AIR QUALITY REPORT FOR I 69 FROM US 27 TO MORRICE, CLINTON AND SHIAWASSEE COUNTIES

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

AIR QUALITY REPORT FOR I 69 FROM US 27 TO MORRICE, CLINTON AND SHIAWASSEE COUNTIES

Research Laboratory Section
Testing and Research Division
Research Project 73 TI-185
Research Report No. R-932

Michigan State Highways and Transportation Commission
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Lansing, July 1974

This report presents air quality information for a proposed section of I 69 in southern Clinton and Shiawassee Counties as shown in Figure 1. Meteorological data, and estimates of pollution levels that might occur adjacent to the roadway should it be constructed, are included.

Terrain and Demography

The terrain surrounding this project is flat to gently rolling so that dispersion of air pollutants is facilitated. The population density of the two counties involved is Clinton - 85 per square mile with 21 percent urban and Shiawassee - 117 per square mile with 38 percent urban. Clinton County is considered part of the Tri-County Region of central Michigan centered around the city of Lansing. The Lansing Metropolitan Region has a population of 378,000 according to the 1970 census.

Meteorology

Michigan lies in the normal track of migrating high and low pressure centers at all times of the year. This results in great variation in day to day weather. Frequent changes in wind speed and direction are experienced. Even on occasions when an atmospheric inversion restricts vertical dispersion of pollutants, horizontal dispersion continues freely. Figure 2 shows a 36-point bar graph of wind speed and direction occurrences at Capital City Airport (Lansing). Hourly weather data were obtained from the National Climatic Center at Asheville, N. C. for the years 1967 through 1971 and a one day in three 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 90 percent of the time. The most probable daytime wind speed was found to be 11 mph. Atmospheric mixing depths generally range between 500 and 1,200 meters (547 to 1,300 yd), which is very favorable for vertical dispersion of pollutants.

Existing Ambient Air Quality

No data are available to establish presently existing air quality in the area of this project.

