CORRIDOR AIR QUALITY REPORT FOR PROPOSED M 59 - UTICA TO I 94

MICHIGAN DEPARTMENT OF
STATE HIGHWAYS AND TRANSPORTATION

CORRIDOR AIR QUALITY REPORT FOR PROPOSED M 59 - UTICA TO I 94

Research Laboratory Section
Testing and Research Division
Research Project 75 AP-3A
Research Report No. R-992

Michigan State Highway Commission
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This report presents air quality information for a corridor study of a proposed section of M 59 in Macomb County. Four alternate corridors (A, B, C, and D) as shown in Figure 1 are considered. 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 Macomb County according to the 1970 census is 1,303 per square mile with 92 percent urban. Most of the urban area is located in the southern part of the county 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. It appears that all four corridors have similar background air quality so that this is not a compelling factor in corridor selection.

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 . Inputs to the model include meteorological conditions, traffic volumes, vehicle emission factors, and design of the highway.[1]

Vehicle emission factors shown in the following table were calculated using procedures from "Compilation of Air Pollutant Emission Factors," AP 42, Supplement No. 5, December 1975 edition, U. S. Environmental Protection Agency. Vehicle age mix data were obtained from the Michigan Department of State.

Emission Factors,
g/mi at 55 miles per hour

Year	Carbon Monoxide	NO_x as Nitrogen Dioxide
1995	2.9(4)* 3.8(6)	1.3(4) 1.6(6)

* (0) percent heavy duty vehicles.

Pollution concentrations were estimated for:

1) Four alternate corridors (A, B, C, and D), an urban section (Mound Rd to Scheonherr Rd) and a rural section (Scheonherr Rd to I 94) within each corridor (Fig. 1).

2) The year 1995.

3) The area above the roadway (mixing cell), above the service roads (mixing cell) where applicable, and at the edge of the right-of-way.

Information used as input to the model consisted of:

1) Estimated peak (4:00 to 5:00 p.m.) and off-peak traffic volumes. Traffic estimates for the highest volume section in each corridor of the proposed route are shown in Table 1. Off-peak traffic was taken as 4 percent of ADT.

[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.

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 2) were chosen for the time of day involved, and the overall most likely stability class (D) was used. Table 3 shows the frequency distribution of atmospheric stability classes for the meteorological data used.

3) Roadway geometry: Three different cross-sections are considered within the various corridors. Rural type, urban type and retaining wall type as shown in Figure 5.

Corridor A - Both the urban and rural sections are rural type, at grade.

Corridor B - The urban section may be either urban type, depressed 17 ft, or retaining wall type, depressed 17 ft. The rural section is urban type, at grade.

Corridor C - The urban section may be either urban type, depressed 17 ft, or rural type, at grade. The rural section is rural type, at grade.

Corridor D - Both the urban and rural sections are urban type, at grade.

All estimates of pollution levels represent maximum one hour concentrations and are in addition to existing background levels. Table 2 presents estimates of pollutant levels for carbon monoxide and nitrogen dioxide for the highest traffic volumes found in both the urban and rural sections of each possible corridor in the area over the highway (mixing cell), above the service roads (mixing cell) where applicable, and at the edge of the right-of-way. Nitrogen oxide data are included as information only. There is no emission factor for nitrogen dioxide as such, so no comparison of the estimate with an air quality standard is possible.

Pollution estimates for peak and off-peak traffic are calculated based on an estimated average speed of 55 mph.

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 within each alternate corridor for the proposed roadway are low. No significant difference in carbon monoxide concentrations between the alternate corridors was found and no adverse environmental effects are expected. Even the worst case estimates are far below the one hour and eight hour air quality standards. The project is consistent with the state implementation plan for meeting air quality standards.

Additional Information for Receptor Sites

Since the project is still in the early planning stages and the precise location of the proposed roadway within each of the alternate corridors is not yet determined, no meaningful estimates of pollution levels near possible sensitive receptor sites can be included. However, potential sensitive receptors and stationary (point) sources of pollution should be identified and the proposed roadway located to avoid close proximity where possible.

