Triple Left-Turn Lanes At Signalized Intersections

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16. Abstract

The use of triple left turns is seen as a means to meet constantly increasing traffic demand at signalized intersections. Although triple left turns have been in use for a number of years and their operational benefits are documented, they are still considered a relatively new design alternative that many agencies are reluctant to approve. While some excellent guidelines appear in the literature, there are no universal standards that apply.

The objectives of this project were to investigate the current usage of triple left turns from an operational, safety and modeling perspective and to develop guidelines for triple left-turn installations based on these findings. The project tasks included:

- Review of existing studies of, operational and safety studies, as well as guidelines used by other states for double and triple left turns.
- Conduct of operational analyses conducted to determine the capacity parameters of multiple left turn lanes.
- Modeling of triple left turn lane operations with available intersection and arterial performance analysis software products.
- Assessment of the safety performance of triple left turns, identifying crash patterns with associated intersection features and comparing the safety performance of triple and double left turn lane configurations
- Development of recommended criteria for adding turn lanes and/or new construction that includes triple left turn lanes.

The results of these analyses suggested that triple left turns can produce substantial operational benefits, however an increase in crash rates was noted at some locations. It was also observed that existing traffic models do not treat triple left turns explicitly and can therefore only offer an approximation of their operation. The principal product of the study was a set of guidelines recommended for incorporation into the Florida Department of Transportation's Traffic Engineering Manual.

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Disclaimer

The opinions, findings and conclusions presented in this report are those of the authors and not necessarily those of the Florida Department of Transportation or any other government agency

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1. INTRODUCTION

1.1 Need for Guidelines

Increasing traffic demand on urban streets has resulted in higher left-turn volumes. This makes left turns more difficult because of the greater levels of opposing traffic. In Florida, strict access control policies have continued to reduce the number of median openings and traversable medians. These policies have shifted mid-block left-turn traffic to already congested downstream intersections. The increasing left-turn demands and decreasing left-turn opportunities point out the need for higher left-turn capacities. The use of triple left turns at signalized intersections is seen as a means to meet this need.

A triple left turn allows three lanes of vehicles to perform a left-turn maneuver simultaneously during a signal phase. It increases intersection capacity by allowing a greater discharge of turning vehicles over a shorter period of time, yielding additional green time to other traffic movement within the intersection. A study of five triple left-turn sites in California by Leonard (1994) recorded an overall saturation flow rate of 1,928 vehicles per hour of green per lane (vphgpl). After adjusting the factors for lane width, heavy vehicle and left-turns, Leonard estimated an ideal saturation flow rate of 2,180 passenger cars per hour of green per lane (pcphgpl). This is a value significantly higher than the ideal saturation flow rate of 1,900 pcphgpl of the Highway Capacity Manual (HCM). A more recent Institute of Transportation Engineers (ITE) study of 17 triple left-turn sites from around the country recorded an average saturation flow rate of 1,830, about 5% higher than observed for double-left turn lanes.

In addition to increasing intersection capacity, triple left turns also provide other potential benefits. For example, the installation of a triple left turn will result in a shorter left-turn queue, thus reducing the probability of blockage of through traffic due to turn-bay overflow. A short left-turn queue may also reduce the probability of left-turn vehicles conflicting with driveway vehicles. And finally, where two intersections are closely spaced, a shorter left-turn queue also means a lower probability of left-turn traffic spilling back into the upstream intersection.

Although triple left turns have been in use for a number of years and their operational benefits are documented, they are still considered a relatively new design alternative that many agencies are reluctant to approve. Very few guidelines for the installation of triple left turns exist, leaving traffic engineers to rely on personal experience and double left-turn criteria for the design of these facilities. In 1994, Ackeret developed the only known design guidelines for triple left turns based on data from triple left turns in Las Vegas, Nevada.[1]

[1] Ackeret's design guidelines are summarized in detail in Chapter 2 of this report.

1.2 Project Objectives

The objectives of this project are twofold. First, to investigate the current usage of triple left turns from an operational, safety and modeling perspective. Secondly, to develop guidelines for triple left-turn installations based on these findings. The guidelines will address the design needs pertaining to the installation and design of geometric and traffic control devices of triple left turns.

1.3 Report Organization

This first chapter provides an overview of the project, organization of the report and addresses the major issues to be considered when implementing the use of triple left turn lanes at interchanges and major arterial intersections. Chapter 2 presents a review of existing studies of flow considerations, operational and safety studies, as well as guidelines used by other states for double and triple left turns. Chapter 3 describes in detail the data collection and reduction procedures for operational analyses conducted in this study. Chapter 4 documents the modeling of triple left turn lane operations with available intersection and arterial performance analysis software products. Chapter 5 documents the assessment of the safety performance of triple left turns, identifying crash patterns with associated intersection features and comparing the safety performance of triple and double left turn lane configurations. Chapter 6 provides an overall assessment and recommended criteria for adding turn lanes and/or new construction that includes triple left turn lanes.

1.4 Current Usage of Triple Left-Turn Lanes in Florida

At the initiation of this project, the State of Florida had a total of 12 known intersections installed with a triple left turns. All but one of these was located in Dade and Broward Counties. The other one is located in Alachua County in the city of Gainesville. Over the course of this project, five new triple left turns have been added, while an existing triple left turn was converted to a double left turn to make room for another traffic movement at the intersection. While Florida appears to be increasing the number intersections installed with a triple left turn, there are no current guidelines in existence. This study provides the basis for such guidelines and suggests criteria for adding left hand turning lanes where they are warranted.

