AIR QUALITY REPORT FOR M 59 FROM US 23 TO PROPOSED M 275 IN LIVINGSTON AND OAKLAND COUNTIES

MICHIGAN DEPARTMENT OF
STATE HIGHWAYS AND TRANSPORTATION

AIR QUALITY REPORT FOR M 59 FROM US 23 TO PROPOSED M 275 IN LIVINGSTON AND OAKLAND COUNTIES

Research Laboratory Section
Testing and Research Division
Research Project 75 TI-292
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Michigan State Highway Commission
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This report presents air quality information for a proposed section of M 59 in Livingston and Oakland 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 according to the 1970 census is Livingston - 103 per square mile with 11 percent urban and Oakland - 1,009 per square mile with 90 percent urban. Most of the urban area of Oakland County is located in the southeastern corner adjacent to the City of Detroit.

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 Pontiac City Airport. Hourly weather data (6 a.m. to 11 p.m. only data recorded) were obtained from the National Climatic Center at 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 at Pontiac City Airport between 6 a.m. and 11 p.m. The most probable daytime wind speeds are in the 8 to 12 mph range. 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.

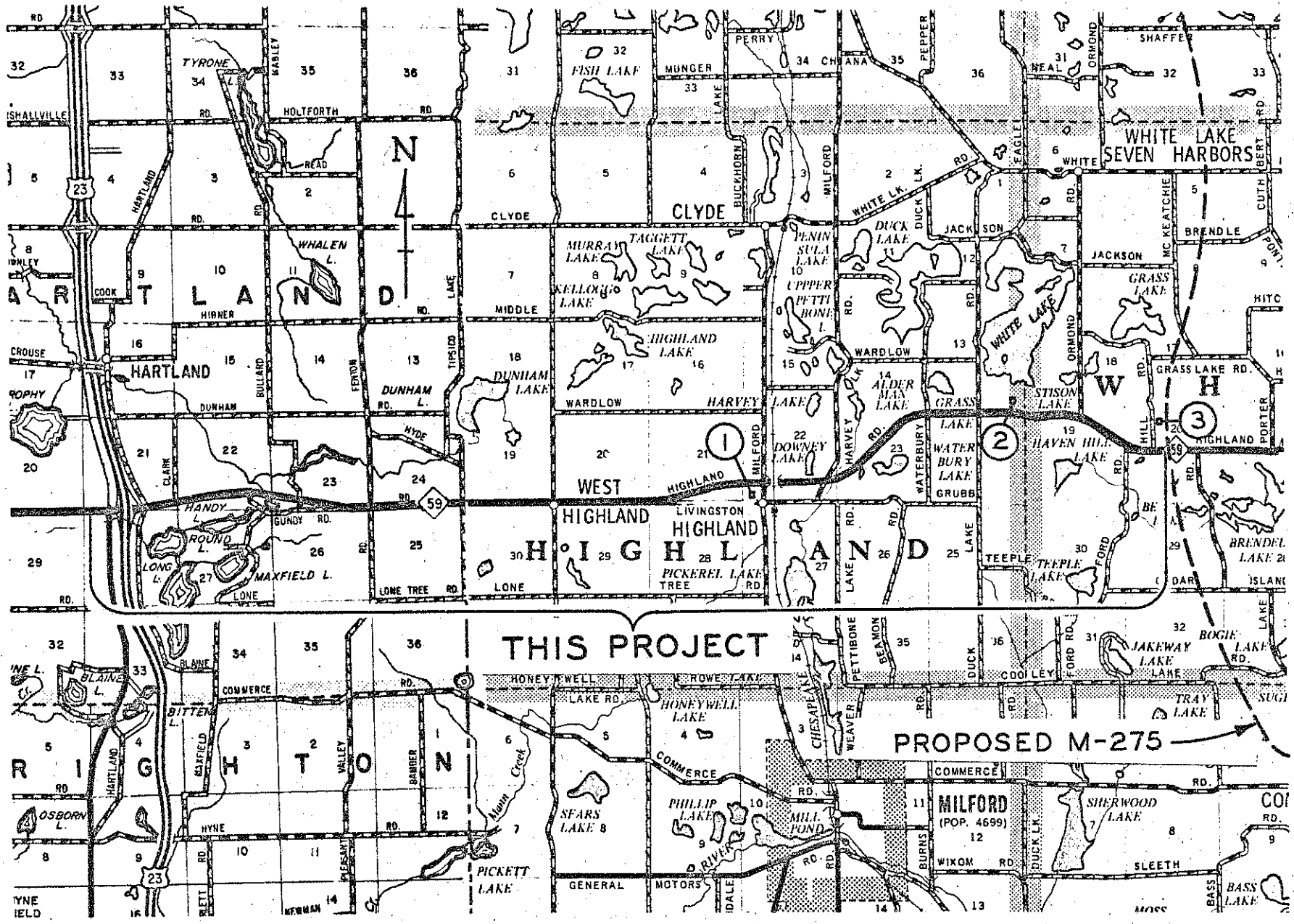

Figure 1. Location of proposed M 59 in Livingston and Oakland Counties.

