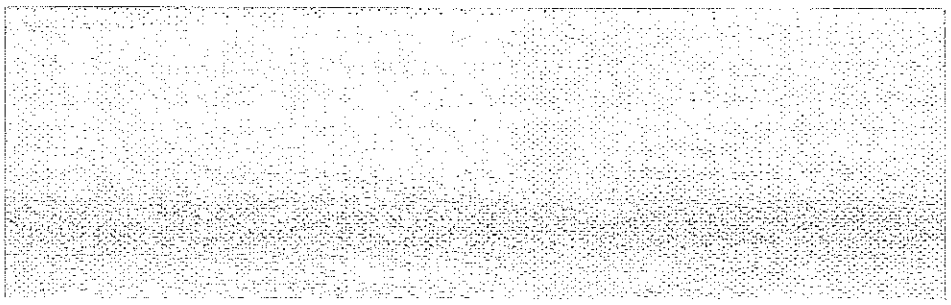
AIR QUALITY REPORT FOR M 59 IN MACOMB COUNTY

TESTING AND RESEARCH DIVISION
RESEARCH LABORATORY SECTION



TD 195 R63 A47 1980 c. 2
Air quality report for
M-59 in Macomb County

AIR QUALITY REPORT FOR M 59 IN MACOMB COUNTY

Research Laboratory Section
Testing and Research Division
Research Project 80 AP-30(A)
Research Report No. R-1153

Michigan Transportation Commission
Hannes Meyers, Jr., Chairman; Carl V. Pellonpaa,
Vice-Chairman; Weston E. Vivian, Rodger D. Young,
Lawrence C. Patrick, Jr., William C. Marshall
John P. Woodford, Director
Lansing, September 1980

This report presents air quality information for a proposed section of M 59 in Macomb County. Five alternate alignments, including a low cost capital improvement alternate, are considered. All alternates parallel and incorporate the existing roadway except the "Bypass Alternate" which bypasses the City of Utica to the north then returns to parallel the existing roadway near Garfield Rd as shown in Figure 1. Meteorological data and estimates of pollution that might occur adjacent to receptor sites along with the total pollutant burden for the various alternates are included.

Terrain and Demography

The proposed project is located in a lightly developed residential-commercial-rural area except at the western end where it passes through a moderately developed residential-commercial area of the City of Utica. The terrain surrounding the project is generally flat with no tall buildings or structures in the immediate vicinity which might hinder dispersion of pollutants.

Meteorology

Meteorological conditions in Michigan are generally good for dispersion and dilution of air pollutants. According to air pollution publication AP 101, U. S. Environmental Protection Agency, 1972 (p. 96) there are few days with a high meteorological potential for air pollution.

Daily weather data recorded every third hour at Detroit City Airport were obtained from the National Climatic Center in Asheville, North Carolina for the years 1967 through 1973. Detroit City is the closest airport to the project that has complete weather data. Figure 2 shows a 36-point bar graph of wind speed and direction occurrences. 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 90 percent of the time. The most probable daytime wind speed was found to be 11 mph.

Existing Ambient Air Quality

The area this project is located in is classified as attainment for carbon monoxide and nitrogen dioxide and non-attainment for photochemical oxidants (ozone) in relation to Federal air quality standards. No carbon monoxide data are available from the immediate project area. The closest available data were recorded by a Department mobile air monitoring unit in the Village of Almont, approximately 20 miles north of Utica, during the period February 13, 1980 to June 25, 1980. The five highest one-hour and

