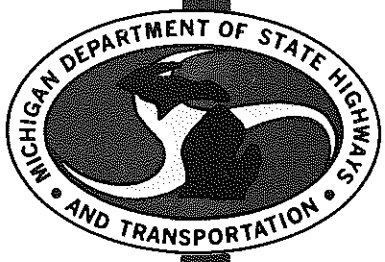
AIR QUALITY REPORT FOR PROPOSED RECONSTRUCTION OF INTERCHANGES AT I 94 AND MERRIMAN ROAD, AND I 94 AND MIDDLE BELT ROAD



TESTING AND RESEARCH DIVISION
RESEARCH LABORATORY SECTION

AIR QUALITY REPORT FOR PROPOSED RECONSTRUCTION OF INTERCHANGES AT I 94 AND MERRIMAN ROAD, AND I 94 AND MIDDLE BELT ROAD

Research Laboratory Section
Testing and Research Division
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Michigan State Highway Commission
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John P. Woodford, Director
Lansing, September 1978

This report presents air quality information for the proposed reconstruction of the I 94 and Merriman Rd, and I 94 and Middle Belt Rd interchanges, in the city of Romulus in Wayne County, as shown in Figure 1. Meteorological data, and estimates of pollution levels that might occur adjacent to the existing roadway and the proposed roadway, should it be constructed, are included.

Terrain and Demography

The proposed project is located in a commercial residential area. The terrain surrounding the project is generally flat with no tall buildings or structures in the immediate vicinity which might hinder dispersion of pollutants. The population of Romulus, according to the 1970 census is 22,879.

Meteorology

Meteorological conditions in Michigan are generally good for dispersion and dilution of air pollutants. According to the air pollution publication AP 101, U. S. Environmental Protection Agency, 1972 (p 96) there are few days with a high meteorological potential for air pollution.

Daily weather data recorded every third hour at Detroit Metropolitan Airport were obtained from the National Climatic Center in Asheville, N. C. for the years 1967 through 1973. Figure 2 shows a 36-point bar graph of wind speed and direction occurrences. 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 12 mph.

Existing Ambient Air Quality

No data are available to establish presently existing air quality in the area of the project; however, estimates of background carbon monoxide (from Michigan Department of Natural Resources, Air Pollution Control Division) that may exist in the project area in 1978 are 5.0 to 5.5 mg/cu m for a maximum eight-hour concentration and 8 to 10 mg/cu m for a maximum one-hour concentration. If traffic volumes remain constant, the Air Pollution Control Division expects the maximum eight-hour concentration of carbon monoxide to decrease to 3 mg/cu m in 1982 and to 2 mg/cu m by the year 2000, and the maximum one-hour concentration is expected to decrease to 6 to 7.5 mg/cu m in 1982 and to 4 mg/cu m by the year 2000. This reduction is due to Federal controls on exhaust emission of new vehi-

