AIR QUALITY REPORT FOR US 24 (TELEGRAPH RD), OAKLAND COUNTY

Research Laboratory Section
Testing and Research Division
Research Project 74 TI-195
Research Report No. R-906

Michigan State Highway and Transportation Commission
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This report presents air quality information on a proposed 8.4 mile section of US 24 (Telegraph Rd) in Oakland Co. The map in Figure 1 shows the location of the project. Included are meteorological data, a limited amount of ambient air quality data, and estimates of pollutant levels that might occur adjacent to the proposed roadway.

Summary and Conclusions

Examination of meteorological data shows that wind conditions in the area of this project are favorable for dispersion and dilution of air pollutants. The most probable daytime wind speeds are in the 8 to 12 mph range. During the 6 a.m. to 11 p.m. part of the day wind speeds measured at Pontiac Airport are greater than 5 mph more than 95 percent of the time.

Pollution estimates made by a mathematical model indicate that pollutant levels adjacent to this proposed segment of US 24 will not cause adverse environmental effects. The project does not conflict with the State of Michigan Implementation Plan for meeting Federal air quality standards. The highest concentration of carbon monoxide calculated at a distance of 40 meters from the shoulder in 1977 for a worst condition (peak traffic with a 3 mph wind parallel to the roadway) was 5.1 mg/cu m (4.5 ppm), including existing background levels.

For a normal condition with off-peak traffic and most probable wind speed and direction at a distance of 40 meters from the shoulder in 1977 the calculated concentration of carbon monoxide is 1.8 mg/cu m (1.6 ppm) including existing background levels. Corresponding levels of carbon monoxide calculated for 1997 are considerably lower than this, due to federal controls on vehicle exhaust emission.

Meteorology

Meteorological data (hourly observations, 6 a.m. to 11 p.m. only) recorded at Pontiac Airport were summarized over a five year period from 1967 through 1971, using a one day in nine day statistical sampling with a random start each year. The data were obtained from the National Weather Records Center in Asheville, North Carolina. Figure 2 shows the frequency of wind speed and direction on a 36-point bar graph. Figure 3 is a 12-point wind rose for the same data. Since Michigan lies in the normal track of migrating high and low pressure centers at all times of the year, there is great variation in day to day weather. While the "prevailing" wind is from westerly directions, the wind blows from any given direction no more than 7.6 percent of the time during the 6 a.m. to 11 p.m. period.

Even on occasions when atmospheric inversions restrict vertical dispersion of pollutants, horizontal dispersion continues freely. Figure 4 shows that over 95 percent of the time wind speeds are greater than 5 mph at Pontiac Airport between 6 a.m. and 11 p.m. Most probable daytime wind speeds are in the 8 to 12 mph range. However, atmospheric mixing depths generally range between 500 and 1,200 meters (1,300 yd) which is very favorable for vertical dispersion of pollutants.

Existing Ambient Air Quality

No ambient air quality data are available for the immediate area of this project. Data from two Wayne Co. analysis sites approximately 7 miles south of the proposed project (Madonna College and Stoepel Park) show monthly averages for carbon monoxide of 1.6 mg/cu m (1.4 ppm) during the period April 1972 to August 1973. This 1.6 mg/cu m carbon monoxide level may be representative of the project area.

Pollution Estimates

Estimates of pollutant concentrations at a height of 1.8 meters (5 ft) above the ground were made for carbon monoxide and nitrogen oxides (as nitrogen dioxide) under various wind conditions at distances up to 80 meters from the shoulder of the roadway. A mathematical model based on the Gaussian Diffusion Equation[1], modified for a line source, was used. 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.

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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, National Technical Information Service, Springfield, Va., 22157, Report No. FHWA-RD-72-36.

