FIRST AVENUE STUDY

PREPARED FOR

CEDAR RAPIDS, IOWA

This report was prepared through a Grant provided by the United States Department of Transportation, Federal Highway Administration, pursuant to the provisions of Section 402 of Title I of the Highway Safety Act of 1966.

BY

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June 30, 1975

Mayor Donald J. Canney and City Council
City of Cedar Rapids
City Hall
Cedar Rapids, Iowa 52404

Honorable Mayor Canney and City Council:

We are pleased to submit our final report for the First Avenue Study in accord with our agreement dated September 6, 1974.

This report documents our analyses and findings related to First Avenue operational and safety needs and develops a recommended implementation program to improve traffic operations and safety. We trust the findings and recommendations will provide a basis for significant improvement of First Avenue.

We wish to acknowledge the cooperation and assistance of Mr. Melvin B. Meyer, Traffic Engineer and Parking Director, and his staff in the conduct of the study.

We appreciate the opportunity of undertaking this important and challenging work program, and we trust that early implementation of our recommendations can be achieved.

Respectfully submitted,

Wilbur Smith and Associates

REPORT IN BRIEF

This report presents analyses, findings, and recommendations of a traffic operations and safety study for First Avenue in Cedar Rapids. Objectives of the study were to evaluate First Avenue traffic operations and safety and to develop a recommended improvement program to satisfy existing and projected future needs. The study extends from the intersection of Williams Boulevard and 16th Avenue SW to Collins Road East.

First Avenue functions as a primary arterial route through the city and is a major regional traffic facility. Much of the east-west traffic movement in Cedar Rapids is carried by First Avenue, since no existing alternative routes are available. The existing and future function of First Avenue as a major traffic facility and its critical role in the City's transportation system, were considered in the development of recommendations.

Existing Conditions

Existing physical and operational conditions on First Avenue were determined in defining current substandard traffic operations and safety conditions. This included analysis of traffic flow data, traffic characteristics, accident records, pedestrian activity, travel time studies, and traffic control devices.

Average daily traffic on First Avenue is as high as 33,000 vehicles-per-day, with actual weekday traffic volumes reaching 37,000 vehicles-per-day. First Avenue provides an existing four-lane facility with painted left turn storage lanes at most signalized intersections. Since the existing traffic level-of-service is below acceptable standards and with continuing future traffic growth, recommendations are made in the study to widen and channelize First Avenue to provide the additional capacity required incorporating safety features into the roadway design to reduce accidents.

Accident experience on First Avenue is significantly high with 914 accidents occurring in the study section in 1974. Of these accidents 596 occurred at intersections, and 318 occurred at non-intersection locations. High accident locations were studied in detail in developing recommendations. The

recommendations presented in the study report will serve to significantly reduce accidents on First Avenue, and improve traffic flow.

Recommended Improvements

A number of recommendations were developed to improve traffic operations and safety on First Avenue. Recommendations are made for immediate action, short-range, and long-range implementation. Scheduling of implementation projects should be done as soon as possible, consistent with other local priorities and availability of funding. Immediate action and short-range recommendations are directed toward gaining the greatest possible service and improvement in safety from the existing facility, while the long-range recommendation calls for the future widening and channelization of First Avenue to gain needed roadway capacity.

Immediate Action Recommendations - Immediate action recommendations are made for signal system timing, phasing and coordination adjustments to favor First Avenue traffic flow. A philosophy of biasing signal timing to favor First Avenue is recommended, thus providing additional capacity and progressive movement on this important arterial facility. Adoption of such an approach is considered necessary because of the indicated capacity deficiencies, delays, and accident experience on

First Avenue. It should be recognized that the additional traffic service to be gained by this approach is limited by constraints of the existing roadway geometry, existing signal equipment, and the need to provide minimum green intervals where pedestrians are a factor. Other traffic signal improvements at six specific locations are recommended to correct existing deficiencies.

An immediate recommendation is made to prohibit parking on portions of First Avenue during peak traffic flow periods. This removal of parking can provide additional capacity and improved safety during the morning and evening peak periods, when traffic demand is the highest.

It is recommended that the City pursue its current plans to improve the warning signal equipment at the 4th Street railroad grade crossing to gain more reliable train crossing warning indications. The City should assume an agressive position with rail lines operating on the 4th Street grade crossing to minimize crossing blockages, reschedule train movements to other tracks, and ultimately make track relocations to eliminate the 4th Street crossing.

Short-Range Recommendations - Short-range recommendations include upgrading of signal installations to provide a high-type

signal display standard on First Avenue. Upgrading of signals providing computer type master and obsolete equipment replacement should be consistent with the long-range recommendations for widening First Avenue. It is recommended that control of traffic signals on First Avenue be initiated as a principal subsystem of the area wide computer type master control system planned by the City.

Complete prohibition of curb parking is recommended for portions of First Avenue to provide additional capacity and improve safety. This prohibition of curb parking is recommended for implemention as traffic volume and accident rates on First Avenue reach a level requiring parking removal.

Long-Range Recommendation - Widening and channelization of First Avenue to a high-type six-lane roadway is recommended as a long-range improvement. The widening to a six-lane facility is necessary to provide adequate capacity and safety to accommodate existing and projected traffic demands, and is consistent with plans of the Linn County Regional Transportation Study. Widening and channelization of First Avenue will, by nature of its high-type design, reduce accident experience significantly, as well as provide increased capacity and a higher level-of-service.

Improvement Priorities

The recommended improvements should be staged for implementation as traffic and safety needs require, consistent with other local needs and availability of funding. The recommended implementation program is divided into three priority categories:

Immediate Action Program

- Upgrading of traffic signal operations;
- Peak period parking removal; and,
- Fourth Street railroad grade crossing improvement.

Short-Range Program

- Parking removal;
- Upgrade signal installations; and,
- Computer control system.

Long-Range Program

- Widening and channelization of First Avenue

Program Costs

Recommendations contained in the immediate action program will be accomplished by personnel of the Traffic Engineering Department. Estimated cost to implement the upgrading of traffic signal operations is $140,604.

Short and long-range recommendations to upgrade signal displays and obsolete equipment replacement on First Avenue are

estimated to cost $409,164. The areawide computer control system is estimated to cost $730,000. Cost associated with removal of parking on First Avenue is not assigned a cost, and would be a maintenance responsibility of the Traffic Engineering Department.

Cost of the proposed widening and channelization of First Avenue through the entire study section (excluding signal improvements) is estimated to be $5,561,300.

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INTRODUCTION

Cedar Rapids is located in east central Iowa and is the second largest city in the state. Its population in 1970 was 110,642, representing a 20 per cent increase between 1960 and 1970. The Cedar Rapids-Marion Metropolitan Area, which has one of the highest growth rates in the State, is expected to have a population of 195,300 by the year 1995, an increase of 42 per cent in 25 years.(1) This urban growth has been accompanied by corresponding increases in motor vehicle travel on a street system which was not designed to accommodate present-day traffic.

First Avenue

As a result of the pattern of urban development, physical constraints, and the configuration of the arterial street system, much of the east-west traffic movement in the city is carried by First Avenue. There are no existing alternate routes for this east-west movement. Consequently, First Avenue is experiencing traffic operational problems as a result of the high traffic demand and fixed capacity. These problems are characterized by

(1) Preliminary Report, 1995 Major Street Plan of the 1995 Transportation Plan, Linn County Regional Planning Commission, 1975.

significant travel delays, frequent stopping, and relatively high accident incidence.

First Avenue will continue in the future to function as a principal arterial route through the City of Cedar Rapids. The Linn County Regional Transportation Plan for 1995 includes First Avenue, giving it a classification of major arterial.

Study Objectives

Objectives of the First Avenue Study are to evaluate First Avenue traffic operations and safety and to develop a recommended implementation program for roadway and traffic control system improvements. The recommended program is to include immediate action improvements, short-range (2-5 year) improvements, and long-range (5+ years) improvements.

Study Area

The study section is approximately 6.9 miles long and extends from the intersection of First Avenue and Collins Road to the intersection of First Avenue and Williams Boulevard and continues along Williams Boulevard to its intersection with 16th Avenue. In this report, general reference to First Avenue includes that portion of Williams Boulevard in the study area.

EXISTING CONDITIONS

Information on the existing physical and operational characteristics of First Avenue was assembled from files of the Traffic Engineering Department, field observations, and from data collected by the Consultant. This chapter of the report summarizes pertinent information relating to existing physical and operational conditions on First Avenue, including: street widths, rights-of-way, traffic volumes, accident experience, traffic signals, and other traffic operational characteristics.

Right-of-Way and Street Width

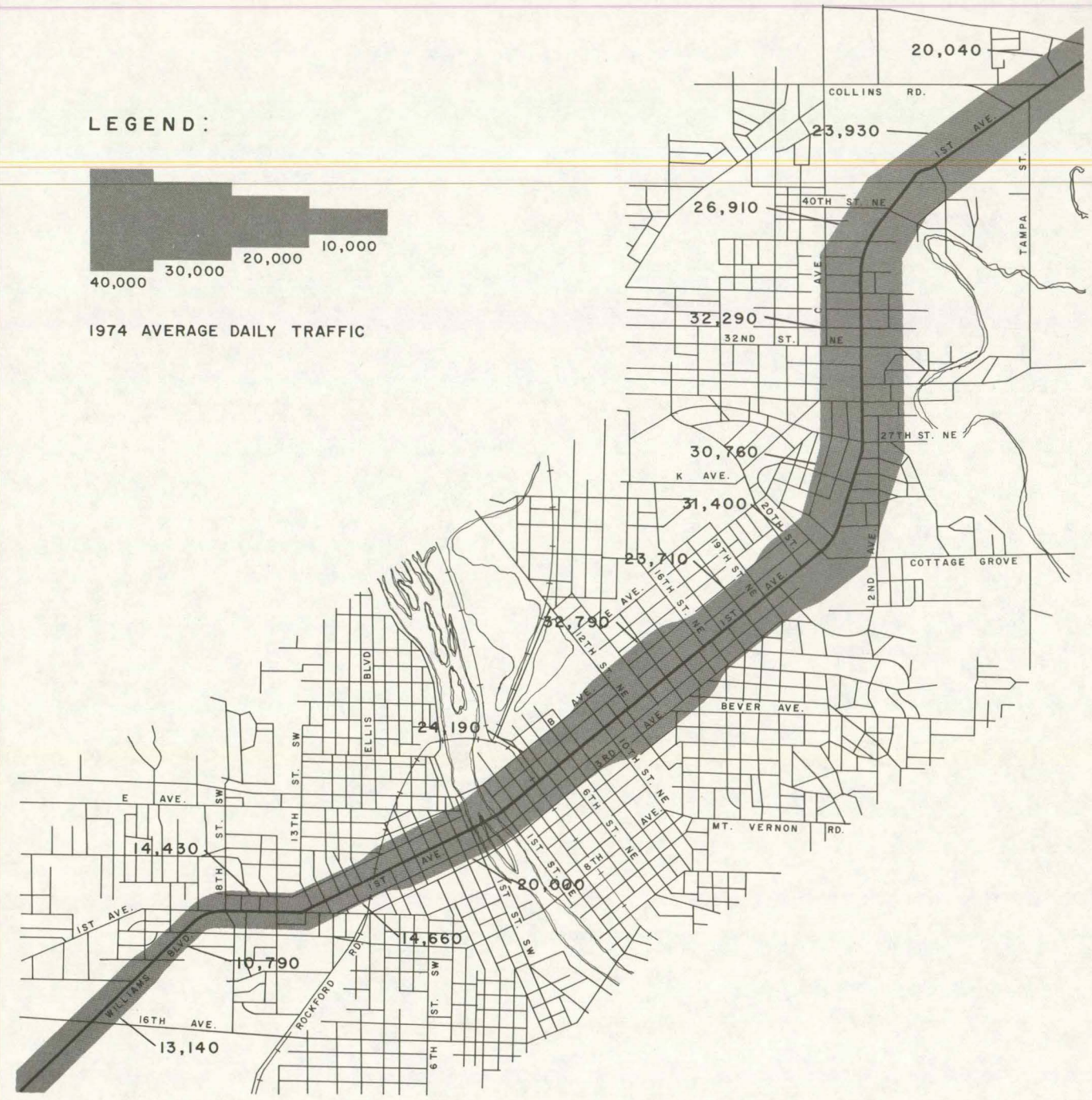
The City of Cedar Rapids is fortunate that First Avenue was developed with a relatively wide right-of-way. This right-of-way provides the opportunity for future widening of the facility without the disruption and cost of acquiring additional right-of-way. A right-of-way width of 120 feet exists on First Avenue from the northeast city limits to 13th Street W, a distance of approximately 5.7 miles. Between 13th Street W

and 18th Street W (0.4 miles), the right-of-way varies between 66 feet and 80 feet. Williams Boulevard from 18th Street W to 16th Avenue has a right-of-way of 100 feet and is approximately 0.8 miles in length.

Street widths vary in the study section although First Avenue operates as a four-lane arterial street along its entire length. First Avenue street width is 48 feet from 16th Avenue to 13th Street W, increasing to a width of 64 feet from 13th Street W to First Street W. Street width from First Street W to 4th Street E is 80 feet narrowing between 4th Street E and Thompson Drive to approximately 70-73 feet. The remaining portion of First Avenue between Thompson Drive and Collins Road has a street width varying between 57 feet and 66 feet. Exclusive left-turn lanes using painted treatments are provided at most signalized intersections between 13th Street W and Collins Road.

Traffic Demand

A graphic representation of average daily traffic volume on First Avenue is presented in Figure 1. Average daily traffic between 16th Avenue and 6th Street W ranges between 13,000 and 15,000 vehicles per day, with volumes of approximately 25,000 vehicles per day through the Central Business District. Traffic



TRAFFIC VOLUME FLOW MAP

FIRST AVENUE STUDY

CEDAR RAPIDS, IOWA

N

SCALE

0 0.50 1

MILES

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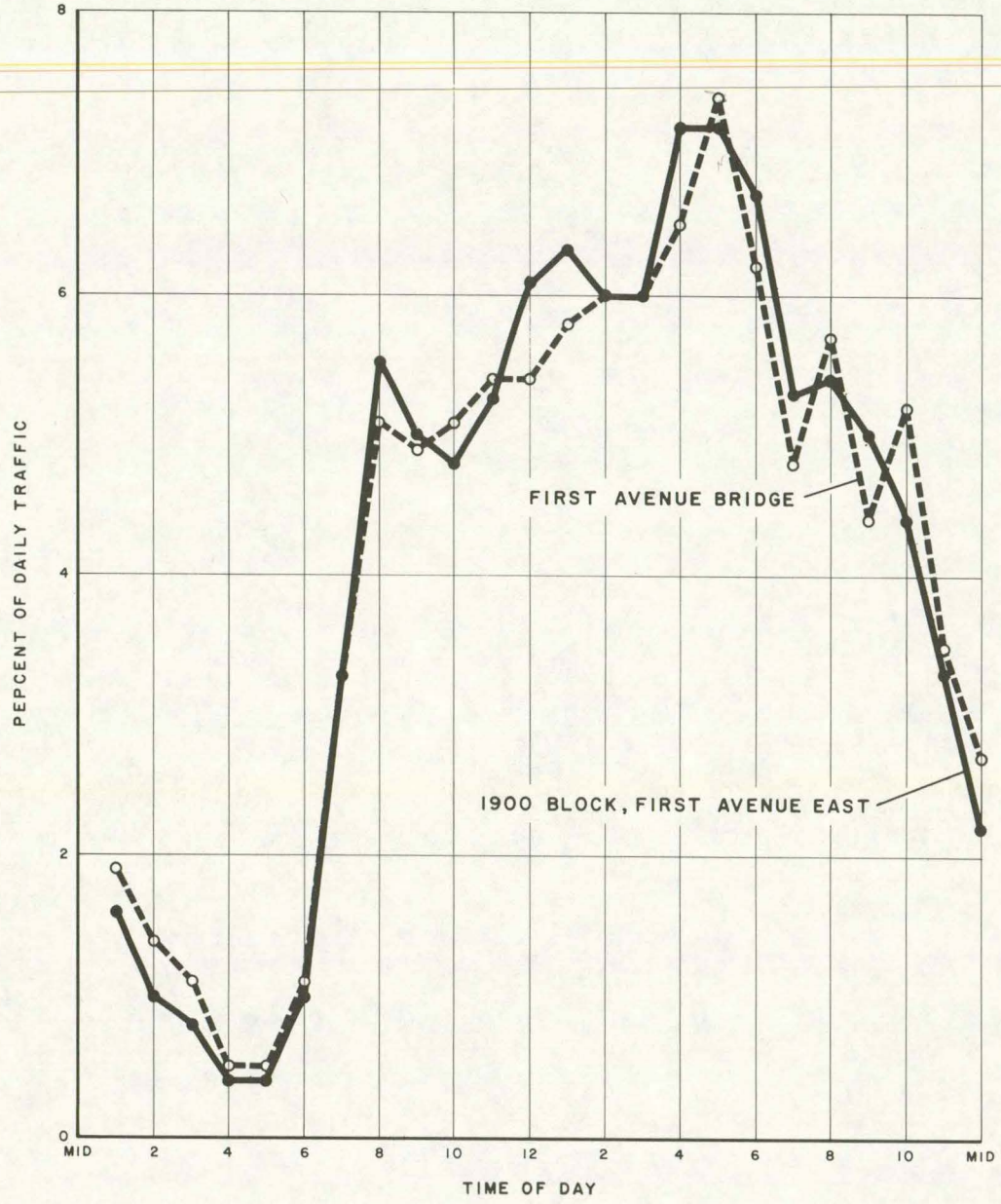
FIGURE 1

volume increases to about 33,000 vehicles per day between 10th Street E and 13th Street E, decreasing to 25,000 between 13th Street E and 19th Street E. Traffic volumes through most of the remainder of First Avenue to the northeast are between 27,000 and 32,000 vehicles per day. Since these traffic volumes represent annual average daily traffic, actual volumes on a given weekday may vary by 10 to 15 per cent from the average daily traffic. Thus, weekday volumes as high as 37,000 vehicles may be experienced.

