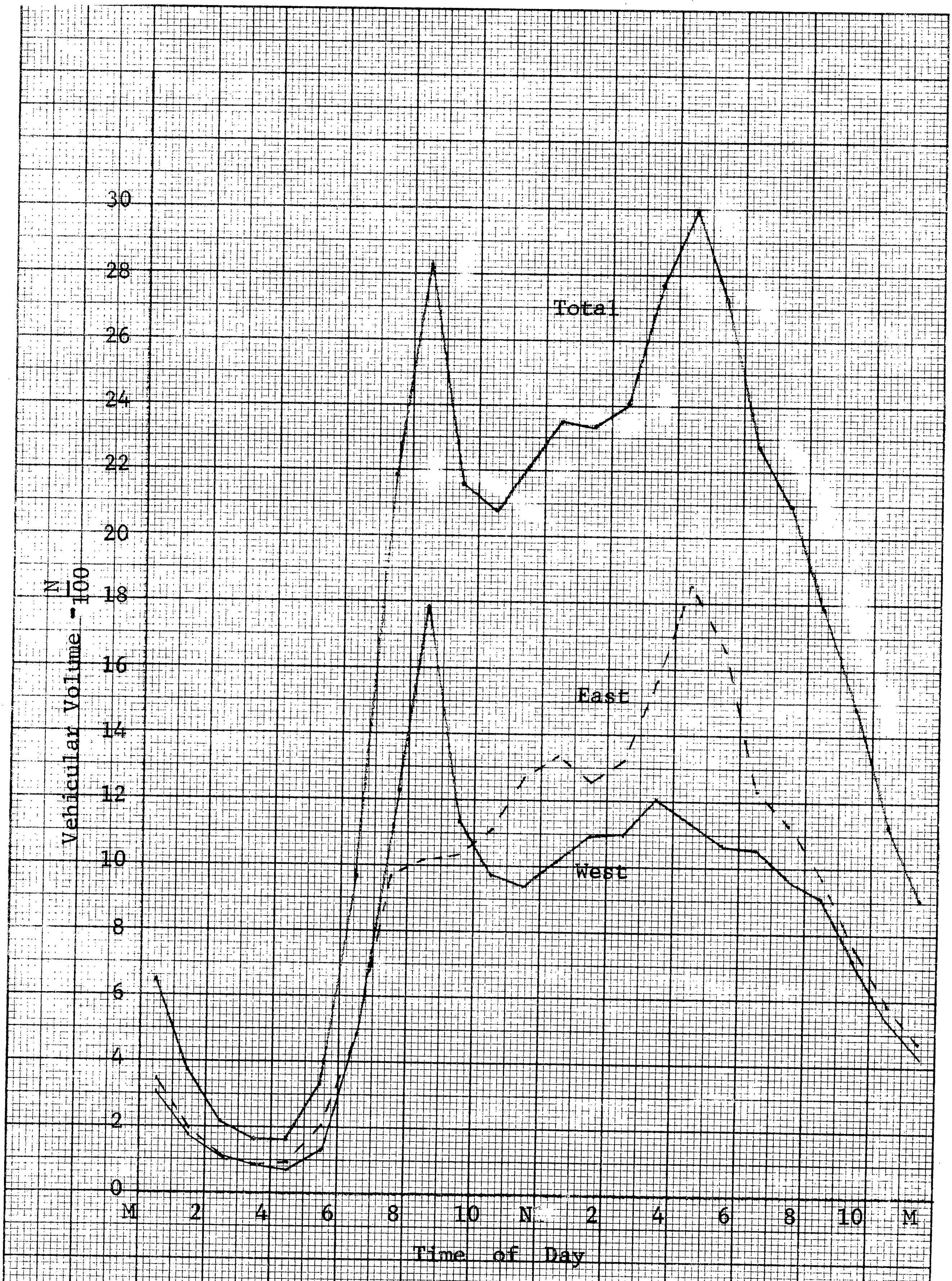


Figure 3.2-5 Diurnal Traffic - Music Building

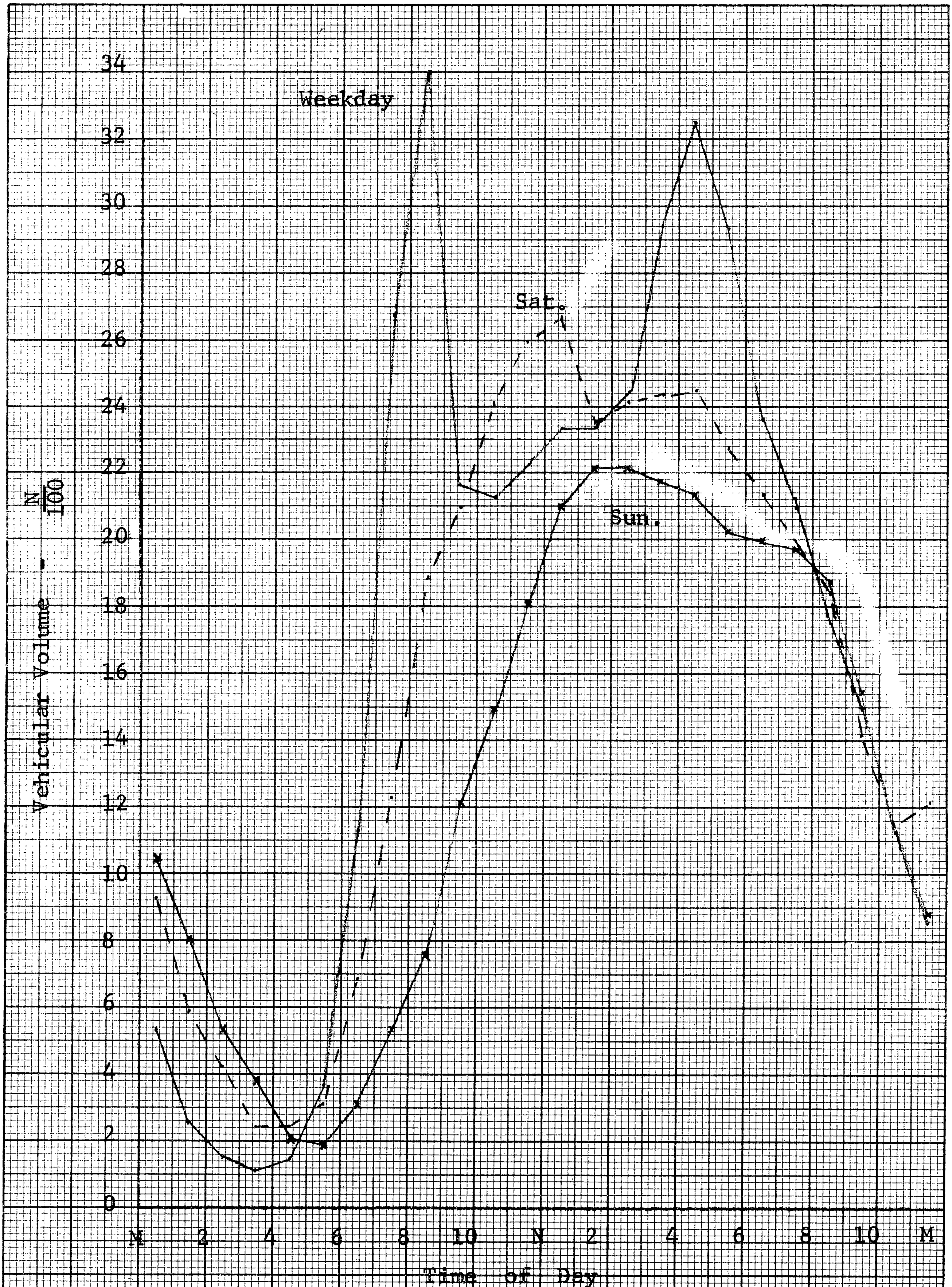


Figure 3.2-6 Diurnal Traffic - Weekday, Sat & Sun - Music Building

3.2.1.3 Meterological Data

Wind azimuth direction and wind speed as seen at the Gibbs Dormitory was measured from 1630 on 28 April to 15 May 1972. The weather vane and cup aneomometer were positioned approximately 8 feet above the chimney top of the dormitory. (This meteorological equipment indicated prevailing conditions at the Music Building and was not necessarily indicative of ground level wind currents.) The hourly wind azimuth and wind speed data obtained is documented in Section 5.0 maintaining Eastern Standard Time as the time reference. The daily averages for wind direction and speed are shown for both Standard Time and clock time. Similarly the hourly average wind speeds are shown on both time bases.

During the monitoring period, the wind blew predominantly from the West and North. An Easterly wind prevailed for approximately 60 hours starting around 6 PM on 7 May. South winds occured more often at this site than noticed at Frelinghuysen. These winds blew at midnight on 1 May, in the early AM on 7 May and frequently during 14 May. Generally the wind direction was quite stable, changing over a period of hours. There is no meaningful diurnal pattern. The average wind azimuth angle was 303°. (NOTE: Route 18, at the Music Building site, lies along a line with a westerly heading of 283°. The exit ramp is basically perpendicular to Route 18.) The winds blew from Route 18 towards the Music Building about 47° of the time. (52° of the time winds blew from the Music Building side of Route 18. No wind direction was present during 4 hours of zero wind speed.) Wind speeds ranged from 0 to 20 mph. The diurnal profile, shown on Eastern Standard Time in Figure 3.2-7, exhibits the same pattern as seen at Frelinghuysen. The average wind speed was 6.7 mph. (Since both carbon monoxide and traffic data are related to clock time, the wind speed diurnal profile is shown in Figure 3.2-8 in clock time. A comparison of Figures 3.2-7 and 8 show no significant difference. Meterological conditions hereafter are presented in clock time.)

The daily (clock time) average wind direction and wind speed recorded at the Music Building are presented in Figure 3.2-9. It will be noticed that the peak wind speed conditions occured on 8 & 9 May while the wind was blowing from 120° and 90°. This high wind condition corresponds with the low CO Concentration level recorded on the median strip (see Figure 3.2-3) on 9 May. Conversely, the low wind speeds of 1, 6 & 13 May correspond with peak median strip CO Concentrations on those dates.

The average wind direction on 1 thru 4 May was essentially constant at 240°. Thus the wind was blowing from the Music Building towards the probe adjacent to the exit ramp and then across the exit ramp. CO Concentrations at probe B for these days were lower (fig. 3.2-3) than typical for the vehicle volume on Route 18.

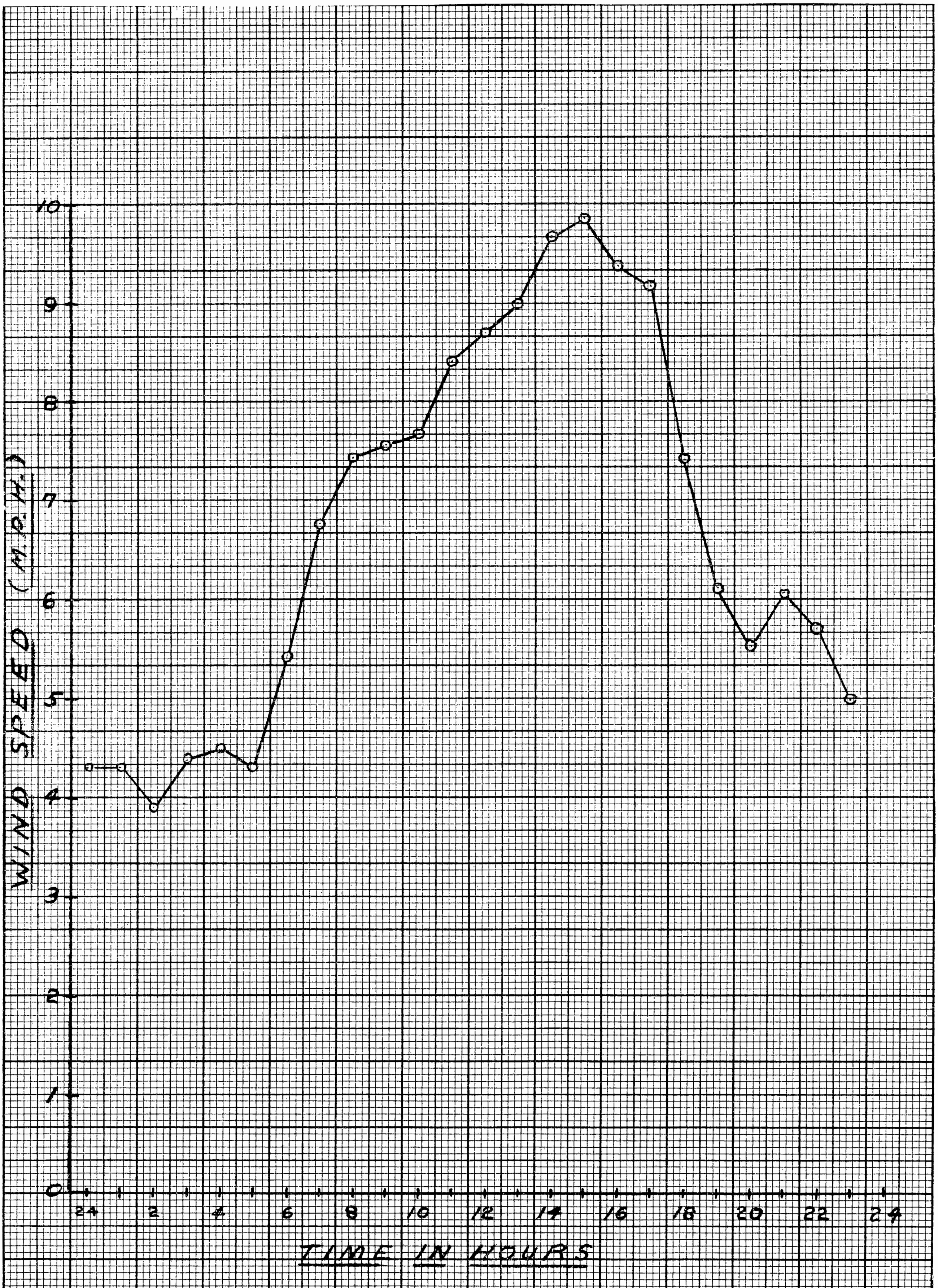


Figure 3.2-7 Diurnal Wind Speed - Music Building - Standard Time

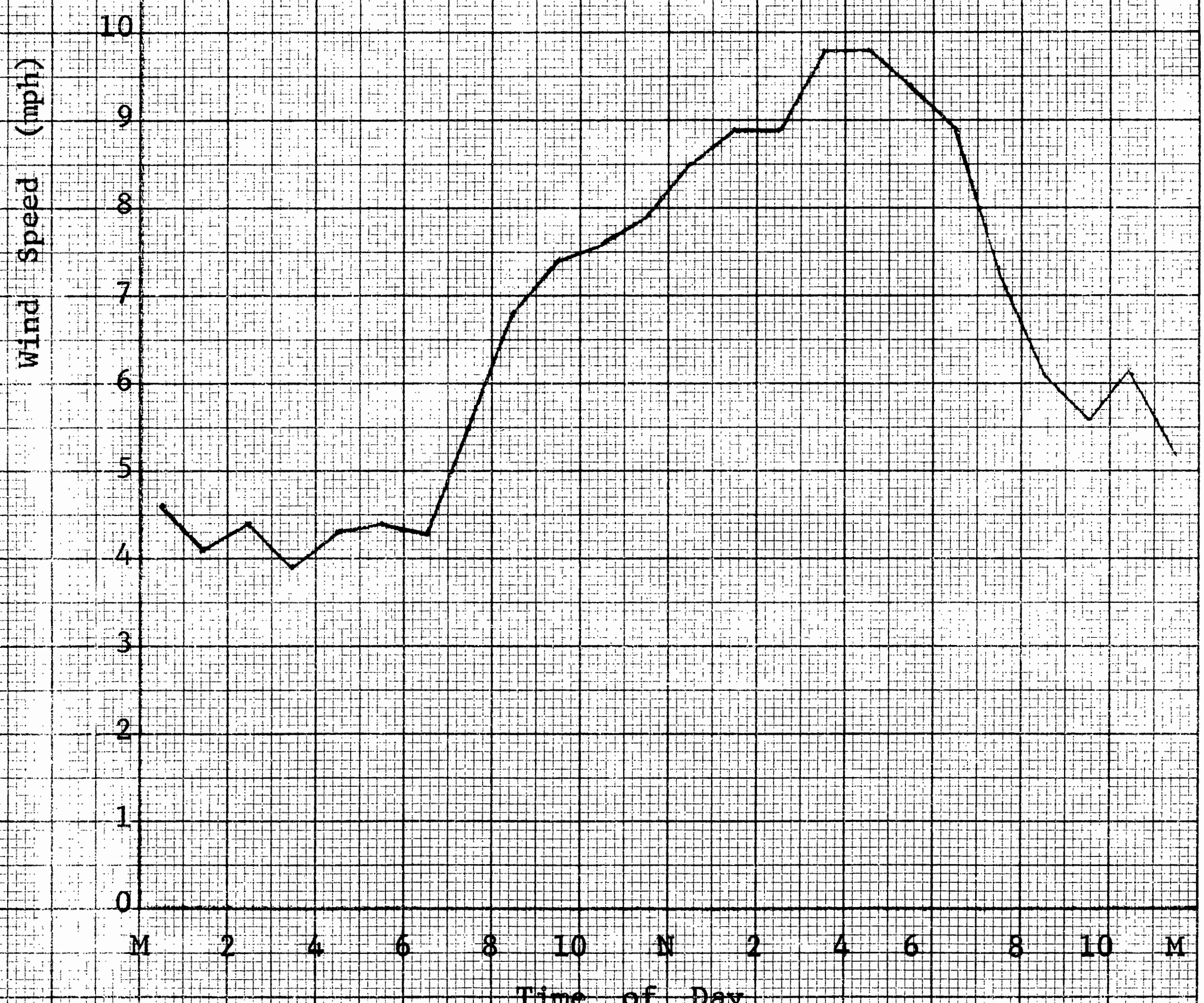


Figure 3.2-8 Diurnal Wind Speed - Music Building - Clock Time

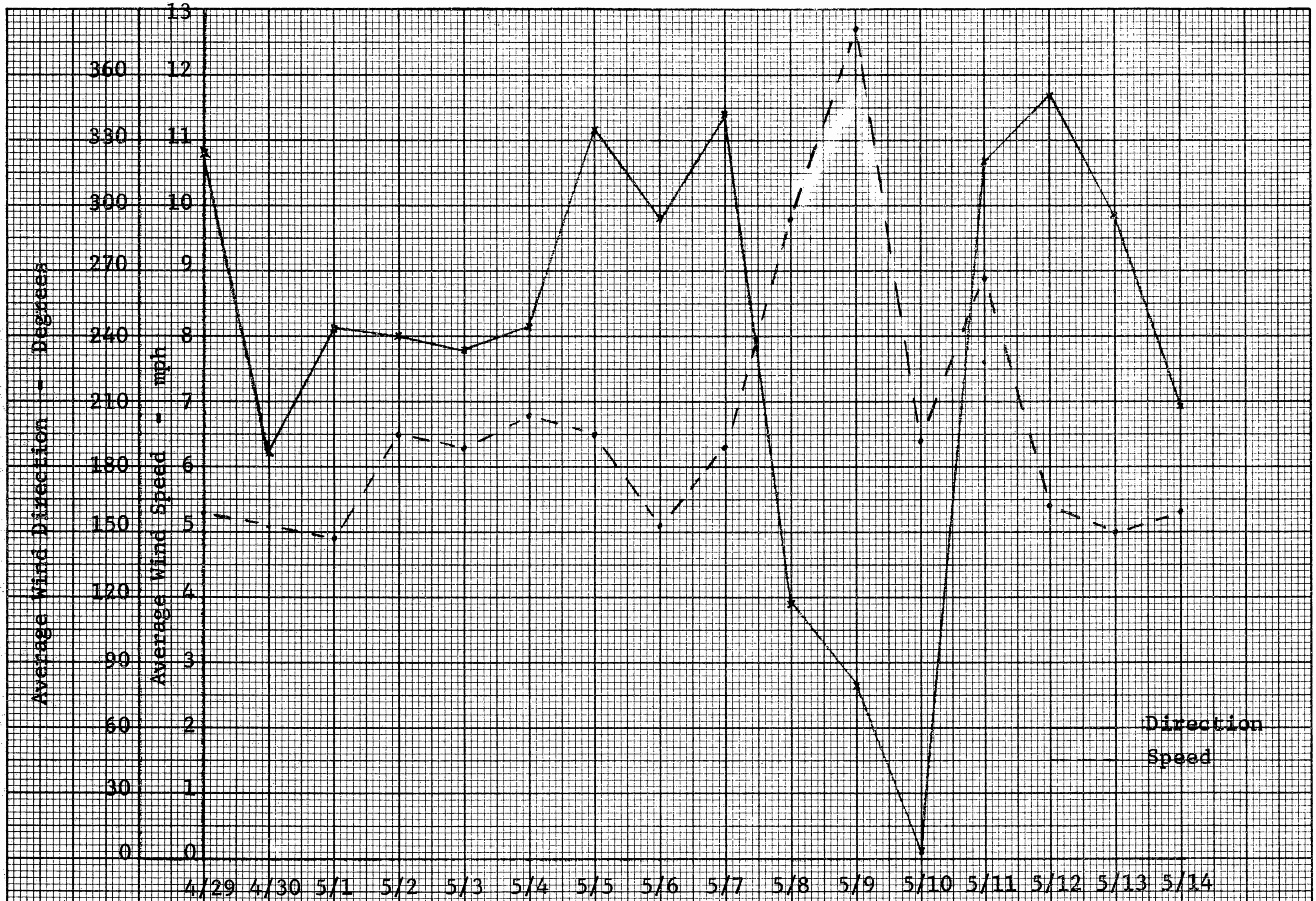


Figure 3.2-9 Daily Average Wind Direction & Wind Speed - Music Building

3.2.2 Carbon Monoxide Diurnal Characteristics

The hourly carbon monoxide concentration levels recorded at the Music Building ranged from 0 to 14 ppm as shown in Section 5.0. These limit concentrations reflect the combined effect of traffic and meteorological conditions and the location of the sampling probe. As mentioned earlier, the diurnal traffic profile is a function of the day of the week. Accordingly, the diurnal carbon monoxide profile is also a function of the time span examined. Figures 3.2-10 and 3.2-11 respectively portray the average hourly concentrations at probes A, B, C and E for the total monitoring period and for weekdays only. This data is presented on Tables 3.2-2 and 3.2-3. The significant difference between the two sets of diurnal CO profiles are lower concentrations for the weekdays only profiles, at the two Route 18 locations, Probes A & E, in the midnight to 4 AM period and a higher AM rush hour peak plus a reduction in the differential between the concentrations at Probes B & C.