EMISSION FACTORS g/mi

Carbon Monoxide

Year	Speed, Miles Per Hour						
	25 (6)[1]	30 (6)	35 (6)	40 (6)	45 (6)	50 (6)	55 (8)
1977	---	---	22.5	---	18.4	17.1	16.6
1982	---	11.3	---	9.0	8.2	7.6	8.1
1997	8.8	---	10.0	---	5.5	---	5.8

Nitrogen Dioxide

Year	Speed, Miles Per Hour						
	25 (6)	30 (6)	35 (6)	40 (6)	45 (6)	50 (6)	55 (8)
1977	---	---	4.2	---	4.6	4.9	5.3
1982	---	2.0	---	2.2	2.3	2.4	2.8
1997	1.1	---	1.3	---	1.4	---	1.8

[1] Number in parenthesis, percent heavy duty vehicles.

Pollution concentrations were estimated for:

1. Five representative sections, which covered the length of the project. Figure 1 shows the location of the sections.

2. Carbon monoxide and nitrogen oxides (as NO_2).

3. The years 1977, 1982, and 1997.

4. Distances of 40, 60, and 80 meters (87 yd) from the edge of the roadway shoulder.

Information, in addition to emission factors, used as input to the model consisted of:

1. Peak traffic (7 to 8 a.m.) and off-peak traffic volumes. Traffic estimates are shown in Table 1. Off-peak traffic was taken as 4.9 percent of ADT.

2. Meteorological conditions

a) Worst meteorological conditions, which seldom occur according to weather records, were taken as a 3 mph wind parallel to the roadway under atmospheric stability class D.

b) Most probable meteorological conditions (shown with data tables) were those prevailing at 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. Roadway profile - all sections are essentially at grade.

4. Width of the roadway - 2 sets of four, 12-ft lanes separated by a 60 ft median.

All estimates provide maximum one hour concentrations and are in addition to existing background levels. Traffic data for the condition of not building the proposed roadway were not available, so future air quality for the no build condition could not be estimated. Deterioration of air quality from present levels as traffic increases on the existing roadway is to be expected, however.

Table 3 presents estimated concentrations of carbon monoxide and nitrogen oxides (as nitrogen dioxide) for off-peak traffic volumes. Table 4 presents similar data for peak traffic volumes. The nitrogen oxide data are included for information only. There is no emission factor for nitrogen dioxide as such, so no comparison of the estimates with the air quality standards is possible.

Federal air quality standards for carbon monoxide and nitrogen dioxide are:

CO: (a) 10 mg/cu m (9 ppm) maximum 8 hr concentration not to be exceeded more than once per year.

(b) 40 mg/cu m (36 ppm) maximum one hour concentration not to be exceeded more than once per year.

NO_2: 100 μg/cu m (0.05 ppm) annual arithmetic mean.

If the only available background data for carbon monoxide, 1.6 mg/cu m (1.4 ppm) is added to the estimated concentration of carbon monoxide near

the proposed roadway, it is found that the highest level of carbon monoxide for peak traffic volumes with unfavorable wind conditions (worst case) is 5.1 mg/cu m (4.5 ppm). This is one half of the concentration in the 8 hr air quality standard and one eighth of the one hour peak air quality standard. For off-peak traffic volumes and most probable wind conditions, the concentration of carbon monoxide near the roadway is estimated to be 1.8 mg/cu m (1.6 ppm) including background. No adverse environmental effects are expected.

Effect of Other Proposed Highway Construction

Two other highway sections proposed for the early 1980's in the general area of this US 24 project will modify traffic volumes on US 24 if they are constructed. These proposed projects are:

a) Northwestern Highway from the intersection of I 696 and US 24 (Telegraph Rd) to M 275 near Oakley Pard Rd.

b) M 275 north from I 96 just west of and roughly parallel to Haggerty Highway continuing northerly to join I 75.

Traffic estimates indicate the following percentage changes in traffic volumes on US 24 subsequent to construction of Northwestern Highway and M 275.

