TASK IV

IDENTIFY/ASSESS ROADWAYS

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INTRODUCTION

Establishing roadway priorities was an important part of developing an Intelligent Transportation System (ITS) Early Deployment Plan (EDP) for the Austin metropolitan area. It (1) provided an initial assessment of roadway operational and safety problems; (2) assisted with identifying and defining potential ITS projects; and most importantly, (3) was based on the priorities of local transportation stakeholders, the Austin ITS Steering Committee.

The primary goal of this task was to develop a roadway priority list that represents the priorities of local transportation entities that serve various transportation markets in the Austin area. In this effort, the Austin ITS Steering Committee played an important role. First, their input was used to define the universe of roadways to consider in a technical prioritization process. Next, staff assigned to the ITS EDP (i.e., the Study Team) evaluated each roadway to assess its operational and safety characteristics. The evaluation produced a priority list that was presented to the Steering Committee for comments and approval. And finally, their comments were incorporated into the final roadway priority list. Identifying priority roadways establishes areas for further investigation to determine the appropriateness of applying ITS.

After prioritizing roadways at a global level, the operational characteristics of each roadway should be evaluated to identify the most problematic areas. As outlined in this report, an arterial street on the priority list underwent further evaluation to assess operational characteristics and to identify problematic areas. Signal delay, stops, accidents, emergency response times, and transit on-time performance were used in the evaluation. Once problem locations are identified, a more microscopic investigation should be performed to determine the cause of the problems. Ultimately, ITS may provide a solution to the problems.

The last section of this report proposes an alternate route planning process to accommodate incident diverted traffic. The Federal Highway *Administration's Freeway Incident Management Handbook*[1] was the source of the alternate route planning process.

ROADWAY PRIORITIZATION

Austin ITS Steering Committee Role

Initial input from the Austin ITS Steering Committee drove the roadway prioritization process. Each Steering Committee member was requested to submit a list of their "top 10" roadways in priority order. In addition, they were asked to identify the limits for each roadway. Top 10 lists were submitted by the Capital Metropolitan Transportation Authority, City of Austin Urban Transportation Commission, City of Austin Department of Public Works and Transportation, Federal Highway Administration, Texas Department of Transportation, Transportation Professionals of Central Texas, Travis County Public Improvements and Transportation Department, and the University of Texas. Copies of these lists are provided in Appendix IVA.

The members approached this prioritization task from different perspectives. During a Steering Committee meeting, the attending members presented their prioritization approach. A summary of the presentations is provided below:

<u>Capital Metropolitan Transportation Authority (Capital Metro)</u>: Mike Ouimet presented Capital Metro's priority list. Their list focused on principle transit corridors. These corridors received the greatest amount of transit service. Mr. Ouimet also mentioned that they are looking at providing enhanced transit service along these corridors in the form of light rail transit (if approved by the voters) and technologies (e.g., transit signal priority).

<u>City of Austin Transportation Division</u>: David Gerard with the City of Austin explained that their list was based on a congestion map developed through the Congestion Demand Management (CDM) study. The map illustrates congested roadways based on a methodology developed by the Texas Transportation Institute[2]. Existing traffic volumes and number of lanes were the two primary variables used in the methodology to determine whether a roadway was congested. Mr. Gerard primarily focused on arterial streets under the assumption that the freeways would be listed in other members' lists. All together, 37 roadways were submitted by the City of Austin. Mr. Gerard indicated that they had to struggle with identifying their top 10 roadways since they would like to have all of the congested roadways considered in the Early Deployment Plan. In addition, Mr. Gerard presented a list of problems encounter along these roadways and potential improvements.

City of Austin Urban Transportation Commission (UTC): John Hickman presented the Urban Transportation Commission's roadway priority list. He along with two other Commissioners prepared their list from their general knowledge of the Austin transportation system and CDM work done by the City of Austin.

Texas Department of Transportation (TxDOT): Bubba Needham explained that he used a network perspective that provided connectivity between the roadways to identify TxDOT's top 10 roadways. Besides the freeway network, Mr. Needham listed roadways that provide cross- town connections between north and south Austin and east and west Austin. He also listed Red River Street since it may be a viable option to accommodate diverted traffic from IH 35 during an incident. Mr. Gerard also indicated that although Congress Avenue did not make the City of Austin's top 10 list, it too could serve as a viable alternative to IH 35 during an incident.

Travis County Public Improvements and Transportation Department (PITD): Through correspondence, David E. McKay with the PITD believed that the priority list submitted by the Urban Transportation Commission provided "the best direction toward improving overall County traffic movement." Mr. McKay added, "Thoroughfares providing alternate routing to and from these corridors during peak traffic periods present additional needs and improving these facilities would certainly follow in consideration."

University of Texas (UT): To identify their priorities, Dr. Michael Walton along with his colleagues used a system perspective that provided connectivity between the roadways. They focused on linking major freeways with arterial streets based on their understanding and appreciation of transportation issues in Austin.

In all, 25 roadways were submitted by the Steering Committee (refer to **Table IV-1**). The roadway limits reflect the furthest north/south or east/west limit submitted by the Steering Committee members. The limits for five roadways, however, resulted in the primary roadway overlapping with another roadway. These roadways included: (1) Ben White Boulevard from Loop 1 to FM 973, (2) Lamar Boulevard/Guadalupe Street from Parmer Lane to MLK Boulevard, (3) Lamar Boulevard from IH 35 to US 290, (4) Burnet Road from IH 35 to 38th Street, and (5) 45th Street from Loop 1 to IH 35. The overlaps usually resulted from different views about the function a particular roadway should serve. Eliminating the overlaps was needed to facilitate the roadway prioritization process. The primary change to remove the overlaps was to split the original roadway into two or more roadways. The splits occurred at points where the roadways changed names. The roadway segments that resulted from the split retained the same priority as the original roadway. These changes are shown in the top 10 lists submitted by the Steering Committee members (refer to Appendix IVA). Nonetheless, the original roadways were important to the agencies that submitted them and need to be remembered to understand their desired functions and to identify potential ITS projects that could enhance these functions.

Prior to the technical evaluation, a simple prioritization process was used to develop a clearer picture of the Steering Committee's roadway priorities as a group. The first priority on each member's list received a score of 10, the second priority received a score of nine and so forth until the tenth priority received a score of one. A cumulative score was then determined for each roadway (refer to Appendix IVB). **Table IV-1** lists the 25 roadways in descending order of cumulative score (note: six roadway pairs received the same cumulative score). As expected, the freeways are the top priorities followed by major and minor arterial streets. These 25 roadways established the universe of roadways to undergo a technical prioritization process.

Technical Prioritization Process

The fundamental goals of ITS are to improve the transportation system's operational efficiency and safety. With these goals in mind, average vehicle delay rate and average accident frequency were chosen respectively to represent each roadway's operational and safety characteristics. In addition, the data required to compute these measures of effectiveness (MOEs) were readily available and relatively current (1991 to 1994). The following sections discuss the roadway inventory process, the methods used to compute average vehicle delay rate and average accident frequency, how these MOEs were used in the technical prioritization process, and ultimately, the roadway prioritization table.

No.	Roadway	From	To	Cumulative Score	Rank
1	US 183	RM 620	SH 71	69	1
2	IH 35	FM 1325	FM 1327	66	2
3	Loop 1	IH 35	William Cannon Dr.	65	3
4	SH 71	US 290	FM 973	37	4
5	Lamar Blvd.	IH 35	SH 71	34	5
6	Koenig Ln.	Loop 360	Springdale Rd.	31	6
7	Burnet Rd.	Loop 1	38th St.	20	7
8	Congress Ave.	Town Lake	Slaughter Ln.	17	8
9	Loop 360	RM 2244	Lamar Blvd.	16	9
10	Guadalupe St.	W. 51st St.	Cesar Chavez St.	12	10
11	Riverside Dr.	Lamar Blvd.	SH 71	12	10
12	Parmer Ln.	FM 1431	IH 35	11	12
13	S. 1st St.	Town Lake	Slaughter Ln.	10	13
14	W. Guadalupe St.	Lamar Blvd.	W. 45th St.	10	13
15	6th/5th St.	Loop 1	Pleasant Valley Rd.	9	15
16	Airport Blvd.	Lamar Blvd.	US 183	9	15
17	Enfield Rd./15th St.	Loop 1	IH 35	7	17
18	38th St.	Loop 1	H 35	6	18
19	45th St.	Loop 1	IH 35	6	18
20	RM 620	US 81	SH 71	4	20
21	Cesar Chavez St.	Loop 1	Springdale Rd.	3	21
22	RM 2244	Barton Creek Blvd.	Loop 1	2	22
23	William Cannon Dr.	Loop 1	IH 35	2	22
24	Red River St.	E. 45th St.	Cesar Chavez St.	1	24
25	Spicewood Spring Rd./ Anderson Ln.	Loop 360	Lamar Blvd.	1	24

Note: This list is not the final roadway priority list approved by the Austin ITS Steering Committee. This list serves to develop a preliminary picture of the Steering Committee's roadway priorities as a group.

