

AIR QUALITY REPORT FOR I 69
CHARLOTTE TO I 96, EATON COUNTY



MICHIGAN DEPARTMENT OF
STATE HIGHWAYS AND TRANSPORTATION

AIR QUALITY REPORT FOR I 69
CHARLOTTE TO I 96, EATON COUNTY

Research Laboratory Section
Testing and Research Division
Research Project 74 TI-224
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Michigan State Highway Commission
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This report presents air quality information for a proposed section of I 69 in northeastern Eaton County 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 Eaton County is 120 per square mile with 33 percent urban. Eaton 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. 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.

According to air pollution publication AP 101, U. S. Environmental Protection Agency, 1972, atmospheric mixing depths in lower Michigan 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 existing air quality in the area of this project; however, estimates of background air quality that may exist in the project area are:



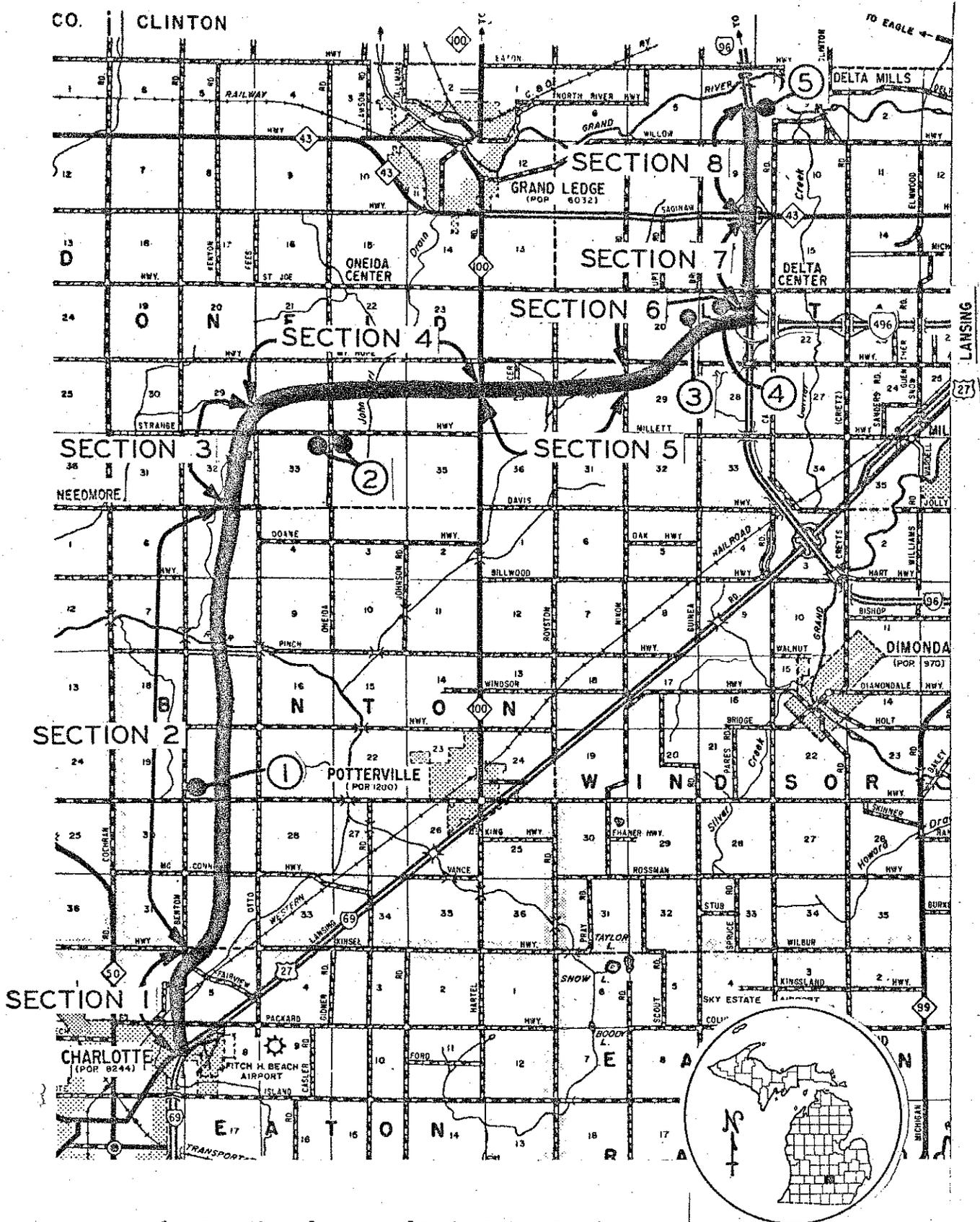


Figure 1. Location of proposed I 69, Eaton County.