2. BACKGROUND AND LITERATURE REVIEW

This chapter summarizes existing literature and design guidelines for double and triple left turns. It is divided into five major sections. The first section provides definitions to help interpret the results of operational studies. The second and third sections summarize findings from existing operational and safety studies, respectively. The fourth section summarizes information provided by state transportation departments about existing design guidelines and practices on double and triple left turns. The fifth and final section covers the application of computer-based performance estimation models to triple left turn operations.

2.1 Signalized Junction Flow Considerations

Left turn lanes are provided to accommodate heavy left turn movements without disrupting the through or right turn movements of the opposite direction. Having exclusive left-turn lanes allows for the use of protected left-turn phasing and provides storage for queued vehicles without disrupting the through movement.

In order to interpret the traffic operational studies of the effectiveness of multiple left-turn lanes, a brief description of discharge flow modes and their respective stages of discharge from an unopposed traffic signal approach is needed. Figure 2-1 shows the four stages associated with the dissipation of traffic at such intersections. They include:

1. Initial start loss;
2. Discharge from queue at saturation flow;
3. Discharge equal to arrival rate (after the initial queue is discharged) and
4. Final end gain.

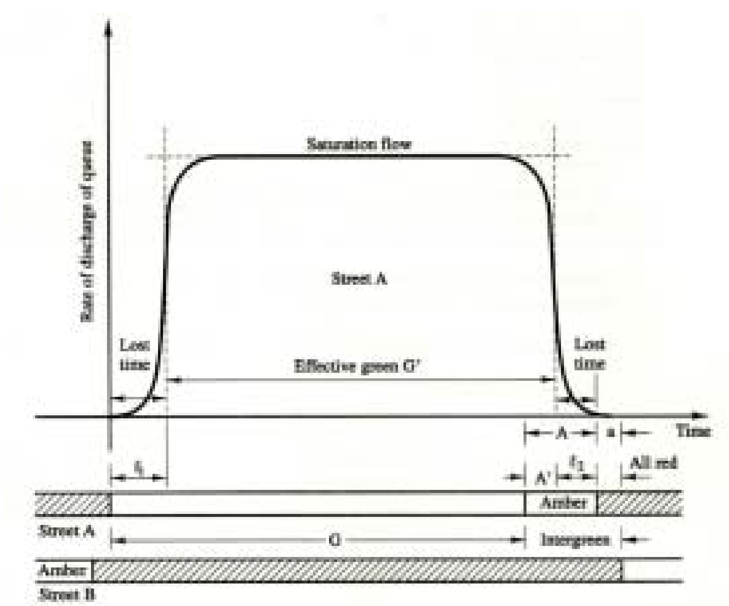


Figure 2-1. Temporal Pattern of Traffic Flows at Signalized Intersection.

The “Saturation Flow Rate” is calculated following the start loss (while the queue is present), vehicles discharge at maximum rate. The simple saturation flow rate = 3600 sec/average headway, after the 3rd discharged vehicle. Typical values are found to be about 1800 to 1900 for the types of intersections to be evaluated in this study, corresponding to time headways averaging 1.92 to 1.97 sec. More time is required for turns of long and heavy vehicle configurations.

Start loss and end gain are used to correct for the vehicle lags at the beginning of the green time and the continued movement of traffic after the signal turns to amber. The start loss (measured in seconds) is the equivalent loss in effective green time before approach discharges at saturation flow. Typically, saturation flow does not occur until the 3rd or 4th vehicle is discharged. Stability occurs in 2 to 3 seconds, but under certain conditions can take as much as 5 seconds or more. The end gain (also measured in seconds) is a gain in effective green arising from the fact that vehicles do not immediately stop. The end gain is usually 1 second longer than the start loss.

The term “effective green” refers to the starting time a few seconds after the beginning of the displayed green when the first vehicle initiates movement until the amber signal light is illuminated.

2.2 Studies of Traffic Operations

There have been a substantial number of operational studies of double left-turn lanes, but very few related to the operation of triple left-turn lanes. Studies of double left-turn operations are reviewed first, followed by the few available studies of triple left-turn lanes.

2.2.1 Double Left Turns

Operational studies on double left-turns have focused on their efficiency in terms of saturation flow rates. One of the early studies by Capelle and Pinnell (1961) attempted to measure starting delays and departure headways of vehicles on six approaches of two signalized diamond interchanges on the Gulf Freeway in Houston, Texas. Table 2-1 presents a summary of the average starting delays, departure headways, and a comparison of the relative magnitudes of the flow rates corresponding to the reported departure headways. It was concluded from the table that there was no difference in the average capacity of straight-through and single-lane turning movements, and that the capacity of the inside and outside lane of the double left-turn movement was found to be only 88% and 95% of the capacity of straight-through, respectively. The difference in capacities was attributed to the tendency of the drivers in both lanes to stagger the position of their vehicles when making the left-turn movement.

Table 2-1. Comparisons of Average Starting Delays, Headways and Flow Rates

Movement	Starting Delay[a] (sec)	Avg. Time-Headway (sec)	Saturation Flow Rate[b] (pcphgpl)	Flow Rate As Ratio of Through Flow
Through	5.8	2.1	1714	1.0
Single Left Turn	5.8	2.1	1714	1.0
Single Right Turn	5.8	2.1	1714	1.0
Double Left Turn[c]				
Inside Lane	6.5	2.4	1500	0.88
Outside Lane	6.5	2.2	1636	0.95

a. Capelle and Pinnell (1961) defined starting delay as the time required for the first two vehicles in a lane to enter the intersection.
b. Calculated from (3600/headway).
c. The double left-turn lane was configured as a permissive double left-turn movement.

