AIR QUALITY REPORT FOR M 21 IN LAPEER AND ST. CLAIR COUNTIES

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

AIR QUALITY REPORT FOR M 21 IN LAPEER AND ST. CLAIR COUNTIES

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Michigan State Highway Commission
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This report presents air quality information for a proposed section of M 21 in Lapeer and St. Clair 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 Lapeer - 80 per square mile with 12 percent urban and St. Clair - 164 per square mile with 46 percent urban.

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 Bishop Airport (Flint). 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 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. 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 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 Administra-

[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, National Technical Information Service, Report No. FHWA-RD-72-36.

tion 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	15 Percent Commercial Vehicles	23 Percent Commercial Vehicles
1980	14.1	18.2
1985	10.2	14.7
2000	9.7	14.2

Oxides of Nitrogen

Year	15 Percent Commercial Vehicles	23 Percent Commercial Vehicles
1980	4.3	5.2
1985	2.9	4.0
2000	2.7	3.8

Pollution concentrations were estimated for:

1) All of the alternate routes shown in Figure 1. Since all of the alternate routes were of about the same length and direction and the other model input parameters were not significantly different, each alternate route was considered one long section.

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 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.

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 all sections, two 24-ft roadways with 10-ft shoulders, separated by a variable (94-ft minimum) median.

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 speed limits be increased to the previous 70 mph limit, carbon monoxide concentrations could decrease by 9 percent, and nitrogen oxide concentrations 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.

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. The project is consistent with the state implementation plan for meeting air quality standards.

