RAMP JUSTIFICATION STUDY IN MANSFIELD, TEXAS

DEBBIE LANE AT U.S. 287

Prepared for

Texas Department of Transportation
Fort Worth District

Prepared by

The Texas Transportation Institute

The Texas A&M University System
Arlington, Texas

RAMP JUSTIFICATION STUDY IN MANSFIELD, TEXAS

DEBBIE LANE AT US 287

Prepared For

Fort Worth District

Texas Department of Transportation

Prepared By

Donald J. Szczesny
Assistant Research Scientist

Carol H. Walters, P.E.
Program Manager

and

Anthony L. Kaman
CO-OP Student Technician

Texas Transportation Institute
The Texas A&M University System
Arlington, TX 76011

March 1992

EXECUTIVE SUMMARY

The Fort Worth District of the Texas Department of Transportation requested that the Texas Transportation Institute conduct a study concerning the justification of a southbound entrance and northbound exit ramp at the interchange of US 287 and Debbie Lane in Mansfield, Texas.

The scope of the study is to determine whether the delay associated with present circuitous traffic patterns might justify the proposed ramps at this time at Debbie Lane; and, whether expected future development will generate any further needs for the ramps in order to avoid capacity overloads at adjacent ramps and interchanges.

The analysis completed includes: (1) the travel time savings, comparing the existing routes to the proposed routes with the ramps in place; (2) benefits derived by the removal from the surrounding intersections of the existing traffic expected to divert to the ramps; and (3) a trip generation analysis to determine the approximate number of additional vehicles that would use the proposed ramps with build-out of the Debbie Lane corridor.

The benefits of constructing the ramps at Debbie Lane include: the travel time savings for those vehicles that would use the ramps; the reduction in intersection delay to those vehicles remaining at the surrounding interchanges after the removal of the Debbie Lane traffic; and the additional travel time savings and reduction in intersection delay to traffic generated from the build-out of the currently undeveloped land along Debbie Lane. The construction costs include the construction of the ramps along with an additional 1,000 feet of three-lane frontage roads.

The findings indicate benefit-cost ratios (B/C) for the Northbound exit ramp of 2.29, and for the Southbound entrance ramp of 0.37; however, only an 11 percent build-out (550 additional trips) would generate enough traffic to increase the B/C ratio to above 1.0. If the construction of the proposed ramps is combined as one project, the resulting B/C ratio is 1.14, implying that the project is justified without any additional build-out.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

As requested by the Fort Worth District, Texas Transportation Institute (TTI) studied the feasibility of providing ramps just south of Debbie Lane on US 287. Because there is no direct access to Debbie Lane, the traffic to and from Debbie Lane is required to use indirect routes within the corridor, causing travel times to increase. These additional vehicles also cause an increase in the signal delay at adjacent interchanges. This study is to identify: (1) whether existing traffic is sufficient to justify the proposed ramps at Debbie Lane; and, if not, (2) whether future development along Debbie Lane may generate the additional traffic necessary to justify the ramps at Debbie Lane.

2.0 PROJECT LOCATION AND STUDY AREA

The study area for the analysis is located in Mansfield, Texas, and includes the Debbie Lane underpass and surrounding interchanges which process traffic originating or having destinations in the Debbie Lane area. Illustrated in Figure 1 is the study area of the project and the proximity of the surrounding interchanges. The distance from Debbie Lane to the interchange of US 287 and FM 157 is approximately 800 feet, while the distance from the interchange of US 287 and Walnut Creek is just over one mile.

3.0 EXISTING CONDITIONS

The US 287 corridor in the vicinity of FM 157 has experienced rapid growth within the past several years. The majority of this growth is due to the opening of the US 287 corridor to the south. Because of this continuing growth, the surrounding intersections have started to experienced some minor congestion during the peak periods. Direct access to Debbie Lane could reduce this problem by allowing those vehicles that would prefer to use the proposed ramps at Debbie Lane to bypass the interchanges at US 287 and FM 157 and US 287 and Walnut Creek.

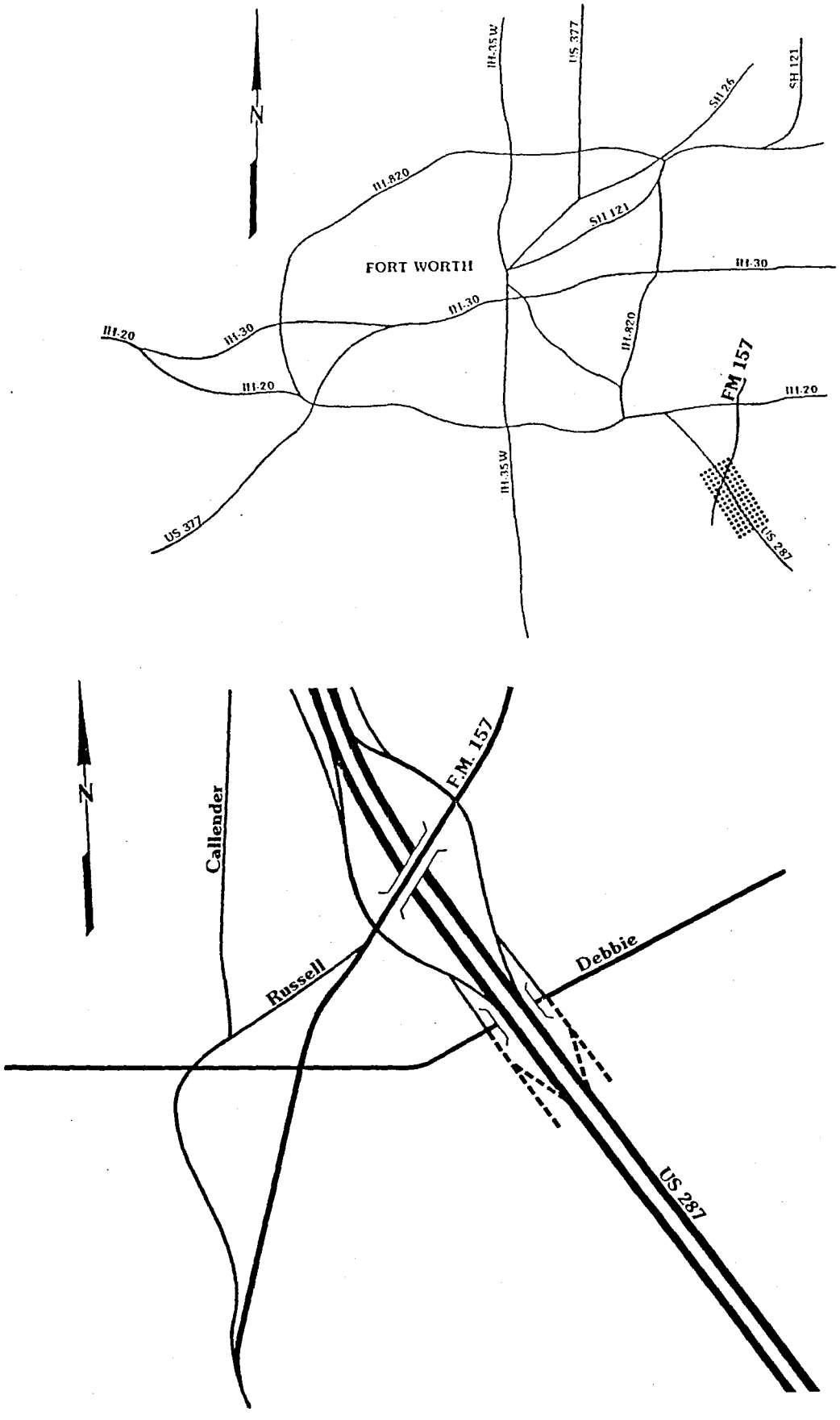

Figure 1. Project Location.