Comparison with the diurnal traffic profiles shown in Figures 3.2-5 and 3.2-6 will show general correspondance between the traffic and CO sets of diurnal data. The marked difference in traffic volume during the midnight to noon hours on Saturdays and Sundays from that experienced on weekdays creates the change in the diurnal CO profiles. Diurnal variations for either the total

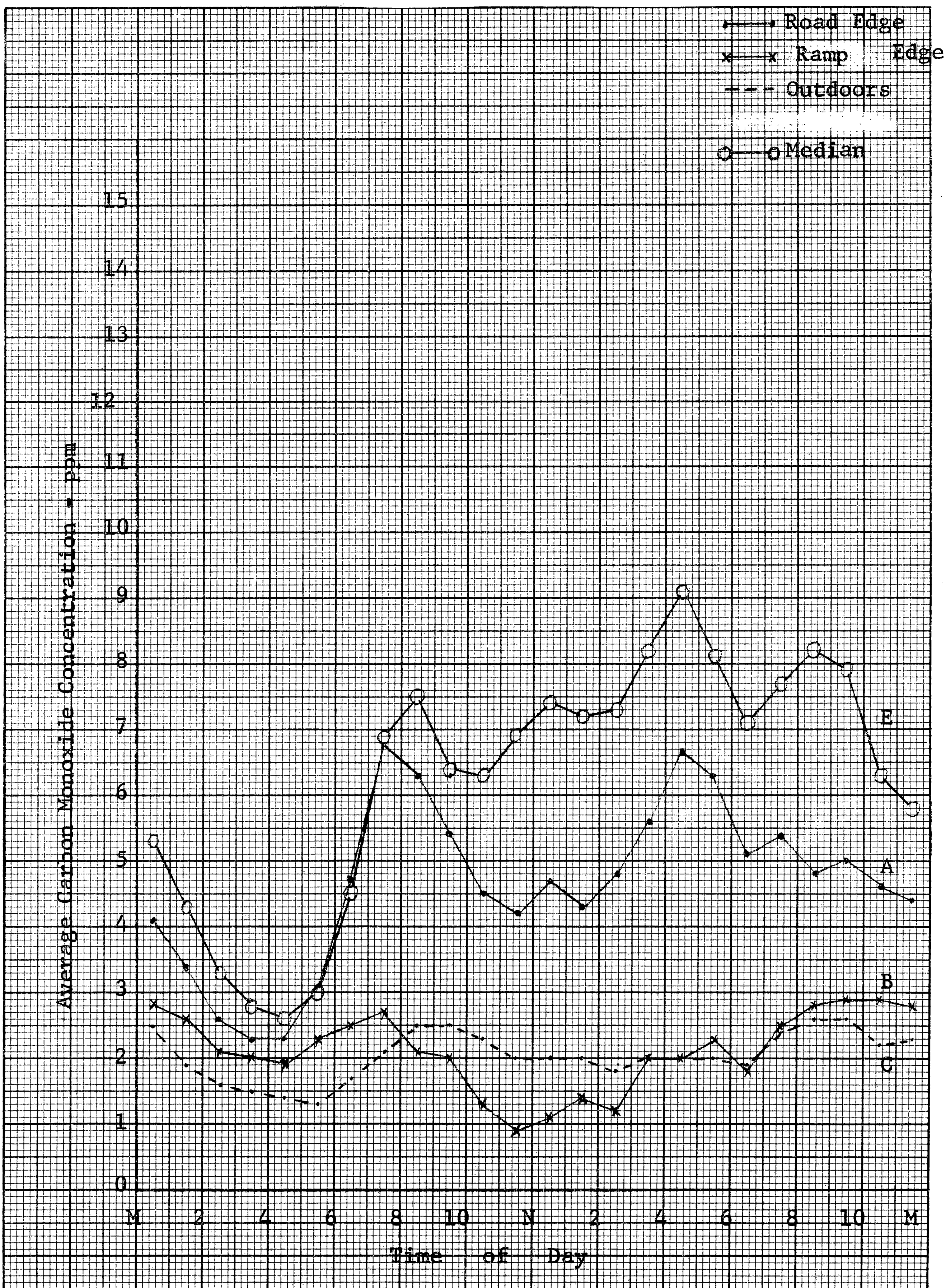


Figure 3.2-10 Diurnal CO - Total Period - Music Building

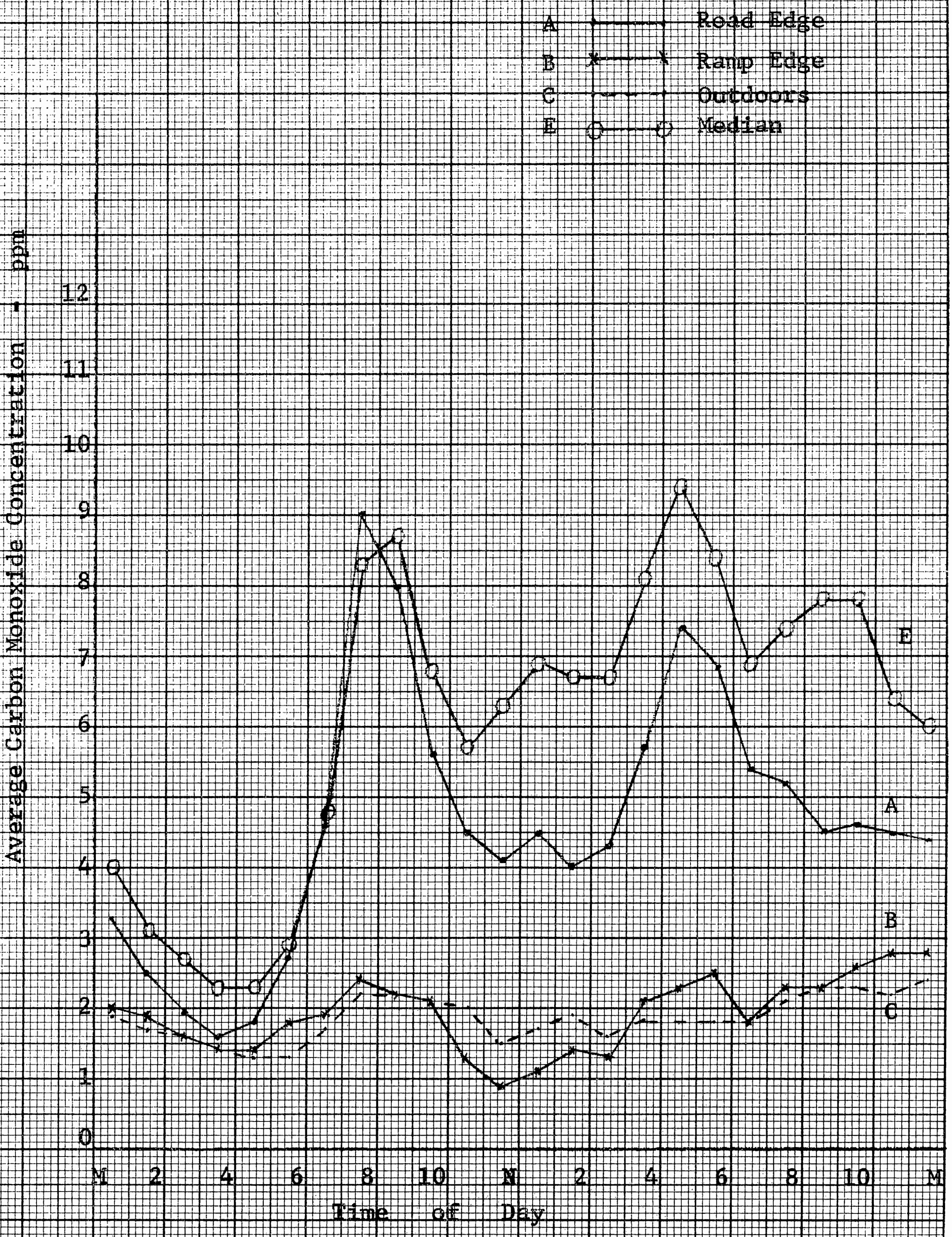


Figure 3.2-11 Diurnal CO - Weekdays only - Music Building

Table 3.2-3
CO Concentration - ppm
Music Building
Week Days Only

PROBE

HOUR	A	B	C	D	E
2400-100	3.3	2.0	1.9	2.2	4.0
100-200	2.5	1.9	1.7	2.0	3.1
200-300	1.9	1.6	1.6	1.8	2.7
300-400	1.6	1.4	1.4	1.7	2.3
400-500	1.8	1.4	1.3	1.7	2.3
500-600	2.7	1.8	1.3	1.5	2.9
600-700	4.6	1.9	1.7	1.4	4.8
700-800	9.0	2.4	2.2	1.6	8.3
800-900	8.0	2.2	2.2	2.1	8.7
900-1000	5.6	2.1	2.1	2.2	6.8
1000-1100	4.5	1.3	2.0	2.1	5.7
1100-1200	4.1	.9	1.5	1.7	6.3
1200-1300	4.5	1.1	1.7	1.8	6.9
1300-1400	4.0	1.4	1.9	2.1	6.7
1400-1500	4.3	1.3	1.6	1.7	6.7
1500-1600	5.7	2.1	1.8	1.7	8.1
1600-1700	7.4	2.3	1.8	1.8	9.4
1700-1800	6.9	2.5	1.8	1.8	8.4
1800-1900	5.4	1.8	1.8	1.8	6.9
1900-2000	5.2	2.3	2.1	1.9	7.4
2000-2100	4.5	2.3	2.3	2.1	7.8
2100-2200	4.6	2.6	2.3	2.2	7.8
2200-2300	4.5	2.8	2.2	2.2	6.4
2300-2400	4.4	2.8	2.4	2.1	6.0
AVE.	4.6	1.9	1.9	1.9	6.1

period data or the weekday only data show the two Route 18 probe locations were very similar during the early morning hours. The median strip concentration closely follows diurnal traffic conditions on the highway, except for the secondary P.M. peak about 8 PM. The road edge location, probe A, also shows correlation with traffic; but at a lower level after the morning peak. The 8 PM peak is barely noticeable at this location but is evident both at probes B & C. This suggests a high eastbound traffic flow on the ramp during the evening hours which influences the CO levels at all locations except, probe A.

While the curves for both the ramp edge probe B, and the outside probe C, show diurnal variations, it appears that Route 18 traffic is not the dominant factor which controls carbon monoxide at these two locations. The ramp edge low concentrations occured during the mid-day period rather than the usual early morning hours. This noontime minimum is not characteristic. The outdoor probe C, does not reflect the 4-5 PM peak seen at the Route 18 locations. Both of these points further suggest that ramp traffic, rather than Route 18 traffic determines the CO concentration at the Music Building.

3.2.3 Carbon Monoxide Spatial Profile

Examination of figures 3.2-1 and -2 will show that the horizontal and vertical distances between the four outdoor probes, using the median strip probe as a reference, is as follows:

	Distance from Probe E, ft		
	A	B	C
Horizontal	38	161	101
Vertical	0	+31	+50
Line of Sight	38	164	113

Figure 3.2-12 presents selected data on the carbon monoxide level at these four probe location, for the weekday only period, as a function of the line of sight distance. It will be noted that the daily average data shows no differential in concentration levels at location C and B. The midnight to 1 AM data indicates a higher concentration at location B than at location C . Only the noon to 1 AM data shows a typical curve of carbon monoxide decay with distance from source. (Examination of the diurnal CO data on Table 3.2-3 will show that the concentration at location B is lower than at probe C for only the 10 AM - 2 PM hours.) Accordingly it is felt that traffic on the George Street ramp, or other local traffic, determines the carbon monoxide level outside the Music Building for the majority of the day. It is during the midday period, when ramp traffic must be low, that Route 18 traffic generated CO is the predominant source seen at the Music Building.

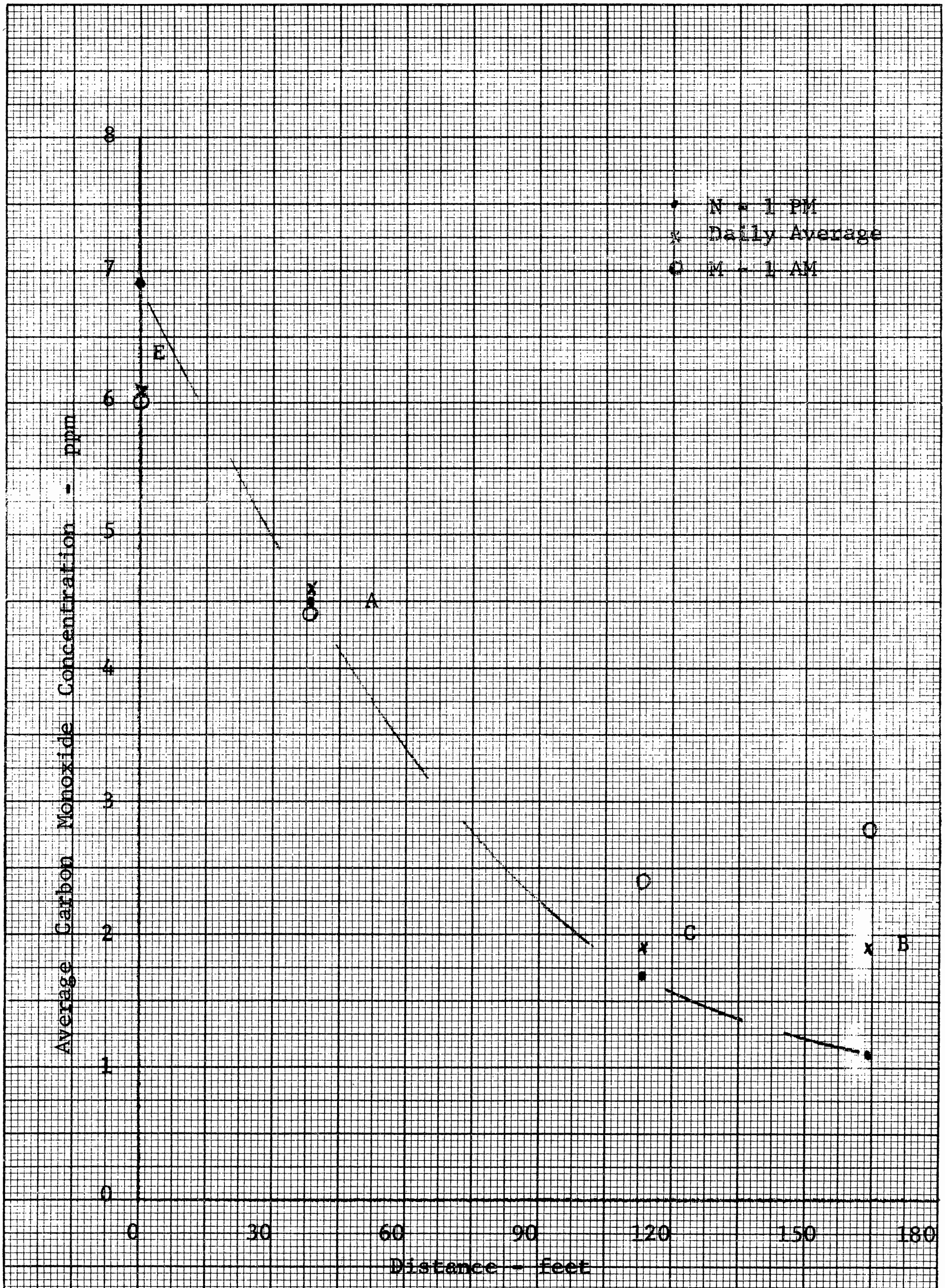


Figure 3.2-12 Carbon Monoxide Spatial Profile

3.2.4 Indoor/Outdoor Relationship

The indoor/outdoor carbon monoxide relationship was determined by probe C & D located at the Route 18 end of the Music Building. The CO levels recorded are plotted on Figure 3.2-13. The upper plot shows the average daily concentration for each day of monitoring. The lower plot portrays the average diurnal CO levels. Both plots clearly indicate that both the indoor and outdoor carbon monoxide concentrations are responsive to a common source.

Concentrations outdoors respond more rapidly to changes in the source strength than do the indoor CO levels. The diurnal curve shows a sharper decrease in the early morning hours, reaching the daily minimum about 1 hour sooner than recorded indoors. The 1 hour lag is noticeable throughout most of the day. The outdoor peak between 8 and 10 PM was less severe indoors.

The slower dissipation of indoor concentrations is evident in the daily plots. Indoor concentrations on 4/29 and 5/1 were lower than outdoors levels on those dates. The reverse is true on the succeeding days. Examination of the hourly data will show that concentrations rose more rapidly outdoors during the late evening hours than indoors on 4/29 and 5/1. Thus higher outdoor levels. These late evening outdoor levels produced higher CO levels indoors during the early morning hours on 4/30 and 5/2 which create the higher daily indoor averages for those dates.

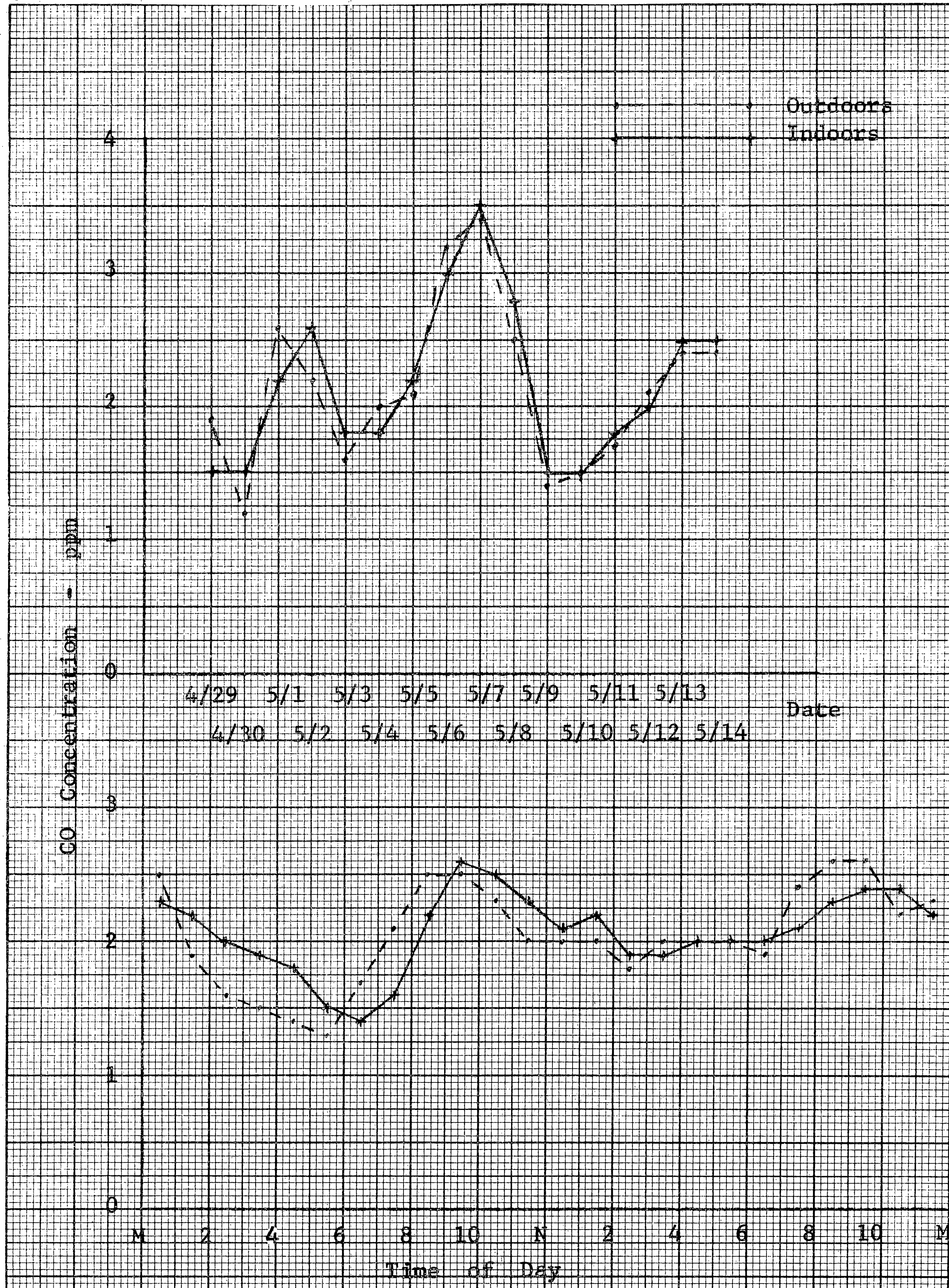


Figure 3.2-13 Indoor/Outdoor CO Relationship

3.2.5 Carbon Monoxide/Wind Relationship

The carbon monoxide concentration recorded at a given probe location is a function of the wind speed and prevailing wind direction. The daily average CO levels recorded on the median strip, Probe E, are plotted on Figure 3.2-14 as a function of the direction from which the average wind blew during the day. The four points, for the days which average hourly traffic volume was 1600 ± 40 vehicles per hour, are interconnected. CO concentrations are the lowest when the average wind blew along the highway from the east. As the wind swung away from the east, in either direction, the concentration levels increased.

Figure 3.2-15 presents the same CO data for Probe E, however, the daily winds speeds are indicated. It will be noted that, as the wind shifts from 295° towards the north and east, CO reduces. In this quadrant, higher wind speeds reduce median strip CO concentrations. The daily data for the road edge Probe A, shows a similar wind influence. This effect, however, cannot be clearly identified at the ramp edge and outside the Music Building on a day to day basis.

Examination of concentrations at Probe C during periods of high and low wind speeds shows the meteorological influence. High winds, above 10 mph, occurred on 5/5 between 1000 and 1800, from 1100 on 5/8 to 1900 on 5/9 and from 1100 to 1900 on 5/11. On 5/5 the wind blew essentially from the north, carrying Route 18 CO towards the building and CO levels were higher than average.

The wind was from 105° along Route 18 during the 5/8 thru 5/9 period and concentrations generally were lower than average. Similarly winds from approximately 300° on 5/11 also produced lower concentrations. Conversely low winds, 1 mph or less, on 4/30 from 45° produced lower than average concentrations while winds from 270° on 5/5 and 5/6 resulted in higher than average concentrations at Probe C.

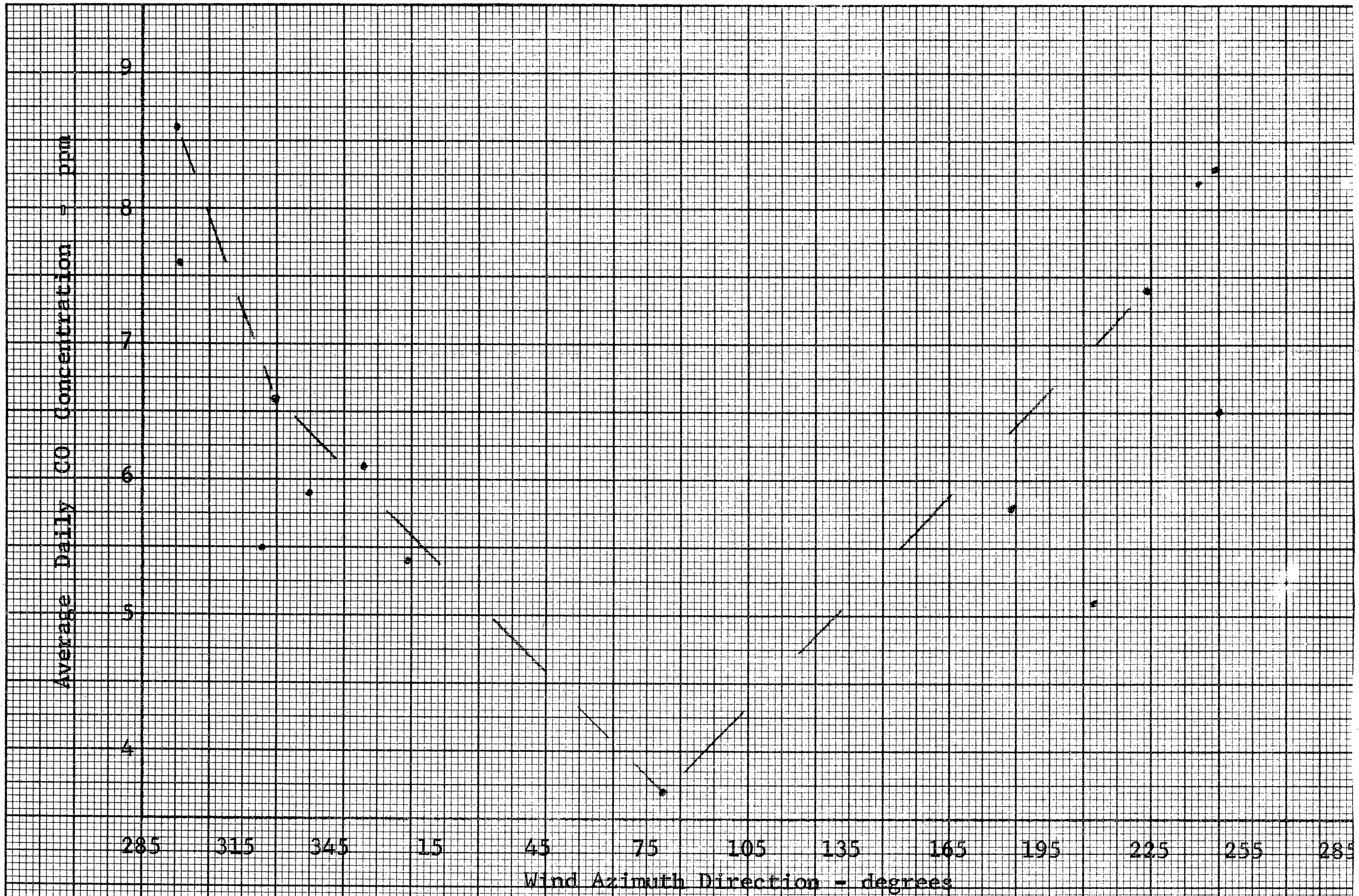


Figure 3.2-14 CO/Wind Relationship (Traffic)

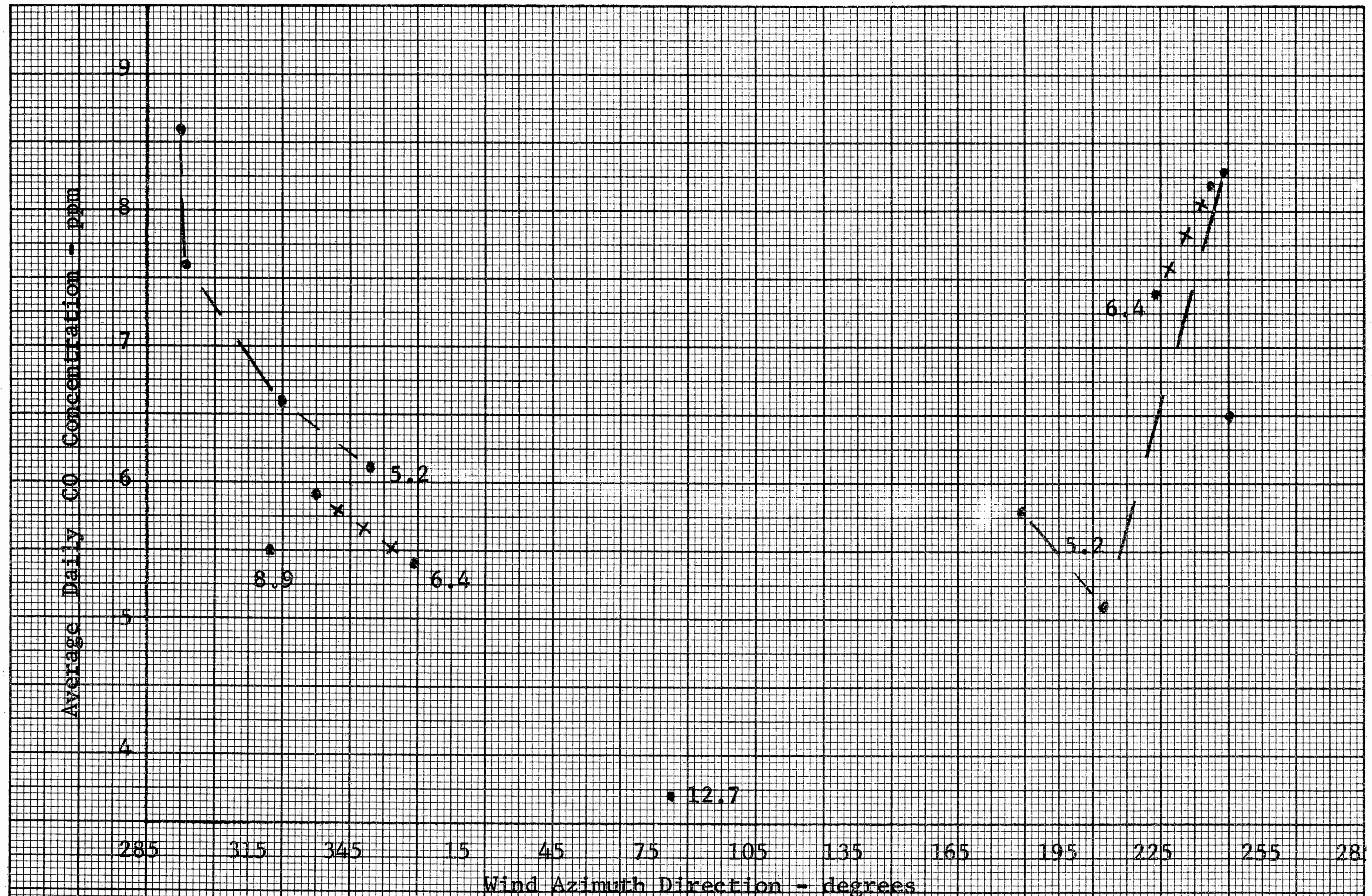


Figure 3.2-15 CO/Wind Relationship (Wind Speed)

3.2.6 Carbon Monoxide/Traffic Relationship

It was shown in paragraph 3.2.5, that meterological factors influence the concentrations recorded at a given probe location. Traffic volume on both Route 18 and the access ramp distinctly affect carbon monoxide levels at specific probes. The CO/Route 18 traffic relationships for the four outdoor probes using average hourly data for the total monitoring period are shown on figures 3.2-16 and 3.2-17. As expected, the median strip CO level is most responsive to diurnal traffic changes. The road edge CO concentrations, Probe A, also reflects Route 18 traffic volume. However, neither the ramp edge Probe B, nor the building Probe C, indicate carbon monoxide relationship with Route 18 traffic. The CO concentrations levels at location B and C are distinctly traffic related , however, as can be seen from the marked similarity of the data points below 800 vehicles per hour and between 2000 and 2400 vehicles per hour. The low traffic points for all four curves show the same hysterises effect as traffic decreases to its minimum and then increases. The 2000-2400 vehicle per hour data for all curves is the result of the typical mid-day changes in traffic volume. The diurnal characteristics of ramp traffic, which strongly influences the carbon monoxide levels at locations B and C must be appreciably different from the Route 18 diurnal traffic profile, as previously mentioned in paragraph 3.2.2.