TABLE 1
MAXIMUM TRAFFIC ESTIMATED FOR PROPOSED M 59
(Total Traffic in Both Directions in 1995)

Corridor A		Corridor B		Corridor C		Corridor D	
Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
23,400	25,800	94,600	79,200	52,200	62,400	40,600	79,200
(2,350)	(2,550)	(8,430)	(7,060)	(5,100)	(4,860)	(3,920)	(7,060)
⟨940⟩	⟨1,030⟩	⟨3,780⟩	⟨3,160⟩	⟨2,080⟩	⟨2,500⟩	⟨1,620⟩	⟨3,160⟩

000 = Average daily traffic (24 hr average)
(000) = Peak traffic (vehicles per hour)
⟨000⟩ = Off-peak traffic (vehicles per hour)

Peak Duration - Variable, around 1 hr
All speeds - 55 mph
Commercial vehicles - 4 percent of peak, 6 percent of off-peak.
All service road traffic less than 5,000 ADT, 500 v/hr peak and 200 v/hr off-peak.

TABLE 2

ESTIMATES OF POLLUTION CONCENTRATIONS [1,2,3]

Corridor	Section Type	Mixing Cell, Roadway		Mixing Cell, Service Road		Edge of Right-of-Way	
		Worst Condition Stability F, Parallel 3 mph Wind, Peak Traffic		Worst Condition Stability F, Parallel 3 mph Wind, Peak Traffic		Worst Condition Stability F, Parallel 3 mph Wind, Peak Traffic	
		CO mg/cu m	NO_x μg/cu m	CO mg/cu m	NO_x μg/cu m	CO mg/cu m	NO_x μg/cu m
A							
Urban	Rural	1.3	592	---	---	0.5	246
Rural	Rural	1.4	640	---	---	0.6	270
B							
Urban	Urban	5.3	2,380	2.0	895	1.4	630
Urban	Retaining Wall	5.3	2,390	2.9	1,340	2.3	1,030
Rural	Urban	4.5	2,000	2.8	1,280	2.1	920
C							
Urban	Rural	2.7	1,225	---	---	1.2	530
Urban	Urban	3.3	1,450	1.1	580	0.8	410
Rural	Rural	2.7	1,225	---	---	1.2	530
D							
Urban	Urban	2.4	1,120	1.6	720	1.2	510
Rural	Urban	4.5	2,000	2.8	1,250	2.1	930

[1] All vehicle speeds are 55 mph.

[2] Angle between roadway direction and wind direction, for all corridors is 20°. Most probable wind speed is 12 mph.

[3] All carbon monoxide values for the most probable condition, 12 mph wind, stability D, off-peak traffic are 0.3 mg/cu m or less.