The types of data collected for the corridor included traffic count data from 24-hour machine counters, manual peak period turning movement counts at all intersections, travel time studies, intersection signalization data, and video tape and field observations. The existing peak period traffic volumes are shown in Figures 2 - 4.

4.0 PROPOSED RAMPS

As seen in Figure 5, there are two proposed ramps that would access Debbie Lane: the northbound exit ramp and the southbound entrance ramp. If the northbound exit ramp were constructed, this ramp would allow those northbound vehicles accessing Debbie Lane to avoid traveling through either the Walnut Creek or the FM 157 interchange. This results in a faster, more direct travel path, and less delay at the other interchanges.

The proposed southbound entrance ramp would also result in decreased travel times and a reduction in the delay at the surrounding interchanges. This ramp would allow vehicles from the east and west to access US 287 South directly at Debbie Lane, without having to proceed through the FM 157 interchange.

5.0 ALTERNATE ROUTES CURRENTLY USED BY DEBBIE LANE

This section of the report describes the alternate routes currently used by those vehicles that would use the proposed ramps at Debbie Lane.

5.1 Northbound Exiting Traffic

Debbie Lane traffic is currently dispersed into three different segments throughout the area because there is no direct access to Debbie Lane (see Figure 6). The traffic in these areas is divided into westbound traffic (Point 1 to Point 2A), interior traffic (Point 1 to Point 2B), and eastbound traffic (Point 1 to Point 2C).

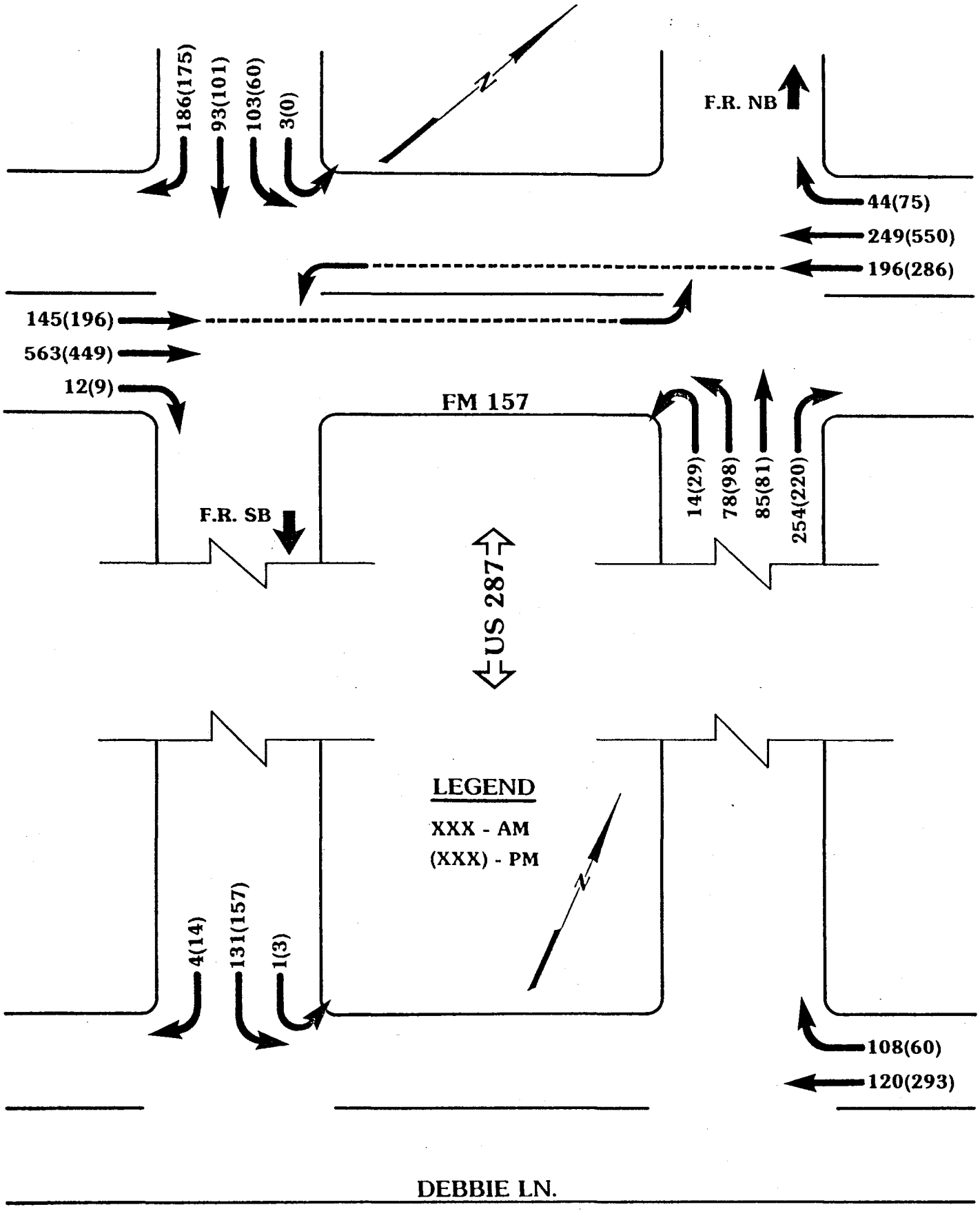

Figure 2. Existing Peak Hour Turning Movements.