Section	1982		1997	
	ADT	Peak	ADT	Peak
1	-6	-1	-3	+5
2	-17	-11	-15	-16
3	-25	-23	-27	-18
4	-32	-29	-29	-25
5	-37	-34	-34	-29

Except for a 5 percent increase in peak traffic on Section 1 of US 24 in 1997, traffic volumes are predicted to decrease by as much as 37 percent for ADT and 34 percent during peak periods. The concentration of roadway generated pollutants would change in direct proportion to traffic decreases or increases. A 5 percent increase in the small concentration of carbon monoxide predicted near Section 1 for 1997 would be insignificant. The traffic decreases would improve on air quality already predicted to be good.

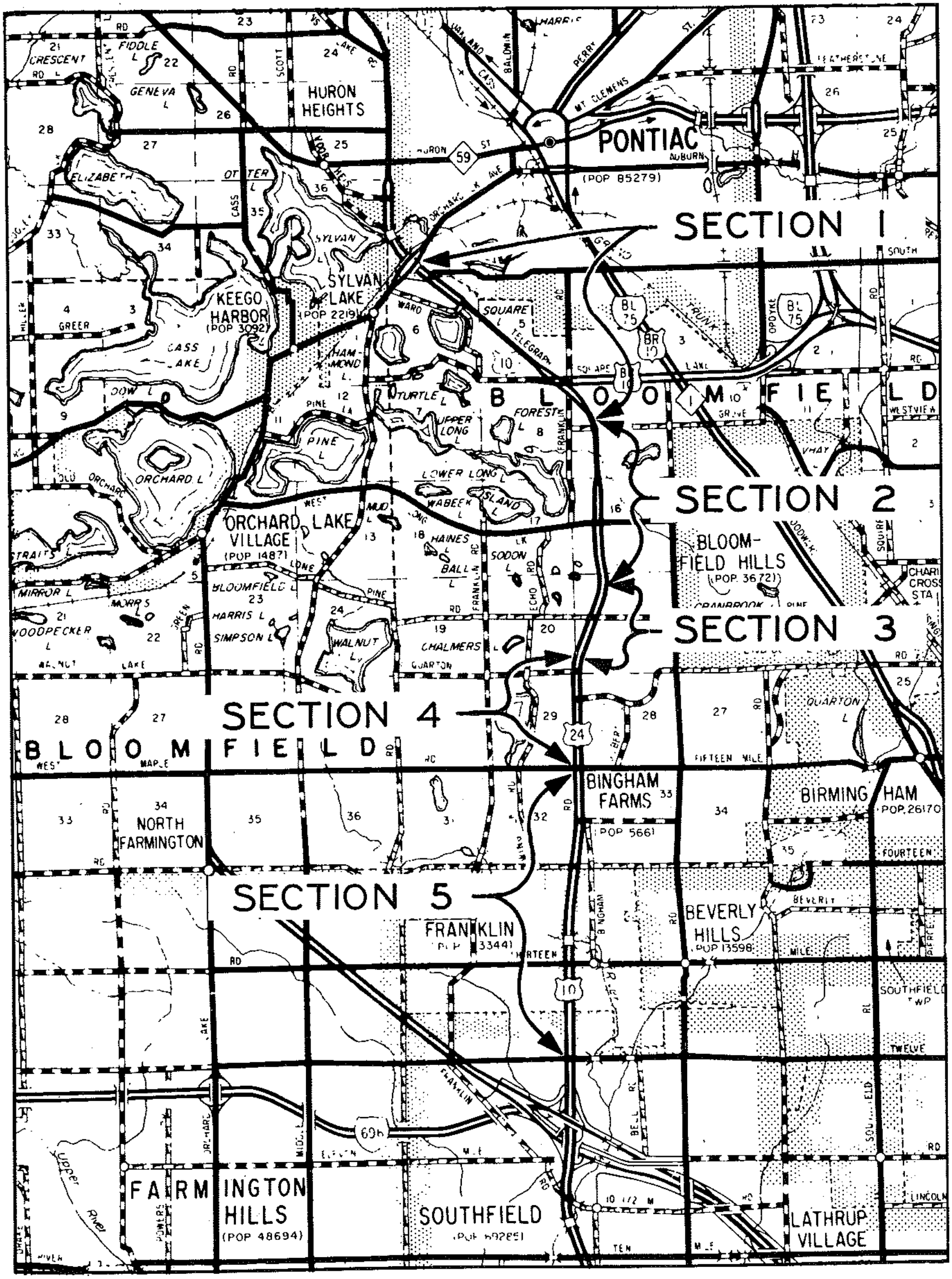
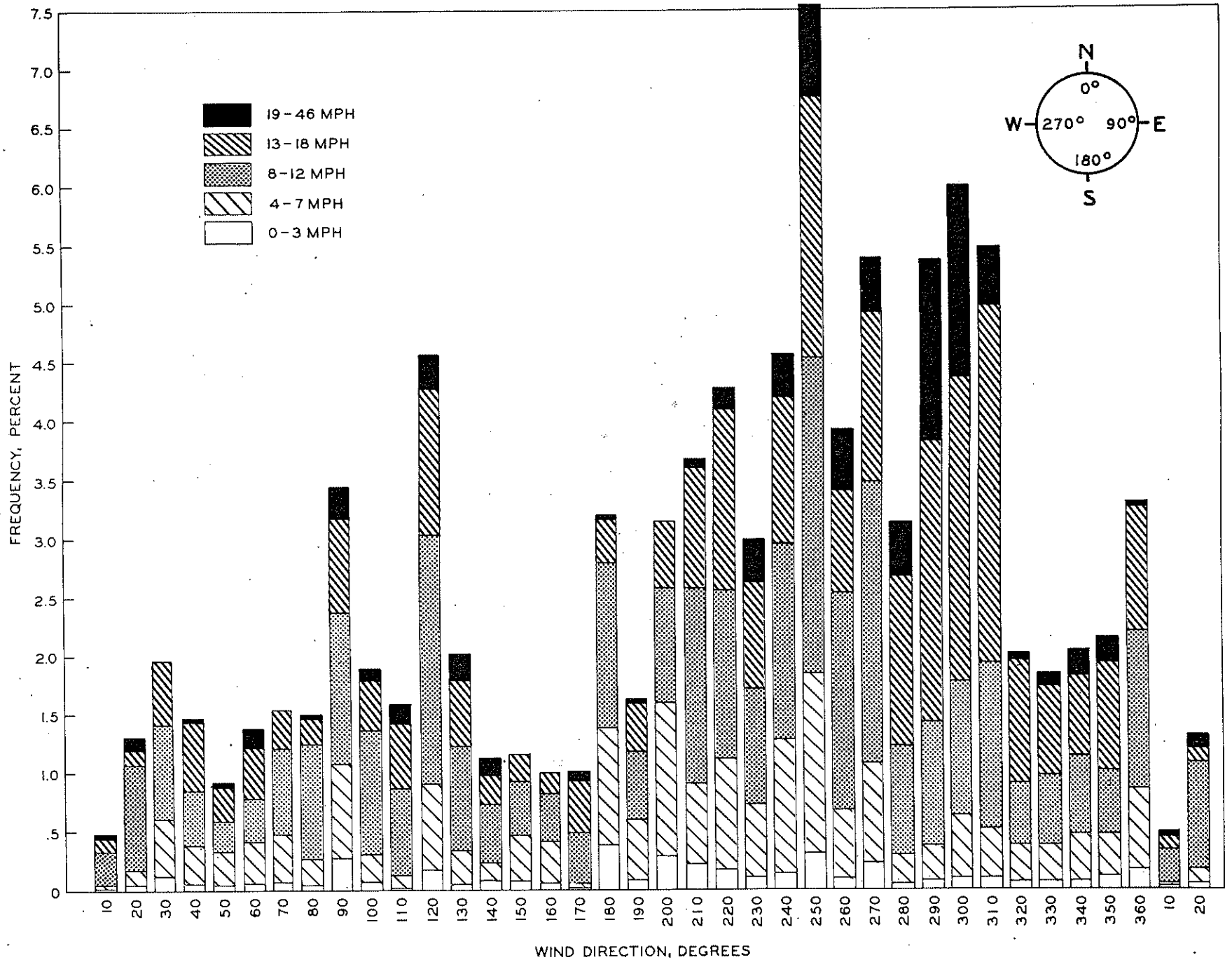


Figure 1. Location of proposed US 24, Oakland Co.


