AIR QUALITY SECTION FOR THE FINAL ENVIRONMENTAL IMPACT STATEMENT FOR PROPOSED I 696

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

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Research Laboratory Section
Testing and Research Division
Research Project 71 TI-53
Research Report No. R-830R
(EV-15)

Michigan State Highway Commission
E. V. Erickson, Chairman; Charles H. Hewitt,
Vice-Chairman, Claude J. Tobin, Peter B. Fletcher
Lansing, February 1973

This report presents air quality information for the final environmental impact statement for proposed I 696. It is a modification of the August 1971 Research Report R-784 (EV-15) which was submitted for the draft environmental statement. The updating was undertaken because of a change in estimated opening date of the project from 1975 to 1980. Refinements of the pollution estimates include the effect of weaving lanes, revised pollutant build-up factors under parallel wind conditions, and more detailed traffic estimates.

GENERAL CHARACTERISTICS OF THE PROJECT AREA

The proposed project is located in southeastern Oakland County, which along with Wayne, Macomb, and St. Clair Counties make up the Detroit Metropolitan Air Quality Control Region.

Topography

This air quality control region is part of a flat plain that rises gradually from approximately 600 ft above sea level to 800 ft above sea level. The only hills in the region are in western and northwestern Oakland County where the gently rolling land rises to about 1,200 ft above sea level. There are no terrain elevation differences that would hinder the dispersion of pollutants.

Demography

Oakland County's population of 908,000 is 90 percent urban, with a population density of 1,046 per square mile. Only 59 percent of the employed workers who live in the County also work there.

Meteorology

Michigan lies in the normal track of migrating high and low pressure centers at all times of the year. This results in great variations in day to day weather. While prevailing winds are from westerly directions, frequent changes in wind speed and direction are experienced. Figure 1 shows wind speed and direction occurrences on a 36-point bar graph for Detroit City Airport, the weather station nearest to the proposed project. A one day in nine day sampling of hourly data was averaged for the years 1967 through 1970. It can be seen that pollutants from a single source will affect a specific receptor only about 6 percent of the time, even though the receptor may be downwind in the prevailing direction. Figure 2 is a conventional wind rose obtained by condensing the 36-point wind data to a 12-point rose.

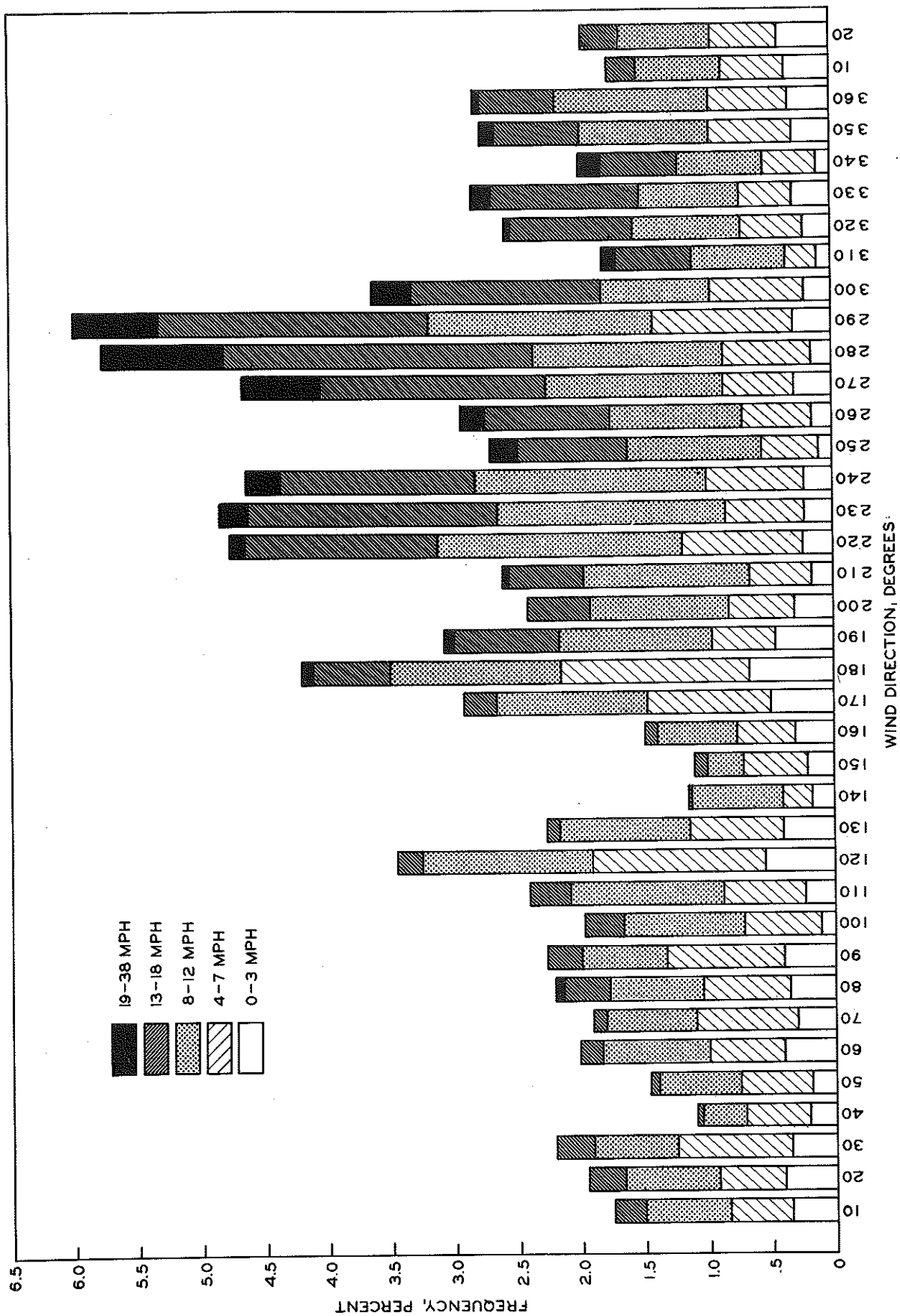

Figure 1. Summary of wind speed and direction occurrences at Detroit City Airport, 1967 through 1970 (one day in nine day sample).

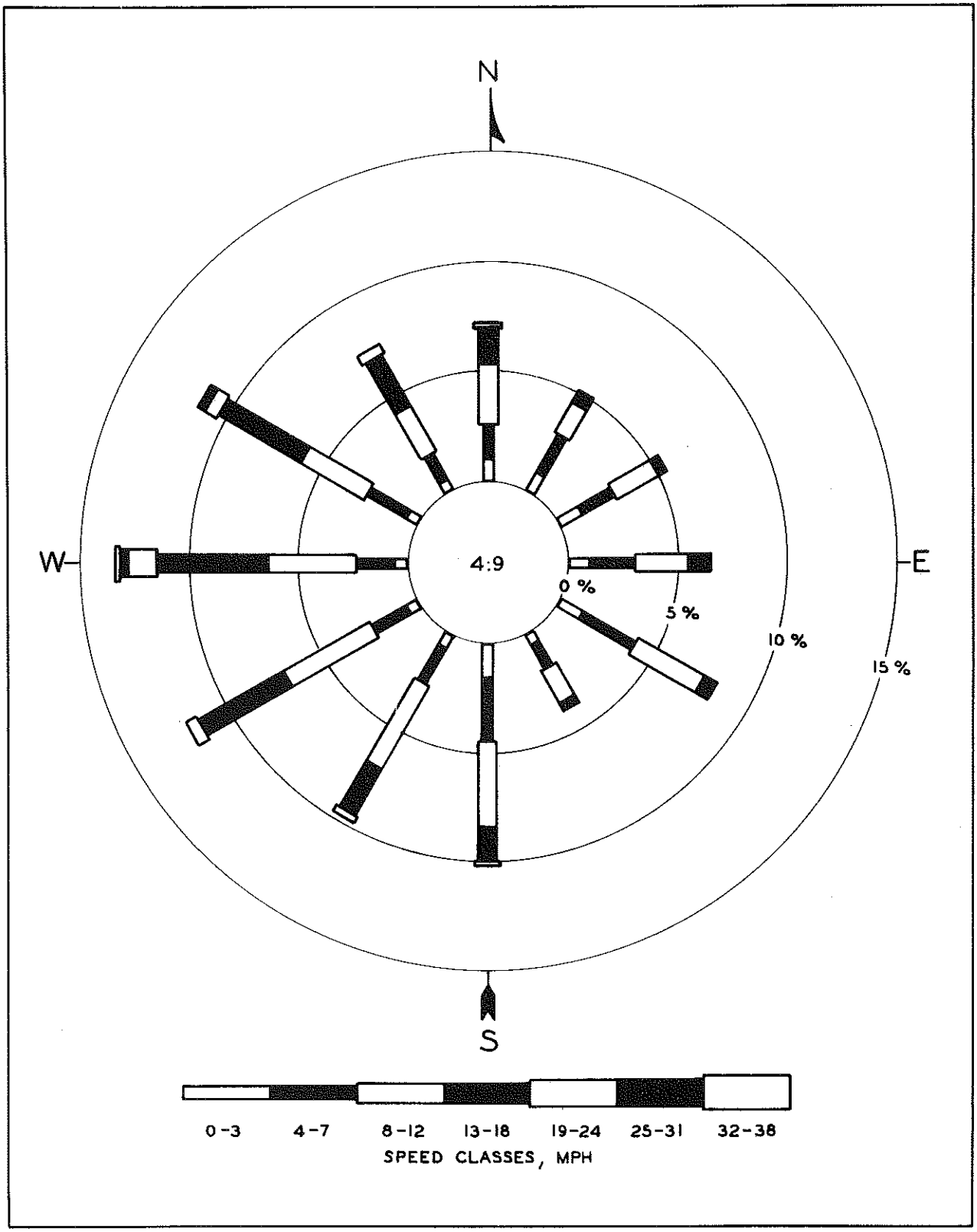

Figure 2. Frequency of wind direction and speed, percent (calms distributed).