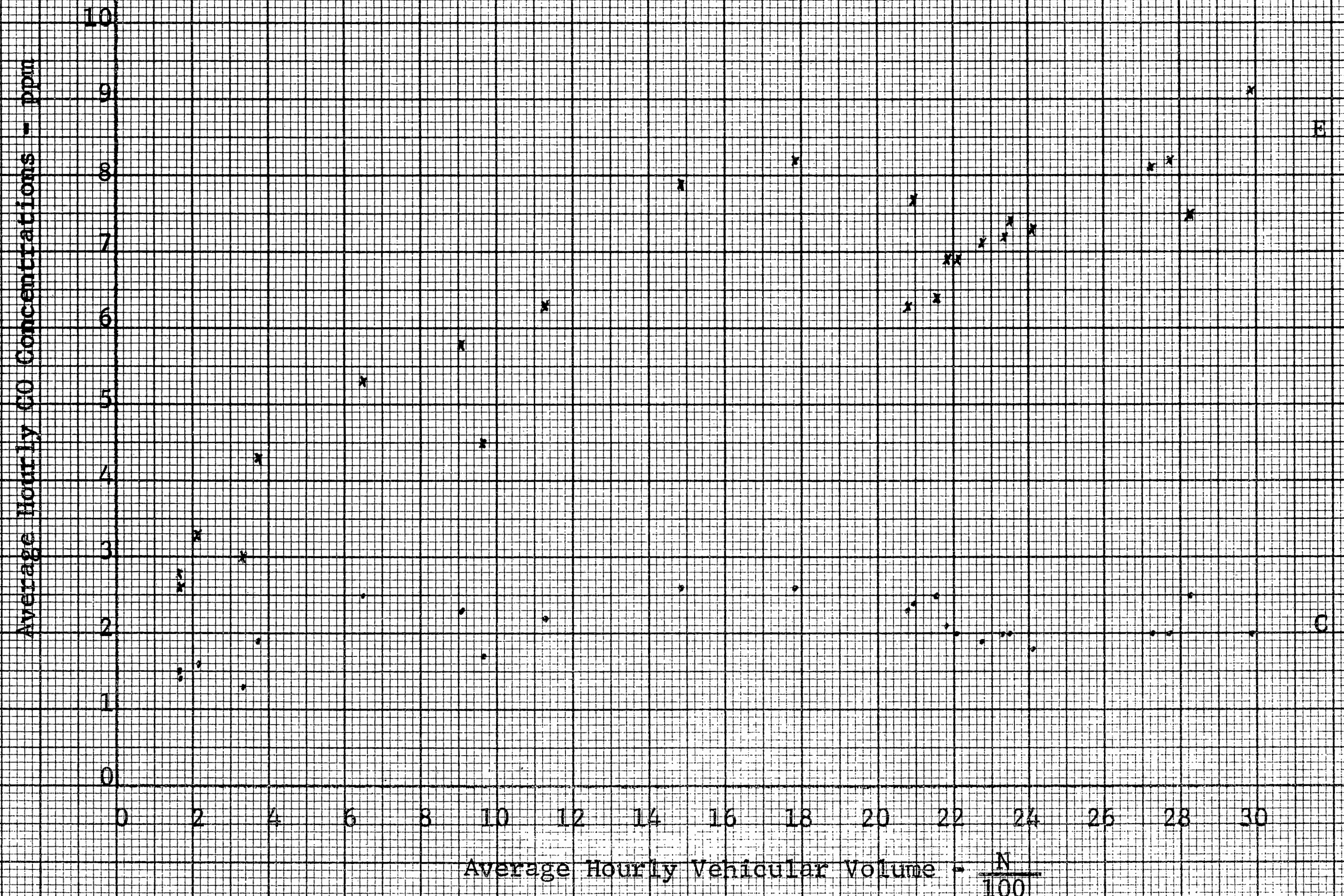


Figure 3.2-16 Diurnal CO/Traffic Relationships - Probes C and E - Music Building

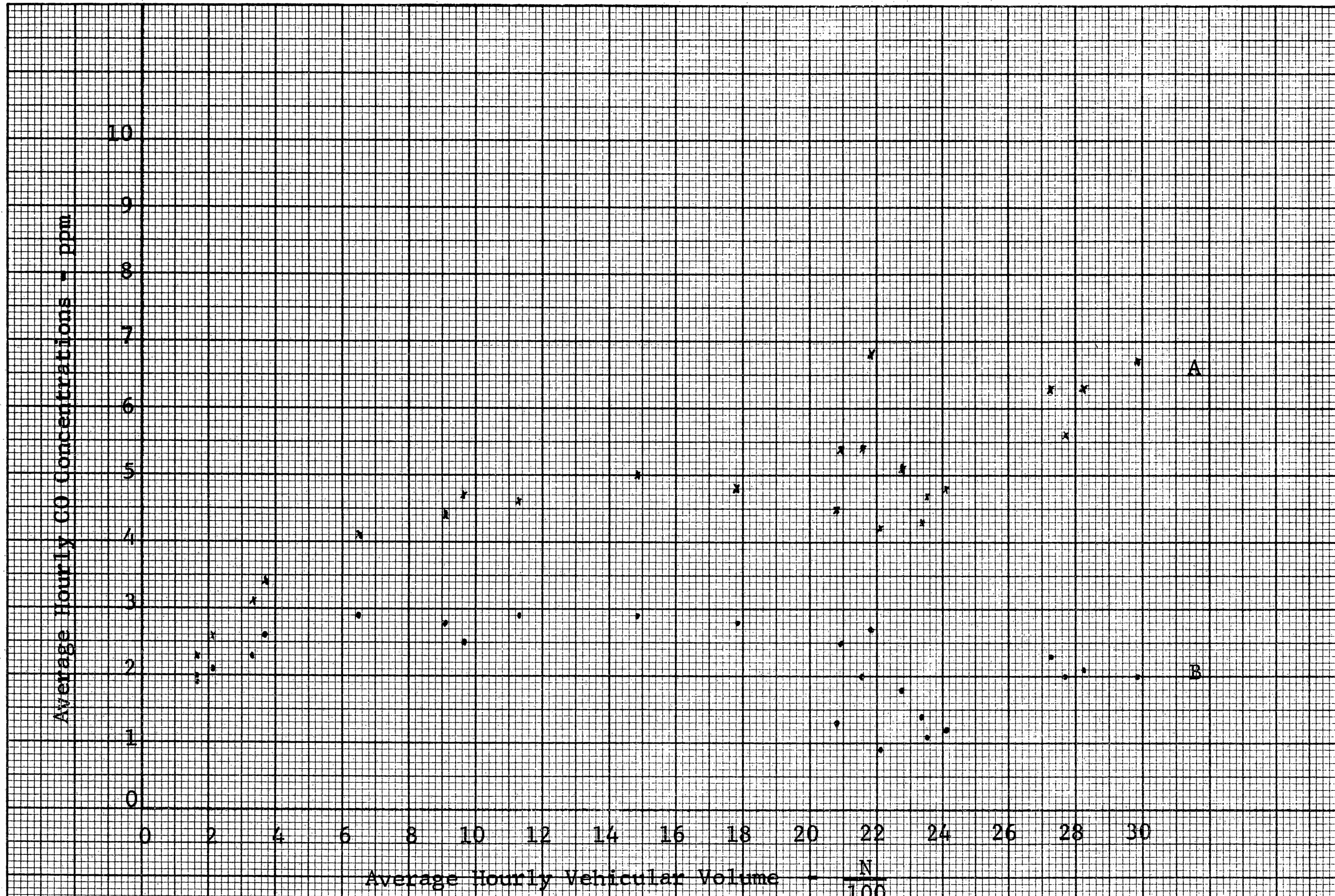


Figure 3.2-17 Diurnal CO/TRAFFIC Relationship - Probes A and B - Music Building

Vehicular pollution factors for the median strip and Music Building probe locations, E and C, were calculated, using Route 18 traffic data. (It should be recognized that the pollution factor so calculated for the Probe C location is somewhat in error due to the absence of ramp traffic data. It is felt that ramp traffic contributed to the concentrations recorded at Probe location E in a manner similar to its contribution at Probe C. Since the proposed physical configuration of Route 18 and its access ramp adjacent to the Frelinghuysen Dormitory and the test site at the Music Building are very similar, the absence of data on ramp traffic is of minor concern.) Figure 3.2-18 presents the daily average CO/traffic relationships for the median strip, Probe E, and the Music Building outside location, Probe C. The vehicle pollution factor for Probe E, as shown by the line thru its daily points, is .0038 ppm-hr/vehicle. At Probe C, it is .0012 ppm-hr/vehicle.

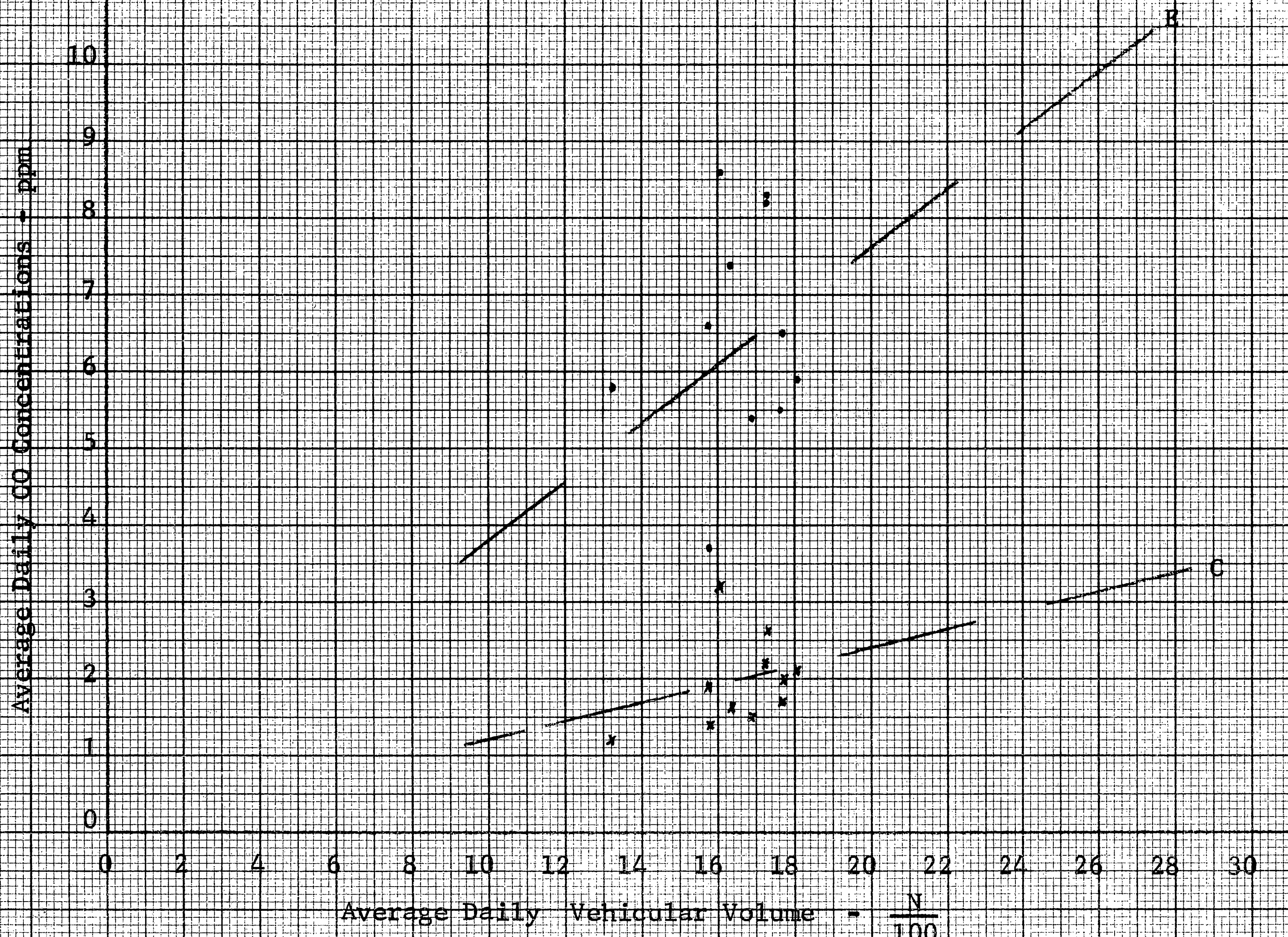


Figure 3.2-18 Daily CO/Traffic Relationships - Probes E and C - Music Building

3.3 ANTICIPATED CARBON MONOXIDE AT FRELINGHUYSEN DORMITORY

3.3.1 Traffic Conditions

The carbon monoxide level generated by traffic on the proposed section of Route 18 adjacent to the Frelinghuysen Dormitory will be dependent upon the year involved. It has been estimated that, in 1975, the daytime average hourly traffic volume will be 2700 vehicles per hour. An average daytime volume of 4300 vehicles per hour is expected in 1995.

Examination of traffic data for both George Street at Frelinghuysen and Route 18 at the Music Building shows that approximately 74% of total daily traffic occurs between 7 AM and 6 PM. Accordingly this 12 hour period is considered as "daytime" traffic. The traffic data for the two roadways also shows that the average hourly traffic volume during this daytime period is approximately 148% of that for the 24 hour day. These relationships are used to define anticipated traffic conditions on Route 18 adjacent to the Frelinghuysen Dormitory. The results are tabulated below:

Route 18 Traffic

	Music Building 1972	Frelinghuysen 1975	Frelinghuysen 1995
24 Hour Volume	39,600	43,783	69,729
24 Hour Average	1,650	1,824	2,905
12 Hour Volume	29,600	32,400	51,600
12 Hour Average	2,444	2,700	4,300

3.3.2 Undecked Roadway Configuration

The carbon monoxide/traffic relationship of the Frelinghuysen Dormitory site is assumed to be essentially the same as determined for the Route 18 Music Building site as discussed in section 3.2. Carbon monoxide on proposed Route 18 just west of the proposed George Street access ramp will be determined by traffic passing the dormitory and using the access ramp. Under typical meteorological conditions, carbon monoxide at the easterly end of the dormitory will be influenced by ramp traffic throughout the day and peak traffic conditions on Route 18.

For all practical purposes the physical dimensions of the highway/access ramp with respect to the Music Building and the proposed roadway features at the Frelinghuysen Dormitory are the same. It therefore is assumed that the undecked roadway configuration at Frelinghuysen, including the access ramp will produce the same vehicle pollution factors as determined for the Music Building. Accordingly, the anticipated average daily carbon monoxide levels (24 hour period) generated by the proposed highway on the median strip and the increase above ambient CO at the mechanical equipment room of Frelinghuysen are as tabulated below:

	Veh. Pol. Factor (ppm - hr/veh)	CO - ppm	
		1975	1995
Rte 18 Median	.0038	6.9	11.0
Mech. Room	.0012	2.2	3.5

Daytime average concentration levels due to the proposed highway/access ramp will be higher. The increase above existing ambient at the mechanical room will be 3.2 ppm in 1975 and 5.2 ppm in 1995.

3.3.3 Decked Configuration

The effect, on the anticipated carbon monoxide levels at the Frelinghuysen Dormitory from a deck cantilevered over the proposed highway was examined by mathematical modeling. The roadway configuration examined is shown in Figure 3.3-1. The deck is assumed to extend to the edge of the roadway, which is approximately 165 feet from the building face.

In performing the mathematical analysis, three basic meteorological situations were examined. These are characterized by the wind direction and include the cases of 1) wind parallel to the roadway, 2) wind perpendicular to the road and directed from the road to the building, and 3) wind blowing from the building toward and perpendicular to the road. Throughout this report these cases will be referred to by the number as designated above.

The results given below are estimates of the increased concentration (ΔC_i) of carbon monoxide at the roadside building face as a result of traffic on the decked roadway. This increase is relative to the background levels and should therefore be added to those values. The following approximate formulas have been derived for the three basic cases:

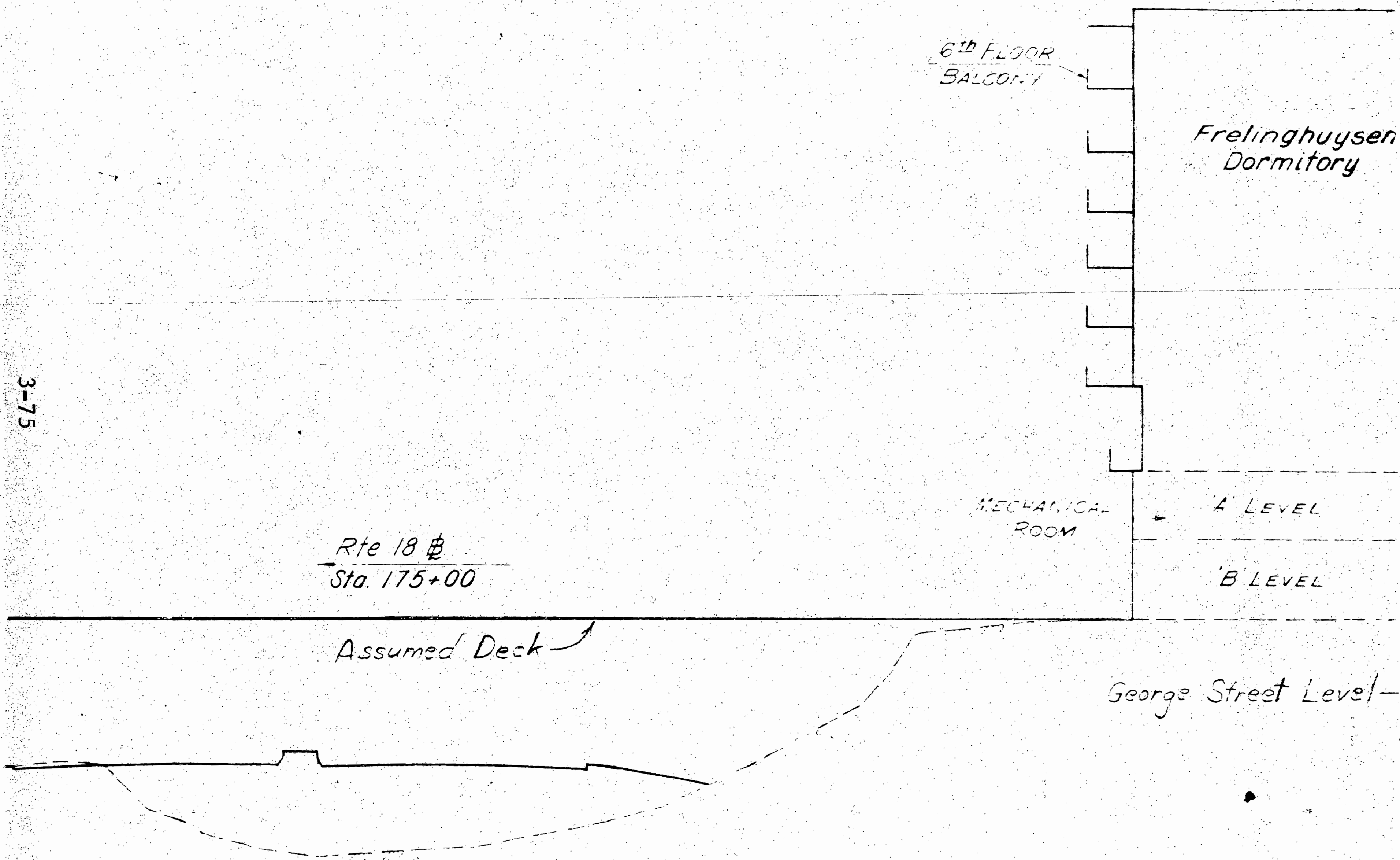


Figure 3.3-1 Decked Configuration

Case 1 (wind parallel to roadway):

$$\Delta C_1 = 0.112 \frac{M \dot{N}}{V W B_s} \quad \text{(I)}$$

Case 2 (wind blowing perpendicular to road, from road toward building):

$$\Delta C_2 = 0.112 \frac{M \dot{N}}{V (\sigma_z)_w} \quad \text{(II)}$$

Case 3 (wind blowing perpendicular to road, from building toward road):

$$\Delta C_3 = 17.7 \frac{M \dot{N}}{V s_r} \quad \text{(III)}$$

(Derivation of these equations and terminology and units used therein are provided in Section 6.0.)

Examination of the first two formulas above reveals that concentrations in cases 1 and 2 are of the same order of magnitude, with case 2 expected to be slightly higher. Specifically it is found that

$$\frac{\Delta C_1}{\Delta C_2} = \frac{(\sigma_z)_w}{W B_s} = .70 \pm .06$$

for all stability categories. Thus it is conservative to neglect case 1 and further consideration will therefore be restricted to cases 2 and 3.

To calculate concentrations for cases 2 and 3, it is necessary to specify $(\sigma_z)_w$ and s_r.

As discussed in the derivation section 6.0, the Pasquill-Gifford values are used for $(\sigma_z)_w$, i.e.

Stability Class	A	B	C	D	E
$(\sigma_z)_w$ (meters)	6.80	5.50	3.90	2.48	1.92

while s_r is assumed as:

$$s_r = 6.5 \; H_r$$

Assuming H_r = 41 meters (approximate height of Frelinghuysen Dormitory above river level) it follows that:

$$s_r = 266 \text{ meters}$$

Given values as above it is possible to calculate the concentration to source strength ratio $\frac{\Delta C_i}{M \dot{N}}$ for cases 2 and 3 according to equations (II) and (III). This was done for the above values and the results are plotted in Figures 3.3-2 and 3.3-3.

Using the curves from Figures 3.3-2 and 3.3-3 the carbon monoxide levels are readily determined for any traffic conditions as specified by the parameters M and $\dot{N}$. For purposes of estimating maximum expected impact of the decked Route - 18 configuration the following values are assumed:

$$M = .025 \frac{\text{lb}}{\text{Veh - mi}} \qquad \dot{N} = 2700 \frac{\text{Veh}}{\text{hr}}$$