19-46 MPH
13-18 MPH
8-12 MPH
4-7 MPH
0-3 MPH
N
0°
W
270°
90°
E
180°
S
FREQUENCY, PERCENT
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
.5
0
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350 360 10 20
WIND DIRECTION, DEGREES

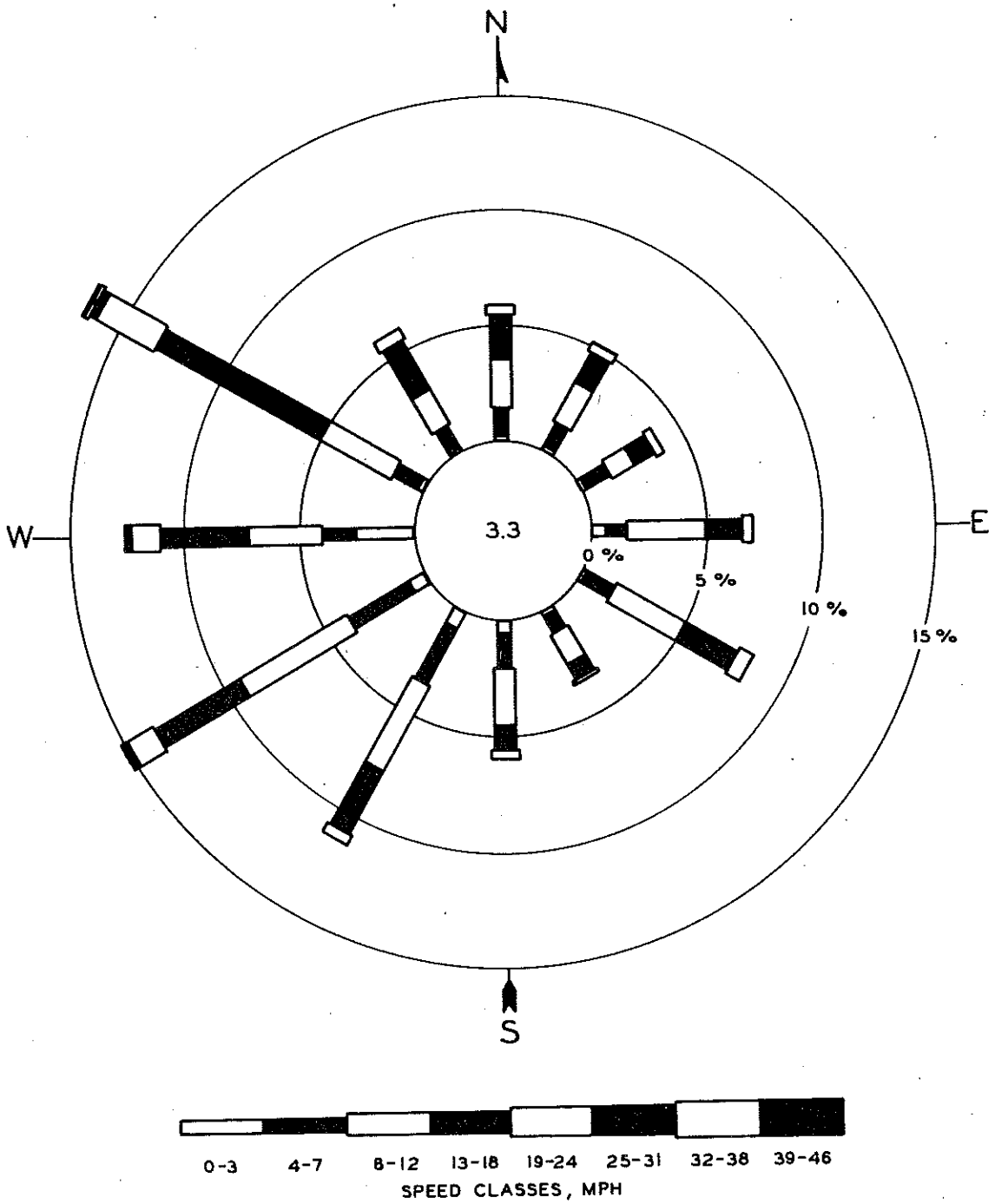


Figure 3. Wind speed and direction occurrences at Pontiac Airport (6 a.m. to 11 p.m.).