Preliminary Austin ITS Steering Committee Roadway Priorities_Table IV-1

Roadway Inventory

Each roadway was inventoried to identify points where names changed, to locate major cross-streets, to determine block numbers, and to estimate distances between cross-streets (refer to Appendix IVC). Identifying points where the roadway changed names was necessary to ensure the accident history correctly matched a specified intersection or roadway section. Major cross-streets included every signalized intersection and grade separated structure within the roadway limits. Block numbers were also needed to compile accident data, specifically, mid-block accidents. Approximate block numbers were estimated from a city map that identifies block numbers at varying intervals along each roadway. Two sources were used to estimate distances between cross streets. Previous travel time studies were one source. A distance measuring instrument (DMI) was connected to the travel time vehicle's transmission to record distances. For sections where travel times studies were not conducted, estimates were made from a scaled map of Austin. The scaled map produced estimates that were typically within +/- 100 feet of the distances measured with the DMI.

Average Vehicle Delay Rate

Seven computations were typically performed to determine average vehicle delay rate for each roadway. Besides the roadway inventory, two data sources were used to compute average vehicle delay rate: (1) travel time studies conducted during the A.M.-peak (7:00 a.m. to 8:30

a.m.) and P.M.-peak (4:30 p.m. to 6:00 p.m.) periods in 1991, 1992, 1993, and/or 1994 and (2) 1992 24-hour volume counts. The following sections present the computations and data used to estimate average vehicle delay rate.

<u>Travel Rate</u>

Travel rates were computed from the travel time studies. Travel rate is the time in minutes required to travel a section of roadway if it were one mile in length (i.e., travel time divided by travel distance). Equation 1 illustrates the basic travel rate formula.

$$tr = \frac{tt}{td} \qquad (1)$$

where,

tr = travel rate (minutes/mile);
tt = travel time (minutes); and,
td = travel distance (miles).

<u>Average Travel Rate</u>

The travel time studies typically divided each roadway into two or more sections to facilitate data collection. For instance, IH 35 was divided into two sections: (1) FM 1325 to Yager Lane and (2) Yager Lane to William Cannon Drive. For each section, several (between four and ten) travel time runs were usually performed in both directions and peak periods. The travel rates resulting from each travel time run were averaged to produce a single travel rate for each direction and peak period (refer to Equation 2). To illustrate, six travel time runs were conducted on the IH 35 section between FM 1325 and Yager Lane in the northbound direction during the A.M.-peak period. An average was taken of the resulting six travel rates to arrive at an average travel rate for the specified direction and peak period.

$$atr_{x,y} = \frac{tr_1 + tr_2 + \ldots + tr_n}{n} \qquad (2)$$

where,

atr	=	average travel rate, (minutes/mile);
x	=	direction of travel--NB, SB, EB, or WB;
y	=	A.M.- or P.M.-peak period; and,
n	=	number of travel time runs.

<u>Average Section Travel Rate</u>

Next, the travel rates for each direction and peak period, as determined above, were averaged to produce an average section travel rate (refer to Equation 3). Using the section of IH 35 from FM 1325 to Yager Lane as an example again, the average travel rates for the northbound direction during the A.M.- and P.M.-peak periods were added to the travel rates for the southbound direction during the A.M.- and P.M.-peak periods and then divided by four to produce an average section travel rate.

$$astr_i = \frac{\sum atr_{x,y}}{n} \qquad (3)$$

where,

$astr_i$	=	average section travel rate (minutes/mile);
i	=	roadway section number; and
n	=	number of average travel rates for section "i", 1 to 4.

On certain sections of Cesar Chavez Street, Enfield Road, and 45th Street, travel times studies were only conducted in the peak direction during the peak periods. Therefore, only two average travel rates were used to compute the average section travel rate. Three average travel rates were available for one section of Cesar Chavez Street. For the remaining roadways, however, four average travel rates were available for each section.

<u>Average Roadway Travel Rate</u>

Since the travel time studies typically required dividing the roadways into sections, a weighted average was used to determine a travel rate for the entire roadway (refer to Equation 4). The weighting is based on the length of each roadway section. As stated previously, IH 35 was divided into two sections. Therefore, the average section travel rate from FM 1325 to Yager Lane and Yager Lane to William Cannon Drive was multiplied by their corresponding section lengths and then divided by the total distance from FM 1325 to William Cannon Drive to produce an average travel rate for IH 35.

$$artr = \frac{\sum(astr_i \ x \ d_i)}{\sum(d_i)} \qquad (4)$$

where,

artr = average roadway travel rate (minutes/mile) and
d_i = length of roadway section "i" (feet).

Travel time studies were not conducted on the sections of US 183 and SH 71 under reconstruction. Therefore, average roadway travel rates were not available for these roadways.

In addition, travel time information was only available for a short section of 5th and 6th Street between West Lynn Street and West Avenue. Since this section was not believed to accurately represent the travel rates along the entire length of 5th and 6th Street, travel rates were not computed. Travel time information was also not available for West Guadalupe Street.

Nearly every roadway had sections where travel time studies were not conducted. Since these sections were relatively short, it was assumed that the travel rates, as determined above, adequately represented the sections where travel rate data was not available.

Average Desired Travel Rate

Now that an estimate of the average roadway travel rate on each roadway was determined, the next step towards developing an average vehicle delay rate was to compute a desired travel rate. For this study, a desired travel rate was based on the speed limit. Since the speed limits typically varied along each roadway, a weighted average was used to compute the desired travel rate (refer to Equation 5). The weighted average is based on the speed limit within each speed zone and the

$$adtr = \frac{60 \ x \ \sum d_i}{\sum(sl_i \ x \ d_i)} \qquad (5)$$

zone's length.

where,

adtr = average desired travel rate (minutes/mile);
60 = conversion factor (miles/hour ⌛ miles/minute);
d_i = length of speed zone "i" (feet); and
sl_i = speed limit in zone "i" (miles/hour).

Average Vehicle Delay Rate

Average vehicle delay rate[3] for a roadway is composed of two components: (1) a traffic volume and (2) a delay rate. The traffic volume component allows a relative comparison between roadways based on the amount of vehicles experiencing delay. An average 24-hour volume was determined for each roadway using 1992 volume data[4]. The traffic volumes were reported for various sections along each roadway. Therefore, a weighted average based on each section's traffic volume and length was used to estimate an average 24-hour volume for the roadway (refer to Equation 6).

$$a24v = \frac{\sum(24Hr.\ Volume_i \ x \ d_i)}{\sum d_i} \qquad (6)$$

where,

a24v = average 24-hour volume (vehicles/day);
24-Hr. $Volume_i$ = 24-hour volume for section "i" (vehicles/day); and,
di = length of roadway section carrying 24-hour $volume_i$ (feet).

