AIR QUALITY SECTION FOR THE DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR PROPOSED I 96

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

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Research Laboratory Section
Testing and Research Division
Research Project 73 TI-172
Research Report No. R-886

Michigan State Highway and Transportation Commission
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This report presents air quality information for the proposed part of I 96 shown in the map in Figure 1. Included are meteorological data, ambient air quality data and estimates of pollution levels that might occur adjacent to the roadway, should it be constructed.

Terrain

The terrain surrounding this project is quite flat, which facilitates dispersion of air pollutants.

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. Even on occasions when an atmospheric inversion restricts vertical dispersion of pollutants, horizontal ventilation continues freely. Figure 2 shows a 36-point bar graph of wind speed and direction occurrences at Detroit Metropolitan and Willow Run Airports. Hourly weather data were obtained from the National Climatic Center in Asheville, N. C. for the years 1967 through 1971 and a one-day in nine-day sampling of the hourly data with a random start each year was used to prepare meteorological data. Figure 3 is a 12-point wind rose obtained by condensing the 36-point wind data.

Figure 4 shows the distribution of wind speeds observed. Wind speeds are greater than 5 mph more than 95 percent of the time. The most probable daytime wind speed was found to be 10 mph. Atmospheric mixing depths generally range between 500 and 1,200 meters, which is very favorable for vertical dispersion of pollutants. There is insufficient time for photochemical reactions between air pollutants to occur before dilution and dispersion occur. As a result, photochemical smog of the Los Angeles type is not thought to occur in Michigan[1].

Existing Ambient Air Quality

Data for carbon monoxide from two Wayne County Health Department stations (Madonna College and Stoepel Park, Fig. 1) for the period April 1972 to August 1973 indicate that background in the area of this project is 1.5 ppm CO (1.6 mg/cu m). No other ambient air quality data were available.

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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. 5-9 to 5-11.

Pollution Estimates

Estimates of pollutant concentrations at a height of 1.8 meters (5 ft) above the ground were made for carbon monoxide and nitrogen oxides (as nitrogen dioxide) under various wind conditions at distances up to 60 meters from the shoulder of the roadway. A mathematical model based on the Gaussian diffusion equation, modified for a line source, was used[2]. This model has not been completely validated but it is accepted by the Federal Environmental Protection Agency and the Federal Highway Administration. Inputs to the model include meteorological conditions, traffic volumes, vehicle emission factors, and design of the highway.

Vehicle emission factors shown in the following table were calculated using procedures from "Compilation of Air Pollutant Emission Factors," AP 42, 2nd edition, U.S. Environmental Protection Agency, April 1973.

EMISSION FACTORS g/mi

Year	Speed, Miles Per Hour							
	30 (5)	35 (10)	40 (5)	45 (8)	50 (6)	60 (17)	60 (20)	70 (18)
Carbon Monoxide								
1980	13.9	15.8	11.1	11.8	9.9	13.3	14.7	13.8
1985	8.2	11.0	6.5	7.8	6.1	10.4	11.9	10.9
2000	7.5	10.5	6.0	7.3	5.6	10.1	11.9	10.6
Nitrogen Dioxide								
1980	2.2	3.0	2.4	3.0	2.8	5.2	5.7	5.4
1985	1.5	2.3	1.7	2.2	2.0	4.3	4.9	4.5
2000	1.4	2.2	1.5	2.1	1.9	4.1	4.6	4.3

(00) Percent of Commercial Vehicles

[2] J. L. Beaton, A. J. Ranzieri, E. C. Shirley and J. B. Skog, "Mathematical Approach to Estimating Highway Impact on Air Quality." Prepared by California Division of Highways. National Technical Information Service, Springfield, Va. 22157 Report No. FHWA-RD-72-36.

Pollution concentrations were estimated for:

1) Five representative sections which covered the entire length of the project. See Figure 1 for location of the sections which are identified as follows:

Section	Location
1	Base Line Rd to Schoolcraft Rd
2	Eckles Rd to Telegraph Rd
3	Telegraph Rd to Outer Dr
4	Outer Dr to Southfield Freeway
5	Southfield Freeway to Grand River Ave.

2) The years 1980, 1985, and 2000.

3) Distances of 30, 40, and 60 meters from the roadway shoulder.