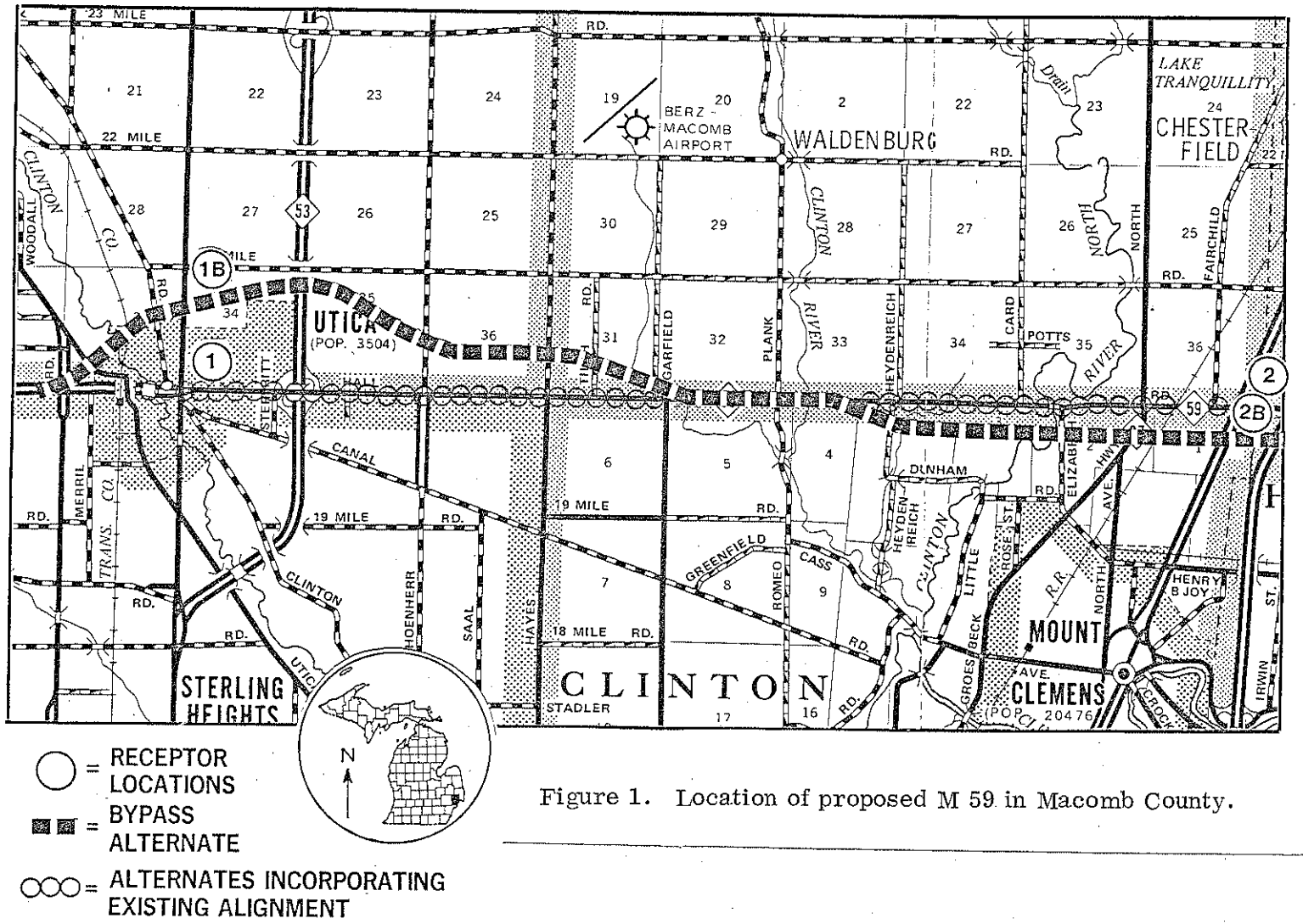


Figure 1. Location of proposed M 59 in Macomb County.