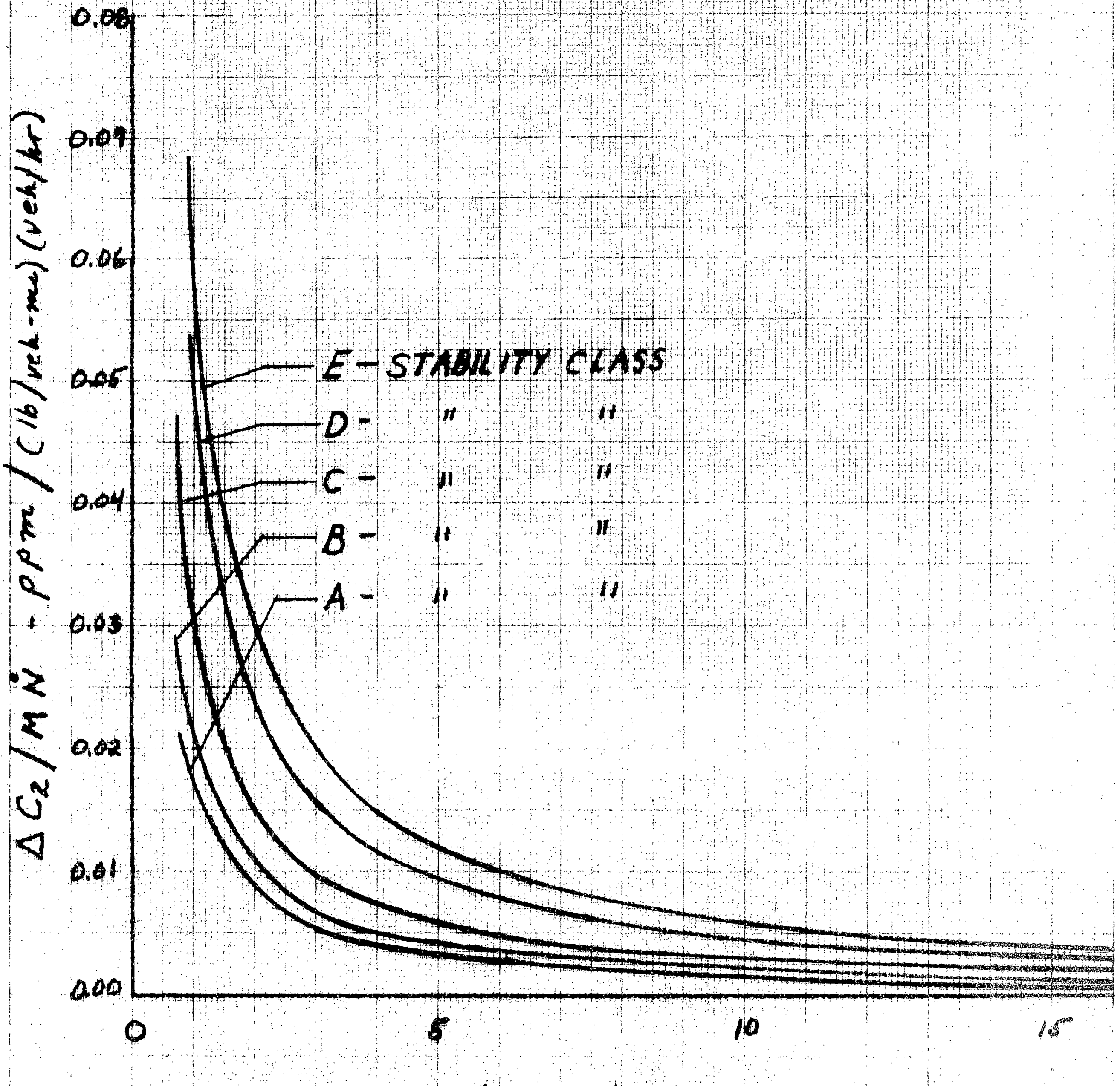


Figure 3.3-2 $\frac{\Delta C_2}{M\dot{N}}$ vs V and STABILITY CLASS

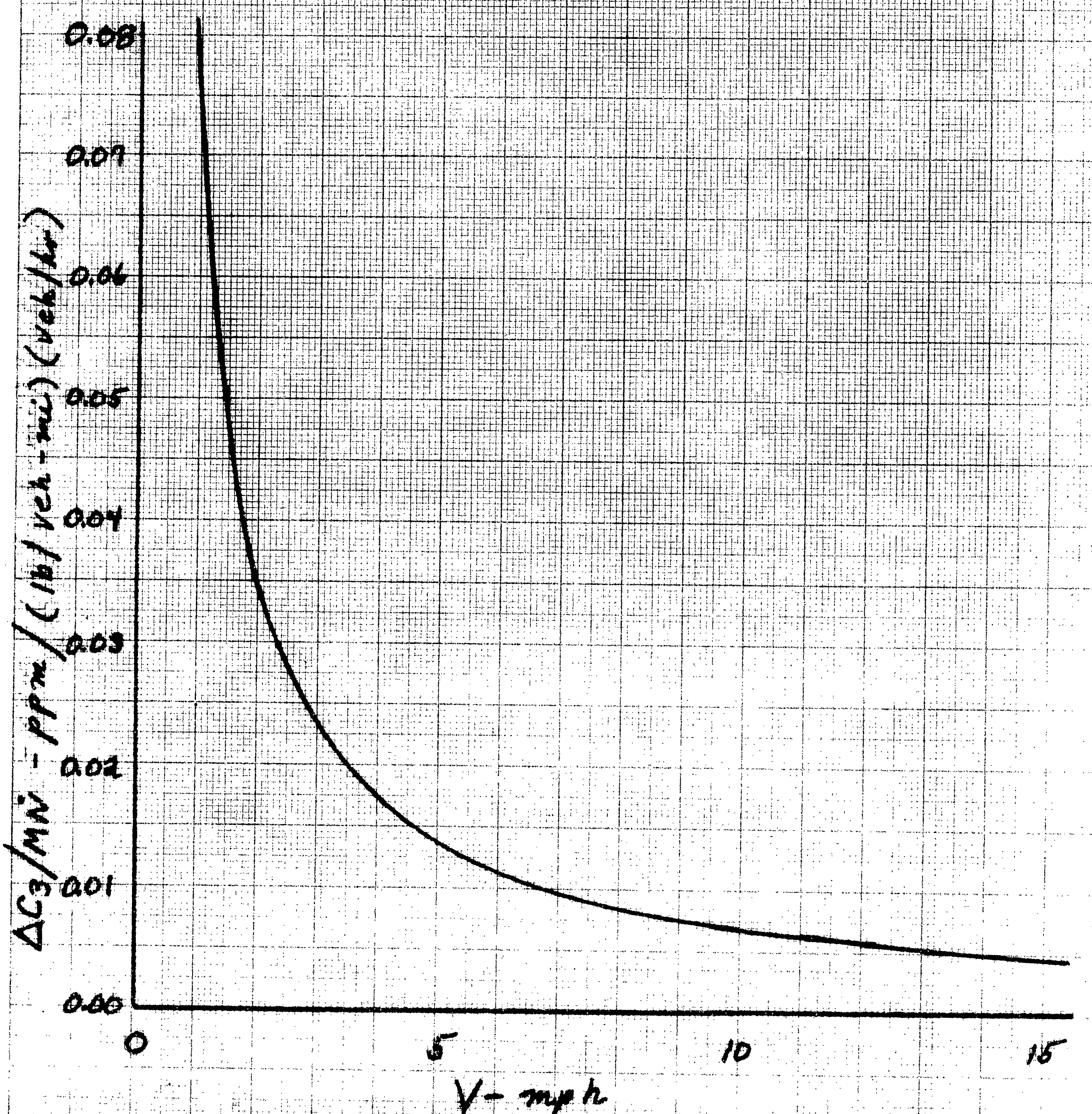


Figure 3.3-3 $\frac{\Delta C_3}{M\dot{N}}$ vs V

Based on the data of Rose, Smith, McMichael and Kruse (Reference 1) for CO exhaust from autos in Los Angeles and Cincinnati, an average value of M for automobiles traveling at 40 mph is about 0.1 (lb/veh-mi). However, these data were for pre-1965 cars and it is expected that by 1975 CO exhaust will be 75% less. Hence the value M = .025 (lb/veh-mi) is assumed here. The value for $\dot{N}$ above is based on estimated 1975 Route 18 traffic. Based on the above assumptions

$$M\dot{N} = 67.5 \frac{\text{lb}}{\text{mi - hr}}$$

It might also be pointed out that the value for M is somewhat conservative in the sense that the car/truck mix was neglected and all vehicles were assumed to emit CO as a primary pollutant.

Assuming the total pollutant generated by the traffic ($M\dot{N}$=67.5 (lb/mi-hr)) escapes from beneath the deck as a line source 165 feet from the dormitory, the impact of the decked Route 18 on the dormitory face can now be estimated from Figures 3.3-1 and 3.3-2 by simply multiplying the ordinate values by 100 to obtain the ΔC_2 or ΔC_3 in ppm for any wind and stability class. Accordingly, it is found that for all windspeeds greater than 1 mph, $\Delta C_2 < 4.1$ ppm while $\Delta C_3 < 4.8$ ppm. This can be seen mathematically be examining the corresponding equations:

$$\frac{\Delta C_2}{M\dot{N}} = \frac{.058}{V} \quad \text{(Stability Class E)}$$

and

$$\frac{\Delta C_3}{M \dot{N}} = \frac{.067}{V}$$

which for $M \dot{N}$ = 67.5 (lb/ mi-hr) become

$$\Delta C_2 = \frac{3.9}{V} \quad \text{and} \quad \Delta C_3 = \frac{4.5}{V}$$

For ΔC_2 in the above equation stability class E is considered since it is the most stable and therefore the most polluted. Hence it is possible to conclude that

$$\Delta C_i < 5 \text{ ppm} \quad \text{for} \quad V \geq 1 \text{ mph}$$

i.e. for all wind speeds of 1 mph or more the concentration increase at the dormitory will be less than 5 ppm for the maximum expected traffic rates. When the wind speed is less than 1 mph the mathematical models developed here are expected to overestimate ΔC and to be no longer appropriate. The reason for this is that at low wind speed the direction is unsteady and highly variable, thus dispersing the carbon monoxide more effectively in all directions. Rather than always blowing from the road to the building, as assumed in case 2, the wind will also carry the CO from the road to the river during part of the time and thereby cause lower pollution levels than calculated according to equation

2. At the same time the low wind speed and variable direction does not permit a well developed shear layer to occur and trap the CO in the recirculation region. Hence much lower values of ΔC_3 are expected than those based on the mathematical model of equation 3. Based on this reasoning, it is expected that impact of the decked Route 18 in 1975 will also be within safe limits for the low wind speeds less than 1 mph.

As mentioned in paragraph 3.3.1, the daytime traffic on Route 18 in 1995 is anticipated to be 4300 vehicles per hour. Using the same equations described above, the roadway pollutant level, assuming no improvement in automotive emission techniques, will be $M\dot{N}$ = 108 (lb/ mi-hr). This will result in $\Delta C_2 V$ = 6.3 ppm and a $\Delta C_3 V$ = 7.2 ppm for 1995.

4.0 INSTRUMENTATION AND CALIBRATION TECHNIQUES

4.1 Test Equipment Used

The following test equipment was used to monitor carbon monoxide levels at the two test sites under evaluation.

1 Intertech Infrared Carbon Monoxide Analyzer

Uras II - S.N. 37460681
(Intertech Corp., Princeton, N.J.)

2 Bendix Infrared Carbon Monoxide Analyzers

UNOR 5 - S.N.'s 5-0135 and 5-0137
(Bendix Process Instruments Div., Ronceverte, West Virginia)

1 Speedomax M Recorder - Mark II

(Leeds and Northrup, North Wales, Pa.)

2 Speedomax H Recorders - Model S

(Leeds and Northrup, North Wales, Pa.)

The meteorological measurements made by the contractor at the test sites were obtained by use of the following test equipment.

1 Windvane and 3 Cup Anemometer - Model #6101

(R.M. Young Company, Ann Arbor, Michigan)

1 Dual Channel Rustrak Recorder - Model #291/2156

4.2 Data Collection Procedures

4.2.1 Carbon Monoxide Data

The carbon monoxide concentrations levels and those meteorological parameters monitored at the two test sites were measured by use of a mobile air pollution laboratory. This laboratory provided the capability of sensing, measuring and recording carbon monoxide and meteorological data.

In this study, carbon monoxide was measured using an infrared analysis technique. The measuring principle of the CO analyzers makes use of the specific radiation absorption band of carbon monoxide in the infrared range. The three carbon monoxide analyzers used in this study were installed in the air pollution laboratory, along with their associated sample handling systems.

At each of the two test sites, polyethylene sampling tubes were positioned at various locations relative to the building under evaluation. (The open end of the tube at the sampling position is termed a "probe"). The sampling tubes carried ambient air from the probe locations to the control solenoid of the carbon monoxide detection systems within the air pollution laboratory. The ambient air was continuously drawn from each probe location by pumps in the sample handling systems.

The Intertech CO analyzer was used to continuously measure carbon monoxide from one sample location. Each Bendix analyzer measured CO concentrations from two sample locations. Each of the two probes connected to the Bendix instruments were alternately sampled on a five minute on, five minute off basis by solenoid valve switches controlled by a synchronous timer. A high volume gas pump was automatically connected to the sampling tubes not being sampled during each five minute cycle to assure that a fresh sample would always be available at the time of solenoid switching. Thus, in one hour, six samples of five minutes duration each were taken from each of the two probes associated with each Bendix analyzer.

Various filters, pumps, flowmeters and coolers were incorporated into each of the sample handling systems to insure proper preconditioning and flow regulation of the sample gas before detection. Water vapor, being the major interference in the carbon monoxide measuring technique, was controlled during the analysis. The Intertech system used a humidifier-condenser combination to maintain a constant water vapor in both sample and calibration gases. The Bendix instruments incorporate an optical filter to eliminate water vapor effects on the accuracy of carbon monoxide analysis.

Each analyzer was electrically connected to a strip chart recorder. Continuous records of carbon monoxide concentrations measured at each site were obtained.

Each carbon monoxide detection system was calibrated once a day (except on weekends) to insure that all measurements were taken with the highest degree of accuracy. Calibration was accomplished by introducing calibration gases of know composition into the control solenoids attached to the sampling tubes and adjusting the detection systems so that the strip chart recorder agreed with the calibration gas composition. Two calibration gases were used. "Zero" was established using high purity nitrogen while the upscale calibration point was fixed using a know carbon monoxide concentration in nitrogen mixture (25 and 42 volume ppm). During calibration zero and span gas was alternately passed through the instruments using electrically controlled solenoid valves.

It should be noted that each detection system after calibration is accurate to ± 1% of full scale, or ± 0.5 ppm. Since the indoor and outdoor probes at a given location were measured by the same analyzer, an excellent indoor/outdoor relationship is obtained. The relationship between carbon monoxide levels measured by different CO analyzers is subject to the ± 0.5 ppm variation for each instrument. Post test calibration at the contractors plant showed that the detection systems varied in an inconsistent pattern over a 24 hour period when simultaneously sampling the same external CO level. Caution should be observed, therefore, in evaluating differential concentration levels between probe locations, especially since the preponderance of data obtained is less than 5.0 ppm.

4.2.2 Meteorological Data

The windvane was used to measure horizontal wind direction while the 3 cup anemometer was used to measure the wind speed. At both test sites, the meteorological test equipment was installed on a 9' mounting arm at a location in which the general wind speed and direction could be best defined. The sensors were installed well above any portion of the buildings in order to reduce the eddy effect of the building or other nearby structures. At the Frelinghuysen dormitory the sensors were located 9' higher than the highest portion of the building. At the Music Building the sensors were positioned 9' above the roof of Gibbs Dormitory approximately 500 to 800 feet southeast of the Music Building.

The balanced vane assembly is supported on a vertical shaft which rotates in stainless steel ball bearings. The vertical shaft is coupled to a precision low torque conductive type potentiometer. Changes in azimuth angle are transmitted through the vertical shaft to the shaft of the potentiometer. With constant voltage applied to the element of the potentiometer the signal output is directly proportional to the angular position of the vane. A calibration switch in the recorder-translator electrically moves an incoming signal to correspond to the end points of the windvane potentiometer which represents the zero position and full scale position of the vane. Any discrepancy of the zero and full scale readings can be adjusted by an adjustable potentiometer.

The 3 cup anemometer is a wind speed sensor utilizing a D.C. tachometer generator whose output voltage is directly proporitional to wind speed. The instrument is self-generating and requires only the proper adjustable calibrating resistance for coupling directly to a strip chart recorder. Calibration is accomplished by removing the cup wheel and driving the shaft at a known R.P.M. by means of synchronous motor calibrating unit. The calibrating resistors are then adjusted to give the proper full scale readings on the recorder.

5.0 DATA

This section includes all carbon monoxide, meteorological and traffic data taken in conjunction with the Air Pollution Impact Study. The data is grouped by sites, i.e.

Frelinghuysen Dormitory

Music Building

Within each grouping, the data tables sequentially present:

Carbon Monoxide

Traffic

Wind Azimuth Direction

Wind Speed

In some instances data taken prior to and after the official monitoring periods has been included to provide a larger statistical data base.

Frelinghuysen Dormitory
CO Concentration

PROBE 1A

HOUR	4/17	4/18	4/19	4/20	4/21	4/22	4/23	4/24	AVE.
2400-100		.5	-	.5	1.8	3.5	.3	.5	1.2
100-200		.3	-	.8	1.8	2.8	.0	.5	1.0
200-300		.3	-	1.5	1.5	2.5	.3	.8	1.2
300-400		.3	-	.5	1.5	1.5	.3	1.0	.9
400-500		.5	-	.0	1.5	1.0	.3	.5	.6
500-600		.3	-	1.5	1.3	.5	.3	.3	.7
600-700		.5	-	1.5	1.5	.5	.3	.3	.8
700-800		.8	-	3.0	-	.8	.3	.0	1.0
800-900		-	-	4.5	-	.8	-	1.3	2.2
900-1000		1.0	-	4.8	-	1.3	.3	1.8	1.8
1000-1100		1.3	-	.8	.5	.8	-	.3	.7
1100-1200	.5	1.5	-	.8	.5	1.3	.5	1.5	.9
1200-1300	.5	.8	-	1.3	.5	1.0	.8	.8	.8
1300-1400	.5	.8	-	1.8	.8	.5	1.0	.0	.8
1400-1500	.5	1.0	-	1.5	.5	.5	1.0		.8
1500-1600	.5	1.8	1.0	2.0	-	.3	1.0		1.1
1600-1700	.8	1.3	1.0	2.3	.5	.5	1.0		1.0
1700-1800	.8	1.3	1.0	2.3	.5	.5	1.3		1.1
1800-1900	.8	1.3	1.3	1.8	.8	.8	1.5		1.2
1900-2000	.5	1.3	1.3	1.8	2.3	.8	1.5		1.4
2000-2100	.8	1.0	1.3	1.5	5.3	1.8	1.0		1.8
2100-2200	.8	1.3	1.5	1.8	1.5	1.5	1.0		1.3
2200-2300	.8	1.0	1.5	2.3	2.0	.8	.5		1.3
2300-2400	.5	-	1.0	1.8	1.3	.5	1.3		1.1
AVE.	.6	.9	1.2	1.8	1.4	1.1	.7	.7	1.1

Frelinghuysen Dormitory
CO Concentration

PROBE 1B

HOUR	4/17	4/18	4/19	4/20	4/21	4/22	4/23	4/24	AVE.
	DAY								
2400-100		.8	-	.8	1.8	2.0	.3	.8	1.1
100-200		1.5	-	.8	1.8	2.0	.3	.5	1.2
200-300		1.5	-	1.3	2.0	2.3	.3	.8	1.4
300-400		1.0	-	1.0	1.8	2.3	.3	1.0	1.2
400-500		.8	-	.3	1.5	2.5	.3	1.0	1.1
500-600		.5	-	.3	1.5	1.3	.3	.3	.7
600-700		.8	-	.8	1.5	.5	.3	.0	.7
700-800		.8	-	1.8	-	.5	.3	.0	.7
800-900		-	-	2.5	-	.5	-	1.0	1.3
900-1000		1.0	-	3.5	-	.5	.3	1.5	1.4
1000-1100		1.0	-	1.3	.5	.3	-	1.0	.8
1100-1200	1.5	1.3	-	.8	.5	.5	.5	1.0	.9
1200-1300	1.3	.8	-	.8	.5	1.0	.5	1.5	.9
1300-1400	1.5	.8	-	1.3	.8	.5	.8	1.0	1.0
1400-1500	.8	.8	-	1.0	.5	.3	1.0		.7
1500-1600	.5	1.5	.8	1.0	-	.0	1.0		.8
1600-1700	.8	1.5	1.0	1.3	.5	.3	1.0		.9
1700-1800	.8	1.3	1.0	1.5	.5	.3	1.3		1.0
1800-1900	.8	1.3	1.3	1.3	.5	.3	1.3		1.0
1900-2000	.8	1.3	1.3	1.3	1.0	1.3	1.3		1.2
2000-2100	.8	1.0	1.3	1.0	3.0	.8	1.3		1.3
2100-2200	1.3	1.0	1.3	1.5	3.3	1.3	1.0		1.5
2200-2300	2.3	1.0	1.8	1.8	2.3	.8	.5		1.5
2300-2400	1.3	-	1.3	1.8	1.8	.5	.8		1.3
AVE.	1.1	1.1	1.2	1.3	1.4	.9	.7	.8	1.1

Frelinghuysen Dormitory
CO Concentration

PROBE 2A

HOUR	DAY 4/17	4/18	4/19	4/20	4/21	4/22	4/23	4/24	AVE.
2400-100		1.5	-	.5	-	4.3	.5	1.5	1.7
100-200		1.5	-	.8	-	3.3	.5	1.8	1.6
200-300		2.0	-	1.5	-	2.3	.5	2.0	1.7
300-400		2.0	-	.8	-	1.0	.5	2.0	1.3
400-500		2.3	-	.5	-	.5	.5	1.8	1.1
500-600		2.5	-	.5	-	.3	.5	1.5	1.1
600-700		2.5	-	1.8	-	.3	.3	1.8	1.3
700-800		2.3	-	3.5	-	.3	.0	1.8	1.6
800-900		1.0	-	4.5	-	.8	.3	2.3	1.8
900-1000	1.0	.5	-	5.0	-	.8	.0	2.8	1.7
1000-1100	.5	1.0	-	2.3	-	.5	-	1.3	1.1
1100-1200	1.0	1.0	-	2.0	1.0	1.0	.5	2.8	1.3
1200-1300	1.3	.8	-	2.5	1.3	1.0	.8	2.3	1.4
1300-1400	1.0	1.3	-	1.5	1.0	.5	.8	1.5	1.1
1400-1500	1.0	1.5	-	1.5	.8	.8	1.0		1.1
1500-1600	1.3	2.0	-	1.8	.5	.8	1.0		1.2
1600-1700	1.5	1.8	-	2.3	.0	.3	1.3		1.2
1700-1800	1.3	1.3	1.8	1.8	.3	.8	1.3		1.2
1800-1900	1.0	1.0	1.8	.8	.3	1.0	1.0		1.0
1900-2000	.8	1.3	1.8	1.0	2.0	1.5	1.3		1.4
2000-2100	.8	1.0	1.3	1.5	6.0	2.0	1.0		1.9
2100-2200	.8	1.5	1.0	-	1.5	2.0	1.0		1.3
2200-2300	1.0	1.5	1.3	-	1.5	1.3	1.0		1.3
2300-2400	1.3	-	1.0	-	1.3	1.3	2.0		1.4
AVE.	1.0	1.5	1.4	1.8	1.3	1.2	.8	1.9	1.4

Frelinghuysen Dormitory
CO Concentration

PROBE 2B

HOUR	4/17	4/18	4/19	4/20	4/21	4/22	4/23	4/24	AVE.
	DAY								
2400-100		1.5	-	.8	-	2.8	.8	1.5	1.5
100-200		1.5	-	.8	-	3.0	.5	1.8	1.5
200-300		2.0	-	1.3	-	2.3	.5	2.0	1.6
300-400		2.0	-	1.0	-	1.5	.5	2.0	1.4
400-500		2.3	-	.5	-	.5	.5	2.0	1.2
500-600		2.5	-	.5	-	.3	.5	1.5	1.1
600-700		2.5	-	1.5	-	.3	.3	1.8	1.3
700-800		2.3	-	2.3	-	.3	.0	1.8	1.3
800-900		1.0	-	3.5	-	.5	.3	1.5	1.4
900-1000	1.0	.5	-	5.0	-	.8	.0	2.3	1.6
1000-1100	.5	.5	-	3.5	-	.8	-	2.0	1.5
1100-1200	1.0	.8	-	2.0	1.0	.8	.5	2.5	1.2
1200-1300	1.3	1.0	-	2.3	1.0	.8	.8	2.5	1.4
1300-1400	1.0	1.3	-	1.0	1.0	.5	.8	1.8	1.1
1400-1500	1.0	1.5	-	1.3	.8	.8	1.0		1.1
1500-1600	1.3	2.0	-	1.3	.5	.8	1.0		1.2
1600-1700	1.5	2.0	-	1.5	.0	.3	1.3		1.1
1700-1800	1.3	1.3	2.0	1.3	.3	.8	1.3		1.2
1800-1900	1.0	1.0	2.0	.5	.3	1.0	1.0		1.0
1900-2000	.8	1.3	1.8	.0	1.0	1.3	1.0		1.0
2000-2100	.8	1.0	1.3	.8	4.5	1.8	1.0		1.6
2100-2200	.8	1.3	1.0	-	3.0	1.8	1.0		1.5
2200-2300	1.0	1.5	1.0	-	1.8	1.5	1.0		1.6
2300-2400	1.3	-	1.0	-	1.0	1.3	1.5		1.2
AVE.	1.0	1.5	1.4	1.6	1.2	1.1	.7	1.9	1.3

Frelinghuysen Dormitory
CO Concentration

PROBE 3A

HOUR	4/10	4/11	4/12	4/13	4/14	4/15	4/16	4/17	AVE.
2400-100		3.8	2.5	1.8	1.8	-	-	-	2.5
100-200		4.8	2.0	1.5	.8	-	-	-	2.3
200-300		1.0	2.3	1.5	.8	-	-	-	1.4
300-400		1.0	2.0	1.5	.3	-	-	-	1.2
400-500		.5	2.0	1.5	.5	-	-	-	1.1
500-600		1.0	2.0	1.5	2.0	-	-	-	1.6
600-700		.8	2.5	1.5	.8	-	-	-	1.4
700-800		1.0	2.3	2.0	.5	-	-	-	1.5
800-900		1.3	1.8	2.5	-	-	-		1.4
900-1000	.8	-	1.0	2.5	-	-	-		1.4
1000-1100	1.0	1.0	1.0	1.0	-	-	-		1.0
1100-1200	.8	1.0	.8	2.5	.8	-	-		1.2
1200-1300	1.0	1.0	.5	2.0	.5	-	-		1.0
1300-1400	1.0	1.0	1.0	2.5	.5	-	-		1.2
1400-1500	1.5	1.0	1.0	2.8	1.0	-	-		1.5
1500-1600	1.0	.3	1.0	4.0	.8	-	-		1.4
1600-1700	.5	.5	1.8	3.3	.8	-	-		1.4
1700-1800	.3	1.0	2.3	2.3	.8	-	-		1.3
1800-1900	.5	.5	2.3	1.5	1.0	-	-		1.2
1900-2000	1.0	.5	3.5	5.0	2.0	-	-		2.4
2000-2100	1.3	.8	2.5	3.0	2.3	-	-		2.0
2100-2200	3.0	1.0	3.5	4.0	2.3	-	-		2.8
2200-2300	2.0	1.5	2.5	2.5	-	-	-		2.1
2300-2400	3.2	1.5	2.0	2.0	-	-	-		2.2
AVE.	1.3	1.2	1.9	2.3	1.1	-	-	-	1.6

Frelinghuysen Dormitory
CO Concentration

PROBE 3B

HOUR	DAY 4/10	4/11	4/12	4/13	4/14	4/15	4/16	4/17	AVE.
2400-100		4.0	2.0	1.8	2.0	-	-	-	2.5
100-200		4.5	2.3	1.5	1.3	-	-	-	2.4
200-300		1.3	2.3	1.5	.8	-	-	-	1.5
300-400		1.3	1.5	1.5	.3	-	-	-	1.2
400-500		.5	2.0	1.5	.3	-	-	-	1.1
500-600		1.0	2.0	1.5	2.0	-	-	-	1.6
600-700		.8	2.5	1.5	1.5	-	-	-	1.6
700-800		1.0	2.3	2.0	.5	-	-	-	1.5
800-900		1.5	2.0	2.3	-	-	-		1.9
900-1000	1.0	-	1.5	3.0	-	-	-		1.8
1000-1100	1.0	1.5	.8	1.0	-	-	-		1.1
1100-1200	1.0	1.0	.5	2.5	.8	-	-		1.2
1200-1300	1.5	1.0	.5	2.0	.8	-	-		1.2
1300-1400	1.5	.8	1.0	2.5	.5	-	-		1.3
1400-1500	1.8	1.0	1.0	2.8	.8	-	-		1.5
1500-1600	1.3	.3	1.3	4.0	.8	-	-		1.5
1600-1700	.8	.5	1.5	3.8	.8	-	-		1.5
1700-1800	.5	.8	2.5	3.3	1.0	-	-		1.6
1800-1900	.8	.5	2.3	1.5	1.0	-	-		1.2
1900-2000	1.8	.5	3.5	4.5	2.5	-	-		2.6
2000-2100	1.5	.8	3.5	3.5	2.3	-	-		2.3
2100-2200	3.5	1.3	3.0	4.0	2.3	-	-		2.8
2200-2300	3.0	1.5	2.5	3.0	-	-	-		2.5
2300-2400	3.3	1.5	2.0	2.0	-	-	-		2.2
AVE.	1.6	1.3	1.9	2.4	1.2	-	-	-	1.7