Information used as input to the model consisted of:

1) Peak a.m. (7:00 to 9:00) and off-peak traffic volumes. Traffic estimates are shown in Tables 1 and 2. Off-peak traffic was taken as 4 percent of ADT.

2) Meteorological conditions.

a) Worst meteorological conditions, which will seldom occur, were taken as a 3 mph wind parallel to the roadway, under atmospheric stability class D. Parallel wind buildup distances used were: Section 1) 12,000 ft; Section 2) 42,500 ft; Section 3) 5,500 ft; Section 4) 12,000 ft: Section 5) 11,000 ft. Calculated pollution levels under parallel wind conditions were found to be higher for atmospheric stability class D than for class F.

b) Most probable meteorological conditions (shown in data tables) were chosen for the time of day involved, and the overall most likely stability class (D) was used. Table 3 shows the frequency distribution of atmospheric stability classes for the meteorological data used.

3) Road profile.

Section 1	at grade
Section 2	below grade 15 ft
Section 3	below grade 15 ft
Section 4	at grade
Section 5	at grade

4) Representative widths of the highway sections were taken as follows:

Section 1

Two 60-ft roadways, including outside shoulders, separated by a 70-ft median.

Sections 2 and 3

Two 60-ft roadways, including outside shoulders, separated by a 26-ft median. Service roads are 32-ft roadways including shoulders. The north service road is located 65-ft from the shoulder of the eastbound freeway and the south service road is located 46 ft from the shoulder of the westbound freeway.

Sections 4 and 5

Four 36-ft roadways, separated by 26-ft medians. The medians consist of two 2-1/2-ft curbs and gutters, two 9-1/4-ft shoulders and one 2-1/2-ft concrete median barrier. On each of the outer roadways there is a 2-1/2-ft curb and gutter and a 9-1/2-ft shoulder.

All estimates of pollution levels represent maximum one-hour concentrations and are in addition to the existing background levels. Traffic estimates for the condition of not building the highway 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.

Table 4 presents estimates of pollutant levels for peak traffic conditions. Table 5 presents estimates of pollutant levels for off-peak traffic conditions. Table 6 presents estimates of pollutant levels for off-peak and peak a.m. traffic conditions with service roads included. Nitrogen oxides, as nitrogen dioxide, are included for information only. There is no emission factor for nitrogen dioxide as such, so no comparison of the estimates with an air quality standard is possible.

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

CO: (a) 10 mg/cu m maximum 8 hr average 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.

NO_2: 100 μg/cu m annual arithmetic mean.

The calculated concentrations of carbon monoxide near the proposed roadway are low. No adverse environmental effects are expected.

