AIR QUALITY REPORT FOR M 20, LEE TOWNSHIP, MIDLAND COUNTY TO INDIAN ST (US 10 BR), CITY OF MIDLAND

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

AIR QUALITY REPORT FOR M 20, LEE TOWNSHIP, MIDLAND COUNTY TO INDIAN ST (US 10 BR), CITY OF MIDLAND

Research Laboratory Section
Testing and Research Division
Research Project 74 TI-263
Research Report No. R-952

Michigan State Highway Commission
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This report presents air quality information for the proposed reconstruction of a section of M 20 beginning in Lee Township, Midland County, and ending at Indian St (US 10 BR) in the city of Midland as shown in Figure 1.

Terrain and Demography

The terrain surrounding this project is flat to gently rolling so that dispersion of air pollutants is facilitated. Midland has a population of 35,176 according to the 1970 census. The population density in Midland County is 123 per square mile.

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 Tri-County Airport (Saginaw). 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.

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

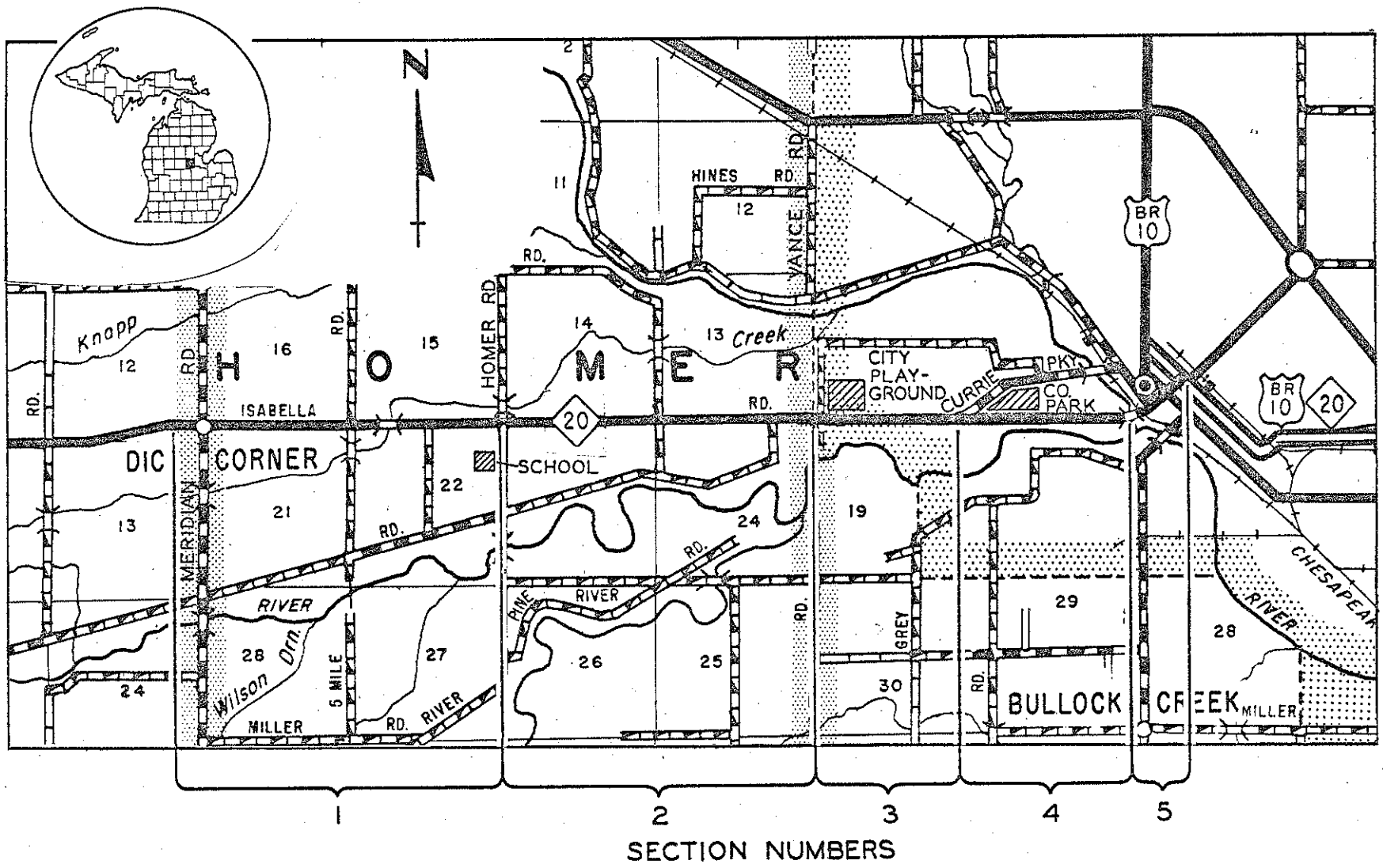

Figure 1. Proposed reconstruction of M 20 extending from east of Meridian Rd in Lee Township, Midland County to Indian St (US 10 BR) in the city of Midland.