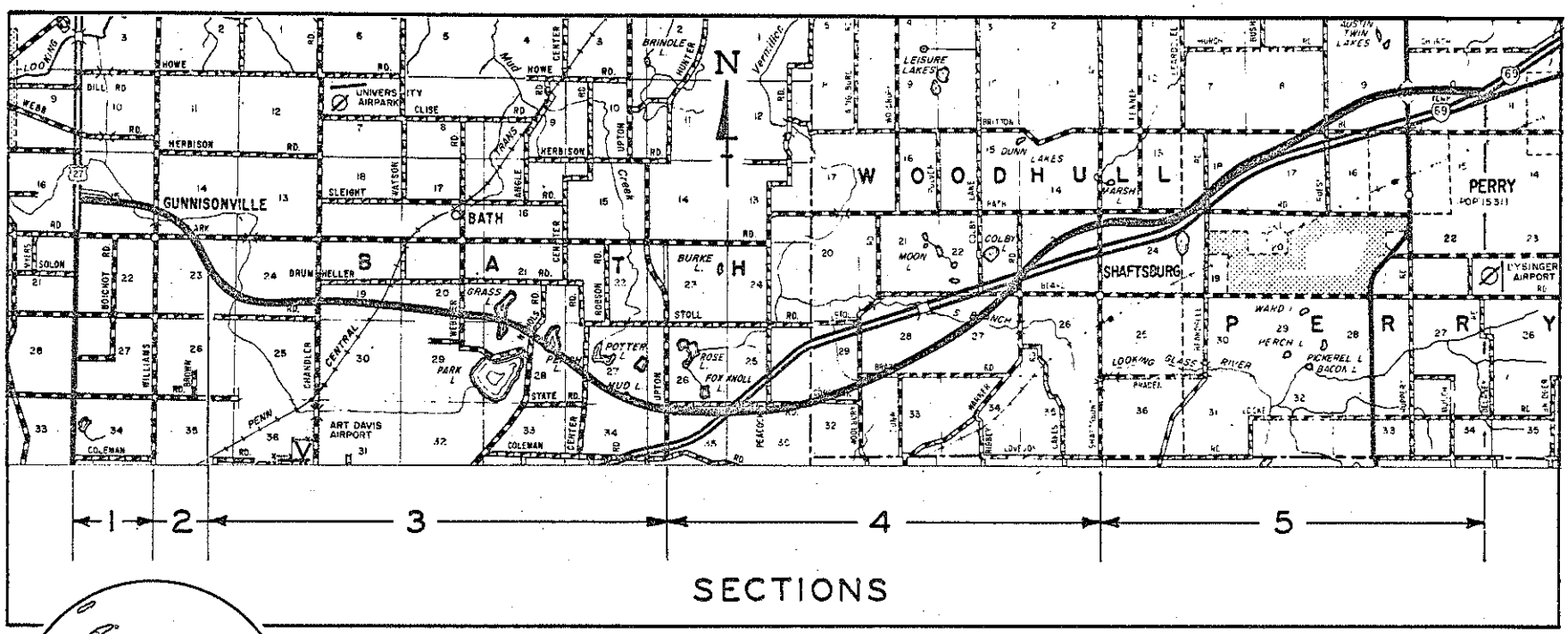

Figure 1. Location of proposed I 69, Clinton and Shiawassee Counties.

Pollution Estimates

Estimates of pollutant concentrations at a height of 1.5 meters (5 ft) above the ground were made for carbon monoxide and nitrogen oxides as nitrogen dioxide under various wind conditions. A mathematical model based on the Gaussian diffusion equation, modified for a line source, was used[1]. This model has been accepted by the Federal Highway Administration and the Federal Environmental Protection Agency. 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 and interim light duty vehicle standards promulgated by the EPA administrator in September 1973.

EMISSION FACTORS
(g/mile at 55 mph)

Carbon Monoxide

Year	7 Percent Commercial Vehicles	8 Percent Commercial Vehicles
1977	16.2	16.6
1982	7.5	8.1
1995	5.2	5.8

Oxides of Nitrogen

Year	7 Percent Commercial Vehicles	8 Percent Commercial Vehicles
1977	5.2	5.3
1982	2.6	2.8
1995	1.7	1.8