Another study conducted by Ray (1965) computed several flow rates from 11 different configurations of double left turns in Sacramento, California. Six of these double left turns involved exclusive left-turn lanes; two involved permissive double-left turns at conventional 4-leg intersections; and three involved exclusive single-lane left turns at a “T” intersection. In addition, four exclusive single left turns were studied to compare the capacity and usage of single versus double left turns. Table 2-2 summarizes the results on flow rates as reported by Ray. Ray’s results were comparable with those of Capelle and Pinell (1961). However, Ray reported a substantially lower flow rate for permissive double left-turn movements. His results showed that permissive double left-turn movements was only about 75% as efficient as a single left-turn movement while Capelle and Pinnell, on the other hand, found permissive double left-turn movements to be 88% to 95% as efficient as single left-turn movements.

Table 2-2. Turn Lane Saturation Flows

	Saturation Flow (vphgpl)		Flow Rate as Ratio of Average Single-Lane Left-Turn Flow	
Types of Turn Lane	**Inside Lane**	**Outside Lane**	**Inside Lane**	**Outside Lane**
Protected Double				
Site 1	1550	1310	0.94	0.80
Site 2	1200	1320	0.73	0.80
Average	1375	1315	0.84	0.80
Permissive Double	1240	1230	0.75	0.75
Exclusive Single				
Site 3	1740	-	1.06	-
Site 4	1450	-	1.06	-
Site 5	1750	-	0.88	-
Average	1647	-	1.00	-

The 1965 Highway Capacity Manual developed a single general statement for the capacity of double left-turn movements. The 1965 HCM gives a maximum capacity of 1200 vphgpl (vehicles per hour of green time per lane) per ten feet of lane width for the case of separate turning lanes with separate signal control. For each additional turning lane, the additional lanes are assigned a service volume of 0.80 times that of the first lane. This efficiency factor is comparable to the 0.75 value reported by Ray. Saturation flow rates calculated from the procedures given in the 1965 HCM are summarized in Table 2-3.

Table 2-3. Double Left-Turn Saturation Flow as Calculated from the 1965 HCM Procedure

	Saturation Flow (vphg)[a]		
Lane Width	**Inside Lane**	**Outside Lane**	**Both Lanes**
10	1200	960	2160
11	1320	1056	2376
12	1440	1152	2592
[a] Flow rates assume trucks constitute 5% of the turning volume			

Leisch (1967) presented a procedure for calculating the capacity of exclusive double left-turn lanes that was somewhat comparable to the method described by the 1965 HCM. The only exception was an additional correction made to account for the angle and lane width of the cross street. Leisch developed a series of nomographs to simplify the capacity analysis process. The calculation of the capacity of an exclusive double left-turn movement involves two basic steps. In the first step, the capacity of a single, exclusive turning lane with separate signal phasing is found by using the nomographs. For the case of exclusive double left-turn movements, the second lane is assigned a service volume 0.80 times that of the first lane. Thus, the capacity of a double left-turn movement is 1.8 times that of a single left-turn lane. In the second step, the capacity obtained in the first step is adjusted to account for the angle of turn and lane widths. Leisch found that the capacity of double left-turn movements was sensitive to the angle of the turn and the width of the receiving approach.

Assmus (1970) conducted an operational study of seven intersections with double left-turn lanes. These intersections were grouped into three categories of similar geometry. Assmus adjusted the vehicle counts he observed by making one commercial vehicle equivalent to three passenger-car units. He also adjusted the starting delay and computed the adjusted average headway in seconds per vehicle. Assmus was able to determine the saturation flow in vehicles per hour of green for each of the intersection types. He further defines the intersection types as follows: (1) Type 1 installations are fully shadowed configurations and are used mainly to handle moderate turning volumes with a very short green phases, and (2) Types 2 and 3 are installations with only one left-turn trap lane with either an exclusive left or left-through shared lane. Both are used to handle very large turning volumes. From this study, Assmus concluded that the total saturation flow of both lanes is independent of the type of intersection. Table 2-4 shows the results of this study. Table 2-5 summarizes the average headways and corresponding saturation flows reported by Assmus for three four-lane approaches with Types 2 and 3 double left-turn movements.

Table 2-4. Vehicles per Hour of Green – Loaded Cycles Only

Intersection	Lane #1	Lane #2	Both Lanes
Type 1	1260	1810	3070
Types 2 and 3	1540	1530	3070
All Types	1420	1650	3070

Table 2-5. Average Straight-Through and Double Left-Turn Saturation Flows from Three Four-Lane Approaches as Reported by Assmus

Lane No	Movement	Average Headway[a] (sec)	Saturation Flow (vphgpl)	Flow Rate as Ratio of Maximum Straight-Through Flow
1 (inside)	Left-Turn	2.34	1540	0.96
2	Left-Turn	2.32	1550	0.97
3	Straight-Through	2.27	1585	0.99
4 (outside)	Straight-Through	2.25	1600	1.00

[a] Assmus (1970) defines headway as the time between third and last vehicle in the queue to cross the stop line divided by the number of vehicles in the queue less three.

The ITE Technical Committee 4L-M (1975) published a report on the use and effectiveness of double left-turn movements. The report identified three common types of double left-turn treatments:

1. Exclusive double left turn with both lanes shadowed.
2. Exclusive double left turn with one trap lane.
3. Permissive double left turn with outside lane optional left or through.