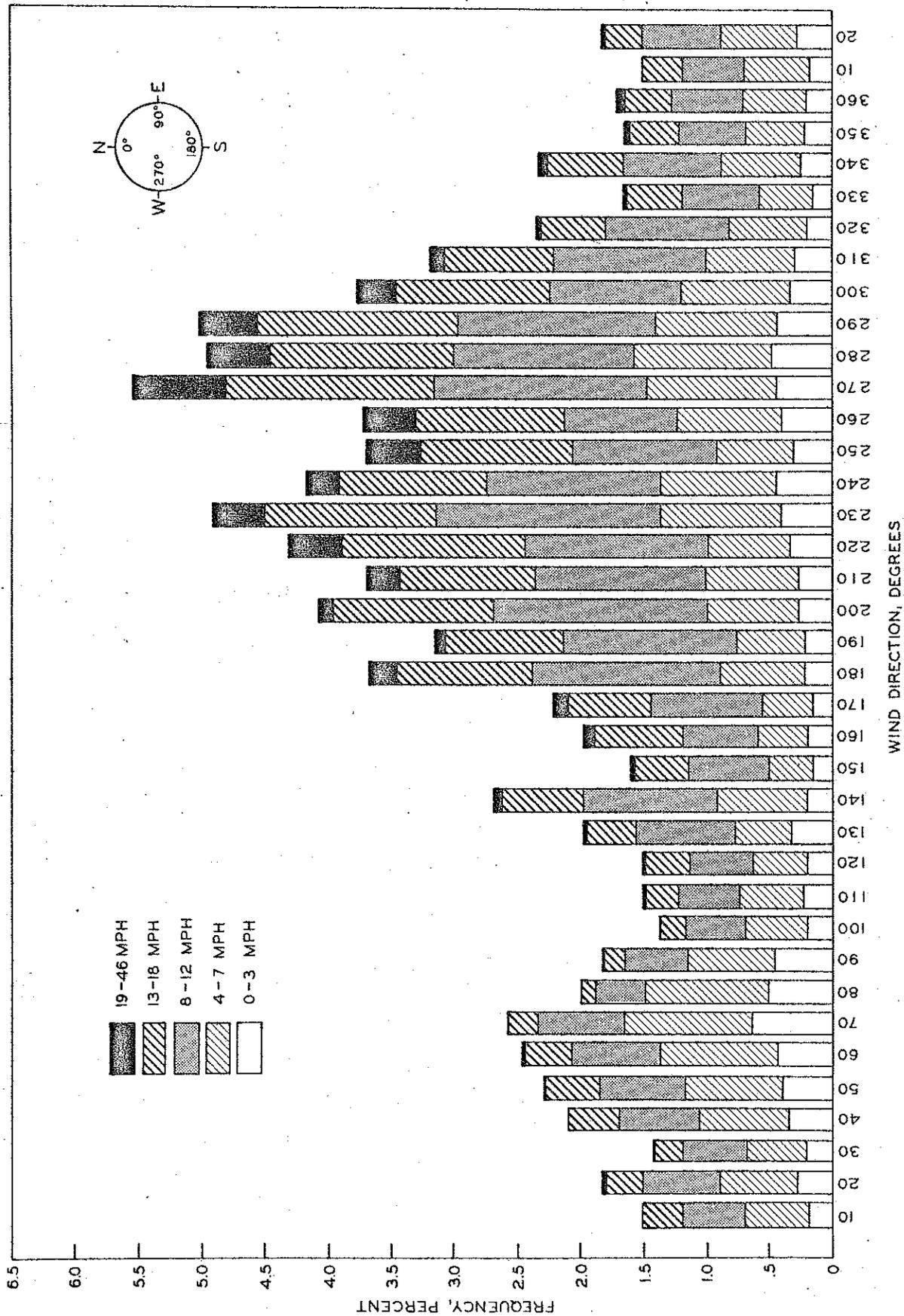


Figure 2. Wind speed and direction occurrences at Capital City Airport (Lansing).