Frelinghuysen Dormitory
CO Concentration

PROBE 4A

HOUR	4/10	4/11	4/12	4/13	4/14	4/15	4/16	4/17	AVE.
2400-100		3.3	2.5	1.0	2.8	.8	.8	.8	1.7
100-200		4.8	2.0	.5	2.0	.8	1.0	.8	1.8
200-300		2.3	1.5	.8	1.8	.5	1.0	.5	1.2
300-400		2.5	1.5	.8	1.8	.3	.8	.3	1.1
400-500		2.8	1.3	.8	1.8	.3	.8	.3	1.2
500-600		3.0	1.5	.8	2.0	.3	1.0	.3	1.3
600-700		2.5	2.0	.8	2.0	.3	1.0	.5	1.3
700-800		2.5	2.0	1.0	1.5	.5	1.3	.8	1.4
800-900		3.5	2.3	1.5	1.3	.8	1.0		1.7
900-1000	1.3	-	1.5	2.0	-	.5	1.0		1.3
1000-1100	1.0	1.5	1.3	1.5	.5	.8	1.8		1.2
1100-1200	1.0	1.0	1.0	1.0	.5	.8	2.3		1.1
1200-1300	.5	1.3	1.0	1.3	.5	.8	2.5		1.1
1300-1400	.5	1.3	.8	1.5	.5	1.3	2.5		1.2
1400-1500	.8	1.0	.8	1.5	.5	1.3	2.3		1.2
1500-1600	.5	1.0	.8	2.5	.5	.5	1.8		1.1
1600-1700	.5	1.0	1.5	2.8	.5	1.0	1.5		1.3
1700-1800	.8	1.0	2.0	2.5	.8	1.0	1.5		1.4
1800-1900	1.0	.8	1.5	2.3	1.0	1.0	1.3		1.3
1900-2000	1.3	.8	1.5	4.0	1.3	1.0	1.0		1.6
2000-2100	2.5	.8	1.5	3.5	2.0	1.0	1.0		1.8
2100-2200	3.3	.8	1.5	3.5	1.8	1.3	.8		1.9
2200-2300	6.0	1.0	1.3	3.0	2.0	1.0	1.3		2.2
2300-2400	5.5	1.0	1.0	2.8	.8	.8	1.0		1.8
AVE.	1.7	1.8	1.5	1.8	1.3	.8	1.3	.5	1.4

Freli nghuysen Dormitory
CO Concentration

PROBE 4B

HOUR	4/10	4/11	4/12	4/13	4/14	4/15	4/16	4/17	AVE.
2400-100		4.5	1.5	1.3	3.0	.8	1.0	1.0	1.9
100-200		5.0	2.0	1.0	2.5	.8	1.0	1.0	1.9
200-300		4.3	2.0	.8	2.3	.8	1.0	.5	1.7
300-400		2.8	1.5	.8	2.0	.5	1.0	.3	1.3
400-500		2.8	1.5	.8	1.8	.3	1.0	.3	1.2
500-600		3.0	1.5	.8	2.0	.3	1.0	.3	1.3
600-700		3.0	1.8	.8	2.3	.3	1.0	.5	1.4
700-800		3.0	2.0	1.0	1.8	.5	1.3	.8	1.5
800-900		3.5	2.5	1.3	1.3	.5	1.0		1.7
900-1000	1.5	-	1.8	2.0	-	.5	1.3		1.4
1000-1100	1.0	2.3	1.5	1.8	.5	.8	1.5		1.4
1100-1200	1.0	1.8	1.3	1.0	.5	.8	2.0		1.2
1200-1300	.8	1.3	1.0	1.3	.5	1.0	2.5		1.2
1300-1400	.5	1.3	.8	1.5	.5	.8	2.5		1.1
1400-1500	.8	1.0	.8	1.5	.5	1.0	2.5		1.2
1500-1600	.5	1.0	.8	2.0	.5	1.0	2.0		1.1
1600-1700	.5	1.0	1.3	2.8	.5	.8	1.5		1.2
1700-1800	.8	1.0	1.8	3.0	.8	1.0	1.5		1.4
1800-1900	1.0	.8	1.5	2.5	.8	1.0	1.3		1.3
1900-2000	1.3	.8	1.8	3.0	1.0	1.0	1.0		1.4
2000-2100	2.0	.8	1.8	4.0	1.3	1.0	1.0		1.7
2100-2200	3.3	.8	1.5	3.5	1.5	1.5	.8		1.9
2200-2300	4.8	1.0	1.5	3.0	1.5	1.3	1.3		2.1
2300-2400	5.5	1.0	1.0	3.0	1.0	1.0	1.3		2.0
AVE.	1.7	2.1	1.5	1.9	1.3	.8	1.4	.6	1.5

Frelinghuysen Dormitory
CO Concentration

PROBE 5A

HOUR	4/10	4/11	4/12	4/13	4/14	4/15	4/16	4/17	AVE.
	DAY								
2400-100		6.5	4.5	.5	4.0	2.0	1.0	2.5	3.0
100-200		6.5	4.0	-	3.5	2.0	1.0	2.0	3.2
200-300		3.5	3.5	-	3.0	2.0	1.0	1.5	2.4
300-400		3.5	3.5	-	3.0	1.5	.5	1.5	2.3
400-500		3.5	3.5	-	3.0	1.5	.5	1.5	2.3
500-600		4.0	3.5	-	3.0	1.5	.5	1.5	2.3
600-700		4.0	4.0	-	3.0	1.5	1.0	1.5	2.5
700-800		4.0	5.0	-	2.5	1.5	1.0		2.8
800-900		4.5	5.5	3.0	2.0	2.0	1.0		3.0
900-1000		5.0	4.0	4.0	2.0	1.5	1.0		2.9
1000-1100		3.0	3.5	3.5	2.0	2.0	2.0		2.7
1100-1200	3.0	3.0	3.5	3.5	2.0	2.0	2.5		2.8
1200-1300	3.5	3.0	3.5	5.5	2.0	2.0	2.5		3.1
1300-1400	4.0	2.5	3.5	7.0	2.0	2.0	2.5		3.4
1400-1500	4.5	2.5	3.5	5.0	2.0	2.0	2.5		3.1
1500-1600	4.5	2.5	3.0	5.0	2.5	2.0	2.0		3.1
1600-1700	2.5	2.5	4.0	5.0	2.0	2.0	1.0		2.7
1700-1800	2.0	2.5	4.0	4.5	2.0	3.0	1.5		2.8
1800-1900	2.5	2.0	3.5	4.0	2.5	3.0	1.5		2.7
1900-2000	7.0	2.0	1.0	4.5	3.0	2.5	1.0		3.0
2000-2100	5.0	2.5	1.0	4.5	5.0	2.0	1.0		3.0
2100-2200	7.0	4.0	1.0	4.5	3.5	2.0	1.5		3.4
2200-2300	10.5	5.0	1.0	4.0	3.5	1.5	1.5		3.9
2300-2400	8.0	3.5	2.0	4.5	2.5	1.0	2.5		3.4
AVE.	4.9	3.6	3.3	4.3	2.7	1.9	1.4	1.7	2.9

Frelinghuysen Dormitory
CO Concentration

PROBE 5B

HOUR	DAY 4/17	4/18	4/19	4/20	4/21	4/22	4/23	4/24	AVE.
2400-100		2.0	2.5	2.5	2.5	3.0	2.0	2.5	2.4
100-200		2.0	2.0	2.0	2.5	3.0	2.0	2.5	2.3
200-300		2.0	2.0	2.5	2.5	3.5	2.0	3.0	2.5
300-400		2.0	2.0	3.0	2.0	2.5	1.5	3.0	2.3
400-500		2.5	2.0	2.5	2.5	2.0	2.0	2.5	2.3
500-600		2.5	2.0	2.0	2.5	1.5	2.0	2.0	2.1
600-700		6.0	2.0	2.0	2.5	1.0	2.0	2.0	2.5
700-800		2.0	5.0	3.0	3.0	1.0	2.0	2.5	2.7
800-900		2.0	2.0	4.5	3.0	1.0	2.0	2.5	2.4
900-1000	1.5	2.0	1.5	4.0	2.5	1.0	2.5	3.5	2.3
1000-1100	1.5	2.0	2.0	1.5	2.0	1.0	2.5	2.0	1.8
1100-1200	1.5	2.5	2.0	1.0	1.0	2.0	2.5	3.5	2.0
1200-1300	2.0	2.5	2.0	1.5	1.5	1.5	2.5	3.5	2.1
1300-1400	2.0	2.5	-	2.5	1.5	1.0	2.5	2.0	2.0
1400-1500	2.5	2.5	-	2.5	1.5	1.0	3.0		2.2
1500-1600	2.0	3.0	-	2.5	1.5	1.0	3.0		2.2
1600-1700	2.5	3.0	-	2.0	1.5	1.5	3.0		2.3
1700-1800	2.5	2.5	-	2.0	1.5	1.5	2.5		2.1
1800-1900	2.0	2.5	2.5	1.5	1.5	1.5	3.0		2.1
1900-2000	2.0	2.5	2.5	1.5	3.5	2.0	3.0		2.4
2000-2100	2.0	2.5	2.0	2.0	5.5	2.5	2.5		2.7
2100-2200	2.0	3.0	2.5	2.0	3.5	2.5	2.5		2.6
2200-2300	2.0	2.5	2.5	2.0	3.0	2.0	2.5		2.4
2300-2400	2.0	2.5	2.5	2.0	3.0	2.0	3.0		2.4
AVE.	2.0	2.5	2.3	2.3	2.4	1.8	2.4	2.6	2.3

Frelinghuysen Dormitory
Vehicular Volume
George Street - Northbound

HOUR	4/10	4/11	4/12	4/13	4/14	4/15	4/16	WEEK AVE.
	DAY							
2400-100	60	72	72	101	67	157	181	101
100-200	37	27	34	44	47	104	139	62
200-300	18	14	13	26	21	67	93	36
300-400	6	10	16	16	21	37	43	21
400-500	8	3	9	14	13	21	9	11
500-600	21	20	19	14	17	23	10	18
600-700	63	62	65	63	60	37	16	52
700-800	223	247	220	215	229	66	37	176
800-900	294	288	289	296	287	139	54	235
900-1000	279	279	253	305	240	161	96	230
1000-1100	251	257	225	258	242	188	138	222
1100-1200	287	256	250	285	261	259	221	259
1200-1300	331	350	306	338	348	298	243	316
1300-1400	281	296	312	298	350	256	263	298
1400-1500	325	310	365	342	301	287	262	313
1500-1600	364	337	355	379	366	272	268	334
1600-1700	369	403	439	421	441	346	254	381
1700-1800	472	517	540	508	509	270	220	433
1800-1900	349	382	376	342	335	255	217	322
1900-2000	307	315	385	341	283	255	249	287
2000-2100	238	239	250	264	297	270	229	255
2100-2200	254	265	264	268	281	224	160	245
2200-2300	167	200	191	224	228	200	173	197
2300-2400	114	153	127	132	200	219	109	150
TOTAL	5118	5302	5275	5494	5444	4411	3684	4949

Frelinghuysen Dormitory
Vehicular Volume
George Street - North bound

HOUR	DAY 4/17	4/18	4/19	4/20	4/21	4/22	4/23	4/24	Week AVE.	Total AVE.
2400-100	73	86	103	87	76	-	122	77	89	95
100-200	27	28	34	46	57	46	96	40	47	54
200-300	12	20	20	18	27	85	92	29	38	37
300-400	10	14	21	23	15	37	33	9	20	21
400-500	5	10	6	7	9	18	20	6	10	11
500-600	14	14	12	14	15	24	13	22	16	17
600-700	60	65	66	50	66	38	17	57	52	52
700-800	245	232	243	208	199	89	31	224	183	181
800-900	283	271	347	268	254	117	50	260	231	233
900-1000	318	253	236	315	252	148	92		230	231
1000-1100	233	254	197	230	256	174	110		207	215
1100-1200	255	281	276	266	281	255	203		259	260
1200-1300	337	352	335	342	367	322	267		331	324
1300-1400	276	248	278	269	352	254	275		278	286
1400-1500	325	309	331	324	332	274	247		306	310
1500-1600	349	343	313	313	349	293	281		320	327
1600-1700	426	416	396	408	385	304	263		371	377
1700-1800	505	516	507	453	474	276	250		425	430
1800-1900	371	390	351	355	351	192	284		327	325
1900-2000	319	364	315	343	331	166	249		298	293
2000-2100	233	257	260	290	320	174	218		250	253
2100-2200	307	261	231	262	317	181	198		251	248
2200-2300	218	208	190	241	279	152	143		204	201
2300-2400	148	132	135	133	103	158	142		136	143
TOTAL	5349	5322	5203	5265	5467	-	3696	-	4979	4924

Frelinghuysen Dormitory
Vehicular Volume
George Street - Southbound

HOUR	DAY 4/10	4/11	4/12	4/13	4/14	4/15	4/16	WEEK AVE.
2400-100	34	53	52	68	53	103	131	71
100-200	20	19	18	33	21	53	138	43
200-300	19	11	18	18	14	39	79	28
300-400	1	5	5	7	4	23	21	9
400-500	10	1	9	10	8	9	15	9
500-600	33	32	31	25	32	32	12	28
600-700	160	147	144	139	149	55	24	117
700-800	510	490	432	440	490	96	69	361
800-900	598	566	567	582	566	196	86	452
900-1000	343	383	349	422	385	277	189	335
1000-1100	296	283	266	260	299	270	214	270
1100-1200	290	274	295	316	355	332	182	292
1200-1300	334	374	338	347	382	313	200	327
1300-1400	321	341	292	326	345	315	236	311
1400-1500	339	284	284	332	370	278	228	302
1500-1600	359	430	409	386	407	264	242	357
1600-1700	399	410	401	447	441	263	228	370
1700-1800	362	348	331	374	371	232	190	315
1800-1900	390	377	335	362	364	174	43	292
1900-2000	315	317	306	368	341	276	49	282
2000-2100	169	225	197	174	236	228	26	179
2100-2200	160	149	185	157	171	147	8	140
2200-2300	105	187	135	126	153	131	47	126
2300-2400	67	88	85	92	140	106	120	100
TOTAL	5634	5794	5484	5811	6097	4212	2777	5116

Frelinghuysen Dormitory
Vehicular Volume
George Street - Southbound

HOUR	4/17	4/18	4/19	4/20	4/21	4/22	4/23	4/24	WEEK AVE.	TOTAL AVE.
2400-100	46	57	-	82	79	179	87	45	82	76
100-200	19	21	-	45	47	156	68	18	53	48
200-300	11	13	-	20	18	47	54	14	25	27
300-400	5	5	-	7	4	25	24	3	10	10
400-500	9	7	-	7	9	15	10	10	10	9
500-600	36	32	-	30	28	23	11	32	27	28
600-700	-	153	-	149	150	51	22	156	114	115
700-800	-	448	-	448	453	121	54	480	334	349
800-900	-	546	-	582	577	248	82	577	435	444
900-1000	404	389	-	413	357	286	161	391	343	339
1000-1100	290	273	258	297	293	282	193		269	270
1100-1200	267	334	268	268	308	345	208		285	289
1200-1300	341	355	334	316	356	311	227		320	323
1300-1400	320	327	271	323	349	290	225		301	306
1400-1500	347	295	337	353	353	289	203		311	307
1500-1600	396	339	352	423	450	294	266		360	358
1600-1700	377	256	432	425	429	261	270		350	360
1700-1800	372	324	325	397	386	209	260		325	320
1800-1900	368	313	350	375	362	166	225		308	300
1900-2000	337	337	335	358	304	227	245		306	294
2000-2100	191	108	223	244	280	191	159		199	189
2100-2200	169	-	190	202	222	138	154		179	158
2200-2300	141	-	156	168	201	125	122		130	138
2300-2400	106	-	119	126	201	109	95		126	112
TOTAL	-	-	-	6058	6216	4388	3425	-	5202	5169

Frelinghuysen Dormitory
Vehicular Volume
George Street - Both Directions

HOUR	day							WEEK AVE.
	4/10	4/11	4/12	4/13	4/14	4/15	4/16	
2400-100	94	125	124	169	120	260	312	172
100-200	57	46	52	77	68	157	277	105
200-300	37	25	31	44	35	106	172	64
300-400	7	15	21	23	25	60	64	31
400-500	18	4	18	24	21	30	24	20
500-600	54	52	50	39	49	55	22	46
600-700	223	209	209	202	209	92	40	169
700-800	733	737	652	655	719	162	106	538
800-900	892	854	856	878	853	335	140	687
900-1000	622	662	602	727	625	438	285	566
1000-1100	547	540	491	518	541	458	352	492
1100-1200	577	530	545	601	616	591	403	552
1200-1300	665	724	644	685	730	611	443	643
1300-1400	602	637	604	624	695	571	499	605
1400-1500	664	594	649	674	671	565	490	615
1500-1600	723	767	764	765	773	536	510	691
1600-1700	768	813	840	868	882	609	482	752
1700-1800	834	865	871	882	880	502	410	749
1800-1900	739	760	711	704	699	429	260	615
1900-2000	622	632	591	709	624	531	298	572
2000-2100	407	464	447	438	533	498	255	435
2100-2200	414	414	449	425	452	371	168	398
2200-2300	272	387	326	350	381	331	210	322
2300-2400	181	241	212	224	340	325	229	250
TOTAL	10752	11097	10759	11305	11441	8623	6451	10089

Frelinghuysen Dormitory
Vehicular Volume
George Street - Both Directions

HOUR	DAY 4/17	4/18	4/19	4/20	4/21	4/22	4/23	4/24	WEEK AVE.	TOTAL AVE.
2400-100	119	143	-	169	155	-	209	122	153	163
100-200	46	49	-	91	104	202	164	58	102	103
200-300	23	33	-	38	45	132	146	43	66	65
300-400	15	19	-	30	19	62	57	12	31	31
400-500	14	17	-	14	18	33	30	16	20	20
500-600	50	46	-	44	43	47	24	54	44	45
600-700	-	218	-	199	216	89	39	213	162	166
700-800	-	680	-	656	652	210	85	704	498	519
800-900	-	817	-	850	831	365	132	837	639	665
900-1000	722	642	-	728	609	434	253	-	565	565
1000-1100	523	527	455	527	549	456	303		477	485
1100-1200	522	615	544	534	589	600	411		545	549
1200-1300	678	707	669	658	723	633	494		652	647
1300-1400	596	575	549	592	701	544	500		580	592
1400-1500	672	604	668	677	685	563	450		617	616
1500-1600	745	682	665	736	799	587	547		680	686
1600-1700	803	672	828	833	814	565	533		721	736
1700-1800	877	840	832	850	860	485	510		751	750
1800-1900	739	703	701	730	713	358	509		636	625
1900-2000	656	701	650	701	635	393	494		604	588
2000-2100	424	365	483	534	600	365	377		450	442
2100-2200	476	-	421	464	539	319	352		429	412
2200-2300	359	-	346	409	480	277	265		356	338
2300-2400	254	-	254	259	304	267	237		263	256
TOTAL	-	-	-	11323	11683	-	7121	-	10041	10064

Frelinghuysen Dormitory
Wind Direction - Degrees
(angle wind blowing from)

HOUR	DAY 4/17	4/18	4/19	4/20	4/21	4/22	4/23	4/24
2400-100		10	270	260	0	60	30	240
100-200		10	270	270	330	90	20	270
200-300		15	280	260	330	120	0	260
300-400		285	300	270	340	120	330	300
400-500		300	270	255	315	110	330	20
500-600		315	250	255	310	105	340	10
600-700		330	270	270	330	105	350	15
700-800		340	270	225	340	105	340	10
800-900		315	290	180	350	90	330	30
900-1000		300	280	135	0	100	300	300
1000-1100		45	270	120	5	105	270	30
1100-1200		90	270	110	5	180	270	180
1200-1300		270	270	60	10	160	270	270
1300-1400		250	270	75	10	135	270	
1400-1500		270	290	80	10	120	270	
1500-1600		270	300	60	15	120	270	
1600-1700		260	270	45	15	110	270	
1700-1800	0	250	270	50	10	90	260	
1800-1900	0	240	250	50	10	80	240	
1900-2000	15	250	250	50	5	60	230	
2000-2100	15	240	270	50	30	50	225	
2100-2200	10	230	270	50	240	45	260	
2200-2300	10	240	270	40	30	45	270	
2300-2400	0	260	300	30	60	40	240	
AVE.	7	299	274	135	359	98	294	315

Frelinghuysen Dormitory
Wind Speed - MPH

HOUR	DAY 4/17	4/18	4/19	4/20	4/21	4/22	4/23	4/24	AVE.
2400-100		10	2	6	3	7	6	4	5.4
100-200		12	2	5	2	6	5	5	5.3
200-300		5	3	5	4	7	5	2	4.4
300-400		2	1	6	5	7	5	1	3.9
400-500		6	5	5	4	9	4	5	5.4
500-600		7	7	2	5	12	5	5	6.1
600-700		6	6	5	5	12	5	5	6.3
700-800		5	6	4	3	11	3	4	5.1
800-900		2	6	1	8	10	3	2	4.6
900-1000		2	7	7	9	10	4	2	5.7
1000-1100		2	8	12	10	9	5	2	6.9
1100-1200		3	10	15	11	7	5	1	7.4
1200-1300		5	10	12	9	10	6	2	7.7
1300-1400		7	10	15	9	12	7		10.0
1400-1500		8	12	18	10	14	10		12.0
1500-1600		7	10	15	10	15	10		11.2
1600-1700		10	10	15	8	15	8		11.0
1700-1800	17	9	10	13	6	15	6		10.9
1800-1900	16	9	9	12	3	10	5		9.1
1900-2000	13	8	8	15	2	9	5		8.6
2000-2100	10	7	7	12	3	9	6		7.7
2100-2200	15	6	6	11	2	9	7		8.0
2200-2300	10	5	5	6	2	9	7		6.3
2300-2400	11	4	3	4	2	7	3		4.9
AVE.	13.1	6.3	6.8	9.3	5.6	10.0	5.6	3.1	7.3

Music Building
CO Concentration - ppm
Probe A

HOUR	4/27	4/28	4/29	4/30	5/1	5/2	5/3	5/4	5/5	5/6
2400-100		5.5	5.8	6.0	-	5.0	2.5	3.5	3.5	10.0
100-200		3.8	5.3	4.0	-	4.0	2.0	2.0	2.0	8.5
200-300		-	4.8	*	-	3.0	1.5	1.5	2.0	5.5
300-400		-	4.3	4.0	-	2.5	2.0	1.0	.5	4.0
400-500		-	4.8	4.5	-	2.0	2.0	1.0	1.5	3.5
500-600		-	5.5	4.5	-	2.0	3.5	2.5	2.5	4.0
600-700		-	6.5	5.5	-	5.0	4.5	5.0	3.5	5.5
700-800		-	5.5	5.0	-	10.0	9.5	10.5	4.5	7.0
800-900		-	3.5	2.5	-	7.5	9.5	9.5	5.5	5.0
900-1000		-	-	-	7.5	6.0	-	8.5	3.5	-
1000-1100	4.0	4.0	-	-	5.0	6.0	6.5	6.5	4.0	-
1100-1200	3.3	4.3	-	-	4.5	6.0	-	7.0	3.5	-
1200-1300	2.0	4.0	-	-	4.5	6.0	6.0	4.5	-	-
1300-1400	-	-	-	-	6.0	5.5	7.0	4.0	2.5	-
1400-1500	3.0	5.0	-	-	6.0	6.8	8.5	3.5	2.5	-
1500-1600	5.0	6.0	-	-	-	10.8	11.0	4.5	2.5	-
1600-1700	11.0	-	2.0	-	-	11.3	12.5	6.0	4.5	-
1700-1800	10.3	-	3.0	-	-	10.5	12.5	3.8	5.0	-
1800-1900	7.0	5.0	2.0	-	6.5	7.5	8.5	3.3	5.0	-
1900-2000	7.5	5.0	7.0	-	8.0	6.5	8.0	4.0	5.0	-
2000-2100	5.5	5.0	7.0	-	5.5	6.0	6.5	3.5	7.0	-
2100-2200	5.5	5.5	9.0	-	4.0	7.0	6.0	4.0	6.0	-
2200-2300	6.0	6.0	7.0	-	6.0	4.0	5.0	3.5	6.0	-
2300-2400	5.5	5.5	7.0	-	6.0	2.8	4.5	3.0	9.5	-
AVE.	5.8	5.0	5.3	4.5	5.8	6.0	6.3	4.4	4.0	5.9

* Switch to Daylight Savings Time

Music Building
CO Concentration - ppm
Probe A (cont)

HOUR	5/7	5/8	5/9	5/10	5/11	5/12	5/13	5/14	5/15	Ave.
2400-100	4.0	-	2.5	1.0	3.5	3.0	5.5	2.0	3.0	4.1
100-200	4.0	-	2.5	.5	2.5	1.5	5.5	2.5	3.0	3.4
200-300	3.0	-	2.5	.5	2.0	1.5	3.5	3.0	2.5	2.6
300-400	2.5	-	2.5	.5	2.0	1.5	3.0	2.0	1.5	2.3
400-500	2.0	2.0	2.0	.5	2.0	2.5	2.5	2.0	2.0	2.3
500-600	2.0	3.0	2.5	1.0	3.5	3.5	3.0	2.0	4.0	3.1
600-700	3.0	5.0	4.0	2.5	5.0	6.0	6.0	2.5	5.0	4.7
700-800	2.5	7.5	-	6.5	8.0	7.5	5.5	4.0	8.0	6.8
800-900	-	7.0	-	-	-	-	-	3.5	9.0	6.3
900-1000	-	4.5	-	5.0	-	4.0	-	4.0		5.4
1000-1100	-	4.5	2.0	-	-	2.5	-	5.0		4.5
1100-1200	-	-	1.0	-	-	3.0	-	5.0		4.2
1200-1300	-	7.5	1.5	-	-	-	-	6.0		4.7
1300-1400	-	3.0	1.5	-	2.5	4.0	-	6.5		4.3
1400-1500	-	3.0	2.0	-	2.5	4.0	-	5.5		4.8
1500-1600	-	3.5	2.5	6.0	5.5	-	-	4.5		5.6
1600-1700	-	4.5	3.0	8.0	6.0	-	-	4.5		6.7
1700-1800	-	4.5	2.5	8.0	5.0	-	-	4.5		6.3
1800-1900	-	3.5	2.5	6.5	4.5	-	-	5.0		5.1
1900-2000	-	2.5	2.0	5.0	4.0	-	-	5.5		5.4
2000-2100	-	1.5	1.5	5.5	4.0	3.0	-	6.0		4.8
2100-2200	-	2.0	2.5	5.5	3.0	4.0	-	6.0		5.0
2200-2300	-	2.0	2.5	6.0	2.0	5.0	-	3.5		4.6
2300-2400	-	2.5	2.0	4.0	2.0	5.5	2.0	3.5		4.4
AVE.	3.0	3.9	2.3	4.0	3.7	3.6	4.1	4.1	4.2	4.6