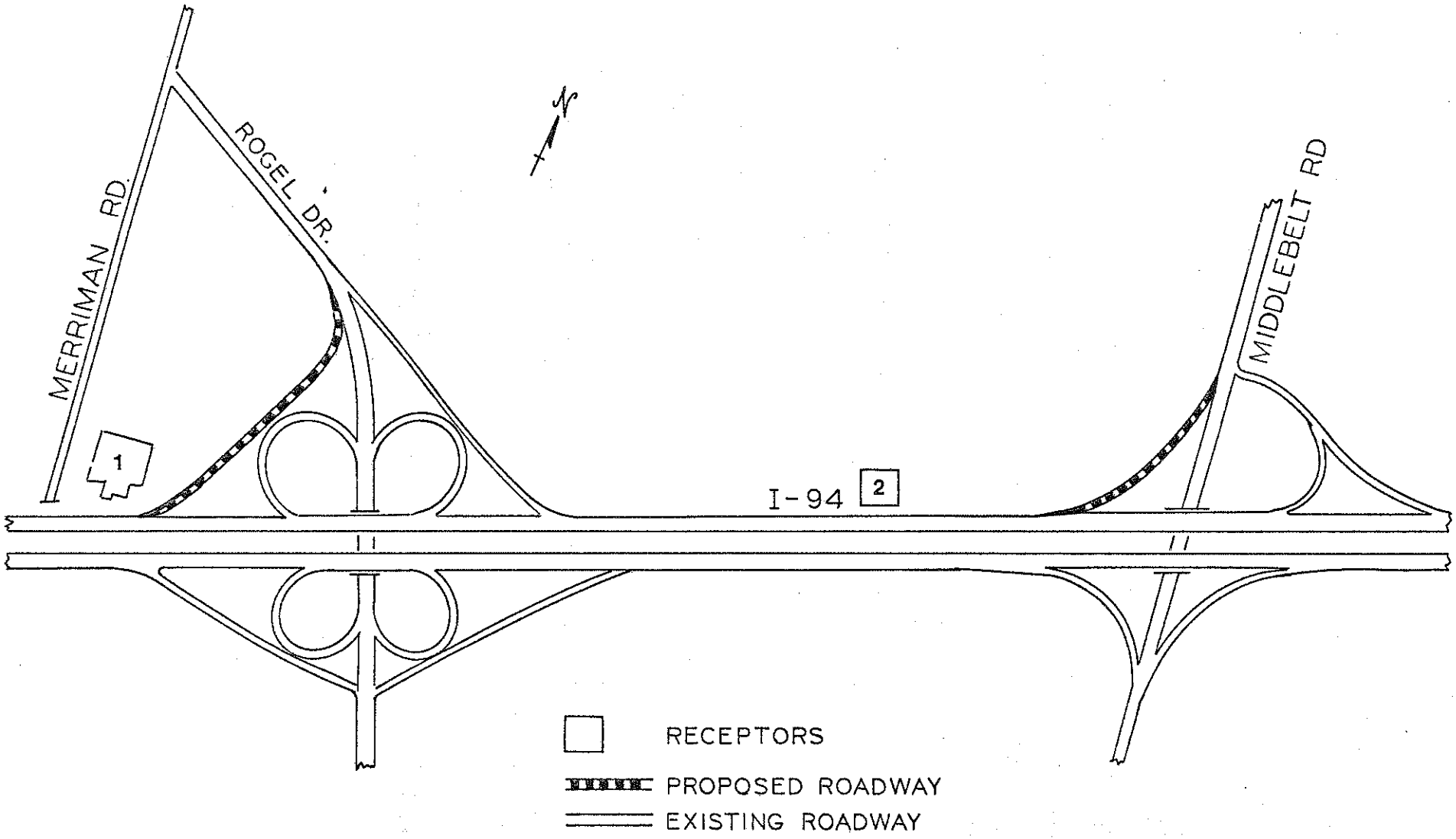

Figure 1. I 94/Merriman Rd and I 94/Middle Belt Rd interchanges in the city of Romulus. Solid lines are existing roadways. Dashed lines are portions of the proposed interchanges near receptor sites.