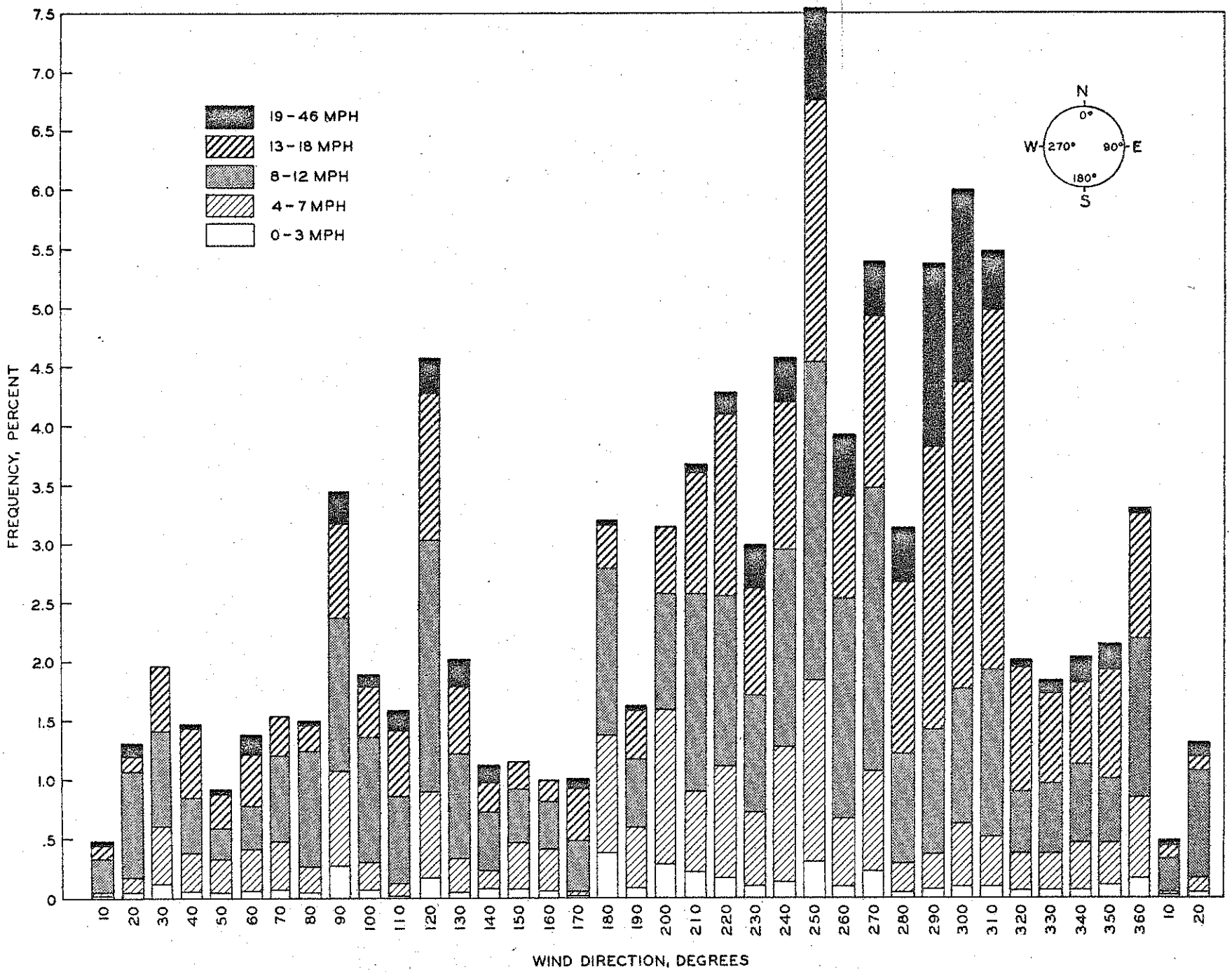

Figure 2. Wind speed and direction occurrences at Pontiac Airport (6 a.m. to 11 p.m.).