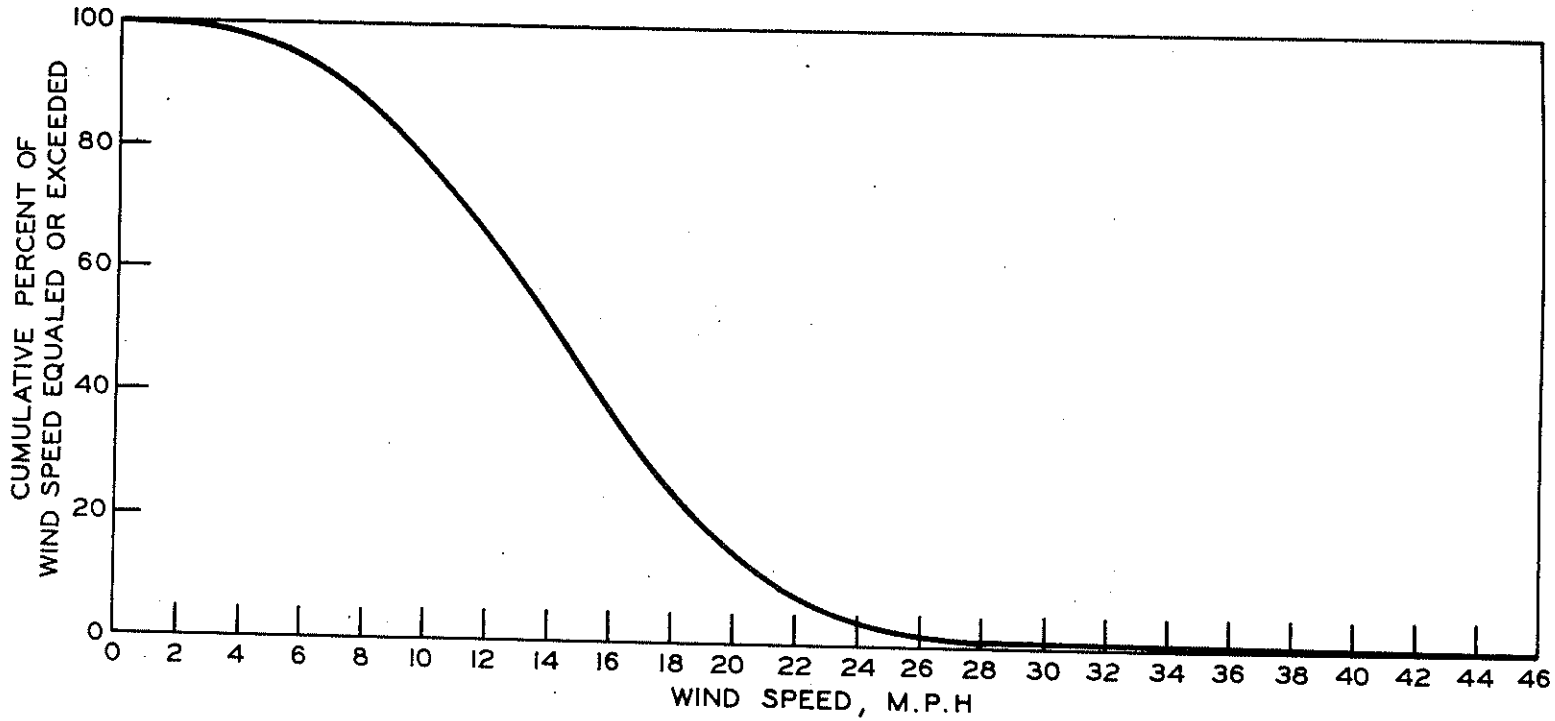


Figure 4. Distribution of wind speeds at Pontiac Airport (6 a.m. to 11 p.m.).

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

TABLE 1
TRAFFIC ESTIMATES FOR PROPOSED US 24 (Telegraph Rd)
(Total Traffic in Both Directions)

Year	Section 1	Section 2	Section 3	Section 4	Section 5
1977	44,400 ⟨2,570(50) + 1,090(55)⟩ [2,180(55)]	42,000 ⟨2,440(50) + 1,030(55)⟩ [2,060(55)]	44,400 ⟨2,570(50) + 1,090(55)⟩ [2,180(55)]	53,800 ⟨3,080(45) + 1,320(55)⟩ [2,640(55)]	65,000 ⟨3,640(35) + 1,600(55)⟩ [3,200(55)]
1982	48,600 ⟨2,750(45) + 1,200(55)⟩ [2,400(55)]	46,000 ⟨2,620(50) + 1,130(55)⟩ [2,260(55)]	48,600 ⟨2,750(45) + 1,200(55)⟩ [2,400(55)]	58,400 ⟨3,270(40) + 1,440(55)⟩ [2,880(55)]	70,000 ⟨3,850(30) + 1,720(55)⟩ [3,440(55)]
1997	54,800 ⟨2,990(45) + 1,350(55)⟩ [2,700(55)]	52,000 ⟨2,860(45) + 1,280(55)⟩ [2,560(55)]	54,800 ⟨2,990(45) + 1,350(55)⟩ [2,700(55)]	65,400 ⟨3,530(35) + 1,610(55)⟩ [3,220(55)]	78,000 ⟨4,130(25) + 1,920(55)⟩ [3,840(55)]

Commercial Vehicles
8 percent of off-peak
6 percent of peak

000 = Avg. Daily Traffic
⟨000⟩ = a.m. Peak Traffic
[000] = Off-Peak Traffic (4.9 percent ADT)
(00) = Avg. Speed

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
POLLUTION ESTIMATES FOR OFF PEAK TRAFFIC