Traffic Characteristics

Hourly distribution of traffic for two locations on First Avenue are shown in Figure 2. It can be seen that a relatively continuous high level of demand exists on First Avenue between 7:00 A.M. and 8:00 P.M., with volume peaking during the 4:00 P.M. to 6:00 P.M. time interval. The peak hour of traffic movement generally occurs between 4:30 P.M. and 5:30 P.M. The two locations presented in this figure (First Avenue at the Cedar River Bridge and in the 1900 Block East) exhibit quite similar peaking characteristics which are representative of the entire facility.



HOURLY DISTRIBUTION OF TRAFFIC

FIRST AVENUE STUDY

CEDAR RAPIDS, IOWA

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FIGURE 2

Atypical of traffic variations found in many cities, the morning peak hour is not comparable in magnitude to the evening peak with traffic demand demonstrating a gradual increase from morning to evening. Also absent is the pronounced midday peak frequently created by lunch-bound trips.

Directional distribution of traffic is an important traffic characteristic, particularly as related to the progressive timing of a traffic signal system. Directional distribution of traffic for selected locations along First Avenue for three periods (morning peak, midday, and evening peak) of the day are shown in Table 1.

Traffic on First Avenue west of First Street W is predominately eastbound in the morning peak and westbound in the evening peak. The remainder of First Avenue is predominately westbound in the morning peak and eastbound during the evening peak. Midday traffic is generally bi-directional with variations from point-to-point along First Avenue. It is interesting to note that the directional distribution during peak periods, does not display a highly directional flow (i.e. 65 per cent - 35 per cent) often found on radial arterial streets.

Table 1

DIRECTIONAL DISTRIBUTION OF TRAFFIC
AT SELECTED LOCATIONS ON FIRST AVENUE

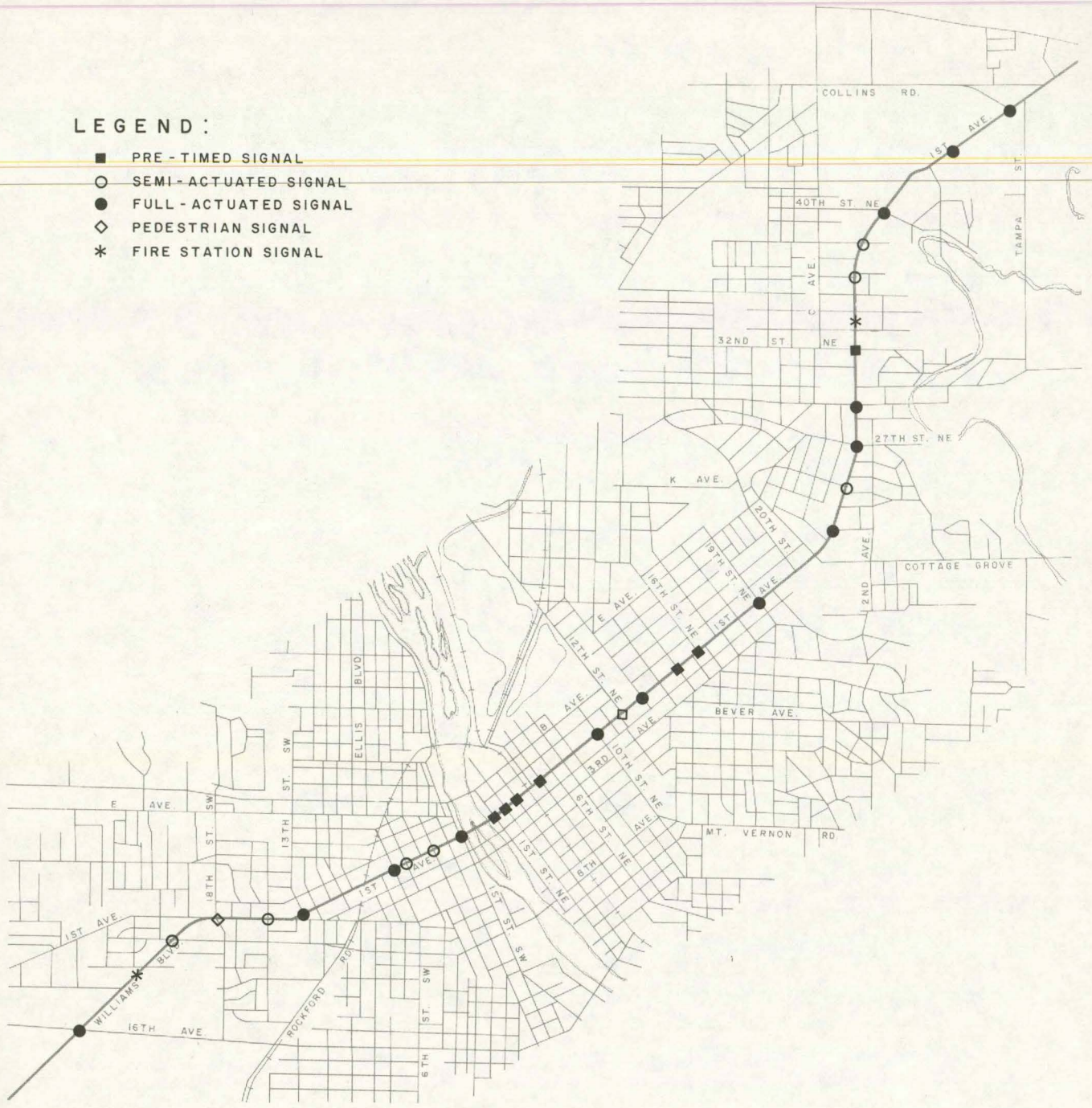
LOCATION	7:00 A.M. - 8:00 A.M. PER CENT OF TRAFFIC		2:00 P.M. - 3:00 P.M. PER CENT OF TRAFFIC		5:00 P.M. - 6:00 P.M. PER CENT OF TRAFFIC	
	Eastbound	Westbound	Eastbound	Westbound	Eastbound	Westbound
E of 16th Avenue	55	45	50	50	44	56
W of 6th St. W	53	47	46	54	36	64
W of 1st St. W	56	44	47	53	47	53
1st Ave. Bridge	43	57	50	50	54	46
E of 5th St. E	43	57	45	55	54	46
E of 10th St. E	42	58	50	50	57	43
E of 21st St. E	39	61	47	53	58	42
N of 32nd St. E	45	55	48	52	54	46
N of 40th St. E	45	55	60	40	59	41
E of Lindale Plaza	36	64	50	50	66	34
E of Collins Rd.	37	63	52	48	62	38

While the facility cannot be described as exhibiting highly directional flow characteristics when viewed on an overall basis, volume reversals near its extremities are of a magnitude to necessitate careful consideration if effective progressive signal timing is to be achieved. In view of First Avenue's position as the primary east-west thoroughfare for Cedar Rapids, it is quite likely that the distribution of trip length and trip purpose varies considerably more than overall volumes indicate. During morning and evening peak periods, longer work-oriented trips can be expected to predominate with shorter trips and circulating traffic contributing more to midday traffic.

Traffic Control

Traffic signals are one of the most significant features of an urban arterial system, particularly as they relate to traffic operations and roadway capacity. There are 31 traffic-control signals in the study area, including two pedestrian signals (which do not control side-street traffic) and two emergency vehicle signals at fire stations. Location and identification of traffic signals are shown in Figure 3.

As is typical with most signal systems which evolve over a long period of time, signals along First Avenue contain



LOCATION OF TRAFFIC SIGNALS

FIRST AVENUE STUDY

CEDAR RAPIDS, IOWA

SCALE
0 0.50 1
MILES

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FIGURE 3

a mixture of control equipment, operational types, and display configurations. First Avenue contains 7 pre-timed signals, 7 semi-actuated signals, 13 full-actuated signals, 2 pedestrian signals and 2 emergency vehicle signals. Information for each signal installation is summarized in Table 2.

Signals on First Avenue between 13th Street W and 40th Street E operate as an interconnected signal system, which in turn is interconnected with the Central Business District signals. The system is capable of providing coordinated operation offering three offsets per cycle. Selection of timing programs is made on a time-of-day basis according to the schedule shown in Table 3. On Sundays the evening peak dial is not activated. The system operates on a 70-second cycle with the exception of the evening peak period (3:22 P.M.-6:00 P.M.), when a 90-second cycle is used.

Coordination of semi and full vehicle-actuated controllers within a background cycle is provided by establishing a permissive yield period during which each controller's primary (artery) phase can transfer to other phases having demand. As indicated in Table 3, a variety of control equipment is utilized with a trend in recent years to install modern, multiphase controllers. In general, loop detectors are used as

Table 2

SIGNAL INSTALLATIONS ON FIRST AVENUE

LOCATION	SIGNAL MOUNTING	INSTALLATION DATE	CONTROLLER TYPE	NUMBER PHASES	CYCLE LENGTH (Seconds)
16th Avenue	Bridge	1969	ET-600	6	120
Fire Station #8	Pedestal	1960	Micro-flex	2	180
8th Avenue	Pedestal	1950	ET-300	2	70
18th Street W	Pedestal	1950	EA-School	2	50
15th Street W	Span & Side	1958	ET-300	3	90
13th Street W	Mast arm	1972	ET-600	6	70-90
6th Street W	Mast arm	1974	DP-900	6	70-90
5th Street W	Pedestal	1958	ET-300	2	70-90
3rd Street W	Pedestal	1955	ETS-217	2	70-90
1st Street W	Mast arm	1972	DP-900	8	90-120
1st Street E	Mast arm	1974	EF-70	3	70-90
2nd Street E	Mast arm	1974	EF-70	3	70-90
3rd Street E	Pedestal	1958	EF 20	3	70-90
5th Street E	Pedestal	1958	EF-20	3	70-90
10th Street E	Mast arm	1972	DP-900	6	70-90
12th Street E	Span & Side	Unk.	EA-School	2	50
13th Street E	Mast arm	1971	ET-600	4	70-90

Table 2

SIGNAL INSTALLATIONS ON FIRST AVENUE
(Continued)

LOCATION	SIGNAL MOUNTING	INSTALLATION DATE	CONTROLLER TYPE	NUMBER PHASES	CYCLE LENGTH (Seconds)
15th Street E	Pedestal	1957	EF-20	2	70-90
16th Street E	Pedestal	1957	EF-20	2	70-90
19th Street E	Mast arm	1971	ET-600	4	70-90
Thompson Drive	Span & Side	1957	ET-300	3	70-90
24th Street E	Pedestal	1951	ET-217	2	70-90
27th Street E	Pedestal	1960	ET-445	3	70-90
29th Street E	Pedestal	1975	EF-20	6	70-90
32nd Street E	Pedestal	1956	EF-20	3	70-90
Fire Station #7	Pedestal	1960	Micro-flex	2	180
36th Street E	Span & Side	1958	ET-300	3	70-90
38th Street E	Span & Side	1959	ETS-217	3	70-90
40th Street E	Span	1968	ET-150	3	70-90
Lindale Plaza	Mast arm	1958	ET-300	4	70-90
Collins Road	Mast arm	1968	ET-600	6	70-90

Table 3

SIGNAL SYSTEM OPERATION SCHEDULE

DIAL	RESET	OPERATION PERIOD	CYCLE LENGTH
1	2	9:30 PM - 5:35 AM	70 Sec.
2	1	5:35 AM - 3:22 PM	70
3	1	3:22 PM - 6:00 PM	90
2	1	6:00 PM - 9:30 PM	70

sensing devices with long loops used in a demand mode of control for left-turn lanes and short loops with volume-density functions used for artery control.

Accident Experience

Accident records for the last five years are presented for intersection accidents in Table 4 and for non-intersection accidents in Table 5. Total accidents occurring in the study area has been relatively stable over the five-year period with a high of 927 accidents in 1970 and a low of 853 accidents in 1971. Total accidents in the study area in 1972, 1973, and 1974 were 914, 891 and 914 respectively.

Curb Usage

Usage of street space along the curb for parking and loading is prohibited over a significant portion of First Avenue. Parallel parking is permitted generally from 12th Street W to 18th Street E. Recessed parking (using curb set-backs) is permitted between 29th Street E and 33rd Street E.