TABLE 3
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

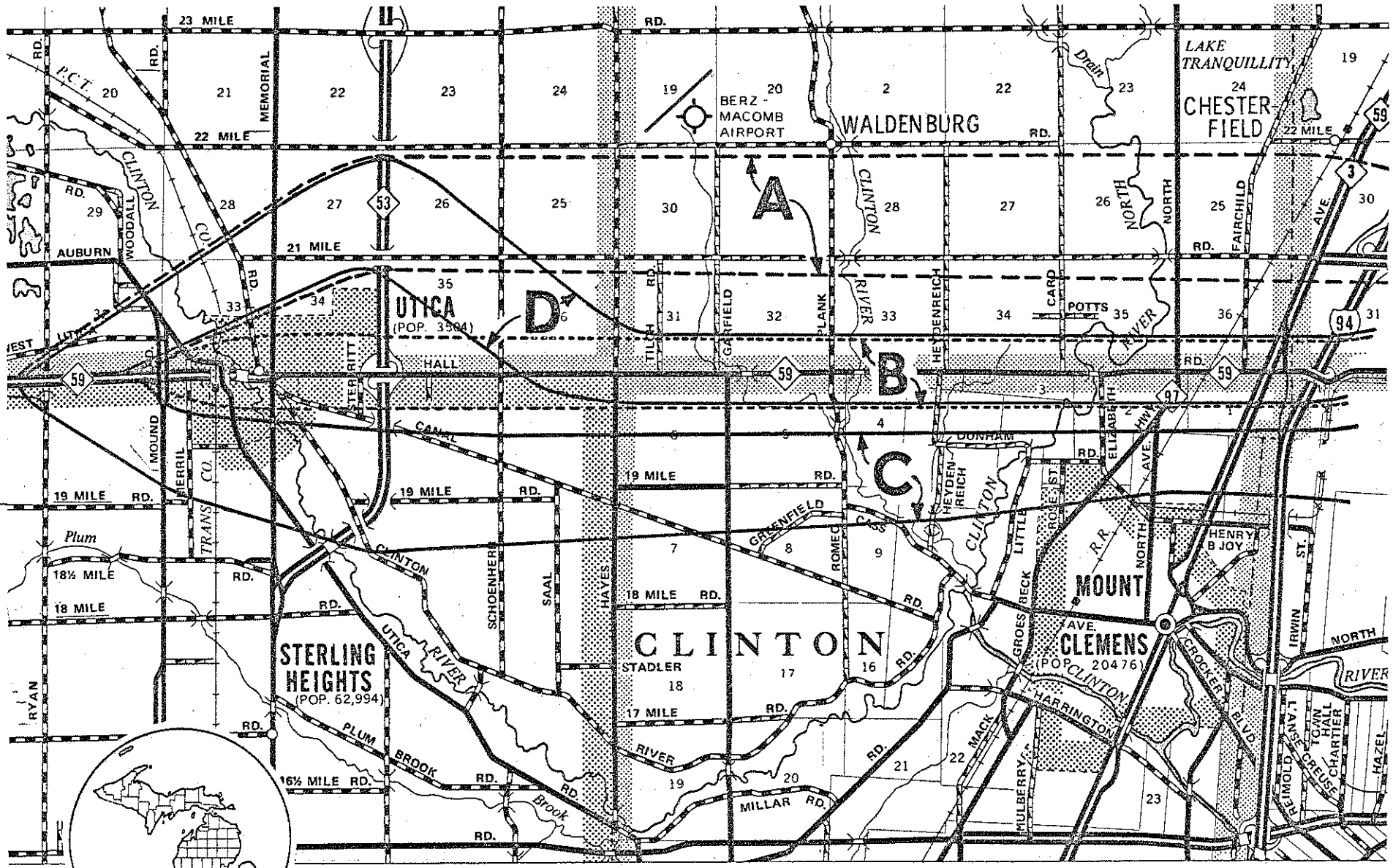


Figure 1. Location of proposed M 59 corridors in Macomb County.