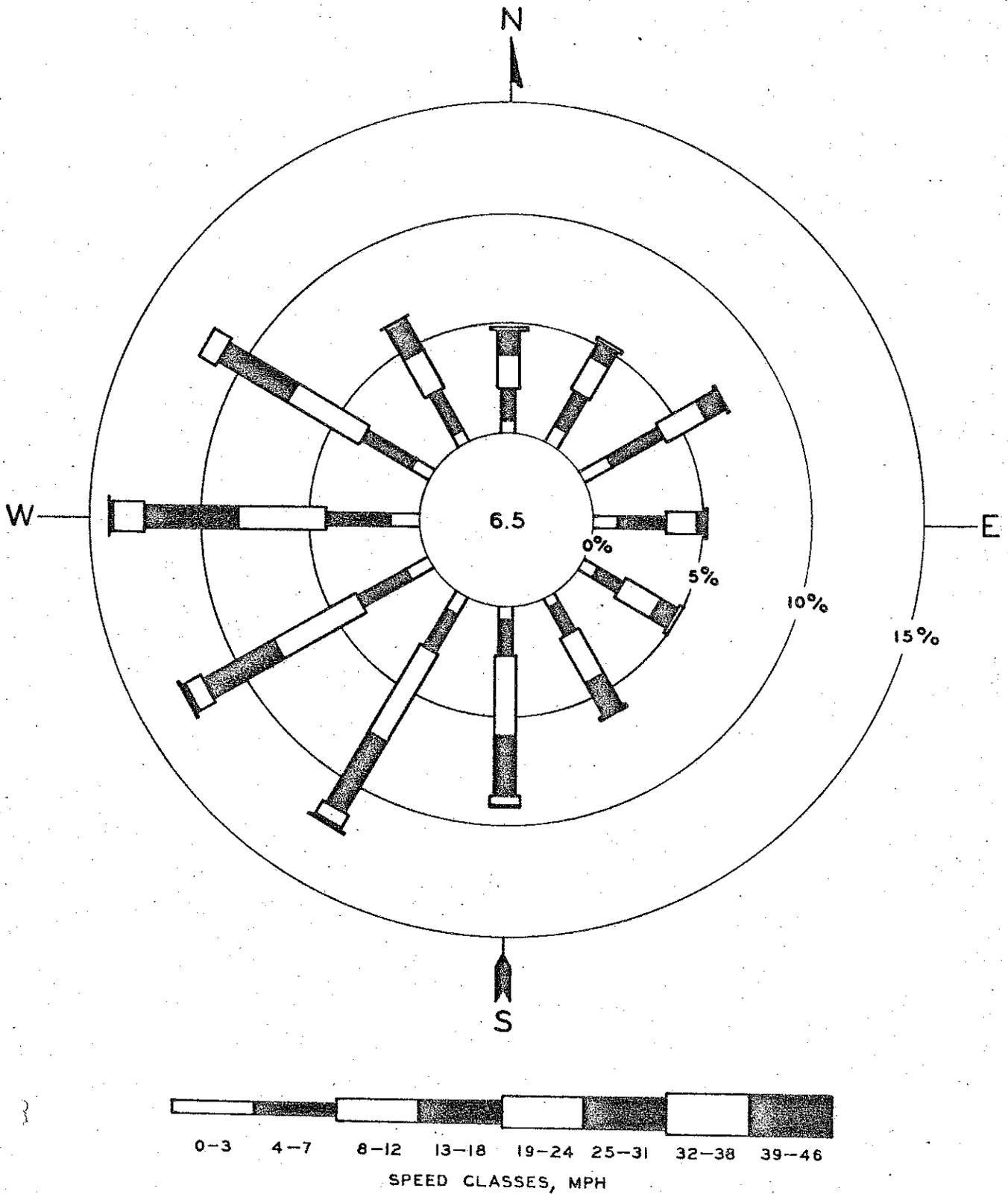


Figure 3. Wind speed and direction occurrences at Capital City Airport (Lansing).