Since the A.M.- and P.M.-peak period travel rates were combined to determine an average roadway travel rate, the A.M.- and P.M.-peak hour volumes were used. Two assumptions were made at this point. First, peak-period travel rates are the same as peak-hour travel rates. Second, 10 percent of the 24-hour traffic volume on any roadway was assumed to occur during the A.M.-peak hour and again during the P.M.-peak hour. The 10 percent value (i.e., "K" factor) is a rough estimate of the proportion of daily traffic occurring during the peak hour on an urban freeway[5,6]. In this study, however, the 10 percent estimate was applied to freeways and arterials. Having made these two assumptions, an average vehicle delay rate was estimated by multiplying the traffic volume component, 20 percent (10 percent in the A.M.-peak hour and 10 percent in the P.M.-peak hour) of the 24-hour traffic volume, by the delay rate component, the difference between average desired travel rate and average actual travel rate (refer to Equation 7). The roadway ranking based exclusively on average vehicle delay rate is provided in Appendix IVD, Table IVD-1.

$$avdr \;=\; 0.2 \; x \; a24v \; x \; (adtr \;\; artr) \qquad (7)$$

where,

avdr	=	average vehicle delay rate (lost minutes/mile) and
0.2	=	estimated percent of average 24-hour volume traveling during both the A.M.- and P.M.-peak hours.

Average Accident Frequency

Average accident frequency was the second MOE used to compare roadways. Signalized intersection and mid-block accidents during 1993 and 1994 were used to compute average accident frequencies. The City of Austin's accident data base was used to retrieve accidents within the city limits. TxDOT's data base was used to retrieve those accidents outside the city limits. Two years of accident data were used to better represent the typical accident frequency along each roadway. An average accident frequency (accidents/mile/year) was estimated by adding the signalized intersection and mid-block accidents together and then dividing by two (since two years of accident data were used) and the length of each roadway in miles (refer to Equation 8). The roadway ranking based on average accident frequency is provided in Appendix IVD, Table IVD-2.

$$aaf = \frac{\sum ia_i + \sum mba_i}{2 \; x \; rl} \tag{8}$$

where,

aaf	=	average accident frequency (accidents/mile/year);
ia_i	=	total accidents at intersection "i" in 1993 and 1994;
mba_i	=	total mid-block accidents in section "i" in 1993 and 1994;
2	=	conversion factor to average accidents/year; and,
rl	=	entire roadway length (miles).

Technical Prioritization Method

The previous sections outlined how the two roadway prioritization MOEs, average vehicle delay rate and average accident frequency, were determined. The next step in the technical prioritization process combined these two values into one number for each roadway. First, the average vehicle delay rate values were normalized by dividing each value by the highest average vehicle delay rate. The average accident frequencies were also normalized in the same manner. Next, the normalized values were added together and divided by two to yield a mean unweighted score. The mean unweighted scores were then listed in descending order to produce a roadway prioritization table.

At this point, a presentation was made to the Steering Committee to receive comments from the members on the technical prioritization process. Their primary recommendation was to combine the Steering Committee's roadway priorities, **Table IV-1**, with the average vehicle delay rate and average accident frequency data. This recommendation was incorporated into the final prioritization table. The cumulative scores for the roadways in **Table IV-1** were normalized in the same manner discussed previously. All three normalized scores were added together and divided by three. The mean unweighted score for the roadways without an average vehicle delay rate were determined by adding the normalized values for average accident frequency and Steering Committee priorities together and dividing by two. The roadways were reprioritized based on the revised mean unweighted scores. The final roadway priority list approved by the Steering Committee is shown in **Table IV-2**.

Roadway	From	To	Average Vehicle Delay Rate		Average Accident Frequency		Steering Committee Priorities		Mean Unweighted Score	Rank
			Actual	Normalized	Actual	Normalized	Actual	Normalized		
			(lost min/mile)	(Actual/Highest) (A)	(acc/mile/yr)	(Actual/Highest) (B)	(cumulative score)	(Actual/Hig (C)	(A+B+C)/	
US 183	RM 620	SH 71	a	N/A	45.8	0.61	69	1.00	0.80 b	1
Loop 1	IH 35	William Cannon Dr.	-7,964	1.00	19.1	0.25	65	0.94	0.73	2
IH 35	FM 1325	FM 1327	-6,429	0.81	26.6	0.35	66	0.96	0.71	3
Lamar Blvd.	IH 35	SH 71	-4,610	0.58	56.3	0.74	34	0.49	0.61	4
Riverside Dr.	Lamar Blvd.	SH 71	-4,610	0.58	75.6	1.00	12	0.17	0.58	5
38th St.	Loop 1	IH 35	-5,932	0.74	64.7	0.86	6	0.09	0.56	6
Guadalupe St.	51st St.	Cesar Chavez St.	-5,290	0.66	58.9	0.78	12	0.17	0.54	7
SH 71	US 290	FM 973 (Bergstrom	a	N/A	39.5	0.52	37	0.54	0.53 b	8
6th/5th St.	Loop 1	Pleasant Valley Rd.	a	N/A	69.8	0.92	9	0.13	0.53 b	9
Parmer Ln.	RM 620	IH 35	-7,949	1.00	14.5	0.19	11	0.16	0.45	10
Congress Ave.	Town Lake	Slaughter Ln.	-3,321	0.42	44.4	0.59	17	0.25	0.42	11
Burnet Rd.	IH 35	38th St.	-3,075	0.39	42.0	0.56	20	0.29	0.41	12
Koenig Ln.	Loop 360	Springdale Rd.	-3,134	0.39	26.7	0.35	31	0.45	0.40	13
Enfield Rd.	Loop 1	IH 35	-1,766	0.22	56.8	0.75	7	0.10	0.36	14
Airport Blvd.	Lamar Blvd.	US 183	-2,504	0.31	47.3	0.63	9	0.13	0.36	15
45th St.	Loop 1	IH 35	-4,761	0.60	26.8	0.35	6	0.09	0.35	16
Loop 360	RM 2244	Lamar Blvd.	-4,160	0.52	20.0	0.26	16	0.23	0.34	17
Cesar Chavez St.	Loop 1	Springdale Rd.	-2,975	0.37	44.9	0.59	3	0.04	0.34	18
William Cannon Dr.	Loop 1	IH 35	-2,418	0.30	48.4	0.64	2	0.03	0.32	19
RM 2244	Barton Creek Blvd.	Loop 1	-3,685	0.46	30.3	0.40	2	0.03	0.30	20
South 1st St.	Town Lake	Slaughter Ln.	-1,568	0.20	32.3	0.43	10	0.14	0.26	21
Red River St.	45th St.	Cesar Chavez St.	-1,507	0.19	33.4	0.44	1	0.01	0.22	22
Spicewood Springs Rd./ Anderson Ln.	Loop 360	Lamar Blvd.	-1,716	0.22	29.6	0.39	1	0.01	0.21	23
RM 620	IH 35	SH 71	-964	0.12	9.0	0.12	4	0.06	0.10	24
W. Guadalupe St.	Lamar Blvd.	W. 45th St.	a	N/A	0.0	0.00	10	0.14	0.05 b	25

a Travel time information was not available for these roadways.
b Mean unweighted score is based on average accident frequency and Steering Committee priorities.

Austin ITS Steering Committee Roadway Priority Table_Table IV-2

ARTERIAL-STREET PROBLEM IDENTIFICATION

After prioritizing roadways at a global level, the operational characteristics of each roadway should be evaluated (1) to identify the most problematic areas and (2) to quantify existing conditions. Knowing the existing magnitude of the problem is necessary for measuring the effectiveness of strategies aimed to address the problem (e.g., before and after studies). Once problem locations are identified and quantified, a more microscopic investigation (e.g., field investigations) should be performed to determine the cause of the problems. Ultimately, ITS may provide a solution to the problems. Nonetheless, traditional transportation engineering tools, like safety studies and signal timing adjustments, should also be considered to address the problems. Although ITS (e.g., dynamic lane control signs) can address some of the site-specific problems discussed in the following text, most ITS elements are geared toward system level improvements (e.g., incident management, traveler information, adaptive signal control, transit signal priority).

Lamar Boulevard was selected as a case study to illustrate a process that identifies problematic locations and quantifies existing conditions along one of the top 25 priority roadways identified by the Austin ITS Steering Committee. Signal delay, stops, accidents, emergency response times, and transit on-time performance were the MOEs used in this case study. Emergency response times and transit on-time performance were not used to identify problematic areas, but to identify trends in operational performance. These MOEs are readily available from Austin transportation stakeholders. A similar process could also be applied to freeways.