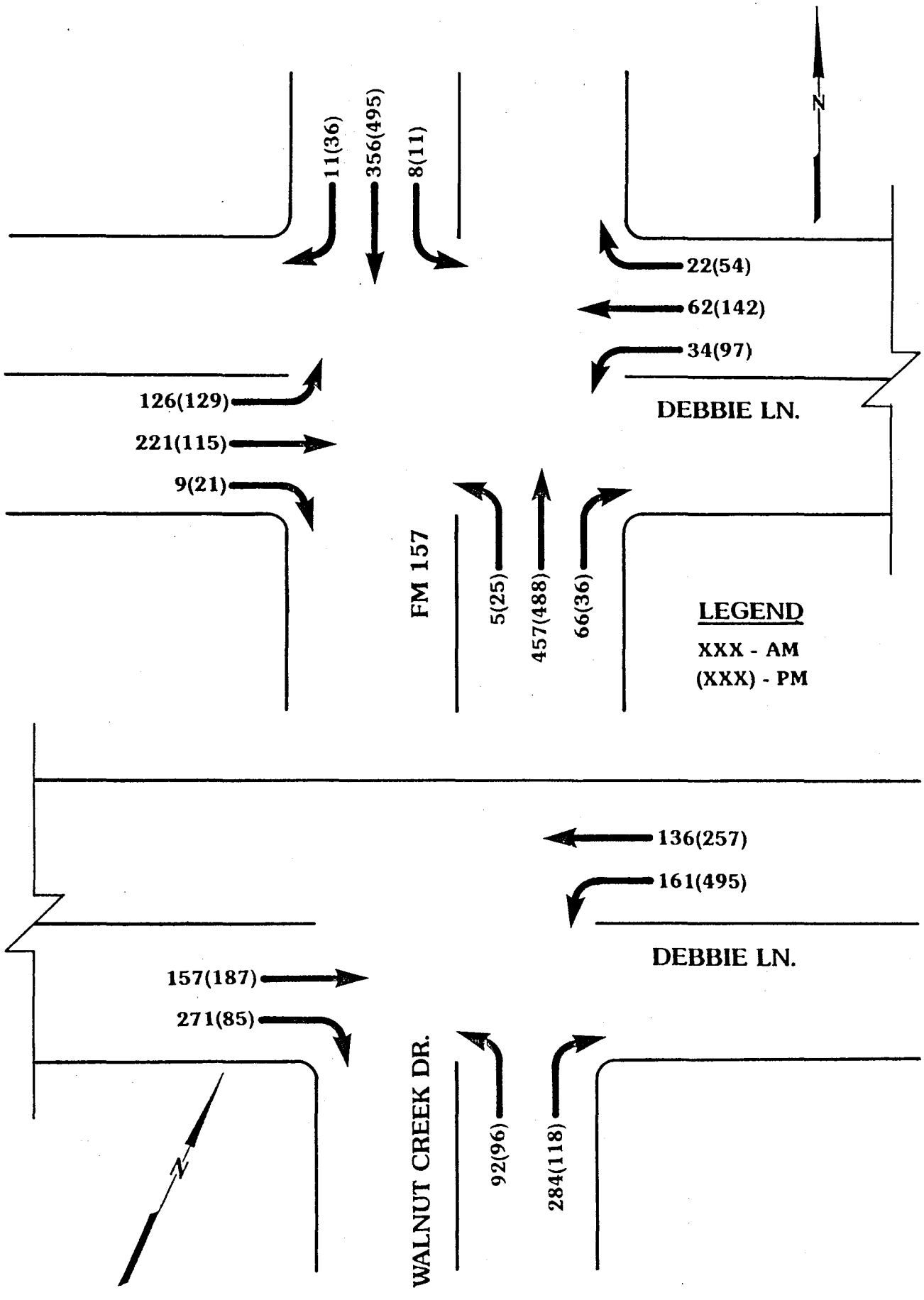

Figure 3. Existing Peak Hour Turning Movements.

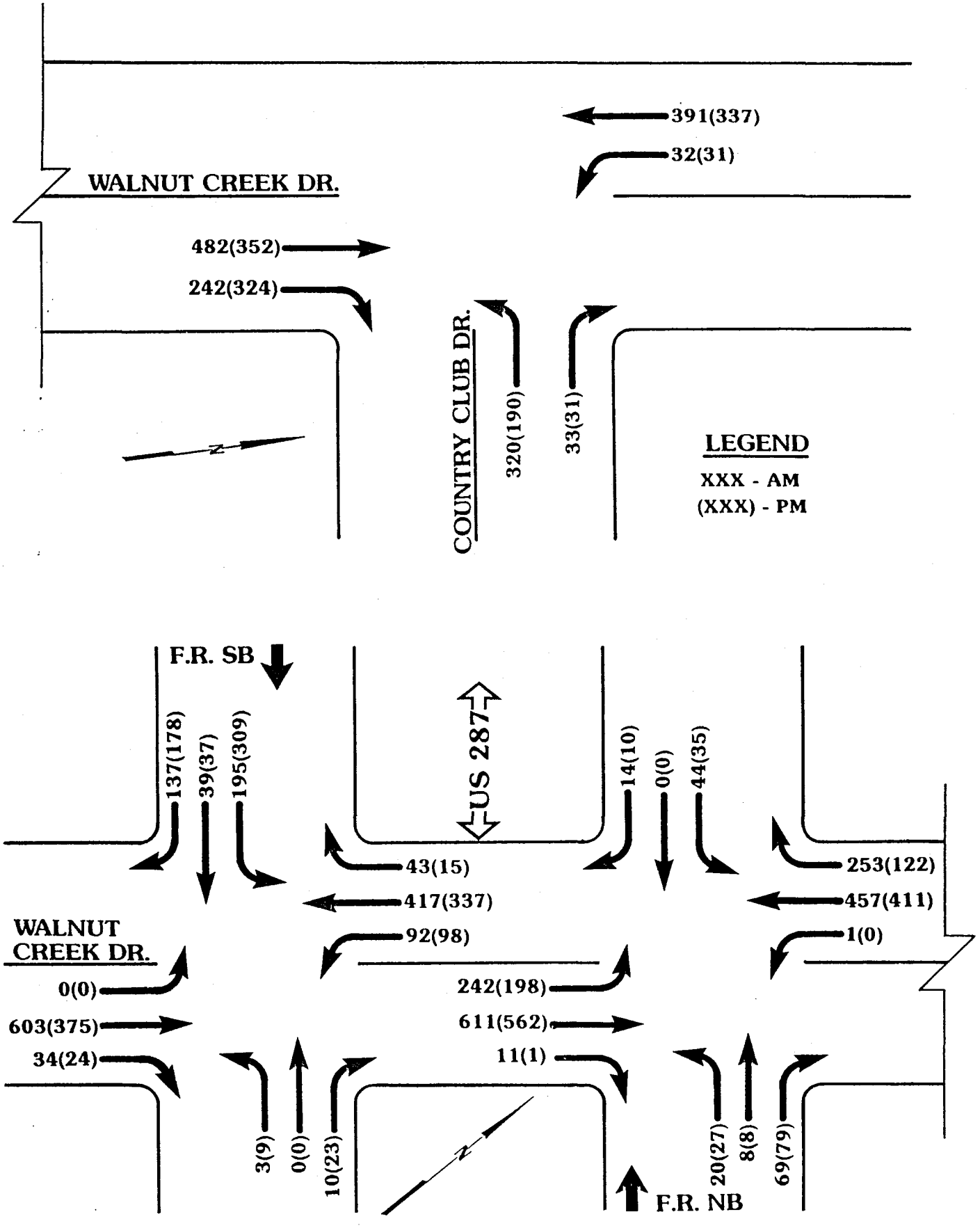

Figure 4. Existing Peak Hour Turning Movements.