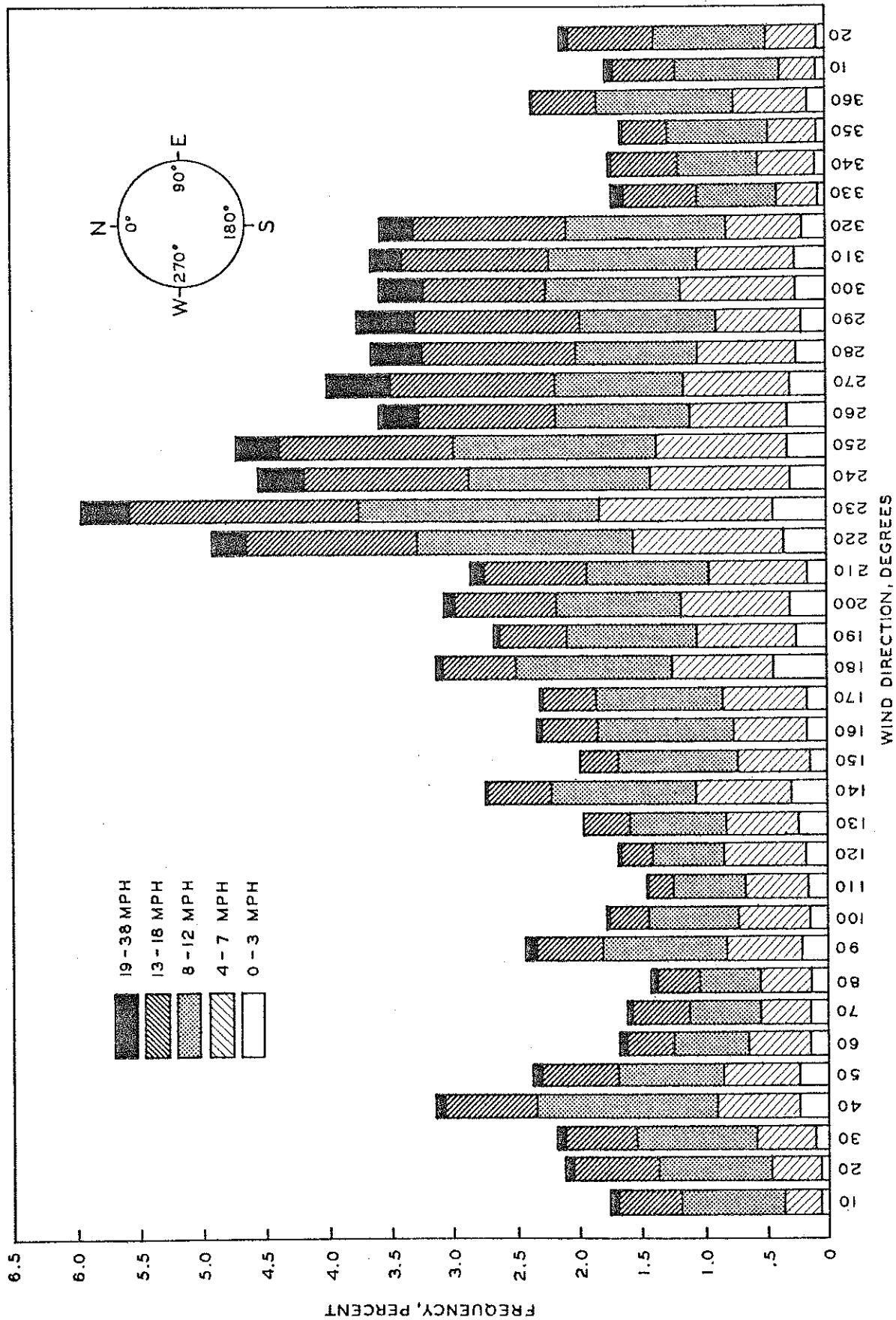

Figure 2. Wind speed and direction occurrences at Detroit Metropolitan Airport.