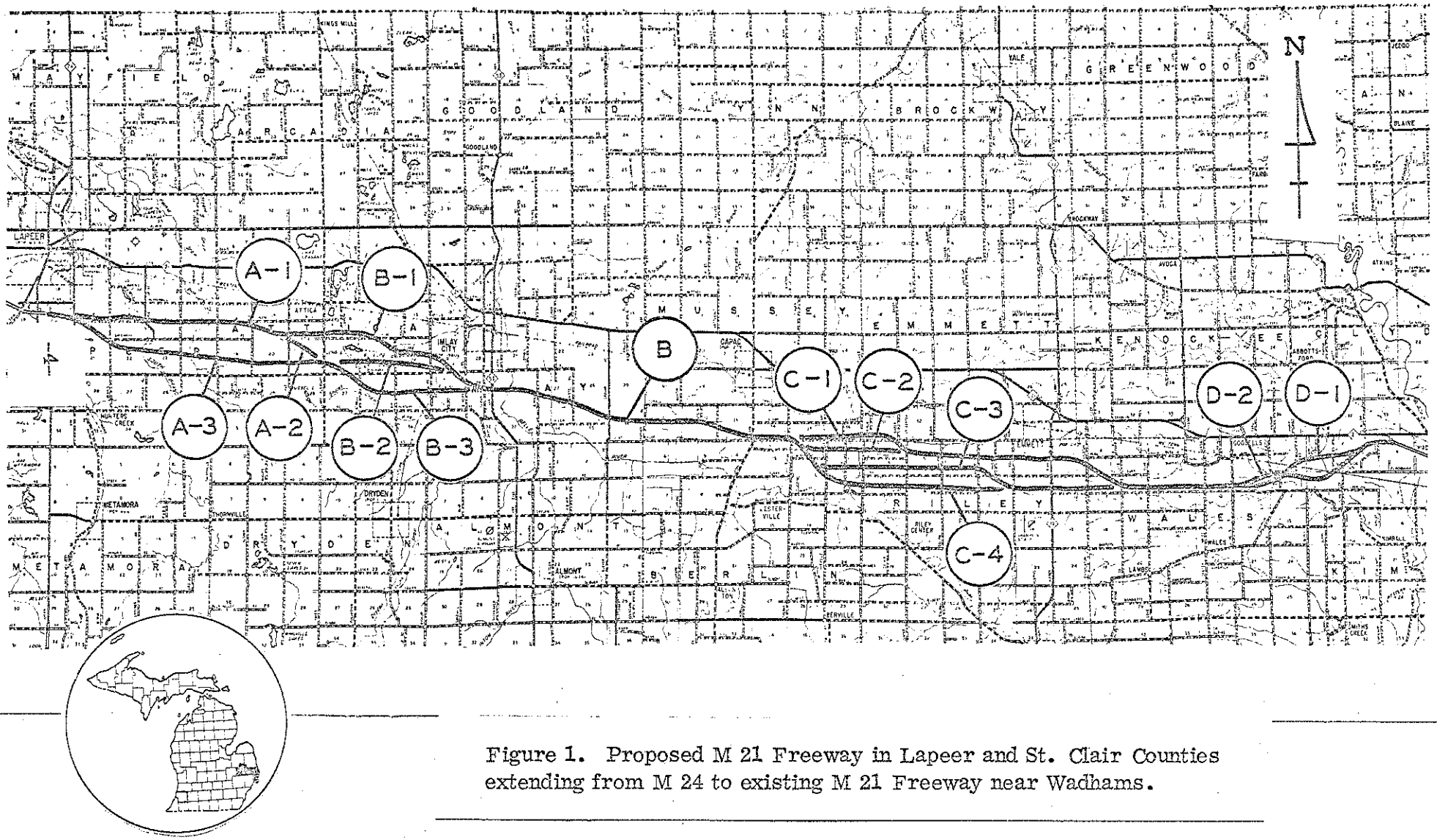

Figure 1. Proposed M 21 Freeway in Lapeer and St. Clair Counties extending from M 24 to existing M 21 Freeway near Wadhams.

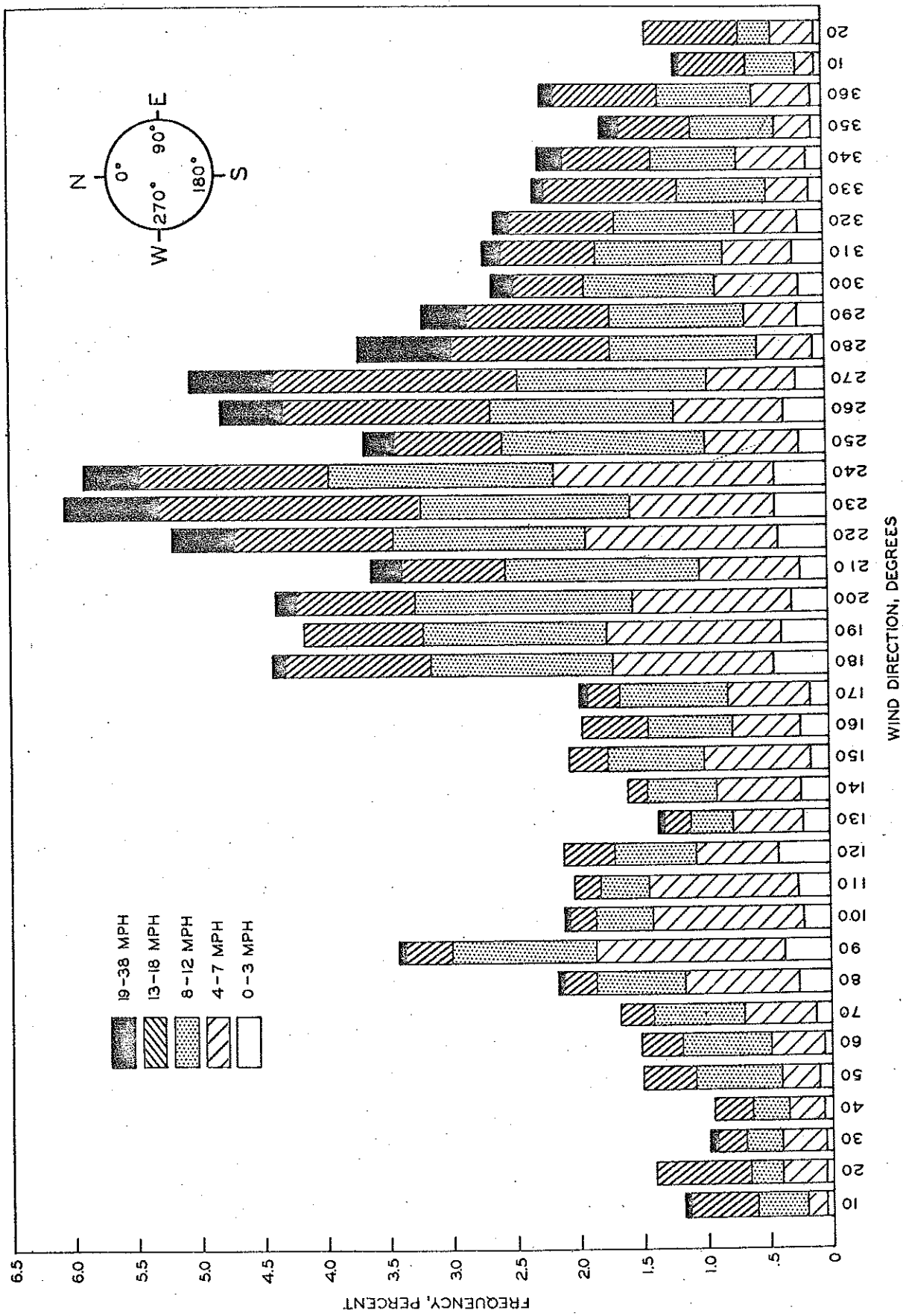

Figure 2. Wind speed and direction occurrences at Bishop Airport.