Music Building
CO Concentration - ppm
Probe B

HOUR	4/27	4/28	4/29	4/30	5/1	5/2	5/3	5/4	5/5	5/6
2400-100		4.0	4.3	4.0	-	4.0	1.0	.8	2.0	9.5
100-200		3.8	4.3	3.5	-	3.5	.8	1.0	1.5	8.5
200-300		-	4.3	*	-	3.0	1.0	.5	1.5	5.0
300-400		-	4.3	3.5	-	2.5	1.3	.5	.5	3.5
400-500		-	3.8	4.0	-	1.5	1.5	.3	1.0	3.0
500-600		-	5.0	4.0	-	1.0	2.0	1.0	1.0	3.5
600-700		-	5.0	5.0	-	1.0	.5	2.0	1.0	4.0
700-800		-	2.0	4.0	-	1.5	.5	4.0	.5	5.5
800-900		-	.5	1.5	-	1.0	1.0	2.5	2.5	4.0
900-1000		-	-	-	2.5	1.5	-	2.0	1.5	-
1000-1100	2.0	2.0	-	-	.8	.5	.5	1.0	1.5	-
1100-1200	1.0	.8	-	-	1.0	.5	-	1.0	1.0	-
1200-1300	.8	.5	-	-	1.5	1.0	1.0	1.0	-	-
1300-1400	-	-	-	-	1.5	.5	2.0	2.0	2.5	-
1400-1500	1.0	.5	-	-	1.5	.8	2.5	1.5	2.5	-
1500-1600	3.0	1.5	-	-	-	2.8	2.0	2.0	2.5	-
1600-1700	3.5	-	.5	-	-	2.3	2.5	2.0	4.5	-
1700-1800	4.0	-	1.0	-	-	1.5	2.5	1.8	5.0	-
1800-1900	3.0	1.5	1.0	-	1.0	1.5	1.5	1.3	5.0	-
1900-2000	5.0	2.0	5.5	-	5.0	2.5	1.0	1.0	5.0	-
2000-2100	4.0	2.0	5.5	-	3.5	2.0	2.0	.5	7.0	-
2100-2200	4.0	2.5	7.5	-	1.5	3.0	2.0	1.5	6.0	-
2200-2300	4.0	3.5	4.5	-	4.5	1.0	1.5	1.5	6.0	-
2300-2400	3.5	4.5	3.5	-	4.5	.3	1.0	2.5	8.0	-
AVE.	3.0	2.2	3.8	3.7	2.4	1.7	1.4	1.5	3.0	5.2

* Switch to Daylight Savings Time

Music Building
CO Concentration - ppm
Probe B (cont)

HOUR	5/7	5/8	5/9	5/10	5/11	5/12	5/13	5/14	5/15	AVE.
2400-100	1.0	-	2.0	.5	2.5	1.0	4.5	1.5	2.0	2.8
100-200	1.5	-	2.5	.5	2.0	1.0	4.0	1.5	2.0	2.6
200-300	1.5	-	2.5	.5	2.0	1.5	2.5	1.5	1.5	2.1
300-400	1.5	-	2.5	.5	2.0	1.5	2.5	1.5	1.5	2.0
400-500	1.5	1.5	2.0	.5	2.0	2.0	2.5	1.5	1.5	1.9
500-600	1.5	2.0	2.5	.5	3.0	3.0	2.5	2.0	1.5	2.3
600-700	1.5	2.5	3.0	1.0	2.5	3.0	3.5	2.0	2.0	2.5
700-800	1.0	4.5	-	2.5	2.0	4.0	4.0	2.0	2.0	2.7
800-900	-	4.0	-	-	-	-	-	1.5	2.0	2.1
900-1000	-	3.5	-	1.5	-	2.0	-	1.5		2.0
1000-1100	-	2.0	1.5	-	-	1.0	-	1.0		1.3
1100-1200	-	-	.5	-	-	1.0	-	1.0		.9
1200-1300	-	2.5	1.0	-	-	-	-	1.0		1.1
1300-1400	-	1.5	1.0	-	.5	1.5	-	1.0		1.4
1400-1500	-	1.5	1.0	-	.5	.5	-	1.0		1.2
1500-1600	-	2.0	1.5	3.0	.5	-	-	1.0		2.0
1600-1700	-	2.0	1.5	1.5	1.0	-	-	1.0		2.0
1700-1800	-	2.5	1.5	3.0	.5	-	-	1.5		2.3
1800-1900	-	2.0	1.0	2.0	.5	-	-	1.5		1.8
1900-2000	-	1.5	1.0	1.5	0	-	-	1.5		2.5
2000-2100	-	1.0	1.0	2.5	.5	2.0	-	2.5		2.8
2100-2200	-	.5	1.0	4.0	2.0	3.0	-	2.5		2.9
2200-2300	-	1.5	1.0	4.5	1.0	3.5	-	2.0		2.9
2300-2400	-	2.0	.5	2.5	.5	3.5	-	2.0		2.8
AVE.	1.4	2.1	1.5	1.8	1.3	2.1	3.3	1.5	1.8	2.1

Music Building
CO Concentration - ppm
Probe C

HOUR	4/27	4/28	4/29	4/30	5/1	5/2	5/3	5/4	5/5	5/6
2400-100		.3	2.3	1.8	1.0	5.0	1.0	1.5	3.3	7.3
100-200		0	2.0	1.3	.8	4.0	1.0	1.5	2.0	4.2
200-300		0	2.0	*	.8	3.5	1.0	1.3	2.5	.5
300-400		0	1.8	1.0	.8	3.0	1.0	1.0	1.3	-
400-500		0	1.3	1.3	.8	2.5	1.0	1.0	1.0	-
500-600		0	1.5	.8	.8	1.5	1.0	1.3	1.0	-
600-700		.5	1.8	.8	1.8	1.5	1.3	2.3	1.0	-
700-800		1.8	1.5	1.5	2.3	1.5	1.8	3.5	1.3	1.4
800-900		-	2.3	1.5	-	1.3	1.3	3.5	3.5	2.6
900-1000		1.0	2.3	2.0	3.0	1.5	1.5	2.8	2.3	4.3
1000-1100	.8	1.0	1.8	2.3	2.3	2.0	1.3	2.5	2.0	4.9
1100-1200	.8	1.0	1.0	1.5	1.8	1.3	1.3	1.5	2.3	4.3
1200-1300	1.3	1.3	1.0	1.3	2.0	1.5	1.5	1.5	2.5	3.6
1300-1400	-	1.5	.3	.8	2.0	1.5	2.0	2.3	1.7	3.7
1400-1500	.8	1.3	.5	.8	2.8	1.5	2.0	1.5	2.0	3.7
1500-1600	1.0	1.5	.5	.5	-	2.0	2.3	2.3	2.6	3.2
1600-1700	1.0	-	.8	.5	-	1.8	-	2.0	2.5	2.9
1700-1800	.8	-	1.0	.5	-	2.0	2.8	2.0	1.7	2.7
1800-1900	1.3	.8	1.3	.5	2.8	2.3	2.5	1.8	1.0	2.7
1900-2000	1.8	1.0	4.0	1.0	6.0	2.3	2.0	2.0	1.7	2.7
2000-2100	1.0	.8	4.3	1.3	5.8	4.0	2.0	2.3	2.0	2.6
2100-2200	.8	1.0	5.5	1.5	3.0	3.8	1.5	2.5	2.3	2.6
2200-2300	.3	2.3	2.0	1.3	6.0	1.3	1.3	2.3	2.6	2.3
2300-2400	.3	2.8	2.0	1.0	5.5	1.0	1.5	2.8	4.7	2.4
AVE.	.9	.9	1.9	1.2	2.6	2.2	1.6	2.0	2.1	3.2

* Switch to Daylight Savings Time

Music Building
CO Concentration - ppm
Probe C (Cont.)

HOUR	5/7	5/8	5/9	5/10	5/11	5/12	5/13	5/14	5/15	AVE.
2400-100	2.3	2.6	-	.9	2.0	1.9	4.5	2.2	1.9	2.5
100-200	2.0	2.5	-	.5	2.0	2.0	3.0	2.1	1.9	1.9
200-300	2.0	2.4	1.0	.7	1.9	1.9	1.7	2.1	2.0	1.6
300-400	2.0	2.2	1.1	.9	-	1.9	1.2	2.0	2.0	1.5
400-500	2.0	2.2	1.0	.9	-	1.9	.9	1.9	1.9	1.4
500-600	1.9	2.2	1.0	1.0	-	1.9	.4	1.9	2.2	1.3
600-700	2.0	3.0	1.4	1.5	-	1.5	2.0	2.0	2.6	1.7
700-800	2.5	3.0	2.0	2.0	-	2.3	3.0	2.0	3.0	2.1
800-900	3.5	2.7	1.9	1.7	1.2	2.1	5.6	1.9	3.0	2.5
900-1000	4.5	2.8	2.5	1.0	1.5	1.9	4.5	2.0	3.1	2.5
1000-1100	4.5	3.5	2.0	1.0	1.9	1.6	3.0	2.4	3.6	2.3
1100-1200	4.5	-	1.8	-	1.5	1.8	2.6	2.6		2.0
1200-1300	4.5	2.6	1.3	1.6	1.2	2.5	2.6	2.6		2.0
1300-1400	4.2	3.0	0.8	1.9	1.2	2.5	2.5	2.7		2.0
1400-1500	3.7	2.0	0.8	1.5	.9	1.5	2.7	2.7		1.8
1500-1600	4.5	2.4	1.5	2.0	1.0	1.3	2.4	2.7		2.0
1600-1700	4.2	2.3	1.5	2.0	1.9	1.5	2.4	3.0		2.0
1700-1800	4.0	2.0	1.5	2.0	1.9	1.5	2.0	3.0		2.0
1800-1900	4.0	1.5	1.4	2.0	2.0	1.7	1.7	3.0		1.9
1900-2000	4.2	-	1.3	1.5	2.0	2.0	1.7	3.0		2.4
2000-2100	5.0	-	1.3	1.7	2.1	2.6	1.9	3.1		2.6
2100-2200	3.7	-	1.3	2.5	3.2	3.5	1.9	3.0		2.6
2200-2300	3.5	-	1.4	2.1	1.9	3.1	1.9	2.1		2.2
2300-2400	3.0	-	1.0	1.5	1.9	3.0	2.3	2.1		2.3
AVE.	3.4	2.5	1.4	1.5	1.7	2.1	2.4	2.4	2.5	2.0

Music Building
CO Concentration - ppm
Probe D

HOUR	4/27	4/28	4/29	4/30	5/1	5/2	5/3	5/4	5/5	5/6
2400-100		.8	1.5	2.8	1.3	4.0	2.0	1.5	2.0	3.0
100-200		.5	1.8	2.3	1.0	4.0	1.8	1.5	2.3	3.5
200-300		.3	1.8	*	1.0	4.3	1.5	1.5	2.3	3.5
300-400		.3	1.8	2.0	.8	4.3	1.5	1.3	2.3	2.6
400-500		.3	1.8	1.8	.8	4.3	1.3	1.3	2.3	2.3
500-600		.3	1.5	1.5	.8	3.8	1.0	1.0	2.0	1.1
600-700		.5	1.5	1.3	.5	3.0	1.0	1.3	1.8	.4
700-800		.8	2.0	1.3	.8	2.8	1.3	1.3	1.5	.6
800-900		-	2.8	2.0	-	1.8	1.3	2.5	2.3	1.8
900-1000		1.0	2.8	2.5	2.5	1.8	1.3	2.8	2.8	4.2
1000-1100	.5	.8	2.0	2.5	2.8	2.0	1.3	2.5	2.5	5.2
1100-1200	.5	1.0	1.5	2.0	2.3	1.8	1.3	2.0	2.8	4.7
1200-1300	1.0	1.3	1.0	1.3	2.0	1.8	1.5	1.5	2.5	4.0
1300-1400	-	1.5	.3	1.0	2.3	1.8	2.3	1.8	2.3	3.2
1400-1500	.8	1.3	.3	.8	2.3	1.5	2.3	2.0	2.5	3.6
1500-1600	.8	1.3	.3	.5	-	1.8	2.0	2.0	2.5	3.2
1600-1700	1.0	-	.3	.8	-	1.8	-	2.0	2.5	3.4
1700-1800	1.0	-	.8	.8	-	1.8	2.5	2.0	1.5	3.2
1800-1900	1.0	.8	1.0	1.0	2.8	2.0	2.5	2.0	1.5	3.2
1900-2000	1.3	.8	1.3	1.0	3.5	2.0	2.5	2.0	1.2	3.2
2000-2100	1.3	.8	1.5	1.3	4.8	2.5	2.5	2.0	1.5	3.1
2100-2200	1.3	.8	2.0	1.5	4.3	3.0	2.0	2.0	2.3	2.9
2200-2300	1.0	1.3	2.5	1.5	3.3	3.0	2.0	2.3	2.5	2.6
2300-2400	1.0	1.3	2.8	1.3	3.5	2.3	1.8	2.0	2.5	2.4
AVE.	1.0	.8	1.5	1.5	2.2	2.6	1.8	1.8	2.2	3.0

* Switch to Daylight Savings Time

Music Building
CO Concentration - ppm
Probe D (Cont.)

HOUR	5/7	5/8	5/9	5/10	5/11	5/12	5/13	5/14	5/15	AVE.
2400-100	2.3	4.0	-	1.0	2.5	2.1	3.1	2.3	2.3	2.3
100-200	2.0	3.5	-	1.0	2.5	2.0	3.0	2.1	2.2	2.2
200-300	2.0	3.0	1.1	1.0	2.0	1.9	2.7	2.1	2.1	2.0
300-400	2.0	2.6	1.1	1.0	-	1.6	2.4	2.0	2.1	1.9
400-500	2.0	2.5	1.0	.9	-	1.5	2.0	1.9	2.1	1.8
500-600	1.9	2.2	1.0	1.0	-	1.5	1.5	1.9	2.2	1.5
600-700	2.0	2.2	1.2	1.0	-	1.3	1.1	2.0	2.3	1.4
700-800	2.5	2.5	1.2	1.2	-	1.5	1.4	2.0	2.5	1.6
800-900	3.5	3.0	1.9	1.6	1.2	2.0	3.1	2.0	2.9	2.2
900-1000	4.5	3.0	2.4	2.5	1.5	2.0	4.5	2.0	2.0	2.6
1000-1100	4.5	3.7	2.0	1.5	1.9	2.0	4.2	2.4	3.6	2.5
1100-1200	4.4	-	2.0	-	1.6	2.1	3.5	2.6		2.3
1200-1300	4.2	3.6	1.3	1.5	1.2	2.5	3.0	2.6		2.1
1300-1400	4.5	4.2	1.2	1.9	1.2	2.1	2.5	2.7		2.2
1400-1500	3.7	2.7	1.2	1.5	.9	1.5	2.5	2.7		1.9
1500-1600	3.6	2.4	1.5	2.2	1.0	1.5	2.4	3.0		1.9
1600-1700	3.5	2.3	1.5	1.5	1.9	1.7	2.4	3.0		2.0
1700-1800	3.7	2.0	1.5	1.7	1.9	2.0	2.0	3.0		2.0
1800-1900	4.0	1.5	1.7	1.7	2.2	2.0	2.0	3.0		2.0
1900-2000	4.1	-	1.9	1.5	2.0	2.0	2.0	3.0		2.1
2000-2100	5.1	-	1.9	1.5	2.1	2.0	2.3	3.0		2.3
2100-2200	5.1	-	1.9	1.5	2.6	2.5	2.3	2.7		2.4
2200-2300	4.7	-	1.4	1.7	2.4	3.1	2.3	2.5		2.4
2300-2400	4.3	-	1.1	1.7	2.4	3.1	2.3	2.4		2.2
AVE.	3.5	2.8	1.5	1.5	1.8	2.0	2.5	2.5	2.5	2.1

Music Building
CO Concentration - ppm
Probe E

HOUR	4/27	4/28	4/29	4/30	5/1	5/2	5/3	5/4	5/5	5/6
2400-100		3.5	7.0	5.5	3.5	8.0	4.5	5.0	7.0	13.5
100-200		3.0	6.0	5.0	2.5	6.0	3.5	3.5	5.5	11.0
200-300		3.0	5.0	*	2.0	5.5	2.5	2.5	4.5	6.5
300-400		3.0	4.0	4.5	2.0	4.5	2.5	2.0	3.5	4.0
400-500		2.5	4.0	4.5	2.5	4.5	2.0	2.0	3.0	4.0
500-600		2.5	4.0	4.0	3.0	4.0	3.0	2.5	3.0	5.0
600-700		3.5	5.0	4.0	5.0	5.0	5.5	5.5	4.0	5.5
700-800		6.5	5.0	3.5	10.5	9.5	10.5	12.0	7.0	6.5
800-900		6.0	5.0	3.5	13.5	10.0	11.0	13.5	8.0	8.5
900-1000		4.5	5.5	4.5	11.5	8.0	9.0	11.5	4.5	8.0
1000-1100	3.5	4.0	7.5	6.0	7.5	7.0	7.5	9.0	4.5	10.0
1100-1200	3.5	6.0	6.5	6.5	8.0	7.0	8.0	9.0	4.5	11.0
1200-1300	4.0	6.0	6.5	8.0	9.0	7.0	9.5	7.0	5.0	11.0
1300-1400	4.0	5.0	7.0	7.0	9.5	8.5	9.5	5.0	4.5	10.5
1400-1500	3.0	5.5	7.0	7.0	10.0	10.0	9.5	4.5	4.5	11.0
1500-1600	4.0	7.5	6.5	7.0	12.0	11.5	12.0	5.0	5.0	11.0
1600-1700	5.5	9.0	5.5	7.0	14.0	12.5	13.5	7.0	7.0	11.5
1700-1800	4.0	8.0	5.5	6.0	12.0	12.0	12.5	6.5	5.5	10.0
1800-1900	4.0	7.0	7.5	7.0	11.0	10.0	9.5	5.5	4.0	8.5
1900-2000	7.5	8.0	9.5	8.0	12.0	10.5	8.0	5.5	4.5	9.0
2000-2100	7.0	7.5	12.0	8.0	11.5	12.0	7.5	8.0	8.0	9.5
2100-2200	4.5	6.5	13.0	7.0	8.0	11.0	7.0	9.5	12.0	7.0
2200-2300	3.5	7.0	7.5	5.0	8.5	6.5	5.5	7.5	11.0	7.0
2300-2400	4.0	7.0	5.5	5.5	9.5	5.5	5.0	8.0	12.0	6.5
AVE.	4.4	5.5	6.6	5.8	8.3	8.2	7.4	6.5	5.9	8.6

* Switch to Daylight Savings Time

Music Building
CO Concentration - ppm
Probe E (Cont.)

HOUR	5/7	5/8	5/9	5/10	5/11	5/12	5/13	5/14	5/15	AVE.
2400-100	6.5	-	2.5	2.0	3.5	2.5	9.0	5.0	2.0	5.3
100-200	5.0	-	1.5	1.0	2.5	3.0	8.0	3.5	2.0	4.3
200-300	3.5	-	2.0	1.5	2.5	2.5	5.0	3.5	1.0	3.3
300-400	3.0	-	1.0	1.0	2.5	2.5	3.5	3.0	.5	2.8
400-500	3.0	-	1.0	1.0	2.5	3.0	3.0	1.5	1.0	2.6
500-600	3.0	-	1.5	1.5	4.5	4.0	2.5	1.5	2.0	3.0
600-700	3.0	-	3.5	3.5	7.0	6.5	3.5	2.0	4.0	4.5
700-800	3.5	-	6.5	6.0	9.0	7.0	5.0	2.5	7.0	6.9
800-900	3.5	-	6.0	6.5	8.0	6.0	7.5	2.5	8.0	7.5
900-1000	5.0	-	5.5	4.0	6.0	4.5	8.0	4.0	5.5	6.4
1000-1100	7.0	-	5.0	3.0	5.5	5.0	10.0	5.5	6.5	6.3
1100-1200	8.0	9.5	4.0	3.5	6.0	5.5	11.0	7.0		6.9
1200-1300	9.0	10.5	4.0	4.5	6.0	8.0	10.0	8.0		7.4
1300-1400	-	10.0	4.0	6.5	5.5	8.0	10.5	8.0		7.2
1400-1500	-	10.0	4.5	6.0	6.0	7.0	11.0	7.0		7.3
1500-1600	-	11.0	6.5	8.0	7.0	7.5	10.5	7.0		8.2
1600-1700	-	13.0	6.0	9.0	8.5	8.0	11.0	7.5		9.1
1700-1800	-	11.0	5.5	10.0	7.0	6.5	9.0	7.0		8.1
1800-1900	-	8.5	4.0	8.0	6.5	5.0	8.5	7.0		7.1
1900-2000	-	7.0	3.5	9.0	6.5	7.0	8.5	6.5		7.7
2000-2100	-	5.0	3.0	9.5	6.5	8.0	8.5	7.5		8.2
2100-2200	-	5.0	3.0	9.5	8.0	10.0	7.0	7.0		7.9
2200-2300	-	4.0	3.0	9.0	2.5	9.5	6.0	4.5		6.3
2300-2400	-	3.0	2.0	5.5	2.0	9.0	6.0	3.0		5.8
AVE.	4.8	8.3	3.7	5.4	5.5	6.1	7.6	5.1	3.6	6.3
*	6.1	6.7								

* Calculated by using period average values for missing hours.

Music Building
Vehicular Volume
Route 18 - Eastbound

HOUR	DAY 4/27	4/28	4/29	4/30	5/1	5/2	5/3	5/4
2400-100		308	466	424	235	242	264	295
100-200		148	288	348	119	129	139	155
200-300		84	195	*	66	65	61	73
300-400		66	117	230	65	45	56	55
400-500		98	144	109	88	77	69	88
500-600		250	204	107	226	221	240	204
600-700		636	412	171	580	577	569	537
700-800		1189	664	229	1123	1247	1150	1153
800-900		1213	896	368	1198	1141	1129	1159
900-1000		1134	1168	562	1106	1092	1074	1097
1000-1100	1125	1200	1376	767	1057	1100	1116	1024
1100-1200	1257	1386	1474	1064	1252	1292	1232	1276
1200-1300	1257	1423	1560	1178	1267	1311	1313	1263
1300-1400	1218	1428	1351	1133	1252	1234	1208	1232
1400-1500	1401	1479	1313	1115	1385	1363	1233	1392
1500-1600	1660	1772	1270	1157	1660	1743	1528	1697
1600-1700	1945	2150	1219	1145	2049	2099	1943	2133
1700-1800	1823	1884	1213	987	1942	1884	1781	1884
1800-1900	1361	1357	1108	920	1324	1257	1183	1357
1900-2000	1207	1330	1123	983	1127	1077	1028	1320
2000-2100	1054	1018	869	898	935	973	762	1187
2100-2200	857	703	620	749	812	771	678	936
2200-2300	657	639	505	512	725	638	513	674
2300-2400	494	530	623	423	409	428	420	467
TOTAL	-	23425	20178	15679	22002	22006	20689	22658
AVE.	-	976	841	682	917	917	862	944

* Switch to Daylight Savings Time

Music Building
Vehicular Volume
Route 18 - Eastbound

HOUR	5/5	5/6	5/7	5/8	5/9	5/10	5/11	5/12	AVE.
	DAY								
2400-100	318	510	572	229	278	294	348	323	347
100-200	123	312	492	110	142	136	150	181	198
200-300	64	246	274	65	63	74	102	109	110
300-400	58	130	142	55	49	68	50	68	84
400-500	82	137	90	81	74	77	98	96	94
500-600	228	175	84	245	181	214	236	231	203
600-700	563	359	166	544	485	508	574	548	482
700-800	1136	663	234	1149	1028	1114	1192	1158	962
800-900	1137	894	399	1143	1048	1087	1192	1195	1013
900-1000	1062	1064	583	1075	1042	1067	1129	1188	1030
1000-1100	1121	1352	878	1181	1033	1159	1088	1180	1110
1100-1200	1304	1578	1037	1270	1131	1188	1231	1346	1270
1200-1300	1447	1575	1215	1364	1134	1377	1270	1449	1338
1300-1400	1313	1383	1207	1248	1082	1358	1208		1257
1400-1500	1501	1274	1145	1403	1148	1338	1308		1320
1500-1600	1795	1275	1185	1720	1600	1674	1694		1562
1600-1700	2150	1427	1190	2102	2061	2151	2023		1852
1700-1800	1943	1234	1066	1882	1712	1822	1784		1656
1800-1900	1444	1077	939	1329	1193	1264	1333		1230
1900-2000	1319	1113	879	1183	985	1089	1250		1134
2000-2100	1049	1020	884	877	875	962	1226		973
2100-2200	777	633	736	782	700	699	910		758
2200-2300	598	545	463	602	519	569	648		587
2300-2400	624	668	358	402	421	443	466		478
TOTAL	23156	20644	16218	22041	19984	21732	22510	-	21048
AVE.	965	860	676	918	833	906	938		877

Music Building
Vehicular Volume
Route 18 - Westbound

	DAY							
HOUR	4/27	4/28	4/29	4/30	5/1	5/2	5/3	5/4
2400-100		235	431	456	286	248	234	243
100-200		119	302	384	143	84	116	105
200-300		78	192	*	65	77	83	70
300-400		61	114	258	68	47	48	49
400-500		82	100	128	74	54	53	75
500-600		164	126	106	139	144	161	141
600-700		607	339	144	592	534	612	585
700-800		1543	575	186	1549	1542	1466	1542
800-900		2224	777	282	2292	2254	2245	2190
900-1000		1232	1029	427	1275	1333	1379	1305
1000-1100	982	993	1070	613	1046	1031	994	1033
1100-1200	974	958	1088	723	970	883	917	951
1200-1300	1004	999	1094	869	1006	1062	1023	1015
1300-1400	1125	1148	1043	990	1107	1116	999	1062
1400-1500	1055	1174	1097	1092	1003	1118	1094	996
1500-1600	1110	1287	1093	1008	1275	1348	1230	1282
1600-1700	1015	1235	1097	937	1195	1219	1051	1233
1700-1800	970	1151	1054	1000	1159	1089	935	1116
1800-1900	967	1083	995	1058	1122	1005	981	1175
1900-2000	1022	995	942	1054	931	922	883	1089
2000-2100	779	839	856	988	765	719	655	803
2100-2200	689	760	747	791	654	661	594	779
2200-2300	474	616	571	673	422	533	446	563
2300-2400	371	526	565	532	321	352	394	390
TOTAL	-	20109	17297	14699	19459	19425	18593	19792
AVE.	-	823	721	639	811	809	775	825