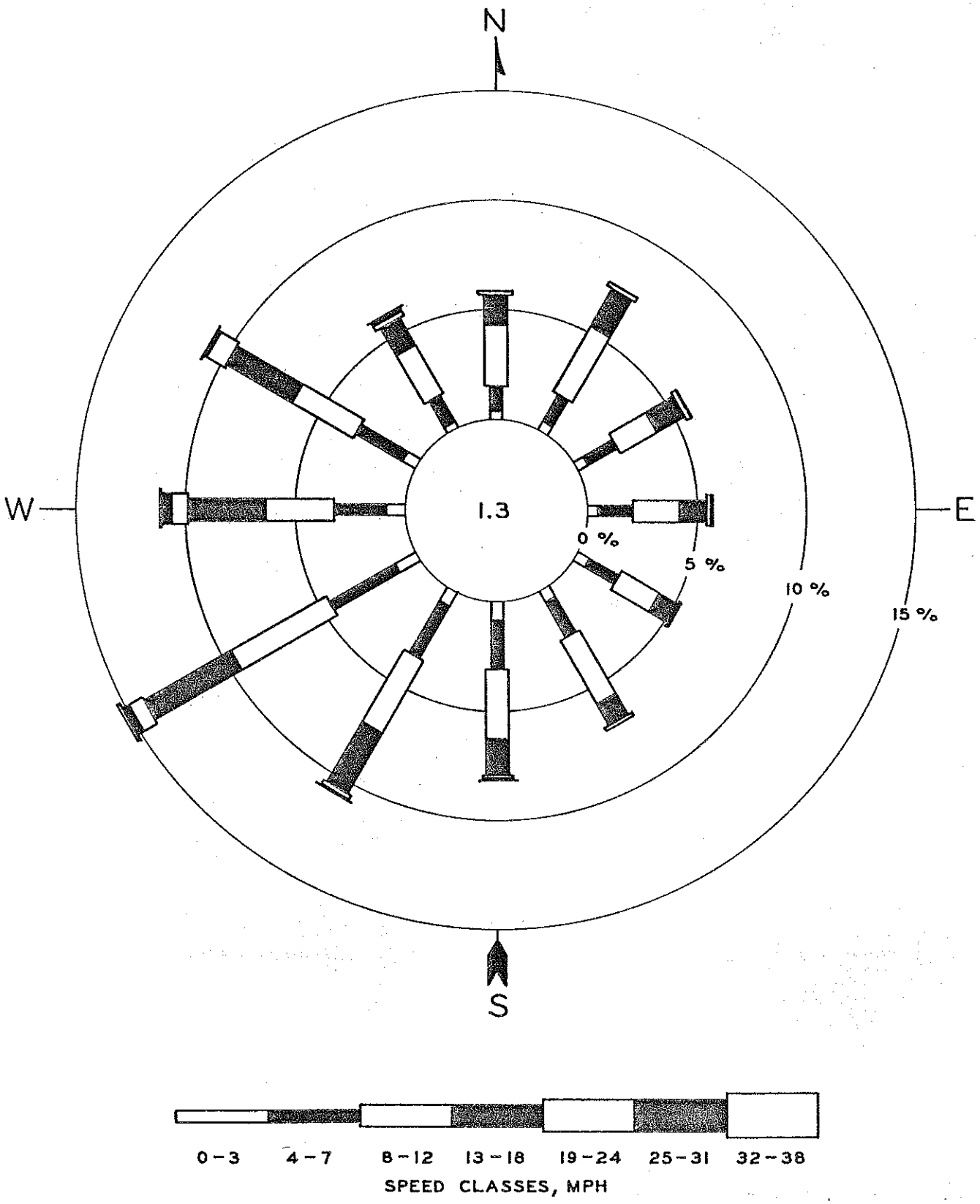

Figure 3. Frequency of wind direction and speed at Detroit Metropolitan Airport (calms, recorded 1.3 percent of the time, are distributed).