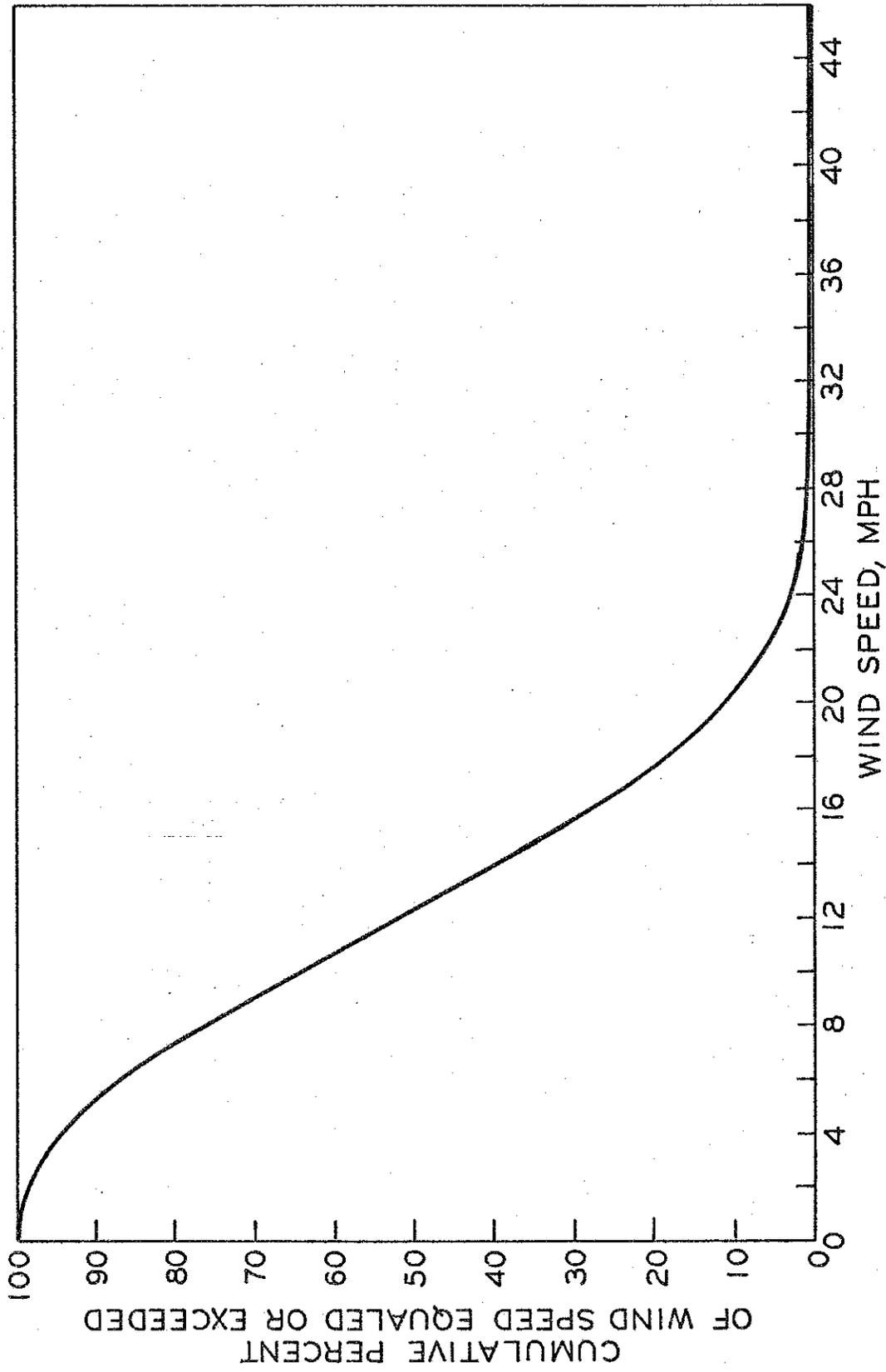


Figure 4. Distribution of wind speeds at Capital City Airport (Lansing).

carbon monoxide - 1 to 3 mg/cu m for a maximum 8-hour concentration, and 5 to 9 mg/cu m for a maximum 1-hour concentration.

These estimates were supplied by the Michigan Department of Natural Resources, Air Pollution Control Division.

Pollution Estimates

Estimates of carbon monoxide concentrations were made at a height of 1.5 meters (5 ft) above the roadway. A mathematical model based on the Gaussian diffusion equation, modified for a line source, was used¹. Inputs to the model include meteorological conditions, traffic volumes, vehicle emission factors and design of the highway.

Estimates of nitrogen dioxide concentrations are not included in this report because, while the national air quality standard is for nitrogen dioxide (NO₂), the mixture of nitrogen oxides (NO_x) emitted by vehicles consists largely of nitric oxide with less than five percent of the nitrogen oxides emitted as NO₂, according to Federal EPA data. Subsequent to being emitted from the tailpipe, NO may be converted to NO₂ at varying rates, depending on atmospheric conditions. There is no air quality standard for NO, which is much less toxic than NO₂. Thus, there is no meaningful way of comparing vehicle exhaust emissions with the air quality standard for NO₂.