* Switch to Daylight Savings Time

Music Building
Vehicular Volume
Route 18 - Westbound

HOUR	5/5	5/6	5/7	5/8	5/9	5/10	5/11	5/12	AVE.
	DAY								
2400-100	267	454	540	254	227	219	284	272	310
100-200	134	277	388	129	110	108	137	134	178
200-300	73	215	258	72	49	77	73	75	103
300-400	64	125	162	50	35	48	46	57	82
400-500	56	109	76	73	56	69	52	60	74
500-600	143	121	77	155	117	141	139	132	134
600-700	564	268	137	573	534	531	580	593	483
700-800	1566	545	229	1619	1456	1482	1510	1536	1223
800-900	2220	789	268	2407	2183	2215	2196	2224	1784
900-1000	1216	934	462	1329	1320	1246	1264	1188	1129
1000-1100	1000	1007	730	1069	940	971	1003	1033	970
1100-1200	990	1057	792	998	892	882	978	987	940
1200-1300	1095	1120	930	1057	903	913	1092	1025	1013
1300-1400	989	1152	1100	1215	1064	984	1127	1152	1086
1400-1500	1132	1144	1085	1079	950	1216	1125		1091
1500-1600	1255	1239	1008	1284	1161	1266	1296		1209
1600-1700	1270	1150	998	1245	1098	1140	1180		1138
1700-1800	1132	1044	989	1162	1049	1080	1125		1070
1800-1900	1065	1083	1078	1043	987	945	1218		1054
1900-2000	992	1012	1017	907	827	890	958		963
2000-2100	908	926	978	723	641	743	801		808
2100-2200	800	825	814	667	595	786	760		721
2200-2300	581	651	643	481	435	533	522		543
2300-2400	566	570	456	317	313	370	394		429
TOTAL	20078	17817	15215	19908	17942	18855	19860	-	18535
AVE.	837	742	634	830	748	786	828	-	772

Music Building
Vehicular Volume
Route 18 - Both Directions

HOUR	4/27	4/28	4/29	4/30	5/1	5/2	5/3	5/4
	DAY							
2400-100		543	897	980	521	490	498	538
100-200		267	590	732	262	213	255	260
200-300		162	387	*	131	142	144	143
300-400		127	231	488	133	92	104	104
400-500		180	244	237	162	131	122	163
500-600		414	330	213	365	365	401	345
600-700		1243	751	315	1172	1161	1181	1122
700-800		2732	1239	415	2672	2789	2616	2695
800-900		3437	2088	650	3490	3395	3374	3349
900-1000		2366	2197	989	2381	2425	2453	2402
1000-1100	2107	2193	2446	1380	2103	2131	2110	2057
1100-1200	2231	2344	2562	1787	2222	2175	2149	2227
1200-1300	2261	2422	2654	2047	2273	2373	2336	2278
1300-1400	2343	2576	2394	2123	2359	2350	2207	2294
1400-1500	2456	2653	2410	2207	2388	2481	2327	2388
1500-1600	2770	3059	2363	2165	2935	3091	2758	2979
1600-1700	2960	3385	2316	2082	3244	3318	2994	3366
1700-1800	2793	3035	2267	1987	3101	2973	2716	3000
1800-1900	2328	2440	2103	1978	2446	2262	2164	2532
1900-2000	2229	2325	2065	2037	2058	1999	1911	2409
2000-2100	1833	1857	1725	1886	1700	1692	1417	1990
2100-2200	1546	1463	1367	1540	1466	1432	1272	1715
2200-2300	1131	1255	1076	1185	1147	1171	959	1237
2300-2400	865	1056	1188	955	730	780	814	857
AVE.	-	1814	1579	1321	1728	1726	1637	1769
TOTAL		43534	37890	30378	41461	41431	39282	42450

* Switch to Daylight Savings Time

Music Building
Vehicular Volume
Route 18 - Both Directions

HOUR	5/5	5/6	5/7	5/8	5/9	5/10	5/11	5/12	AVE.
	DAY								
2400-100	585	964	1112	483	505	513	632	595	650
100-200	257	589	880	239	252	244	287	315	376
200-300	137	461	532	137	112	151	175	184	214
300-400	122	255	304	105	84	116	96	125	166
400-500	138	246	166	154	130	146	150	156	168
500-600	371	296	161	400	298	355	375	363	337
600-700	1127	627	303	1117	1019	1039	1154	1128	964
700-800	2702	1208	463	2768	2484	2596	2702	2694	2185
800-900	3357	1683	667	3550	3231	3302	3388	3419	2825
900-1000	2278	1998	1045	2404	2362	2313	2393	2376	2159
1000-1100	2121	2359	1608	2250	1973	2130	2091	2213	2080
1100-1200	2294	2635	1829	2268	2023	2070	2209	2333	2210
1200-1300	2542	2695	2145	2421	2037	2290	2362	2474	2351
1300-1400	2302	2535	2307	2463	2146	2342	2335	-	2338
1400-1500	2633	2418	2230	2482	2098	2554	2433		2411
1500-1600	3050	2514	2193	3004	2761	2940	2990		2771
1600-1700	3420	2577	2188	3347	3159	3291	3203		2990
1700-1800	3075	2278	2055	3044	2761	2902	2909		2726
1800-1900	2509	2160	2017	2372	2180	2209	2551		2277
1900-2000	2311	2125	1896	2090	1812	1979	2208		2097
2000-2100	1957	1946	1862	1600	1516	1705	2027		1781
2100-2200	1577	1458	1550	1449	1295	1485	1670		1486
2200-2300	1179	1196	1106	1083	954	1102	1170		1130
2300-2400	1190	1238	814	719	734	813	860		908
AVE.	1801	1603	1310	1748	1580	1691	1765	-	1650
TOTAL	43234	38461	31433	41949	37926	40587	42370		39600

Music Building
Wind Directions - Degrees (from)

HOUR*	4/28	4/29	4/30	5/1	5/2	5/3	5/4	5/5	5/6
2400-100	-	280	50	270	90	220	290	270	300
100-200	-	295	30	265	150	215	150	260	300
200-300	-	265	90	270	170	215	125	275	315
300-400	-	270	60	270	215	235	120	295	310
400-500	-	260	60	285	225	240	125	315	350
500-600	-	285	◎	260	250	235	130	210	350
600-700	-	270	30	265	255	240	135	315	10
700-800	-	315	75	275	270	250	140	10	90
800-900	-	340	105	255	270	260	160	10	65
900-1000	-	360	70	285	265	260	210	5	105
1000-1100	-	350	180	285	275	240	220	360	225
1100-1200	-	330	280	270	270	230	280	360	225
1200-1300	-	305	300	270	270	225	360	360	240
1300-1400	-	300	285	270	280	235	360	5	240
1400-1500	-	300	285	270	270	235	360	5	265
1500-1600	-	310	285	270	280	240	350	5	250
1600-1700	-	5	280	275	265	225	345	10	260
1700-1800	290	360	270	300	265	225	345	15	265
1800-1900	290	360	270	120	300	225	340	15	240
1900-2000	280	360	275	135	255	225	320	30	245
2000-2100	270	360	260	110	210	215	320	◎	225
2100-2200	260	360	240	150	240	235	285	◎	225
2200-2300	280	45	240	180	235	250	260	◎	235
2300-2400	290	45	255	185	235	240	210	295	250
STD. TIME AVE.	280	325	187	241	242	234	243	339	293
CLOCK TIME AVE.	280	325	184	244	240	234	245	335	295

* All data presented on STANDARD TIME

◎ Zero Wind Speed condition - no wind direction

Music Building
Wind Direction (cont) Degrees (from)

HOUR*	5/7	5/8	5/9	5/10	5/11	5/12	5/13	5/14	5/15	AVE.
2400-100	270	180	110	55	350	20	305	225	180	
100-200	270	85	100	45	330	45	300	180	200	
200-300	275	120	95	45	315	340	315	180	240	
300-400	280	120	90	45	310	315	320	240	260	
400-500	280	135	90	30	310	330	330	120	300	
500-600	280	130	90	30	305	320	25	180	315	
600-700	290	120	90	45	300	355	5	225	290	
700-800	300	125	95	35	305	0	30	225	300	
800-900	305	120	100	45	315	5	45	255	300	
900-1000	305	130	90	5	315	10	255	280	300	
1000-1100	325	135	85	15	310	20	250	265	280	
1100-1200	330	130	85	15	315	355	270	240	260	
1200-1300	335	110	80	0	315	5	270	240	255	
1300-1400	315	105	75	0	305	245	255	235	-	
1400-1500	330	105	70	320	300	340	270	225	-	
1500-1600	350	105	65	330	290	350	270	225	-	
1600-1700	5	110	65	0	300	5	270	215	-	
1700-1800	145	115	70	300	310	5	225	180	-	
1800-1900	105	120	65	270	300	0	230	180	-	
1900-2000	110	125	65	285	320	340	225	150	-	
2000-2100	130	125	55	270	335	300	225	140	-	
2100-2200	65	120	40	5	30	315	230	150	-	
2200-2300	70	105	45	20	30	320	225	195	-	
2300-2400	60	105	45	5	25	150	240	180	-	
STD. TIME AVE.	350	120	78	2	322	356	284	205	268	303
CLOCK TIME AVE.	343	118	80	4	321	351	296	208	262	303

* All data presented on STANDARD TIME

Music Building
Wind Speed - MPH

HOUR*	4/28	4/29	4/30	5/1	5/2	5/3	5/4	5/5	5/6
2400-100	-	6	3	5	2	5	3	1	2
100-200	-	9	2	6	2	4	3	1	2
200-300	-	9	2	4	3	4	2	2	3
300-400	-	5	1	6	3	4	2	3	3
400-500	-	4	1	4	4	3	4	4	1
500-600	-	2	0	2	5	5	4	7	3
600-700	-	2	1	3	7	6	4	6	2
700-800	-	5	2	4	10	7	4	7	3
800-900	-	5	5	5	10	7	5	9	2
900-1000	-	5	2	7	10	10	6	10	4
1000-1100	-	5	2	7	10	9	8	10	3
1100-1200	-	7	7	5	11	10	13	10	6
1200-1300	-	9	7	6	10	10	12	13	7
1300-1400	-	10	9	5	7	9	12	12	8
1400-1500	-	8	9	7	8	7	12	14	8
1500-1600	-	9	11	7	9	7	13	13	9
1600-1700	-	7	12	7	7	6	13	12	10
1700-1800	10	7	9	5	7	7	12	12	10
1800-1900	8	9	7	2	5	6	10	7	7
1900-2000	7	3	7	5	2	5	7	2	8
2000-2100	7	2	7	4	5	5	6	0	7
2100-2200	7	3	7	3	8	6	4	0	7
2200-2300	6	5	4	3	8	5	2	0	6
2300-2400	5	5	6	3	4	2	1	1	6
STD TIME AVE.	7.1	5.3	5.1	4.8	6.5	6.2	6.8	6.5	5.0
CLOCK TIME AVE.	7.1	5.3	5.1	4.9	6.5	6.3	6.8	6.5	5.1

* All data presented on STANDARD TIME

Music Building
Wind Speed (cont) - MPH

HOUR *	5/7	5/8	5/9	5/10	5/11	5/12	5/13	5/14	5/15	AVERAGES STD	CLOCK
2400-100	8	5	11	7	5	2	2	3	3	4.3	4.6
100-200	8	9	12	6	4	1	2	2	5	4.3	4.1
200-300	7	5	13	5	3	1	2	2	4	3.9	4.4
300-400	7	4	14	6	5	2	3	2	4	4.4	3.9
400-500	6	4	15	7	4	2	4	2	7	4.5	4.3
500-600	6	4	15	6	4	3	1	1	5	4.3	4.4
600-700	5	7	17	6	7	4	1	5	9	5.4	4.3
700-800	7	9	20	7	7	7	1	6	9	6.8	5.5
800-900	8	11	16	9	8	7	2	7	10	7.4	6.8
900-1000	6	10	16	9	9	7	4	5	9	7.6	7.4
1000-1100	7	10	17	8	10	8	5	6	7	7.7	7.6
1100-1200	7	9	13	7	13	5	7	5	8	8.4	7.9
1200-1300	6	11	14	6	13	6	7	6	7	8.6	8.5
1300-1400	7	13	12	5	12	9	8	8	7	9.0	8.9
1400-1500	6	12	15	9	15	10	8	7	-	9.7	8.9
1500-1600	4	14	12	8	17	10	8	7	-	9.9	9.8
1600-1700	3	13	12	5	16	10	10	7	-	9.4	9.8
1700-1800	6	13	12	6	15	9	9	7	-	9.2	9.4
1800-1900	7	15	11	7	10	6	8	6	-	7.4	8.9
1900-2000	5	15	8	5	8	5	7	5	-	6.1	7.3
2000-2100	5	14	7	3	4	4	7	7	-	5.5	6.6
2100-2200	6	12	6	4	11	4	6	9	-	6.1	5.6
2200-2300	7	10	6	5	8	3	5	7	-	5.3	6.1
2300-2400	5	11	7	5	5	3	5	5	-	4.7	5.2
STD TIME AVE.	6.2	10.0	12.5	6.3	8.9	5.3	5.1	5.3	6.7	6.7	
CLOCK TIME AVE.	6.3	9.8	12.7	6.4	8.9	5.4	5.0	5.3	6.6		6.7

* All data presented on STANDARD TIME

6.0 Mathematical Models of Carbon Monoxide Concentrations at Frelinghuysen

The derivation of the mathematical models presented in Section 3.3 is discussed herein. The analysis is divided into three basic cases characterized by the wind direction. These are:

Case 1 - wind parallel to roadway

Case 2 - wind blowing perpendicular to roadway, from road toward building

Case 3 - wind blowing perpendicular to roadway, from building toward road

To make the analysis tractable a 2-dimensional configuration is assumed in all cases, i.e. a line source with an infinitely long (in road direction) building. This is a conservative assumption since it neglects edge effects and the accompanying reduction of pollution levels by ventilation and escape between buildings. Development of the mathematical models is presented below. Table 6.1 lists the nomenclature used. References are included on Table 6.2.

CASE 1

For case 1 the source is modeled as an infinite line aligned in the wind direction and located at the edge of the deck. An infinitely high impermeable vertical wall is placed a distance from the deck to simulate the dormitory wall. This is a conservative assumption since it prevents escape of CO over the building tops. A cross sectional illustration of the

TABLE 6.1

NOMENCLATURE

ΔC_i = ppm = increased above background of carbon monoxide at building site for case i.

M = $\frac{\text{pounds of CO emitted}}{\text{vehicle mile}}$

$\dot{N}$ = $\frac{\text{vehicles}}{\text{hr}}$ = traffic volume rate

V = Mph = wind speed

W = meters = horizonital distance from outer edge of deck to building wall

H = meters = height of building above deck level

H_r = meters = height of building above street level

Bs = dimensionless = horizonital spreading coefficient, dependent on stability class

$(\sigma_z)_W$ = meters = vertical spread (standard dev.) at a distance W from source, dependent on stability class

s_r = meters = wetted length of shear layer measured from building top to reattachment point.

model is given in Figure 6.1.

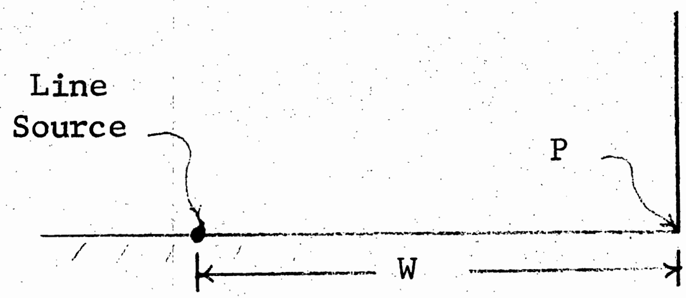


Figure 6.1 Case 1 Model

Concentrations are modeled at point P the intersection of the deck level with the dormitory wall (point of highest concentration along building wall), by treating infinitesimal segments of highway as point sources and integrating along the infinite line representing the source. The method of images is used to achieve the zero concentration gradient at the impermeable vertical wall. Mathematically stated:

$$\Delta C_1 = (.140) \frac{2 M \dot{N}}{\pi V} \int_0^{\infty} \frac{e^{-W^2/2\sigma_y^2}}{\sigma_y^2} \, dx$$

The number (.140) is a conversion factor to allow for the system of units used. For the horizontal spreading represented by σ_y the following relationship is assumed in terms of downwind distance (x) from a source:

$$\sigma_y = B_s x$$

where:

Stability Class	A	B	C	D	E
B_s	.213	.158	.104	.068	.050

This form closely approximates the Pasquill-Gifford curves for σ_y vs x for various stability categories (Reference 2). Actually $\sigma_y \sim x^{.93}$ would be a better fit. Substituting in the equation and integrating gives:

$$\Delta C_1 = 0.112 \frac{M \dot{N}}{V W B_s} \tag{I}$$

which is the formula used for calculations in the above section.

CASE 2

For Case 2 the source is again modeled as an infinite line source which is now perpendicular to the wind. An impermeable wall of height H is located a distance W downwind of the line source. For such a flow field a recirculating region will occur across the corner intersection of the deck level and the building wall. A cross - sectional illustration is given in Figure 6.2.

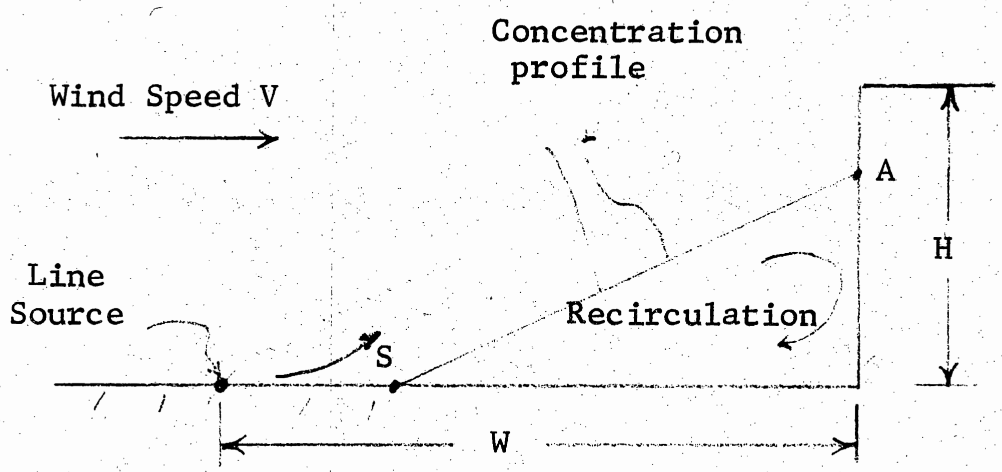


Figure 6.2 Case 2 Model

Concentration in the recirculation region builds up until flux across the separation streamline (S-A) becomes zero and a uniform steady state value is reached. This uniform concentration is the maximum exposure along the dormitory wall and is the value estimated herein by ΔC_2. It is assumed that this value is an average of that achieved along the separation streamline S-A. In particular this average is taken as the concentration at some intermediate location between the separation point S and the attachment point A. Along this streamline the concentration is calculated according to the equation for ground level concentration associated with a Gaussian vertical distribution downwind of an infinite ground-level line source (Reference 2). Distance X downwind is taken as the distance from the source to point S plus that from point S to the intermediate point along S-A. The equation for concentration at X is:

$$\Delta C_2 = (.140)\sqrt{\frac{2}{\pi}}\ \frac{M\dot{N}}{V(\sigma_z)_X} = (.112)\ \frac{M\dot{N}}{V(\sigma_z)_X}$$

where (.140) is again a conversion factor peculiar to the system of units used herein. As in Case 1, it is possible to obtain this equation by integration of point sources along an infinite line. The term σ_z is the vertical spread as represented by the standard deviation of the vertical profile. To evaluate the above formula it is necessary to specify the distance X and therefore the points S and A must be known. Although difficult to determine exactly, the point X is readily estimated by realizing that point S must be between the source location and the wall since the deck edge is well above the river level. Thus if X were taken as the mid-point of S-A, the minimum possible value for X would be W/2 while the maximum would be (W + H/2). For Frelinghuysen Dormitory and a deck extending to the roadway edge, W is approximately 2H. Hence $\frac{W}{2} < X < \frac{5W}{4}$. Thus for simplicity and in the spirit of the approximation, it is assumed here that X = W. The equation for ΔC_2 can now be written as

$$\Delta C_2 = (.112)\ \frac{M\dot{N}}{V(\sigma_z)_W} \qquad \text{(II)}$$

where $(\sigma_z)_W$ is evaluated at a distance W from the source. Values for $(\sigma_z)_W$ are obtained here from the Pasquill-Gifford curves for σ_z vs distance from the source (Reference 2). Since these results are limited to distances of 0.1 km to 100 km, it is necessary to extrapolate to 50 meters which is the assumed value of W. Thus the following values are taken:

Stability Class	A	B	C	D	E
$(\sigma_z)_W$ (meters)	6.80	5.50	3.90	2.48	1.92

where stability class A is the most unstable with class E being most stable. Due to disturbances by urban roughness and heat island effects, stability class F is neglected here as it is generally considered so stable as to occur only in rural areas of flat terrain.

CASE 3

Case 3 is modeled as an infinite line source at the deck edge with a building of height H a distance W upwind of the source. It is important in this case to distinguish the height H above deck level and the height H_r above river level. Figure 6.3 illustrates the model.

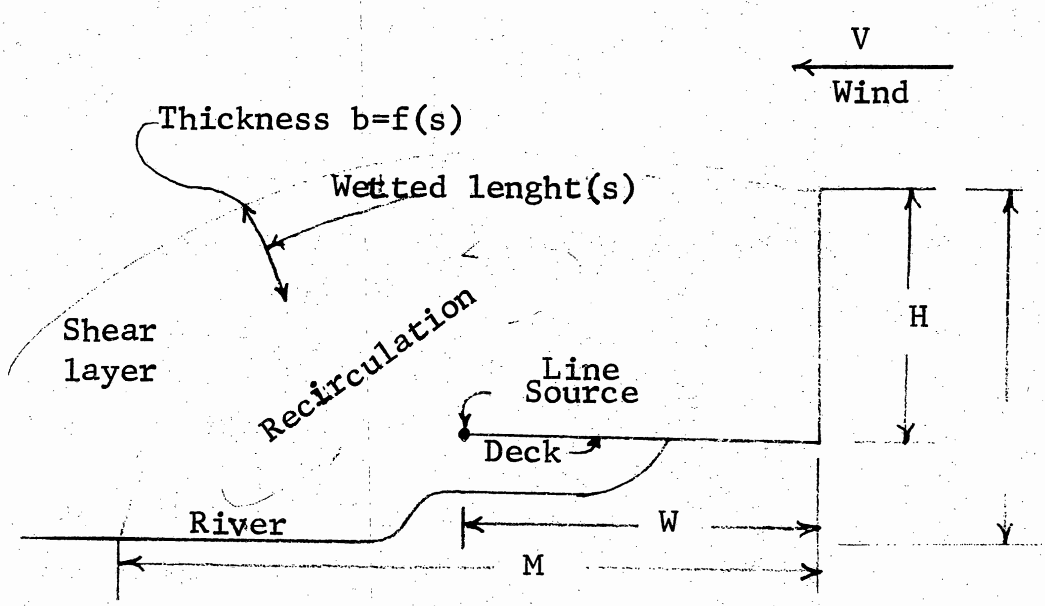


Figure 6.3 Case 3 Model

For Case 3 there is a trapping effect by the shear layer which extends from the building top to a distance M out from the face of the building. Within this layer is a recirculation region with an approximately uniform concentration level. Carbon monoxide builds up in the trapped recirculating region until a steady state value is reached for which the input from the road source is balanced by the output by turbulent transport across the shear layer. A mathematical statement of this balance leads to the concentration excess ΔC_3 above background. Thus

$$M \dot{N} = \int_0^{s_T} D \frac{\Delta C_3}{b} ds$$

where the l.h.s is the input and the r.h.s. is the output. The r.h.s. is simply the integral along the entire shear layer length of the turbulent diffusion which is specified according to Ficks law in terms of the turbulent diffusion coefficient D and the approximate concentration gradient $\frac{\Delta C_3}{b}$. To obtain a usable form of the above equation, it is necessary to substitute D and b as functions of s. There are specified here, according to classical theory (see Reference 3, Chap 23), as:

$$b = 0.178\ s \qquad D = 0.00137\ Vs$$

where it has been assumed that the Schmidt number is unity so that the turbulent diffusivity equals the eddy viscosity. Substituting the above b and D as well as a conversion factor to allow for the system of units used herein yields:

$$\Delta C_3 = 17.7\ \frac{M\dot{N}}{V s_r} \qquad \text{(III)}$$

which is the formula used above for calculation of the results. To implement equation (III), the total wetted length of the shear layer (s_r) must be specified. This is estimated here to be given according to:

$$s_r = 6.5\ H_r$$

Following is the basis of the above estimate of s_r.

According to Reference 4 and 5 the horizontal reattachment distance m in a 2-dimensional flow expected to be about 10-15 H where H is as shown in Figure 6.4:

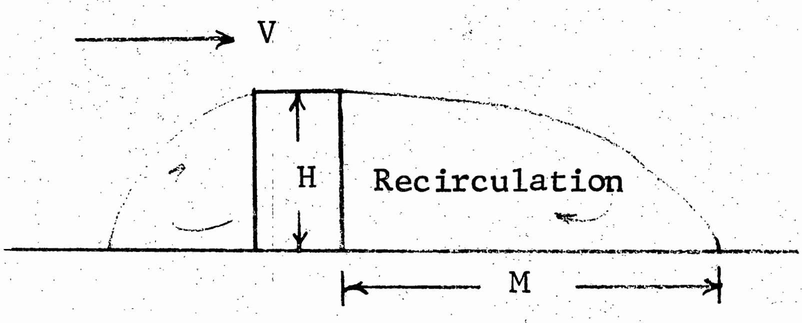


Figure 6.4

The reattachment distance m behind a step in a finite channel (Figure 6.5) has been studied experimentally by Abbott and Kline (Reference 6) and by Hsu (Reference 7).