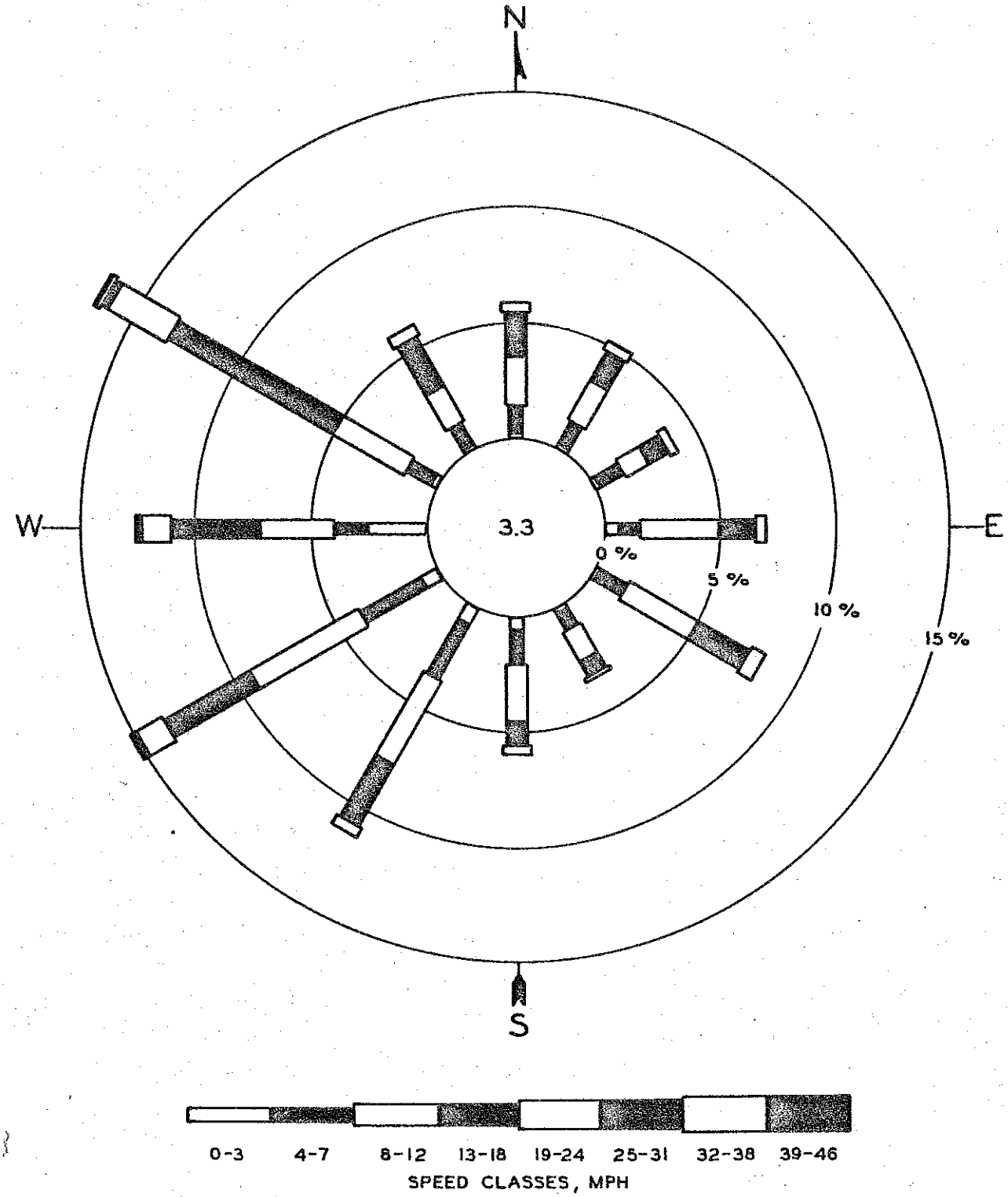

Figure 3. Wind speed and direction occurrences at Pontiac Airport (6 a.m. to 11 p.m.).