Objectives

1. Identify locations that experience the poorest operational characteristics. Stop delay, stops, and accident frequencies at signalized intersection along with mid-block accident rates were used to identify these locations.
2. Identify trends in emergency response times and dispatching characteristics of emergency medical service (EMS) units.
3. Identify trends in transit on-time performance.

Study Area

The Lamar Boulevard study area extends from IH 35 at the north end to Ben White Boulevard at the south end. This section is approximately 16.1 miles in length and contains 43 signalized intersections.

Stop Delay

Data Collection

Travel time studies were used to measure stop delay on Lamar Boulevard approaches to signalized intersections during the A.M.- and P.M.-peak periods in 1991, 1992, 1993, 1994, and 1995. Seven o'clock in the morning to 8:30 a.m. defined the A.M.-peak period and 4:30 p.m. to 6:00 p.m. defined the P.M.-peak period. The initial data collection effort to establish baseline travel time conditions on all roadways of interest began in 1991 and ended in 1994. Therefore, signal delay data during this initial period were grouped together and labeled as "1991/1994" data. Comparison are made between the 1991/1994 and 1995 data collection periods. Four study periods existed in each data collection period: (1) A.M.-peak southbound, (2) A.M.-peak northbound, (3) P.M.-peak southbound, and (4) P.M.-peak northbound. Cross-street stop delay data was not collected.

Objectives

1. Which intersections consistently experienced unacceptable delays (level-of-service "E"--stopped delay = 40.1 to 60.0 sec/veh or greater was considered an unacceptable level of delay) during both the 1991/1994 and 1995 data collection periods?
2. Which intersections exhibited an increase in the number of study periods operating at a LOS E or greater from 1991/1994 to 1995?
3. Did signal delay increase from 1991/1994 to 1995?

The answers to these questions will be used to indicate where recurring congestion occurs during the peak periods and whether it is increasing.

Analysis and Findings

Stop delay data for 1991/1994 and 1995 are summarized in **Table IV-3**. Shaded study periods indicate that the respective Lamar Boulevard approach experienced a level-of-service (LOS) "E" or greater. (Please refer **to Table IV-3**. It provides a clearer picture of the intersections experiencing unacceptable delay levels than the following lists.) **Table IV-4** illustrates the change in peak, off-peak, and total stop delay from 1991/1994 to 1995.

1. Five intersections consistently experienced unacceptable delays during both the 1991/1994 and 1995 data collection periods (refer to **Table IV-3**). Although Lamar Boulevard was retimed during December 1994/January 1995, these intersections continued to exhibit recurring congestion (signal timing changes may not be able to improve operations).

   1. Rundberg Lane
   2. 38th Street
   3. 24th Street
   4. 6th Street
   5. 5th Street

2. Seven intersections exhibited an increase in the number of study periods operating at a LOS E or greater from 1991/1994 to 1995 (refer to **Table IV-3**).

   1. Braker Lane
   2. Morrow Street
   3. Justin Lane
   4. Koenig Lane
   5. 38th Street
   6. 24th Street
   7. MLK Boulevard

3. Signal delay increased from 1991/1994 to 1995.

   A. In 1995, more intersections (10 intersections versus eight intersections) experienced a LOS E or greater more frequently (15 periods versus eight periods) than in 1991/1994 (refer to **Table IV-3**).

Major Cross-Streets (signalized Intersections)	A.M.-Peak Period				P.M.-Peak Period			
	Southbound		Northbound		Southbound		Northbound	
	1991/1994 (sec/veh)	1995 (sec/veh)	1991/1994 (sec/veh)	1995 (sec/veh)	1991/1994 (sec/veh)	1995 (sec/veh)	1991/1994 (sec/veh)	1995 (sec/veh)
N. I 35 WF	--	--	--	--	--	--	--	--
W. Parmer Ln.	--	--	--	--	--	--	--	--
W. Yager Ln.	--	--	--	--	--	--	--	--
North Bend Dr.	--	--	1	4	--	--	1	0

Major Cross-Streets (signalized Intersections)	A.M.-Peak Period				P.M.-Peak Period			
W. Braker Ln.	15	**46**	0	9	24.6	34	28	**51**
Kramer Ln.	5	0	0	2	6	8	1	0
Meadows	0	0	0	0	0	0	0	0
Masterson Pass	0	0	0	0	1	0	2	0
Rutland Dr.	10	34	0	0	6	13	6	2
W. Rundberg Ln.	15	8	5	22	24.9	28	**125**	**89**
Peyton Gin Rd.	0	6	0	3	10	1	2	14
Thurmond St.	2	0	3	0	0	0	0	0
W. Anderson Ln./Research Blvd.(GS)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Morrow St.	8	0	--	0	5	17	--	**42**
W. St. Johns Ave.	--	0	6	0	--	0	0	0
Airport Blvd.	0	9	7	7	0	4	4	24
Justin Ln.	0	6	2	0	17	10	6	**48**
Brentwood St.	0	4	0	0	0	8	1	2
Denson Dr.	0	14	1	0	0	2	6	0
W. Koenig Ln.	9	**57**	0	2	22	12	19	39
W. North Loop Blvd.	11	33	0	10	4	0	29	6
W. 51st St.	0	0	19	0	0	0	17	12
W. Guadalupe St.	0	0	--	0	0	0	--	0
W. 45th St.	--	0	0	9	--	1	13	20
W. 38th St.	2	**40.3**	14	12	9	**41**	**47**	**48**
W. 34th St.	11	0	26	30	26	0	27	25.0
W. 29th St.	2	7	1	8	5	7	0	29
W. 24th St.	29	**41**	0	**41**	**64**	**68**	0	37
W. MLK Blvd.	0	0	--	1	0	0	--	**54**
W. 15th St. (GS)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Parkway	--	14	0	0	0	0	0	0
W. 12th St.	0	5	0	11	0	0	11	6
W. 10th St.	0	0	0	0	**42**	0	0	2
W. 9th St.	0	0	2	15	25.0	19	5	14
W. 6th St.	10	5	3	0	**91**	**75**	3	0
W. 5th St.	2	0	**56**	**65**	5	4	5	9
W. 1st St. (GS)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
W. Riverside Dr.	0	0	15	31	**56**	22	0	11
Barton Springs Rd.	7	12	**45**	29	39	6	20	14
Treadwell St.	0	2	0	4	0	4	3	2
Hether St./W. Mary St.	0	12	0	0	7	0	0	0
W. Oltorf St.	0	2	18	0	2	0	16	16
Bluebonnet Ln.	2	10	0	0	25.2	0	0	5
Manchaca Rd.	0	0	0	0	0	0	0	5
Barton Skwy.	11	7	0	8	8	2	3	5
Panther Trl.	0	2	0	0	0	6	0	0
Brodie Oaks (Pull Mid-Block)	--	--	--	--	--	--	--	--
W. Ben White Blvd. (GS)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Notes: 1.intersection approaches with stop delay >= LOS E (40.1 sec/veh) are shaded.
2."GS" refers to grade separated cross streets.

Stop Delay for Lamar Boulevard Signalized Intersection Approaches_Table IV-3

Direction	A.M. Peak				P.M. Peak				% ✦ 1991/1994 to 1995
	SB		NB		SB		NB		
	1991/ 1994	1995	1991/ 1994	1995	1991/ 1994	1995	1991/ 1994	1995	
Peak	119	305	139	163	300	138	345	548	28
Off-Peak	32	71	85	160	224	254	55	83	43
Total	151	376	224	323	524	392	400	631	33

Note: Directional traffic volume splits indicate the change from peak to off-peak direction occurs immediately south of 15th Street in the A.M. peak and 12th Street in the P.M. peak (refer to Appendix IVE).

Cumulative Peak and Off-Peak Directional Stopped Delay (sec/veh)_Table IV-4

B. Lamar Boulevard signal stop delay increased 28 percent in the peak direction, 43 percent in the off-peak direction, and 33 percent when the peak and off-peak directions were combined from 1991/1994 to 1995 (refer to **Table IV-4**).