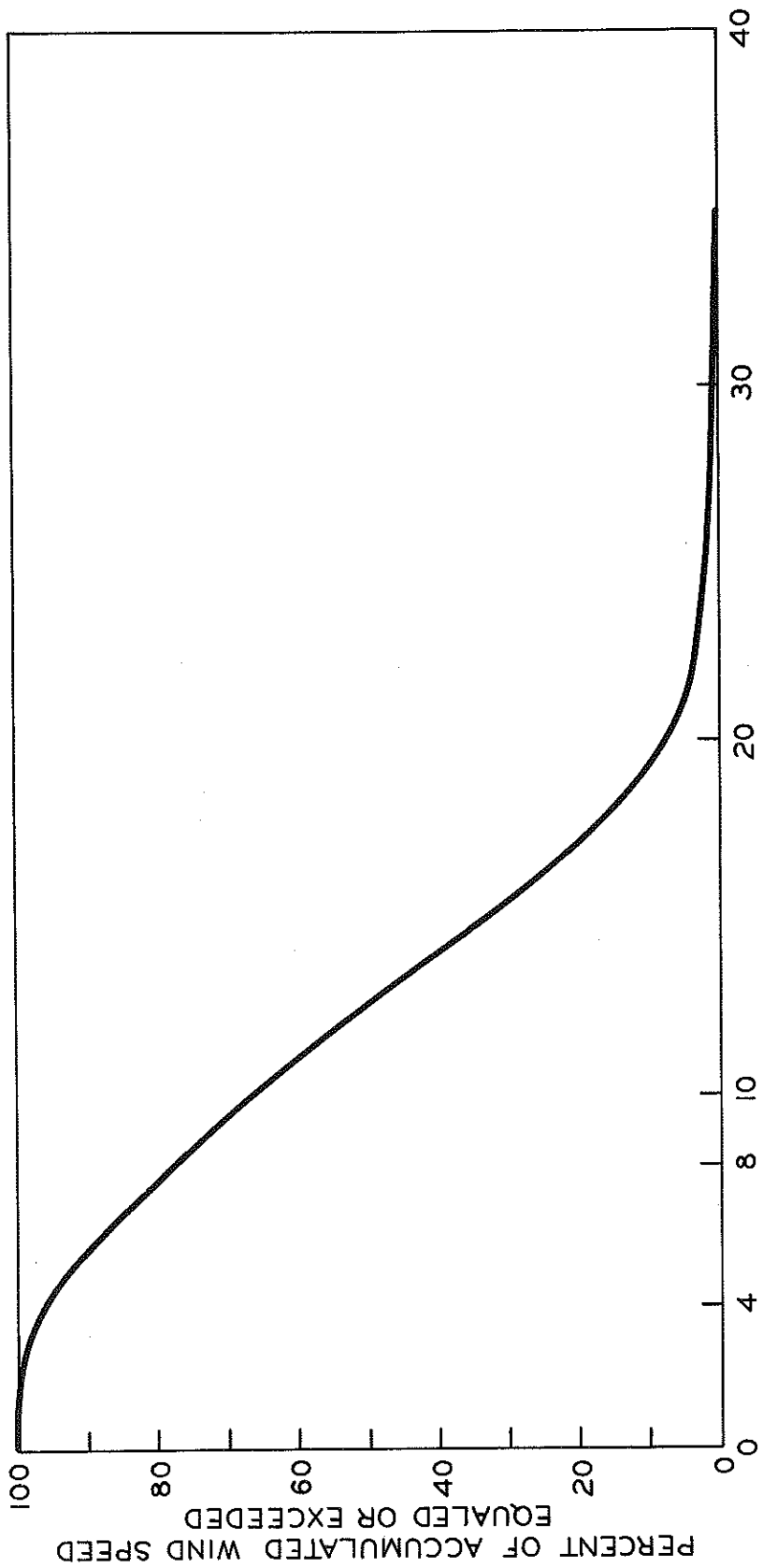

Figure 3. Wind speed distribution.

On those occasions when atmospheric inversions restrict the vertical dispersion of pollutants, horizontal ventilation generally continues freely. Figure 3 shows the overall distribution of wind speeds. Over 95 percent of the time wind speed exceeds 4 mph. The most probable wind speed during 7 to 9 a. m. peak traffic and 4 to 6 p. m. periods was found to be 10 mph.

The potential for air pollution episodes is related to the incidence of stagnating anticyclones (high pressure areas) with associated inversions that linger a few days. A study of weather patterns for the 30-year period 1936 through 1965, found that stagnating anticyclones lasting four days or more occurred in the Michigan area on an average of only once every two years.[1] It is concluded that the geographical area of the proposed project has meteorological conditions which lead to rapid dispersal and dilution of air pollutants.

EXISTING AMBIENT AIR QUALITY

Air quality data for the proposed I 696 corridor were not available from the Michigan Department of Public Health or any city or county agency. Wayne County Health Department data were obtained for 1970 and 1971 covering carbon monoxide and nitrogen dioxide levels at selected locations in the City of Detroit. No data were obtained from a City of Detroit agency because Wayne County handles air pollution analysis for Detroit. No hydrocarbon data were available since little analytical work is currently being done on hydrocarbon levels in Michigan.

A limited number of air quality measurements were made by the Department's Research Laboratory in the area of the proposed construction corridor and in metropolitan Detroit near existing freeways. The air quality data obtained are presented in the three following sections. Section 1 presents data obtained by Research Laboratory personnel in or adjacent to the proposed I 696 corridor. Section 2 presents Research Laboratory data obtained near existing Detroit freeways for background information. Section 3 presents data from the Wayne County Health Department.

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[1] Implementation Plan for the Control of Suspended Particulates, Sulfur Oxides, Carbon Monoxide, Hydrocarbons, Nitrogen Oxides, and Photochemical Oxidants in the State of Michigan, January 1972, pp. 1-2.

TABLE 1
WEATHER DATA FOR DAYS WHEN AIR ANALYSES WERE MADE
(From Detroit City Airport)

Date	Hour	Sky Cover, tenths	Ceiling, hunds. of ft	Visibility, miles	Weather[1]	Temp, F	Wind	
							Direc-tion	Speed, mph
8-16-71	1	0	200	13		59	34	6
	4	0	200	7		57	35	6
	7	0	200	7		60	07	4
	10	3	200	7		72	09	10
	13	0	200	7		75	08	10
	16	0	200	10		77	10	8
	19	0	200	8		75	12	6
	22	0	200	8		67	19	8
8-17-71	1	0	200	7		63	33	5
	4	0	200	10		61	28	4
	7	0	200	7		63	30	4
	10	0	200	6	K	75	35	5
	13	0	200	7		82	09	9
	16	0	200	7		83	12	10
	19	0	200	7		79	16	10
	22	0	200	7		72	24	4
8-18-71	1	0	200	6	H	66	07	4
	4	0	200	5	H	64	00	0
	7	2	200	2	GF, K, H	65	00	0
	10	3	200	2	K, H	80	13	6
	13	0	200	5	K, H	86	17	13
	16	0	200	4	K, H	86	16	13
	19	0	200	4	K, H	82	19	14
	22	0	200	6	K, H	76	19	8
8-19-71	1	0	200	5	K, H	72	22	8
	4	0	200	5	K, H	69	26	5
	7	1	200	2	K, H	69	23	4
	10	6	50	4	K, H	80	26	10
	13	6	50	4	K, H	86	23	19
	16	6	50	4	K, H	89	23	18
	19	8	100	4	K, H	85	23	19
	22	10	50	3	RW, K, H	76	24	15
8-20-71	1	10	50	3	K, H	75	22	14
	4	5	200	6	K, H	73	24	14
	7	2	200	2	K, H	73	25	13
	10	8	35	4	K, H	81	27	13
	13	7	30	5	K, H	85	29	13
	16	6	50	7		89	29	13
	19	2	200	10		87	27	13
	22	8	80	10		84	24	8
8-25-71	1	10	100	7		68	14	13
	4	10	17	7		70	21	13
	7	8	45	4	K, H	70	23	13
	10	4	200	7		75	34	15
	13	2	200	7		82	31	15
	16	4	200	13		83	31	8
	19	5	200	13		78	10	9
	22	2	200	13		73	13	10

[1] K = smoke; H = haze; GF = ground fog; RW = rain showers.

