AIR QUALITY SECTION FOR THE FINAL ENVIRONMENTAL IMPACT STATEMENT FOR PROPOSED M 99

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

AIR QUALITY SECTION FOR THE FINAL ENVIRONMENTAL IMPACT STATEMENT FOR PROPOSED M 99

Research Laboratory Section
Testing and Research Division
Research Project 73 TI-151
Research Report No. R-880

Michigan State Highway Commission
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This report presents air quality information for the environmental impact statement concerning proposed M 99. Included are meteorological data and estimates of pollution levels that might occur adjacent to the roadway, should it be constructed.

General Description of the Project

This 11.7 mile project consists of an urban part and a rural part connected by an existing section of roadway as shown on the map in Figure 1. The 1.9 mile urban part is in the City of Lansing, Ingham County and extends from Kalamazoo St south to Victor St. The 9.8 mile rural part starts at Waverly Rd in Eaton County and continues in a southerly direction to the city limits of Eaton Rapids. Both sections incorporate and parallel existing M 99. The surrounding terrain is level to gently rolling, facilitating the dispersal of air pollutants.

Summary

Examination of meteorological data shows that the potential for air pollution episodes in the area of this project is very low. Wind direction is variable and the probable daytime wind speed is 11 mph. Atmospheric mixing depth ranges between 500 and 1,200 meters. This means that pollutants will be quickly diluted and dispersed.

Pollution estimates made by a mathematical model indicate that pollutant levels adjacent to this part of M 99 will be low. The project does not conflict with the State of Michigan Implementation Plan for meeting Federal air quality standards.

Meteorology

Meteorological data (hourly observations) recorded at Capital City Airport near Lansing 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 at Asheville, North Carolina. Figure 2 shows the frequency of wind direction and wind speed on a 36-point bar graph. Figure 3 shows 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. Thus, while the "prevailing" wind direction is from westerly directions, the wind actually comes from any given direction only about 6 percent of the time. Even on occasions when atmospheric inversions restrict vertical dispersion of pollutants, horizontal ventilation continues freely. Figure 4 shows that about 94 percent