The Committee conducted the study by reviewing the available literature and by conducting a survey of 46 practicing professionals who were known to have interest and knowledge in the subject. The committee concluded from the survey in addition to other published information that:

1. Double left turns can effectively accommodate large volumes of left-turn traffic;

2. A thorough study of signal timing and phasing needs, intersection and roadway geometrics, signing and marking requirements, etc., must precede and influence the design of double left-turn facilities;

3. The development of national guidelines for double left turn movements would be helpful;

4. Except where traffic and roadway conditions would otherwise permit safe and efficient operation, double left-turn movements at signalized intersections should be protected from conflicting traffic movements by a separate signal phase;

5. Where an optional left-turn or through traffic is permitted from the same lane at a signalized intersection, signal phasing should be provided in such a manner that both movements operate simultaneously but not with the opposing through movement to avoid lane blockage and the resulting rear-end collision potential;

6. Mandatory left-turn lanes should be shadowed whenever possible to avoid trapping conditions;

7. Where an optional double left-turn lane is employed or where a mandatory turn lane cannot be shadowed, overhead signing should be used whenever possible to promote the efficient use of the optional lane and to insure compliance to the turning requirements of the mandatory lane;

8. Lane line extensions should normally be used to delineate the proper turning path through the intersection for the double left-turn maneuver to reduce the sideswipe collision potential and to promote efficient double left-turn operations. The markings should be carefully planned to coincide closely with normal vehicular turning paths; and

9. Consideration should be given to providing at least one signal indication to control protected double left-turn movements.

An extensive study was done by Kunzman (1970). He measured headways of straight-through and left-turning vehicles at 175 locations in Orange County, California. Table 2-6 shows Kunzman's saturation flow rates calculated using the average headway for all the vehicles clearing the intersection from a stopped position.

Table 2-6. Straight-Through and Left-Turn Saturation Flow and Relative Efficiency Factors as Reported by Kuzman

	Average Saturation Flow (vphgpl)[a]			**Double Left-Turn Flow as Ratio of Straight-Through Flow**	**Double Left-Turn Flow as Ratio of Single Left-Turn Flow**
Queue Length	**Straight-Through**	**Single Left-Turn**	**Double Left-Turn**		
< 4 veh/ln	1597	1494	1439	0.90	0.96
> 5 veh/ln	1702	1726	1581	0.93	0.92
All	1672	1632	1523	0.91	0.93
[a] Flow rates are for various mixes of trucks and cars.					

As part of his dissertation, Stokes (1984) performed a study based on observations of 3,458 completed left turns from exclusive double left-turn lanes on 14 intersection approaches in Austin, College Station, and Houston, Texas. The study estimated the saturation flows of exclusive double left-turn lanes and investigated the physical and operating characteristics of those intersections affecting left-turn saturation flows. Table 2-7 provides the 95% confidence intervals of average saturation flows by turning lane and city. The results are also reported in another related Transportation Research Board (TRB) publication by the author (Stokes, et al., 1986). The results showed that the average left-turn departure headways vary significantly among the intersection approaches studied. However, within each city, departure headways did not differ significantly between the two lanes of a double left-turn movement. It was suggested that an average double left-turn saturation flow rate of approximately 1,600 vehicles per hour of green per lane be used for most planning applications. In addition, this flow rate could be assumed to be achieved for the third vehicle in the queue and beyond and for mixed traffic conditions in which heavy vehicles constituted as much as 3 to 5% of the left-turn traffic volume.

Table 2-7. 95% Confidence Intervals for Average Saturation Flows (vphgpl) by City

Lane	Austin	College Station	Houston
1	$1565 < S_L < 1714$	$1636 < S_L < 1800$	$1714 < S_L < 1895$
2	$1565 < S_L < 1714$	$1565 < S_L < 1714$	$1800 < S_L < 2000$
Grand Mean	1636	1636	1800

[a] Calculated from $(1/h_L)$ x 3600
S_L = Left-turn movement saturation flow average.
h_L = Left-turn average headway.

Based on the same data described above, Stokes et al. (1986) reported their findings on the distributions of left turns on amber and red from exclusive double left-turn lanes during saturated conditions, defined as having a queue length of five or more vehicles per lane. It was found that the average number of left turns on amber and red tended to increase as average left-turn green time decreased, and that the average number of left turns on red tended to increase with the number of left turns on amber. It was also found that the average number of left turns on amber did not appear to differ substantially between the two left-turn lanes. However, drivers on the outside lane were found to make fewer left turns on red than drivers on the inside lane, particularly when the left-turn green time was relatively short.

Marcus (1989) attempted to validate Stokes' findings using field observations at two sites in Austin, Texas. The Texas Model was used to determine the average and the maximum bay length needed for double left-turn operations. Marcus obtained a saturation flow of 1615 vphgpl, which was in close agreement with that of Stokes’ determination of 1600 vphgpl.

Coleman (1989) conducted an evaluation study on the operational aspects of double left-turns in the City of Albuquerque, New Mexico. Coleman discussed about the impact exerted by double left-turns on capacity, signal timing and accident experience. He also pointed out the benefit of an appropriate pavement marking and signing used to delineate the travel lanes for the turning vehicles. Coleman’s report indicated that motorists were generally pleased with the excellent performance of double left-turns. Although there were some problems, double left-turns were found to increase capacity at a relatively low cost.