SECTION 1. Air Quality Data Obtained Adjacent to the Proposed I 696 Corridor

Sampling stations are shown on portions of a strip map for the proposed corridor (Figs. 4 and 5). All of the samples were taken between 6 a.m. and 8:30 p.m. Table 1 shows typical weather conditions during the sampling period. Carbon monoxide was determined by the NBS indicator tube method. Nitrogen dioxide was determined by the Griess Saltzman method, using sample collection periods ranging between one-half and two hours at a flow rate of 200 ml/min.

Station Locations

Station A - Station A is located in a sparsely settled subdivision, as shown in Figure 4. The few houses near the sampling site are indicated by small rectangles. Open land area around the houses is covered by brush and tall weeds. Analyses were made during off-peak traffic periods.

Station B - Station B is located within 100 ft of the proposed right-of-way as shown in Figure 5. The area east of Woodward Ave along Ten Mile Rd is a general business area that merges into a well maintained residential section. Sampling was done along Main St which carried a steady flow of traffic that moved well on the occasions it was observed. Analyses were made during peak traffic periods.

Stations C and D - Stations C and D are also shown in Figure 5. Station C is north of Station B, within 200 ft of the proposed right-of-way. Station D is north of Station C, within 600 ft of the proposed right-of-way. Analyses were made during peak traffic periods.

Station E - Station E is located east of Station D as shown in Figure 5. This area was sampled to check a district along the railroad indicated to be "industrial" on the map of existing land use along the proposed corridor. The area actually contained mostly warehouses and shipping docks and appeared to be little used. Analyses were made during off-peak traffic periods.

Federal air quality standards for carbon monoxide and nitrogen dioxide are:

Carbon Monoxide - (a) 10 mg/cu m maximum 8-hr concentration not to be exceeded more than once per year.
(b) 40 mg/cu m maximum 1-hr concentration not to be exceeded more than once per year.

Nitrogen Dioxide - 100 μg/cu m annual arithmetic mean

Data Obtained From the Sampling Stations
(When no average is reported a single measurement is indicated)

Station	Carbon Monoxide, mg/cu m less than	Nitrogen Dioxide, μg/cu m
A	1.0 avg	60
B	4.4 avg	140 avg
C	3.3 avg	140 avg
D	3.3 avg	200 avg
E	1.1 avg	120

Carbon monoxide levels are currently estimated to average 1.4 mg/cu m for most of the proposed corridor, which is bordered by residential areas. The lowest values measured were raised somewhat to correct for the fact that analyses were conducted during off-peak traffic periods. In the area of Woodward Ave and Main St the area is more commercially developed and traffic is heavier, as reflected in the peak traffic measurements at Stations B, C, and D. If allowance is made for off-peak periods, the average ambient carbon monoxide level in the Woodward Ave - Main St area is estimated at 2.5 mg/cu m.

The short term nitrogen dioxide samples, with values higher than the standards, do not include parts of the day when lower nitrogen dioxide levels would be expected. It is also known that short term sampling may yield results higher than the true long term average concentration. Ambient levels of nitrogen dioxide will be estimated from data presented later.

Hydrocarbon data have not been included because no data which can be compared with the Federal air quality standards are available. Also, hydrocarbons at the concentrations encountered in ambient air are not hazardous to health; and photochemical smog, which requires hydrocarbons to form, is not believed to occur with any significant frequency in Michigan.[2]

[2] Implementation Plan for the Control of Suspended Particulates, Sulfur Oxides, Carbon Monoxide, Hydrocarbons, Nitrogen Oxides, and Photochemical Oxidants in the State of Michigan, January 1972, pp. 1-1.

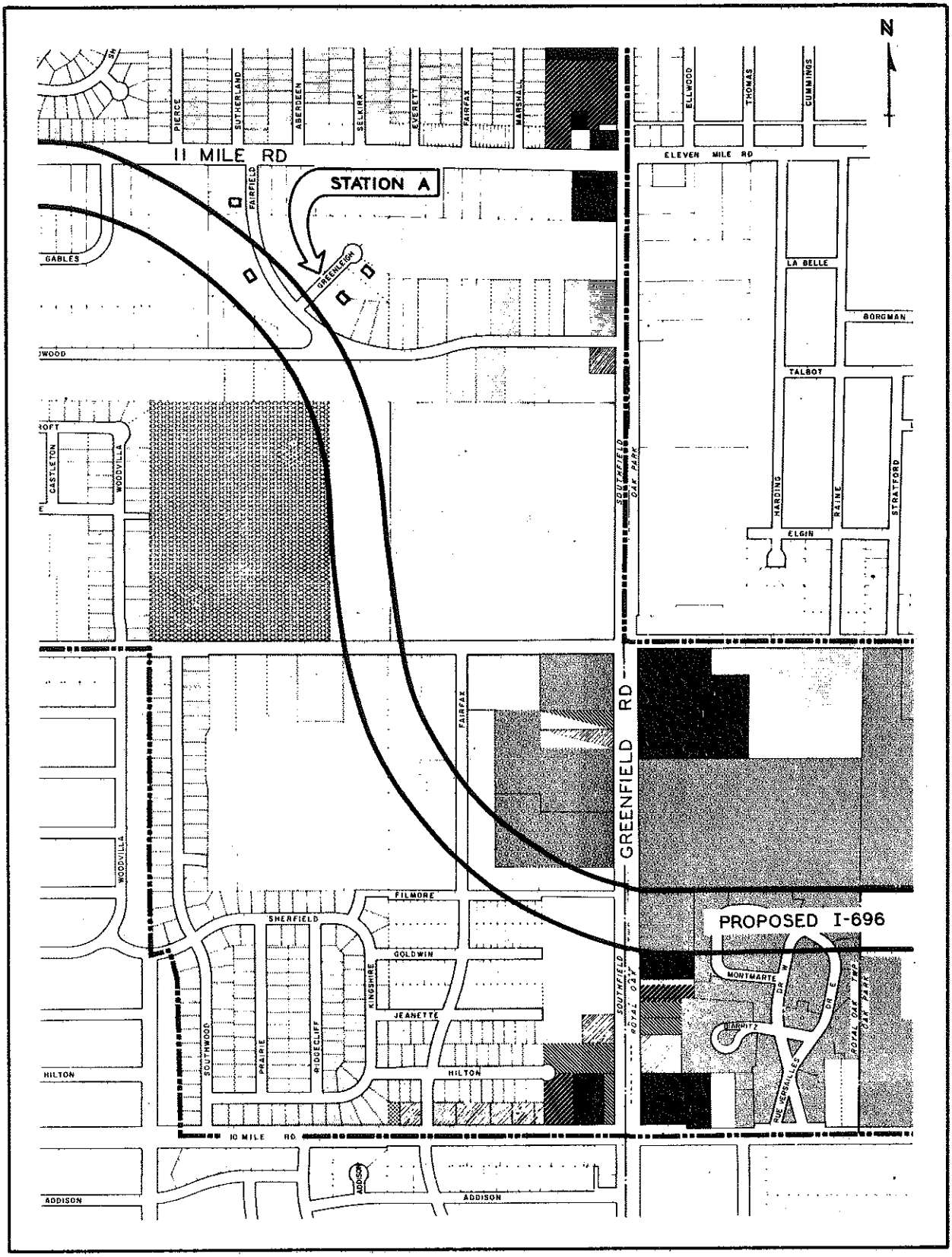

Figure 4. Station A location.