Pedestrian Provisions

Pedestrian signals are provided at most signalized intersections on First Avenue, with several locations providing pedestrian pushbuttons to activate pedestrian crossing signal

Table 4

INTERSECTION ACCIDENT FREQUENCY
Williams Blvd. and First Avenue

INTERSECTING STREET	ACCIDENTS BY YEAR				
	1970	1971	1972	1973	1974
16th Avenue	25	28	21	25	35
12th Avenue	2	4	2	4	2
10th Avenue	2	3	6	2	3
8th Avenue	4	5	8	7	8
18th St. W	4	8	7	4	3
17th St. W	2	0	0	0	2
16th St. W	0	0	1	0	1
15th St. W	14	13	7	8	8
14th St. W	3	0	2	2	2
3rd Ave & 13th St. W	9	7	11	8	6
12th St. W	1	0	2	2	3
11th St. W	4	1	3	7	5
10th St. W	14	5	5	6	5
9th St. W	4	6	9	0	3
7th St. W	1	3	6	2	3
6th St. W	20	12	16	21	11
5th St. W	20	21	9	10	16
4th St. W	3	3	1	3	5
3rd St. W	21	8	26	24	8
2nd St. W	14	6	13	12	10
1st St. W	33	23	25	16	18
1st St. E	19	26	15	18	28
2nd St. E	31	8	10	11	18

Table 4

INTERSECTION ACCIDENT FREQUENCY
Williams Blvd. and First Avenue
(Continued)

INTERSECTING STREET	ACCIDENTS BY YEAR				
	1970	1971	1972	1973	1974
3rd St. E	16	18	25	23	22
5th St. E	51	14	6	13	16
6th St. E	4	4	2	5	8
7th St. E	3	4	3	6	4
8th St. E	9	3	3	5	4
10th St. E	31	17	25	22	24
11th St. E	3	10	13	3	6
12th St. E	17	9	10	7	13
13th St. E	26	25	26	20	16
14th St. E	2	5	3	7	9
15th St. E	18	25	25	17	24
16th St. E & Park Court	24	22	20	28	24
17th St. E	4	4	4	5	11
18th St. E	3	4	3	3	5
19th St. E	35	27	28	20	18
Cresent St.	4	2	1	2	0
21st St. E & Cottage Grove	6	10	7	10	5
22nd St. E	2	4	4	3	3
Thompson Dr.	8	5	4	7	8
23rd St. E	0	1	2	4	4
24th St. E	11	17	8	23	18
25th St. E	0	1	1	1	1
26th St. E	2	0	2	0	0

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Table 4

INTERSECTION ACCIDENT FREQUENCY
Williams Blvd. and First Avenue
(Continued)

INTERSECTING STREET	ACCIDENTS BY YEAR				
	1970	1971	1972	1973	1974
27th St. E	12	18	16	19	13
28th St. E	5	4	4	3	2
29th St. E	20	21	20	24	20
30th St. E	3	2	6	4	4
31st St. E	4	2	2	3	5
32nd St. E	24	16	23	20	16
33rd St. E	8	7	6	7	4
34th St. E	3	2	5	7	3
35th St. E	5	6	8	4	5
36th St. E	12	7	7	6	11
37th St. E	0	1	0	0	2
38th St. E	8	11	14	13	14
Dawley St.	1	0	0	2	0
Kenmore St.	4	2	2	1	0
40th St. E	10	13	9	16	14
Glennbrook Dr.	3	0	1	0	0
Lindale Plaza	21	12	26	31	30
Collins Rd.	10	4	5	7	7
TOTALS	628	549	584	593	596

Table 5

NON-INTERSECTION ACCIDENT FREQUENCY
Williams Blvd. and First Avenue

BLOCK	ACCIDENTS BY YEAR 1970	1971	1972	1973	1974
Williams Blvd.					
2500-2600	0	5	8	7	13
2200-2400	1	2	3	2	6
2100	1	2	1	0	1
1800-2000	2	1	2	3	4
First Avenue West					
1700	0	1	2	2	0
1600	1	1	0	0	1
1500	3	1	1	1	2
1400	0	0	1	5	1
1300	3	3	3	3	3
1200	3	6	4	2	1
1100	3	7	2	3	4
1000	2	2	3	2	1
900	6	5	4	5	2
800	3	2	3	2	3
700	3	6	5	5	8
600	2	1	1	6	1
500	7	2	6	6	1
400	2	2	3	1	2
300	0	1	5	1	2
200	5	4	6	3	0
100	10	7	7	7	6
Bridge	27	18	20	15	12
First Avenue East					
100	9	2	5	7	9
200	6	2	4	7	7
300	4	4	5	8	17
400	9	3	6	3	8
500	2	6	2	5	6
600	3	5	3	3	0
700	4	1	1	1	0
800-900	8	8	14	7	16
1000	4	6	3	5	4

Table 5

NON-INTERSECTION ACCIDENT FREQUENCY
Williams Blvd. and First Avenue
(Continued)

BLOCK	ACCIDENTS BY YEAR 1970	1971	1972	1973	1974
First Avenue East					
1100	2	5	3	3	2
1200	22	13	12	14	11
1300	8	11	10	10	9
1400	7	11	14	11	6
1500	9	13	16	10	10
1600	3	2	3	6	5
1700	2	6	4	2	7
1800	5	3	7	6	3
1900	13	19	12	7	10
2000	1	3	0	3	4
2100	2	1	3	0	3
2200	5	9	4	5	4
2300	1	1	0	1	1
2400	0	1	1	4	2
2500	1	1	3	3	1
2600	4	1	4	1	1
2700	3	4	6	10	8
2800	6	2	1	3	2
2900	6	7	10	9	4
3000	2	2	2	4	4
3100	5	5	5	6	4
3200	5	4	12	6	7
3300	10	6	5	9	9
3400	1	2	3	1	1
3500	4	4	3	3	2
3600	6	3	2	2	1
3700	1	4	2	3	5
3800	8	4	10	4	8
3900	9	7	14	6	8
4000	1	16	5	3	11
4100	0	0	0	0	2
4200	4	2	3	6	3
4300	0	1	1	0	4
4400	4	9	12	6	3

Table 5

NON-INTERSECTION ACCIDENT FREQUENCY
Williams Blvd. and First Avenue
(Continued)

BLOCK	ACCIDENTS BY YEAR				
	1970	1971	1972	1973	1974
First Avenue East					
4500	1	0	1	0	4
4600	1	2	1	1	3
4700	0	0	0	0	0
4800	3	2	0	1	2
4900	0	1	1	0	1
5000	1	1	2	2	2
TOTALS	299	304	330	298	318

intervals. Pedestrian signals are provided on First Avenue at all signalized intersections in the Central Business District. Two signal installations are established solely for pedestrian crossings. These are located at 18th Street W and at 12th Street E..

There are 11 designated school crossings at signalized locations on First Avenue, which serve students attending schools in the First Avenue Corridor. A number of schools are located within several blocks of First Avenue, with one parochial school (St. Matthews) located on First Avenue. Pedestrian counts were made at designated school crossings during the normal school crossing periods, and are shown in Table 6. School pedestrian movement during the school crossing periods ranges from 13 at 15th Street W to 70 at Thompson Drive.

Railroad Grade Crossings

At-grade crossings of railroads on arterial streets often create operational and safety problems. On First Avenue there are two at-grade railroad crossings--at 4th Street E and between 7th Street W and 9th Street W. Both crossings involve multiple tracks, with train movements consisting entirely of low speed switching operations. Both crossings provide motorist protection with automatic flashing signals.

Table 6

PEDESTRIANS CROSSING FIRST AVENUE
AT SCHOOL CROSSINGS

LOCATION	PEDESTRIAN CROSSING 8:15 A.M.-9:00 A.M.	3:14 P.M.-4:00 P.M.
8th Avenue	15	20
18th Street W	20	30
15th Street W	23	23
13th Street W	68	68
5th Street W	25	25
15th Street E	13	13
19th Street E	32	48
Thompson Drive	60	70
24th Street E	23	23
27th Street E	45	45
36th Street E	28	28

The Cedar Rapids Traffic Engineering Department has conducted several detailed studies of the 4th Street E crossing. Because of the high number of train movements, this crossing has a significant impact on First Avenue operations. The crossing, which consists of three tracks, has sixty train movements on weekdays between 6:00 A.M. and 6:00 P.M. However, the average length of time First Avenue is blocked by these train movements is one minute, with a range of blockages from 3 seconds to 7 minutes and 28 seconds. As a result of these studies, City Council enacted an ordinance which prohibits movements across First Street between 3:30 P.M. and 5:30 P.M.

The at-grade crossing between 7th Street W and 9th Street W consists of five tracks with an average of 12 train crossings per day. Of these crossing movements, half are "engine only" movements. Other train movements may contain up to 30 cars.

ANALYSIS AND FINDINGS

Existing physical and operational characteristics of First Avenue are analyzed in this chapter in order to define deficiencies and identify improvement opportunities. These include analysis of available data from the City, data obtained by the consultant, and field observations. Discussions of particular analyses and findings are presented.

Volume Capacity Relationships

First Avenue is a four-lane facility with separate left-turn lanes provided at most signalized intersections. Existing capacity of the roadway at Level-of-Service C (design condition) is 25,000-27,000 vehicles per day. However, average daily traffic now exceeds this capacity over much of its length. With seasonal and daily fluctuations in traffic, daily traffic volumes may reach as high as 37,000 vehicles per day on First Avenue.

Intersection volume-capacity analyses were made for all signalized intersections on First Avenue. These analyses

indicate that a number of locations experience traffic demand in excess of capacity during peak periods. For intersections controlled by vehicle-actuated signal controllers, capacity analyses were made assuming the maximum green time established for each actuated phase with no attempt was made to re-allocate any unused minor street green times to the artery movement. Locations and approaches having evening peak hour volume-capacity ratios in excess of 1.0, referenced to Level-of-Service C, are presented in Table 7.

One point of substantial significance can be drawn from this table; capacity deficient approaches on First Avenue are generally not accompanied by capacity deficient approaches on the cross streets. However, by its nature, capacity calculation does not reflect unique operational conditions, such as offset intersections. There are a number of poorly aligned intersections which have unique operational conditions which would effectively have actual capacities less than those calculated.

There is an indication that generally the signal timing is allotting more time to the side streets, in proportion to their demand, than to First Avenue. While actuated minor street movements can be anticipated to return unused green

Table 7

CAPACITY DEFICIENT APPROACHES
ON FIRST AVENUE EVENING PEAK
(Level-of-Service C)

CROSS STREET	FIRST AVENUE APPROACHES		SIDE STREET APPROACHES	
	East	West	South	North
16th Avenue	x			
13th Street W			x	
1st Street W	x		x	x
1st Street E			x	
3rd Street E		x		
5th Street E	x	x		
10th Street E		x		
13th Street E		x		
19th Street E	x			
27th Street E		x		
29th Street E				x
38th Street E		x		x
Lindale Plaza		x		
Collins Road		x	x	

time to the main street, if continuous demand is not present, the return to main street green before its scheduled offset point will result in the early release of vehicles from the intersection with the resultant increased probability of stops and delay at downstream intersections. This results in a disparity between true progression and programmed progression along First Avenue.

From the Consultant's field observation, it was found that consecutive trips during both light and heavy traffic flow periods indicated inconsistent stopping patterns. This is believed to be the result of varying time of return of the green signal indication to First Avenue.

Future Traffic Demand

Future traffic demand on First Avenue and the role it will play in the total urban transportation network are key factors in the development of long-range recommendations for the facility. There are three previous studies which developed future traffic projections for First Avenue.(1)(2)(3)

The 1990 Transportation Plan included a combination freeway and high type arterial facility to parallel First Avenue.

(1) 1990 Transportation Plan, Cedar Rapids-Marion, Iowa Metropolitan Area, Linn County Regional Planning Commission, Howard, Needles, Tammen and Bergendoff, 1970.
(2) NE-SW Corridor Location Study Report, Howard, Needles, Tammen, and Bergendoff, for the Iowa State Highway Commission, 1972.
(3) Preliminary Report, 1995 Major Street Plan of the 1995 Transportation Plan, Linn County Regional Planning Commission, 1975.

Projected 1990 traffic volumes on this facility ranged between 12,600 vehicles-per-day (vpd) and 42,700 vpd. These projected volumes are in addition to traffic assigned to First Avenue, which were as high as 10,000 vpd. Considering the entire corridor, including First Avenue and the proposed freeway, traffic demand was as high as 51,700 vpd. The subsequent corridor study of the NE-SW corridor investigated the locational alternatives for a facility parallel to First Avenue to accommodate projected future traffic. The proposed facility met with considerable opposition from the community and has been deleted from the area's transportation plan.

A revised transportation network was developed, which removed the proposed freeway paralleling First Avenue and indicated the improvement of First Avenue to a six-lane facility. The Preliminary 1995 Report provides projections of future traffic on First Avenue without the parallel facility, and indicates 1995 volumes as high as 33,000 vpd. In view of existing traffic volume and corridor projections of the 1990 Plan, these traffic projections for 1995 may be conservative.

Travel Speeds and Delays

Field observations made by the Consultant have identified few instances of congestion between intersections

and have shown that travel speeds approximating the speed limit can be anticipated during both peak and off-peak periods. Stops at intersections appear to be relatively frequent and also appear to be somewhat independent of traffic flow volumes.

Data gathered by Cedar Rapids Traffic Engineering Department to identify the frequency of stopping at signalized intersections and the delay created by stops is presented in Figure 4. This figure summarizes the results of 10 trips made over the entire study section during the afternoon peak period and indicates the total number of stops in each travel direction and the average delay per stop, for each location. In summary, this data shows that a vehicle traveling east on First Avenue can anticipate about 12 stops and experience a total delay of about 5.7 minutes. Traveling west during the afternoon peak, approximately 11 stops and an accumulated delay of 4.3 minutes are expected.

If no stops or delays were encountered, traveling eastbound on the 6.9 miles of First Avenue under investigation at an average speed of 30 miles per hour would require 13.8 minutes. The 5.7 additional minutes caused by stops and delays will increase the travel time to 19.5 minutes resulting in an average travel speed of 21.6 miles per hour. In different

VEHICLE STOPS AND DELAYS

FIRST AVENUE STUDY

CEDAR RAPIDS, IOWA

Wilbur Smith and Associates

FIGURE 4

terms, stops and delays contribute to nearly one third of the travel time on this section of First Avenue. Westbound travel, including stops and delays would reduce effective travel speed to about 23 miles per hour. While the delays used in this computation were derived from the field studies, the average speed of 30 miles per hour was assumed. The actual effective travel speeds derived from the study indicated 21 miles per hour westbound and 19 miles per hour eastbound, with 25 per cent of the travel time being attributed to stops and resulting delay.

One particularly significant finding emerges from the comparison of intersection approaches having capacity deficiencies (Table 7) with locations having high delays and stopping incidents. Referring first to eastbound intersection approaches, it is evident that a significant number of approaches have a high number of stops and/or delays at locations which do not have capacity deficiencies. Also, capacity deficient approaches are not necessarily accompanied by high stopping frequency and delays. Comparison of corresponding westbound data presents similar results.

It is apparent that stops and delays at a significant number of locations are more a function of progressive timing deficiencies than capacity deficiencies. It appears that

opportunities for stops and delay improvement through timing changes are available. It should be recognized that all travel delay for traffic on First Avenue cannot be eliminated because attainment of perfect progression is constrained by such factors as intersection spacing and the need to provide minimum green intervals in timing traffic signals.

Accident Analysis

A compilation of intersection accident rates (expressed as accidents per million entering vehicles) is shown in Table 8. In all cases, the higher accident rates and total number of accidents occur at signalized intersections, with the intersection of Williams Boulevard and 16th Avenue having both the highest number of accidents and the highest rate.

Locations with high accident rates were studied in detail to determine possible countermeasures to improve the accident experience. Collision diagrams for the years 1973 and 1974 were developed for high-accident locations from individual accident reports.

This accident analysis focused primarily upon low or non-capital intensive measures which could be achieved as immediate-action improvements, since a significant recommenda-

Table 8

INTERSECTION ACCIDENT RATES - 1974

CROSS STREET	NUMBER OF ACCIDENTS	EXPOSURE (MEV) (1)	RATE (ACC/MEV)
16th Avenue	35	10.13	3.46
8th Avenue	8	4.98	1.61
18th Street W	3	6.19	0.48
15th Street W	8	8.28	0.97
13th Street W	6	6.95	0.86
6th Street W	11	8.77	1.25
5th Street W	16	7.96	2.01
3rd Street W	8	8.64	0.93
2nd Street W	10	8.79	1.14
1st Street W	18	12.48	1.44
1st Street E	28	11.56	2.42
2nd Street E	18	10.76	1.67
3rd Street E	22	11.24	1.96
5th Street E	16	10.80	1.48
6th Street E	8	9.90	0.81
7th Street E	4	9.21	0.43
8th Street E	4	9.14	0.44
10th Street E	24	14.30	1.68
12th Street E	13	12.29	1.06
13th Street E	16	13.02	1.23
15th Street E	24	10.73	2.24
16th Street E	24	9.81	2.45
19th Street E	18	12.55	1.43
Cottage Grove	5	11.99	0.42
Thompson Drive	8	11.33	0.71
24th Street E	18	11.31	1.59
27th Street E	13	13.14	0.99
29th Street E	20	10.80	1.85
32nd Street E	16	12.65	1.26
36th Street E	11	11.32	0.97
38th Street E	14	10.36	1.35
40th Street E	14	9.44	1.48
Lindale Plaza	30	10.55	2.84
Collins Road	7	8.26	0.85

(1) MEV - Million Entering Vehicles Per Year

tion of this study is a widening of First Avenue to a high-type six-lane facility. The widening project, coupled with upgraded signal displays at many locations, will significantly reduce accident experience at both intersection and non-intersection locations.