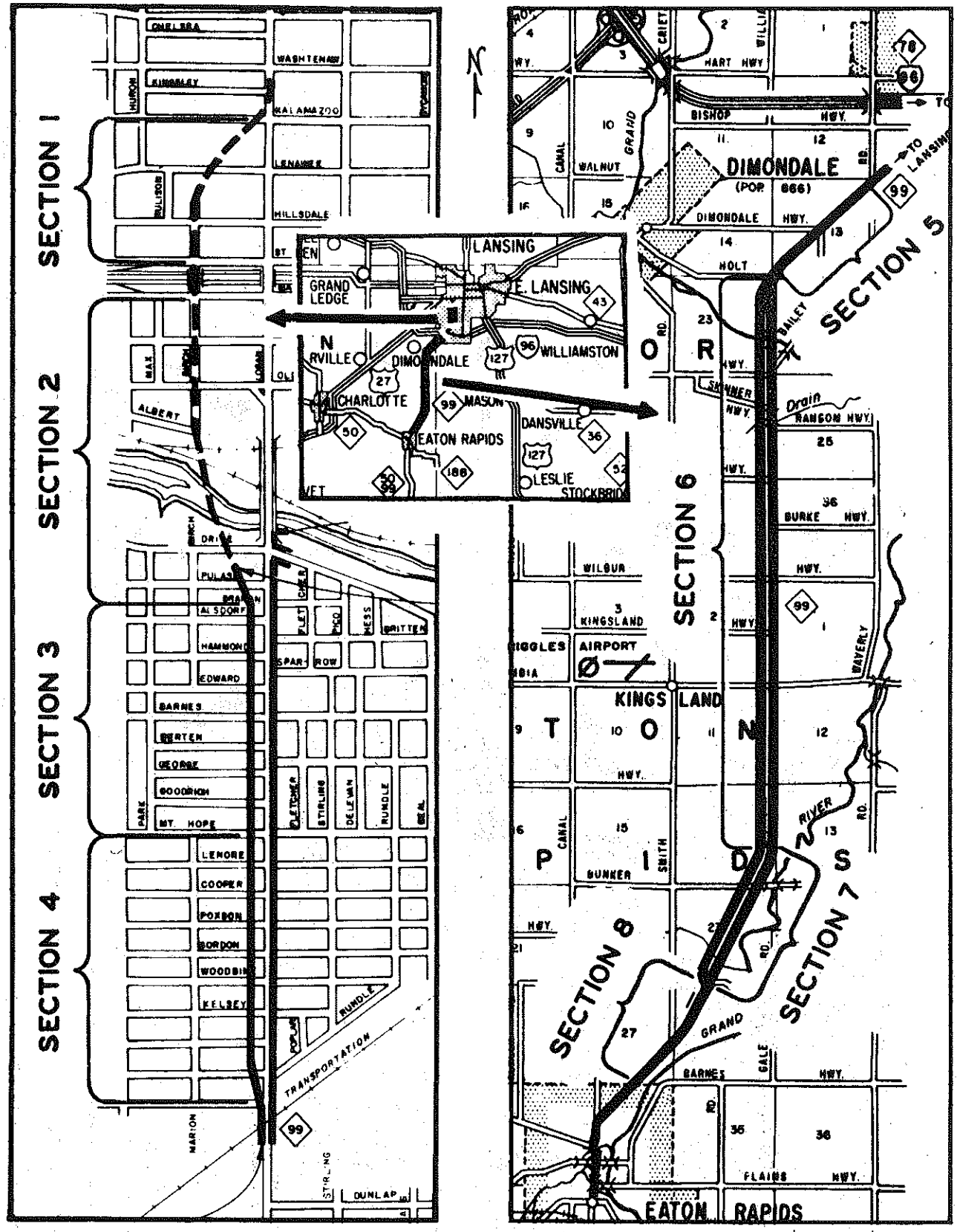

Figure 1. Location of the sections used for pollution estimates. Left half of map shows the urban part; right half of map shows the rural part.