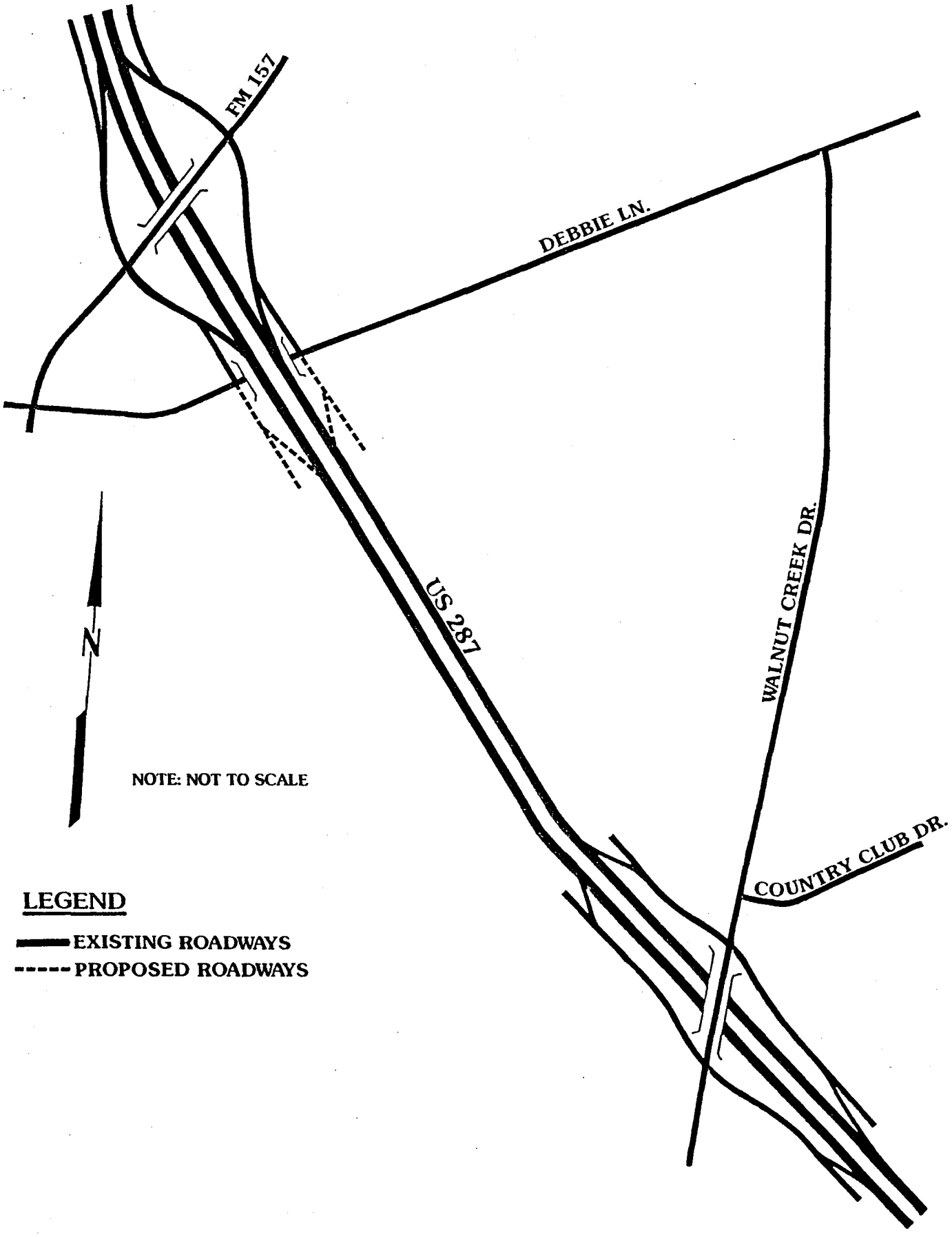

Figure 5. Possible Ramp Locations.