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

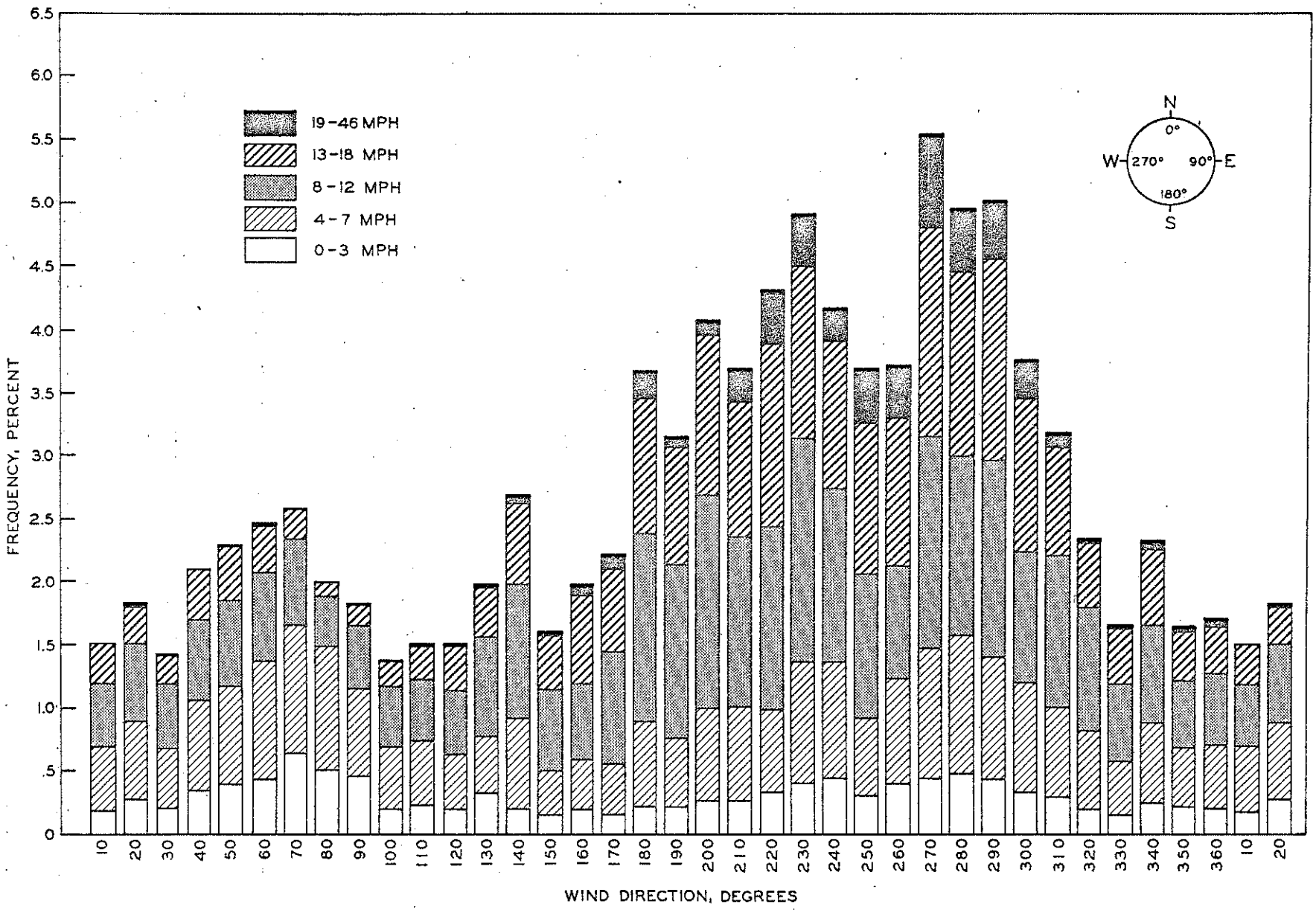

Figure 2. Wind speed and direction occurrences at Capital City Airport (Lansing).

Pollution concentrations were estimated for:

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

Section	Location
1	US 27 to Williams Rd
2	Williams Rd to I 69 - US 127 Interchange
3	I 69 - US 127 Interchange to Upton Rd
4	Upton Rd to Shaftsburg Rd
5	Shaftsburg Rd to end of project.

2) The years 1977, 1982, and 1995.

3) The area above the pavement (mixing cell).

Information used as input to the model consisted of:

1) Estimated peak p.m. (4:30 to 5:30) and off-peak traffic volumes. Traffic estimates are shown in Table 1. Off-peak traffic was taken as 4 percent of ADT.

2) Meteorological Conditions

a) Worst meteorological conditions, which will seldom occur according to meteorological records, were taken as a 3 mph wind parallel to the roadway, under atmospheric stability class F. Parallel wind buildup distances used were: Section 1) 5,400 ft; Section 2) 6,200 ft; Section 3) 32,400 ft; Section 4) 33,000 ft; Section 5) 29,800 ft.

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 2 shows the frequency distribution of atmospheric stability classes for the meteorological data used.

3) Road profile. All sections are at grade.

4) Width of Sections, Sections 1 and 2, two 36-ft roadways with 10-ft shoulders, Sections 3, 4, and 5, two 24-ft roadways with 10-ft shoulders. All sections are separated by a variable (94-ft minimum) median.