Recently improved locations and programmed improvements were considered in evaluating high-accident locations and developing recommendations. Specific high-accident locations are discussed in following sections, with the recommendations resulting from the analysis.

Williams Boulevard and 16th Avenue - This intersection experienced 60 accidents during 1973-1974, and had the highest accident rate of any intersection in the study area. Of these accidents, 41 were rear-end accidents. This high frequency of rear-end accidents may be partially attributed to the relatively high approach speeds, where the posted speed limit is 35 miles per hour on the north and east approaches and 45 miles per hour on the west and south approaches. Fifteen rear-end accidents occurred in the right-turning roadway for southbound traffic. This roadway is controlled by a yield sign. The other three right-turning roadways at the intersection had a total of one accident.

Indicated improvement needs at this intersection are provisions of separate left turn lanes for Williams Boulevard to provide for heavy southbound left turns, and provision of an acceleration lane in conjunction with the southbound right-turning roadway. Speed zoning on the south and west approaches should be studied to determine if lower speed zones should be employed.

First Avenue and Lindale Plaza - This intersection is located at private roadways which serve two shopping centers, Lindale Plaza north of First Avenue and Executive Plaza to the south. These roadways provide the major access to these two centers, with most of the traffic using the roadways interchanging with First Avenue. The principal interchange movement is between the west (First Avenue) and north (Lindale Plaza).

During the 1973-1974 period, 59 accidents occurred at this intersection. It is significant that 20 accidents involved left-turning vehicles colliding with through-moving vehicles on First Avenue. Left turns from First Avenue are accommodated by an exclusive left-turn interval and a permissive green interval. It is assumed that most of these left-turning accidents occurred during the permissive period when on-coming traffic also moves.

To improve accident experience, the signal should be rephased to eliminate the conflict between left-turning vehicles and opposing traffic on First Avenue. The rephasing should eliminate the permissive left-turning movement (turning on circular green indication) on First Avenue, requiring these turns to be made on an exclusive left-turn phase. This left-turn phase would be coupled with a phase overlap for the right-turn from the north. Through traffic on First Avenue would move on the second phase, while side street movement from the shopping centers would be handled on the third phase.

First Avenue and 16th Street E - This location is problematic primarily because of the physical configuration of the intersection. Sixteenth Street and its continuation to the south (Park Court) are offset at First Avenue by 130 feet. This creates a large intersection area with unusual traffic conflicts. During 1973-1974 there were 48 collisions at this location, of which more than half were rear-end collisions on First Avenue. Signal displays at this intersection are side mounted and do not meet existing City standards for overhead displays. In addition, the required minimum of two signal indications per approach is not satisfied on the 16th Street and Park Court approaches.

A long-range recommendation of this study is the widening of First Avenue with the elimination of this traffic signal and the continuation of the barrier median through the intersection. To improve accident experience at this intersection, the signal installation should be removed (rather than upgraded) and a painted median (or other suitable treatment) be used to effectively close cross movement at the intersection. No left-turn movements would be allowed on First Avenue and only right turns allowed for 16th Street and Park Court traffic. This should not create undue hardships to traffic, since the intersection is in a grid system and other routes are available to make the eliminated movements.

First Avenue and 24th Street - Review of accident experience at this intersection indicates one predominate accident type: rear-end accidents on First Avenue. Of the 39 accidents occurring in 1973-1974, 29 accidents were rear-end accidents on First Avenue approaches to the intersection. This intersection is controlled by a semi-actuated controller. Pedestrian pushbuttons are also provided for pedestrian actuation, since this intersection is also a school crossing for St. Matthews School.

The traffic signal does not meet minimum traffic warrants and its primary function is to serve pedestrian needs. The signal should be removed since it is not warranted, and pedestrian needs provided for by installation of a midblock pedestrian signal.

Curb Parking

Parallel parking is permitted generally from 12th Street W to 18th Street E. Parking is permitted between 29th Street E and 33rd Street E with parking recessed. Curb parking often has an effect on traffic operations and safety, particularly on high volume facilities. This effect is a function of "exposure"; that is, with higher traffic volumes ahd higher parking turnover, the effect of parking on traffic operations and safety become more significant. The presence of a parked vehicle itself creates a fixed object which may be involved in a collision.

The influence of curb parking is also related to the width of the roadway. Minimum width of a parking lane is 8 feet, while desirable width of moving traffic lanes is 12 feet. Therefore, for a four-lane facility with left-turn lanes, the street width necessary to accommodate parking on both sides is 76 feet. On First Avenue, parking is permitted where street

widths are less than the desirable width of 76 feet. This results in a reduction in effective widths of traffic lanes to less than the desirable width. Accident experience on First Avenue was examined to determine the possible influence of parking upon accident rates. Accident rates for non-intersection accidents were determined for sections along First Avenue, as shown in Table 9. It can be seen that those sections where curb parking is permitted exhibit a higher accident rate than those sections where parking is prohibited. Over the entire length of First Avenue, the accident rate where parking is prohibited is 4.34 accidents per million vehicle miles, compared to 6.86 for sections where parking is permitted.

A comparatively high accident rate is indicated for the section between 1st Street W and 10th Street E, where parking is permitted. This section is in the Central Business District and is influenced by factors unique to the CBD. However, if this section is deleted from the comparative accident analysis, the accident rate for locations where parking is permitted is 5.72 accidents per million vehicle miles, which remains significantly higher than locations where parking is prohibited.

Table 9

NON-INTERSECTION ACCIDENT RATES
RELATED TO CURB PARKING

SECTION	PARKING	1974 ACCIDENTS	MVM (1)	ACCIDENT RATE (2)
16th Avenue - 12th Street W	Prohibited	32	6.43	4.98
12th Street W - 1st Street W	Permitted	30	4.95	6.07
1st Street W - 10th Street E	Permitted	75	7.86	9.55
10th Street E - 18th Street E	Permitted	57	9.61	5.93
19th Street E - 29th Street E	Prohibited	36	12.38	2.91
29th Street E - 33rd Street E	Permitted	19	3.96	4.81
33rd Street E - Collins Road	Prohibited	69	12.77	5.31

SUMMARY	ACCIDENTS	MVM	RATE
Parking Prohibited	137	31.58	4.34
Parking Permitted	181	26.38	6.86

(1) Million Vehicle Miles of Travel in 1974
(2) Accident rate in accidents per million vehicle miles

It can be noted that the accident rate for the section of First Avenue between 33rd Street and Collins Road is higher than for other sections where parking is prohibited. This higher rate is probably caused by a combination of factors, such as numerous private driveways, midblock turning movements, horizontal curvature, and higher speeds in portions of the section.

The width of First Avenue is less than 76 feet for all locations where parking is permitted, except between First Street W and 4th Street E where the street width is 80 feet. Therefore, consideration should be given to eliminating curb parking along First Avenue except for the portion between First Street W and 4th Street E, where adequate street width can accommodate curb parking.

Traffic Signal Displays

The Cedar Rapids Traffic Engineering Department has adopted a signal design practice for First Avenue of providing overhead signal displays mounted on mast arms. The signal installation practice has been used on First Avenue at a number of intersections signalized or redesigned in recent years. The use of overhead signal displays is an excellent

engineering practice, particularly for multilane roadways such as First Avenue, whose street width can cause signal visibility problems for side-mounted signals. Signal visibility is often a key factor in accident experience at signalized intersections.

There are 20 signalized intersections on First Avenue which do not utilize overhead signal mounting. The upgrading of signal displays at these locations would serve to provide a high standard of signal display as well as providing consistency of display along First Avenue.

Although significant deficiencies are not common on First Avenue, the upgrading would afford the opportunity to eliminate all displays which are not in conformance with the Iowa Manual on Uniform Traffic Control Devices. Upgrading of signal displays should be compatible with the ultimate widening of First Avenue, which is a long-range recommendation of this study.

Signal Warrant Review

Traffic signals should not be installed or continued in operation if they do not meet the minimum warrants established by the Iowa Manual on Uniform Traffic Control Devices. Signal

installations on First Avenue were reviewed to determine if they are warranted under existing traffic conditions.

It was found that three signal installations do not satisfy the minimum warrants. These signals are located at Thompson Drive, 24th Street, and 36th Street. It appears that these signals were installed primarily to serve pedestrian needs since designated school crossings exist at each location. These signals should be removed from operation since they do not meet necessary warrants for intersection signalization. However, the pedestrian needs which these signals satisfy should be considered because of the high traffic volumes on First Avenue and the inherent difficulty for the pedestrian crossing movement. Midblock pedestrian signals can accommodate the school crossing needs, with a minimum effect upon First Avenue traffic operations. Since the pedestrian signals would be pushbutton actuated, the stopping of First Avenue traffic would occur only when pedestrian demand exists. Midblock pedestrian signals should be placed near 24th Street and 36th Street, concurrent with the removel of signals at these intersections. The midblock pedestrian signals should be integrated into the existing interconnected signal system on First Avenue to insure progressive traffic movement.

The Thompson Drive signal should be removed and the Cottage Grove intersection signalized. The signalization of Cottage Grove is warranted under the "Interruption of Continuous Traffic" warrant. This will allow the movement of the designated school crossing from Thompson Drive to Cottage Grove. The existing school crossing at Thompson Drive serves students attending Washington High School and Franklin Junior High School. The relocation of the school crossing to Cottage Grove will better serve the pedestrian movement patterns of these two schools.

Two intersection signals are provided solely for pedestrian crossings, without controlling the cross street, which in both cases are controlled by stop signs. These signals are located at 18th Street W and 12th Street E. This practice of controlling pedestrians by signal and traffic by stop signs at an intersection is not in conformance with the Iowa Manual on Uniform Traffic Control Devices, which requires that the side streets as well as First Avenue be under signal control.

The 12th Street E location is programmed by the City for realignment and upgrading as part of the 12th Street E--13th Street E one-way street project, and correction of the signal deficiency will be made as part of the improvement.

The signal installation at 18th Street W should be brought up to standard by providing complete intersection control. Signalization of this intersection is warranted under the "Interruption of Continuous Traffic" warrant.

Emergency Vehicle Signals

Emergency vehicle signals are provided at Fire Station #8 located south of 10th Avenue and at Fire Station #7 south of 34th Street E. These signals are side mounted and consist of a single red lens which is illuminated upon actuation by fire department personnel during emergency vehicle runs. With this type of operation, motorists have no forewarning of the signal actuation and an unsafe situation may result upon actuation as some motorists observe the red indication and stop immediately while following motorists may not stop.

These two signals are not in conformance with the Iowa Manual on Uniform Traffic Control Devices, which specifies that signal displays must be similar to those displayed at intersections, and should be upgraded to meet signal display standards.

Pedestrian Overpasses - Although no specific recommendations have been made in this study to provide pedestrian overpasses on First Avenue, an analysis of their potential

application was made in response to the strong local interest which has been expressed in their possible construction. Pedestrian overpasses are an alternative to providing signalized at-grade pedestrian crossings where significant pedestrian and vehicular volumes exist.

Pedestrian overpasses, if properly designed and used, potentially eliminate the vehicle-pedestrian conflicts inherent in the at-grade pedestrian crossing as well as reduce traffic delays. However, it is often difficult to develop a high voluntary pedestrian usage of overpasses because of the normal resistance to walking up stairs or ramps. In addition, pedestrians generally select the shortest travel path rather than the safest pattern. Therefore, to gain usage of an overpass, pedestrian barriers (such as fences and walls) are usually required to direct pedestrians into the overpass and prevent undesired crossing movements. Experience has shown that an adult crossing guard is also often required at an overpass structure to enforce its use by school children.

Costs of a typical pedestrian overpass on First Avenue are estimated to be approximately $50,000. The cost for a midblock pedestrian signal installation is estimated to be $17,000 plus annual costs for maintenance and operations (M&O).

An economic comparison on an assumed 20-year construction life basis indicates that a structure would cost about $60,000 and a signal $45,000, including M&O but without inflation as a factor. A new policy has been adopted which would utilize adult crossing guards at school crossings on First Avenue. Annual cost of these crossing guards is estimated to be $3,200 per year per crossing. Over a 20-year period this would amount to $64,000 per crossing. However, a similar crossing guard expense may be necessary with overpasses, as noted previously.

The measured pedestrian activity at school crossings was shown in Table 6, which indicated the highest pedestrian movement to be 70 pedestrians during the school crossing time interval. Since the schools are all removed by several blocks from First Avenue (except for the one at 24th Street E), added new protection improvements (beyond signals provided) appear unjustified on the basis of the low-crossing demand determined by field investigation in this study.

A definitive set of warrants or cost-benefit criteria for the construction of a pedestrian structure have not been established on a state or national basis except for guidelines

prepared by the Instutute of Traffic Engineers.[1] However, the City of Cedar Rapids has developed a manual which includes policies and practices which have proved effective in design of a school crossing safety program.[2] This manual is employed by the Cedar Rapids School Crossing Safety Committee in the consideration of pedestrian safety improvement needs. Action by the Cedar Rapids School Crossing Committee on April 24, 1975, resulted in the following resolution which was submitted to the Cedar Rapids City Council and received by the consultant for additional consideration in this study:

> *"That pedestrian overpasses be constructed in conjunction with the 1st Avenue improvement at all locations where official school crosswalks have been reviewed and designated by the School Crossing Safety Committee, at which locations the School Board and Parochial School administrations have confirmed that redistricting is not evident to eliminate the need of said crosswalks; And that this recommendation be directed to the City Council of the City of Cedar Rapids such that it may be considered in the current evaluations which are being made by the 1st Avenue Study consultant."*

Accordingly, the analyses and findings were again reviewed, to research locations which would have a sound factual basis for installation of an overpass. It is

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(1) A Program for School Crossing Protection, Institute of Traffic Engineers, 1971

(2) School Crossing Manual, City of Cedar Rapids, 1974.

recognized that numerical basis for justification becomes obscure when related to the emotional factors generated for the protection of school children.

The analyses have found the need for midblock pedestrian signals at 24th Street E and 36th Street E, based on pedestrian crossing protection needs, although the two existing intersection signals were found to be unwarranted. It was also recommended that the signal installation at Thompson Drive be relocated to Cottage Grove, where it is warranted, and will better serve school crossing needs.

An engineering feasibility study is recommended for the 24th Street E and 36th Street E crossings to determine the feasibility of providing pedestrian overpasses as an alternative to the recommended midblock pedestrian signals. This study should include consideration of need for additional right-of-way, pedestrian flow patterns, required fencing, and adult supervision, as well as design and cost of the overpasses.

Public Transportation

Existing transit service on First Avenue was analyzed as to its effect of First Avenue traffic operations and the possible inclusion of special transit provisions in the

recommendations. There are eight transit lines which operate on various segments of First Avenue. The segment between 2nd Street E and 10th Street E has three lines operating, with an hourly bus volume during the peak period of 8 buses (4 buses each direction). With this relatively low bus volume, capital improvements, such as bus turnouts, were not considered necessary in the proposed widening of First Avenue. The effect of bus loading and unloading at curbside bus stops will have only a minor influence on traffic operations on First Avenue.