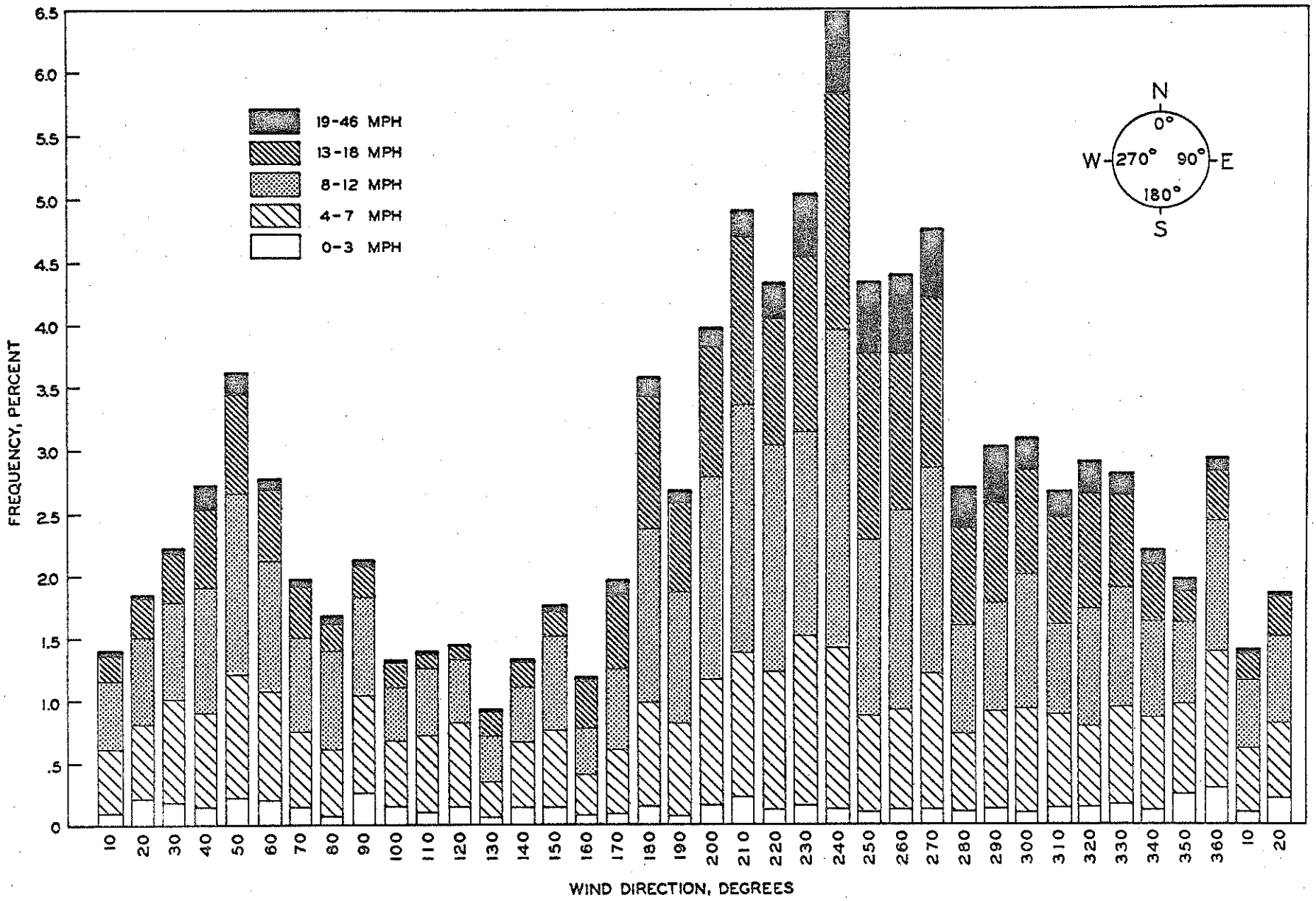

Figure 2. Wind speed and direction occurrences at Tri-County Airport (Saginaw).