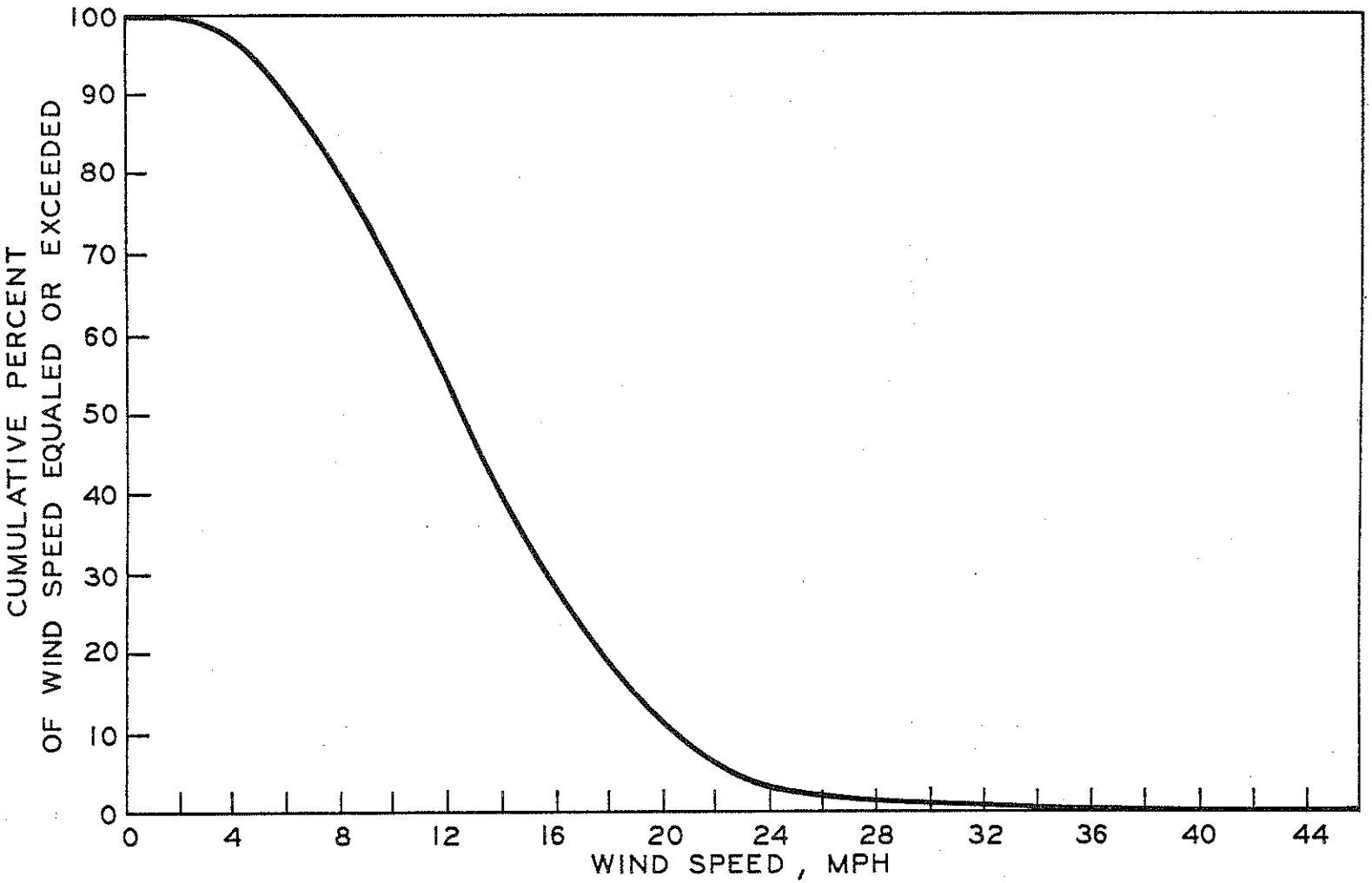

Figure 4. Wind speed distributions at Detroit Metropolitan Airport.

cles. However, Michigan Department of State Highways and Transportation analysts predict traffic volumes will increase by 20 percent by 1982 and 50 percent by 2000. Thus the estimated maximum eight-hour background concentration of carbon monoxide would be 3.0 x 1.2 = 3.6 mg/cu m in 1982 and 2.0 x 1.5 = 3.0 mg/cu m in 2000. The estimated maximum one-hour background concentration would be 6 to 7.5 x 1.2 = 7.2 to 9.0 mg/cu m in 1982 and 4 x 1.5 = 6 mg/cu m in 2000.