A generally accepted criteria for bus stop spacing is one stop every 600 feet for local transit service, or approximately every 2 blocks under the usual city street pattern. This means a maximum lateral walking distance for riders of only 300 feet, or less than 1.5 minutes in walking time.

Closer spacing of bus stops would increase the number of stops by buses for pickup or discharge of passengers, thereby sharply reducing bus travel speeds and making the service less satisfactory for all riders.

Longer spacing of stops is desirable when a bus traverses relatively undeveloped sections of the urban area on portions of its route, since the few passengers that might be lost by the longer spacing will be more than offset by the reduction in delays and travel time for the great majority of riders.

RECOMMENDED IMPROVEMENTS

A number of improvement opportunities have been identified based upon field observations, analyses, and findings discussed in the previous chapter. Recommendations were developed which address current and future traffic and safety needs of First Avenue. These recommendations include both operational and physical improvements. Cost estimates were developed for those improvements with which a cost can be associated. Some recommendations are non- or low-capital intensive and can be implemented as part of the normal operation of the Traffic Engineering Department. Other recommendations such as the widening of First Avenue and the upgrading of signal installations require a substantial public investment.

Individual recommendations are discussed in this chapter, with the ordering of recommendations into an implementation program discussed in the following chapter.

Immediate Traffic Signal Improvements

At present, the intersection of First Avenue and 18th Street W has traffic signals only on the First Avenue approaches

which are pedestrian actuated. No signals are provided to the 18th Street approaches. This mixed mode of control is not desirable practice and it is recommended that signals be displayed to all approaches. Retention and upgrading of the signal are warranted under the "Interruption of Continuous Traffic" warrant. This will necessitate replacement of the existing pedestrian controller, which was installed in 1950, by a semi-vehicle actuated controller with actuated pedestrian movement timing. A similar pedestrian crossing exists at 12th Street E. This crossing will be upgraded under present plans of the city to make 12th Street E and 13th Street E a one-way street pair between Oakland Road and 3rd Avenue. This one-way pair will benefit First Avenue between the Central Business District and 13th Street E, by providing an alternate route along 2nd Avenue and 3rd Avenue with connections to the north.

At the intersection of 16th Street E and First Avenue, it is recommended that the signal installation be eliminated (rather than upgraded to ultimate First Avenue design) and a painted median or other suitable treatment be used to effectively close cross traffic and left turning at this intersection. This location will not be provided a median opening

when First Avenue is widened, and this interim painted median will serve to reduce the high accident experience of this intersection.

It is recommended that the existing traffic signals at the intersections of First Avenue with 24th Street E and 36th Street E be removed and replaced with midblock pedestrian signals. At present, those intersections do not warrant signal control, but a means of affording protected pedestrian crossing of First Avenue is defined. Movement of the control to a midblock location will provide pedestrian protection at less cost and with less delay to First Avenue traffic than would be caused by the intersection located signal. Since pedestrian demand during peak vehicular traffic periods should be light, few stops to First Avenue traffic are anticipated.

It is recommended that the existing signal control at First Avenue and Thompson Drive be relocated to Cottage Grove where it would operate as a vehicle and pedestrian actuated signal. It was found that the signal at Thompson Drive does not meet necessary warrants for intersection control. In addition, the school crossing movement can be better served at Cottage Grove than at Thompson Drive.

Emergency vehicle signals at Fire Station #8 (south of 10th Avenue) and Fire Station #7 (south of 34th Street E) do not provide signal displays or operation consistent with requirements of the Iowa Manual on Uniform Traffic Control Devices. It is recommended that new dual-indication overhead displays and traffic controllers be installed at these locations.

The intersection of Williams Boulevard and 16th Avenue is currently part of a separate operations study, however, as a terminus of this study two recommendations affecting its operation are defined. It is recommended that an exclusive left-turn lane be provided on Williams Boulevard approaches to better accommodate the heavy left-turn movement. It is also recommended that the free right-turn movement from the northeast approach be modified to provide an acceleration lane before this movement is forced to merge with 16th Avenue traffic. The movement has a very high rear-end accident history which is in large part the result of right turning vehicles being forced to stop because of difficulties in merging with 16th Avenue traffic. These recommendations should be integrated with those resulting from the 16th Avenue study. The need and feasibility of a grade separated interchange of 16th Avenue

and Williams Boulevard should be studied, since projected future traffic demand indicates the possible need for such a design.

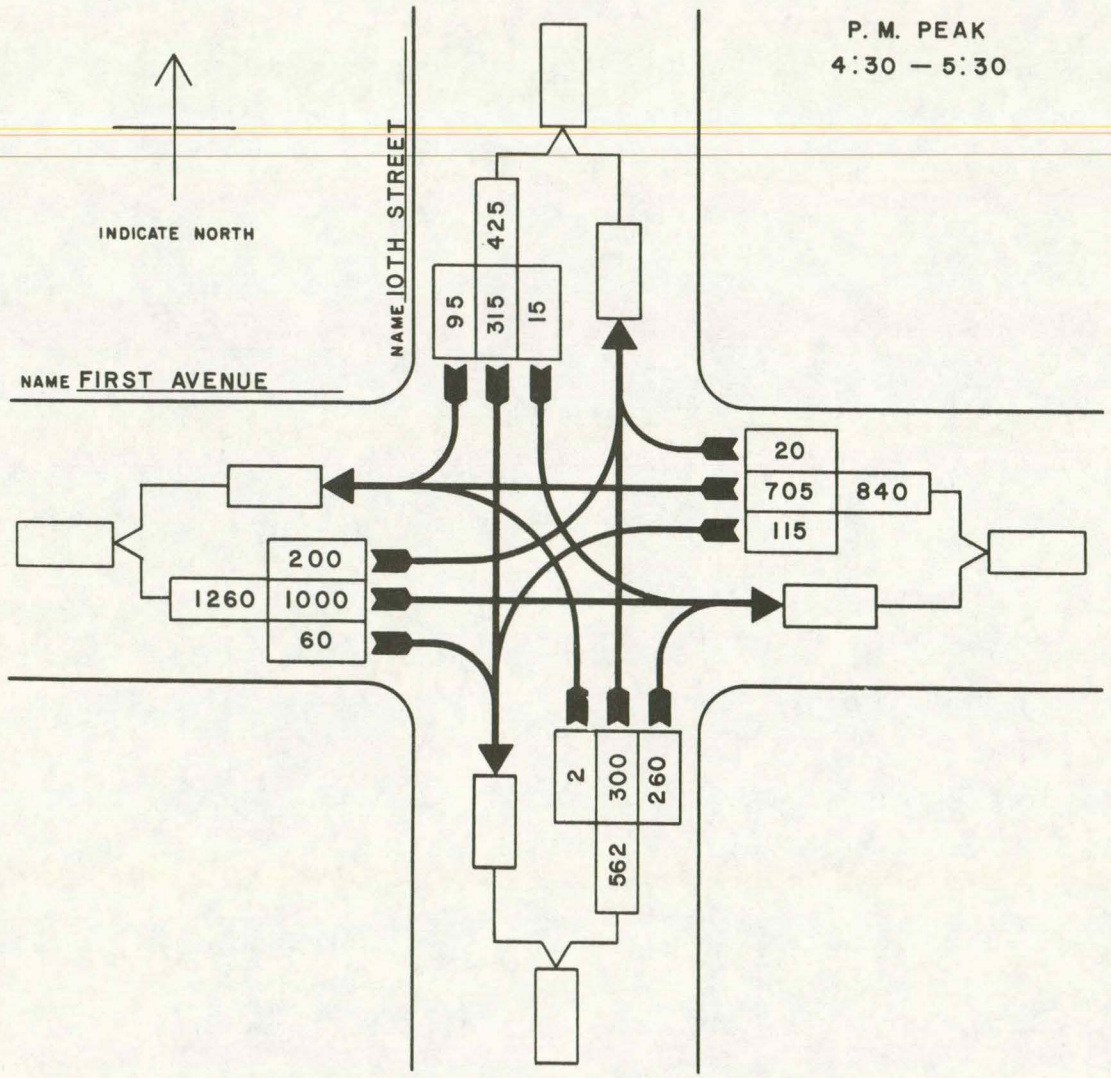
Signal Timing

It is recommended that the traffic controller timings be modified to achieve a balanced volume-capacity relationship between First Avenue approaches and minor street approaches. At locations haveing lower minor street volumes, it is further recommended that the timing be biased to provide a somewhat lower volume-capacity to First Avenue movements than to side street movements. This reallocation of green time will result in traffic controllers operating in essentially a fixed-time mode during peak traffic flow periods, making possible more predictable, constant progressive movement of First Avenue traffic.

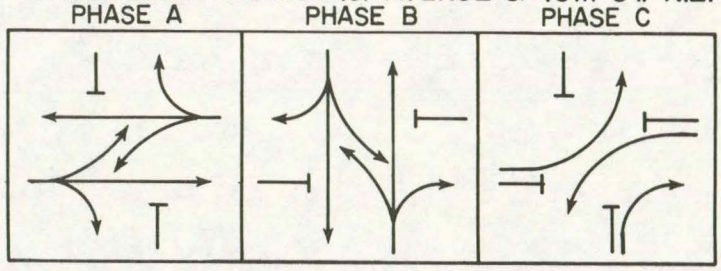
Timing Example - The following example illustrates a methodology for developing signal timing consistent with the above stated intent. In presenting this example, it must be realized that some modification to the calculated interval durations or "fine-tuning" after implementation may be necessary to adequately accommodate unusual volume peaking or other operational characteristics unique to each

intersection. The methodology does, however, give an apportionment of green time which is closely related to actual approach capacity and which should serve as a sound initial point of departure.

The intersection selected as an example is First Avenue and 10th Street E. The signal timing referenced as existing is actually that which was in effect prior to a recent revision of this intersection's control. The afternoon peak hour (4:30 P.M. to 5:30 P.M.) has been selected for the example and turning movement volumes for this period are shown in Figure 5. The volumes at the 10th Street E are typical of other intersections on First Avenue during this peak hour, exhibiting an eastbound flow of 1,260 vehicles and a westbound volume of 840 vehicles. Left turns show a more significant directional imbalance than through movements with 200 from the eastbound approach and 115 from the westbound approach. The northbound approach on 10th Street has a significant impact on timing and phasing needs resulting from its high right-turning movement (260 vehicles). Phasing utilized at this intersection is also shown in Figure 5. The phasing matches the flow demand fully and achieves efficient green time utilization by overlapping the heavy northbound right turn movement with non-conflicting, opposing left turns on First Avenue.



EXISTING PHASING- 1st AVENUE & 10th ST. N.E.



10th STREET E TRAFFIC CHARACTERISTICS

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FIGURE 5

Existing timing and volume/capacity relationships are shown in Table 10. With this timing, the First Avenue eastbound movement exhibits a capacity deficiency (1.18 for the through movement, and 1.25 for the left-turning movement) while the highest V/C ratio on 10th Street is 0.69 on the northbound approach. This operation is more biased to minor street traffic and results in an opportunity to reallocate green time with the intent of achieving more equal levels of service on all approaches.

The capacity relationships shown in Table 11 result from a reallocation of green time which was done by manual calculation, using the Leisch Capacity Analysis charts. Corresponding results would be achieved using the Highway Capacity Manual, however, iterative calculations would be more laborious. In this example, the amount of green time required to achieve a V/C ratio of 1.00 on the heavier side street approach (northbound) was determined initially, then the remaining green time was apportioned to the side street. Since this initial allocation resulted in V/C ratios of less than 1.0 at level-of-service "C" for the heavier main street movement, the process was carried no further.

With the new timing the First Avenue through movement which previously operated with a V/C ratio of 1.18 now is

Table 10

FIRST AVENUE AND 10TH STREET E
Existing Volume/Capacity Ratio
P.M. Peak Hour

APPROACH	CAPACITY[1] (veh./hr. green)	GREEN TIME (per cent cycle)	CAPACITY PER G/C RATIO[1] (veh./hr.)	VOLUME (veh./hr.)	V/C[1]
1st Avenue Eastbound (Straight & Right)	2,200	41	900	1,060	1.18
1st Avenue Eastbound (Left Turn)	N/A	13	160[3]	200	1.25
1st Avenue Westbound (Straight & Right)	2,200	41	900	725	0.80
1st Avenue Westbound (Left Turn)	N/A	13	160[3]	115	0.72
10th Street, Southbound (4)	2,400	34	815	425	0.52
10th Street, Northbound (4)	2,560[4]	34[2]	815	560	0.69

(1) Referenced to Level of Service "C".
(2) Plus 13 per cent for overlapped right-turn movement.
(3) Includes capacity for permissive left turns during through movement.
(4) Including right-turn overlap.

Table 11

FIRST AVENUE AND 10TH STREET E
Volume/Capacity Ratio With Proposed Signal Timing

APPROACH	CAPACITY[1] (veh./hr. green)	PROPOSED GREEN TIME (per cent cycle)	CAPACITY[1] PER G/C RATIO (veh./hr.)	VOLUME (veh./hr.)	V/C[1]
1st Avenue Eastbound (Straight & Right)	2,200	52	1,145	1,060	0.92
1st Avenue Eastbound (Left Turn)	N/A	15	205[3]	200	0.97
1st Avenue Westbound (Straight & Right)	2,200	52	1,145	725	0.63
1st Avenue Westbound (Left Turn)	N/A	15	205[3]	115	0.56
10th Street, Southbound	2,400	21	500	425	0.85
10th Street, Northbound (4)	2,560[4]	21[2]	560	560	1.00

(1) Referenced to Level of Service "C".
(2) Plus 15 per cent for overlapped right-turn movement.
(3) Includes capacity for permissive left turns during through movements.
(4) Including right turn overlap.

calculated to be 0.92 and its left turn movement has reduced from 1.25 to 0.97, well within level-of-service "C". In the event the initial interation of this procedure had not resulted in an under-capacity situation for all movements, it would have been necessary to make subsequent calculations. Should it not be possible to maintain all approaches under the design level of service, then a decision would be required either to equalize the V/C ratio on all approaches or to bias operational efficiency in favor of a preferred movement.

Since many of the First Avenue controllers are actuated or semi-actuated, it is evident that there will be cycles during which the maximum green times established by the previous technique will not be required. Unused side street green time will revert to the main street, however, return to the main street before the optimum point for progressive flow will result in a premature arrival of vehicles at downstream intersections with resultant delay. Consequently it is recommended that during the "fine-tuning" process close attention be given to adjustment of the side street maximum green period and its gap interval duration to achieve operation wherein the side street runs to its maximum for a large proportion of peak-hour cycles.

Signal Phasing Changes

The following phasing changes are recommended with the general intent of providing more green time to First Avenue movements. The intent of these changes is upgrade the Level-of-Service by providing as much green time to First Avenue as possible, thereby increasing capacity and improving progressive movement. The primary means recommended includes deletion of exclusive turning phases for lighter turning volumes, combining movements now timed separately, and elimination of left turns. These recommended changes should not adversely affect intersection operations.

It is recommended that the westbound leg of the dual left-turning movement at First Avenue and 40th Street E be eliminated since fewer than 10 vehicles use it during either peak hour. Its deletion would permit the eastbound through movement on First Avenue to run concurrently with its heavy left-turning movement, increasing the capacity of the eastbound approach.

The Lindale Plaza intersection should be rephased to reduce the frequency of left-turning accidents, by eliminating the conflict between left-turning vehicles and opposing traffic on First Avenue. The rephasing should eliminate the permissive

left-turning movement on First Avenue, requiring these turns to be made on an exclusive left-turn phase. This left-turn phase would be coupled with a phase overlap for the right-turn from the north. Through traffic on First Avenue would move on the second phase. Side street movement from the shopping centers would be accommodated on the third phase.

It is recommended that both approaches of Collins Road be run on a single phase rather than on separate phases. The south approach on Collins Road has fewer than 50 vehicles in either peak hour and the green time currently allocated to this movement could be better utilized on First Avenue which has capacity deficiencies on both approaches.