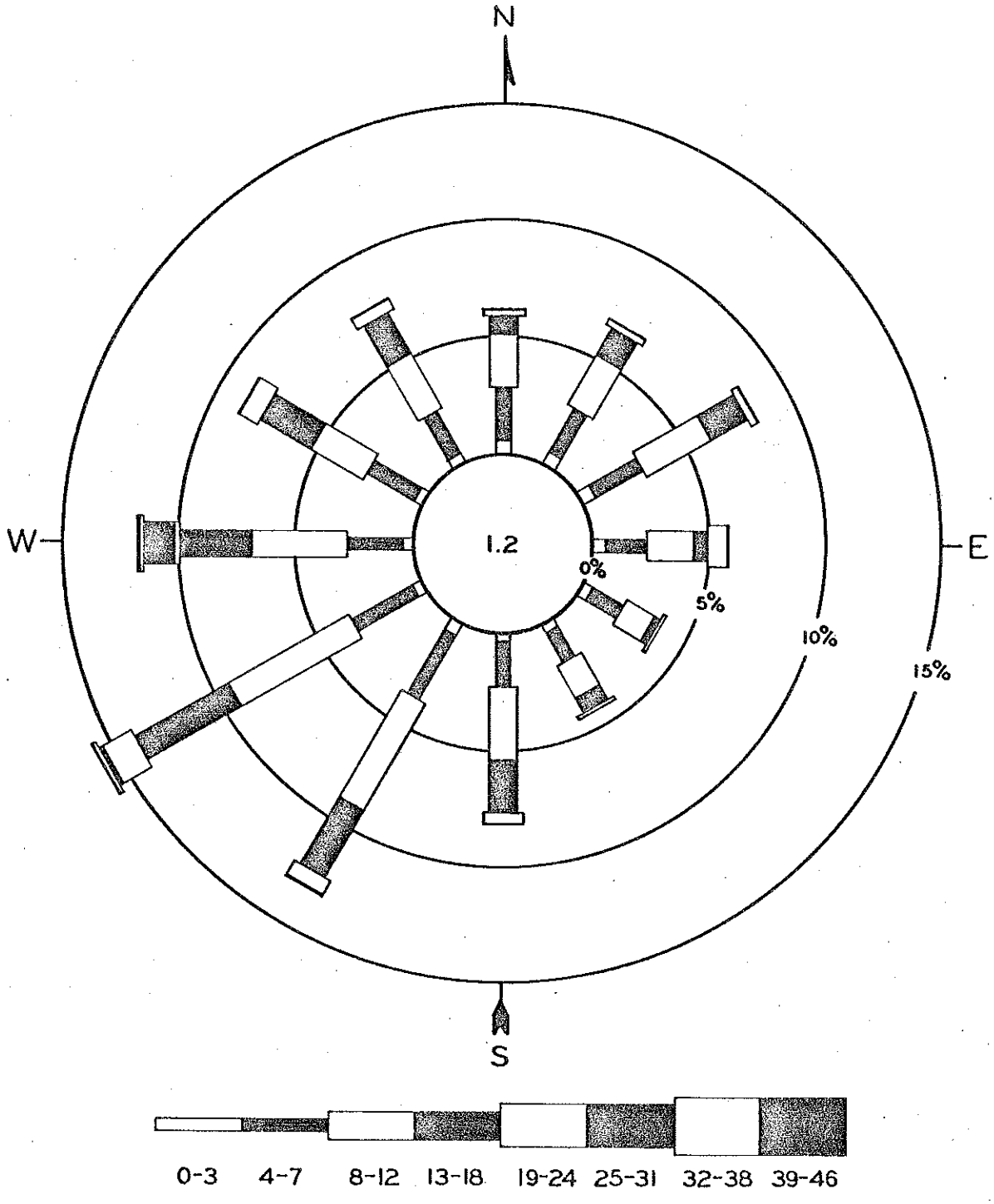

Figure 3. Wind speed and direction occurrences at Tri-County Airport (Saginaw).