Pollution Estimates

Estimates of carbon monoxide concentrations were made at a height of 1.5 meters (5 ft) above the ground level. A mathematical model based on the Gaussian diffusion equation, modified for a line source, was used[1]. Inputs to the model include wind speed and direction, traffic volumes, vehicle emission factors, and design of the highway.

Carbon monoxide concentrations were estimated at the two closest significant receptor sites near the subject interchanges for both the 'No Build' and 'Build' alternates (Fig. 1) for the years 1982 and 2000. Other alternate configurations of the interchanges, detailed in the body of the environmental statement, place ramps at greater distances from possible receptors than shown in Figure 1, so pollutant concentrations at receptors would be even lower for those configurations. The receptors are as follows:

1) Holiday Inn - The Inn is located approximately 60 ft north of an existing westbound collector-distributor road paralleling I 94 and about 75 ft from existing I 94. An existing eastbound collector-distributor parallels I 94 about 260 ft south of Receptor 1. These distances do not change significantly for the Build alternates.

2) Residences north of I 94. The nearest residence is approximately 95 ft from existing I 94 (No Build). The Build alternates extend both collector-distributors through the Middle Belt Rd interchange. This extension of the collector-distributors does not move the proposed roadway significantly nearer to Receptor 2 because additional right-of-way will be purchased and several houses removed leaving the closest residence about the same distance to the road as the No Build alternate. The additional traffic on the extended collector-distributors is considered in the carbon monoxide estimates at Receptor 2.

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[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.

Information used as input to the model consisted of:

1) Vehicle emission factors shown in the following table, were calculated using "Mobile Source Emission Factors," March 1978, U. S. Environmental Protection Agency. Emission factors were calculated at temperatures of 30 and 60 F with 5 percent of the vehicles in a cold start condition, 5 percent of the vehicles in a hot start condition, and the remainder of the vehicles in a hot operation mode.

Vehicle age mix data and average annual miles driven for various age vehicles used were national estimates from "Mobile Source Emission Factors."

EMISSION FACTORS FOR CARBON MONOXIDE, g/mi

Temperature, F	Year	Average Vehicle Speed, mph					
		10 (5)*	20 (5)	35 (5)	35 (6)	45 (6)	50 (5)
30	1982	--	42.9	25.5	--	22.4	21.3
	2000	29.4	--	11.0	11.6	--	9.4
60	1982	--	40.4	23.9	--	21.0	19.0
	2000	28.0	--	10.5	11.0	--	9.0

* (0) Percent heavy duty vehicles.

2) Estimated peak a.m. (7:00 to 8:00) traffic volumes. Traffic estimates for the roadway sections adjacent to the receptors are shown in Table 1.

3) Meteorological Conditions.

a. Worst meteorological conditions were taken as a 2.2 mph (1 m/sec) wind parallel to the roadway, under atmospheric stability class D.

b. Most probable meteorological conditions, a 12 mph wind at 230 degrees under atmospheric stability class D. Table 2 shows the frequency distribution of atmospheric stability classes for the meteorological data used.

TABLE 1
TRAFFIC ESTIMATES FOR I 94/MERRIMAN ROAD
AND I 94/MIDDLE BELT ROAD INTERCHANGE

Location	Year	No-Build		Build	
		Receptor 1	Receptor 2	Receptor 1	Receptor 2
I 94	1982	7,400(45)	8,300(45)	7,400(50)	8,300(50)
	2000	9,900(35)	11,000(35)	9,900(50)	11,000(50)
Eastbound[1]	1982	900(35)	---	900(35)	900(35)
Collector-Distributor	2000	1,200(35)	---	1,200(35)	1,200(35)
Westbound[1]	1982	1,200(35)	---	1,200(35)	1,200(35)
Collector-Distributor	2000	1,650(35)	---	1,650(35)	1,650(35)
Merriman Road[2]	1982	240(20)	---	---	---
	2000	330(10)	---	---	---

Commercial Vehicles: no-build, I 94, 6 percent, all other roadways 5 percent; build, all roadways 5 percent.