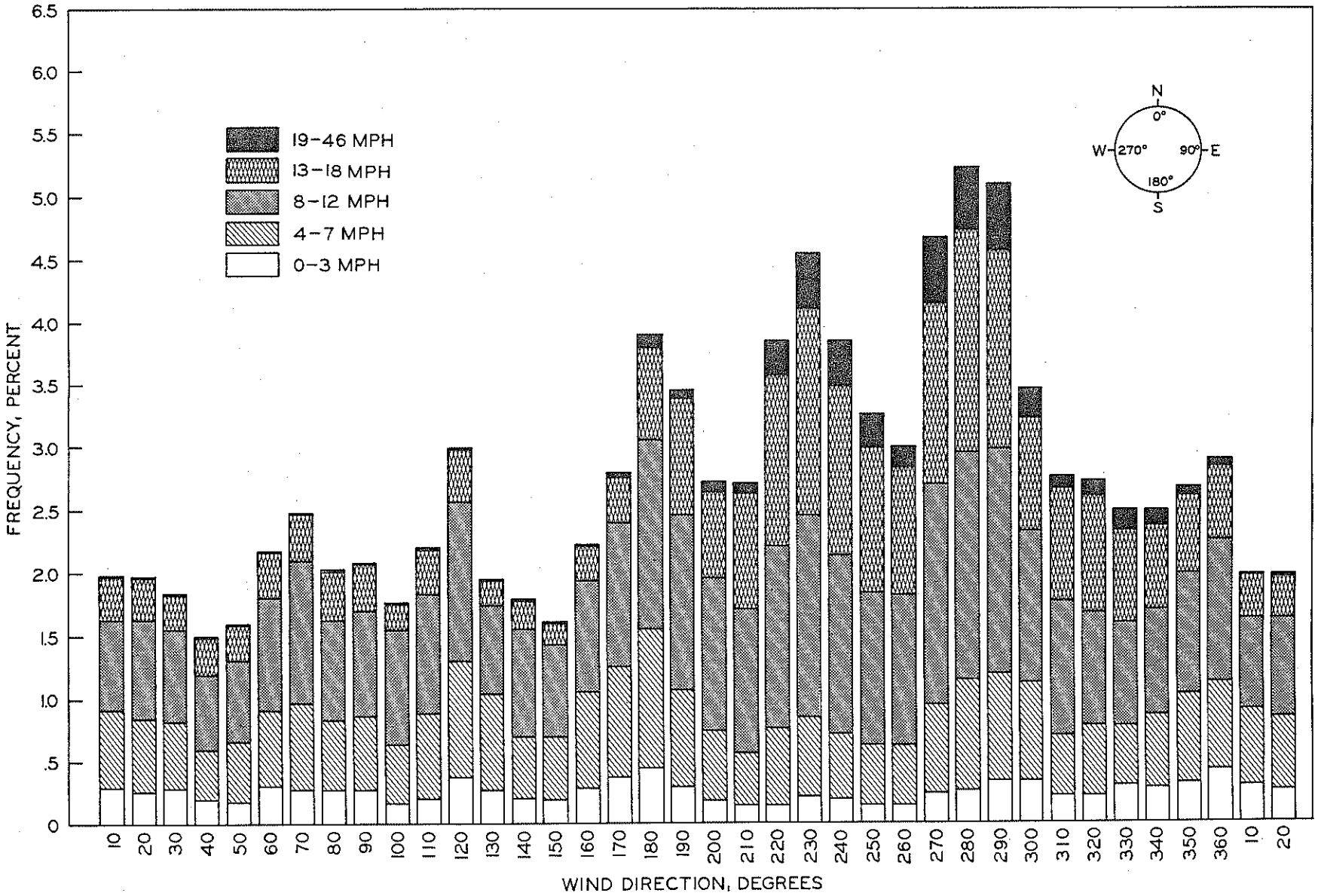


Figure 2. Wind speed and direction occurrences at Detroit City Airport.

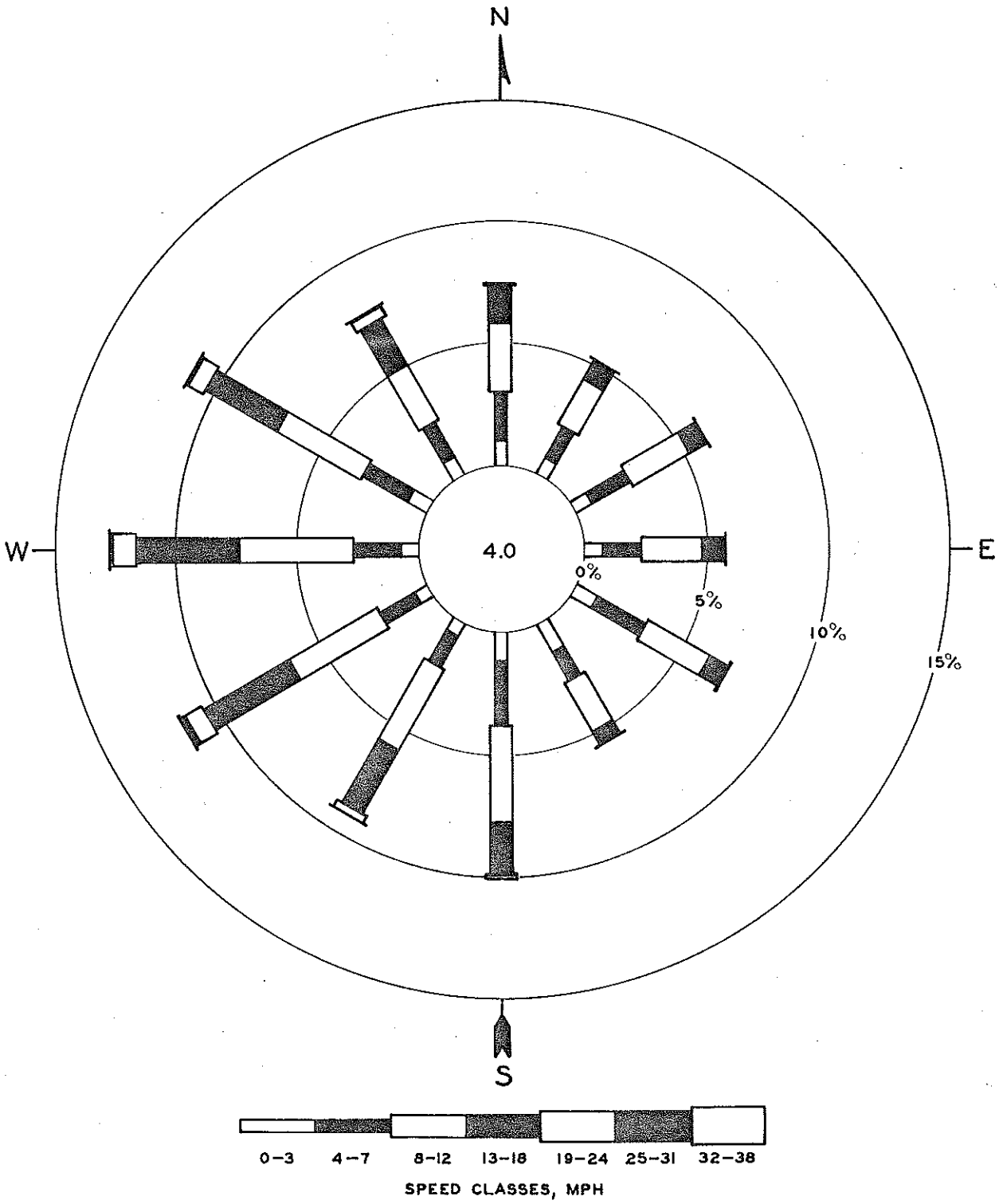


Figure 3. Frequency of wind direction and speed, percent (calms distributed).