Stops

Data Collection

The travel time studies used for stop delay were also used to examine stops. Each time a stop delay was recorded, it indicated that the travel time study vehicle had to stop. A ratio was developed with the number of travel time runs when the study vehicle had to stop in the numerator and the total number of travel time runs in the denominator. This ratio was used to indicate how frequently vehicles had to stop.

Objectives

1. Which intersections consistently required travel time study vehicles to stop at least 75 percent of the time during both the 1991/1994 and 1995 data collection periods?
2. Which intersections exhibited an increase in the number of study periods requiring the study vehicle to stop at least 75 percent of the time from 1991/1994 to 1995?
3. Did the percentage of stops increase from 1991/1994 to 1995?

The answers to these questions will be used to indicate where recurring congestion occurs during the peak periods and whether it is increasing. In addition, the answers should support those findings for stop delay as well as identify additional locations where congestion exists.

Analysis and Findings

The 1991/1994 and 1995 number of stops and number of travel time runs are summarized in **Table IV-5**. Any Lamar Boulevard approach requiring the travel time vehicle to stop more than 75 percent of the time is shaded in **Table IV-5**.

1. Two intersections consistently required travel time study vehicles to stop at least 75 percent of the time during both the 1991/1994 and 1995 data collection periods (refer to **Table IV-5**). These intersections also consistently experienced unacceptable delay levels in 1991/1994 and 1995.

    1. Rundberg Lane 2. 6th Street

2. Eight intersections exhibited an increase in the number of study periods requiring the study vehicle to stop at least 75 percent of the time from 1991/1994 to 1995 (refer to **Table IV-5**).

1. Braker Lane	5. 34th Street
2. Rundberg Lane	6. 29th Street
3. 45th Street	7. 24th Street
4. 38th Street	8. 5th Street

A. In 1995, <u>more intersections</u> (nine intersections versus seven intersections) <u>more frequently</u> (14 periods versus nine periods) required the study vehicle to stop at least 75 percent of the time than in 1991/1994 (refer to **Table IV-6**).

B. The percentage of stops increased 21 percent in the peak direction, 38 percent in the off-peak direction, and 29 percent when the peak and off-peak directions were combined from 1991/1994 to 1995 (refer **to Table IV-6**).

Direction	**A.M. Peak**				**P.M. Peak**				**% ✦ 1991/1994 to 1995**
	SB		**NB**		**SB**		**NB**		
	1991/ 1994	**1995**	**1991/ 1994**	**1995**	**1991/ 1994**	**1995**	**1991/ 1994**	**1995**	
Peak	18	23	12	23	42	22	28	39	21
Off-Peak	15	21	14	26	22	24	16	26	38
Total	17	23	13	25	27	23	25	35	29

Note: Directional traffic volume splits indicate the change from peak to off-peak direction occurs immediately south of 15th Street in the A.M. peak and 12th Street in the P.M. peak (refer to Appendix IVE).

Peak and Off-Peak Directional Stop Percentages_Table IV-6

Major Cross-Streets (signalized Intersections)	A.M.-Peak Period				P.M.-Peak Period			
	Southbound		Northbound		Southbound		Northbound	
	1991/1994 (stops/run)	1995 (stops/run)	1991/1994 (stops/run)	1995 (stops/run)	1991/1994 (stops/run)	1995 (stops/run)	1991/1994 (stops/run)	1995 (stops/run)
N. I 35 WF	--	--	--	--	--	--	--	--
W. Parmer Ln.	--	--	--	--	--	--	--	--
W. Yager Ln.	--	--	--	--	--	--	--	--
North Bend Dr.	--	--	2/21	1/6	--	--	2/18	0/7
W. Braker Ln.	13/21	4/6	0/14	4/6	14/19	7/7	5/11	4/7
Kramer Ln.	1/14	0/6	0/14	1/6	1/11	1/7	1/11	0/7
Meadows	0/14	0/6	0/14	0/6	0/11	0/7	0/11	0/7
Masterson Pass	0/14	0/6	0/14	0/6	1/11	0/7	1/11	0/7
Rutland Dr.	4/14	3/6	0/14	0/6	2/11	4/7	3/11	1/7
W. Rundberg Ln.	4/14	2/6	1/14	6/6	4/11	3/7	11/11	7/7
Peyton Gin Rd.	0/14	2/6	0/14	1/6	6/11	1/7	1/11	5/7
Thurmond St.	1/14	0/6	4/14	0/6	1/11	0/7	0/11	0/7
W. Anderson Ln./Research Blvd.(GS)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Morrow St.	3/14	0/6	--	0/6	1/11	2/7	--	5/7
W. St. Johns Av.	--	0/6	6/8	0/6	--	0/7	0/13	0/7
Airport Blvd.	0/8	2/6	2/8	1/6	0/13	1/7	4/13	4/7
Justin Ln.	0/8	1/6	1/8	0/6	6/13	2/7	4/13	3/7
Brentwood St.	0/8	1/6	0/8	0/6	0/13	3/7	1/13	1/7
Denson Dr.	0/8	3/6	1/8	0/6	0/13	1/7	3/13	0/7
W. Koenig Ln.	5/8	3/6	0/8	1/6	6/13	3/7	7/13	4/7
W. North Loop Blvd.	2/8	3/6	0/8	1/6	4/13	0/7	5/13	1/7
W. 51st St.	0/8	0/6	8/8	0/6	0/13	0/7	13/13	5/7
W. Guadalupe St.	0/8	0/6	--	0/6	0/13	0/7	--	0/7
W. 45th St.	--	0/6	0/7	2/6	--	1/7	2/6	7/7
W. 38th St.	1/7	3/6	2/7	2/6	1/6	6/7	4/6	5/7
W. 34th St.	2/7	0/6	5/7	6/7	3/6	0/7	3/6	5/6
W. 29th St.	1/7	1/6	1/7	6/7	2/6	2/7	0/6	6/6
W. 24th St.	4/7	6/6	0/7	7/7	4/6	6/7	0/6	3/6
W. MLK Blvd.	0/7	0/7	--	1/7	0/6	0/7	--	4/6
W. 15th St. (GS)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Parkway	--	4/6	0/7	0/7	0/6	0/7	0/7	0/6
W. 12th St.	0/8	1/6	0/8	3/7	0/6	0/7	2/7	1/6
W. 10th St.	0/8	0/6	0/8	0/7	3/6	0/7	0/7	1/6
W. 9th St.	0/8	0/6	1/8	5/7	3/6	3/7	1/7	4/6
W. 6th St.	7/8	2/6	1/8	0/7	5/6	6/7	1/7	0/6
W. 5th St.	1/8	0/6	4/8	6/7	1/6	1/7	2/7	1/6
W. 1st St. (GS)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
W. Riverside Dr.	0/8	0/6	2/8	2/7	5/6	4/7	0/7	1/6
Barton Springs Rd.	1/8	1/6	3/8	3/7	6/6	2/7	3/7	3/6
Treadwell St.	0/8	1/6	0/8	2/7	0/6	2/7	3/7	1/6
Hether St./W. Mary St.	0/8	4/6	0/8	0/7	1/6	0/7	0/7	0/6
W. Oltorf St.	0/8	1/6	3/8	0/7	1/6	0/7	5/7	4/6
Bluebonnet Ln.	1/8	3/6	0/8	0/7	4/6	0/7	0/7	2/6
Manchaca Rd.	0/8	0/6	0/8	0/7	0/6	0/7	0/7	1/6
Barton Skwy.	7/8	1/6	0/8	3/7	4/6	1/7	0/7	2/6
Panther Trl.	0/8	1/6	0/8	0/7	0/6	1/7	0/7	0/6
Brodie Oaks (Pull Mid-Block)	--	--	--	--	--	--	--	--
W. Ben White Blvd. (GS)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Notes: 1. Intersection approaches which required the study vehicle to stop more than 75 percent of the time are shaded.
2. "GS" refers to grade separated cross streets.
3. The percentage of stops increased from 1991/1994 to 1995.