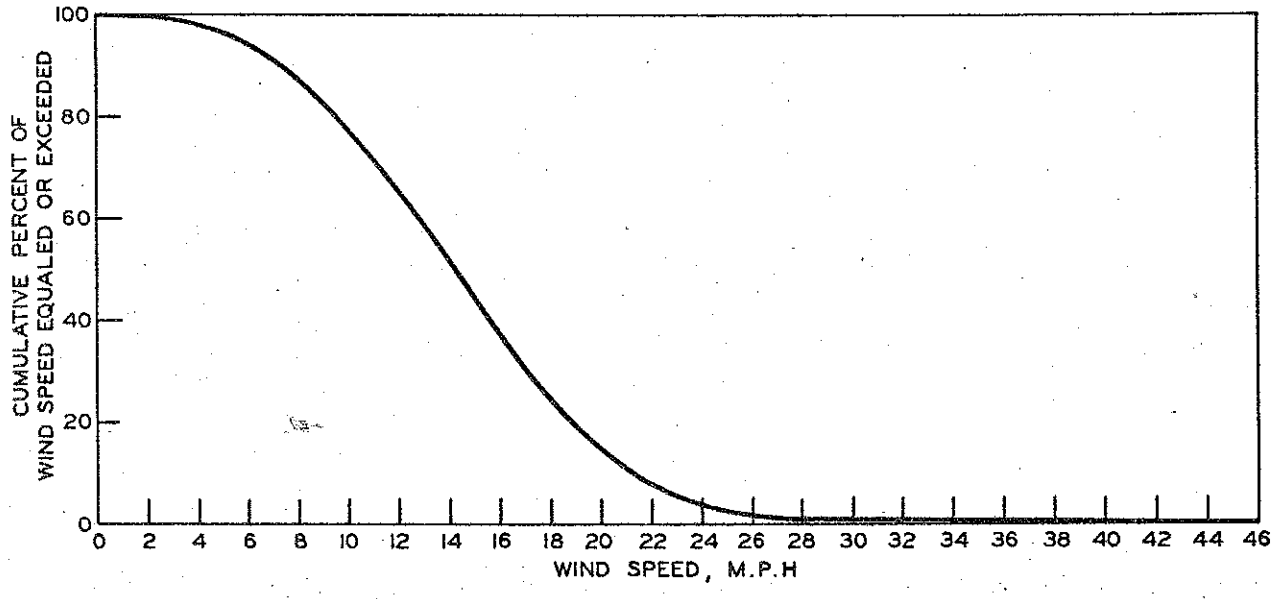

Figure 4. Distribution of wind speeds at Pontiac Airport (6 a.m. to 11 p.m.).

Pollution Estimates

Estimates of pollutant concentrations at a height of 1.5 meters (5 ft) above the ground were made for carbon monoxide under various wind conditions. A mathematical model based on the Gaussian diffusion equation, modified for a line source, was used[1]. 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 (NO_2), 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 NO_2, according to Federal EPA data. Subsequent to being emitted from the tailpipe, NO may be converted to NO_2 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 NO_2.

[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.

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 with revisions by the EPA administrator as reported in the Federal Register, Volume 40, No. 109, June 1975. Vehicle age mix data were obtained from the Michigan Department of State.

Emission Factors, g/mi

Carbon Monoxide				
Year	Speed, Miles Per Hour			
	40 (3)*	45 (3)	55 (3)	55 (8)
1980	---	---	10.0	12.5
1985	---	5.4	---	7.3
2000	3.9	---	---	5.8

* (0) percent heavy duty vehicles.

Pollution concentrations were estimated for:

1) Four alternate cross-sections. All of the alternates incorporate the existing roadway so are of the same length and direction (Fig. 1).

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) Estimated peak (4:00 to 5:00 p. m., Friday or Sunday) and off-peak traffic volumes. Traffic estimates for the highest volume section along the proposed route (Ford Rd east to proposed M 275) are shown in Table 1. On Friday afternoon approximately 60 percent of the peak traffic is westbound and 40 percent eastbound. On Sunday afternoon approximately 60 percent of the peak is eastbound and 40 percent westbound. Off-peak traffic was taken as four percent of ADT, with half of the traffic in each direction. The week day peak was found to be lower than the Friday and Sunday peaks.

TABLE 1
MAXIMUM TRAFFIC ESTIMATED FOR PROPOSED M 59
(Total Traffic in Both Directions)

Year		
1980	1985	2000
20,600 ⟨2,470(55)⟩ [820(55)]	24,600 ⟨2,950(45)⟩ [1,000(55)]	30,000 ⟨3,450(40)⟩ [1,300(55)]

Peak Duration - variable around 1 hour
Commercial vehicles - 3 percent of peak for 1980 and 1985, 2 percent for 2000, 8 percent of off-peak.