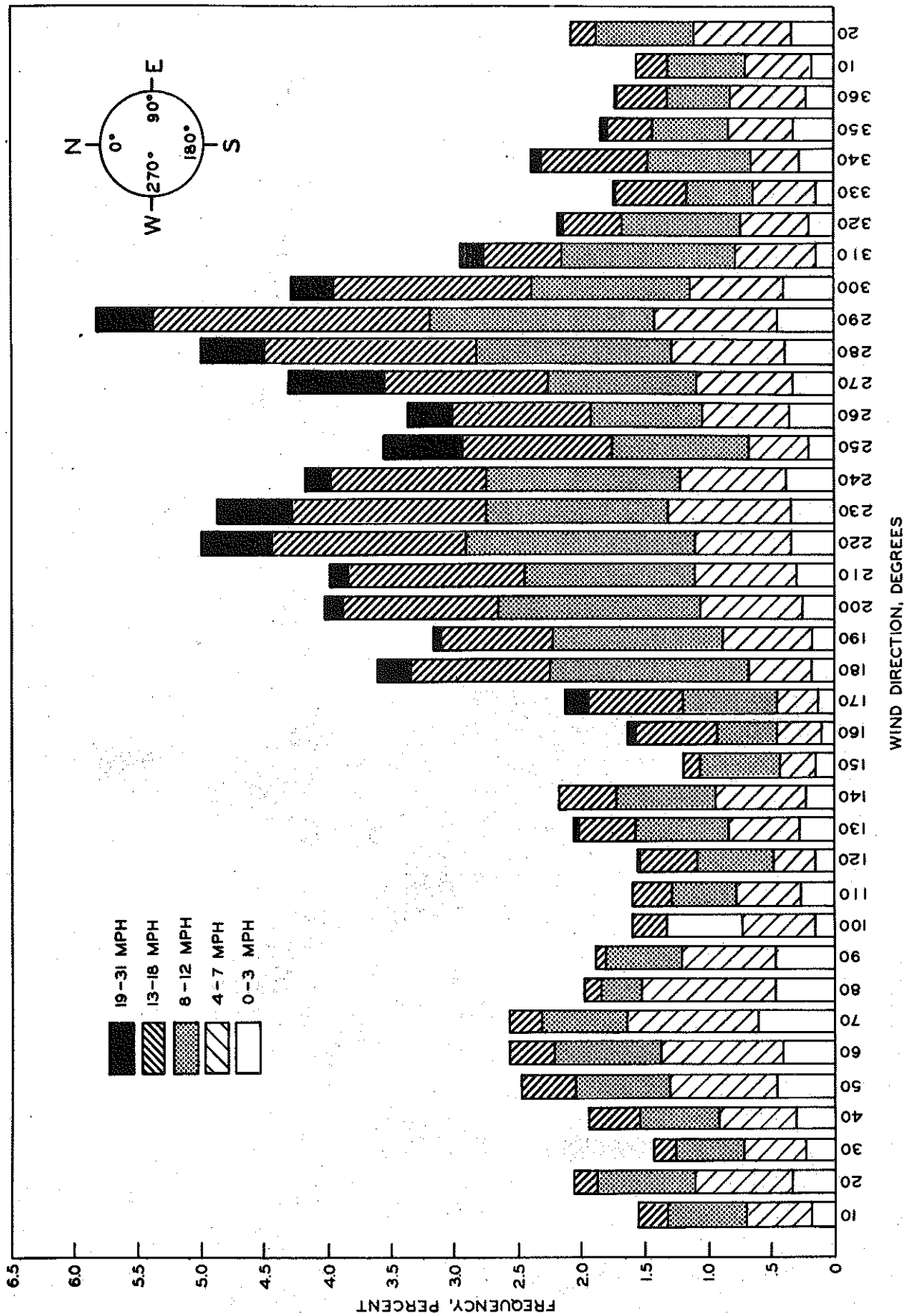

Figure 2. Frequency of wind speed and direction occurrences at Capital City Airport.