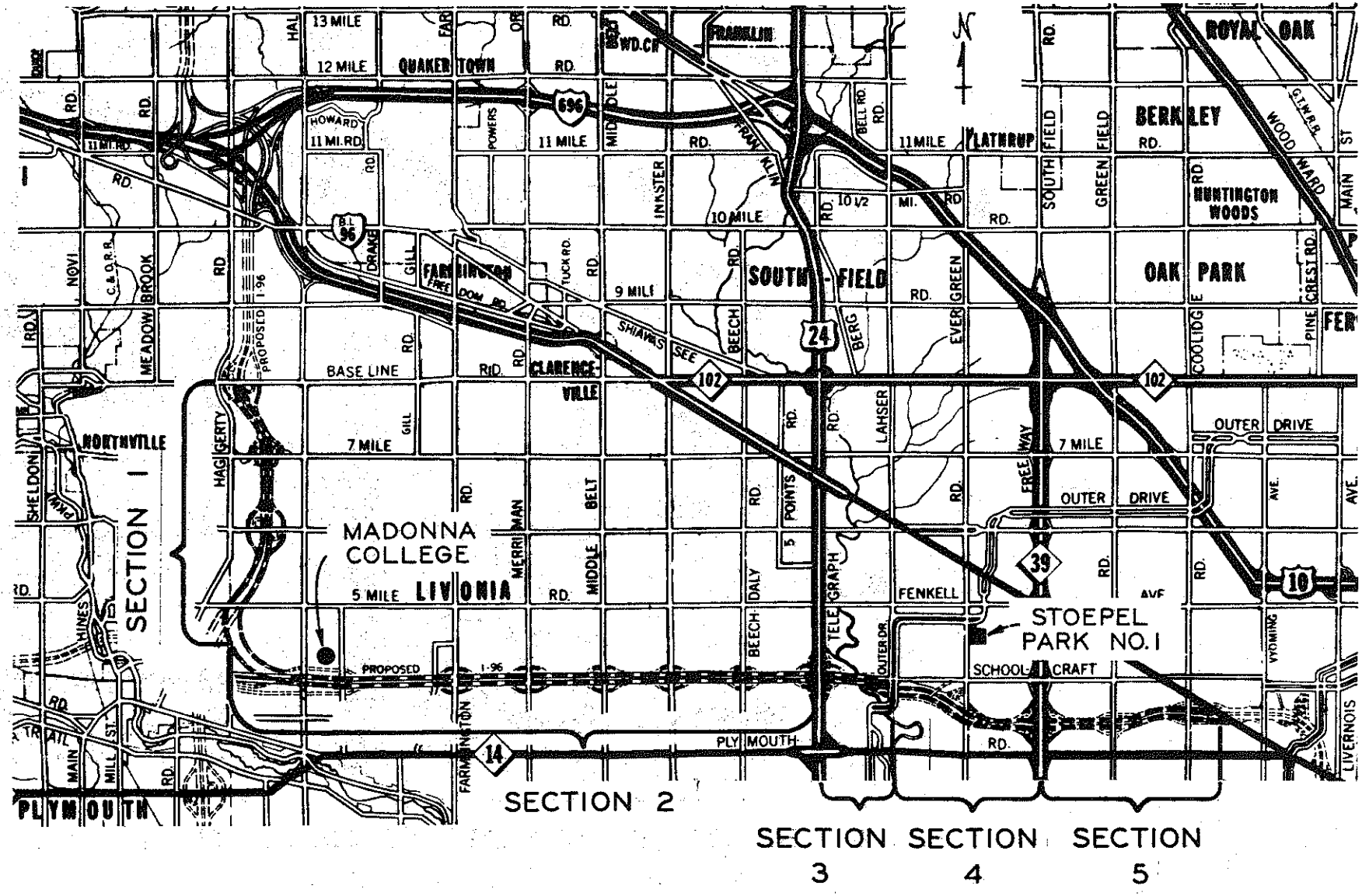

Figure 1. Location of sections used for pollution estimates.