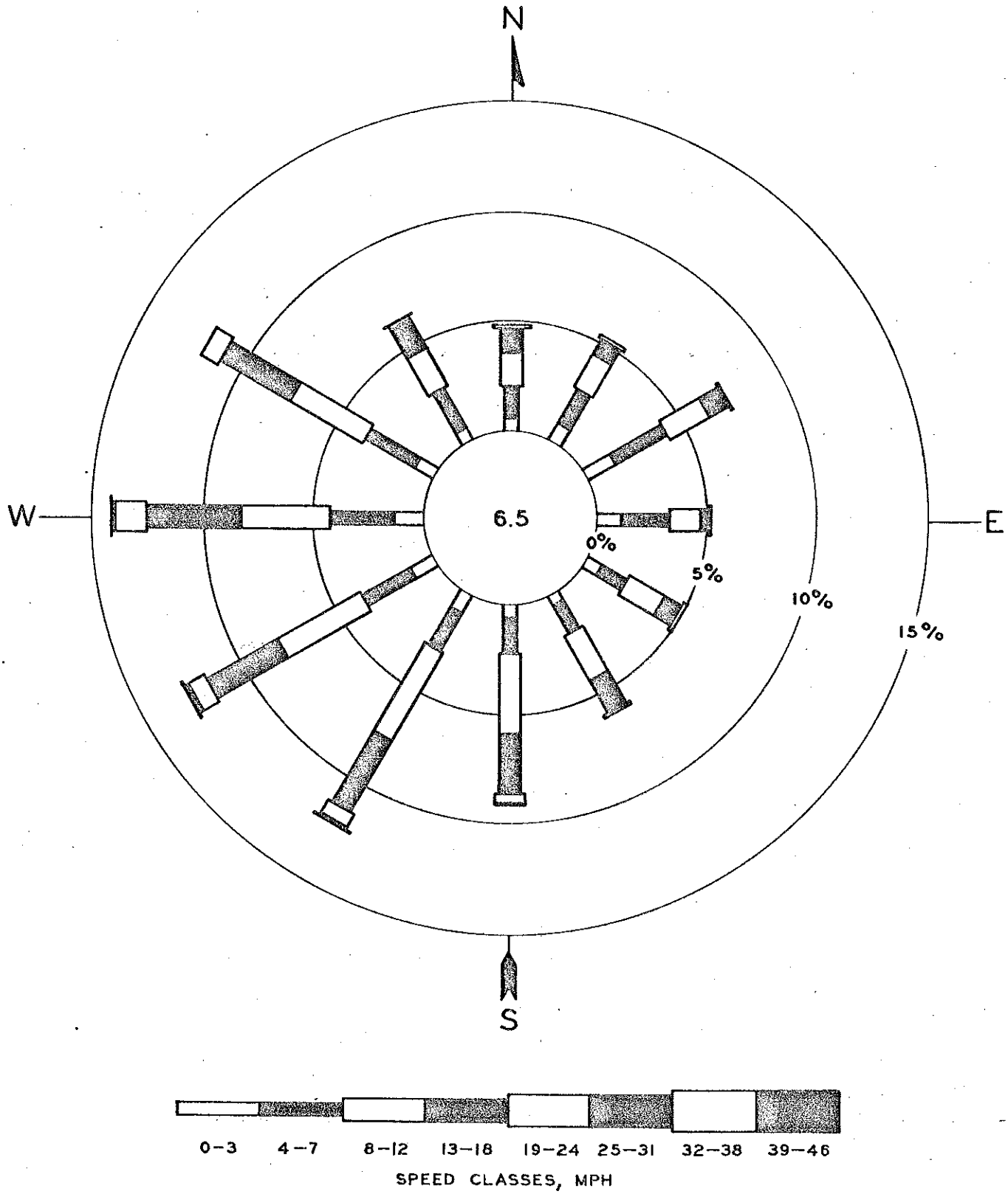

Figure 3. Wind speed and direction occurrences at Capital City Airport (Lansing).

All estimates of pollution levels represent maximum one hour concentrations and are in addition to existing background levels. Table 3 presents estimates of pollutant levels for carbon monoxide and nitrogen dioxide in the area over the highway (mixing cell). Nitrogen oxide data are included as 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.

Pollution estimates are calculated based on the present speed limit (55 mph). Should traffic speed limits be increased to the previous 70 mph limit carbon monoxide levels could decrease by 9 percent, and nitrogen oxide levels could increase by 28 percent.

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

CO: (a) 10 mg/cu m (9 ppm) maximum 8 hr average concentration not to be exceeded more than once per year.

(b) 40 mg/cu m (36 ppm) maximum 1 hr concentration not to be exceeded more than once per year.

NO_2: 100 μg/cu m (0.05 ppm) annual arithmetic mean.

The estimated concentrations of carbon monoxide on and near the proposed roadway are low. No adverse environmental effects are expected. The project is consistent with the state implementation plan for meeting air quality standards.