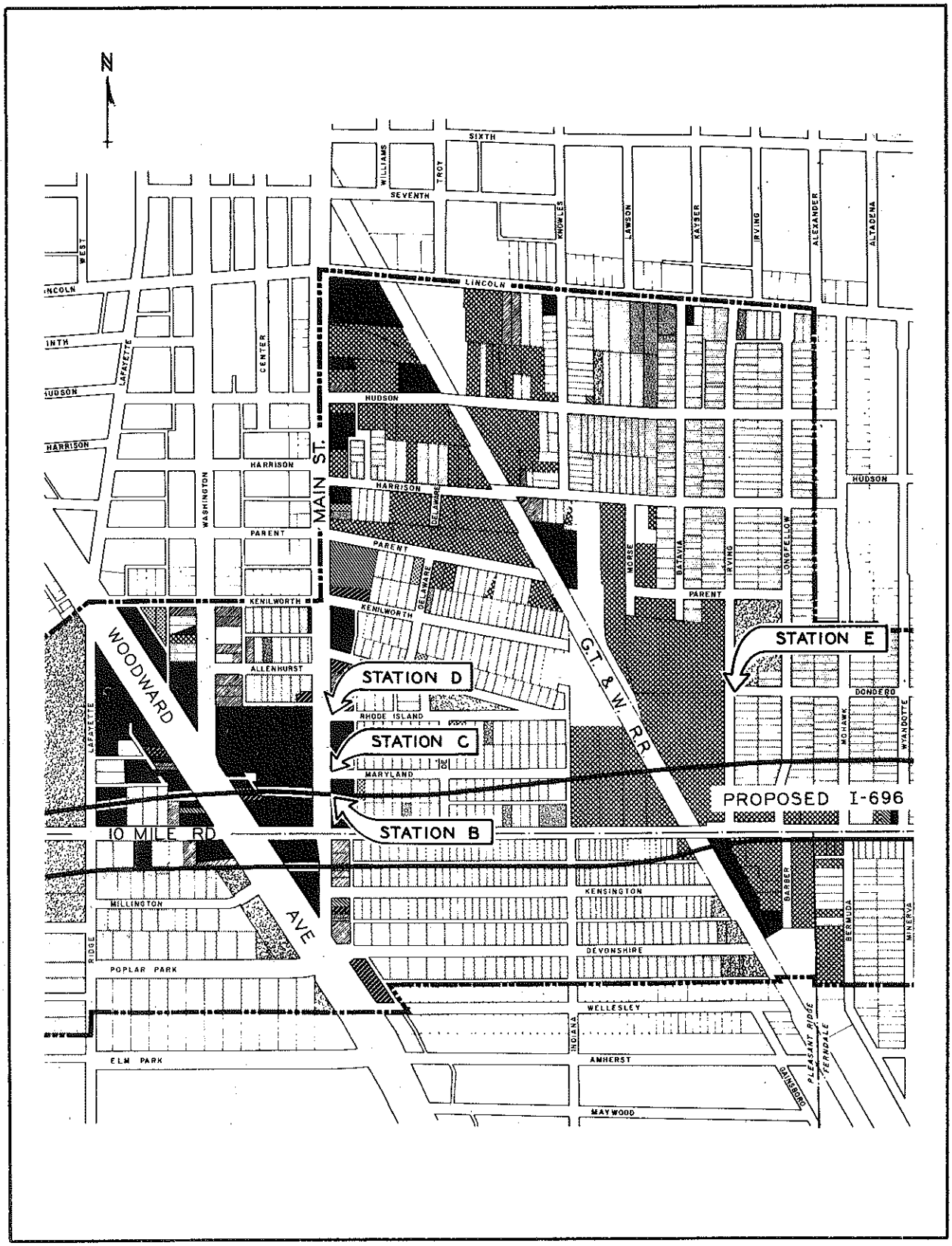

Figure 5. Station B, C, D, and E locations.

SECTION II. Other Data Obtained in the Detroit Area

Station Locations

Station F - Located on a service road shoulder on the east side of the Lodge Freeway near Nine Mile Rd, adjacent to a depressed freeway with light surface traffic. The Lodge Freeway heads in a northwest-southeast direction in this area.

Station G - This station is located on the east service road shoulder of the Lodge Freeway at Seven Mile Rd, adjacent to a depressed freeway with heavy surface traffic.

Station H and I - Station H is located approximately 200 ft east of the Lodge Freeway on Seven Mile Rd, Station I is approximately 600 ft east of the Lodge Freeway on Seven Mile Rd.

Measurements were made during off-peak afternoon traffic at Station F. Measurements at Stations G, H, and I were made during morning and afternoon peak traffic periods. No measurements were made at roadway level for depressed freeway sections.

Data Obtained From the Sampling Locations
(Where no average is recorded a single measurement is indicated)

Station	Carbon Monoxide, mg/cu m	Nitrogen Dioxide, μg/cu m
F	1.1 avg	160
G	6.6 avg 4.4 to 8.8 range	140 avg 80 to 200 range
H	6.6 avg 5.5 to 8.8 range	180
I	4.4 avg 3.3 to 5.5 range	110 avg 100 to 120 range

No winds parallel to the Lodge Freeway were observed during the period of air sampling. Even during rush hour traffic carbon monoxide levels adjacent to this existing freeway are observed to be well within Federal air quality standards. Again, short term samples do not permit comparison of nitrogen dioxide levels with air quality standards, which are based on an annual average.

SECTION III. Data From Wayne County Department of Health

The following table presents carbon monoxide data obtained by the Wayne County Department of Health near the Fisher Freeway (I 75) at 16th St in downtown Detroit. The sample site is on the shoulder of an exit ramp of I 75 between the freeway and Michigan Ave (US 12), a heavily travelled highway. Both the freeway, which is depressed, and Michigan Ave travel east-west in this area, making the location comparable to the bulk of proposed I 696. The data show that this existing area adjacent to a freeway and heavy surface traffic, resulting in a heavier combined traffic volume than would be expected anywhere along proposed I 696, is well below the Federal requirement for levels of carbon monoxide.

WAYNE COUNTY DEPARTMENT OF HEALTH
DATA FOR CARBON MONOXIDE
(Fisher Freeway - 16th St)

Date	Hours sampled	Max. hour mg/cu m	Avg. all hours mg/cu m	Max. 8-hr avg. mg/cu m
Sept. 1970	384	12.1	4.6	---
Oct. 1970	360	12.1	4.1	8.2
Nov. 1970	720	8.8	3.2	5.3
Dec. 1970	528	11.5	3.7	7.3
Jan. 1971	744	9.3	2.4	---
Feb. 1971	576	12.1	---	8.9
Mar. 1971	552	7.6	---	5.9

The next table presents Wayne County Health Department data for nitrogen dioxide at a downtown Detroit location. The cumulative average for this data is 50 μg/cu m. This figure may be taken as the existing average ambient nitrogen dioxide level in the Woodward Ave - Main St area. The remainder of the proposed construction corridor, being less commercial, is estimated to have an average ambient nitrogen dioxide level of 25 μg/cu m.

WAYNE COUNTY DEPARTMENT OF HEALTH
DATA FOR NITROGEN DIOXIDE
(Measured at 1311 E. Jefferson Ave., Detroit)

Date	24-hr avg., μg/cu m
Aug. 31, 1970	50
Sept. 8, 1970	50
9,	30
10,	40
15,	40
16,	40
18,	100
19,	60
21,	50
25,	40
Oct. 19, 1970	40
20,	40
22,	40
23,	40
26,	40
28,	50
30,	50
Nov. 6, 1970	50
9,	50
	Cumulative Avg. = 50

CALCULATED POLLUTANT LEVELS

An analysis was made to estimate ground level concentrations of traffic-emitted pollutants (carbon monoxide, nitrogen oxides) under varying conditions at several distances from, and normal to, the shoulder of the roadway. California's generally unvalidated highway line source dispersion model was used. This model was recommended for use at a workshop given by the Environmental Protection Agency at Durham, North Carolina during May 1972. It includes meteorological conditions, traffic volumes, traffic emission factors, and highway design as variables.

The basic method of calculation is derived from a general form given in EPA's "Workbook of Atmospheric Dispersion Estimates," AP-26, by Turner (1970). Assumptions used in this approach to atmospheric dispersion estimation include the following: the plume spread has a normal distribution in both horizontal and vertical planes, total reflection of the plume at the earth's surface, uniform wind flow field, atmospheric stability classes representative of open areas, roadways as continuous infinite line sources, and continuous emission from source vehicles for the time period analyzed.

Meteorological data (hourly observations) recorded at Detroit City Airport were summarized over a four-year period from 1967 to 1971 based on a one day in nine day statistical sampling with a random start each year. The data were obtained from the National Weather Records Center at Asheville, North Carolina on microfilm and were the best data available at the time for the proposed I 696 highway corridor.

Emission factors were obtained from the U.S. Environmental Protection Agency, Office of Air Programs Publication, "Compilation of Air Pollutant Emission Factors," No. AP-42, Table 3-1. The 1975 emissions were adjusted for vehicle speed according to Figures 3-1 and 3-2 of the same publication in order to fit the peak and off-peak average traffic speeds for this project. These speed adjusted emissions were used as a base and further adjusted for future years according to projected national urban emissions from motor vehicles as shown in Figures 1-3 in the August 14, 1971 Federal Register. The emission factors so derived and used for this study are:

Emission Factors, g/mi

Year	CO		NO_x
	30 mph	50 mph	
1980	20.5	13.4	2.6
1982	14.7	9.6	1.8
1985	8.2	5.4	1.2
1990	5.1	3.3	0.6
1995	5.1	3.3	0.6
2000	5.1	3.3	0.6

No variation in the NO_x emissions with speed appear since AP-42 states that, "... nitrogen oxides are independent of speed." and hence no speed adjustment graph was provided.

Pollutant concentrations were estimated for:

1) Each section of the freeway between interchanges
2) Carbon monoxide and nitrogen oxides (as NO_2)
3) The years 1980 (estimated opening), 1982, 1985, 1995, and 2000
4) Distances of 40, 60, and 100 meters from the edge of the roadway.