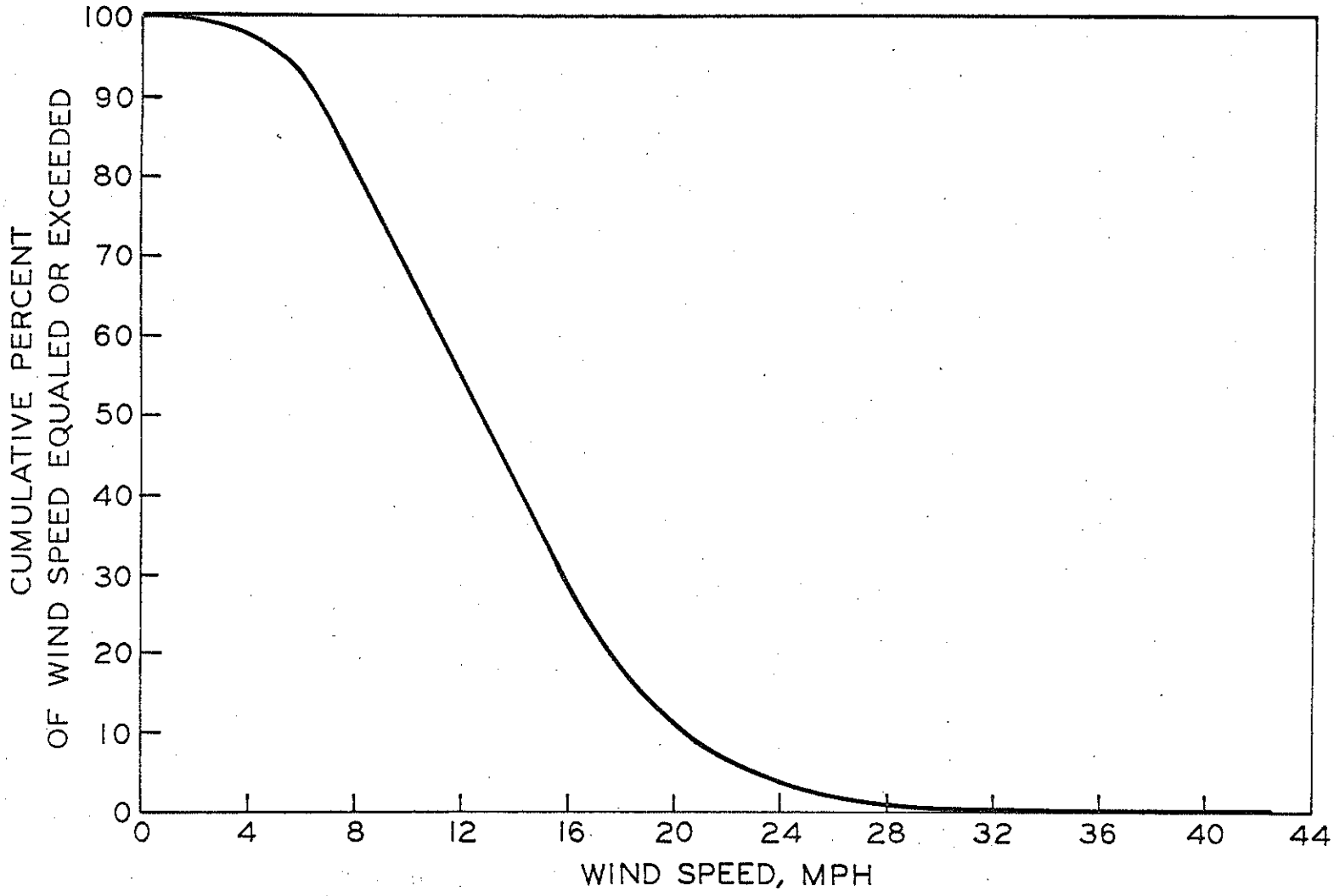

Figure 4. Distribution of wind speeds at Tri-County Airport (Saginaw).

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
(Three percent commercial vehicles)

Carbon Monoxide

Year	Speed, miles per hour				
	26	28	42	44	46
1982	---	9.3	---	6.4	6.2
1987	---	5.5	---	3.8	3.7
2002	5.4	---	3.7	3.6	---

Nitrogen Dioxide

Year	Speed, miles per hour				
	26	28	42	44	46
1982	---	1.6	---	1.9	2.0
1987	---	1.0	---	1.2	1.2
2002	0.9	---	1.0	1.1	---

[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.

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	Point of Beginning (1,300 ft west of Meridian Rd) to Homer Rd
2	Homer Rd to Vance Rd
3	Vance Rd to Currie Parkway
4	Currie Parkway to Tittabawassee River
5	Tittabawassee River to Indian St

2) The years 1982, 1987, and 2002.

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

Information used as input to the model consisted of:

1) Estimated peak p.m. (4:00 to 5:00) 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) 11,600 ft; Section 2) 10,550 ft; Section 3) 5,550 ft; Section 4) 5,300 ft; Section 5) 1,950 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, 2, 3, and 5, five 12-ft lanes (two 24-ft roadways with center lane for left turns), Section 4, two 24-ft roadways with 10 ft shoulders.

TABLE 1
TRAFFIC ESTIMATES FOR PROPOSED M 20
(Total Traffic in Both Directions)

Year	Section 1	Section 2	Section 3	Sections 4 and 5
1982	11,000 ⟨1,000(46)⟩ [440(49)]	15,300 ⟨1,300(44)⟩ [612(46)]	17,200 ⟨1,440(37) [688(39)]	13,600 ⟨1,200(28)⟩ [544(30)]
1987	13,300 ⟨1,200(46)⟩ [532(49)]	18,300 ⟨1,500(44)⟩ [732(46)]	21,400 ⟨1,760(37) [856(39)]	16,800 ⟨1,400(28)⟩ [672(30)]
2002	21,500 ⟨1,700(44)⟩ [860(47)]	29,400 ⟨2,200(42)⟩ [1,176(44)]	34,200 ⟨2,530(35) [1,368(37)]	28,900 ⟨2,200(26)⟩ [1,156(28)]

Peak Duration - variable, around 1 hour

Commercial vehicles - All sections - 3 percent of peak

000 = Average daily traffic (24 hr average)
⟨000⟩ = Peak traffic (vehicles per hour)
[000] = Off-peak traffic (vehicles per hour)
(00) = Average speed