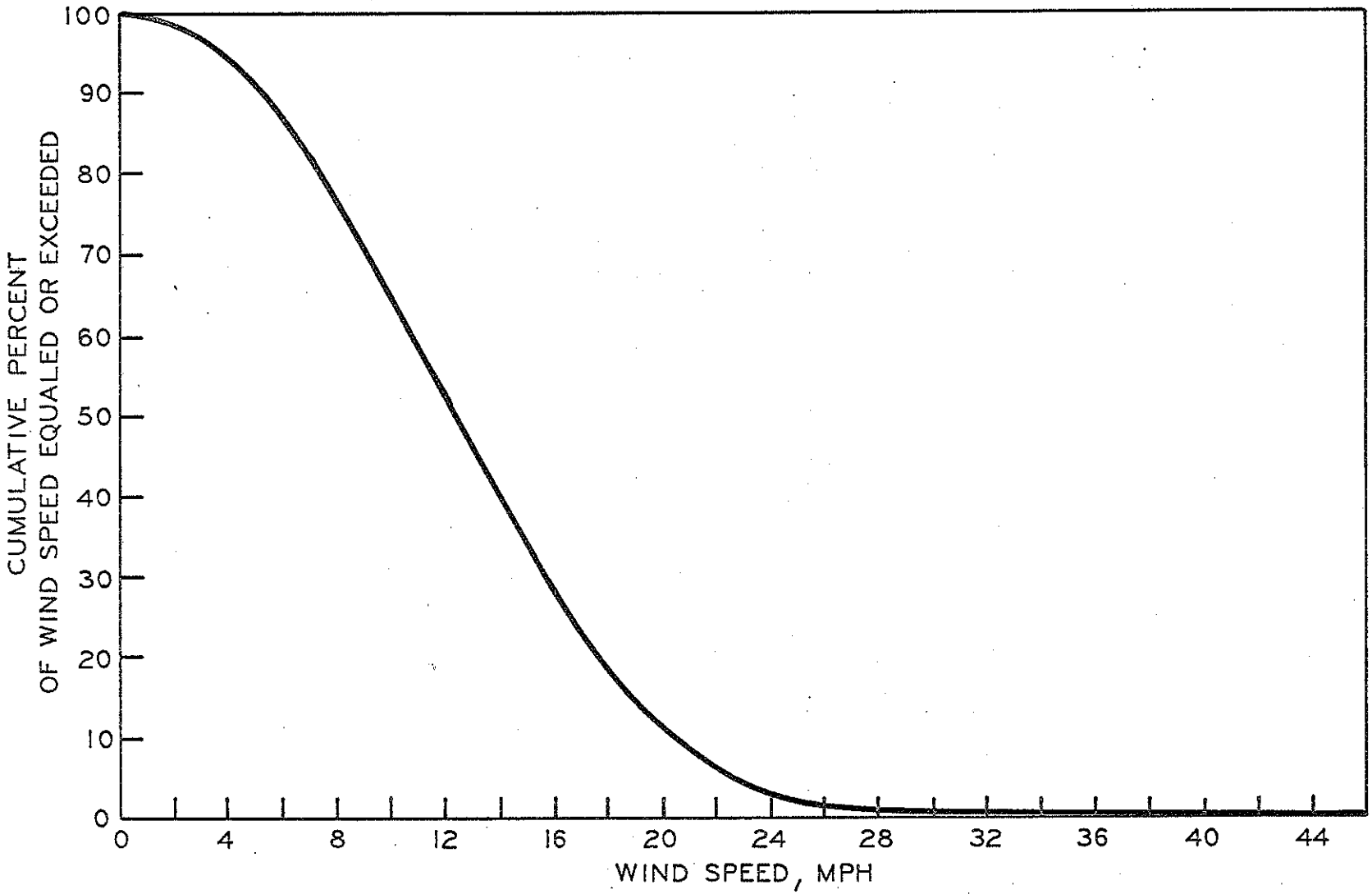

Figure 4. Distribution of wind speeds at Capital City Airport (Lansing).

TABLE 1
TRAFFIC ESTIMATES FOR PROPOSED I 69
(Total Traffic in Both Directions)

Year	Section 1	Section 2	Section 3	Section 4	Section 5
1977	22,200 ⟨1,994⟩ [888]	22,200 ⟨1,994⟩ [888]	17,400 ⟨1,568⟩ [696]	17,400 ⟨1,658⟩ [696]	17,200 ⟨1,634⟩ [688]
1982	25,600 ⟨2,302⟩ [1,024]	25,600 ⟨2,302⟩ [1,024]	20,200 ⟨1,814⟩ [808]	20,200 ⟨1,924⟩ [808]	19,900 ⟨1,888⟩ [796]
1995	35,500 ⟨3,200⟩ [1,420]	35,500 ⟨3,200⟩ [1,420]	27,800 ⟨2,506⟩ [1,112]	27,800 ⟨2,646⟩ [1,112]	27,500 ⟨2,610⟩ [1,100]