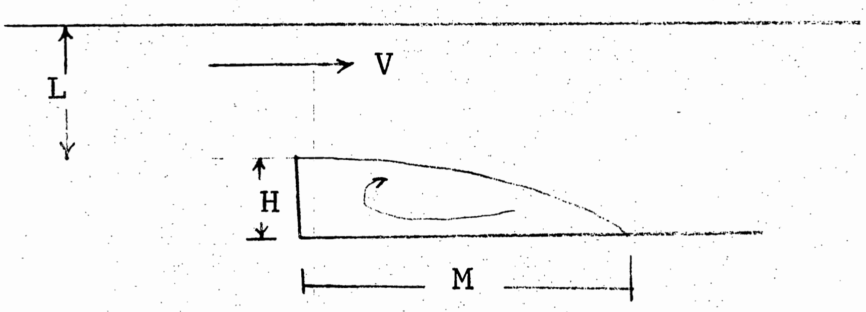


Figure 6.5

Examination of these experimental results for $L>3H$ indicates that $m > 5$ H. Evaluation of Abbott and Klines analytical solution in the limit of infinite L shows m = 6.5 H. Since the street and rooftops in the vicinity of Frelinghuysen are lower than Frelinghuysen roof, but higher than river level the actual Route 18/Dormitory configuration is considered to be a combination of Figures (6.4) and (6.5) and hence a value between 6.5 H and 10-15 H might be assumed for m. However, since ΔC_3 is inversely proportional to s_r the smaller, more conservative, value (m = 6.5 H) has been adopted. Further, it has been assumed, again conservatively, that s_r is the shortest distance from the rooftop to the reattachment point, i.e.

$$s_T = H_T \sqrt{1 + \left(\frac{m}{H_T}\right)^2} = H_T \sqrt{1 + (6.5)^2} \cong 6.5 H_T$$

Finally it is pointed out that the above estimates are based on two dimensional flow and in a three dimensional case air escapes around the building sides and thus smaller values of s_r are expected Byrne and Peskin (Reference 4) have verified this by wind tunnel experiments with the actual 3-dimensional Route 18/Dormitory configuration. The effect of this reduced s_r in increasing ΔC_i however, is expected to be more than compensated for by the ventilating effect of air curling around the building sides as well as the added opportunity for CO removal due to the actual finite roadwise dimension of the recirculation region.

TABLE 6.2

REFERENCES

1. Rose, A.H. Jr., Smith, R. McMichael and Kruse, R.E., "A Comparison of Auto Exhaust Emiasions from Two-Major Cities", Public Health Service, June, 1965.

2. Turner, D.B., "Workbook of Atmospheric Dispersion Estimates", Environmental Health Series, U.S. Dept. H.E.W., Public Health Service Publication No. 999-AP-26.

3. Schlichting H., Boundary Layer Theory, McGraw-Hill, N.Y., N.Y.

4. Byrne W.A., and Peskin R., "The Effects of the Proposed Deck Over Route 18 on Pollution", Report to King and Gavaris, February 7, 1972.

5. Arie M. and Rouse H., "Experiments on Two-Dimensional Flow over a Normal Wall", Journ. of Fluid Mech., Vol. 1, July 1956.

6. Abbot A.D. and Kline S.J., "Theoretical and Experimental Investigation of Flow over Single and Double Backward Facing Steps", Stanford University, Department of Mechanical Engineering Rept. No. MD-5, June 1961.

7. Hsu H.C., "Characteristics of Mean Flow and Turbulance at an Abrupt Two-Dimensional Expansion", Ph. D. Dissertation, Department of Mechanical and Hydraulics, State University of Iowa, 1950.

7.0 Photographs

Photographs were taken of the three test sites involved in the Route 18 Freeway Extension Study. The photograph index map showing the relative location of these sites follows, along with the photographs pertinent to this Air Pollution Impact Study. A description follows:

4. Aerial view of Frelinghuysen Dormitory building taken 2/24/72.

5. Aerial view of Frelinghuysen Dormitory building with rendering of proposed Route 18.

6. View of air pollution mobile lab at the Frelinghuysen Dormitory building canal side taken 4/24/72.

7. Aerial view of Music Building taken 2/24/72.

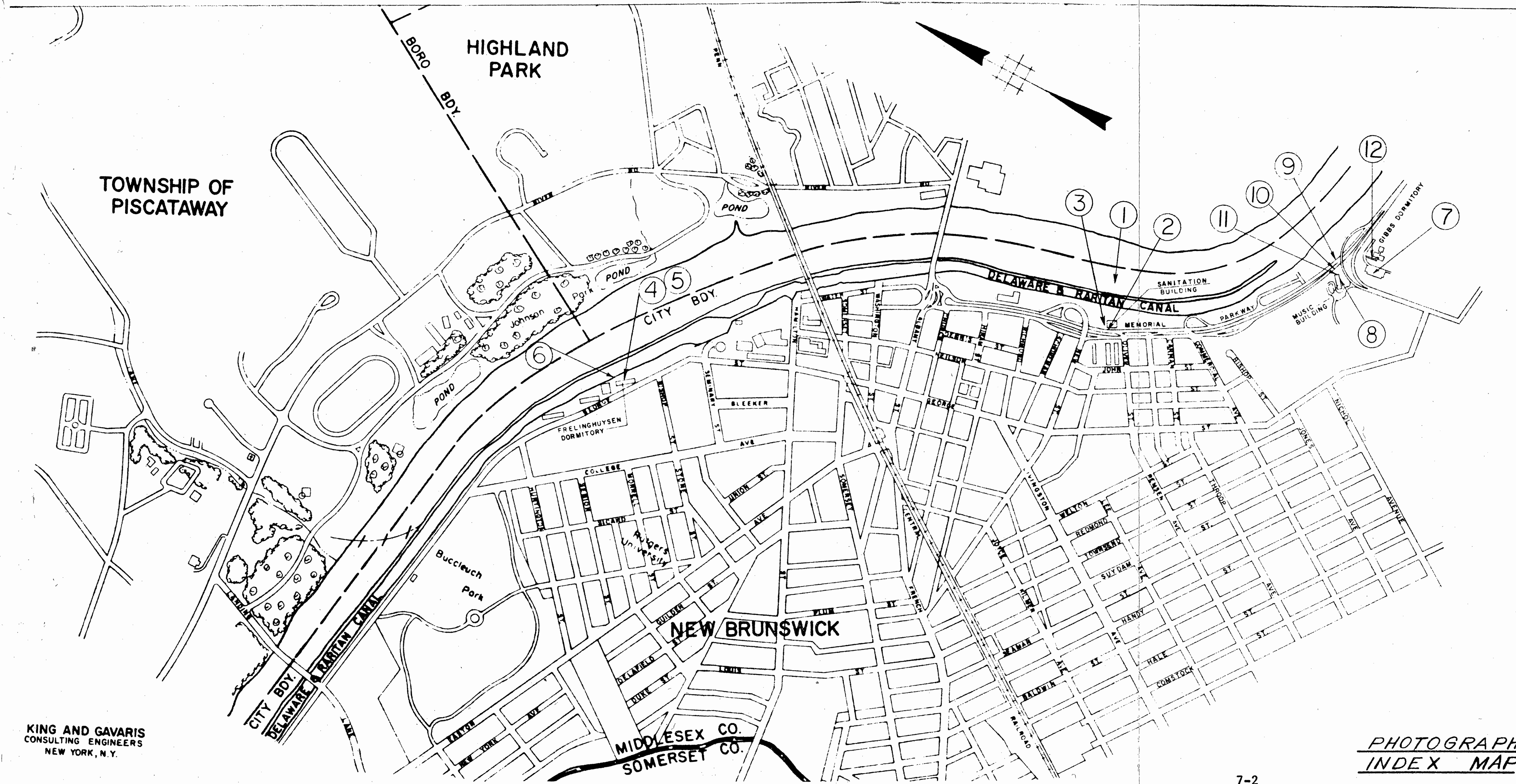
8. View of air pollution mobile lab at the Music Building Douglas Campus taken 5/11/72 showing air monitoring probe in foreground attached to wood utility pole.

9. View of air monitoring probe attached to center pier of George Street exit ramp at Route 18 and Music Building taken 5/11/72.

10. View of air monitoring probe attached to wood utility pole off eastbound Route 18 at bottom of slope at Music Building.

11. View of air monitoring probe at second floor of Music Building on Route 18 side taken 5/11/72.

12. View of set up of meteorological instruments on the roof of the Gibbs Dormitory Douglas directly across George Street from Music Building.



PHOTOGRAPH INDEX MAP

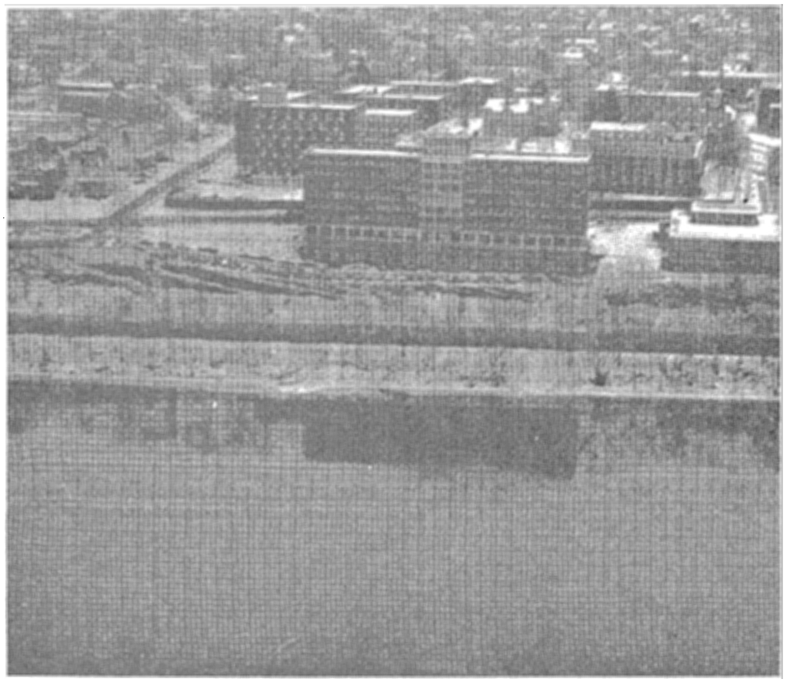


Photo #4

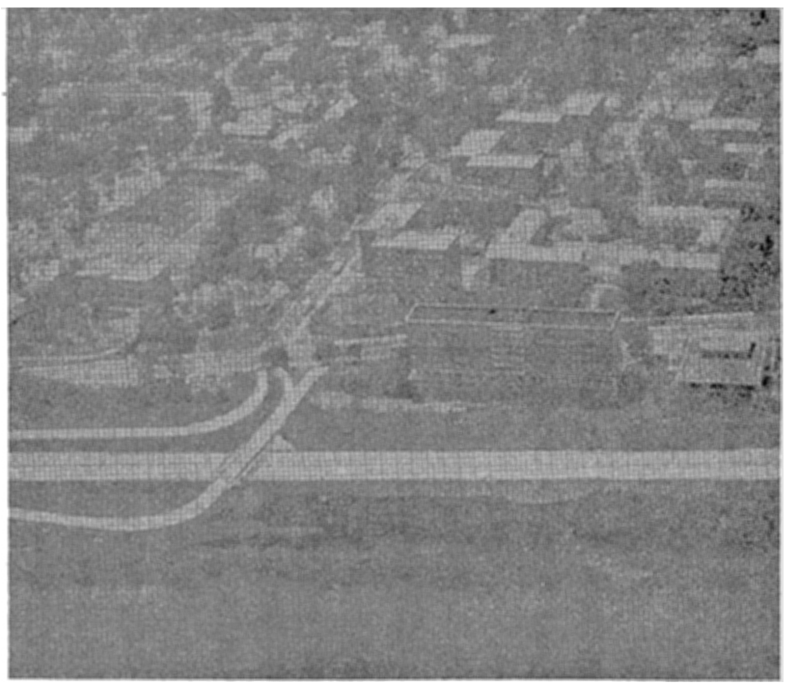
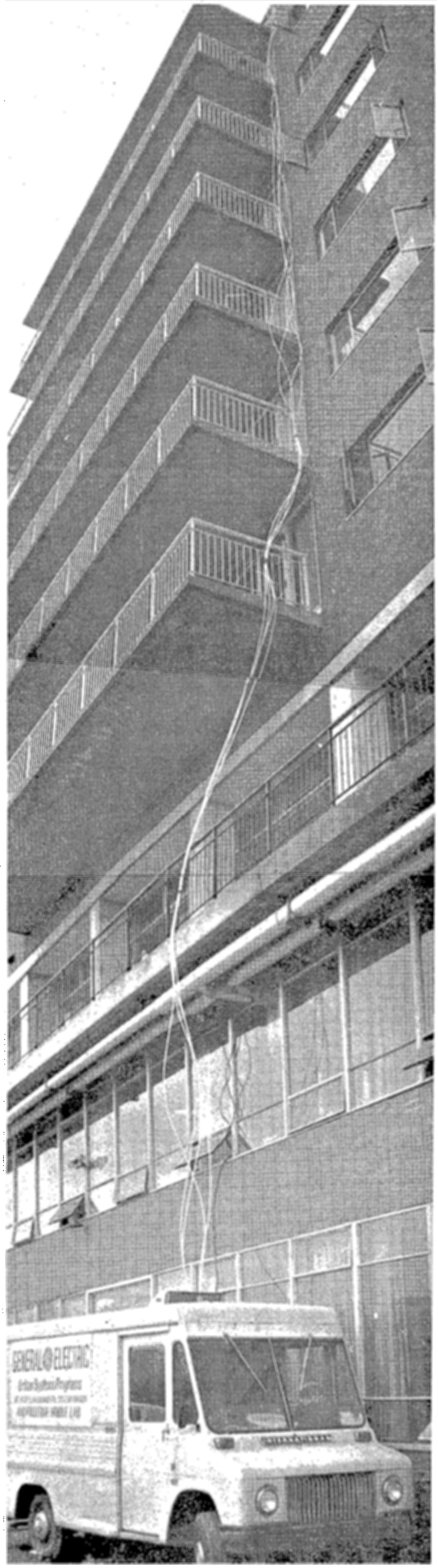
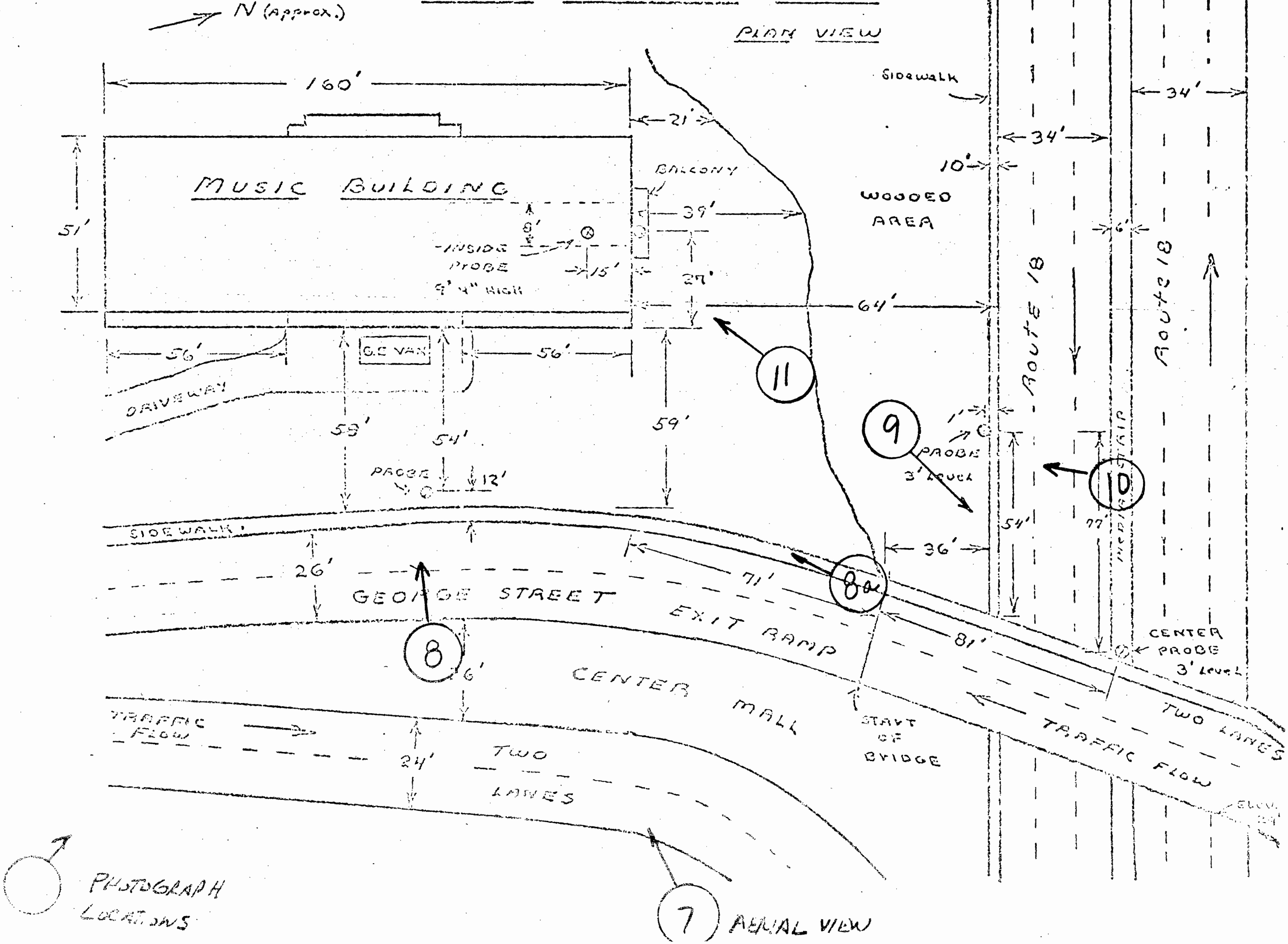


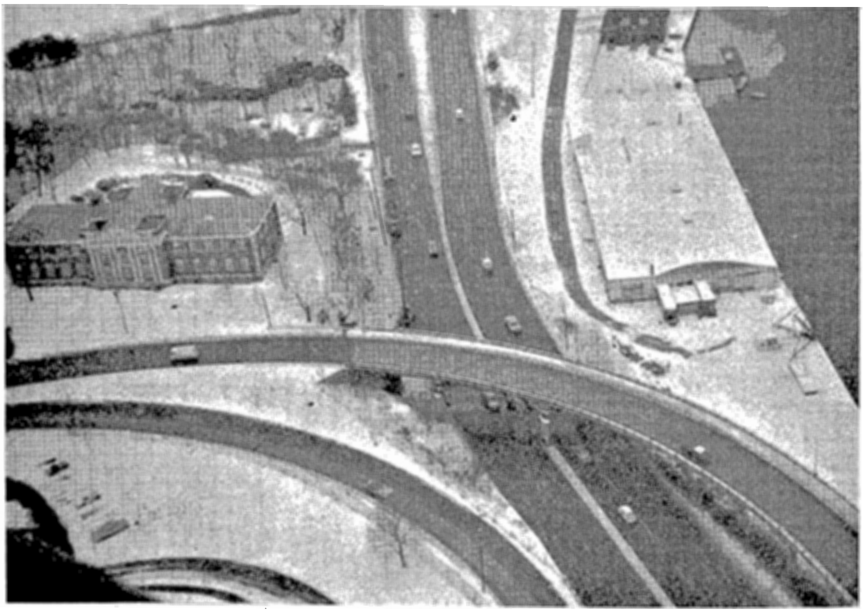
Photo #5

Photo #6



MUSIC BUILDING SITE





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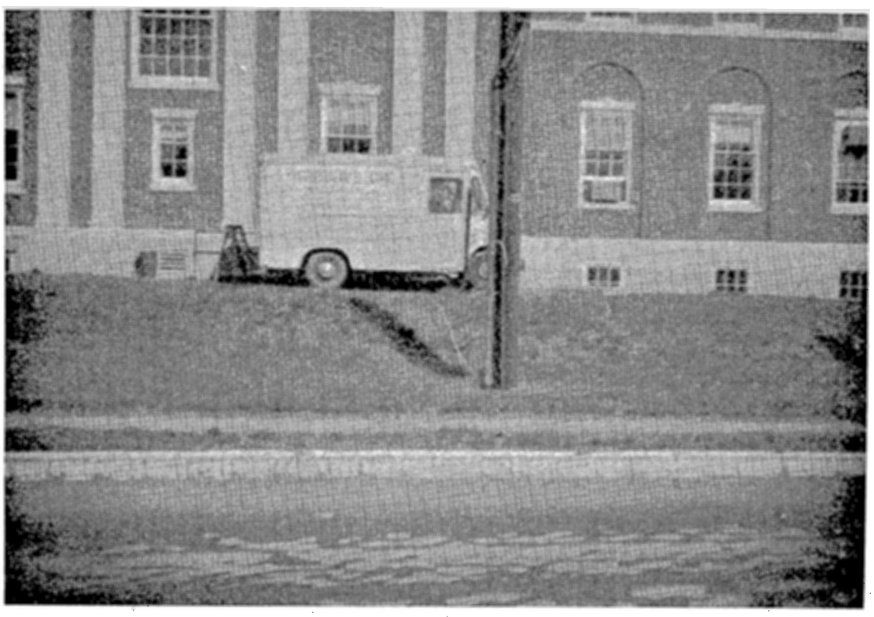

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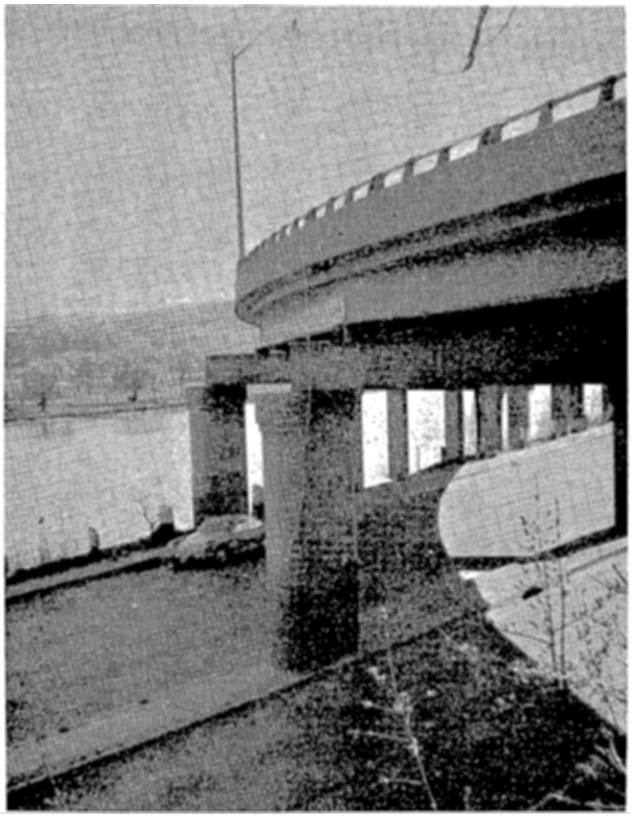

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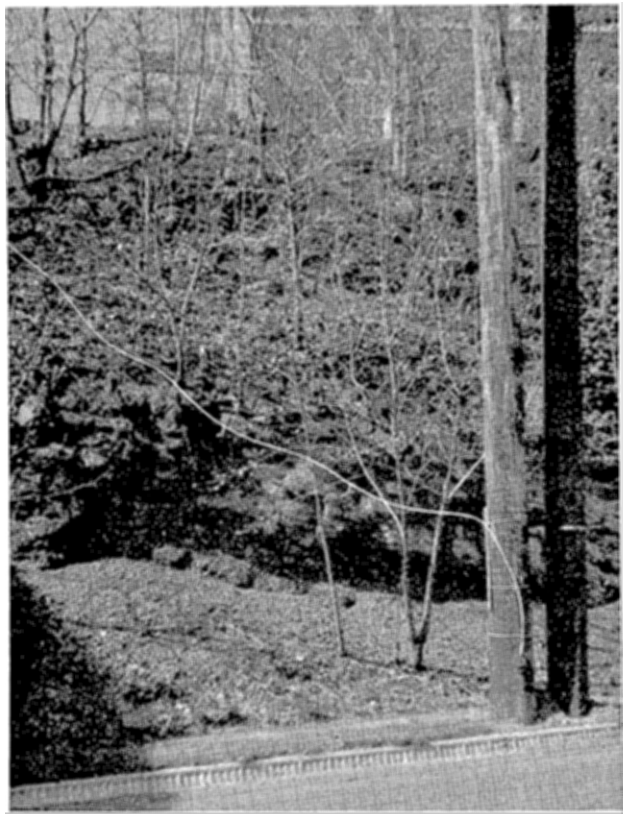

Photo #10

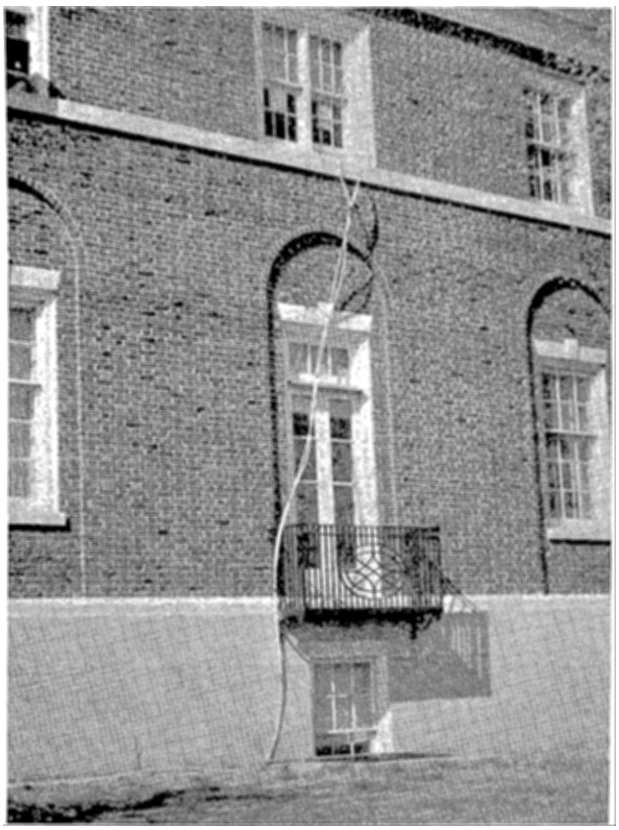

Photo #11

Photo #12