Information used as the input to the mathematical model consisted of:

1) Peak a.m. (7 to 9), peak p.m. (4 to 6) and off-peak traffic volumes. Traffic estimates are shown in the Appendix. Off-peak traffic volume was approximated by:

$$\frac{\text{ADT} - 2(\text{peak hour})}{22}$$

2) Worst meteorological conditions and most probable meteorological conditions. Worst meteorological conditions were taken as a 3 mph wind parallel to the roadway, under Atmospheric Stability Class D.[3] Most probable meteorological conditions (shown in data tables) were chosen for the time of day involved, and Atmospheric Stability Class D (by far the most likely in Michigan) was used.

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[3] Calculations were made for parallel wind under Stability Classes D and F. Since pollutant levels were higher for Class D, the Class D values are reported as the worst case. The California Division of Highways has also found highest pollutant levels for Class D in some parallel wind cases.

The Atmospheric Stability Class describes the amount of vertical movement of air near the earth's surface due to temperature differentials. During periods of bright sunlight (strong insolation) the earth's surface is heated and warm air close to the earth's surface rises, carrying any pollutants present with it. This is an unstable condition (Class A) which aids in dispersing pollutants. When there is no upward movement of warm air away from the earth's surface, the atmosphere is said to be stable (Class F). A stable atmosphere tends to increase pollutant concentrations because dispersal of pollutants away from the source is impaired. In the Appendix, Table 5 shows the stability classification system, and Table 6 indicates the meteorological conditions used to determine which stability class prevails. The frequency distribution of stability classes for the meteorological data used is shown in the Appendix as Table 7.

3) Depressed roadways 15 ft below ground level. The 15-ft plot of factors for depressed roadways in the model was closest to the actual average depth of 16 ft. The roadway depth is 20 to 24 ft in places, but the increase in pollutant levels due to such depth over short distances was not judged significant. Figure 6 relates carbon monoxide levels to roadway depth for parallel and crosswind situations.

4) Freeway width was taken as 50 meters (164 ft) except for the Lahser to Evergreen section where a width of 46.3 meters (152 ft) was used due to a reduction in the amount of weaving lane planned for that section. Width was calculated as follows:

Ten 12-ft lanes (including 2 weaving lanes)	120 ft
Two 10-ft shoulders	20 ft
One 24-ft median.	24 ft
	164 ft

All estimates are intended to provide maximum one-hour concentrations and are in addition to the ambient levels. Traffic estimates for the condition of not building the freeway were not available, so future air quality for the no-build condition could not be estimated. Deterioration of air quality as traffic increases on existing roadways is to be expected.

Tables 2, 3, and 4 present the pollution estimates. Nitrogen oxides, as nitrogen dioxide, are included for information purposes. There is no emission factor for nitrogen dioxide as such, so no comparison of the estimates with the air quality standard is possible. It will be noted that pollutant concentrations near the freeway are higher for parallel winds than for crosswinds, but that the rate of decrease of pollutant concentrations with distance away from the freeway is much greater for parallel winds than for crosswinds. This is because pollutants in the parallel wind case are dispersing in a direction normal to the wind direction, which dictates that the concentration falls off with distance according to an exponential factor. Pollutants in the crosswind case are being dispersed in the same general direction as the wind is moving, so that the concentration falls off in a rather linear fashion.

The tables present pollution estimates for both worst and most probable meteorological conditions as follows:

Table 2 - Peak morning traffic (7 to 9 a.m.)
Table 3 - Peak afternoon traffic (4 to 6 p.m.)
Table 4 - Off-peak or average traffic

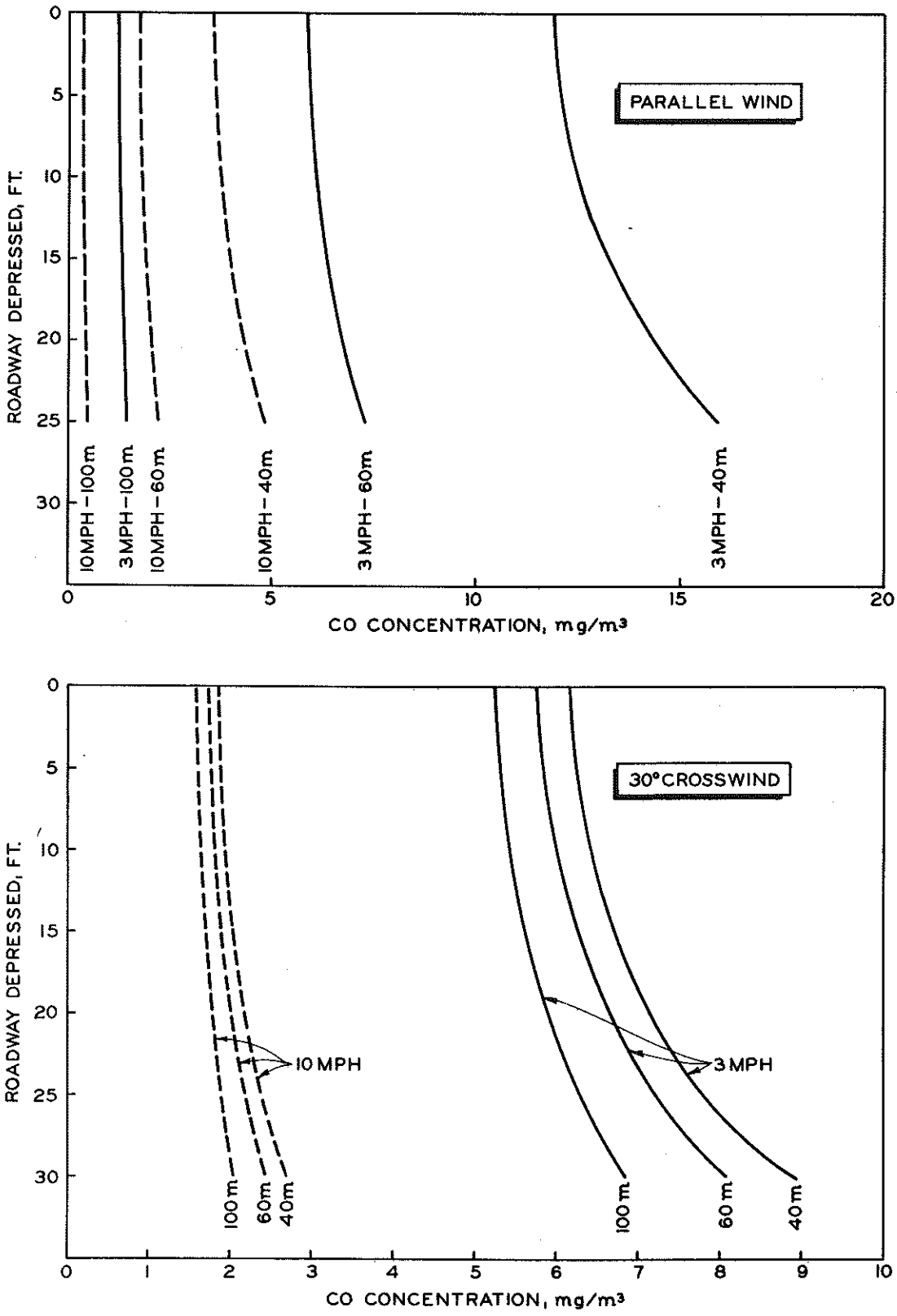


Figure 6. Relationship between depth of roadway depression and pollutant levels at 40m, 60m and 100m distance from the roadway for atmospheric stability Class D and wind speeds of 3 and 10 mph.

TABLE 2
POLLUTION ESTIMATES FOR PEAK TRAFFIC, 7-9 a.m.
(Atmospheric Stability Class D, Traffic at 30 mph)