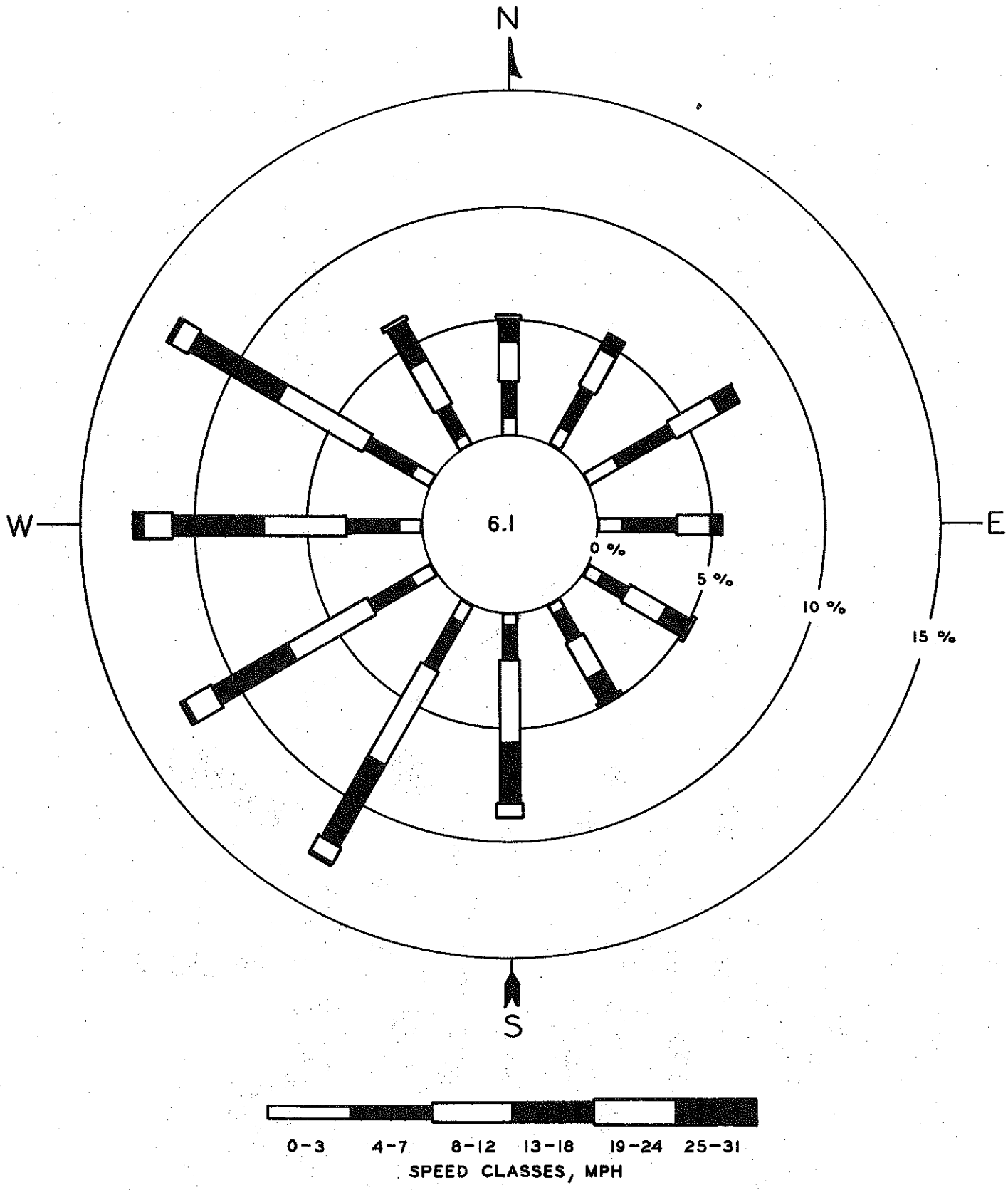

Figure 3. Frequency of wind speed and direction occurrences at Capital City Airport.

of the time wind speeds exceed 4 mph. Considering only the 7 a.m. to 8 p.m. part of the day, 95 percent of the wind speeds are 5 mph or greater. The most probable wind speeds are 11 mph for both off-peak daytime traffic and peak p.m. traffic (4:30 to 5:30). Atmospheric mixing depths, which range between 500 and 1,200 meters, are also very favorable for vertical dispersion of pollutants.

There is insufficient time for photochemical reaction between air pollutants to take place before dispersion and dilution occur. As a result, photochemical smog of the Los Angeles type is not thought to occur in Michigan[1].

Existing Ambient Air Quality

No ambient air quality data are available for the area of this project.

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 100 meters from the shoulder of the roadway. A mathematical model based on the Gaussian diffusion equation, modified for a line source, was used[2]. This model has not been completely validated but it is accepted by the Federal Environmental Protection Agency and the Federal Highway Administration. Inputs to the model include meteorological conditions, traffic volumes, vehicle emission factors, and design of the highway.

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[1] "Implementation Plan for the Control of Suspended Particulates, Sulfur Oxides, Carbon Monoxide, Hydrocarbons, Nitrogen Oxides, and Photochemical Oxidants in the State of Michigan," January 1972, pp. 5-9 to 5-11.

[2] J. L. Beaton, A. J. Ranzieri, E. C. Shirley and J. B. Skog, "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.