Lamar Boulevard Travel Time Study Vehicle Stop Frequency_Table IV-5

Accidents--Intersection and Mid-Block

Data Collection

The Austin Police Department's accident data base was used to retrieve Lamar Boulevard accident data. Nineteen ninety-three and 1994 accidents were averaged to more accurately represent the typical accident frequency in a given year. Accident frequency was the measure of effectiveness (MOE) used at intersections. An intersection accident rate was not used since 24-hour cross-street traffic data were not readily available for every signalized intersection. Accident rates (accidents/hundred million vehicle miles traveled=HMVM) were the MOE used for each mid-block between two adjacent signalized intersections. Nineteen ninety-two, 24-hour mid-block traffic volumes were available from previous work performed while prioritizing roadways for the Austin ITS Steering Committee. Therefore, these volumes were used to compute mid-block accident rates.

Objectives

1. Identify intersections experiencing the greatest accident frequency?
2. Identify mid-block sections experiencing the greatest accident rate?

Answers to these questions will identify locations that experience higher rates of non-recurring congestion than other locations along Lamar Boulevard.

Analysis and Findings

Table IV-7 depicts the accident frequency for each signalized intersection and accident rate for each mid-block section. Top 10 intersections and mid-block sections are shaded in **Table IV-7**.

1. The top-10 intersections experiencing the greatest accident frequency were:

    1. Braker Lane--18 acc./year
    2. Rundberg Lane--17.5 acc./year
    3. Rutland Drive--12.5 acc./year
    4. 6th Street--10 acc./year
    5. 38th Street--9.5 acc./year
    6. 5th Street--7.5 acc./year
    7. Morrow Street--7.5 acc./year
    8. 45th Street--7 acc./year
    9. Koenig Lane--7 acc./year
    10. 12th Street--6.5 acc/year
    11. Barton Springs Road--6.5 acc./year
    12. Manchaca Road--6.5 acc./year

2. The top-10 mid-block sections experiencing the greatest accident rate were:

    1. Rutland to Rundberg--2206/HMVM
    2. St. Johns to Airport--989/HMVM
    3. North Loop to 51st--763/HMVM
    4. Masterson Pass to Rutland--750 HMVM
    5. Koenig Lane to North Loop--668/HMVM
    6. Braker to Kramer--661/HMVM
    7. Airport to Brentwood--583/HMVM
    8. 10th to 9th--548/HMVM
    9. Rundberg to Peyton--489/HMVM
    10. 9th to 6th--484/HMVM

Major Cross-Streets (signalized Intersections)	Accidents	
	Intersections (accidents/year)	Mid-Blocks (accidents/HMV)M)
N. I 35 WF	0.0	176
W. Parmer Ln.	4.0	231
W. Yager Ln.	2.5	119
North Bend Dr.	0.5	242
W. Braker Ln.	**18.0**	**661**
Kramer Ln.	5.0	385
Meadows	3.5	174
Masterson Pass	4.0	**750**
Rutland Dr.	**12.5**	**2206**
W. Rundberg Ln.	**17.5**	**489**
Peyton Gin Rd.	4.5	402
Thurmond St.	2.0	
W. Anderson Ln./Research Blvd.(GS)	n/a	391
Morrow St.	**7.5**	
W. St. Johns Av.	5.0	**989**
Airport Blvd.	4.0	
Justin Ln.	4.0	**583**
Brentwood St.	5.5	387
Denson Dr.	3.0	298
W. Koenig Ln.	**7.0**	**668**
W. North Loop Blvd.	5.5	**763**
W. 51st St.	2.0	252
W. Guadalupe St.	4.0	94
W. 45th St.	**7.0**	322
W. 38th St.	**9.5**	370
W. 34th St.	3.0	278
W. 29th St.	4.5	104
W. 24th St.	5.0	86
W. MLK Blvd.	3.5	54
W. 15th St. (GS)	n/a	239
Parkway	0.0	218
W. 12th St.	**6.5**	148
W. 10th St.	2.5	**548**
W. 9th St.	2.5	**484**
W. 6th St.	**10.0**	307
W. 5th St.	**7.5**	
W. 1st St. (GS)	n/a	107
W. Riverside Dr.	5.0	402
Barton Springs Rd.	**6.5**	359
Treadwell St.	0.0	276
Hether St./W. Mary St.	5.5	458
W. Oltorf St.	5.5	154
Bluebonnet Ln.	4.0	269
Manchaca Rd.	**6.5**	--
Barton Skwy.	4.5	323
Panther Trl.	5.5	454
Brodie Oaks (Pull Mid-Block)	n/a	453
W. Ben White Blvd. (GS)	n/a	n/a

Notes:
1. Accident data based on 1993 and 1994 Austin Police Department statistics.
2. "GS" refers to grade separated cross streets.
3. Boxes outlined in bold represent the mid-block accident rate between the intersections above and below the box.

1. **Lamar Boulevard Intersection and Mid-Block Accident Data_Table IV-7**

Traffic Flow Summary--Stop Delay, Stops, and Accidents

<u>Data Collection</u>

This section summarizes data from the signal delay, stops, and accident sections.

<u>Objective</u>

1. Identify priority locations to focus ITS or traditional transportation engineering recommendations.

Combining stop delay, stops, and accident data into one table provided a clearer picture of where to focus ITS recommendations.

<u>Analysis and Findings</u>

Table IV-8 summarizes and combines stop delay, stops, and accidents. Although mid-block data (i.e., link lengths, 24-hour volumes, and accident rates) are placed on an intersection row, the data actually refers to the mid-block between that intersection and the intersection immediately below it. An asterisk ("*") represents the number of study periods at each intersection that exhibited at least a LOS "E" or required the study vehicle to stop at least 75 percent of the time.

Major Cross-Streets (signalized Intersections)	Distance (feet)	1992 24-Hr. Vol. (veh/day)	Signal Delay		Stops		Accidents	
			1991/1994	1995	1991/1994	1995	Top-10 Intersect.	Top-10 Mid-Blk.
			(SPs >= LOS E)		(SPs w/stops >= 75%)		(acc/HMVM)	
N. I 35 WF	6600	2490						
W. Parmer Ln.	2224	15510						
W. Yager Ln.	6609	16620						
North Bend Dr.	1079	16620						
W. Braker Ln.	905	30240		**		*	18	661
Kramer Ln.	2188	33510						
Meadows	1242	33510						
Masterson Pass	2533	33510						750
Rutland Dr.	800	40170					12.5	2206
W. Rundberg Ln.	2180	37300	*	*	*	**	17.5	489
Peyton Gin Rd.	2360	38130						
Thurmond St.		38130						
W. Anderson Ln./Research Blvd.(GS)	4400	40080						
Morrow St.	1800	39100		*			7.5	
W. St. Johns Av.	780	40820			*			989
Airport Blvd.	380	30790						
Justin Ln.	1150	30790		*				583
Brentwood St.	1580	30790						
Denson Dr.	1890	30790						
W. Koenig Ln.	2040	33960		*			7	668
W. North Loop Blvd.	890	25570						763
W. 51st St.	1010	25570			**			
W. Guadalupe St.	2100	25570						
W. 45th St.	3488	25735				*	7	
W. 38th St.	1040	26340	*	**		*	9.5	
W. 34th St.	2072	26340				**		
W. 29th St.	4720	26430				**		
W. 24th St.	1857	31810	*	***		***		
W. MLK Blvd.	1700	31810		*				
W. 15th St. (GS)	1300	32550						
Parkway	204	32550						
W. 12th St.	774	37900					6.5	
W. 10th St.	418	37900	*					548
W. 9th St.	947	37900						484
W. 6th St.	498	37900	*	*	**	*	10	
W. 5th St.		48070	*	*		*	7.5	
W. 1st St. (GS)	2257	48070						
W. Riverside Dr.	1381	40380	*		*			
Barton Springs Rd.	2066	35120	*		*		6.5	
Treadwell St.	3061	35120						
Hether St./W. Mary St.	900	35120						
W. Oltorf St.	2370	43660						
Bluebonnet Ln.	1599	43660						
Manchaca Rd.	401	43660					6.5	
Barton Skwy.	2850	34580			*			
Panther Trl.	1382	34580						
Brodie Oaks (Pull Mid-Block)	1200	34580						
W. Ben White Blvd. (GS)								

Notes:
1. Accident data is based on 1993 and 1994 Austin Police Department statistics.
2. "GS" refers to grade separated cross streets.
3. "SPs" refer to study periods. Four study periods existed during each data collection period: (1) A.M.-peak southbound, (2) A.M.-peak northbound, (3) P.M.-peak southbound, and (4) P.M.-peak northbound.
4. Asterisks represent the number of study periods having the characteristics described in the column's header.
5. Although mid-block data (i.e., link lengths, 24-hour volumes, and accident rates) are placed on an intersection row, the data actually refers to the mid-block between that intersection and the intersection below it. Shaded link lengths are estimated.