Location	Traffic Projection Year	40 Meter Distance From Edge of Freeway Shoulder				60 Meter Distance From Edge of Freeway Shoulder				100 Meter Distance From Edge of Freeway Shoulder			
		Worst Condition, Parallel Wind, 3.0 mph		Most Probable Condition, 10 mph Wind at 30° to the Highway		Worst Condition, Parallel Wind, 3.0 mph		Most Probable Condition, 10 mph Wind at 30° to the Highway		Worst Condition, Parallel Wind, 3.0 mph		Most Probable Condition, 10 mph Wind at 30° to the Highway	
		CO, mg/cu m	NO_2, μg/cu m	CO, mg/cu m	NO_2, μg/cu m	CO, mg/cu m	NO_2, μg/cu m	CO, mg/cu m	NO_2, μg/cu m	CO, mg/cu m	NO_2, μg/cu m	CO, mg/cu m	NO_2, μg/cu m
Lahser to Evergreen [1]	1980	10.5	1311	1.3	164	5.3	660	1.2	154	1.0	132	1.1	136
	1982	8.2	996	1.0	123	4.2	502	1.0	117	0.8	101	0.9	104
	1985	5.3	706	0.7	88	2.7	356	0.6	83	0.5	72	0.6	74
	1990	3.5	412	0.4	51	1.8	208	0.4	48	0.4	42	0.4	43
	1995	4.1	470	0.5	59	2.1	237	0.5	55	0.4	48	0.4	49
	2000	4.7	536	0.6	66	2.3	269	0.5	63	0.5	54	0.5	56
Evergreen to Southfield [1]	1980	11.7	1462	1.5	188	5.9	736	1.4	176	1.2	148	1.2	156
	1982	9.0	1093	1.2	140	4.6	550	1.1	132	0.9	110	1.0	117
	1985	5.6	746	0.7	95	2.8	375	0.7	90	0.6	75	0.6	80
	1990	3.9	456	0.5	58	2.0	229	0.5	55	0.4	46	0.4	49
	1995	4.1	466	0.5	60	2.0	236	0.5	56	0.4	47	0.4	50
	2000	4.2	488	0.5	62	2.1	246	0.5	59	0.4	49	0.5	52
Southfield to Greenfield [1,2]	1980	9.7	1210	0.9	111	4.9	610	0.8	104	1.0	122	0.7	93
	1982	7.5	905	0.7	83	3.8	456	0.6	78	0.8	91	0.6	69
	1985	4.6	619	0.4	56	2.3	312	0.4	53	0.5	63	0.4	47
	1990	3.2	376	0.3	34	1.6	190	0.3	32	0.3	38	0.2	29
	1995	3.4	391	0.3	36	1.7	218	0.3	34	0.3	39	0.3	30
	2000	3.5	407	0.3	37	1.8	205	0.3	35	0.4	41	0.3	31
Greenfield to Coolidge [1]	1980	13.2	1650	1.8	220	6.6	831	1.7	209	1.3	167	1.5	185
	1982	9.8	1188	1.3	158	4.9	598	1.2	150	1.0	120	1.1	133
	1985	5.7	762	0.8	102	2.9	384	0.7	96	0.6	77	0.6	86
	1990	3.7	438	0.5	59	1.9	221	0.5	55	0.4	44	0.4	49
	1995	3.9	451	0.5	60	2.0	226	0.5	57	0.4	45	0.4	50
	2000	4.0	462	0.5	62	2.0	232	0.5	58	0.4	47	0.4	52
Coolidge to Woodward [3]	1980	14.5	1808	1.8	229	7.3	910	1.7	216	1.5	182	1.5	192
	1982	10.8	1302	1.3	164	5.4	656	1.3	156	1.1	131	1.1	138
	1985	6.3	846	0.8	107	3.2	426	0.8	101	0.6	85	0.7	90
	1990	4.1	484	0.5	61	2.1	243	0.5	58	0.4	49	0.4	51
	1995	4.3	491	0.5	62	2.2	247	0.5	59	0.4	50	0.5	52
	2000	4.4	502	0.6	64	2.2	253	0.5	60	0.4	51	0.5	53
Woodward to Mohawk [3]	1980	15.5	1935	2.0	245	7.8	975	1.8	231	1.6	195	1.6	205
	1982	11.5	1392	1.4	175	5.8	700	1.4	166	1.2	140	1.2	148
	1985	6.7	899	0.8	114	3.4	453	0.8	107	0.7	91	0.7	95
	1990	4.2	494	0.5	62	2.1	249	0.5	59	0.4	50	0.4	52
	1995	4.3	497	0.5	63	2.2	250	0.5	59	0.4	50	0.5	52
	2000	4.4	508	0.6	64	2.2	256	0.5	61	0.4	51	0.5	54
Campbell to I 75 [1]	1980	16.0	2006	2.1	251	8.1	1010	1.9	238	1.6	202	1.7	211
	1982	11.9	1428	1.5	182	6.0	719	1.4	171	1.2	145	1.2	151
	1985	6.8	916	0.9	115	3.4	462	0.8	108	0.7	93	0.7	96
	1990	4.3	500	0.5	63	2.2	252	0.5	59	0.4	50	0.4	52
	1995	4.4	501	0.5	63	2.2	252	0.5	59	0.4	51	0.5	53
	2000	4.4	512	0.6	64	2.2	258	0.5	61	0.4	52	0.5	54

[1] Ambient CO level estimated at 1.4 mg/cu m.
[2] Most probable 7-9 a.m. wind direction, Southfield to Greenfield, is at 60° to the freeway.
[3] Ambient CO level near Woodward estimated at 2.5 mg/cu m.

TABLE 3
POLLUTION ESTIMATES FOR PEAK TRAFFIC, 4-6 p.m.
(Atmospheric Stability Class D, Traffic at 30 mph)

Location	Traffic Projection Year	40 Meter Distance From Edge of Freeway Shoulder				60 Meter Distance From Edge of Freeway Shoulder				100 Meter Distance From Edge of Freeway Shoulder			
		Worst Condition, Parallel Wind, 3.0 mph		Most Probable Condition, Parallel Wind, 10 mph		Worst Condition, Parallel Wind, 3.0 mph		Most Probable Condition, Parallel Wind, 10 mph		Worst Condition, Parallel Wind, 3.0 mph		Most Probable Condition, Parallel Wind, 10 mph	
		CO, mg/cu m	NO_2, µg/cu m	CO, mg/cu m	NO_2, µg/cu m	CO, mg/cu m	NO_2, µg/cu m	CO, mg/cu m	NO_2, µg/cu m	CO, mg/cu m	NO_2, µg/cu m	CO, mg/cu m	NO_2, µg/cu m
Lahser to Evergreen[1]	1980	9.6	1197	2.9	359	4.8	603	1.4	181	1.0	121	0.3	36
	1982	7.6	920	2.3	276	3.8	463	1.2	139	0.8	93	0.2	28
	1985	4.9	652	1.5	196	2.4	328	0.7	98	0.5	66	0.2	20
	1990	3.3	380	1.0	114	1.6	192	0.5	57	0.3	38	0.1	11
	1995	3.8	435	1.1	130	1.9	219	0.6	66	0.4	44	0.1	13
	2000	4.4	500	1.3	150	2.2	252	0.7	76	0.4	50	0.1	15
Evergreen to Southfield[1]	1980	12.0	1495	3.6	449	6.0	753	1.8	226	1.2	151	0.4	45
	1982	9.2	1116	2.8	334	4.6	562	1.4	168	0.9	113	0.3	34
	1985	5.7	761	1.7	228	2.9	383	0.9	115	0.6	77	0.2	23
	1990	4.0	464	1.2	139	2.0	234	0.6	70	0.4	47	0.1	14
	1995	4.2	477	1.2	143	2.1	240	0.6	72	0.4	48	0.1	14
	2000	4.3	496	1.3	148	2.2	250	0.6	75	0.4	50	0.1	15
Southfield to Greenfield[1,2]	1980	9.2	1144	0.7	90	4.6	576	0.7	86	0.9	116	0.6	76
	1982	7.1	856	0.6	68	3.6	431	0.5	64	0.7	86	0.5	57
	1985	4.4	588	0.4	46	2.2	296	0.3	44	0.4	59	0.3	39
	1990	3.1	359	0.2	28	1.6	181	0.2	27	0.3	36	0.2	24
	1995	3.4	394	0.3	31	1.7	198	0.3	29	0.3	40	0.2	26
	2000	3.6	412	0.3	32	1.8	207	0.3	31	0.4	42	0.2	27
Greenfield to Coolidge[1]	1980	12.6	1573	3.8	471	6.3	792	1.9	238	1.3	159	0.4	48
	1982	9.4	1134	2.8	340	4.7	571	1.4	172	1.0	114	0.3	34
	1985	5.5	730	1.6	220	2.8	368	0.8	110	0.6	74	0.2	22
	1990	3.6	419	1.1	125	1.8	211	0.5	63	0.4	42	0.1	13
	1995	3.8	439	1.1	131	1.9	221	0.6	66	0.4	44	0.1	13
	2000	4.0	466	1.2	139	2.0	235	0.6	70	0.4	47	0.1	14
Coolidge to Woodward[3]	1980	13.8	1722	4.1	516	6.9	867	2.1	260	1.4	174	0.4	52
	1982	10.3	1242	3.1	373	5.2	625	1.6	188	1.0	125	0.3	38
	1985	6.1	811	1.8	242	3.0	408	0.9	122	0.6	82	0.2	24
	1990	3.9	462	1.2	139	2.0	232	0.6	70	0.4	47	0.1	14
	1995	4.2	486	1.2	145	2.1	245	0.6	73	0.4	49	0.1	15
	2000	4.4	507	1.3	152	2.2	255	0.7	76	0.4	51	0.1	15
Woodward to Mohawk[3]	1980	15.2	1902	4.6	570	7.7	958	2.3	288	1.5	192	0.5	58
	1982	11.3	1369	3.4	410	5.7	689	1.7	207	1.1	138	0.3	41
	1985	6.6	882	2.0	264	3.3	444	1.0	133	0.7	89	0.2	27
	1990	4.2	488	1.2	146	2.1	246	0.6	74	0.4	49	0.1	15
	1995	4.4	503	1.3	151	2.2	253	0.7	76	0.4	51	0.1	15
	2000	4.5	520	1.4	155	2.3	262	0.7	78	0.5	52	0.1	16
Campbell to I 75[1]	1980	16.0	2003	4.8	600	8.1	1009	2.4	302	1.6	202	0.5	61
	1982	11.9	1438	3.6	431	6.0	724	1.8	218	1.2	150	0.4	44
	1985	6.8	909	2.0	273	3.4	458	1.0	137	0.7	92	0.2	27
	1990	4.3	428	1.3	150	2.2	216	0.6	76	0.4	50	0.1	15
	1995	4.5	513	1.3	154	2.2	258	0.7	77	0.4	52	0.1	16
	2000	4.6	524	1.4	156	2.3	264	0.7	79	0.5	53	0.1	16

[1] Ambient CO level estimated at 1.4 mg/cu m.
[2] Most probable 4-6 p.m. wind direction, Southfield to Greenfield, is at 90° to the freeway.
[3] Ambient CO level near Woodward estimated at 2.5 mg/cu m.