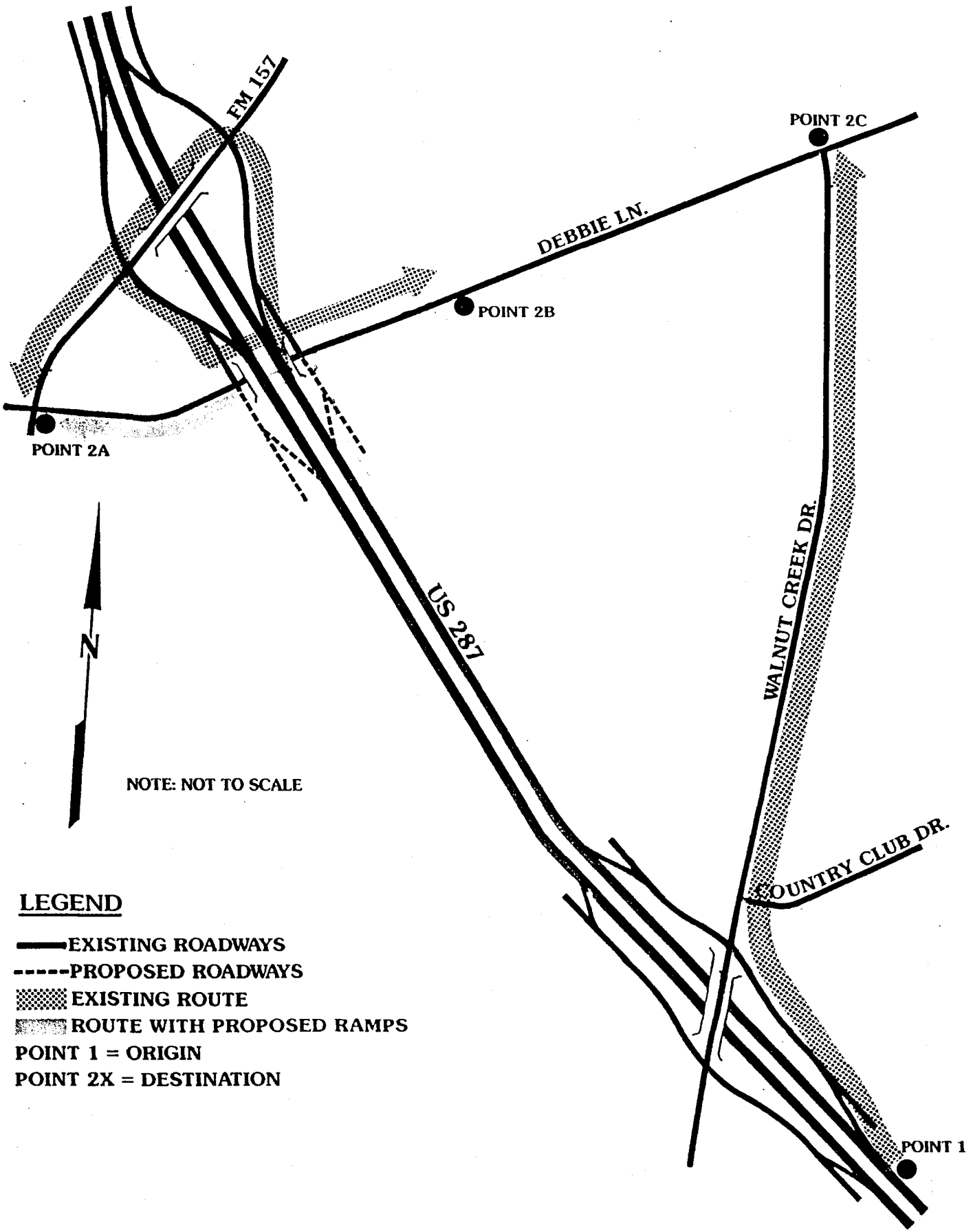

Figure 6. Northbound Alternate Routes.

The westbound traffic destined for Debbie Lane must use the FM 157 exit ramp and travel south on FM 157 to Debbie Lane. These westbound vehicles increase the minor congestion that exists at the intersections along FM 157, and also experience additional travel time in comparison to the route that would use the proposed northbound exit ramp at Debbie Lane.

Similar to the westbound traffic, the interior traffic must also use the existing FM 157 exit. These vehicles are then required to make a U-turn over the freeway (on FM 157), travel south on the US 287 Frontage Road, and then turn left onto Debbie Lane. This movement also increases the congestion of the US 287/FM 157 interchange, as well as increasing the travel times of these vehicles. (Depending on the destination of the interior traffic, some may elect to exit at Walnut Creek and turn left at Debbie Lane.)

The eastbound traffic most likely uses the existing exit ramp at Walnut Creek and travels north along Walnut Creek to reach the Debbie Lane area (see Figure 6). The proposed route, proceeding northbound on the freeway to the Debbie Lane exit and then eastbound on Debbie Lane, provides no decrease in travel time for those vehicles destined for Debbie Lane, just east of Walnut Creek.

5.2 Southbound Entering Traffic

Those vehicles that originate at Debbie Lane and have a destination that requires access to the southbound US 287 freeway mainlanes also use three routes (see Figure 7). Route "A" (Point 3A to Point 4) consists of the origins west of US 287. These vehicles must travel north on FM 157 and enter at the existing southbound FM 157 entrance ramp.

Route "B" (Point 3B to Point 4) also requires the vehicles from the interior to use the existing southbound entrance ramp at FM 157. These vehicles travel north on the US 287 Frontage Road, make a U-turn over the freeway (on FM 157), and then enter at the existing southbound entrance ramp (see Figure 7). The vehicles using routes "A" and "B"

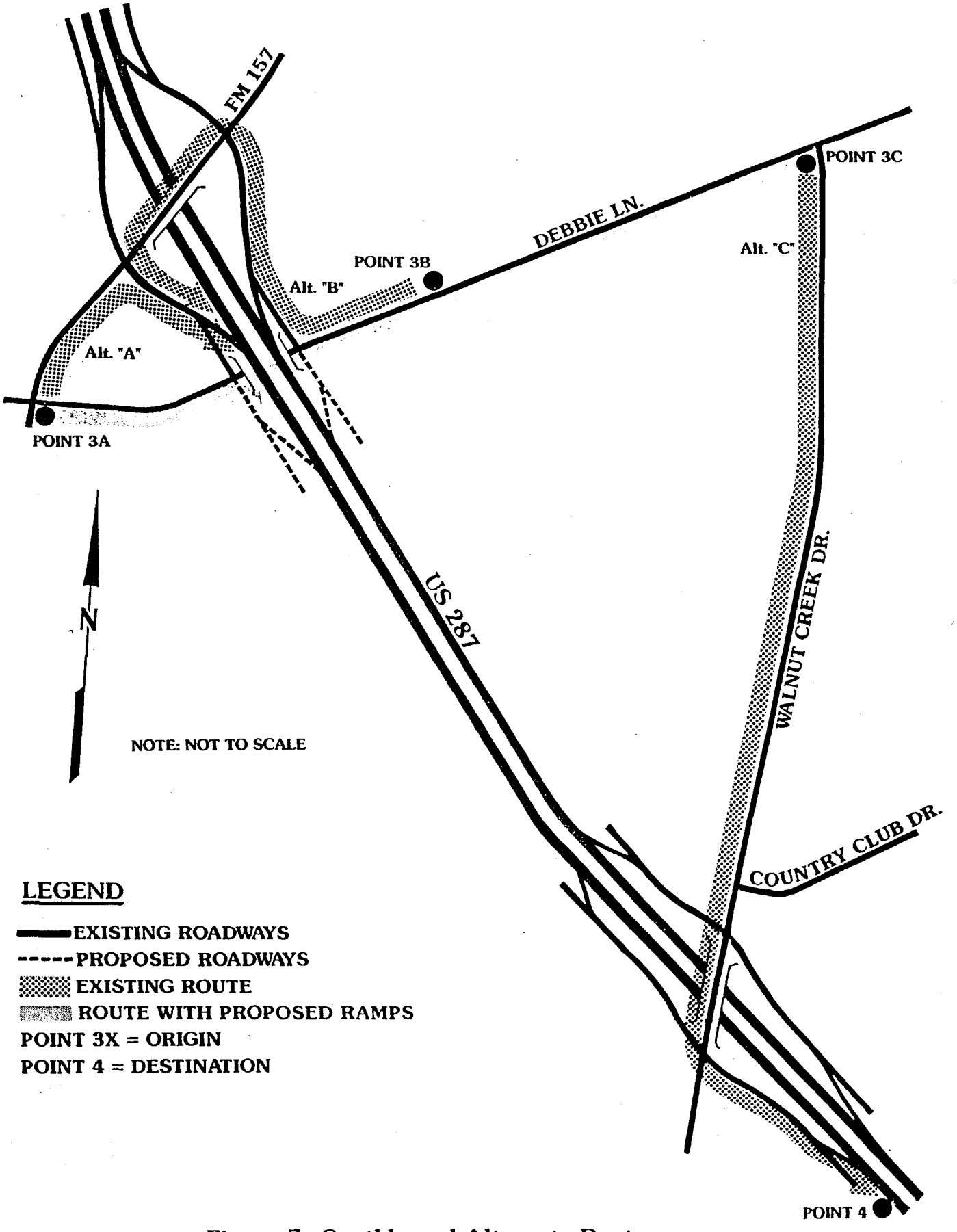

Figure 7. Southbound Alternate Routes.

experience a longer travel time when compared with the routes with the proposed entrance ramp at Debbie Lane. These vehicles also add to the congestion at the US 287 and FM 157 interchange.