Lamar Boulevard Traffic Flow Characteristics and Accident Summary_Table IV-8

1. Table IV-8 reveals four somewhat distinct patterns where considerable delays, stops, and accidents existed on Lamar Boulevard.

   1.Braker Lane to Kramer Lane, primarily Braker Lane (approximately 1000 feet)
   2.Masterson Pass to Peyton Gin, primarily Rundberg Lane (approximately 5600 feet)
   3.45th Street to MLK Boulevard (approximately 13,200 feet)
   4.12th Street to 5th Street (2700 feet)

   A number of the primary cross streets (e.g., Braker, Rundberg, 45th, 38th, 6th, 5th) included in these sections provide connections to freeways parallel to Lamar Boulevard, either MoPac and/or IH 35. In addition, sections #3 and #4 provide access to major traffic generators like the University of Texas and the central business district, respectively. Therefore, congestion is expected at the major cross-streets that intersect Lamar Boulevard.

Emergency Response Times and Dispatching Characteristics

Data Collection

The City of Austin Emergency Medical Service (EMS) Department provided average response time and dispatches per day data for the EMS fleet from 1990 to 1994. This data was analyzed to establish trends in EMS response times.

Although EMS data does not readily lend itself to analyzing response times along specific routes, a method to estimate route specific response times may be possible. EMS uses serial zones to identify the origin and destination of EMS units when dispatched to an emergency. EMS's database does not contain information about which route the EMS unit traveled to an emergency.

EMS response times on Lamar Boulevard, however, could be estimated by analyzing response times to and from serial zones adjacent to Lamar Boulevard. This approach does not guarantee that an EMS unit used Lamar Boulevard to respond to an emergency. It is recommended that transportation and EMS staff work closely together to prioritize roadways or areas for improvements in emergency response times.

Supporting information pertaining to EMS and the Fire Department are provided below:

1. EMS has two response time goals: (1) respond to 90 percent of advance calls (life or limb threatening) within eight minutes and (2) respond to 90 percent of basic calls within 10 minutes.
2. The Fire Department's goal is to respond to any fire emergency within three minutes inside the city limits.
3. More than 60 percent of the Fire Department's calls are first responder calls for EMS.
4. EMS response times include three stages: (1) process--from the time a 911 call is received until a dispatch call is sent to the EMS unit (unit is toned out); (2) time-out-of-station--from the time an EMS unit is toned out until it starts moving; and (3) drive time--from the time the vehicle starts moving until it makes patient contact.
5. Fire response times currently include two stages: (1) time-out-of-station and (2) drive time.

Objectives

1. Are EMS average response times increasing over time?
2. How many times per day, on average, is an EMS unit dispatched?

Call Type	Average Response Times (min)						Average Dispatches/Day					
	1990	1991	1992	1993	1994	1990-1994 Avg. Annual % △	1990	1991	1992	1993	1994	1990-1994 Avg. Annual % △
Advance	7.12	7.16	7.27	7.39	7.62	1.7	28.05	29.54	29.75	31.41	34.28	5.1
Basic	7.05	7.31	7.49	7.79	7.96	3.1	63.52	68.21	69.04	68.56	71.09	2.9
Total	7.07	7.27	7.42	7.66	7.84	2.6	91.57	97.75	98.79	99.97	105.4	3.6

Note: 1. 1990 to 1994 average annual percent changes are compounded rates.
2. Advance calls are those that are life or limb threatening and likely require administering drugs.

City-Wide Emergency Medical Services Average Response Times and Dispatches/Day_Table IV-9

Fire Department response times were not available during the preparation of this report. Although the trends for EMS units are probably similar to fire units, any final conclusions should include Fire Department data.

Analysis and Findings

EMS average response times and dispatches per day are summarized in Table IV-9.

1. From 1990 to 1994, average response times for EMS units increased. City-wide average response times increased 2.6 percent annually.
2. As of 1994, on a city-wide basis, EMS units are dispatch approximately 106 times per day. City-wide dispatches increased at an annual rate of roughly 3.6 percent from 1990 to 1994.

Transit On-Time Performance

Data Collection

Lamar Boulevard serves a substantial portion of three bus routes:

1. #1--North Lamar (turns into /#13 South Congress)
2. #38--Lamar/Westgate (turns into #37 Colony Park)
3. #45--Copperfield

Capital Metropolitan Transportation Authority (Capital Metro) provided on-time performance data for these three routes and for their entire bus fleet. If a bus is either more than five minutes behind schedule or one minute ahead of schedule it is considered not on-time. On-time performance studies are performed monthly. The #1 also provides service to South Congress

Avenue as the #13. The #38 also provides service to Colony Park as the #37. On-time performance data reflects the combined routes, not Lamar Boulevard exclusively.

<u>Objectives</u>

1. How is transit on-time performance changing over time?
2. If on-time performance falls to an unacceptable level, what are the impacts to Capital Metro?

<u>Analysis and Findings</u>

On-time performance data from 1991 to 1994 are summarized in Table IV-10. These tables revealed the following findings:

1a. From 1991 to 1994, on-time performance improved on the two bus routes in which Lamar Boulevard is the primary route, #1 and #38. On-time performance data were not available for the #45.

1b. On-time performance, however, decreased at an annual rate of 0.7 percent for the entire Capital Metro bus fleet from 1991 to 1994.

1c. Observing the actual trend in on-time performance for each year, however, does not establish a clear trend whether on-time performance is getting better or poorer for either of the two bus routes using Lamar Boulevard or for the entire bus fleet.

2. During the day, when on-time performance falls to an unacceptable level on Lamar Boulevard, Capital Metro will dispatch another bus. The capital cost for a bus is approximately $200,000 to $225,000.

Primary Lamar Bus Routes	On-Time Performance (%)				
	1991	1992	1993	1994	1991-1994 Avg. Annual % ✦
1--North Lamar (13--S. Congress)	87.8	87.3	86.9	89.4	0.6
38--S. Lamar/Westgate (37--Colony Park)	87.1	93.9	87.4	92.5	2.0
45--Copperfield	n/a	n/a	n/a	n/a	n/a
All Capital Metro Routes	90.6	93.0	90.6	88.6	-0.7

Transit On-Time Performance_Table IV-10

Although on-time performance data was analyzed for Lamar Boulevard, it is recommended that additional discussions between Capital Metro and the City of Austin Transportation Division occur to discuss transit related problems on their priority roadways. These discussions may show that data other than on-time performance are more appropriate for quantifying transit problems. In addition, these discussions would set the stage for developing potential solutions to the problems.

Summary of Findings

<u>Traffic Flow</u>

1. Locations consistently experiencing recurring congestion in the peak periods were identified.
2. Stop delay increased from 1991/1994 to 1995. A greater increase in stop delay was seen in the off-peak direction than the peak direction. In addition, the P.M.-peak period

experienced a greater amount of stop delay than the A.M.-peak period.

3. Stop percentages increased from 1991/1994 to 1995. A greater increase in stop percentage was seen in the off-peak direction than in the peak direction. In addition, the P.M.-peak period experienced a higher stop percentage than the A.M.-peak period.
4. Locations experiencing non-recurring congestion (i.e., high accident intersections and mid-block sections) were identified.
5. Four somewhat distinct patterns where considerable delays, stops, and accidents existed on Lamar Boulevard were identified.
    a. Braker Lane to Kramer Lane, primarily Braker Lane (approximately 1000 feet)
    b. Masterson Pass to Peyton Gin, primarily Rundberg Lane (approximately 5600 feet)
    c. 45th Street to MLK Boulevard (approximately 13,200 feet)
    d. 12th Street to 5th Street (2700 feet)
6. A correlation appears to exist between highly congested locations and accident experience.