All Speeds - 55 mph
Peak Duration - variable, around 1 hour
Commercial Vehicles:
All sections - 8 percent of peak, 7 percent of off-peak

000 = Average Daily Traffic, vehicles in 24 hours
⟨000⟩ = Peak Traffic, vehicles per hour
[000] = Off-Peak Traffic, vehicles per hour

TABLE 2
STABILITY CLASS FREQUENCY DISTRIBUTION BY HOUR
(Percent)

Hour	Stability Class					
	A	B	C	D	E	F
1	0.0	0.0	0.0	51.7	18.9	29.5
2	0.0	0.0	0.0	50.8	18.2	31.0
3	0.0	0.0	0.0	48.8	18.2	32.9
4	0.0	0.0	0.0	48.5	20.2	31.3
5	0.0	0.0	0.0	50.7	19.5	29.8
6	9.3	6.5	5.0	48.0	12.4	18.9
7	10.4	14.9	10.8	47.7	6.1	10.1
8	8.3	16.2	16.7	52.8	3.1	2.8
9	6.6	13.6	24.7	55.1	0.0	0.0
10	3.6	14.7	21.2	60.4	0.0	0.0
11	4.1	12.4	21.7	61.8	0.0	0.0
12	4.5	10.6	21.4	63.6	0.0	0.0
13	3.3	10.4	19.9	66.4	0.0	0.0
14	3.6	10.4	21.2	64.7	0.0	0.0
15	3.5	10.8	20.4	65.4	0.0	0.0
16	3.6	11.9	19.0	62.6	2.0	0.8
17	3.5	10.9	17.9	59.6	5.6	2.5
18	4.6	6.1	12.4	57.0	10.8	9.1
19	0.0	0.0	0.0	60.8	21.4	17.9
20	0.0	0.0	0.0	53.8	20.2	26.0
21	0.0	0.0	0.0	51.0	20.4	28.6
22	0.0	0.0	0.0	50.8	17.9	31.3
23	0.0	0.0	0.0	50.7	19.5	29.8
24	0.0	0.0	0.0	51.7	19.2	29.1
Overall percent	2.9	6.2	9.8	55.6	10.6	15.1

TABLE 3
ESTIMATES OF MIXING CELL CONCENTRATIONS[1]

Location	Traffic Projection Year	CO (mg/cu m)				NO_x (μg/cu m)			
		Worst Condition Stability F, Parallel 3 mph Wind		Most Probable[2] Condition Stability D		Worst Condition Stability F, Parallel 3 mph Wind		Most Probable[2] Condition Stability D	
		Peak Traffic	Off-Peak Traffic	Peak Traffic	Off-Peak Traffic	Peak Traffic	Off-Peak Traffic	Peak Traffic	Off-Peak Traffic
1	1977	4.3	1.5	0.4	0.3	1,354	490	140	87
	1982	2.4	0.8	0.3	0.2	817	287	84	51
	1995	2.4	0.8	0.3	0.1	753	257	78	46
2	1977	4.3	1.5	0.3	0.1	1,365	494	99	42
	1982	2.4	0.8	0.2	0.1	824	290	60	24
	1995	2.4	0.8	0.2	0.1	760	259	55	22
3	1977	2.8	1.0	0.3	0.3	904	326	95	89
	1982	1.6	0.6	0.2	0.2	546	192	57	53
	1995	1.6	0.5	0.2	0.1	500	171	53	47
4	1977	3.0	1.0	0.6	0.2	964	326	199	67
	1982	1.7	0.6	0.4	0.1	584	193	120	40
	1995	1.7	0.5	0.4	0.1	533	171	110	35
5	1977	3.0	1.0	0.6	0.2	945	321	196	67
	1982	1.7	0.5	0.4	0.1	570	189	118	39
	1995	0.5	0.5	0.3	0.1	523	168	108	35

[1] All vehicle speeds are 55 mph.

[2] Angle between roadway direction and wind direction, off-peak (speed 11 mph) - Section 1, 5°; Section 2, 45°; Section 3, 15°; Sections 4 and 5, 20°, a.m. peak (speed 9 mph) - Section 1, 45°; Section 2, 85°; Section 3, 55°, p.m. (peak (speed 11 mph) - Sections 4 and 5, 20°, (a significant change in the roadway direction between Sections 3 and 4 requires the use of both a.m. and p.m. peak traffic volumes in the calculations).