000 = peak hour traffic, vehicles per hour
(00) = average traffic speeds, mph

[1] The collector-distributor roadways do not extend to the immediate vicinity of Receptor 2 for the no-build alternate.
[2] Merriman Rd will be blocked and not merge with I 94 for the build alternate.

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	49.7	22.0	28.3
4	0.0	0.0	0.0	49.8	21.1	29.1
7	8.8	16.4	10.1	47.4	9.9	7.3
10	3.7	13.9	22.2	60.2	0.0	0.0
13	2.3	9.8	21.6	66.4	0.0	0.0
16	1.3	9.1	22.4	64.7	2.1	0.4
19	0.0	0.0	0.0	62.7	26.4	10.9
22	0.0	0.0	0.0	50.7	24.8	24.4
Overall percent	2.0	6.1	9.5	56.5	13.3	12.6

4) Road Profile. The roadway is elevated 6 ft above grade at Receptor 1, and 9 ft above grade at Receptor 2.

5) Roadway Width. The existing roadway adjacent to both receptors is two 36-ft roadways separated by a 115-ft median. At the Merriman Rd interchange there is an additional 12-ft wide collector-distributor roadway adjacent to both the eastbound and westbound lanes of I 94 in the area of Receptor 1. The Build alternates extend these collector-distributors through the Middle Belt Rd interchange to the proximity of Receptor 2.

All estimates of carbon monoxide levels represent maximum one-hour concentrations and are in addition to existing background levels. Table 3 presents estimates of carbon monoxide, excluding background, at two receptors for both the No Build and Build alternates.

Comparison of Estimates with Air Quality Standards

a. One-hour carbon monoxide standard - 40 mg/cu m (36 ppm), not to be exceeded more than once per year.

The maximum estimated one-hour concentrations of carbon monoxide from the roadway at each receptor are 9.5 mg/cu m and 6.4 mg/cu m for 1982 and 2000, respectively, for the No Build alternate at Receptor 1 and 9.2 mg/cu m and 5.6 mg/cu m for the Build alternates. At Receptor 2

Table 3
Estimates of Carbon Monoxide From The Roadway (mg/cu m)
(Not including Background)

Location	Traffic Projection Year	Ambient Temp. °F	Worst Condition, Parallel Wind, 1 m/sec, Stability D, Peak Traffic		Most Probable Condition[1] Stability D, Peak Traffic	
			No-Build	Build	No-Build	Build
Receptor 1[2]	1982	30	9.5	9.2	1.7	1.6
		60	8.9	8.6	1.5	1.5
	2000	30	6.4	5.6	1.0	0.9
		60	6.2	5.4	1.0	0.8
Receptor 2[3]	1982	30	6.8	8.8	1.2	1.5
		60	6.4	8.2	1.1	1.4
	2000	30	4.7	5.1	0.8	0.9
		60	4.4	4.9	0.8	0.8

1 Most probable wind, 12 mph, angle between wind direction and road direction, 20 degrees.
2 Includes carbon monoxide contributions from Merriman Rd and both the eastbound and westbound collector-distributors.
3 Includes carbon monoxide contributions from both the eastbound and westbound collector-distributors for the Build alternate.

the maximum one-hour concentrations of carbon monoxide are 6.8 mg/cu m and 4.7 mg/cu m for 1982 and 2000, respectively, for the No Build alternate and 8.8 mg/cu m and 5.1 mg/cu m for the Build alternates. Adding these concentrations to the estimated 7.2 to 9.0 mg/cu m estimated background for 1982 and 6.0 mg/cu m for 2000 results in total one-hour concentrations of:

Receptor 1

1982	No Build	16.7 to 18.5 mg/cu m
	Build	16.4 to 18.2 mg/cu m
2000	No Build	12.4 mg/cu m
	Build	11.6 mg/cu m

Receptor 2

1982	No Build	14.0 to 15.8 mg/cu m
	Build	16.0 to 17.8 mg/cu m
2000	No Build	10.7 mg/cu m
	Build	11.1 mg/cu m

All of these concentrations are below the 40 mg/cu m standard.

b. Eight-hour carbon monoxide air quality standard - 10 mg/cu m (9 ppm), not to be exceeded more than once per year.