Route "C" (Point 3C to Point 4) allows the vehicles traveling from the Debbie Lane and Walnut Creek intersection to travel south on Walnut Creek to the interchange of US 287 and Walnut Creek. These vehicles then use the existing southbound entrance ramp to access the US 287 freeway mainlanes (see Figure 7). This route is faster than the proposed routes which would use the proposed southbound entrance ramp from Debbie Lane.

6.0 ANALYSIS AND COMPARISON OF EACH ALTERNATE ROUTE

This section of the report analyzes the proposed ramps that were considered for direct access to and from Debbie Lane. The criteria used to analyze these ramps is based on travel time and signal savings.

The existing travel times on the routes currently used by the motorists throughout the study area were collected and were compared with the calculated travel times if the proposed ramps were constructed.

The analysis consists of a comparison of the existing routes to the routes with the proposed ramps at Debbie Lane. The difference in the travel times of the existing routes and the travel times with the proposed ramps is the travel time saved per route (Table I). The average of the travel time savings was then computed for each proposed ramp based on the number of vehicles using and savings associated with each route.

Table I. Travel Time Savings of Routes with Proposed Ramps Over Existing Routes.

Addition of Ramps	Alternate Route	Points of Origin & Destination	Existing Routes		Routes with Ramps		Ramp Travel Time Savings over Existing	Number of Vehicles Using Routes
			Length (Miles)	Travel Time (Min)	Length (Miles)	Travel Time (Min)	(Min)	
Ramp 1: North-bound Exit Ramp	South to West ALT "A" (Figure 5)	1-2A	2.4	3.53	1.85	2.67	.86	690
	South to Middle ALT "B" (Figure 5)	1-2B	2.6	3.86	1.6	2.02	1.84	204
	South to East ALT "C" (Figure 5)	1-2C	1.5	2.61	2.25	2.89	-.28	-
Average Savings[1], minutes							1.08	894
Ramp 2: South-bound Entrance Ramp	West to South ALT "A" (Figure 6)	3A-4	2.05	2.76	1.8	2.63	.13	903
	Middle to South ALT "B" (Figure 6)	3B-4	2.5	3.77	1.65	2.16	1.61	50
	East to South ALT "C" (Figure 6)	3C-4	1.6	2.65	2.3	3.03	-.38	-
Average Savings[1], minutes							.21	953

[1] Weighted average not including Alternate "C".

7.0 IMPACT OF DEBBIE LANE TRAFFIC AT SURROUNDING INTERCHANGES

The impact of traffic to and from Debbie Lane at the surrounding interchanges varies depending on the amount of traffic that is currently being processed through the interchanges. For example, if ramps are constructed at Debbie Lane, this would remove traffic from the US 287 and FM 157 interchange and alleviate some of the congestion that is currently experienced throughout the day. Because the Debbie Lane traffic is required to use alternative routes, this creates additional congestion at the surrounding intersections.

To determine the impacts of the proposed ramps at Debbie Lane, level-of-service analysis was performed with the existing turning movements for both the AM and PM peak hours. The traffic volumes that were used were the peak 15 minute volumes expanded to peak hour flowrates (peak 15 minute volumes times 4). This was done to simulate the peak condition which occurs during the peak hour, recognizing that once intersection traffic breaks down, it is difficult to recover during a congested peak period.

The interchange of US 287 and FM 157 was analyzed using PASSER III-90. The average total intersection delay for both the AM and PM peak hour was LOS B. However, there are some movements that have a LOS E. The interchange of US 287 and Walnut Creek, which is currently operating as stop-controlled was also analyzed. To analyze this interchange, PASSER II-87 was used since the frontage roads are currently operating as two-way. The maximum (worst) and average level-of-service at each intersection is recorded in Table II, this is done for both the AM and PM peak hour. Once the impact of the Debbie Lane traffic is determined, the benefits associated with the removal of the Debbie Lane traffic can be determined. These benefits are further discussed in the next section.

Table II. Level-of-Service of the Surrounding Intersections.

Intersection	Type of Control	Delay, sec/veh (LOS)				Used by Existing Routes	Used by Routes with Frontage Roads	Used by Routes with Proposed Ramps
		AM Peak Hour		PM Peak Hour				
		Avg	Max	Avg	Max			
FM 157/US 287 (NB Front Rd)	Signal	B	C	B	D	Yes	No	No
FM 157/US 287 (SB Front Rd)	Signal	B	D	B	D	Yes	No	No
FM 157/Debbie Lane	Signal	B	C	C	C	Yes	Yes	Yes
Walnut Creek/ US 287 (SB Front Rd)	Stop	B	C	B	C	Yes	Yes	No
Walnut Creek/ US 287 (NB Front Rd)	Stop	A	D	A	D	Yes	Yes	No
Walnut Creek/ Country Club	Signal	B	C	C	C	Yes	No	No

8.0 BENEFIT COMPONENTS

In order to determine the benefits of possible ramps at Debbie Lane, there are two components to be considered. The first component is the potential travel time savings for those vehicles which would be able to access Debbie Lane directly by the proposed ramps. In order to determine the difference in travel time for those vehicles, travel time savings for various routes have been determined (see Table I).

To determine the B/C ratios for the proposed ramps, several assumptions were made and these assumptions are listed on the following page.

- The construction cost of the proposed ramps is annualized at a 4 percent discount rate for 20 years.
- A cost of $12.81 per vehicle-hour of delay is used for travel time savings. This cost assumes a 1.25 occupancy ratio per vehicle.
- Analyzed over 312 days per year (6 out of 7 days per week).
- A 5 percent growth rate in traffic (suggesting that the benefits from travel time savings would also grow at 5 percent growth rate).

As shown earlier in Table I, the approximate number of vehicles that use each alternate route was determined. This was done by using a gravity model approach, along with the 24-hour counts that were collected and/or calculated. When analyzing the proposed routes over the existing routes, the weighted-average savings for the Northbound exit and Southbound entrance ramps are 1.08 and 0.21 minutes saved per vehicle, respectively. Using the number of vehicles that would use the proposed ramps and the assumptions stated above, the resultant annual savings for the Northbound exit ramp is $64,315 per year; while the Southbound entrance ramp is $13,331 per year.

The second benefit is the delay reduction due to the removal of the Debbie Lane traffic from the surrounding intersections. Since there is no direct access to Debbie Lane, the Debbie Lane traffic is forced to travel through the US 287/FM 157 interchange. If the proposed ramps are built, the intersection delay saved by the proposed northbound exit ramp is 5.64 vehicle-hours per day, while the proposed southbound entrance ramp would save 1.90 vehicle-hours per day. The resultant annual savings associated with the Northbound exit is $22,541 per year; while the savings associated with the Southbound entrance ramp is $7,593 per year.