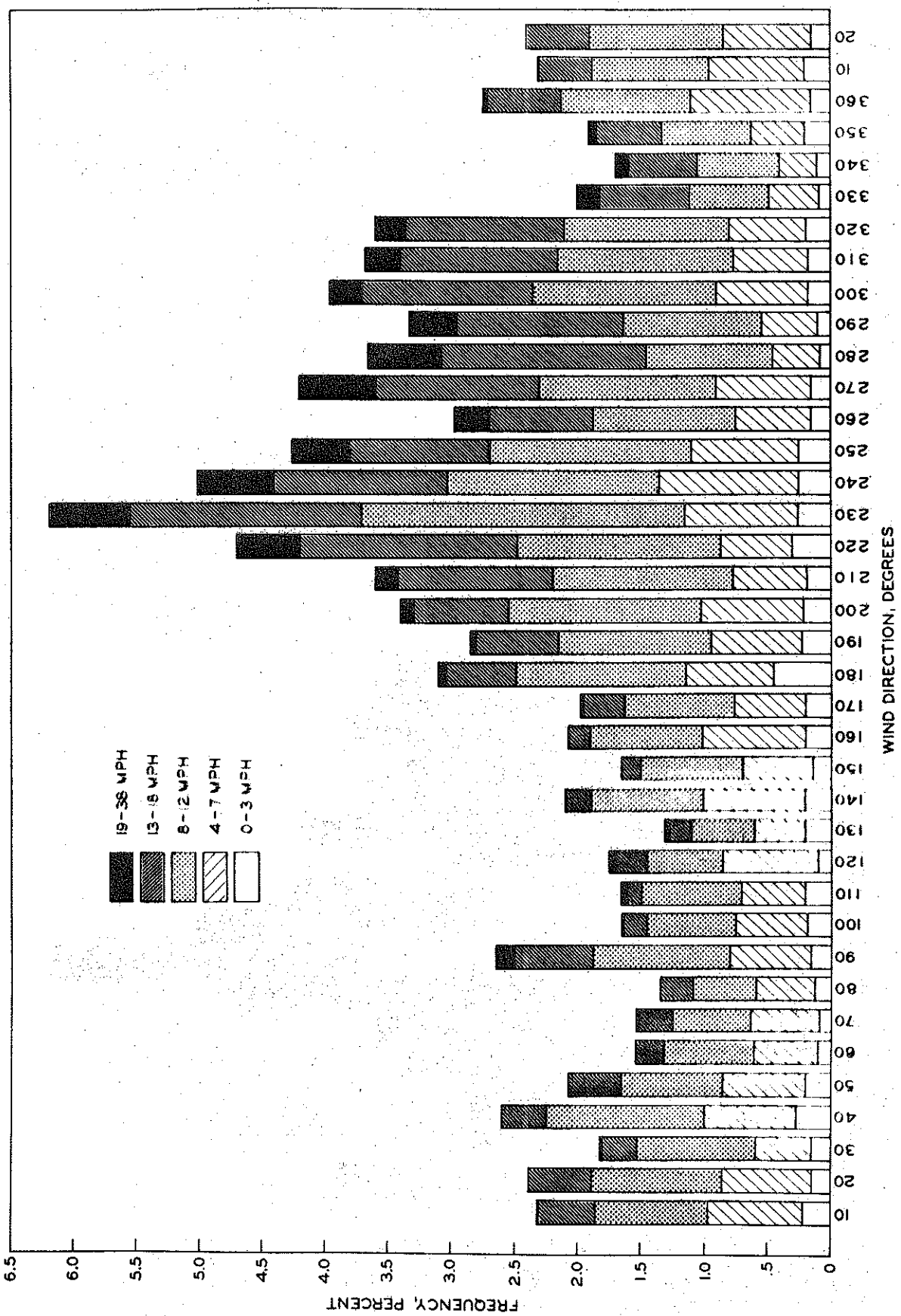

Figure 2. Averaged frequency of wind speeds and directions from Detroit Metropolitan and Willow Run Airports.