TABLE 4
POLLUTION ESTIMATES FOR OFF-PEAK TRAFFIC
(Atmospheric Stability Class D, Traffic at 50 mph)

Location	Traffic Projection Year	40 Meter Distance From Edge of Freeway Shoulder				60 Meter Distance From Edge of Freeway Shoulder				100 Meter Distance From Edge of Freeway Shoulder			
		Parallel Wind, 3.0 mph		Overall Most Probable Condition, 10 mph wind, at 20° to the Highway		Parallel Wind, 3.0 mph		Overall Most Probable Condition, 10 mph wind, at 20° to the Highway		Parallel Wind, 3.0 mph		Overall Most Probable Condition, 10 mph wind, at 20° to the Highway	
		CO, mg/cu m	NO_2, μg/cu m	CO, mg/cu m	NO_2, μg/cu m	CO, mg/cu m	NO_2, μg/cu m	CO, mg/cu m	NO_2, μg/cu m	CO, mg/cu m	NO_2, μg/cu m	CO, mg/cu m	NO_2, μg/cu m
Lahser to Evergreen[1]	1980	1.8	347	0.3	63	0.9	175	0.3	60	0.2	35	0.3	53
	1982	1.4	268	0.3	49	0.7	135	0.2	46	0.2	27	0.2	41
	1985	0.9	190	0.2	34	0.5	95	0.2	32	0.1	19	0.1	29
	1990	0.7	129	0.1	23	0.4	65	0.1	22	0.1	13	0.1	20
	1995	0.8	150	0.2	27	0.4	76	0.1	26	0.1	15	0.1	23
	2000	1.0	174	0.2	32	0.5	90	0.2	30	0.1	18	0.2	26
Evergreen to Southfield[1]	1980	2.6	496	0.5	93	1.3	250	0.5	88	0.3	50	0.4	78
	1982	2.0	370	0.4	69	1.0	187	0.4	65	0.2	37	0.3	58
	1985	1.2	252	0.2	47	0.6	127	0.2	44	0.1	25	0.2	40
	1990	0.9	164	0.2	31	0.5	83	0.2	29	0.1	17	0.1	26
	1995	1.1	189	0.2	35	0.5	95	0.2	33	0.1	19	0.2	30
	2000	1.2	213	0.2	40	0.6	107	0.2	38	0.1	22	0.2	34
Southfield to Greenfield[1,2]	1980	2.4	463	0.2	39	1.2	233	0.2	37	0.2	47	0.2	33
	1982	1.9	347	0.2	29	0.9	175	0.2	28	0.2	35	0.1	24
	1985	1.2	236	0.1	20	0.6	119	0.1	19	0.1	24	0.1	17
	1990	0.8	151	0.1	13	0.4	76	0.1	12	0.1	15	0.1	11
	1995	1.0	170	0.1	14	0.5	86	0.1	14	0.1	17	0.1	12
	2000	1.1	193	0.1	16	0.6	97	0.1	15	0.1	19	0.1	14
Greenfield to Coolidge[1]	1980	3.3	634	0.6	124	1.7	319	0.6	117	0.3	64	0.5	104
	1982	2.5	456	0.5	89	1.2	229	0.4	84	0.2	46	0.4	75
	1985	1.5	297	0.3	58	0.7	150	0.3	55	0.1	30	0.2	49
	1990	1.0	166	0.2	34	0.5	89	0.2	33	0.1	18	0.2	29
	1995	1.0	187	0.2	37	0.5	94	0.2	34	0.1	19	0.2	31
	2000	1.1	202	0.2	40	0.6	102	0.2	37	0.1	20	0.2	33
Coolidge to Woodward[3]	1980	3.6	689	0.7	128	1.8	347	0.6	120	0.4	70	0.6	107
	1982	2.7	496	0.5	92	1.4	250	0.5	87	0.3	50	0.4	77
	1985	1.6	323	0.3	60	0.8	163	0.3	57	0.2	33	0.2	50
	1990	1.1	194	0.2	36	0.5	98	0.2	34	0.1	20	0.2	30
	1995	1.2	206	0.2	38	0.6	104	0.2	36	0.1	21	0.2	32
	2000	1.2	222	0.2	41	0.6	112	0.2	39	0.1	22	0.2	34
Woodward to Mohawk[3]	1980	4.0	773	0.8	143	2.0	389	0.7	135	0.4	78	0.6	120
	1982	3.0	555	0.6	103	1.5	280	0.5	97	0.3	56	0.5	86
	1985	1.8	358	0.3	66	0.9	180	0.3	62	0.2	36	0.3	55
	1990	1.2	212	0.2	39	0.6	107	0.2	37	0.1	21	0.2	33
	1995	1.3	223	0.2	41	0.6	112	0.2	39	0.1	23	0.2	34
	2000	1.3	239	0.2	44	0.7	121	0.2	42	0.1	24	0.2	37
Campbell to I 75[1]	1980	4.2	798	0.8	146	2.1	402	0.7	138	0.4	81	0.6	123
	1982	3.1	574	0.6	106	1.6	289	0.5	100	0.3	58	0.5	88
	1985	1.8	371	0.3	68	0.9	187	0.3	64	0.2	37	0.3	57
	1990	1.2	220	0.2	40	0.6	111	0.2	38	0.1	22	0.2	34
	1995	1.3	229	0.2	42	0.6	115	0.2	40	0.1	23	0.2	35
	2000	1.4	247	0.3	45	0.7	125	0.2	43	0.1	25	0.2	38

[1] Ambient CO level estimated at 1.4 mg/cu m.
[2] Most probable overall wind direction, Southfield to Greenfield, is at 70° to the freeway.
[3] Ambient CO level near Woodward estimated at 2.5 mg/cu m.

The peak traffic data for carbon monoxide should be compared with the 40 mg/cu m maximum figure in the Federal standard. The data for off-peak traffic should be compared with the standard's 10 mg/cu m requirement.

One special case for potential elevated pollution levels was considered. This was for a parallel wind from the west causing pollutant build-up from Lahser Rd to the curve in proposed I 696 east of Southfield Rd, and having this build-up spill out downwind (eastward) from the curve. This situation was approximated by calculating the carbon monoxide concentration at roadway level (for peak traffic conditions) just before the curve, then dispersing that concentration downwind from a line source with length equal to 100 meters, twice the width of the highway. It was estimated that since the wall at the end of the curve would direct the pollutants around the curve, the effective length of the line source would be at least twice the freeway width. Pollutant levels would be lower in proportion to any increase in the length of the line source over which the pollutants are released. Results are:

	CO	
	3 mph wind	10 mph wind
40m downwind	24 mg/cu m	7 mg/cu m
60m downwind	16 mg/cu m	5 mg/cu m

Analysis of weather data indicates that the maximum concentrations shown above may never actually occur. The section of the freeway involved is about two miles long. Thus, it could require 2/3 of an hour after a 3 mph wind started to blow parallel to the roadway before the maximum concentration would occur at the curve. The one day in nine day sample of weather data for four years did not show up a single instance when a 3 mph wind parallel to the proposed freeway was recorded for a one hour period (two consecutive hourly observations).

APPENDIX

Traffic Estimates for Proposed I 696

Traffic Volumes: The traffic estimates for the five year networks were obtained by plotting existing estimates for 1980 and 2000 and interpolating the graphs for the remaining time periods. Data shown on next page.

Average Speed: The average speed was obtained from speed runs on freeways, in the Detroit area, which were assumed to have the same operating characteristics as the proposed project.

Speed during peak hour	30 mph	Speed off-peak	50 mph

Trip Length: The trip length was obtained from the "Southeast Michigan Council of Governments Transportation and Land Use Study," 1990 model runs.