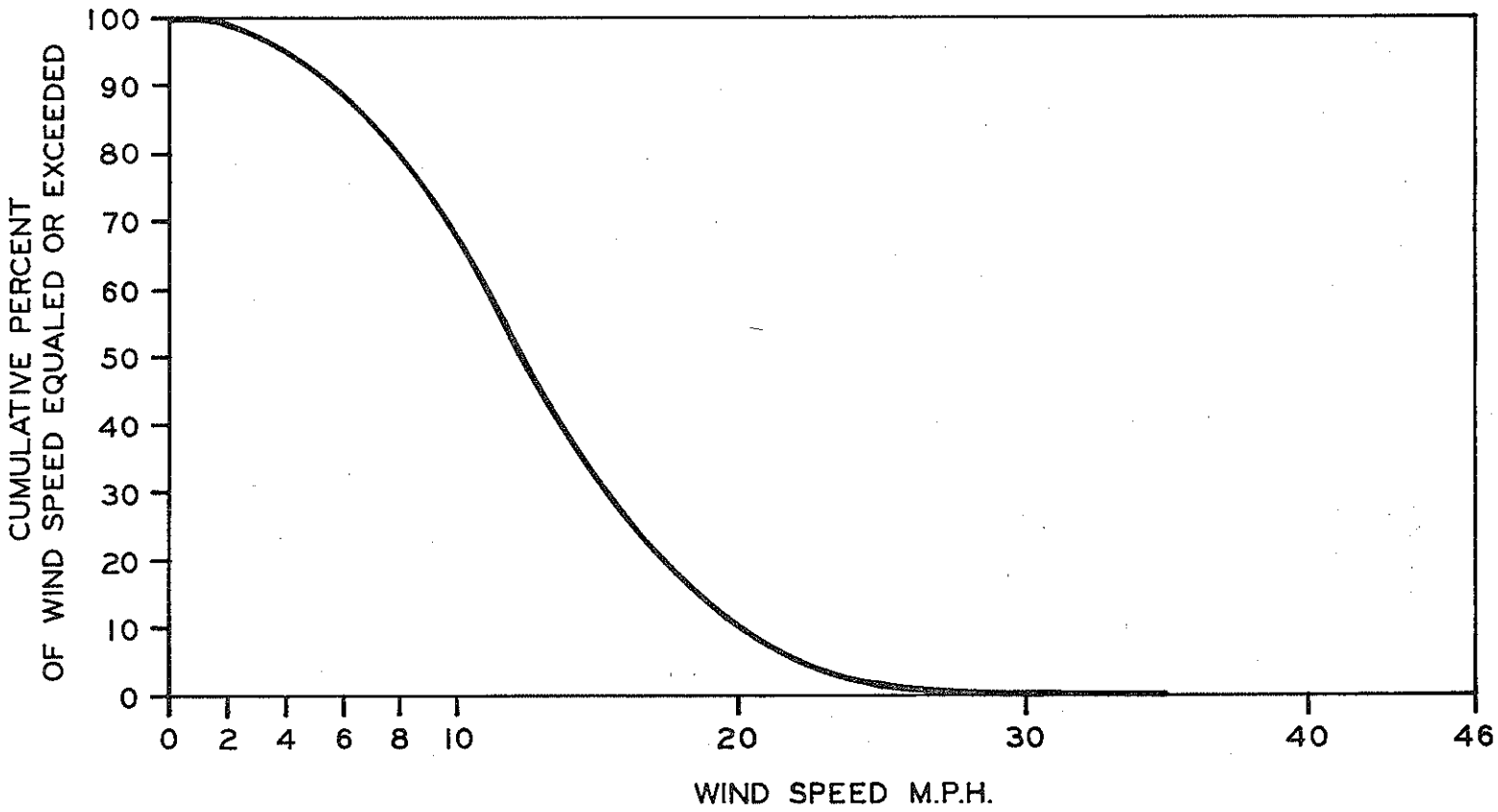


Figure 4. Wind speed distribution at Detroit City Airport.

eight-hour averages recorded are presented in Table 1. The data require no seasonal adjustment since the monitoring period included part of the October through March high carbon monoxide season. The highest one-hour and eight-hour concentrations found were 2.8 mg/cu m and 0.9 mg/cu m, respectively. Since the concentrations found are low, the normal correction to represent conditions in 1986 (the estimated time of completion) and 2000, was not applied. The normal correction would include reductions in vehicle emissions due to Federal controls and changes in traffic volumes and speeds resulting in even lower values.