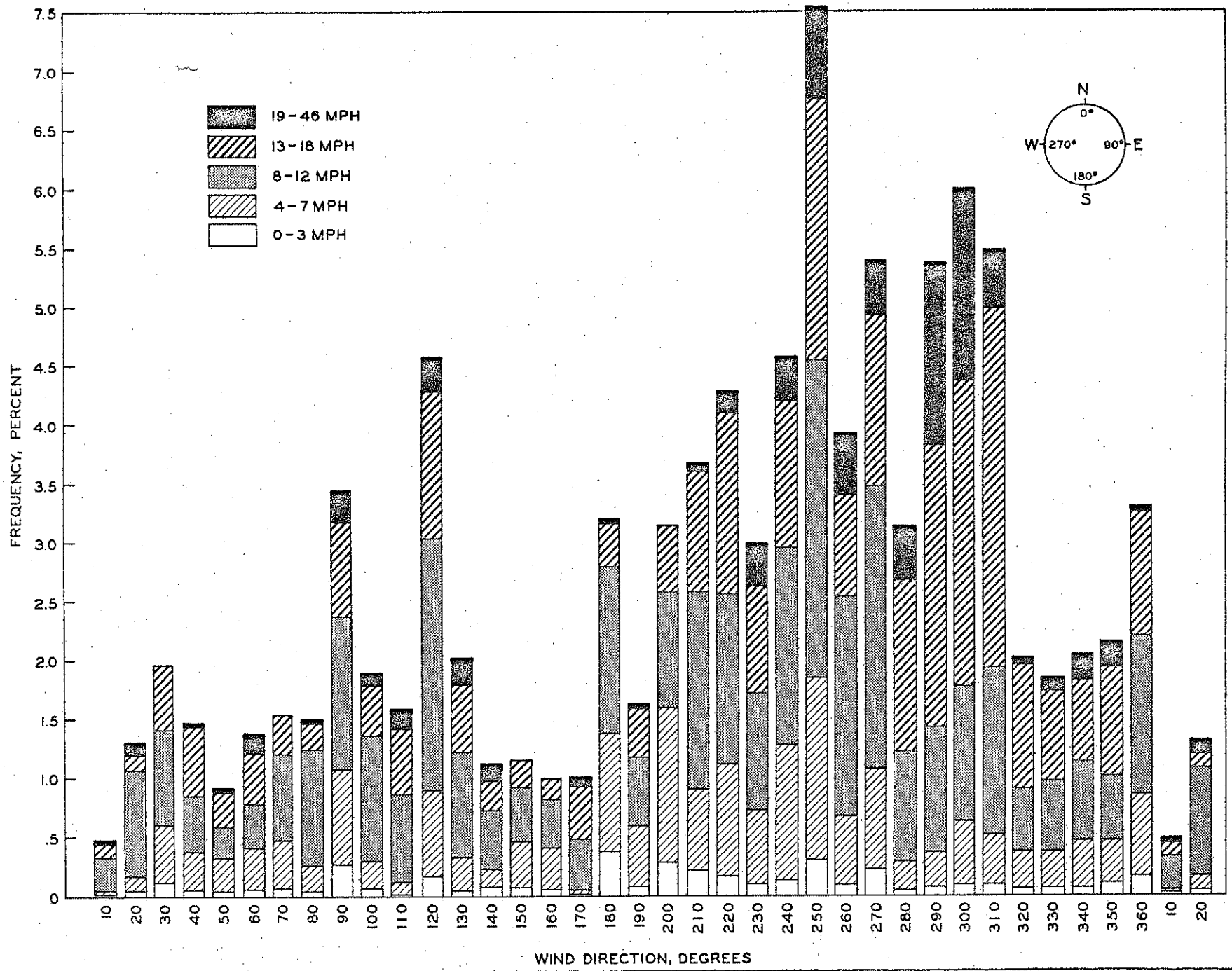


Figure 2. Wind speed and direction occurrences at Pontiac Airport (6 a.m. to 11 p.m.).