It is recommended that the opposing left-turning phase at First Avenue and 13th Street W be eliminated. Also, combining the two 13th Street approaches in one phase is proposed. This will result in two phase operation of the intersection which is currently operated by a six phase controller.

At the intersection of First Avenue and 6th Street W it is recommended that the existing opposing left-turn movement be replaced by a leading left-turning movement on the east approach. The intersection will then operate with three phases; First Avenue westbound advance left turn and through movement,

two-way movement on First Avenue, and 6th Street two-way traffic. Left-turn lanes on First Avenue should be provided by means of pavement markings, concurrent with this change in phasing.

At First Avenue and 5th Street E it is recommended that the eastbound left turn be prohibited and the intersection controlled with three phases corresponding to the recommended operation of First Avenue and 6th Street W.

It is recommended that the exclusive opposing left-turn movement on First Avenue at Thompson Drive be eliminated because of the low volume of left-turning vehicles (less than 25 during the peak hour). While the movement is actuated and will not be timed unless demand is present, this volume of turning movement can be accommodated without exclusive control and disruption to progressive movement which results when the phase is introduced.

It is recommended that the opposing left-turning movement at First Avenue and 36th Street E be eliminated because of low demand. Fewer than 20 vehicles from either approach use the movement in either the morning or evening peak period.

Implementation of the last two recommended phasing changes (Thompson Drive and 36th Street E) could be affected

by the timing of action to remove these two signals from their present locations. Rephasing of these signals should occur at the time of retiming of signals on First Avenue, if their removal has not been implemented.

Signal System Operation

Several operational recommendations are offered for the signal system in operation on First Avenue between 13th Street W and 40th Street E. These recommendations concern timing programs (use of master controller dials and offsets) and progressive signal timing.

Timing Program Selection - The First Avenue coordination equipment has the capability of providing three cycle lengths and three offsets per cycle length. One cycle split is associated with each cycle length. At present, the system is programmed (as shown in Table 3) to provide patterns for overnight, daytime (with exception of P.M. peak), and P.M. peak period.

It is recommended that the three dials be utilized through the daytime when traffic is heaviest to provide three split selections.

The additional split available during the day should permit a closer allocation of green time to traffic demand

consistent with the previously developed timing procedure, and to provide offsets necessary for progressive movement.

The proposed timing program schedule is shown in Table 12. This schedule provides a pattern for the A.M. peak period, P.M. peak period, and off-peak period, which also recognizes the differences in directional distribution experienced during the day.

It should be noted that the full offset capability of the equipment is not utilized, giving opportunity to experiment with alternative progressive timing patterns. The spare offset capability may also find usage to accommodate special events or inclement weather conditions which have not been specifically addressed in this study. One example might be the provision of a basically simultaneous offset pattern with a 90-second cycle length for use during snow.

Progressive Timing Programs - To provide a basis for refinement of progressive system timing, a computer program was used, SIGPROG, based on the Morgan-Little technique to achieve maximum progressive bandwidth. The offsets, referenced to beginning of main street green for the morning peak period, off-peak period, and afternoon peak are presented in Table 13.

These offsets were calculated for assumed travel speeds ranging from 25 miles per hour in the central business area to 35 miles per hour in the other areas. Green time for the

Table 12

PROPOSED SIGNAL SYSTEM OPERATION SCHEDULE

DIAL	RESET	OPERATION PERIOD	CYCLE LENGTH	CHARACTERISTICS
1	1	6:00 A.M. - 9:00 A.M.	70 seconds	Medium traffic, Inbound Flow
2	1	9:00 A.M. - 3:30 P.M.	70 seconds	Average traffic, Balanced Flow
3	1	3:30 P.M. - 6:30 P.M.	90 seconds	Heavy traffic, Outbound Flow
2	1	6:30 P.M. - 6:00 A.M.	70 seconds	Light traffic, Balanced Flow

Table 13

PROPOSED FIRST AVENUE SIGNAL OFFSETS[1]

INTERSECTION	AM PEAK (70 Sec. Cycle) APG*	AM PEAK (70 Sec. Cycle) Offset	OFF-PEAK (70 Sec. Cycle) APG*	OFF-PEAK (70 Sec. Cycle) Offset	PM PEAK (90 Sec. Cycle) APG*	PM PEAK (90 Sec. Cycle) Offset
40th Street, E	55	54%	55	30%	55%	61%
38th Street, E	65	75	65	15	70	70
36th Street, E	60	2	60	72	65	7
32nd Street, E	60	4	60	20	65	66
29th Street, E	55	96	55	87	60	70
27th Street, E	60	36	55	70	55	23
24th Street, E	65	95	65	11	70	12
Thompson Drive	55	87	55	32	60	70
19th Street, E	45	9	45	30	45	25
16th Street, E	55	38	55	70	60	63
15th Street, E	60	37	60	84	65	58
13th Street, E	45	96	45	32	50	32
10th Street, E	45	53	45	73	50	29
5th Street, E	50	88	50	35	55	78
3rd Street, E	50	43	50	65	55	13
2nd Street, E	50	32	50	80	55	10
1st Street, E	50	48	50	32	55	22
1st Street, W	45	90	45	38	45	75
3rd Street, W	55	46	55	60	60	51
5th Street, W	55	32	55	80	60	19
6th Street, W	45	53	45	37	50	20
13th Street, W	50	44	50	70	50	62

* Assumed Per Cent Green

(1)Offsets are shown as per cent of cycle and are referenced to beginning of First Avenue through movement.

First Avenue through movement utilized in the computation was generally increased somewhat from that now utilized to approximate a reasonable bias for the primary traffic movement as a result of recommended retiming. The offsets included in Table 13 are based on a 70 second cycle length for the morning peak and off-peak flow periods and a 90 second cycle for the evening peak.

The computed bandwidths as shown in Table 14 do not, at first reading, appear particularly wide. However, in the context of their representing through-flow over an artery which is nearly five miles long and which has 22 randomly-spaced signalized intersections, maintenance of any two-way progressive flow is encouraging. Furthermore, it must be understood that these bandwidths are the minimum "through" bandwidths experienced over the entire length of the system and the actual bandwidth over any given segment of the system may be considerably wider.

Table 14

COMPUTED PROGRESSION BANDWIDTH
PROPOSED FIRST AVENUE TIMING PROGRAMS

PROGRAM	BANDWIDTH (1)		CYCLE LENGTH
	Inbound (2)	Outbound (3)	
Morning Peak Hour	9%	9%	70 seconds
Off-Peak (Midday)	8%	8%	70 seconds
Afternoon Peak Hour	12%	16%	90 seconds

(1) Bandwidth is shown as per cent of cycle length.
(2) Inbound direction is toward CBD.
(3) Outbound direction is away from CBD.

As with interval timing at the individual intersection, any set of progressive timing offsets requires "fine tuning" to adjust for unique flow characteristics. In general, the leading left-turn movements common to First Avenue should be started before the indicated offset point so that the through movement beginning will coincide with the offset. Where only one left-turn movement is given exclusive timing, being concurrent with a through movement, it is suggested that beginning of the through movement in the heavier flow direction corresponds to the offset point. At intersections having wide cycle-to-cycle variations in side street demand, it may be beneficial to use the actuated controllers force-off circuit, actuated by the coordination unit, to ensure that the leading turn movement and/or through movements begin at the prescribed offset point.

Traffic Control System Modernization - Modernization of the Central Business District traffic control system to provide traffic-responsive control is understood to be under consideration by the City. This control system is recommended for consideration, with First Avenue incorporated as a principal subsystem to this areawide control system.

This type of traffic control system would very likely utilize a digital computer as the master control element. It would provide the potential for control flexibility and control effectiveness evaluation which are not available with the existing equipment. In being traffic responsive, such a control system would implement timing programs in response to actual traffic demand, not on the basis of historical experience, as is done with the existing control system.

Tangible benefits can be derived from modernization of this type; however, it is vital to clearly understand that computerized traffic control systems do not, of themselves, necessarily provide or assure improved traffic control and benefits. The traffic control system only provides the capability to achieve improvement with the actual results being highly dependent upon skillful use of the system by the responsible engineering personnel.

A computerized control system will provide three highly significant features:

1. The capability to implement a large number of timing programs (related combinations of cycle, length, split, and offset).

2. The capability to select the most appropriate timing program for a given set of traffic demand characteristics.

3. The capability to evaluate the effectiveness of control in terms of delay, vehicle stopping frequency, and queueing. It will further afford the capability to determine the systems operational status on a minute by minute basis.

Examples of the desirability and benefits of a powerful central system possessing well-developed control flexibility and evaluation capabilities are found throughout this discussion, particularly in the area of signal timing. At present, the only means of establishing, with certainty the improvement of one timing plan over another involves detailed speed and delay studies using the "floating car" techniques. This is costly in terms of both time and labor and can rarely be utilized to the extent that a clear operational evaluation, except for peak hours, can be obtained. The technique is particularly cumbersome when it is desired to compare alternative timing programs because of the impracticality of obtaining data on a continuous, daily basis.

Under the existing control system, any change in intersection timing or progressive timing necessitates a trip to the intersections involved. The central control system can eliminate this need since, if so structured, essentially all timing changes can be made at the central control location.

While the desirability and need for on-site observation of intersection and system operation is not eliminated with a system, it is significantly minimized, making more efficient use of traffic engineering staff time. Improved response to equipment failures is also obtainable through the system since they are instantly detected by the central control equipment. At present, improperly operating intersection controllers can only be detected visually.

Because of the complexity of a digital computer controlled system it is the Consultant's viewpoint that the installation, implementation and furnishing of all system components should be the responsibility of a single vendor or contractor. This is not intended to mean that all components should necessarily be of a common manufacturer; but, that a central responsibility for their procurement and assurance of compatability is defined.

While a detailed study of an areawide signal system for Cedar Rapids was not within the scope of this study, some general estimates and observations can be made. Depending upon the extent to which the system would be projected to extend beyond the central business area and First Avenue, a total control capacity of about 100 intersections appears reasonable with approximately 65 intersections being implemented initially.

Obviously many factors must be studied and defined to arrive at even a budgetary cost estimate for a control system. These would include the number of detectors, communications techniques to be used including cableing, conduit and multiplexing equipment (if used), types of local controllers, and central facility and utility considerations. For planning purposes, it is estimated that such a system would cost approximately $730,000.

Several means of reducing this figure may be possible, primarily, by the City performing the construction tasks such as controller foundations and the laying of cable. It is further possible that a vendor could be contracted who would permit city forces to install controllers, detectors and communications wiring but who would still assume responsibility for total system operation which would reduce estimated costs considerably.

Controller Modernization - If the installation of a new central traffic control system were not to occur within the immediate future (less than five years), it is recommended that a program be instituted to replace older actuated or semi-vehicle actuated controllers with new controllers. In addition the existing pretimed controllers

outside of the central business area, particularly those at 15th Street E, and 32nd Street E are recommended to be replaced with semi-vehicle actuated equipment. Older actuated controllers (those installed before 1960) should be replaced with current hardware as their reliability can be expected to decrease. It is recommended that all new actuated controllers be equipped with dual maximum green selection capability. These controllers would be actuated by the existing coordination equipment to provide better overall allocation of green time.

Signal Display Standardization - The Cedar Rapids Traffic Engineering Department has adopted a signal design practice for First Avenue of providing overhead signal displays mounted on mast arms. This signal installation practice has been used on First Avenue at a number of intersections signalized or redesigned in recent years. The use of overhead signal displays is an excellent engineering practice, particularly for multi-lane roadways such as First Avenue, whose street width can cause signal visibility problems for side-mounted signals.

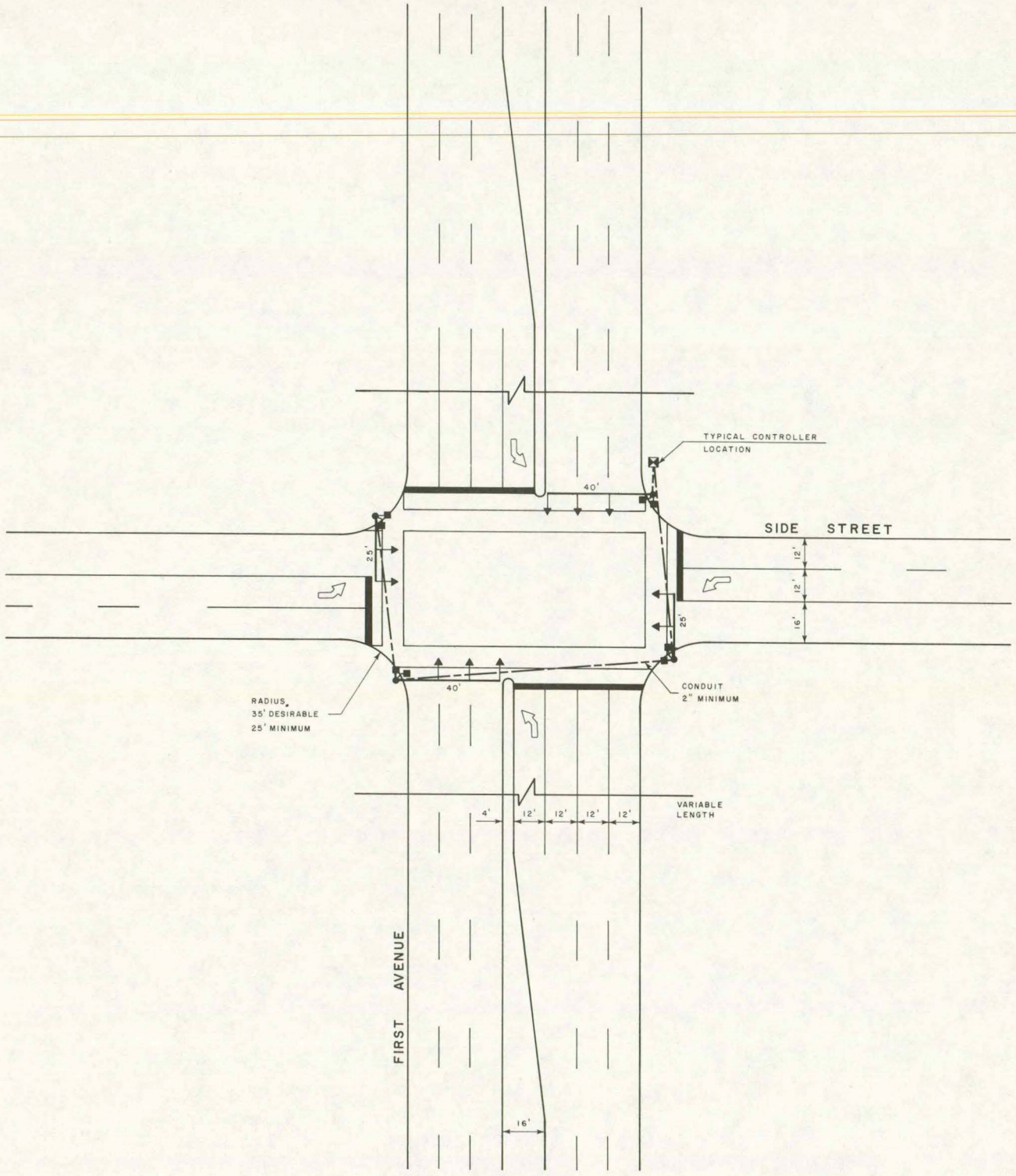
There are 20 signalized intersections on First Avenue which do not utilize overhead signal mounting. The upgrading of signal displays at these locations would serve to provide a

high standard of signal display as well as providing consistency of display from intersection to intersection along First Avenue.