Average Trip Length	8 miles

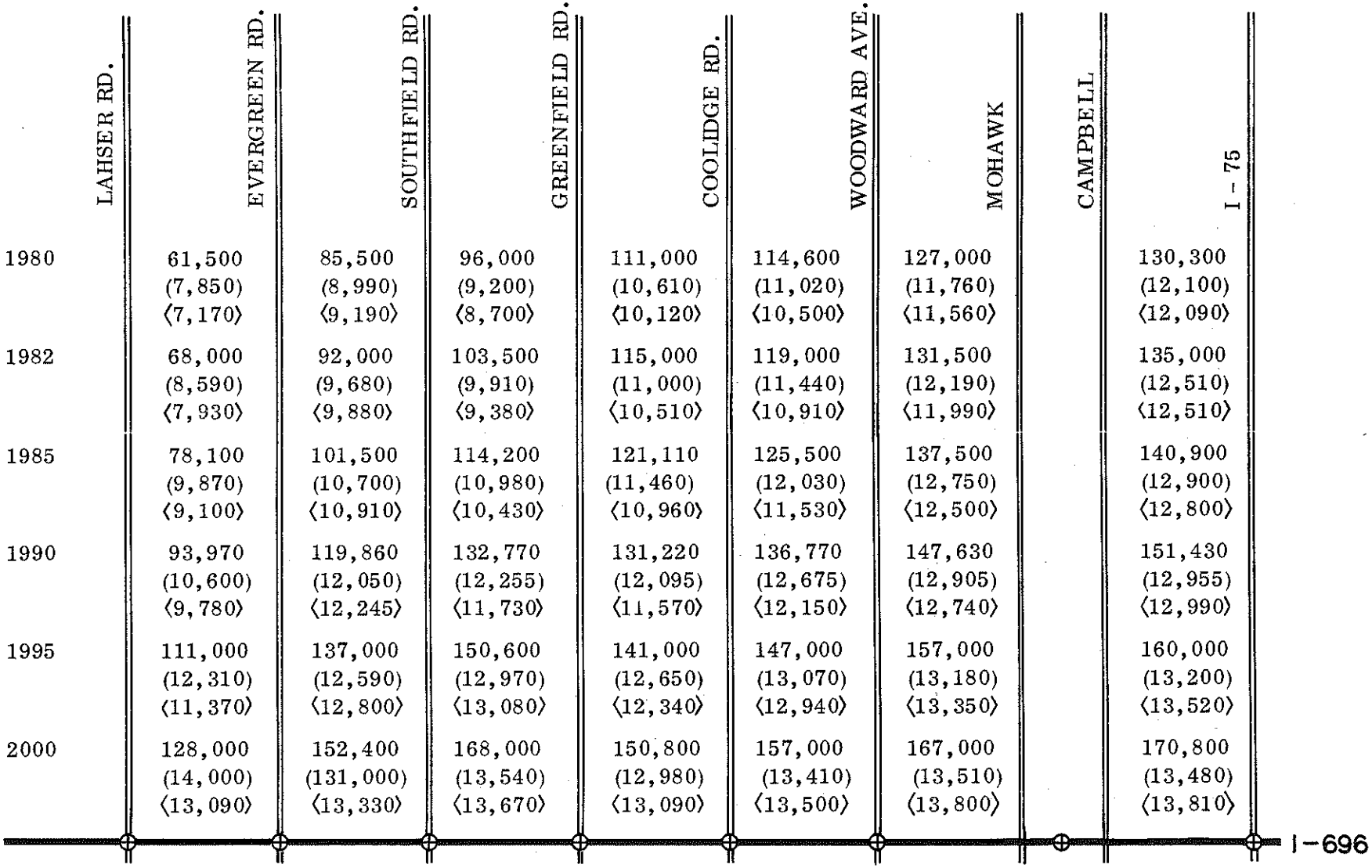
Commercial Traffic: The commercial traffic is from the 1972 "Estimate of the Cost of Completing the National System of Interstate and Defense Highways in the State of Michigan," August 1972.

Commercial Traffic of ADT	17 percent
Commercial Traffic of DHV	6 percent

Duration of Peak Hour: The duration of the peak hour was estimated from existing patterns on similar freeway facilities in the Detroit area.

Peak Duration	2 hours

TOTAL TRAFFIC
(Both Directions)



	LAHSER RD.	EVERGREEN RD.	SOUTHFIELD RD.	GREENFIELD RD.	COOLIDGE RD.	WOODWARD AVE.	MOHAWK	CAMPBELL	I - 75
1980		61,500	85,500	96,000	111,000	114,600	127,000		130,300
		(7,850)	(8,990)	(9,200)	(10,610)	(11,020)	(11,760)		(12,100)
		⟨7,170⟩	⟨9,190⟩	⟨8,700⟩	⟨10,120⟩	⟨10,500⟩	⟨11,560⟩		⟨12,090⟩
1982		68,000	92,000	103,500	115,000	119,000	131,500		135,000
		(8,590)	(9,680)	(9,910)	(11,000)	(11,440)	(12,190)		(12,510)
		⟨7,930⟩	⟨9,880⟩	⟨9,380⟩	⟨10,510⟩	⟨10,910⟩	⟨11,990⟩		⟨12,510⟩
1985		78,100	101,500	114,200	121,110	125,500	137,500		140,900
		(9,870)	(10,700)	(10,980)	(11,460)	(12,030)	(12,750)		(12,900)
		⟨9,100⟩	⟨10,910⟩	⟨10,430⟩	⟨10,960⟩	⟨11,530⟩	⟨12,500⟩		⟨12,800⟩
1990		93,970	119,860	132,770	131,220	136,770	147,630		151,430
		(10,600)	(12,050)	(12,255)	(12,095)	(12,675)	(12,905)		(12,955)
		⟨9,780⟩	⟨12,245⟩	⟨11,730⟩	⟨11,570⟩	⟨12,150⟩	⟨12,740⟩		⟨12,990⟩
1995		111,000	137,000	150,600	141,000	147,000	157,000		160,000
		(12,310)	(12,590)	(12,970)	(12,650)	(13,070)	(13,180)		(13,200)
		⟨11,370⟩	⟨12,800⟩	⟨13,080⟩	⟨12,340⟩	⟨12,940⟩	⟨13,350⟩		⟨13,520⟩
2000		128,000	152,400	168,000	150,800	157,000	167,000		170,800
		(14,000)	(131,000)	(13,540)	(12,980)	(13,410)	(13,510)		(13,480)
		⟨13,090⟩	⟨13,330⟩	⟨13,670⟩	⟨13,090⟩	⟨13,500⟩	⟨13,800⟩		⟨13,810⟩

000 = Estimated ADT
(000) = Estimated 7-9 a.m. peak
⟨000⟩ = Estimated 4-6 p.m. peak

TABLE 5

Stability Class	Description of Atmosphere
A	Extremely Unstable
B	Unstable
C	Slightly Unstable
D	Neutral
E	Nearly Stable
F	Stable

TABLE 6
ATMOSPHERIC STABILITY CLASSES

Surface Wind Speed		Daytime			Night	
mph	m/sec	Strong Insolation	Moderate Insolation	Slight Insolation	Thin Overcast, or ≥ 4/8 Low Cloud Cover	≤ 3/8 Cloud Cover
< 4.5	< 2	A	B	B	--	--
4.5- 6.7	2-3	B	B	C	E	F
6.7-11.2	3-5	B	C	C	D	E
11.2-13.4	5-6	C	D	D	D	D
>13.4	>6	C	D	D	D	D

TABLE 7
STABILITY CLASS FREQUENCY DISTRIBUTION BY HOUR
(Percent)

Hour	Stability Class					
	A	B	C	D	E	F
1	0.0	0.0	0.0	52.5	17.3	30.2
2	0.0	0.0	0.0	50.0	18.5	31.5
3	0.0	0.0	0.0	46.3	22.2	31.5
4	0.0	0.0	0.0	51.2	16.0	32.7
5	0.0	0.0	0.0	51.9	16.7	31.5
6	8.6	5.6	3.7	48.8	16.7	16.7
7	11.7	11.7	8.6	53.1	6.2	8.6
8	9.3	16.7	14.2	52.5	3.7	3.7
9	4.3	16.0	25.9	53.7	0.0	0.0
10	4.9	10.5	19.8	64.8	0.0	0.0
11	4.9	11.7	22.8	60.5	0.0	0.0
12	3.7	11.1	22.2	63.0	0.0	0.0
13	3.7	9.3	19.1	67.9	0.0	0.0
14	1.2	9.3	19.1	70.4	0.0	0.0
15	1.2	11.7	19.1	67.9	0.0	0.0
16	1.9	9.9	15.4	72.2	0.6	0.0
17	2.5	9.9	16.7	63.6	4.3	3.1
18	1.2	4.9	13.0	64.8	12.3	3.7
19	0.0	0.0	0.0	70.4	19.8	9.9
20	0.0	0.0	0.0	64.8	21.6	13.6
21	0.0	0.0	0.0	58.0	19.1	22.8
22	0.0	0.0	0.0	50.0	23.5	26.5
23	0.0	0.0	0.0	53.7	16.7	29.6
24	0.0	0.0	0.0	51.2	16.0	32.7
Overall percent	2.5	5.8	9.2	58.5	10.5	13.7