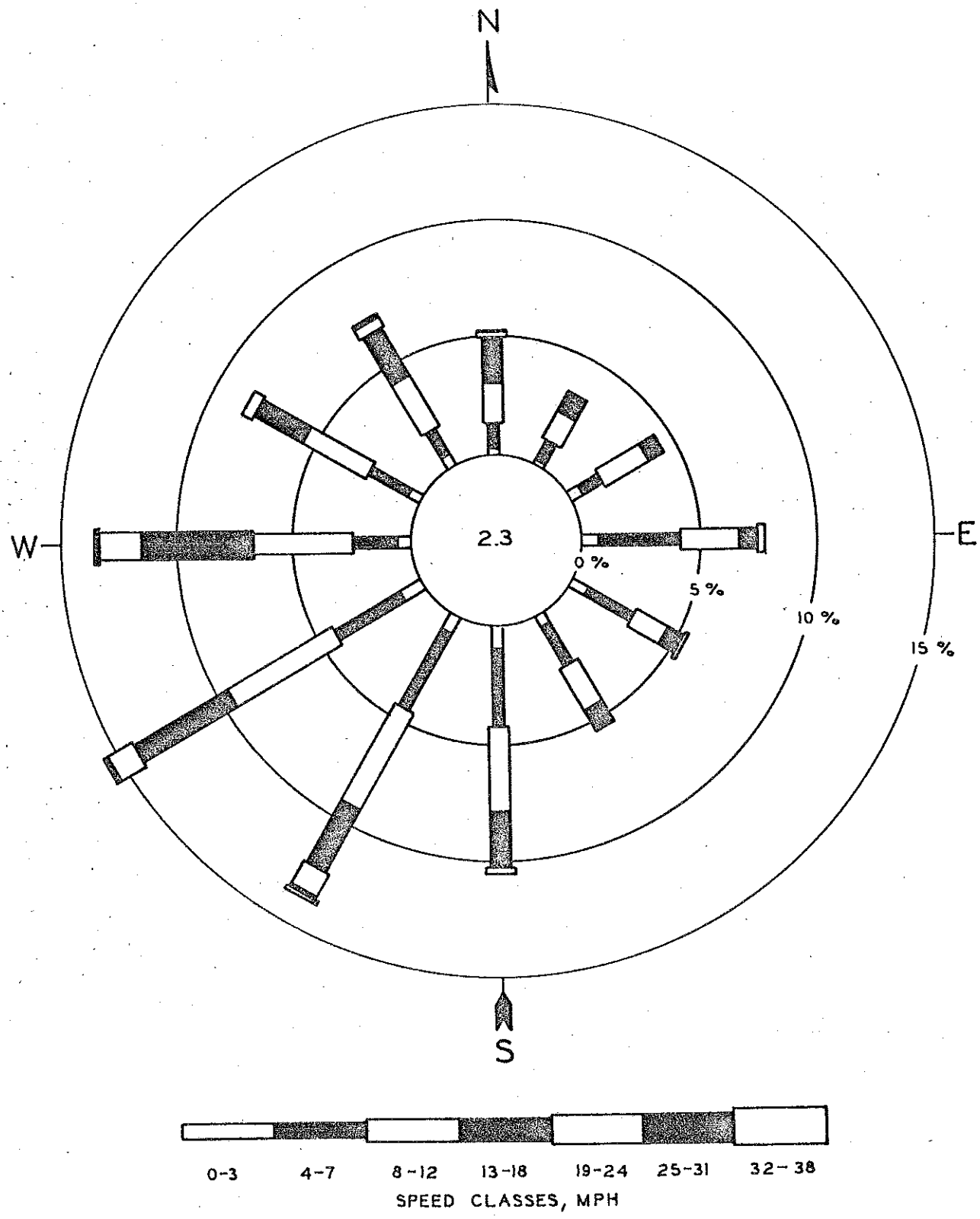

Figure 3. Frequency of wind direction and speed, percent (calms distributed).