A long-term recommendation has been made in this report to widen First Avenue to an 88-foot cross-section with six through lanes and a 16-foot median, providing room for opposing left-turn lanes at intersections. Since the widening is not projected to be realized for some time, and the need for signal display modernization is immediately defined, it is recommended that engineering studies be undertaken to establish functional plans for the widening to the extent that signal structures can be located to serve both the existing and proposed roadway cross-sections. A typical intersection plan for the improved First Avenue cross-section can be accommodated within existing right-of-way. A reasonably high probability exists for installing signal structures so that minimum resetting of them would be required at the time of the future widening.

Curb Parking Removal

A discussion of the effects of curb parking along First Avenue upon traffic operations and safety were discussed in the



TYPICAL INTERSECTION DESIGN

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FIGURE 6

previous chapter. A comparison of accident experience on those sections of First Avenue where parking is permitted to those sections where it is prohibited illustrated the impact on safety of parking on First Avenue. In addition, most of the existing curb parking is permitted in sections which are too narrow to adequately accommodate parking without affecting First Avenue traffic operations and capacity.

Prohibition of parking is recommended along the entire length of First Avenue when it is ultimately widened to six lanes. It is recommended that a program of curb parking removal be implemented to remove parking between 12th Street W and First Street Street W; between 4th Street E and 18th Street E, and between 29th Street E and 33rd Street E. As an initial step in removing parking in these sections, it is recommended that parking be removed during peak periods, during those times when the effects of parking will be most significant.

A means of staging the implementation of complete parking removal could be employed, whereby advance notice (for example, one year) is given of the impending change to adjacent property owners so that they may have time to make provisions for the loss of parking. It appears that adequate parking is available on nearby streets to compensate for most of the parking space to be removed on First Avenue. However, there

may be areas along First Avenue where it may be necessary to provide additional off-street parking. One means of providing this parking could be through the establishment of a Benefit Parking District, whereby benefited property owners share in the cost of providing the parking facility.

Fourth Street Railroad Grade Crossing

Significant traffic delay and safety problems exist at this crossing due to the high volume of traffic on First Avenue and the high number of daily train movements. More responsive grade crossing signal equipment should be installed to provide more reliable crossing protection and to gain better compliance and respect of the motorists. It is understood that a separate study is developing a specific recommendation on the crossing signal equipment.

Because of the significance of First Avenue as a major arterial street, the City should pursue an aggressive position with rail lines operating on the crossing to reschedule train movements to other tracks or to make track relocations to eliminate the crossing at First Avenue.

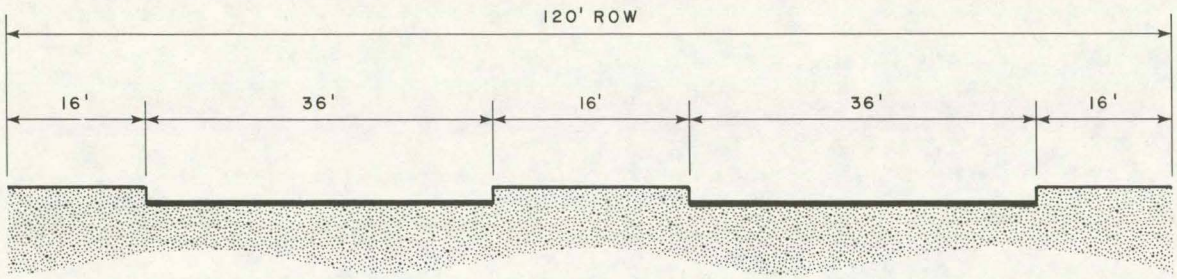
First Avenue Widening

The analyses of the previous chapter have identified the safety and operational characteristics of First Avenue.

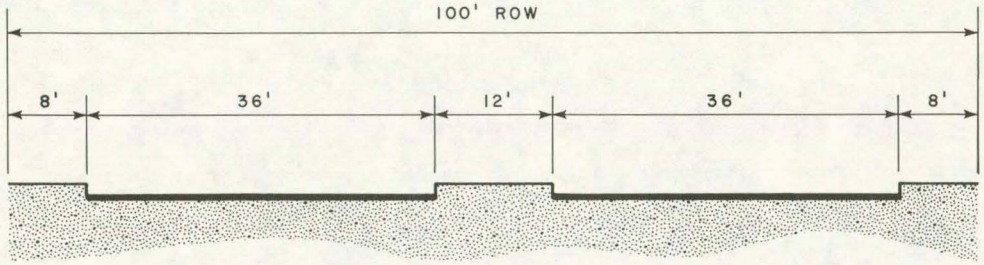
It is apparent that First Avenue will continue to function as the primary facility for northeast-southwest movement in the City. Review of transportation planning study traffic projections indicate that First Avenue will continue to experience traffic demand exceeding capacity in the future, even after completion of Interstate 380.

As a result of this existing and projected need for additional capacity on First Avenue, long-range improvements are recommended to provide the physical improvement necessary to obtain the needed additional roadway capacity.

Development of First Avenue into a high-type six-lane facility would provide a capacity in the order of 33,000 to 36,000 vehicles per day at Level-of-Service "C". Improvement to a six-lane divided facility can be accomplished within existing rights-of-way for most of its length (east of 13th Street W). It will be necessary to acquire additional right-of-way between 13th Street SW and 18th Street SW. Williams Boulevard has a right-of-way width of 100 feet, requiring a reduction in median width and border strip. It was considered undesirable to obtain additional right-of-way on Williams because of cost and disruption to abutting property. Recommended cross-sections of the proposed improvement are shown in Figure 7.



FIRST AVENUE



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RECOMMENDED FIRST AVENUE CROSS-SECTION

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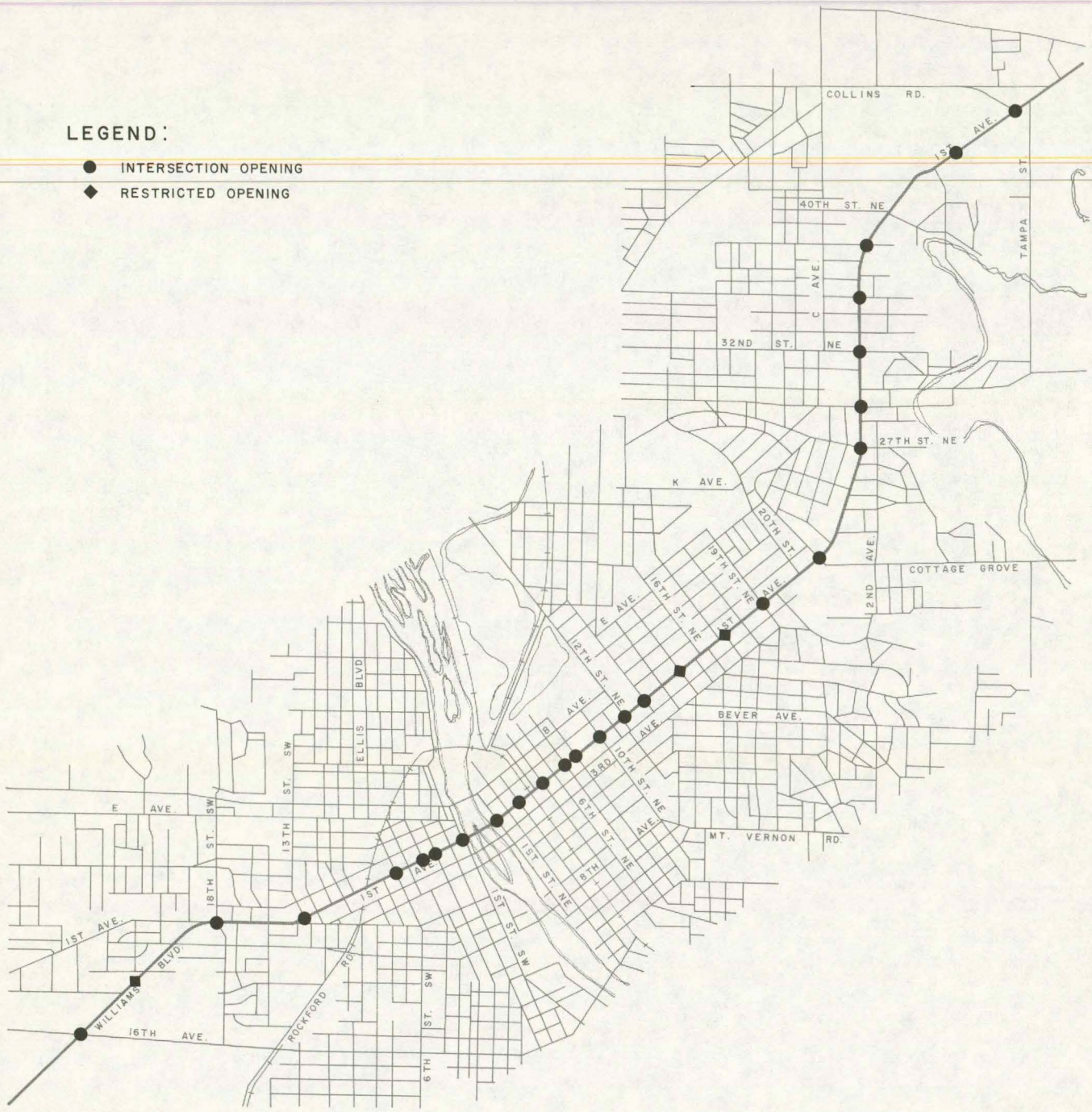
FIGURE 7

Medial and marginal access are important factors in developing plans for the upgraded First Avenue facility. Medial access refers to openings provided in the median for crossing and turning traffic, while marginal access is related to access (driveways) provided to abutting property. It is recommended that preliminary design of the facility include a study of land use development and environmental considerations to ensure a total design of the First Avenue corridor. This would allow the City to relate possible land use modification to the design of First Avenue, as well as relate it to medial and marginal access considerations.

Medial Access - Medians function to provide a separation of opposing traffic streams and to control the location of left-turning and crossing traffic resulting in favorable influence on traffic operations, increased driver confort and convenience and reduction in accident occurrence. Recommendations were developed for the proposed location of median openings after a detailed review of expected traffic flow patterns and programmed improvements (such as street connections to Interstate 380).

The location of these proposed median openings are indicated in Figure 8. Several special median opening



PROPOSED LOCATION OF MEDIAN OPENINGS

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SCALE

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FIGURE 8

treatments are recommended to accommodate unique situations. At Fire Stations #7 and #8, it is proposed that madian openings be provided solely for emergency vehicle use, which would allow these vehicles to turn left on First Avenue from the fire stations. A unique traffic pattern exists between 10th Street E and 19th Streen E as traffic on First Avenue interchanges with 2nd Avenue and 3rd Avenue for access to the CBD. This results in a high volume of westbound left turns on First Avenue, and a corresponding high volume of right turns onto eastbound First Avenue in this section. To accommodate the left turns, it is recommended that median openings be provided at 15th Street E and 17th Street E, designed to handle only westbound left-turning traffic.

Marginal Access - Access needs of property owners abutting First Avenue should be carefully reviewed during the design of the First Avenue widening, and adjustments made where possible to minimize the number of driveways on First Avenue, and to ensure an adequate design of access drives rebuilt during construction. Access from side streets should be utilized as much as possible for those properties located at street corners. Where possible, joint use of driveways by a number of properties should be considered to reduce the

number of driveways required on First Avenue. The City should institute a procedure to review access needs and design during any rezoning actions on First Avenue. This would ensure compatibility with the ultimate widening.

To protect the function of First Avenue as a high-capacity primary arterial route, curb parking should not be permitted on the improved facility.

Any development by the City of a bikeway system should exclude First Avenue as a bike route because of the inherent incompatibility of bicycle traffic on this primary artery, and the safety concerns related to this traffic mix. However, if the City determines that a bicycle facility is to be provided on the First Avenue right-of-way, care should be exercised in its design to maximize safety for both bicyclist, pedestrians and motorists. A shared bicycle-pedestrian facility (essentially a wide sidewalk) appears to be the most feasible approach. Such a facility should be a minimum of 7 feet wide and be located as far as possible from the First Avenue travelled-way.

Improvement Benefits

The operational improvements recommended in this

report include intersection timing and phasing changes, signal display standardization, and roadway widening. Inclusion of First Avenue as a subsystem of a computer-controlled CBD signal system is also recommended should such a system be implemented.

Benefits of Signal Improvements - Signal displays are viewed as the basic driver communications media of traffic control and while much of the success and safety of control operation is dependent upon their function, it is quite difficult, if not impossible, to assign a dollar benefit value to them. Certainly accident experience at intersections can be related, in part, to signal display visibility and clarity-of-intent, but identification of display inadequacy as a contributing factor to accidents is rarely recorded. Consequently, the recommendations involving only signal display standardization and uniformity are felt justified on the basis of good traffic engineering practice, without economic considerations.

As traffic volumes on First Avenue increase in the future, their accommodation by traffic control system improvements and other operational means will decrease with resulting level-of-service degredation. While it was not the intent of this study to fully develop the technical

details of future traffic system control, the benefits of computerized traffic control appear attainable if applied in Cedar Rapids. Representative improvements achieved from several of the longer established systems are shown in Table 15. It is felt that the potential achievement of these benefit magitudes should offer justification to consider further this means of improving First Avenue operational efficiency.

The two improvements for which immediate cost-benefit justifications are developed are the signal phasing and control recommendations. The costs of these were estimated to be $3,600 and $137,404, respectively, for a total investment of $140,604. It is assummed that the improvements can be amortized over 10 years at 6 per cent interest resulting in an annual cost of $18,980. Since all locations covered by these improvements have existing signalized control, it is assummed that no increases in operational and maintenance costs will result from their implementation.

The operational benefits to the motorist from improved intersection operation are reduced travel time resulting from fewer stops and less delay, accident reduction resulting from less stopping and smoother flow, and improved travel comfort. The cost of stops and delay can be measured by their effect on

Table 15

EXAMPLE BENEFITS OF COMPUTERIZED TRAFFIC CONTROL

MUNICIPALITY	NUMBER OF CONTROLLED INTERSECTIONS	NUMBER OF SENSORS	RESULTS
Wichita Falls, Texas	57	63	18 per cent delay improvement
San Jose, California	59	400	11 to 14 per cent delay improvement
Toronto, Canada	550+	-	--11 to 45 per cent in progressive offset networks --27 per cent improvement in critical intersections -- 8 per cent to 37 per cent improvement resulting from traffic responsive pattern modification --10 per cent improvement resulting from volume density control of isolated intersections
Glasgow, Scotland	80	240	12 per cent delay improvement

vehicle operating costs and motorist time. In the following discussion only the cost of passenger-vehicle motorist time will be considered based on an average of $2.50 per hour and 1.5 passengers per vehicle for a total cost of $3.75 per vehicle hour. This figure is quite conservative since it does not include vehicle operating costs or commercial vehicle costs which are several times this value. The analysis will also consider a 250 work-day year, thus totally neglecting all weekend trips which would tend to be more recreationally oriented with possibly less value assignable to motorist time.

Based on these assumptions, a daily cost saving of about $76.00 must be realized to achieve the estimated annual cost of $18,980. At $3.75 per vehicle hour this converts to a daily time saving of 20.3 hours per day or, assumming an average daily traffic of 25,000 vehicles, less than three seconds per vehicle. Considering the reductions in number of phases, capacity improvement, and progression improvement, this appears to be a time saving which should actually be realized many times over.

Benefits of Widening Project - A number of tangible and intangible benefits can be gained with the widening of First Avenue. Widening of First Avenue will provide increased

mobility to the community by increasing roadway capacity in this high-demand travel corridor. The primary benefit of the widening project will accrue to the motorist who will use the facility.

Benefits are realized on a communitywide basis if the widening is viewed in terms of satisfaction of community transportation needs. First Avenue is an important facility in the regional transportation plan. If additional traffic capacity is not provided on First Avenue, travel needs must be satisfied on other traffic facilities, which merely distributes the corridor capacity problem to alternate routes. This could be a significant problem, since there are actually few alternative routes in the First Avenue corridor to provide a possibility for diversion of future traffic demand from First Avenue.