To arrive at the savings associated with the removal of the Debbie Lane traffic from the US 287 and FM 157 interchange, an analysis was performed with and without the Debbie Lane traffic during the AM and PM peak hour. The average savings during the AM

and PM peak hour were then applied throughout the day depending on the ratio of the approach volumes for each hour to the sum of the approach volumes during the peak hours.

9.0 CONSTRUCTION COST ESTIMATES FOR RAMPING OPTIONS

The capital or construction costs used in this study are based on the estimated freeway costs for advance planning, dated August, 1990. These typical cost figures, obtained from the Fort Worth District, are as follows:

- ADD EXIT RAMP (WITH 1000 FEET OF FRONTAGE ROAD)
  $800,000 each
  (Annualized at a 4% discount rate for 20 years) = $58,900

- ADD ENTRANCE RAMP (WITH 1000 FEET OF FRONTAGE ROAD)
  $1,200,000 each
  (Annualized at a 4% discount rate for 20 years) = $88,300

10.0 BENEFIT/COST RATIO

To determine the benefit/cost ratio, the Net Present Value, NPV, of the total benefits (over 20 year project life) derived from the proposed ramps (the travel time savings for those vehicles that would use the proposed ramps, plus the intersection delay saved by the remaining vehicles at the US 287/FM 157 interchange once the Debbie Lane traffic has been removed) are divided by the NPV of the capital or construction costs as described in the previous section.

The benefits and costs associated with both the Northbound exit ramp and the Southbound entrance ramp are shown in Tables III and IV, respectively. The annual

Table III. Cost Analysis of the Northbound Exit Ramp.

Discount Rate = 4 Percent					B/C Ratio = 2.29
Growth Rate = 5 Percent					
Percent Build-out = 0					
Year	Amortized Construction Cost	Annual Travel Time Savings	Development Benefits	Annual Signal Savings	Total Benefits
1992	$58,900	$64,316	0	$22,541	$86,857
1993	$58,900	$67,532	0	$23,668	$91,200
1994	$58,900	$70,908	0	$24,851	$95,760
1995	$58,900	$74,454	0	$26,094	$100,548
1996	$58,900	$78,176	0	$27,399	$105,575
1997	$58,900	$82,085	0	$28,769	$110,854
1998	$58,900	$86,190	0	$30,207	$116,397
1999	$58,900	$90,499	0	$31,717	$122,217
2000	$58,900	$95,024	0	$33,303	$128,327
2001	$58,900	$99,775	0	$34,968	$134,744
2002	$58,900	$104,764	0	$36,717	$141,481
2003	$58,900	$110,002	0	$38,553	$148,555
2004	$58,900	$115,502	0	$40,480	$155,983
2005	$58,900	$121,277	0	$42,504	$163,782
2006	$58,900	$127,341	0	$44,630	$171,971
2007	$58,900	$133,708	0	$46,861	$180,569
2008	$58,900	$140,394	0	$49,204	$189,598
2009	$58,900	$147,413	0	$51,664	$199,078
2010	$58,900	$154,784	0	$54,248	$209,032
2011	$58,900	$162,523	0	$56,960	$219,483
NPV	$800,000				$1,832,078

Table IV. Cost Analysis of the Southbound Entrance Ramp.

Discount Rate = 4 Percent B/C Ratio = 0.37

Growth Rate = 5 Percent

Percent Build-out = 0

Year	Construction Cost	Travel Time Savings	Development Benefits	Signal Savings	Total Benefits
1992	$88,300	$13,331	0	$7,594	$20,925
1993	$88,300	$13,998	0	$7,974	$21,971
1994	$88,300	$14,697	0	$8,372	$23,070
1995	$88,300	$15,432	0	$8,791	$24,223
1996	$88,300	$16,204	0	$9,231	$25,434
1997	$88,300	$17,014	0	$9,692	$26,706
1998	$88,300	$17,865	0	$10,177	$28,042
1999	$88,300	$18,758	0	$10,686	$29,444
2000	$88,300	$19,696	0	$11,220	$30,916
2001	$88,300	$20,681	0	$11,781	$32,462
2002	$88,300	$21,715	0	$12,370	$34,085
2003	$88,300	$22,801	0	$12,988	$35,789
2004	$88,300	$23,941	0	$13,638	$37,578
2005	$88,300	$25,138	0	$14,320	$39,457
2006	$88,300	$26,394	0	$15,036	$41,430
2007	$88,300	$27,714	0	$15,787	$43,502
2008	$88,300	$29,100	0	$16,577	$45,677
2009	$88,300	$30,555	0	$17,406	$47,960
2010	$88,300	$32,083	0	$18,276	$50,359
2011	$88,300	$33,687	0	$19,190	$52,876
NPV	$1,200,000				$441,372

benefits described previously (travel time and signal savings) are the benefits that can be expected during the first analysis year. To arrive at the subsequent savings for each of the 19 following years (based on a project life of 20 years), a five percent growth rate is applied. The five percent growth rate is applied to both the travel time savings and the intersection delay savings. When the five percent growth rate is applied to the intersection delay savings, the total savings over the life of the project is considered conservative. Since the operation of the interchange will deteriorate over time as traffic volumes increase, the intersection delay savings will increase as the square rather than the single geometric path as suggested by the five percent growth rate.

The column titled "Development Benefits" concerns any additional benefits (based on percent build-out) that those trips from the possible development along Debbie Lane would receive if the ramps were in place. The calculated benefit-cost ratio is simply the Net Present Value, NPV, of the total benefits divided by the NPV of the construction costs.

The proposed Northbound exit ramp has a resultant benefit-cost ratio of 2.29, implying that the construction of the NB exit ramp is justified. The proposed Southbound entrance ramp has a resultant benefit-cost ratio of 0.37, implying that the construction of the SB entrance ramp is not justified. These B/C ratios do not include any future development along Debbie Lane.

If the two ramps are added together and considered as one project, the resultant B/C ratio is as shown below.

$$\text{Project B/C} = \frac{\text{Benefits}}{\text{Costs}} = \frac{\$1{,}832{,}078 + \$441{,}372}{\$1{,}200{,}000 + \$800{,}000} = \frac{\$2{,}273{,}450}{\$2{,}000{,}000} = 1.14$$

The resulting B/C ratio implies that the overall project, the construction of both the Northbound exit and the Southbound entrance ramps, is justified without any future build-out along Debbie Lane.

11.0 TRIP GENERATION

Since most of the land in the study area is undeveloped, a total build out of this area could drastically increase the amount of traffic that would access the proposed ramps at Debbie Lane (Figure 8). A trip generation study was completed after receiving additional information from the City of Mansfield on the proposed zoning in the Debbie Lane area. Based on the information provided, the majority of the land will be developed commercially, such as the construction of a shopping center, specialty retail stores, and/or a business park. The analysis of the total build out in these sections resulted in approximately 5,000 vehicles per day using both the proposed entrance and exit ramps. These vehicles using the proposed ramps consisted of vehicles travelling along US 287, primarily to and from the area south of Debbie Lane, assuming an even directional distribution (50/50).