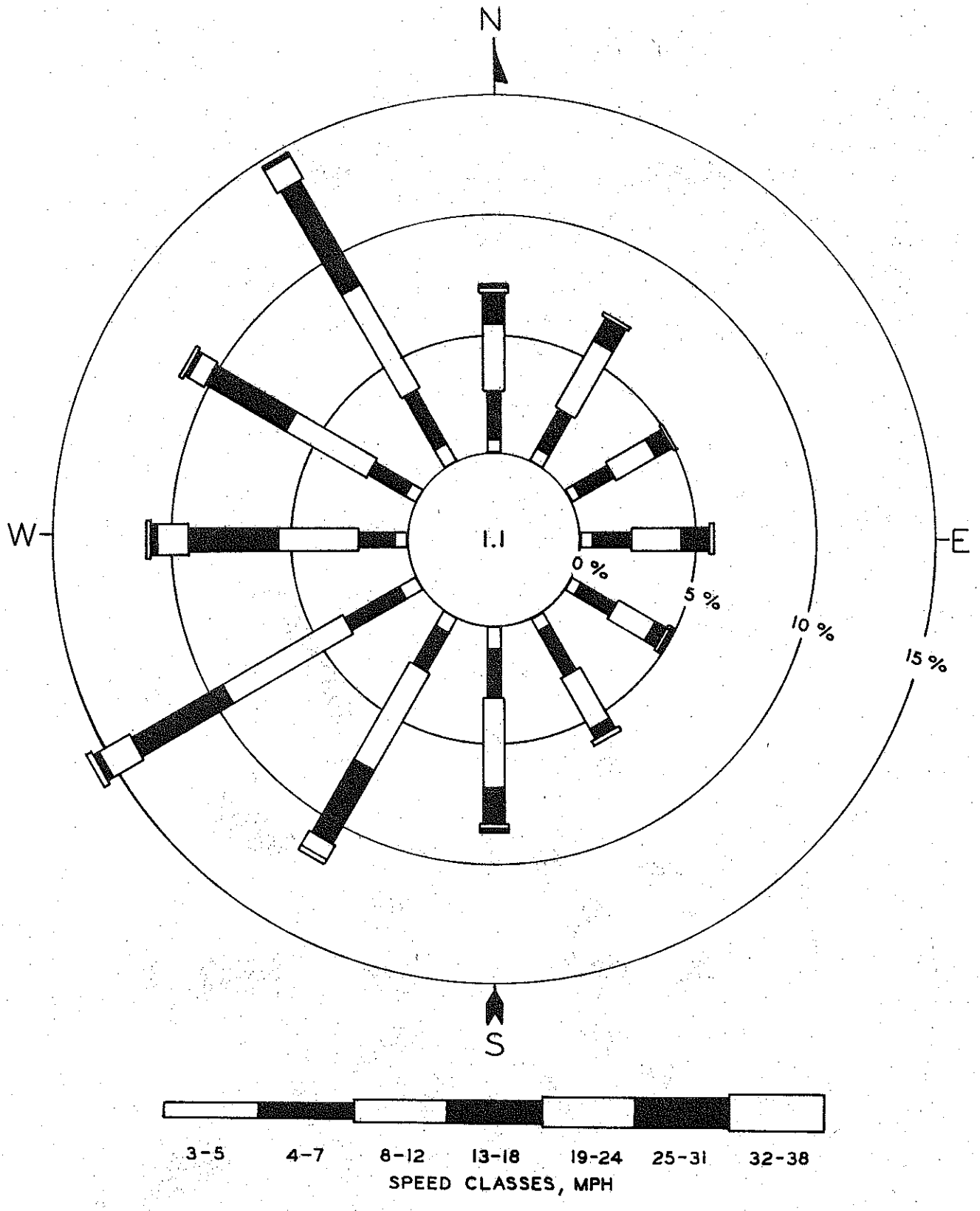

Figure 3. Averaged frequency of wind speed and directions from Detroit Metropolitan and Willow Run Airports.