TABLE 1
BACKGROUND CARBON MONOXIDE MEASURED
IN ALMONT IN 1980

1-hr Average mg/cu m	Date	8-hr Average mg/cu m	Date
2.8	March 14	0.9	March 19
1.5	March 9	0.8	March 20
1.5	March 14	0.8	June 15
1.4	March 8	0.8	March 20
1.4	March 11	0.8	March 19

Since the area where the measurements were obtained may be slightly less populated with less traffic than the proposed project area, 1 mg/cu m of carbon monoxide was added to the measured highest one-hour and eight-hour averages, thus 3.8 mg/cu m and 1.9 mg/cu m will be considered the background carbon monoxide in the project area and are used in Table 2 to show the total carbon monoxide concentrations at the receptors for each of the alternates.

Air monitoring is currently being done near the M 59 corridor north of Mt. Clemens. This background data will be available for the final Environmental Impact Statement.

Pollution Estimates

Estimates of carbon monoxide concentrations were made at a receptor height of 5 ft (1.5 m). A mathematical model based on the Gaussian diffusion equation employing a mixing zone concept was used[1]. Inputs to the

[1] Benson, P. E., "Caline 3 - A Versatile Dispersion Model for Predicting Air Pollutant Levels Near Highways and Arterial Streets," Prepared by California Department of Transportation, Report No. FHWA/CA/TL-79/23, November 1979.

TABLE 2
ESTIMATES OF ONE-HOUR AND EIGHT-HOUR CARBON MONOXIDE CONCENTRATIONS, mg/cu m (INCLUDING BACKGROUND)

Receptor Site	Alternate								Bypass Freeway			
	Low Cost Capital Improvement		Widened to Five Lanes		Six Lane Boulevard		Urban Freeway		Existing Roadway		Freeway	
	1986	2000	1986	2000	1986	2000	1986	2000	1986	2000	1986	2000
Max. 1-hr	8.8	13.9	9.8	14.4	8.9	12.9	9.3	13.5	8.7	12.9	8.4	12.1
1 Background	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
Total	12.6	17.7	13.6	18.2	12.7	16.7	13.1	17.3	12.5	16.7	12.2	15.9
Max. 1-hr	4.9	5.6	5.6	6.8	3.8	5.0	3.8	4.8	4.3	5.7	3.3	4.6
2 Background	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
Total	8.7	9.4	9.4	10.6	7.6	8.8	7.6	8.6	8.1	9.5	7.1	8.4
Max. 8-hr	2.5	3.8	2.7	4.0	2.5	3.6	2.5	3.7	2.4	3.6	2.3	3.3
1 Background	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
Total	4.4	5.7	4.6	5.9	4.4	5.5	4.4	5.6	4.3	5.5	4.2	5.2
Max. 8-hr	1.4	1.5	1.5	1.9	1.0	1.4	1.0	1.3	1.2	1.6	0.9	1.3
2 Background	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
Total	3.3	3.4	3.4	3.8	2.9	3.3	2.9	3.2	3.1	3.5	2.8	3.2

model include wind speed and direction, traffic volumes, vehicle emission factors, highway design, and site characteristics.

Carbon monoxide concentrations were estimated for two sites (an urban site and a rural site) near the proposed project for each of the alternates for 1986 (estimated time of completion) and 2000 (Fig. 1). The alternates and receptor sites are identified as follows:

Alternates

1. Low cost capital improvement - Four 12-ft lanes along existing roadway.
2. Five lane - Five 12-ft lanes incorporating the existing roadway.
3. Six lane boulevard - Three 12-ft lanes, each direction, separated by a 60-ft median incorporating the existing roadway.
4. Bypass - Three 12-ft lanes, each direction, with a variable median width from Mound Rd to Schoenherr Rd. Two 12-ft lanes, each direction, with a variable median width from Schoenherr Rd to end of project.
5. Urban freeway - Three 12 ft lanes, each direction, with a 26-ft median from Mound Rd to Hayes Rd. Two 12-ft lanes, each direction, with a 26-ft median from Hayes Rd to North Rd. Two 12-ft lanes each direction from North Rd to end of project except in areas where traffic and safety considerations indicate the need for an additional lane for turning or weaving movements. This alternate has both north and south service roads and parallels and incorporates the existing roadway as one service road.

Receptors

1. Urban - Three meters from the edge of the roadway for each of the alternates.
2. Rural - At the edge of the right-of-way for each of the alternates. (For the bypass alternate, Receptors 1 and 2 refer to the existing roadway and 1B and 2B refer to the proposed roadway, Fig. 1.)

Information used as input to the model consisted of:

1) Vehicle emission factors, shown in the following table, calculated using "Mobile Source Emission Factors," March 1978, U. S. Environmental Protection Agency. Emission factors were calculated at temperatures of 30 F with 20 percent of the vehicles in a cold start condition, 27 percent of the vehicles in a hot start condition, and the remainder of the vehicles in a hot operation mode. Vehicle age mix data used were for Michigan

registrations, and average annual miles driven for various age vehicles were national estimates from "Mobile Source Emission Factors."