Vehicle emission factors shown in the following table were calculated using procedures from "Compilation of Air Pollutant Emission Factors," AP 42, Supplement No. 5, December 1975 edition, U. S. Environmental Protection Agency.

Emission factors were calculated at a temperature of 60 F, with all vehicles in hot operation mode. Vehicle age mix data used were obtained from the Michigan Department of State. Average annual miles driven for various age vehicles are national figures from AP 42.

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. CALINE 2 modification, programmed March 1975, was used.

Carbon Monoxide Emission Factors
(g/mile at 55 mph)

Year	Percent Commercial					
	6	7	8	9	10	13
1980	7.6	8.1	8.7	9.2	9.7	11.4
1985	4.1	4.6	5.1	5.5	6.0	7.4
2000	3.5	3.9	4.4	4.8	5.3	6.4

Year	Percent Commercial					
	14	18	21	22	24	25
1980	12.0	14.0	16.0	16.4	17.4	18.0
1985	7.9	9.9	11.2	11.6	12.6	13.0
2000	6.8	8.1	9.7	10.2	11.0	11.4

Pollution concentrations were estimated for:

1) Eight 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 Kinsel Highway
2	Kinsel Highway to Needmore Highway
3	Needmore Highway to Strange Highway (near)
4	Strange Highway (near) to M 100
5	M 100 to Nixon Road
6	Nixon Road to I 96
7	I 96/I 496 to M 43
8	M 43 to Point of Ending

2) The years 1980, 1985, and 2000.

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

Information used as input to the model consisted of:

1) Traffic estimates as shown in Table 1. Highest traffic volumes are estimated to occur in the afternoon -- 4 to 5 p. m. for Sections 1 through 6, and 5 to 6 p. m. for Sections 7 and 8. Seventy percent of this afternoon peak traffic is westbound, 30 percent is eastbound. Off-peak traffic was taken as 4 percent of ADT, with half of the traffic in each direction. Traffic volumes for Sections 7 and 8 are totals of existing I 96 traffic and traffic from proposed I 69.

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.

b) Most probable meteorological conditions for the afternoon - an 11 mph wind at 270 degrees (west) under atmospheric stability class D. 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. Section 1, two 24-ft roadways with 10-ft shoulders and a 70-ft median, Sections 2, 3, 4, 5, and 6, two 24-ft roadways with 10-ft shoulders and a variable (94-ft minimum) median, Sections 7 and 8, two 36-ft roadways with 10-ft shoulders and a 46-ft median.

All estimates of carbon monoxide levels (Table 3) represent maximum one-hour concentrations and are in addition to existing background levels, except in Sections 7 and 8. Carbon monoxide levels in these sections are totals for existing I 96 traffic and proposed I 69 traffic.

Comparison of Estimates with Air Quality Standards

a) 8 hr carbon monoxide air quality standard - 10 mg/cu m (9 ppm)

If for 1980 the highest carbon monoxide levels from the roadway are used (Section 7), and an 8-hr period is taken as two peak hours of 4.7 mg/cu m and six off-peak hours of 3.4 mg/cu m, the 8-hr average carbon monoxide concentration from the roadway is 3.7 mg/cu m. Adding this concentration to the 1 to 3 mg/cu m estimated background results in a total carbon monoxide concentration of 4.7 to 6.7 mg/cu m, well below the air quality standard. For 1985 and 2000 the carbon monoxide concentrations are estimated to be even lower than the 1980 concentrations.

TABLE 1
 TRAFFIC ESTIMATES FOR PROPOSED I 69 (CHARLOTTE TO I 96)
 (Total Traffic in Both Directions)