The Federal Highway Administration's report "Project Level Considerations to Assure Adequate Air Quality Analysis" suggests the following technique for determining the eight-hour carbon monoxide concentration from the one-hour concentrations.

$$\frac{V_8}{V_1} \times (\text{1-hr CO concentration}) \times P = \text{8-hr concentration}$$

where V_8 = average hourly traffic volume in both directions during the 8-hr period of interest

V_1 = peak hour traffic volume in both directions.

P = 1-to-8-hr meteorological persistence factor for the 8-hr period.

A value of P = 0.6 is suggested unless data are available to calculate a persistence factor for the proposed highway project.

If this technique is used to calculate the eight-hour carbon monoxide levels for 1982 and 2000 at 30 degrees ambient temperature the highest eight-hour concentration from the roadway at the receptors is:

Receptor 1

1982

No Build $\frac{4,100 \text{ vehicles per hour}}{7,400 \text{ vehicles per hour}} \times 9.5 \text{ mg/cu m} \times 0.6$

$= 3.2 \text{ mg/cu m}$

Build $\frac{4,100 \text{ vehicles per hour}}{7,400 \text{ vehicles per hour}} \times 9.2 \text{ mg/cu m} \times 0.6$

$= 3.1 \text{ mg/cu m}$

2000

No Build $\frac{5,400 \text{ vehicles per hour}}{9,900 \text{ vehicles per hour}} \times 6.4 \text{ mg/cu m} \times 0.6$

$= 2.1 \text{ mg/cu m}$

Build $\frac{5,400 \text{ vehicles per hour}}{9,900 \text{ vehicles per hour}} \times 5.6 \text{ mg/cu m} \times 0.6$

$= 1.8 \text{ mg/cu m}$

Receptor 2

1982

No Build $\frac{4,500 \text{ vehicles per hour}}{8,300 \text{ vehicles per hour}} \times 6.8 \text{ mg/cu m} \times 0.6$

$= 2.2 \text{ mg/cu m}$

Build $\frac{4,500 \text{ vehicles per hour}}{8,300 \text{ vehicles per hour}} \times 8.8 \text{ mg/cu m} \times 0.6$

$= 2.9 \text{ mg/cu m}$

No Build $\frac{6,000 \text{ vehicles per hour}}{11,000 \text{ vehicles per hour}} \times 4.7 \text{ mg/cu m} \times 0.6$

$= 1.5 \text{ mg/cu m}$

2000

Build $\frac{6,000 \text{ vehicles per hour}}{11,999 \text{ vehicles per hour}} \times 5.1 \text{ mg/cu m} \times 0.6$

$= 1.7 \text{ mg/cu m}$

Adding these concentrations to the 3.6 mg/cu m estimated eight-hour background for 1982 and 3.0 mg/cu m for 2000 results in total eight-hour concentrations as follows:

Receptor 1

1982	No Build	6.8 mg/cu m
	Build	6.7 mg/cu m
2000	No Build	5.1 mg/cu m
	Build	4.8 mg/cu m

Receptor 2

1982	No Build	5.8 mg/cu m
	Build	6.5 mg/cu m
2000	No Build	4.5 mg/cu m
	Build	4.7 mg/cu m

The eight-hour average carbon monoxide concentrations for both receptors are below the air quality standard.

The estimated concentrations of carbon monoxide, including existing background at receptor sites near the proposed interchanges are within the national air quality standards. There is no significant difference in carbon monoxide concentrations between the No Build and Build alternates. The project is consistent with the State implementation plan for meeting national air quality standards for carbon monoxide.