<u>Emergency Response Times and Dispatching Characteristics</u>

1. EMS response times increased 2.6% annually from 1990 to 1994 on average throughout the city.
2. As of 1994, on a city-wide basis, EMS units are dispatched 106 times/day on average.
3. From 1990 to 1994, city-wide dispatches increased at annual rate of roughly 3.6 percent.

<u>Transit On-Time Performance and Ridership Characteristics</u>

1. From 1991 to 1994, a clear trend in transit on-time performance was not demonstrated with the data analyzed.
2. When on-time performance falls to unacceptable levels during the day, an additional bus is dispatched to Lamar Boulevard.

The previous process outlines steps to identify problematic locations and to quantify existing problems. The following steps are recommended to occur after the previous process is completed: (1) perform a more detailed investigation of the problematic locations to determine the cause of the problems; (2) generate potential solutions (either traditional transportation engineering or ITS solutions) to address the problems; (3) select and plan the implementation of a solution; (4) implement the solution; (5) evaluate the solution; and (6) revise the solution based on the evaluation.

ALTERNATE ROUTE PLANNING PROCESS

When major incidents occur on a freeway or arterial street (e.g., one of those roadways in the Steering Committee's roadway priority list), a key element of traffic management is diversion of traffic to other surface streets or freeways to by-pass the incident. These alternate routes should be pre-selected based on incident scenarios developed for each section of the freeways and arterial streets. Following selection, a plan should be developed for each alternate route to better accommodate diverted traffic, to reduce time deciding where to detour traffic, and to avoid unsuitable routes. Most of the following alternate route planning process is found in the *Freeway Incident Management Handbook*[1] prepared by Dunn Engineering Associates for the Federal Highway Administration. Although freeways are stressed in developing alternate route plans, these plans can also be applied to arterial streets.

Introduction

The purpose of an alternate route plan is to provide the framework and guidelines for responding to incidents that require closure of section(s) of the freeway or arterial street system. Traffic will be re-routed onto adjacent surface streets that parallel the route experiencing the incident, and guided to return to their original route at the next appropriate location.

Specifically, the plan will: (1) identify alternate traffic routes for each section of the system; (2) establish authority and responsibility of the transportation, police, and other affected agencies; and (3) document the notification process and standard procedures to be utilized for implementing the alternate route(s) and later removal following the termination of the incident period.

Incident Management Team

The first step is to identify organizations and officials likely to have a vested interest in establishing an incident management program. These organizations may include: elected officials, state, county, and city transportation departments, public safety organizations--law enforcement, emergency medical services, and fire protection, transit operators, towing services, commercial traffic reporters, and environmental protection agencies.

Incident Management Team Tasks

Task 1--Project Scope

Identify the sections of the system for development of an alternate route plan.

Task 2--Assemble and Index Data

Data required to develop an alternate routing plan shall be assembled and indeed. This data will include the following:

- roadway maps and plans
- location of maintenance shops
- location of police jurisdictions
- traffic data
- freeway, ramp, arterial street, and potential alternate route traffic volumes
- accident summary records at critical locations on alternate routes
- existing signing on freeway, arterial street, and potential alternate routes

Task 3--Establish Alternate Route Criteria

Criteria shall be established under which alternate routes shall be selected. These include:

- length of alternate route versus freeway route
- jurisdiction of detour (i.e., number of travel lanes, number of signalized intersections, number of turns, number of left turns, number of route changes)
- accident history
- capacity

Criteria shall be established for alternates which are:

- long term
- short term

Task 4--Identify Preliminary Alternate Routes

Assemble a set of preliminary detour routes and sketch on 8 1/2" x 11" sheets.

Task 5--Drive and Videotape Preliminary Alternate Routes

Each preliminary route shall be driven and critical sections or junctions videotaped. Critical turn areas shall also be video taped. Total distance of each route shall be determined.. Relevant features and characteristics shall be recorded such as structures with limited overhead clearance, weight restrictions, route number changes, and school zones.

Task 6--Revise Preliminary Alternate Routes

Based on the data and experience of driving the preliminary routes, a revised set of alternate routes will be prepared. These will be presented as simplified maps on 8 1/2" x 11" sheets with explanations and descriptions of significant features.

Task 7--Identify Problem Areas

A list of alternate routes shall be compiled indicating any problem sections. The problem section will be keyed to the simplified map of the detour route. These problems will include:

- ✐ significant delays
- ✐ limited fuel availability (diesel and conventional)
- ✐ overhead clearance limitations
- ✐ structures with weight limitations
- ✐ residential areas
- ✐ school, hospital, church zones
- ✐ high accident zones
- ✐ heavy pedestrian flows
- ✐ tight turn radii
- ✐ locations where temporary signals may be necessary will be identified

Task 8--Identify Commercial Vehicle Restrictions

Alternate routes with vehicle restrictions shall be compiled including weight, length, height, and any other restrictions.

Task 9--Determine Signing

The following aspects of signing shall be analyzed and recommendations made:

A.On Freeway

- type (i.e., velcro, small semi-permanent, large guide)
- storage (stockpiling, locations of stockpiles, computerized inventory)
- fabrication (by agency, by contractor)
- placement
- erection (truck mounted, permanent folding sign, post requirements)

B.Off Freeway

- permanent trailblazers
- placement (location on detour routes from diversion point to re-entrance point)
- temporary signing
- storage (stockpiling, locations of stockpiles, computerized inventory)
- fabrication (by agency, by contractor)
- placement
- erection (truck mounted, permanent folding sign, post requirements)

C.Trailer Mounted Variable Message Signs (VMS)

- assess the need for trailer mounted VMS

Task 10--Assess Highway Advisory Radio

The Use of highway advisory radio (HAR) will be assessed for use in emergency alternate routing. Aspects to be explored are:

- permanent HAR locations
- truck mounted HAR
- compatibility with other operations
- construction
- weather advisory

This task should also consider using a public telephone number to convey alternate route information.

Task 11--Develop Operational Procedural Guide for Termination of Alternate Routes

An operational procedural guide shall be developed. This guide shall be targeted to enforcement and other personnel with incident traffic management responsibilities. The guide shall notify, identify, and explain each affected party's duties including where signs are stored and who is to erect them both on and off the freeway or arterial street.

The assistance and concurrence of the involved officials shall be obtained in development of this guide. The following aspects shall be included:

- responsible parties and duties
- maintenance
- state police patrols
- roadside service to disabled vehicles
- retrieval of signs and/or temporary covering
- storage
- replacement
- restocking of maps
- responsible parties for videotaping incident and traffic management aspects for post-incident review

Task 12--Develop Notification Procedures

Notification procedures shall be developed that will follow the alternate routes to be updated on a continuous basis if affected by construction of a permanent or long-term nature, closures of surface street routes, bridge limitations or other factors.

Task 13--Estimate Costs

Cost to implement the procedures, identified for alternate routing shall be estimated. These costs shall include:

- signs
- printing
- material
- trucks
- other equipment

REFERENCES

1. *Freeway Incident Management Handbook*, U.S. Department of Transportation, Federal Highway Administration, Washington, D.C., July 1991.

2. *Quantifying Congestion*, Final Report, NCHRP Report 7-13, National Cooperative Highway Research Program, Transportation Research Board, National Research Council, Washington, D.C., September 1995.

3. *Determining Travel Time*, Procedure Manual, Public Administration Service, Chicago, Illinois, 1958.

4. *1992 Traffic Volumes Austin Metropolitan Area*, Austin Transportation Study, Austin, Texas, September 1993.

5. *Highway Capacity Manual*, Special Report 209, Transportation Research Board, National Research Council, Washington, D.C. 1985.

6. *Traffic Engineering*, McShane, W.R. and P.R. Roger, Prentice Hall, Englewood Cliffs, New Jersey, 1990.