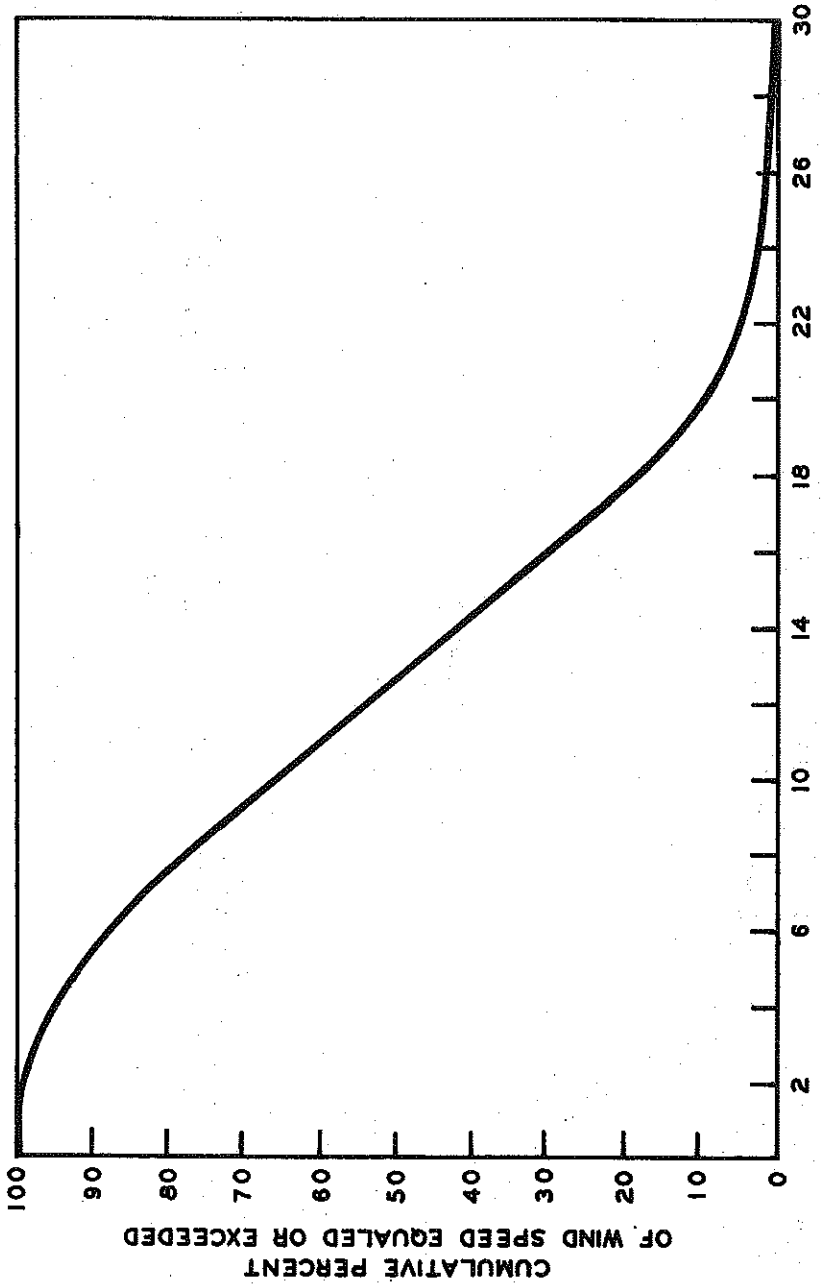

Figure 4. Overall distribution of wind speeds, Capital City Airport.

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.