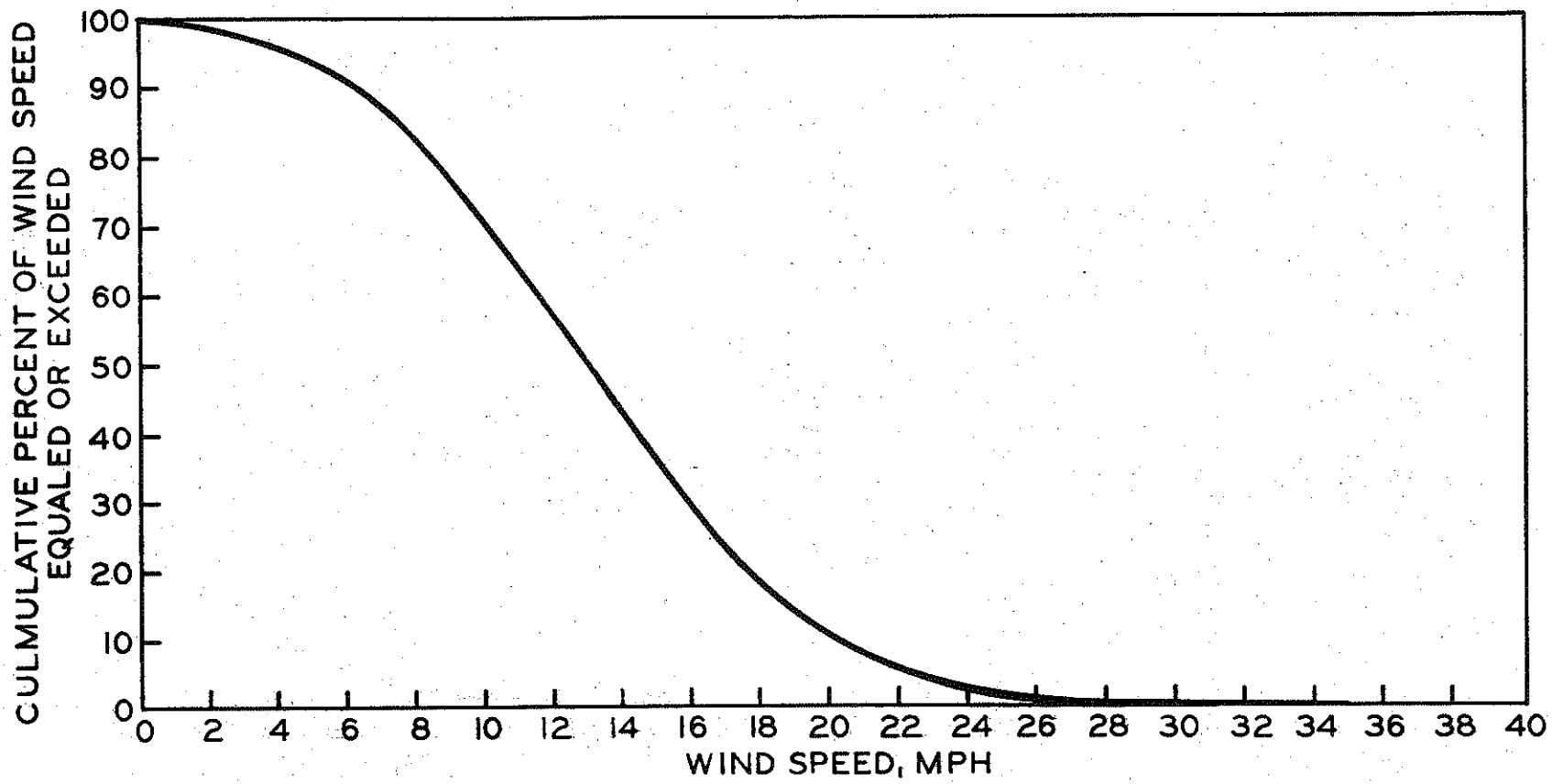

Figure 4. Distribution of wind speeds averaged from Detroit Metropolitan and Willow Run Airports.

TABLE 1

TRAFFIC ESTIMATES FOR PROPOSED I 96

(Total Traffic in Both Directions)

Year	Section 1	Section 2	Section 3	Section 4	Section 5
1980	94,800 ⟨8,440(50)⟩ [3,792(70)]	104,000 ⟨9,370(45)⟩ [4,160(60)]	135,300 ⟨12,580(40)⟩ [5,412(60)]	135,300 ⟨12,580(40)⟩ [5,412(60)]	193,000 ⟨15,820(40)⟩ [7,720(60)]
1985	109,200 ⟨9,610(50)⟩ [4,368(70)]	110,800 ⟨9,860(45)⟩ [4,432(60)]	146,300 ⟨13,470(40)⟩ [5,852(60)]	146,300 ⟨13,470(40)⟩ [5,852(60)]	202,000 ⟨16,360(40)⟩ [8,080(60)]
2000	145,500 ⟨12,370(50)⟩ [5,820(70)]	128,300 ⟨11,030(45)⟩ [5,132(60)]	169,800 ⟨15,110(40)⟩ [6,792(60)]	169,800 ⟨15,110(40)⟩ [6,792(60)]	218,700 ⟨17,050(40)⟩ [8,748(60)]

Peak Duration - Variable, around 2 hours

Commercial Vehicles

Section 1 - 6 percent of Peak, 18 percent of Off-Peak

Section 2 - 8 percent of Peak, 20 percent of Off-Peak

Sections 3, 4, and 5 - 5 percent of Peak, 17 percent of Off-Peak

000 = Avg. Daily Traffic

⟨000⟩ = a.m. Peak Traffic

[000] = Off-Peak Traffic (4 percent ADT)

(00) = Avg. Speed

TABLE 2
TRAFFIC ESTIMATES FOR SECTION 2 AND 3
SERVICE ROADS

Year	Sections 2 and 3	
	Eastbound	Westbound
1980	3,800 ⟨380(30)⟩ [152(35)]	4,000 ⟨400(30)⟩ [160(35)]
1985	3,800 ⟨380(30)⟩ [152(35)]	4,000 ⟨400(30)⟩ [160(35)]
2000	4,180 ⟨418(30)⟩ [167(35)]	4,400 ⟨440(30)⟩ [176(35)]

Commercial Vehicles
5 percent of Peak
10 percent of Off-Peak

000 = Avg. Daily Traffic
⟨000⟩ = a.m. Peak Traffic
[000] = Off-Peak Traffic (4 percent ADT)
(00) = Avg. Speed

TABLE 3

STABILITY CLASS FREQUENCY DISTRIBUTION BY HOUR
(Percent)