The recommended high-type roadway design will provide a safer facility and can be expected to reduce accident rates. Safety should be enhanced by roadway geometrics, increased capacity, smoother traffic operation, and reduced number of conflict points (with addition of the median). Studies of accident reduction resulting from addition of a median with left turn lanes indicate that accidents should be reduced on the order of 15 to 30 per cent.

Intangible benefits are realized, such as contribution to community growth goals. Improvement of First Avenue enhances the community's mobility which has an affect on community growth potential and growth patterns. A lack of transportation mobility, if severe enough, can detrimentally affect an urban area's growth potential.

Impacts

Recommendations offered in this report are basically of two types: operational improvements, and widening of First Avenue along its existing alignment. Operational improvements will have little or no negative impact on social, economic, or environmental concerns. Impacts of the proposed widening projects will be generally positive since the project will be basically an improvement of street cross-section within existing rights-of-way. Social, economic and environmental impacts are discussed in the following sections.

Social Impacts - The overall impact of the widening will be favorable, since it contributes to the community's mobility. No changes will result in neighborhood appearance or configuration, school service areas, or individual family life styles and patterns. No degradation of existing neighborhood quality is expected. Localized social impacts

will be felt in the short section of First Avenue for which additional right-of-way must be acquired for the widening project. It is estimated that approximately 16 residential units will be eliminated by the acquisition of necessary right-of-way. For this limited number of families, relocation and the associated disruption of individual family social patterns will result.

Economic Impacts - The widening project should provide a positive economic impact on the community in general due to increased traffic capacity in the corridor and therefore greater accessibility in the corridor. This accessibility is an important factor for commercial establishments and employment centers in the service area of First Avenue.

The project should not adversely affect residential property values along First Avenue, and could serve to enhance values of commercial properties. The direct economic impact upon public taxing bodies (due to loss of taxable property) will be minimal because of the small amount of additional right-of-way required for the widening project.

Environmental Impacts - There will not be any significant degradation in environmental factors, since the widening will be accomplished along existing alignment and almust entirely within existing rights-of-way. There will be

no effect on existing land use patterns, community facilities, and sites of historical or natural significance. Since the improved facility will have an increased traffic capacity, a minimal degradation in air and noise quality could result due to increased travel. However, viewing air and noise relating to vehicular travel, a worse impact could result from not widening First Avenue to accommodate expected future traffic demand. In this case, traffic operation at a lower level-of-service, with slower speeds and traffic congestion, could result in a negative impact on air and noise quality greater in magnitude than the proposed facility.

A number of trees presently located between the curb line and property line must be relocated or removed by the street widening. This relocation or replanting of trees can lessen the negative environmental impact caused by the widening project.

The improved facility will have a more aesthetically pleasing cross-section than the existing facility with the addition of a median. The median provided in the design serves to provide a visual break of the roadway and can be enhanced by use of low plantings or sodded with grass to gain a park-like appearance.

One small city park located between 15th Street W and 17th Street W, will be affected by the proposed widening. A narrow strip of the park approximately 54 feet wide along First Avenue will be needed for right-of-way to provide the width required for the improvement. This acquisition amounts to approximately nine per cent of the park area. The function and effectiveness of the park is not expected to be affected by this loss of land.

IMPLEMENTATION PROGRAM

Recommended improvements have been developed for First Avenue, as discussed in the previous chapter. The improvements are placed into three general implementation phases: immediate (0-2 years), short-range (2-5 years) and long-range (5+ years). These priorities may change based upon changing conditions, local concerns, programming of related improvement projects and availability of funding. The recommended program provides a good beginning point in instituting a program to upgrade First Avenue service and operation. Recommended priorities were established based upon need, ease of implementation, costs, and expected improvement benefits.

Program Priorities

The various recommendations are provided in the following listing by priority category. Detailed discussion of the recommended improvement projects are found in Chapter 4.

Immediate Action Program

- Upgrading of traffic signal operations;
- Peak period parking removal; and
- Fourth Street Railroad grade crossing improvement.

Short-Range Program

- Parking Removal;
- Upgrade Signal Installations; and,
- Computer Control System.

Long-Range Program

- Widening and channelization of First Avenue

Signal Improvement Cost Estimates

Cost estimates for the signal recommendations are developed in this section and are related to the suggested staging of improvements. Since design plans are not prepared for the indicated improvements, the cost estimates are developed at a budgetary planning level. All costs are developed assuming equipment installation by City of Cedar Rapids personnel under force account, with necessary subcontract work being administered by the City. In all cases costs are estimated in 1975 dollars with reasonable accommodations for contingent items are indicated.

The basic unit costs of items used for the improvements are enumerated in Table 16 along with an estimate of installation labor per unit, where applicable. These costs are derived from purchasing experience in Cedar Rapids and from current labor estimates in the midwest. Costs were estimated in four general categories, corresponding to the various traffic control and display recommendations presented in this study.

These categories are:

(1) Intersection timing modifications,
Progressive timing modifications,
Timing program selection changes;

(2) Intersection phasing changes;

(3) Immediate signal improvements; and,

(4) Upgrading of signal displays.

The cost of implementing the first group of improvements is almost entirely labor and the Cedar Rapids traffic engineering staff is fully capable of performing these changes. Since this program has an inherent element of experimentation and testing, it is difficult to assign either a time or dollar value to the tasks. It is therefore felt that these improvements should be programmed as an ongoing maintenance function of the department.

Table 16

UNIT COST ESTIMATES

TRAFFIC SIGNAL IMPROVEMENTS

ITEM	COST PER UNIT INSTALLED
40 foot Mast Arm Assembly and Foundation	$4,200.00
35 foot Mast Arm Assembly and Foundation	3,600.00
30 foot Mast Arm Assembly and Foundation	2,900.00
25 foot Mast Arm Assembly and Foundation	2,400.00
3-section, One-Way Vehicle Signal (Mast Arm Mounting)	310.00
5-section, One-Way Vehicle Signal (Mast Arm Mounting)	450.00
2-section, One-Way Pedestrian Signal (Bracket Mounting)	350.00
2-section, Two-Way Pedestrian Signal (Bracket Mounting)	625.00
2-inch Conduit, Installed in Pavement, including Excavation and Restoration (per foot)	30.00
2-inch Conduit, Installed in Turf, including Excavation and Restoration (per foot)	12.00
Vehicle Loop Detector	225.00
Saw Cutting, Furnishing Installing and Sealing of Loop Wire (per foot)	1.60
Precast Pull Box, 24"x36"	400.00
Precast Hand Hole, 18"x18"	200.00
Traffic Signal Cable, 12 cond. aw612, Installed (per foot)	1.25
Removal of Existing Equipment, per intersection	250.00
Semi-Vehicle Actuated Controller with Actuated Pedestrian Timing, with Cabinet	3,800.00
Midblock Pedestrian or Fire House Controller, with Cabinet	1,000.00

The second group of improvements involves implementing phasing changes at the following eight intersections with First Avenue:

Collins Road
Lindale Plaza
40th Street E
36th Street E
Thompson Drive
5th Street E
6th Street W
13th Street W

Only minor hardware costs are anticipated in implementing the proposed phasing changes, and the labor involved in controller modification and signal reqiring should represent the major cost item. Including engineering design time and construction time, it is estimated these changes will cost approximately $400 per intersection, which for the eight intersections results in a total estimated cost of $3,200. These changes would be made by the Traffic Engineering Department.

New signal displays and control equipment have been proposed for six locations.

36th Street E (midblock)
Fire Station #7
24th Street E (midblock)
Thompson Drive (Cottage Grove)

Fire Station #8

18th Street W

In all cases, signal improvements are estimated based on installations which would be compatible with the long-range roadway widening recommendation. Table 17 presents an enumeration of the major hardware items and their costs for each location which can be identified without detailed design. A figure of 15 per cent is added to identifiable major items to accommodate contingencies. It is assumed that existing coordination units will be reused for these improvements.

The total cost estimate for these improvements, including contingent items is $137,404. Of this amount $23,400 is for installation of new conduit under pavement which may not be required in all cases if conduit exists and is in usable condition.

The cost of signal display standardization, exclusive of intersection control equipment is developed in this section. The 30 existing signalized intersections on First Avenue and Williams Boulevard, excluding the 16th Avenue intersection can be divided into five categories for planning and costing purposes as indicated in Table 18. These categories are:

1) Locations having side mounted signal displays which are not recommended for other improvements;

Table 17

COST ESTIMATE

IMMEDIATE TRAFFIC SIGNAL IMPROVEMENTS

INTERSECTION	ITEMS 40'Mast Arm	25' Mast Arm	3-Section 12" Sigs.	Loop DET	Loop & Wiring	Conduit in Pavement	Signal Cable	Semi-Actuated Controller	Pedestrian or Fire House Contr.	Equipment Removal	One-Way Ped. Signal	Two-Way Ped. Signal	TOTAL
36th St. E (Midblock Pedestrian)	$8,400 (2)		$1,240(4)			$3,000(100)	$313 (250)		$1,000 (1)	$250	700 (2)		$ 17,138
Fire Station No. 7	8,400 (2)		1,550(5)			4,200(140)	313 (250)		1,000 (1)	250	700 (2)		18,875
24th St. E (Midblock Pedestrian)	8,400 (2)		1,240(4)			3,000(100)	313 (250)		1,000 (1)	250	700 (2)		17,138
Cottage Grove	8,400 (2)	$4,800 (2)	2,480(8)	450(2)	$720 (450)	4,500(150)	525 (420)	$3,800 (1)		250		2,500(4)	32,689
Fire Station No. 8	8,400 (2)		1,500(5)			4,200(140)	313 (250)		1,000 (1)	250	700 (2)		18,875
18th St. W	8,400 (2)	8,400 (2)	2,480(8)	450(2)	720 (450)	4,500(150)	525 (420)	3,800 (1)		250		2,500(4)	32,689
												TOTAL	$137,404

NOTE: Numbers in parentheses indicate units estimated for each item.
Total cost includes 15 per cent contingency.

Table 18

FIRST AVENUE SIGNAL IMPROVEMENT CATEGORIES AND COST ESTIMATES

LOCATION	SIDE MOUNTED SIGNALS TO BE UPGRADED	POSSIBLE INTERIM SIGNAL IMPROVEMENTS	EXISTING MAST ARM DISPLAYS TO BE IMPROVED ON WIDENING	TO BE IMPROVED BY I 380 CONSTRUCTION	TO BE IMPROVED UNDER IMMEDIATE SIGNAL RECOMMEN
Collins Road			$29,226		
Lindale Plaza			29,226		
40th Street E		$15,180			
38th Street E	$29,226				
36th Street E					$ 17,138
Fire Station#7					18,875
32nd Street E	29,226				
29th Street E	U.C.		29,226		
27th Street E	29,226				
24th Street E					17,138
Thompson Dr.(Cottage Grove)					32,689
19th Street E			29,226		
16th Street E					
15th Street E		15,180			
13th Street E			29,226		
12th Street E	29,226				
10th Street E			29,226		
5th Street E	29,226				
3rd Street E	29,226				
2nd Street E					
1st Street E			29,226		
1st Street W				X	
3rd Street W				X	
4th Street W				X	
5th Street W		15,180			
6th Street W				X	
13th Street W			29,226		
15th Street W		15,180			
18th Street W					32,689
8th Avenue W		15,180			
Fire Station #8					18,875
TOTAL ESTIMATED COST	$175,356	$75,900	$233,808		$137,404

2) Locations which are to have signals eliminated by proposed medians, but which may need interim improvement;

3) Locations having existing mast arm signal displays which must be replaced by First Avenue widening;

4) Locations to be improved by I-380 construction; and,

5) Locations to be improved under immediate signal improvement recommendations.

A single cost estimate is developed for standardizing these intersections in accordance with the proposed typical intersection design shown in Figure 6. The major hardware and construction items are indicated in Table 19. A contingency amount of 20 per cent is used to accommodate intersection variations and details which cannot be defined without detailed design plans.

Table 19

COST ESTIMATE

TYPICAL INTERSECTION DISPLAY

ITEM	QUANTITY	COST
40' Mast Arm	2	$ 8,400
25' Mast Arm	2	4,800
3-section, 12" signal	8	2,480
5-section, 12" signal	2	900
Conduit Impavement	150	4,500
Signal Cable	420	525
2-Way Pedestrian Signal	4	2,500
Equipment Removal	1	250
Subtotal		$24,355
Contingent Items		4,871
TOTAL		$29,226

The estimated cost of improving the six locations, which have side-mounted signals and will not be modified by other recommendations, is $175,356. Of the five locations which are to be eliminated by roadway widening, only one (at 2nd Street E) currently has mast arm displays.

Upon ultimate widening, eight locations with mast arm displays will need to be replaced. These are indicated in Table 18 to cost $233,808. This cost is actually a cost directly related to the widening project.

Should the widening of First Avenue not appear realistic for some time, it is recommended that the remaining locations with substandard displays be provided with less costly span wire-mounted overhead signals. This type signal installation is estimated to cost $15,180 per location, assuming that four span poles costing $1,500 each are used and that no conduit construction is required, and using a contingency amount of 20 per cent. The total cost of these interim installations is estimated to be $75,900.

Construction Cost Estimates

Cost estimates were developed for the First Avenue widening proposal to provide a basis for budgetary planning.

These costs are based upon 1975 dollars and actual costs will be highly dependent upon the timing of construction.

The development of the construction estimates are based on estimated quantities and unit bid prices indicative of the Cedar Rapids area. Construction items are the major items inherent in the proposed typical section for the new facility and were obtained from field review of the corridor and available mapping. Quantities were estimated for both salvage, resurfacing, and widening of the existing pavements where it was considered acceptable; and for the complete reconstruction of all the subgrade and pavement where necessary. Separate cost estimates were made for the bridge structure and added to estimated roadway costs.

Costs have been developed for individual sections of First Avenue recognizing that the entire widening project would not likely be accomplished under a single construction contract. For example, it is understood the City and the Iowa State Highway Commission are planning ultimate widening for the section between 6th Street SW and 1st Street SW as part of the Interstate Highway 380 project. Cost estimates for the First Avenue widening are shown in Table 20. Total estimated cost of the project is $5,795,108.

Table 20

CONSTRUCTION COST ESTIMATES

First Avenue Widening Project

SECTION	CONSTRUCTION COST	RIGHT-OF-WAY COST	TOTAL
16th Avenue-18th St. W	$ 534,100		$ 534,100
18th St. W-13th St. W	346,200	$595,000	941,200
13th St. W-1st St. W	366,700		366,700
1st St. W-10th St. E	356,500		356,500
10th St. E-19th St. E	399,100		399,100
19th St. E-27th St. E	665,500		665,500
27th St. E-40th St. E	1,558,300 (1)		1,558,300
40th St. E-East City Limit	739,900 (2)		739,900
Traffic Signal Replacement	233,808		233,808
TOTALS	$5,200,108	$595,000	$5,795,108

(1) Includes structure cost of $616,200.
(2) Includes half of cost for railroad grade separation at City Limit of $158,000.

Acquisition of right-of-way has been indicated for only one section of the facility. This right-of-way acquisition is necessary to accommodate the widening, since existing right-of-way between 13th Street W and 18th Street W is now between 66 and 80 feet wide. It may be necessary in the final design to make minor acquisitions depending upon final alignment of First Avenue.

Funding

Funding of the recommended projects is envisioned as a joint participation of the City, the Iowa State Highway Commission, and Federal Highway Administration. The entire study section of First Avenue-Williams Boulevard is a designated Federal Aid Primary route, and as such is eligible for federal assistance. No specific allocation of funding responsibilities is attempted in this report, as this will be a function of implementation timing, statewide improvement priorities, availability of funding and other considerations.