EMISSION FACTORS, g/mi
(12 percent Heavy Duty Vehicles)

	Year	Speed, mph	
		25	28
CO	1975	36.5	33.5
	1980	12.3	11.3
	1995	4.2	3.8
NO_2	1975	10.0	10.4
	1980	4.8	4.9
	1995	1.9	2.0

EMISSION FACTORS, g/mi
(10 percent Heavy Duty Vehicles)

	Year	Speed, mph	
		50	57
CO	1982	4.2	3.7
	1997	2.4	2.1
NO_2	1982	3.0	3.2
	1997	2.3	2.4

TABLE 1
TRAFFIC ESTIMATES FOR PROPOSED M 99
(Total traffic in both directions)

Year	Section 1	Section 2	Section 3,4
1975	24,300 ⟨2,190(25)⟩ [972(28)]	39,800 ⟨3,980(25)⟩ [1,592(28)]	31,200 ⟨2,810(25)⟩ [1,248(28)]
1980	28,500 ⟨2,570(25)⟩ [1,140(28)]	44,500 ⟨4,450(25)⟩ [1,780(28)]	36,500 ⟨3,290(25)⟩ [1,460(28)]
1995	37,500 ⟨3,380(25)⟩ [1,500(28)]	55,000 ⟨5,500(25)⟩ [2,200(28)]	48,000 ⟨4,320(25)⟩ [1,920(28)]

12 Percent Commercial Vehicles

Year	Section 5	Section 6	Section 7,8
1982	11,500 ⟨650(50)⟩ [460(57)]	8,400 ⟨470(50)⟩ [336(57)]	8,600 ⟨480(50)⟩ [344(57)]
1997	18,800 ⟨1,040(50)⟩ [752(57)]	12,200 ⟨670(50)⟩ [488(57)]	12,800 ⟨700(50)⟩ [512(57)]

10 Percent Commercial Vehicles

Peak Duration - Approximately 1 Hour

000 = Avg. Daily Traffic
⟨000⟩ = p.m. Peak Traffic
[000] = Off-Peak Traffic (4 percent ADT)
(00) = Avg. Speed

Pollution concentrations were estimated for:

1) Eight representative sections, which covered the entire length of the project. See Figure 1 for location of the sections which are identified as follows, proceeding north to south:

	Section	Location
Urban	1	Kalamazoo St to St. Joseph St
	2	Main St to Braman St
	3	Braman St to Mt. Hope Ave
	4	Mt. Hope Ave to Victor Ave
Rural	5	Waverly Rd to Holt Rd
	6	Holt Rd to Sta. 170+00
	7	Sta. 170+00 to Petrieville Hwy
	8	Petrieville Hwy to Eaton Rapids City Limits.

2) The years 1975, 1980, and 1995 for the urban part and 1982 and 1997 for the rural part.

3) Distances of 40, 60, and 100 meters from the edge of the roadway shoulder.

Information used as input to the model consisted of:

1) Peak p.m. (4:30 to 5:30) 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, were taken as a 3 mph wind parallel to the roadway, under atmospheric stability class D. Parallel wind buildup distances used were: Section 1) 1,600 ft; Section 2) 3,100 ft; Section 3) 1,900 ft; Section 4) 3,000 ft; Section 5) 6,600 ft; Section 6) 31,000 ft; Section 7) 7,400 ft; Section 8) 5,600 ft. Calculated pollution levels under parallel wind conditions were found to be higher for atmospheric stability class D than for class F.