Hour	Stability Class					
	A	B	C	D	E	F
1	0.0	0.0	0.0	50.2	23.6	26.1
2	0.0	0.0	0.0	50.7	20.2	29.1
3	0.0	0.0	0.0	48.3	22.7	29.1
4	0.0	0.0	0.0	50.2	22.7	27.1
5	0.0	0.0	0.0	52.2	20.7	27.1
6	6.9	4.9	5.4	48.8	15.8	18.2
7	7.9	15.8	11.3	43.8	12.3	8.9
8	5.9	15.8	20.2	49.3	3.4	5.4
9	3.9	16.3	22.7	57.1	0.0	0.0
10	3.0	14.3	19.7	63.1	0.0	0.0
11	3.0	11.3	20.2	65.5	0.0	0.0
12	1.5	13.8	23.2	61.6	0.0	0.0
13	3.0	11.3	17.2	68.5	0.0	0.0
14	1.0	12.8	17.7	68.5	0.0	0.0
15	2.5	9.4	21.7	66.5	0.0	0.0
16	2.0	11.3	17.7	66.5	2.5	0.0
17	1.0	11.3	18.7	61.1	5.9	2.0
18	1.0	10.8	9.9	59.1	15.3	3.9
19	0.0	0.0	0.0	68.0	23.2	8.9
20	0.0	0.0	0.0	60.8	20.6	18.6
21	0.0	0.0	0.0	59.9	20.8	19.3
22	0.0	0.0	0.0	52.7	25.1	22.2
23	0.0	0.0	0.0	53.7	22.2	24.1
24	0.0	0.0	0.0	56.7	15.8	27.6
Overall percent	1.8	6.6	9.4	57.6	12.2	12.4

TABLE 4

POLLUTION ESTIMATES FOR PEAK A.M. TRAFFIC[1]
(Freeway Only)

Location	Traffic Projection Year	30 Meter Distance From Edge of Freeway Shoulder				40 Meter Distance From Edge of Freeway Shoulder				60 Meter Distance From Edge of Freeway Shoulder			
		Worst Condition Parallel Wind, 3 mph		Most Probable Condition, 10 mph wind[2]		Worst Condition Parallel Wind, 3 mph		Most Probable Condition, 10 mph wind[2]		Worst Condition Parallel Wind, 3 mph		Most Probable Condition, 10 mph wind[2]	
		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
Section 1	1980	3.1	892	0.4	130	2.3	645	0.4	110	1.1	316	0.4	100
	1985	2.2	721	0.3	90	1.6	521	0.3	90	0.8	256	0.3	80
	2000	2.6	857	0.3	110	1.9	620	0.3	110	0.9	304	0.3	100
Section 2	1980	9.2	2351	0.8	310	6.6	1701	0.7	190	3.3	840	0.7	170
	1985	6.4	1834	0.7	160	4.6	1327	0.5	150	2.3	655	0.5	130
	2000	6.7	1915	0.6	170	4.9	1385	0.5	150	2.4	684	0.5	140
Section 3	1980	10.5	2295	1.0	320	7.6	1660	0.9	200	3.8	820	0.8	180
	1985	6.6	1696	0.6	160	4.8	1227	0.6	150	2.4	606	0.5	130
	2000	6.9	1748	0.7	170	5.0	1265	0.6	150	2.5	625	0.5	140
Section 4	1980	4.5	989	0.9	200	3.3	727	0.8	180	1.7	366	0.8	160
	1985	2.9	731	0.6	140	2.1	537	0.5	130	1.1	270	0.5	120
	2000	3.0	753	0.6	150	2.2	554	0.5	140	1.1	279	0.5	130
Section 5	1980	5.7	1239	1.1	250	4.2	911	1.1	230	2.1	459	1.0	210
	1985	3.5	884	0.7	150	2.5	650	0.7	160	1.3	327	0.6	150
	2000	3.3	847	0.7	170	2.4	623	0.6	160	1.2	313	0.6	140

[1]average vehicle speeds are reported in Tables 1 and 2.
[2]angle between wind direction and roadway direction - section 1, 50°; sections 2, 3, 4, 5, 40°.

TABLE 5

POLLUTION ESTIMATES FOR OFF-PEAK TRAFFIC[1]
(Freeway Only)