EMISSION FACTORS FOR
CARBON MONOXIDE, g/mi, 30 F
(Five Percent Commercial Traffic)

Year	Average Vehicle Speeds, mph						
	25	30	35	40	45	50	55
1986	--	26.4	23.1	21.0	19.9	19.5	18.8
2000	22.6	--	17.1	15.5	14.7	14.4	14.1

2) Design hour traffic volume (DHV). Traffic estimates and peak traffic speeds are shown in Table 3.

3) Meteorological Conditions. The Caline 3 model was run at several wind angles to the roadways to determine the angle which produced the highest carbon monoxide levels (worst case) at each of the sites for each of the alternates. A wind speed of 2.2 mph (1 m/sec) under atmospheric stability class D was used with all wind angles. Table 4 shows the frequency distribution of atmospheric stability classes for the meteorological data used.

4) Road Profile. All alternate roadways are at grade except the urban freeway which is depressed 20 ft, except at locations where it crosses the North Branch of the Clinton River between Card and North Rds and the Middle Branch of the Clinton River near Romeo Plank Rd.

5) Roadway Widths.

6) Surface Roughness. A value of 108 cm was used for the urban Receptors 1 and 1B. This is a typical value for city land use with predominantly single family residential. A value of 74 cm was used for the rural Receptors 2 and 2B. This is a typical value for rural land use.

7) Mixing height - 100 m.

All estimates of carbon monoxide levels represent maximum worst case one-hour concentrations and are in addition to existing background levels. Worst case conditions are peak traffic, stability D, and a 2.2 mph (1 m/sec) wind. Table 2 presents the calculated estimates, the background and the total carbon monoxide concentration at the receptor sites for each alternate scheme.

TABLE 3
TRAFFIC ESTIMATES FOR PROPOSED M 59 AND MAJOR CROSSROADS

Proposed Roadway and Crossroads	Alternate									
	Low Cost Capital Improvement		Widened to Five Lanes		Six Lane Boulevard		Urban [1] Freeway		Bypass [2]	
	1986	2000	1986	2000	1986	2000	1986	2000	1986	2000
M 59 and Mound Rd	3,600 (40) 2,500 (45)	4,400 (35) 4,240 (45)	5,600 (45) 2,500 (45)	9,500 (40) 4,240 (45)	5,600 (45) 2,500 (45)	9,500 (40) 4,240 (45)	5,600 (50) 2,500 (45)	9,500 (45) 4,240 (45)	5,600 (55) 2,500 (45)	9,500 (50) 4,240 (45)
M 59 and Van Dyke	3,650 (35) 4,100 (30)	5,000 (35) 7,180 (25)	5,220 (30) 4,100 (30)	9,040 (25) 7,180 (25)	5,220 (45) 4,100 (30)	9,040 (40) 7,180 (25)	5,220 (55) 4,100 (30)	9,040 (55) 7,180 (25)	5,220 (55) 4,100 (30)	9,040 (55) 7,180 (25)
M 59 and M 53	3,850 (45) 4,700 (55)	5,500 (40) 7,700 (55)	5,970 (45) 4,700 (55)	9,940 (40) 7,700 (55)	6,000 (55) 4,700 (55)	9,940 (45) 7,700 (55)	6,000 (55) 4,700 (55)	9,940 (55) 7,700 (55)	6,000 (55) 4,700 (55)	9,940 (55) 7,700 (55)
M 59 and M 3	2,860 (50) 4,350 (45)	3,900 (50) 7,500 (40)	3,710 (50) 4,350 (45)	6,100 (45) 7,500 (40)	3,720 (55) 4,350 (45)	6,100 (55) 7,500 (40)	3,720 (55) 4,350 (45)	6,100 (55) 7,500 (40)	3,720 (55) 4,350 (45)	6,100 (55) 7,500 (40)

0000 = design hour volume (DHV), vehicles per hour
(00) = vehicle speeds, mph

[1] Urban freeway - 70 percent of the traffic will use the freeway, 30 percent will use the service roads. Service road vehicle speeds: 35 mph at Mound Rd and Van Dyke intersections, and 45 mph at M 53 and M 3 interchanges.
[2] Bypass - 50 percent of the traffic will use the bypass, 50 percent will use the existing M 59.

Percent commercial - 5 percent all roadways, both years.

Comparison of Estimates with Air Quality Standards

a) One-hour carbon monoxide standard - 40 mg/cu m (35 ppm)

The maximum estimated one-hour concentrations of carbon monoxide at each of the receptor sites in 1986 and 2000 for all alternates are shown in Table 2. All alternates produce essentially the same carbon monoxide levels and all are below the standard.

b) Eight-hour carbon monoxide standard - 10 mg/cu m (9 ppm)

The Federal Highway Administration's report "Project Level Considerations to Assure Adequate Air Quality Analyses," June 1977, suggests the use of the following technique for determining the eight-hour carbon monoxide concentration from the one-hour concentration.

$$\frac{V_8}{V_1} \times (\text{1-hr CO concentration}) \times P = \text{8-hr CO concentration}$$

where V_8 = average hourly traffic volume in both directions during the eight-hour period of interest

V_1 = peak hour traffic volume in both directions

P = one to eight-hour meteorological persistence factor for the eight-hour period.