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	53.2	15.3	31.5
2	0.0	0.0	0.0	54.2	15.8	30.0
3	0.0	0.0	0.0	52.7	14.3	33.0
4	0.0	0.0	0.0	53.2	16.7	30.0
5	0.0	0.0	0.0	53.7	16.3	30.0
6	6.4	6.4	4.4	51.2	13.8	17.7
7	8.9	12.3	11.3	49.3	7.4	10.8
8	8.4	12.8	15.8	57.1	2.0	3.9
9	5.9	12.3	22.2	59.6	0.0	0.0
10	3.9	12.8	21.2	62.1	0.0	0.0
11	3.9	12.3	20.2	63.5	0.0	0.0
12	3.4	9.4	22.2	65.0	0.0	0.0
13	4.4	8.9	18.2	68.5	0.0	0.0
14	3.0	8.4	21.3	67.3	0.0	0.0
15	3.4	10.3	18.1	68.1	0.0	0.0
16	3.9	10.3	18.7	65.5	1.5	0.0
17	3.9	9.9	19.2	60.1	4.9	2.0
18	4.9	5.9	11.8	57.1	11.3	8.9
19	0.0	0.0	0.0	60.6	22.2	17.2
20	0.0	0.0	0.0	54.2	20.7	25.1
21	0.0	0.0	0.0	53.2	19.7	27.1
22	0.0	0.0	0.0	54.7	13.8	31.5
23	0.0	0.0	0.0	53.7	17.7	28.6
24	0.0	0.0	0.0	53.2	16.7	30.0
Overall percent	2.7	5.5	9.4	58.0	9.6	14.9

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 class for the meteorological data used.

3) Roadway profile. All sections are at grade.

4) Representative widths of the highway sections were taken as follows:

*Sections 1 and 2
A 50-ft average roadway width including curb and gutter.

**Sections 3 and 4
Two roadways 50-ft in average width, including curb and gutters, separated by a median with an average width of 55 ft.

Sections 5 and 8
A 65-ft roadway, including curb and gutter.

Sections 6 and 7
A 20-ft roadway and a 24-ft roadway (both having 10-ft outside shoulders and 8-ft inside shoulders) separated by a 69-ft median.

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*The northbound and southbound roadways of sections 1 and 2 are widely separated so their pollution levels are nonadditive.
**The northbound and southbound roadways of sections 3, 4, 6, and 7 are sufficiently separated that calculations were made for each set of lanes and the pollutant concentrations were summed at the appropriate distances.

All estimates of pollution levels represent maximum one-hour concentrations and are in addition to the existing background levels. Traffic estimates for the condition of not building the highway were not available, so future air quality for the no-build condition could not be estimated. Deterioration of air quality as traffic increases on existing roadways is to be expected.

Table 3 presents estimates of pollutant levels for peak traffic conditions. Table 4 presents estimates of pollutant levels for off-peak traffic conditions. Nitrogen oxides, as nitrogen dioxide, are included for 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.

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

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

(b) 40 mg/cu m maximum 1 hr concentration not to be exceeded more than once per year.

NO_2: 100 μg/cu m annual arithmetic mean.

The calculated concentrations of carbon monoxide near the proposed roadway are low. No adverse environmental effects are expected.

TABLE 3
POLLUTION ESTIMATES FOR PEAK TRAFFIC [1]

Location	Traffic Projection Year	40 Meter Distance From Edge of Freeway Shoulder				60 Meter Distance From Edge of Freeway Shoulder				100 Meter Distance From Edge of Freeway Shoulder			
		Worst Condition Parallel Wind, 3 mph		Most Probable Condition, 8 mph wind [2]		Worst Condition Parallel Wind, 3 mph		Most Probable Condition, 8 mph wind [2]		Worst Condition Parallel Wind, 3 mph		Most Probable Condition, 8 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 [3]	1975	1.1	315	0.2	67	0.6	161	0.2	63	0.1	33	0.2	56
	1980	0.5	176	0.1	37	0.2	90	0.1	35	*	18	0.1	31
	1995	0.2	94	*	20	0.1	48	*	19	*	10	*	17
Section 2 [3]	1975	2.2	599	0.4	122	1.1	307	0.4	114	0.2	63	0.4	102
	1980	0.8	319	0.2	65	0.4	163	0.2	61	0.1	34	0.1	54
	1995	0.3	159	0.1	32	0.2	82	0.1	30	*	17	0.1	27
Section 3	1975	1.9	532	0.6	164	1.0	262	0.6	154	0.2	52	0.5	139
	1980	0.8	297	0.2	92	0.4	146	0.2	86	0.1	29	0.2	77
	1995	0.3	158	0.1	49	0.2	78	0.1	46	*	15	0.1	41
Section 4	1975	2.0	540	0.6	164	1.0	266	0.6	154	0.2	53	0.5	139
	1980	0.8	301	0.2	92	0.4	148	0.2	86	0.1	30	0.2	77
	1995	0.3	160	0.1	49	0.2	79	0.1	46	*	16	0.1	41
Section 5	1982	0.1	74	*	12	0.1	38	*	11	*	8	*	10
	1997	0.1	89	*	14	*	45	*	14	*	9	*	12
Section 6	1982	*	23	*	6	*	11	*	6	*	2	*	5
	1997	*	24	*	7	*	12	*	6	*	2	*	6
Section 7	1982	*	25	*	7	*	12	*	6	*	2	*	6
	1997	*	27	*	8	*	13	*	7	*	3	*	6
Section 8	1982	*	27	*	4	*	14	*	3	*	3	*	3
	1997	*	30	*	4	*	15	*	4	*	3	*	3