Using the existing highway capacity software, Nicholas (1989) compared the overall operating efficiency between double and single left-turn lanes at intersections with similar characteristics. Nicholas analyzed 14 intersections—half of them had double left-turn approaches and the other half had single left-turn approaches. The single left-turn lane intersections were analyzed and simulated as double left-turn to evaluate the overall performance of the intersection. The results from the simulation are presented in Table 2-8. It shows that six of the single left-turn intersections experienced an amount of delay classified under a "failed" level of service. When these approaches were simulated as double left turns, four of the seven intersections improved to a functioning level of service. Under simulated double left-turns conditions, overall vehicular throughput was raised by 17.5%. Through his observations, Nicholas determined that the use of double left-turn lanes at intersections containing high volumes of left-turning traffic and opposing traffic was favorable.

Table 2-8. Capacity of a Single Left-Turn Lane Intersection Simulated as a Double Left-Turn Lane Intersection

Existing Single Left Intersection	Total Delay (sec/veh)	v/c	LOS	Double Left Simulation Total Delay	v/c	LOS
1	39.8	0.961	D	37.8	0.818	D
2	*	1.011	*	27.9	0.813	D
3	*	1.240	*	*	1.092	*
4	*	1.148	*	39.5	0.988	D
5	*	1.159	*	56.8	1.150	E
6	*	1.857	*	*	1.620	*
7	*	0.209	*	22.2*	0.878	D
* Intersection fails to operate at an acceptable level of service						

The ITE Technical Council Committee 5P-5 (1993) carried out a survey in which questionnaires were sent to a number of agencies and companies. Based on the data obtained by these sources, the Committee suggested that the HCM left-turn factor (f_{LT}) of 0.92 may be relatively low; and a left-turn factor of 1.0 is more appropriate for at least some intersection geometries. The HCM left-turn saturation flow rate is 1656 vphgpl while the Committee data suggested a saturation flow rate on the order of 1950 vphgpl. It was also found that the distance between opposing left-turn flows was one of the most consistently related to f_{LT} and saturation flow. Other variables that may affect saturation flows are as follows:

1. Length of the left-turn bay;
2. Radius of turn;
3. Type of lane; and
4. Short bays.

The Committee concluded that additional research was needed to expand the scope and to improve the scientific basis of its work.

Kagolanu and Szplett (1994) performed a study to estimate the saturation headways and lane distribution of the inside and outside double left-turn lanes. A total of 2735 data points was collected. The results showed a statistically significant difference in the saturation headways of inside and outside left-turn lanes at 95% confidence level. The results also showed that the left-turn lane use was 46% for the inside lane and 54% for the outside lane.

Shaik and Graham (1996) reported a study in which ten intersections were selected to compare the overall operating efficiency between intersections with double left-turn lanes on one or more approaches and intersection with similar characteristics but with only a single left-turn lane. A field study was undertaken to calculate the saturation flow rate of the inside and outside left-turn lanes, considering the total time as being computed from the second vehicle through the last vehicle in queue. The second part of the study consisted of simulating the traffic flow using TRAF-NETSIM for each of the chosen intersections with and without the double left-turn lanes. Although the study revealed that single left-turn intersections simulated as double left turn operated under congested level of service (LOS) F, it was concluded that adding a second turning lane reduces overall intersection delay by an amount between 6% to 37%.

A more recent study conducted by Spring and Thomas (1999) analyzed 30 double left-turn approaches grouped as having or not having a through movement. After collecting average headways of the third vehicle through the eighth vehicle and calculating saturation flows for each left-turning lane and through lane, the approaches were segregated into geometric and operational factors. The geometric factor considered was the turn angle and the operational factors considered were the presence of opposing flow and/or through movement. Subsequently, left-turn factors were obtained by relating each left-turning lane saturation flow to the through saturation flow. Table 2-9 summarizes the results from all 30 approaches under study.

Table 2-9. Summary of Approach Data

	Mean Headway	Average Saturation Flow	Average F_{LT}
Inside Left Turn	11.7	1543	0.91
Outside Left Turn	12.1	1491	0.88
Through lane	10.4	1730	1.0

An analysis of variance was performed on lane saturation flows to access the difference between each of the left-turn lanes and the adjacent through lane. Approaches were segregated as follows:

- With opposing left-turn traffic;
- Without opposing left-turn traffic;
- With measurable through movement;
- With insignificant through movement;
- With left-turn angle equal to 90°;
- With left-turn angle less than 90°; and
- With left-turn angle greater than 90°.

The study revealed that lane saturation flows on approaches with through movements were larger than those without. For approaches with through movement, the left-turn saturation flows differ from each other and was different when compared with the saturation flow in the through lane. While on approaches with no through movement, left-turn saturation flows were equal at a 95% level of confidence. On the other hand, turn angles less than 90° eliminate the difference between the inside and the outside lane's saturation flow. It was concluded that neither geometric nor traffic-related characteristics have an adverse effect on the performance of double left-turns, but rather the presence or absence of through and opposing traffic were key factors in their performance.

2.2.2 Triple Left-Turn Lanes

Operational studies on triple left turns are very limited. In 1991, the FDOT conducted an operational study at two "T" ramp terminals off the Florida Turnpike (1991). The study was performed to assess the impacts of a third left-turn lane installation. The results revealed that improvements at the intersection did reduce delay and, therefore, an improvement in the level of service. On the other hand, headways also increased due to the larger turning radii required by the triple left-turn movement. Another factor that was found to contribute to this increase was driver's hesitance in the center lane, caused by having turning traffic on both sides. Although the study found a decrease in the intersection delay, it could not be attributed to the triple left turn alone because the intersection volumes decreased overall. The use of triple left-turn lanes was recommended for similar T-intersections where left-turn capacity is inadequate with double left-turn lanes.