Location	Traffic Projection Year	30 Meter Distance From Edge of Freeway Shoulder				40 Meter Distance From Edge of Freeway Shoulder				60 Meter Distance From Edge of Freeway Shoulder			
		Worst Condition Parallel Wind, 3 mph		Most Probable Condition, 10 mph wind[2]		Worst Condition Parallel Wind, 3 mph		Most Probable Condition, 10 mph wind[2]		Worst Condition Parallel Wind, 3 mph		Most Probable Condition, 10 mph wind[2]	
		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
Section 1	1980	2.0	761	0.3	100	1.4	550	0.2	90	0.7	270	0.2	90
	1985	1.8	731	0.2	100	1.3	528	0.2	90	0.6	259	0.2	80
	2000	2.3	929	0.3	120	1.7	672	0.3	120	0.8	330	0.3	110
Section 2	1980	5.1	1979	0.4	170	3.7	1432	0.4	160	1.8	707	0.4	140
	1985	4.4	1781	0.4	160	3.2	1289	0.4	140	1.6	637	0.3	130
	2000	4.9	1973	0.4	170	3.6	1428	0.4	160	1.8	705	0.4	140
Section 3	1980	5.5	2120	0.5	200	3.9	1534	0.5	190	1.9	758	0.4	170
	1985	4.6	1897	0.4	180	3.3	1373	0.4	170	1.7	678	0.4	150
	2000	5.2	2099	0.5	200	3.8	1519	0.5	180	1.9	750	0.4	160
Section 4	1980	2.4	914	0.5	180	1.7	672	0.4	170	0.9	338	0.4	150
	1985	2.0	818	0.4	160	1.5	601	0.4	150	0.7	303	0.3	140
	2000	2.2	905	0.4	180	1.6	665	0.4	170	0.8	335	0.4	150
Section 5	1980	3.3	1298	0.7	260	2.5	954	0.6	240	1.2	480	0.6	220
	1985	2.7	1125	0.5	220	2.0	827	0.5	210	1.0	416	0.5	190
	2000	2.9	1161	0.6	230	2.1	853	0.5	210	1.1	429	0.5	190

[1] average vehicle speeds are reported in Tables 1 and 2.
[2] angle between wind direction and roadway direction - section 1, 50°; sections 2, 3, 4, 5, 40°.

TABLE 6

POLLUTION ESTIMATES FOR OFF PEAK AND PEAK A.M. TRAFFIC[1]

(Service Roads Included)

OFF-PEAK TRAFFIC

Location	Traffic Projection Year	30 Meter Distance From Edge of Freeway Shoulder				40 Meter Distance From Edge of Freeway Shoulder				60 Meter Distance From Edge of Freeway Shoulder			
		Worst Condition Parallel Wind, 3 mph		Most Probable Condition, 10 mph wind[2]		Worst Condition Parallel Wind, 3 mph		Most Probable Condition, 10 mph wind[2]		Worst Condition Parallel Wind, 3 mph		Most Probable Condition, 10 mph wind[2]	
		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
Section 2	1980	5.2	1997	0.5	180	3.7	1446	0.4	160	1.8	715	0.4	150
	1985	4.4	1795	0.4	160	3.2	1300	0.4	150	1.6	643	0.3	130
	2000	5.0	1988	0.5	180	3.6	1439	0.4	160	1.8	711	0.4	140
Section 3	1980	5.5	2137	0.6	210	4.0	1547	0.5	190	2.0	765	0.5	170
	1985	4.7	1910	0.5	190	3.4	1382	0.4	170	1.7	683	0.4	150
	2000	5.3	2112	0.5	210	3.8	1529	0.5	190	1.9	756	0.4	170

PEAK a.m. TRAFFIC

Location	Traffic Projection Year	30 Meter Distance From Edge of Freeway Shoulder				40 Meter Distance From Edge of Freeway Shoulder				60 Meter Distance From Edge of Freeway Shoulder			
		Worst Condition Parallel Wind, 3 mph		Most Probable Condition, 10 mph wind[2]		Worst Condition Parallel Wind, 3 mph		Most Probable Condition, 10 mph wind[2]		Worst Condition Parallel Wind, 3 mph		Most Probable Condition, 10 mph wind[2]	
		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
Section 2	1980	9.4	2383	0.9	220	6.8	1726	0.8	200	3.4	854	0.7	180
	1985	6.5	1856	0.6	170	4.7	1345	0.6	150	2.3	665	0.5	140
	2000	6.8	1937	0.6	180	4.9	1403	0.6	160	2.5	694	0.5	140
Section 3	1980	10.7	2324	1.1	230	7.8	1684	1.0	210	3.8	833	0.9	190
	1985	6.7	1716	0.7	170	4.9	1243	0.6	160	2.4	615	0.6	140
	2000	7.0	1769	0.7	180	5.1	1281	0.6	160	2.5	634	0.6	140

[1] average vehicle speeds are reported in Tables 1 and 2.

[2] angle between wind direction and roadway direction - sections 2 and 3, 40°.

*values less than 0.1.