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	50.7	21.3	27.9
2	0.0	0.0	0.0	51.2	21.5	27.3
3	0.0	0.0	0.0	51.7	20.0	28.2
4	0.0	0.0	0.0	51.9	21.0	27.1
5	0.0	0.0	0.0	53.9	19.4	26.8
6	6.2	8.4	4.9	48.1	16.7	15.6
7	7.7	16.7	9.5	49.8	10.2	6.1
8	6.2	19.2	17.4	52.5	2.5	2.1
9	4.9	15.4	23.2	56.5	0.0	0.0
10	3.9	15.8	22.8	57.5	0.0	0.0
11	4.1	12.8	22.8	60.3	0.0	0.0
12	3.3	12.0	23.0	61.7	0.0	0.0
13	3.4	9.9	22.2	64.5	0.0	0.0
14	3.4	9.4	23.5	63.7	0.0	0.0
15	2.1	11.5	20.9	65.5	0.0	0.0
16	2.1	10.2	21.5	61.9	3.9	0.3
17	2.6	10.2	17.1	59.8	8.4	2.0
18	3.0	8.9	10.0	59.4	13.6	5.1
19	0.0	0.0	0.0	62.7	23.0	14.3
20	0.0	0.0	0.0	60.1	22.2	17.7
21	0.0	0.0	0.0	57.6	21.7	20.7
22	0.0	0.0	0.0	57.0	20.0	23.0
23	0.0	0.0	0.0	54.8	23.6	21.5
24	0.0	0.0	0.0	52.5	22.8	24.6
Overall percent	2.2	6.7	9.9	56.9	12.2	12.1

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, Peak Traffic	Most Probable Condition[2] Stability D, Peak Traffic	Worst Condition Stability F, Parallel 3 mph Wind, Peak Traffic	Most Probable Condition[2] Stability D, Peak Traffic
1	1982	1.4	0.1	441	32
	1987	1.0	0.1	321	23
	2002	1.4	0.1	402	29
2	1982	1.9	0.1	562	41
	1987	1.3	0.1	393	29
	2002	1.8	0.1	509	37
3	1982	2.0	0.2	592	45
	1987	1.4	0.1	439	33
	2002	2.0	0.2	557	43
4	1982	2.0	0.2	353	32
	1987	1.4	0.1	250	23
	2002	2.1	0.2	346	31
5	1982	2.2	0.3	387	62
	1987	1.5	0.2	274	44
	2002	2.4	0.4	379	60

1 Average vehicle speeds are reported in Table 1.

2 Angle between roadway direction and wind direction - Sections 1, 2, 3, and 4, 30°; Section 5, 15°.

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 levels for off-peak traffic are very low, therefore they are not included in Table 3.

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.

Conclusions

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.

Additional Information for a School, Playground, and Park

Concentrations of carbon monoxide were estimated at a school playground, a city playground, and a county park near the proposed route (Fig. 1). The locations are as follows:

1) Windover Elementary School playground - The school faces Homer St and the playground is approximately 170 ft south of proposed roadway.

2) City playground - The playground faces Vance St and extends to the right-of-way line placing it about 10 ft north of the proposed roadway.

3) County park - The park faces Currie Parkway and extends to the right-of-way line placing it about 70 ft north of the proposed roadway.

Estimated carbon monoxide concentrations at the school playground, city playground and the park under worst meteorological conditions (3 mph wind parallel to the roadway, atmospheric stability class F) are presented in Table 4. These estimated concentrations of carbon monoxide are low enough to indicate that there will be no adverse environmental effects.

TABLE 4
CARBON MONOXIDE, mg/cu m

Location	Traffic Projection Year	Worst Case Peak Traffic Parallel Wind 3 mph
Windover Elementary School	1982	0.1
	1987	0.1
	2002	0.1
Playground	1982	1.8
	1987	1.2
	2002	1.7
County Park	1982	0.8
	1987	0.6
	2002	0.8