In 1994 Ackeret conducted a study of triple left-turn intersections for the Nevada Department of Transportation. Based on triple left turns in Las Vegas, Nevada, Ackeret formulated general criteria for the geometric design of triple left-turn lanes at signalized intersections. He identified three general types of triple left-turn lane configurations that have been gaining acceptance for its design and construction. The three configurations are commonly extensions of those used for double left turns:

- Type A: Three exclusive left turn bays
- Type B: Two exclusive left turn bays plus an exclusive left turn trap lane
- Type C: Two exclusive left turn bays plus an optional through-left lane

Ackeret suggested that there are numerous variations related to site-specific conditions, including whether an intersection is of "Y" or "T" configuration, the intersection angle, concurrent opposing left turn with either single, double or triple left turn, design vehicle, lane width, and left turns from a two-way to a one-way or from a one-way to a two-way street. In addition, Ackeret considered the following five conditions to be inappropriate for triple left-turn lane installations:

- There is a potential for higher number of pedestrian-vehicle conflicts.
- Left-turning vehicles are not anticipated to queue uniformly within the provided left-turn storage due to downstream conditions.
- Conditions exist that obscure, or result in, confusing pavement markings within the intersection.
- Right-of-way restrictions prohibit adequate design-vehicle turning maneuver space within the intersection.
- The installation is not economically justified when compared with other alternatives to improve intersection capacity.

Ackeret's recommendations on the geometric design of triple left turns include the following considerations:

1. Select the design vehicle governed by single-unit truck/bus for roadways on truck-restricted areas, or by WB-15 otherwise.
2. The lateral clearance between the running design vehicles should be maintained with a minimum clearance of 2 feet on each side of the design vehicle overhang limits within turning maneuvers.
3. Concurrent opposing left turns should have at least 10 feet vehicle clearance between opposing left turns.
4. Left-turn approach lane widths should have at least 11 feet in width with a desirable width of 3.6 meter (12 feet).
5. The downstream departure lane widths should have an absolute minimum of 11 feet with a desirable width of 12 feet.
6. The receiving leg should have a raised median island of at least 2 feet in width to provide drivers on the inside lane with a visual point of reference to guide the vehicle through the left-turn maneuver.
7. Determine storage bay length based on anticipated left-turn arrival rates, cycle length, need to prevent spillover to thru lanes, and presence of adjacent upstream intersections and driveways.
8. Determine approach taper length based on design speed and local preference for reverse curves versus taper sections.

Ackeret also suggested the use of advanced overhead signs to inform the drivers of lane options. These signs should be supplemented with appropriate downstream lane destination messages if they will reduce downstream weaving maneuvers. Each turn lane should be marked with turn arrows and "ONLY" legends as appropriate. Shared left-lane arrows (for Type C) are provided to warn drivers and to regulate the intersection. Skip lines, preferably comprised of raised markers, should be used through the intersection with appropriate spacing to control the multiple turning path and safely keep each vehicle within its lane. In closing, Ackeret found that triple left-turn lanes have the following advantages:

1. The ability to increase an intersection capacity to handle a large left-turn volume of left-turn maneuvers (600 vph or more) and reduce delays and intersection queues. Reduction in upstream driveway conflicts by reducing queue lengths and resulting on vehicle storage lane lengths for left-turn lane.
2. The ability to reduce the green time given to the left-turn movement so that it may be assigned to other intersection movements (thus reducing overall intersection delay and improves the intersection level of service.)

Ackeret concluded that additional research is necessary and further studies are strongly required to address safety concerns by comparing crashes between double and triple left-turn lane installations.

Leonard (1994) conducted a study of five intersections with triple left turns in California. The objective was to document the associated operating characteristics such as flows of vehicles serviced by the turns, saturation flow rates, and various signal-timing characteristics. Manual saturation flow rates using electronic counter boards and queue discharge times for all vehicles by lane and by cycle were computed. Table 2-10 presents a summary of saturation flow rates computed at each site by lane and time of the day.

Table 2-10. Observed Saturation Flow Rates (Vphpgl) at Triple Left Turns

Sites	Lane			Time-of-Day			
	Inner	Middle	Outer	AM	MD	PM	Total
PCH/Dover	1938	1979	1894	1977	1908	-	1939
I5/LakeF	1888	1834	1913	-	1877	-	1877
PDV/LosAI	1954	1994	2005	-	-	1989	1989
PCH/Jamb	1948	1954	1868	1992	1838	1888	1921
PCH/BaySi	2209	1655	1942	-	-	1997	1997
All Sites	1946	1950	1891	1991	1856	1921	1928
Values computing using n-4 vehicles in queue (HCM suggested)							

The average saturation flow rate observed by this investigation was 1928 vphgpl. The ideal saturation flow rate assuming a 4% heavy truck volume was 2001 vphgpl using the HCM saturation flow rate adjustment procedure.

Table 2-11 presents a summary of the signal timing characteristics of the sites. After processing the data it was found that the average flow for these triple left turns was 795 vehicles per hour (vph) although they received only an average of 19% of the total cycle time. The busy time, which represents that portion of the green time spend discharging queue, on average accounted for 57% of the cycle length. The study concluded by examining the influence of variables on the observed saturation flow rates using an analysis of variance. The results revealed no significant differences between saturation flow rates by site, among weekdays or by observer. Significant differences were observed among lanes (inner, middle, outer), the time of day, and by weekday versus weekend.