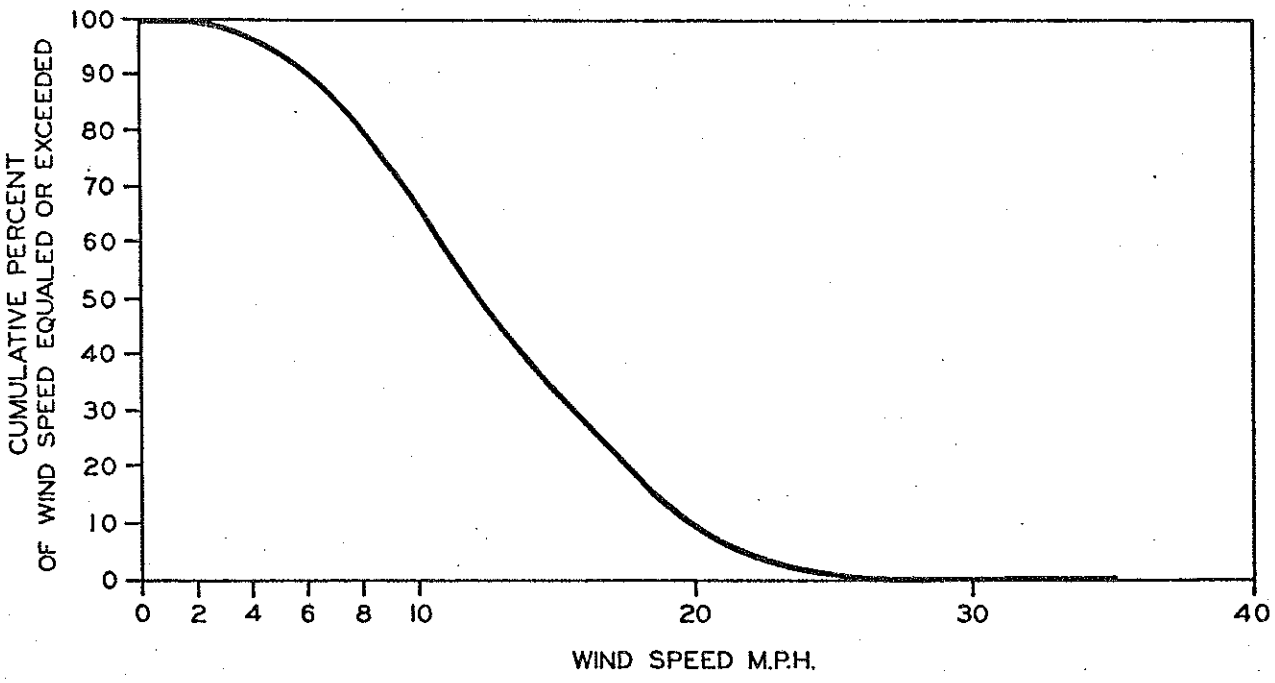

Figure 4. Wind speed distribution at Bishop Airport.

TABLE 1
TRAFFIC ESTIMATES FOR PROPOSED M 21
(Total Traffic in Both Directions)

Year		
1980	1985	2000
17,000 〈1,350〉 [680]	20,000 〈1,600〉 [800]	26,000 〈2,120〉 [1,040]

All speeds - 55 mph
Peak Duration - variable around 1 hour
Commercial vehicles - 15 percent of peak, 23 percent of off-peak.

000 = Average daily traffic (24 hr average)
〈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	55.2	16.3	28.6
2	0.0	0.0	0.0	53.7	16.7	29.6
3	0.0	0.0	0.0	50.2	20.2	29.6
4	0.0	0.0	0.0	49.8	17.7	32.5
5	0.0	0.0	0.0	52.2	17.7	30.0
6	9.9	4.4	2.5	52.7	11.3	19.2
7	9.4	12.3	13.3	48.3	9.4	7.4
8	6.9	13.8	17.2	56.2	2.0	3.9
9	5.4	13.8	18.2	62.6	0.0	0.0
10	3.0	16.7	14.3	66.0	0.0	0.0
11	3.4	17.2	17.7	61.6	0.0	0.0
12	3.0	14.3	16.3	66.5	0.0	0.0
13	2.0	12.8	20.7	64.5	0.0	0.0
14	1.0	13.8	22.2	63.1	0.0	0.0
15	3.0	10.8	20.7	65.5	0.0	0.0
16	1.5	13.3	20.2	62.6	1.5	1.0
17	3.4	9.9	18.7	62.6	3.9	1.5
18	3.0	7.4	10.3	60.1	12.8	6.4
19	0.0	0.0	0.0	62.1	22.7	15.3
20	0.0	0.0	0.0	57.1	24.1	18.7
21	0.0	0.0	0.0	54.7	25.1	20.2
22	0.0	0.0	0.0	51.7	26.6	21.7
23	0.0	0.0	0.0	51.2	25.6	23.2
24	0.0	0.0	0.0	52.2	19.7	28.1
Overall percent	2.3	6.7	8.8	57.6	11.4	13.2

TABLE 3
ESTIMATES OF MIXING CELL CONCENTRATIONS[1]

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, Off-Peak Traffic	Worst Condition Stability F, Parallel 3 mph Wind, Peak Traffic	Most Probable Condition[2] Stability D, Off-Peak Traffic
1980	2.6	0.2	850	62
1985	2.2	0.2	653	52
2000	2.5	0.2	706	59

[1] All vehicle speeds are 55 mph.
[2] Angle between average roadway direction and wind direction - 45° (wind speed 11 mph).