TABLE 4
STABILITY CLASS FREQUENCY DISTRIBUTION BY HOUR
(Percent)

Hour	Stability Class					
	A	B	C	D	E	F
1	0.0	0.0	0.0	50.8	19.8	29.5
4	0.0	0.0	0.0	50.4	19.5	30.1
7	10.6	14.4	9.4	50.3	8.3	7.0
10	4.4	14.9	22.3	58.5	0.0	0.0
13	1.8	9.2	23.0	66.1	0.0	0.0
16	1.2	7.5	23.1	66.1	1.9	0.2
19	0.0	0.0	0.0	66.7	23.7	9.7
22	0.0	0.0	0.0	53.2	22.8	24.0
Overall percent	2.2	5.7	9.7	57.8	12.0	12.6

A value of P = 0.6 is suggested unless data are available to calculate a persistence factor for the proposed project. This technique was used to calculate the eight-hour carbon monoxide level for each alternate, and the highest eight-hour concentrations at the receptor sites in 1986 and 2000 including background are presented in Table 2. A typical calculation for the five-lane alternate at Receptor 1 in 1986 follows:

Receptor 1

$$\text{M 59} - \frac{2{,}360 \text{ vehicles per hour}}{5{,}220 \text{ vehicles per hour}} \times 2.1 \text{ mg/cu m} \times 0.6 = 0.6 \text{ mg/cu m}$$

$$\text{Van Dyke} - \frac{1{,}860 \text{ vehicles per hour}}{4{,}100 \text{ vehicles per hour}} \times 7.8 \text{ mg/cu m} \times 0.6 = 2.1 \text{ mg/cu m}$$

$$\text{TOTAL} \qquad 2.7 \text{ mg/cu m}$$

All alternates produce essentially the same carbon monoxide levels and all are below the standard.

Conclusions

The estimated concentrations of carbon monoxide, including existing background at all of the receptor sites for all alternates of the proposed project are within Federal air quality standards. There is no significant difference between the alternates.

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

Total Pollutant Burden Analysis

A total pollutant burden analysis for carbon monoxide, hydrocarbons, and oxides of nitrogen is included for both the no-build and build alternates for the years 1986 and 2000 at ambient temperatures of 30 and 60 F. The vehicle emission factors calculated as described previously in Item (1), under information used as input to the model were used to calculate vehicle emissions. Table 5 shows traffic data for the significant roadways in the study area used to calculate total emissions. Since the total traffic volumes, vehicle miles traveled, vehicle speeds, and percent commercial traffic in the study area do not significantly change for the various build alternates and the total pollutant burden would accordingly be essentially the same for all alternates, only one total pollutant burden estimate for the build alternates was performed and is presented along with the no-build estimate in Table 6.

TABLE 5
TRAFFIC ESTIMATES FOR TOTAL POLLUTANT
BURDEN (MESOSCALE) ANALYSIS

	1986		2000	
	No Build	Build	No Build	Build
M 59				
Ryan Rd to Mound Rd				
VMT	60,240	82,330	60,240	109,740
Average Speed	50	50	50	50
Percent Commercial	8	8	8	8
Mound Rd to M 53				
VMT	112,700	173,910	112,700	231,680
Average Speed	25	50	25	50
Percent Commercial	8	8	8	8
M 53 to Hayes Rd				
VMT	109,400	158,010	109,400	210,780
Average Speed	40	50	40	50
Percent Commercial	8	8	8	8
Hayes Rd to Romeo Plank				
VMT	66,290	113,640	66,290	131,490
Average Speed	35	50	35	50
Percent Commercial	8	8	8	8
Romeo Plank to North Rd				
VMT	106,080	98,220	106,080	130,490
Average Speed	35	55	35	55
Percent Commercial	8	8	8	8
North Rd to Fairchild Rd				
VMT	29,800	31,290	29,800	41,780
Average Speed	35	50	35	50
Percent Commercial	8	8	8	8
Fairchild Rd to I 94				
VMT	22,700	19,610	22,700	26,120
Average Speed	30	50	30	50
Percent Commercial	8	8	8	8

TABLE 5 (Cont.)
TRAFFIC ESTIMATES FOR TOTAL POLLUTANT
BURDEN (MESOSCALE) ANALYSIS

	1986		2000	
	No Build	Build	No Build	Build
21 Mile Rd				
Van Dyke to M 53				
VMT	29,550	7,880	29,550	11,239
Average Speed	35	35	35	35
Percent Commercial	2	2	2	2
M 53 to Romeo Plank				
VMT	116,490	17,650	116,490	23,560
Average Speed	35	40	35	40
Percent Commercial	2	2	2	2
Romeo Plank to Fairchild Rd				
VMT	108,810	5,710	108,810	7,410
Average Speed	35	40	35	40
Percent Commercial	2	2	2	2
Fairchild Rd to I 94				
VMT	22,730	9,850	22,730	12,650
Average Speed	35	35	35	35
Percent Commercial	2	2	2	2
19 Mile Rd				
Clinton Rd to Saal Rd				
VMT	40,000	17,200	40,000	22,800
Average Speed	25	30	25	30
Percent Commercial	2	2	2	2
Hayes Rd to Romeo Plank				
VMT	37,880	26,970	37,880	35,900
Average Speed	25	30	25	30
Percent Commercial	2	2	2	2