Table 2-11. Signal Timing Characteristics of Triple Left Turns

Site Name	Flow (vphgpl)	Sat Flow (vphgpl)	Green (sec)	Yellow (sec)	Cycle (sec)	Split (%)	Busy (%)
PCH/Dover	274	1939	21	3.3	100	21	65
I5/LakeF	382	1877	29	3.8	104	28	56
PDV/LosAI	298	1989	21	4.1	87	25	46
PCH/Jamb	253	1921	18	3.0	103	17	59
PCH/BaySi	188	1997	15	2.8	103	15	71
Totals	265	1928	19	3.2	101	18	57

ITE Technical Committee 5P-5A (1995) investigated the capacities of triple left-turn lanes and correlated the findings with roadway geometric features. The study is an extension of Committee 5P-5's work, which examined the capacities and operational characteristics of double left-turn lanes. The study consisted of a data collection and the analysis of 17 intersections with triple left-turn lanes. The data collection effort contained general descriptive, lane headway data, and ten independent variables for each intersection studied. These variables are as follows:

- Population
- Angle
- Number of through lanes
- Bay length
- Taper length
- Radius of turn
- Minimum distance between concurrent opposing left turns
- Type of left-turn signalization
- Intersection configuration (4-leg, "T", and so forth)
- Existence of opposing left-turn movement at the intersection
- Type of left-turn movement studied (exclusive, optional right turn, optional through)

Saturation flow rates were calculated for the triple left-turn lanes and adjacent through lanes using average headways measured from the fourth vehicle to the eighth vehicle in the queue as recommended by the HCM. The results yielded an overall saturation flow rate for triple left-turn lanes of 1830 pcphgpl. This saturation flow rate is within about 5% of the rates reported by Leonard (1928 pcphgpl) for triple left turns and by ITE Committee 5P-5 (1950 pcphgpl) for double left-turn lanes. Analysis of variance (ANOVA) tests were performed to study the differences in average saturation flow rates by lane position (inside, middle, outside) and by turn-lane type (exclusive left-turn, optional through/right). The results indicated that there were no significant difference in the saturation flow rates between each of the three left-turn lanes, or among any of the turn lanes and adjacent through lanes. The ANOVA results also suggested that a left-turn factor of 1.0 might be appropriate for triple left-turn lanes, meaning that triple left-turns saturation flow rates may not be significantly different from the adjacent through lanes calculated in the study.

ITE Committee 5P-5A reported similar results for double left-turn lanes. Leonard, however, reported significant difference in the saturation flow rates among left-turn lanes (i.e., inner, middle and outer). With regards to the effects of various geometric factors on left-turn saturation flow rates, only preliminary investigations were possible due to the small sample size and missing geometric data for many intersections. Therefore, it was concluded that none of the geometric factors produced any significant correlation with left-turn saturation flow. The lack of evidence found in this study concerning any significant relationship may be attributable in part to the effects of downstream conditions that may cause drivers to pre-position themselves in the most favorable left-turn lane immediate to their downstream destination.

2.3 Studies of Safety Considerations

In general, crashes are concentrated at intersections. Those making left turning movements are particularly vulnerable.

2.3.1 Double Left Turns

A number of safety studies have been reported in the literature. ITE Technical Committee 4L-M conducted a survey in 1975 of 46 practicing professionals. Of the 29 individuals who provided a definite response, 13 indicated that the employment of double left turns had reduced crashes, while only one indicated an increase in the number of crashes and 15 indicated no significant difference in crashes.

Nicholas (1989) conducted a safety study involving seven single left-turn intersections and seven double left-turn intersections in Chicago, Illinois. It was found that double left-turn intersections experienced an average of 2.49 crashes per million entering vehicles (MEV), compared to 1.69 crashes per MEV for single left-turn intersections. For average crash rates based on movement, the study found that the double left-turn movements experienced 9.44 crashes per MEV, compared to 8.48 per MEV of the single left-turn movements.

Coleman (1989) reported that the City of Albuquerque experienced a reduced crash rate at most of the double left-turn intersections. He pointed out that the crashes people were most concerned about were sideswipe crashes between vehicles on the outside opposing turning lanes. However, no increase in such crashes was found.

The Traffic Signal Technical Committee of the Colorado/Wyoming Section of ITE (1995) conducted a study to determine if permissive double left-turn movements experience reasonable crash rates, as compared with protected-only double left turns and with single left turns. The results showed that crash rates were generally higher at permissive double left turns than at protected-only double left turns, although the difference was only less than one crash per million entering vehicles. The analysis also showed that double left-turn crash rates increased with the increase in the number of opposing approach lanes. However, no correlation was found between double left-turn crash rates with the opposing approach speed limits. In addition, double left-turn crash rates were found to vary significantly by city jurisdiction, even more so than by number of turn lanes and type of phasing.

2.3.2 Triple Left Turns

Safety studies on triple left turns are very limited. Mitchell (1993) conducted a safety study involving six triple left turns. It was found that only one of the triple left turns contributed to more than 20% of the total intersection crashes. The main cause of the crashes on the triple left-turn lanes was attributed to violations by vehicles changing lanes to proceed straight rather than making the mandatory left-turn movement. Mitchell pointed out that advance signing and proper markings are important in advising drivers of the left-turn restrictions. He also emphasized that turning radii and pavement surface conditions must be adequate for the vehicle speeds.