Year	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8
1980	14,600 <1,020(7)> [584(15)]	15,000 <1,050(7)> [600(15)]	15,500 <1,085(7)> [620(15)]	15,500 <1,085(7)> [620(15)]	17,500 <1,225(6.5)> [700(14)]	18,500 <1,300(6.5)> [740(14)]	34,000 <3,160(8)> [1,360(22)]	29,000 <2,760(10)> [1,160(25)]
1985	17,200 <1,290(6.5)> [688(14)]	17,700 <1,330(6.5)> [708(14)]	18,300 <1,375(6.5)> [732(14)]	18,300 <1,375(6.5)> [732(14)]	20,800 <1,560(6)> [832(13)]	22,300 <1,675(6)> [892(13)]	43,500 <3,920(7.5)> [1,740(21)]	37,900 <3,520(9)> [1,516(24)]
2000	25,500 <2,040(5.5)> [1,020(12)]	26,200 <2,100(5.5)> [1,048(12)]	27,100 <2,170(5.5)> [1,084(12)]	27,100 <2,170(5.5)> [1,084(12)]	34,500 <2,760(5)> [1,380(11)]	39,500 <3,160(5)> [1,580(11)]	63,400 <5,580(6)> [2,536(18)]	57,000 <5,070(7)> [2,280(21)]

Peak Duration - Variable, around 1 hr

All speeds - 55 mph

000 = Avg. Daily Traffic, vehicles in 24 hours

<000> = Peak Traffic, vehicles per hour

[000] = Off-Peak Traffic, vehicles per hour

(00) = Percent Commercial Vehicles

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 CARBON MONOXIDE CONCENTRATIONS
OVER THE ROADWAY ¹

Location (Section No.)	Traffic Projection Year	CO (mg/cu m)			
		Worst Condition Stability F, Parallel 3 mph Wind		Most Probable ² Condition Stability D	
		Peak Traffic	Off-Peak Traffic	Peak Traffic	Off-Peak Traffic
1	1980	1.4	1.0	0.1	*
	1985	1.0	0.8	*	*
	2000	1.4	1.0	*	*
2	1980	1.3	0.9	*	*
	1985	1.3	0.7	*	*
	2000	1.6	0.9	0.1	*
3	1980	1.4	1.0	0.1	*
	1985	1.0	0.8	*	*
	2000	1.3	1.0	0.1	*
4	1980	1.4	1.0	0.1	0.1
	1985	1.0	0.8	0.1	0.1
	2000	1.3	1.0	0.1	0.1
5	1980	1.5	1.0	0.2	0.1
	1985	1.1	0.8	0.1	0.1
	2000	1.7	1.2	0.2	0.1
6	1980	1.5	1.1	0.1	0.1
	1985	1.1	0.9	0.1	0.1
	2000	1.7	1.3	0.2	0.1
7	1980	4.7	3.4	0.2	0.1
	1985	3.4	3.0	0.1	0.1
	2000	3.2	3.1	0.1	0.1
8	1980	4.6	3.2	0.1	0.1
	1985	3.4	2.9	0.1	0.1
	2000	3.4	3.4	0.1	0.1

¹ All vehicle speeds are 55 mph.

² Angle between roadway direction and wind direction, peak and off-peak (speed 11 mph) - Section 1, 80°; Section 2, 90°; Section 3, 75°; Section 4, 0°; Section 5, 5°; Section 6, 25°; Sections 7 and 8, 90°.

* * Value less than 0.1.

b) One-hour carbon monoxide air quality standard - 40 mg/cu m (36 ppm)

The maximum estimated one-hour concentration of carbon monoxide (roadway plus background) is 4.7 plus 5 to 9 mg/cu m, a range of 9.7 to 13.7 mg/cu m. This is far below the 40 mg/cu m standard.

The estimated concentrations of carbon monoxide, including existing background, above the proposed roadway are within national air quality standards. No adverse environmental effects are expected. The project is consistent with the state implementation plan for meeting national air quality standards.

Additional Information for Receptor Sites

Concentrations of carbon monoxide were estimated at two churches, two subdivisions, a school, and a sportsmans club near the proposed route (Fig. 1). The locations are as follows:

1. The church on the northeast corner of Benton Rd and Vermontville Hwy is approximately 2,400 ft west of the proposed route.
2. The church on the southeast corner of Oneida Rd and Strange Hwy and the school on the southwest corner are approximately 3,000 ft south of the proposed route.
3. Subdivision - Countryside Estates is located approximately 500 ft north of the proposed route.
4. Subdivision - Evergreen Heights is located approximately 800 ft north of the proposed route.
5. The Sportsmans Club located approximately 400 ft east of proposed route.

Estimated carbon monoxide concentrations at these sites under worst meteorological conditions (3 mph wind blowing across the roadway toward the receptors, stability class F) are less than 0.5 mg/cu m above background at all sites thus no adverse environmental effects are indicated.