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

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 (shown in Table 3), 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 alternate cross-sections: Alternate 1, five 12-ft lanes with curb and gutter; Alternate 2, five 12-ft lanes with shoulders; Alternate 3, two 24-ft roadways with shoulders separated by an 84-ft median (one roadway south of existing roadway); Alternate 4, two 24-ft roadways with shoulders separated by an 84-ft median (one roadway north of existing roadway).

All estimates of carbon monoxide levels represent maximum one hour concentrations and are in addition to existing background levels. Table 3 presents estimates of levels for carbon monoxide for the Ford Rd to the

proposed M 275 section (highest traffic volume section) in the area over the highway (mixing cell). The carbon monoxide estimates shown in Table 3 and for the receptor sites are based on the Alternate 2 cross-section (five 12-ft lanes with shoulders). Alternate 2 estimates were found to be slightly higher than the other alternates.

TABLE 2
STABILITY CLASS FREQUENCY DISTRIBUTION BY HOUR
(Percent)

Hour	Stability Class					
	A	B	C	D	E	F
6	11.6	14.0	7.0	48.8	7.0	11.6
7	11.8	6.2	13.7	54.0	10.6	3.7
8	9.3	9.3	18.5	55.6	3.7	3.7
9	7.4	9.9	21.6	61.1	0.0	0.0
10	6.2	6.8	17.9	69.1	0.0	0.0
11	4.3	6.8	16.7	72.2	0.0	0.0
12	3.7	4.3	17.3	74.7	0.0	0.0
13	3.7	4.9	17.9	73.5	0.0	0.0
14	3.1	6.2	17.3	73.5	0.0	0.0
15	3.7	5.6	15.4	75.3	0.0	0.0
16	3.7	4.9	13.6	76.5	0.6	0.6
17	3.1	4.9	19.1	65.4	4.9	2.5
18	2.5	5.6	11.7	63.0	11.7	5.6
19	0.0	0.0	0.0	67.3	21.6	11.1
20	0.0	0.0	0.0	64.2	23.5	12.3
21	0.0	0.0	0.0	57.4	24.1	18.5
22	0.0	0.0	0.0	57.4	19.1	23.5
23	0.0	0.0	0.0	61.3	16.0	22.7
Overall percent	3.9	4.6	11.9	65.8	7.8	6.0

TABLE 3
ESTIMATES OF MIXING CELL
CONCENTRATIONS [1]

Traffic Projection Year	CO (mg/cu m)	
	Worst Condition Stability F, Parallel 3 mph Wind, Peak Traffic	Most Probable Condition [2] Stability D, Off-Peak Traffic
1980	3.0	0.2
1985	1.9	0.2
2000	1.6	0.2

[1] Average vehicle speeds are reported in Table 1.

[2] Angle between average roadway direction and wind direction - 20° (wind speed 12 mph).

Carbon monoxide estimates for off-peak traffic are calculated based on the present speed limit (55 mph). Estimates for peak traffic are based on the speeds shown in Table 1.

Federal air quality standards for carbon monoxide are:

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.

Conclusions

The estimated concentrations of carbon monoxide on and near each alternate route of the proposed roadway are low. No significant difference in carbon monoxide concentrations between the alternate routes was found and no adverse environmental effects are expected. Even the worst case estimates are far below the 8 hr air quality standard. The project is consistent with the state implementation plan for meeting air quality standards.

Additional Information for Receptor Sites

Concentrations of carbon monoxide were estimated at two schools and a church near the proposed route (Fig. 1). The locations are as follows:

1. Highland Junior High School - M 59 and John St. The school playground is located about 45 ft south of the proposed roadway and the school building is about 200 ft south of the proposed roadway.

2. Faith Lutheran Church - M 59 and Ridge Rd. The church is located about 200 ft north of the proposed roadway.

3. Brooks Elementary School - M 59 and Hill Rd. The school playground is located about 300 ft north of the proposed roadway and the school building is about 350 ft north.

Estimated carbon monoxide concentrations at the edge of the Highland Junior High School playground under worst meteorological conditions (3 mph wind parallel to the roadway stability class F) are presented in Table 4. Carbon monoxide levels at all of the other receptor sites under worst meteorological conditions are less than 0.5 mg/cu m. The worst meteorological condition for sites 200 ft or more off the roadway is a 3 mph wind blowing at 90 degrees across the roadway toward the site under stability class F. These estimated concentrations 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, Wind Speed, 3 mph
Highland Junior High School at the playground	1980	1.4
	1985	0.9
	2000	0.8