Location	Traffic Projection Year	40 Meter Distance From Edge of Freeway Shoulder				60 Meter Distance From Edge of Freeway Shoulder				80 Meter Distance From Edge of Freeway Shoulder			
		Worst Condition Parallel Wind, 3 mph		Most Probable Condition, 12 mph wind [2]		Worst Condition Parallel Wind, 3 mph		Most Probable Condition, 12 mph wind [2]		Worst Condition Parallel Wind, 3 mph		Most Probable Condition, 12 mph wind [2]	
		CO, mg/cu m	NO_2, μg/cu m	CO, mg/cu m	NO_2, μg/cu m	CO, mg/cu m	NO_2, μg/cu m	CO, mg/cu m	NO_2, μg/cu m	CO, mg/cu m	NO_2, μg/cu m	CO, mg/cu m	NO_2, μg/cu m
Section 1	1977	0.9	301	0.1	40	0.5	148	0.1	36	0.2	68	0.1	34
	1982	0.5	173	0.1	23	0.2	85	0.1	21	0.1	39	0.1	20
	1997	0.4	129	0.1	17	0.2	63	*	16	0.1	29	*	15
Section 2	1977	0.9	278	0.1	33	0.4	136	0.1	30	0.2	62	0.1	29
	1982	0.5	160	0.1	19	0.2	78	0.1	17	0.1	36	*	16
	1997	0.4	120	*	14	0.2	59	*	13	0.1	27	*	12
Section 3	1977	0.9	293	0.1	36	0.5	144	0.1	34	0.2	66	0.1	32
	1982	0.5	169	0.1	21	0.2	83	0.1	19	0.1	38	0.1	18
	1997	0.4	126	*	16	0.2	62	*	14	0.1	28	*	14
Section 4	1977	1.1	352	0.1	44	0.5	173	0.1	41	0.2	79	0.1	38
	1982	0.6	201	0.1	25	0.3	98	0.1	23	0.1	45	0.1	22
	1997	0.5	149	0.1	19	0.2	73	0.1	17	0.1	33	0.1	16
Section 5	1977	1.4	430	0.2	54	0.7	211	0.2	49	0.3	97	0.1	46
	1982	0.7	242	0.1	30	0.3	119	0.1	28	0.2	54	0.1	26
	1997	0.6	179	0.1	22	0.3	88	0.1	21	0.1	40	0.1	19