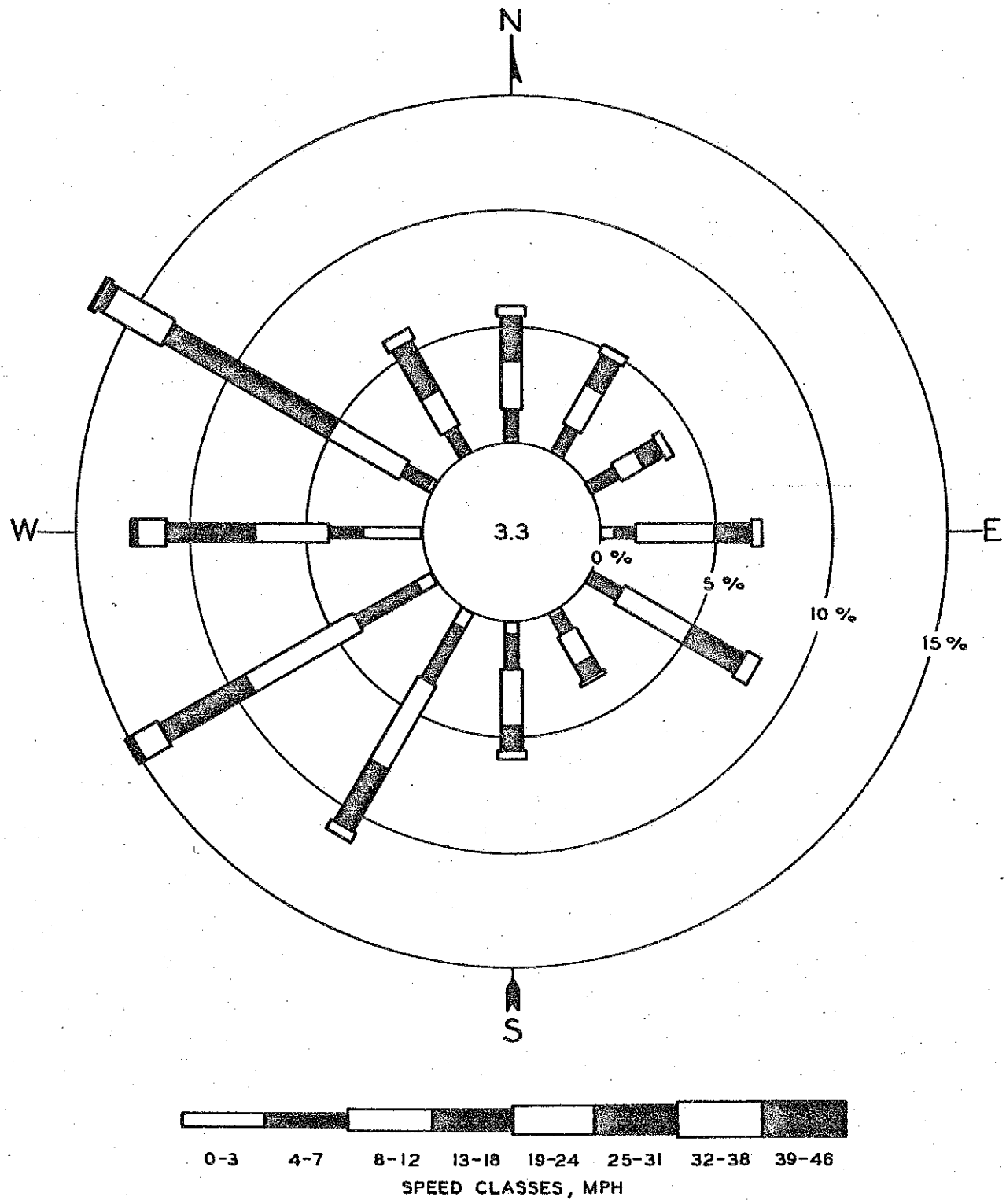


Figure 3. Wind speed and direction occurrences at Pontiac Airport (6 a.m. to 11 p.m.).

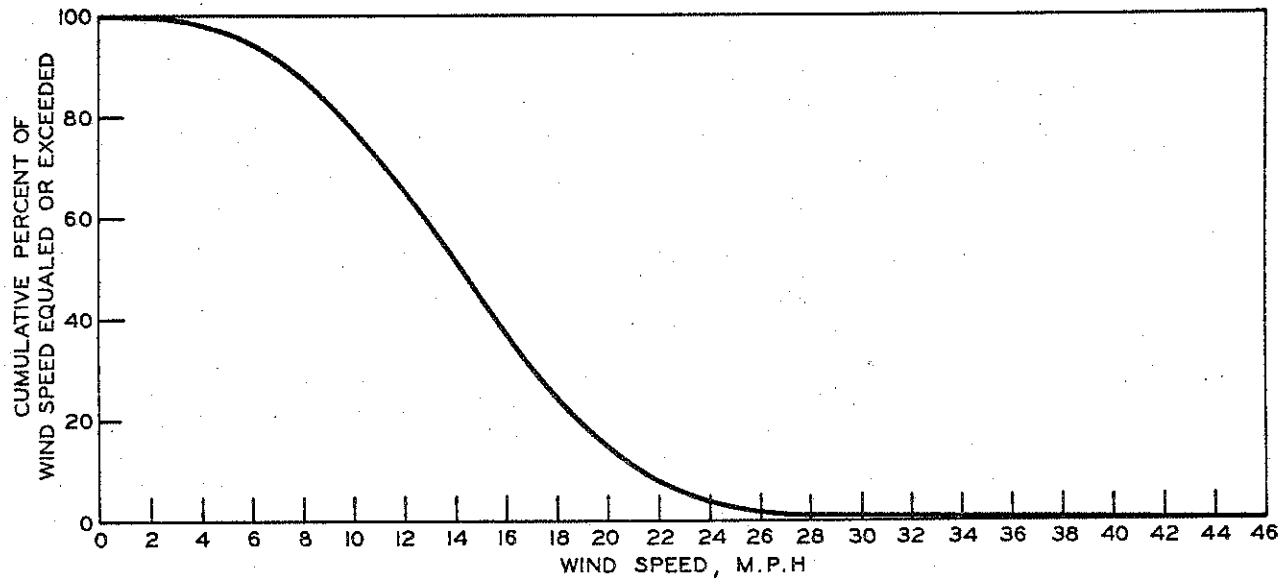
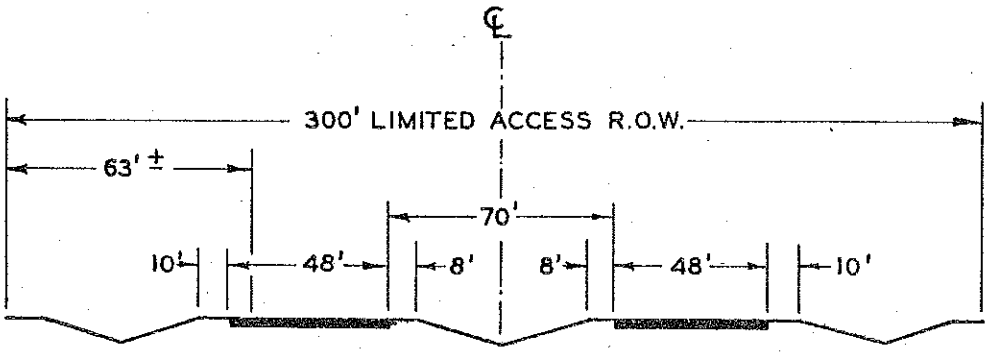
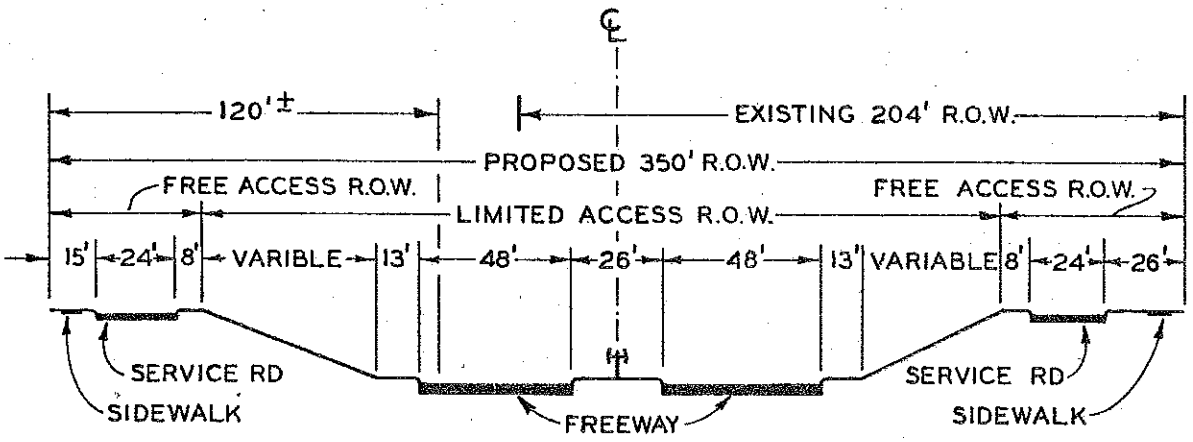