The next item determined is what percentage of build-out would be required to justify the proposed ramps. Since the B/C ratio for the NB exit ramp is greater than 1.0, no additional build-out is needed for justification. However, the SB entrance ramp would need approximately 11 percent general build-out to raise the B/C ratio from 0.37 to 1.01 (see Table V). The 11 percent general build-out would result in an additional 550 trips per day using the proposed ramps. This is not unrealistic as a gas station would generate approximately 750 trips per day.

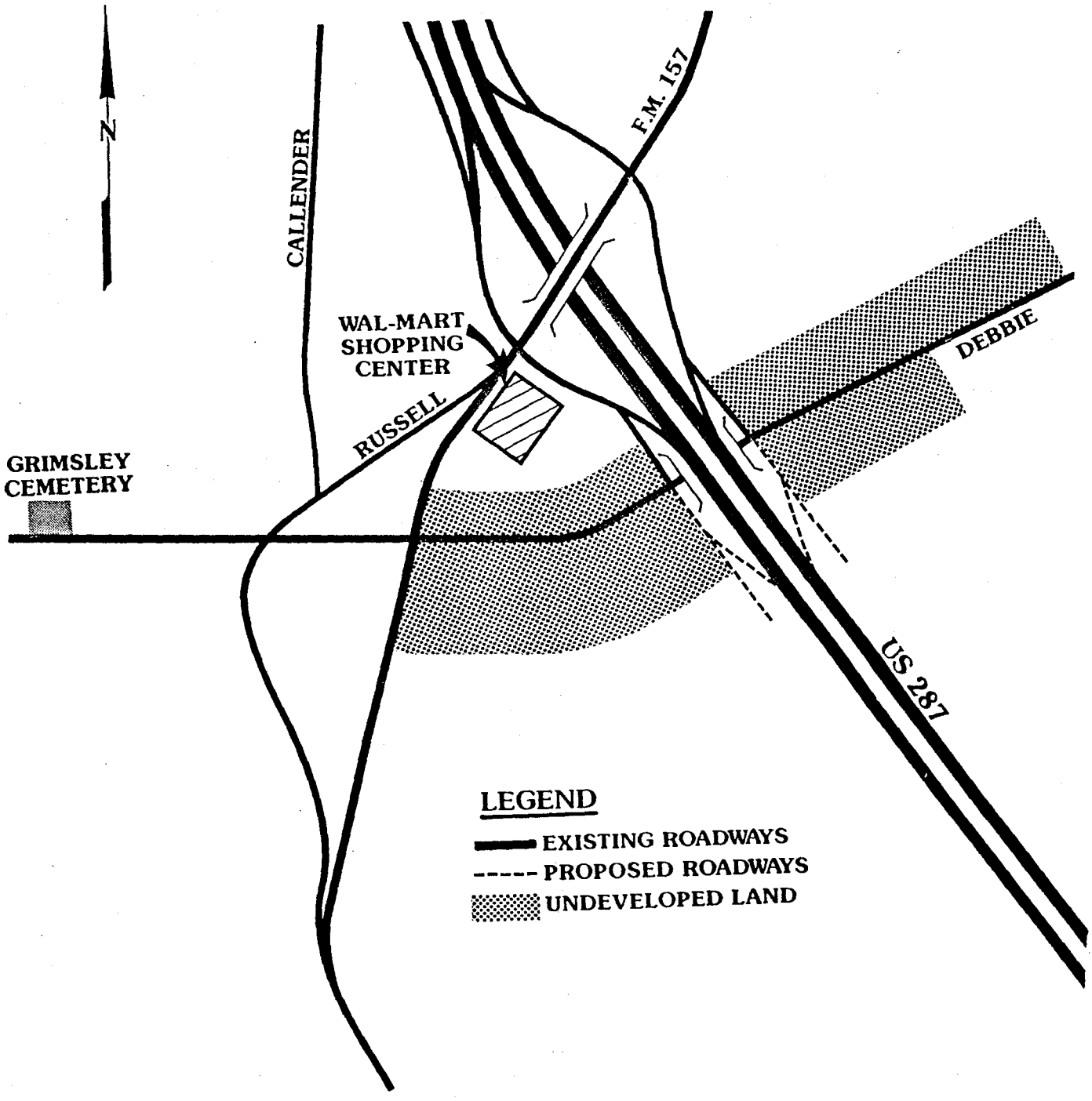

Figure 8. Trip Generation Study Area.

Table V. Cost Analysis of the Southbound Entrance Ramp with 11 Percent Build-Out.

Discount Rate = 4 Percent B/C Ratio = 1.01

Growth Rate = 5 Percent

Percent Build-out = 11 Percent

Year	Amortized Construction Cost	Annual Travel Time Savings	Annual Development Benefits	Annual Signal Savings	Total Benefits
1992	$88,300	$13,331	$56,420	$7,594	$77,345
1993	$88,300	$13,998	$56,420	$7,974	$78,392
1994	$88,300	$14,697	$56,420	$8,372	$79,490
1995	$88,300	$15,432	$56,420	$8,791	$80,644
1996	$88,300	$16,204	$56,420	$9,231	$81,855
1997	$88,300	$17,014	$56,420	$9,692	$83,127
1998	$88,300	$17,865	$56,420	$10,177	$84,462
1999	$88,300	$18,758	$56,420	$10,686	$85,864
2000	$88,300	$19,696	$56,420	$11,220	$87,336
2001	$88,300	$20,681	$56,420	$11,781	$88,882
2002	$88,300	$21,715	$56,420	$12,370	$90,505
2003	$88,300	$22,801	$56,420	$12,988	$92,209
2004	$88,300	$23,941	$56,420	$13,638	$93,999
2005	$88,300	$25,138	$56,420	$14,320	$95,878
2006	$88,300	$26,394	$56,420	$15,036	$97,850
2007	$88,300	$27,714	$56,420	$15,787	$99,922
2008	$88,300	$29,100	$56,420	$16,577	$102,097
2009	$88,300	$30,555	$56,420	$17,406	$104,381
2010	$88,300	$32,083	$56,420	$18,276	$106,779
2011	$88,300	$33,687	$56,420	$19,190	$109,297
NPV	$1,200,000				$1,208,143

12.0 RECOMMENDATION

As a result of this study, TTI has determined that the construction of the Northbound exit ramp is currently justified with a benefit-cost ratio of 2.29. The results also reveal that the Southbound entrance ramp is not justified at this time. However, the benefit-cost ratio for the overall project is 1.14, which would indicate that this is a feasible project. Moreover, because only 11 percent build-out is required over the next 20 years to justify the southbound entrance ramp, there is a good possibility that once the ramps are constructed, the surrounding area will develop and the generated traffic will gain travel time benefits needed to justify the proposed ramps.