TABLE 5 (Cont.)
TRAFFIC ESTIMATES FOR TOTAL POLLUTANT
BURDEN (MESOSCALE) ANALYSIS

	1986		2000	
	No Build	Build	No Build	Build
Major Crossroads				
Utica Rd West of Mound Rd				
VMT	6,930	4,620	6,930	4,970
Average Speed	30	35	30	35
Percent Commercial	2	2	2	2
Mound Rd				
VMT	78,400	54,490	78,400	72,660
Average Speed	40	40	40	40
Percent Commercial	2	2	2	2
Auburn Rd				
VMT	22,500	15,500	22,500	20,630
Average Speed	30	35	30	35
Percent Commercial	2	2	2	2
Shelby Rd				
VMT	13,600	10,200	13,600	13,600
Average Speed	30	30	30	30
Percent Commercial	2	2	2	2
Merril Rd				
VMT	4,800	3,600	4,800	4,800
Average Speed	25	25	25	25
Percent Commercial	2	2	2	2
Utica Rd South of M 59				
VMT	18,000	7,000	18,000	9,400
Average Speed	30	30	30	30
Percent Commercial	2	2	2	2
Van Dyke				
VMT	133,000	119,400	133,000	132,100
Average Speed	25	25	25	25
Percent Commercial	2	2	2	2

TABLE 5 (Cont.)
TRAFFIC ESTIMATES FOR TOTAL POLLUTANT
BURDEN (MESOSCALE) ANALYSIS

	1986		2000	
	No Build	Build	No Build	Build
Major Crossroads (Cont.)				
Clinton Rd				
VMT	21,000	12,040	21,000	15,960
Average Speed	30	35	30	35
Percent Commercial	2	2	2	2
Canal Rd				
VMT	75,000	14,700	75,000	19,500
Average Speed	30	35	30	35
Percent Commercial	2	2	2	2
M 53				
VMT	147,300	127,300	147,300	169,600
Average Speed	50	50	50	50
Percent Commercial	6	6	6	6
Schoenherr Rd				
VMT	64,000	47,700	64,000	63,500
Average Speed	30	35	30	35
Percent Commercial	2	2	2	2
Hayes Rd				
VMT	45,000	31,000	45,000	41,300
Average Speed	35	40	35	40
Percent Commercial	2	2	2	2
Garfield Rd				
VMT	50,000	34,500	50,000	36,700
Average Speed	35	40	35	40
Percent Commercial	2	2	2	2
Romeo Plank Rd				
VMT	65,000	42,900	65,000	59,200
Average Speed	35	40	35	40
Percent Commercial	2	2	2	2

TABLE 5 (Cont.)
TRAFFIC ESTIMATES FOR TOTAL POLLUTANT
BURDEN (MESOSCALE) ANALYSIS

	1986		2000	
	No Build	Build	No Build	Build
Major Crossroads (Cont.)				
Heydenreich Rd				
VMT	6,000	2,200	6,000	3,000
Average Speed	35	40	35	40
Percent Commercial	2	2	2	2
Card Rd				
VMT	500	300	500	300
Average Speed	40	40	40	40
Percent Commercial	2	2	2	2
Elizabeth Rd				
VMT	18,000	13,400	18,000	17,800
Average Speed	30	35	30	35
Percent Commercial	2	2	2	2
Groesbeck Hwy				
VMT	77,000	71,400	77,000	95,340
Average Speed	35	35	35	35
Percent Commercial	8	8	8	8
North Rd				
VMT	41,000	30,600	41,000	40,800
Average Speed	35	35	35	35
Percent Commercial	2	2	2	2
Fairchild Rd				
VMT	1,000	800	1,000	1,000
Average Speed	35	40	35	40
Percent Commercial	2	2	2	2
M 3				
VMT	135,000	126,450	135,000	168,640
Average Speed	35	40	35	40
Percent Commercial	8	8	8	8
I 94				
VMT	151,880	138,710	151,880	186,300
Average Speed	50	50	50	50
Percent Commercial	6	6	6	6

TABLE 6
ESTIMATES OF TOTAL POLLUTANT BURDEN

Traffic Projection Year	Alternate	Pollutant, tons per day					
		Carbon Monoxide		Hydrocarbons		Oxides of Nitrogen	
		30 F	60 F	30 F	60 F	30 F	60 F
1986	No Build	47.00	39.57	4.58	3.98	5.66	5.66
	Build	35.42	30.06	3.34	2.99	5.31	5.31
2000	No Build	34.43	29.61	3.64	3.11	4.81	4.81
	Build	33.75	29.26	3.37	2.87	5.78	5.78