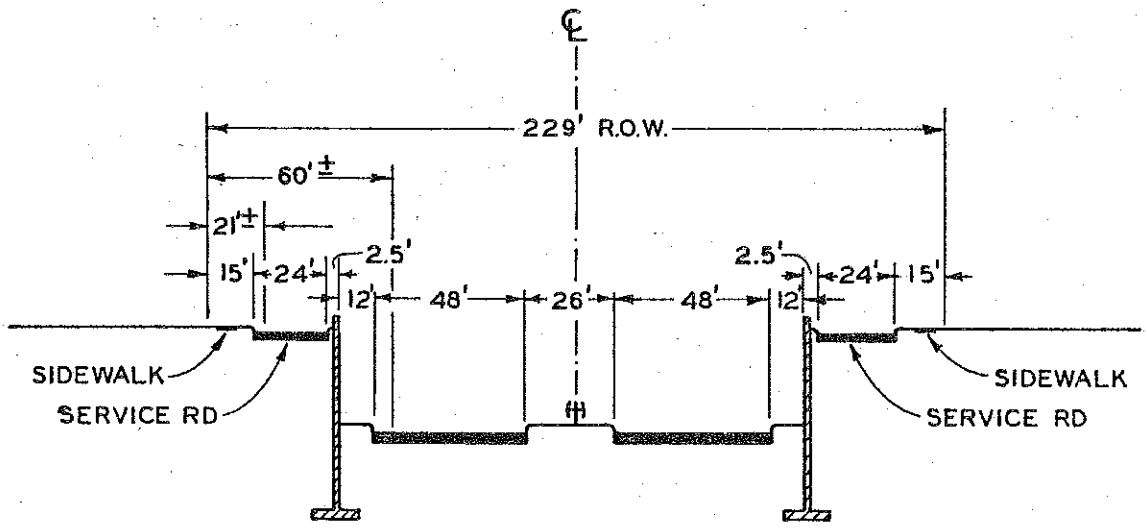
Figure 4. Distribution of wind speeds at Pontiac Airport (6 a.m. to 11 p.m.).



RURAL TYPE SECTION



URBAN TYPE SECTION WITH SERVICE ROAD



RETAINING WALL (DEPRESSED) SECTION WITH SERVICE ROAD

Figure 5. Typical sections that may be used in this project.