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

[2] angles between wind direction and roadway direction - sections 1, 2, 3, 4, 5, 50°; section 6, 80°; sections 7,8, 70°.

[3] the northbound and southbound roadways are sufficiently separated so that pollutants from one do not add to pollutants from the other.

* value less than 0.1

TABLE 4
POLLUTION ESTIMATES FOR OFF-PEAK TRAFFIC [1]

Location	Traffic Projection Year	40 Meter Distance From Edge of Freeway Shoulder				60 Meter Distance From Edge of Freeway Shoulder				100 Meter Distance From Edge of Freeway Shoulder			
		Worst Condition Parallel Wind, 3 mph		Most Probable Condition, 8 mph wind [2]		Worst Condition Parallel Wind, 3 mph		Most Probable Condition, 8 mph wind [2]		Worst Condition Parallel Wind, 3 mph		Most Probable Condition, 8 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 [3]	1975	0.5	145	0.1	25	0.2	74	0.1	24	*	15	0.1	21
	1980	0.2	81	*	14	0.1	41	*	13	*	8	*	12
	1995	0.1	43	*	7	*	22	*	7	*	5	*	6
Section 2 [3]	1975	0.8	248	0.1	41	0.4	127	0.1	39	0.1	26	0.1	34
	1980	0.3	132	0.1	22	0.2	68	*	21	*	14	*	18
	1995	0.1	66	*	11	0.1	34	*	10	*	7	*	9
Section 3	1975	0.8	245	0.2	62	0.4	121	0.2	58	0.1	24	0.2	52
	1980	0.3	136	0.1	34	0.2	67	0.1	32	*	13	0.1	29
	1995	0.1	73	*	18	0.1	36	*	17	*	7	*	15
Section 4	1975	0.8	248	0.2	62	0.4	123	0.2	58	0.1	24	0.2	52
	1980	0.3	138	0.1	34	0.2	68	0.1	32	*	14	0.1	29
	1995	0.1	74	*	18	0.1	36	*	17	*	7	*	15
Section 5	1982	0.1	55	*	8	*	28	*	7	*	6	*	7
	1997	0.1	68	*	10	*	35	*	9	*	7	*	8
Section 6	1982	*	17	*	5	*	8	*	5	*	2	*	4
	1997	*	19	*	6	*	9	*	5	*	2	*	5
Section 7	1982	*	19	*	5	*	9	*	5	*	2	*	4
	1997	*	21	*	6	*	10	*	5	*	2	*	5
Section 8	1982	*	21	*	3	*	11	*	2	*	2	*	2
	1997	*	23	*	3	*	12	*	3	*	2	*	2

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

[2] angles between wind direction and roadway direction - sections 1, 2, 3, 4, 5, 70°; section 6, 60°; sections 7, 8, 80°.

[3] the northbound and southbound roadways are sufficiently separated so that pollutants from one do not add to pollutants from the other.

* value less than 0.1