* value less than 0.1

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

[2] angle between wind direction and roadway direction - section 1, 60°; section 2, 80°; section 3, 60°; sections 4 and 5, 70°.

TABLE 4
POLLUTION ESTIMATES FOR PEAK A.M. TRAFFIC

Location	Traffic Projection Year	40 Meter Distance From Edge of Freeway Shoulder				60 Meter Distance From Edge of Freeway Shoulder				80 Meter Distance From Edge of Freeway Shoulder			
		Worst Condition Parallel Wind, 3 mph		Most Probable Condition, 10 mph wind[2]		Worst Condition Parallel Wind, 3 mph		Most Probable Condition, 10 mph wind[2]		Worst Condition Parallel Wind, 3 mph		Most Probable Condition, 10 mph wind[2]	
		CO, mg/cu m	NO_2, μg/cu m	CO, mg/cu m	NO_2, μg/cu m	CO, mg/cu m	NO_2, μg/cu m	CO, mg/cu m	NO_2, μg/cu m	CO, mg/cu m	NO_2, μg/cu m	CO, mg/cu m	NO_2, μg/cu m
Section 1	1977	2.0	569	0.5	131	1.0	283	0.2	65	0.5	131	0.1	30
	1982	1.0	290	0.2	67	0.5	144	0.1	33	0.2	66	0.1	15
	1997	0.7	197	0.2	46	0.4	98	0.1	23	0.2	45	*	10
Section 2	1977	1.8	528	0.2	63	0.9	262	0.2	58	0.4	121	0.2	54
	1982	0.9	281	0.1	34	0.4	140	0.1	31	0.2	64	0.1	29
	1997	0.7	184	0.1	22	0.3	91	0.1	21	0.2	42	0.1	19
Section 3	1977	1.9	555	0.2	59	1.0	275	0.2	54	0.4	127	0.2	51
	1982	1.0	283	0.1	30	0.5	140	0.1	28	0.2	65	0.1	26
	1997	0.7	192	0.1	21	0.4	95	0.1	19	0.2	44	0.1	18
Section 4	1977	2.4	632	0.3	69	1.2	314	0.2	63	0.6	145	0.2	59
	1982	1.3	319	0.1	35	0.6	158	0.1	32	0.3	73	0.1	30
	1997	1.0	206	0.1	23	0.5	102	0.1	21	0.2	47	0.1	20
Section 5	1977	3.5	694	0.4	76	1.7	344	0.3	70	0.8	159	0.3	65
	1982	1.8	347	0.2	39	0.9	172	0.2	35	0.4	79	0.2	33
	1997	1.5	222	0.2	25	0.8	110	0.1	23	0.4	51	0.1	22

* value less than 0.1

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

[2] angle between wind direction and roadway direction - section 1, 10°; section 2, 50°; section 3, 70°; sections 4 and 5, 60°.