Belluccia et al. (1996) described a project involving the installation of a proposed triple left turn at an intersection, as shown in Figure 2-2, in the City of St. Petersburg, Florida. The proposed intersection consisted of four approaches, one being a major state road (SR 686), a county road (Pinellas County) and a major development driveway. The idea of installing a triple left turn was conceived when traffic forecasts revealed that the PM rush-hour traffic was going to increase and more than 700 vehicles were expected to be making a left turn onto SR 686, causing queues and delay. The triple left-turn option was thought of for an immediate improvement that will help ease the traffic on that approach. A fatal flaw analysis was performed and it was found that installation of a triple left turn could provide the following benefits over the other alternatives:

- It was the only feasible improvement that significantly decreased delays and queues;
- It would increase capacity on the side street thus making more green time available for allocation on State Road 686 for preserving and improving the state highway system;
- Solves a potential hazardous condition at the on-site intersection by eliminating excessive vehicular queuing; and
- Immediate improvement that reduces unsafe conditions at the intersection.

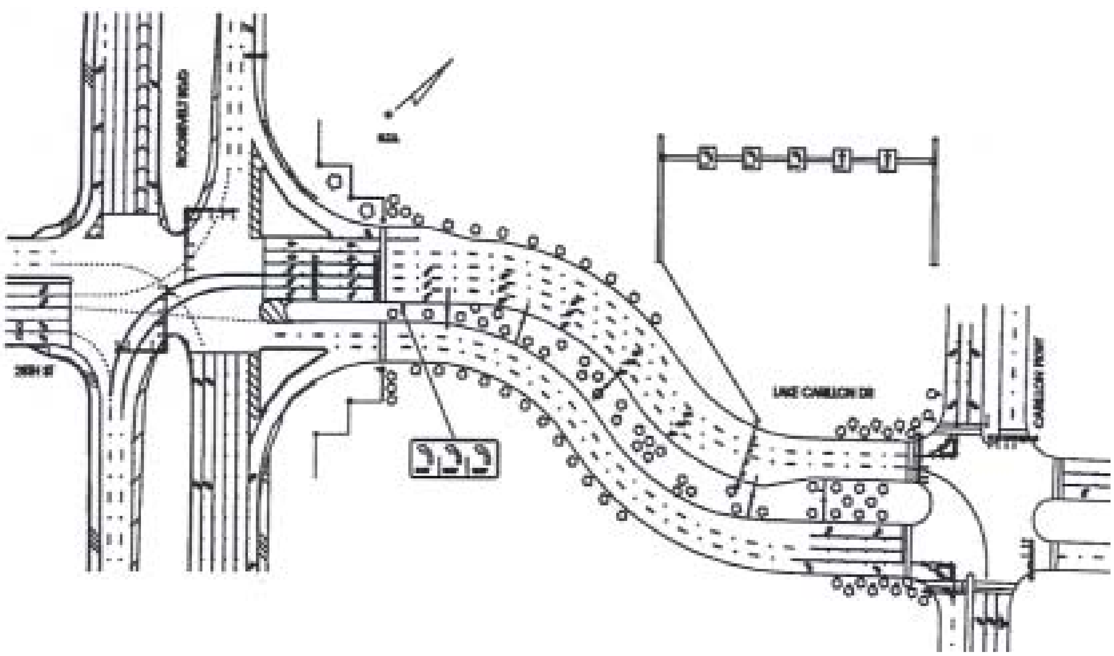


Figure 2-2. Proposed Triple Left-Turn Improvement (Belluccia 1996)

Part of the project consisted of reviewing crashes at locations with similar intersection conditions. Three intersections in Dade County, Florida and one intersection in Broward County (Ft. Lauderdale), Florida were selected based on driver population similarities. Four other locations in Georgia, Nevada, and California were also reviewed. It was found that less than 10% of the intersection crashes occurred in the triple left-turn approach. All crashes were angle crashes involving left-turning vehicles colliding with opposing through vehicles perpendicular to the triple left-turn approach. The study indicated that angle crashes were usually due to inadequate red phases or possible sight distance problems, but they were most likely not attributable to the operation of the triple left-turn maneuver. The study also concluded that crashes occurring in the left-turn movement were attributable more to signal timing or sight distance obstructions. Bellucia et al. suggested guidelines (see Table 2-12) for use in preparing or reviewing the study and design efforts associated with implementing triple left-turn improvements.

Table 2-12. Suggested Guidelines for Study and Design of Triple Left-Turn Improvements

Study Guidelines	Design Guidelines
Detailed data collection including upstream and downstream locations	Select appropriate design vehicles
Understand impacts of planned roadway improvements and future land use activity	Design using vehicle tracking paths
Review crash patterns	Use tracking to locate guidelines
Develop alternative improvements and make recommendations	Consider overhead and/or ground-mounted lane use signs
Triple left-turn considerations: • Downstream weave analysis. • Understand lane utilization • Vehicle tracking path analysis. • Literature review and research at similar locations. • Develop public awareness program.	Consider need for lane positioning signs
	Improve signal design and optimize timings
	Consider lighting improvements

A comparative study of double and triple left turns was conducted by Ackeret (1999) to evaluate the safety of triple left turns in terms of their potential for sideswipe crashes. The study was based on crash records from 1988 to 1997 and included three triple left turns and five double left turns in Las Vegas, Nevada. The study found that double left-turn approaches experienced an average of 0.2 sideswipe crashes per year. This crash rate represents 1.4% of total intersection crashes, or 7.7% of all intersection sideswipe crashes. On the other hand, triple left-turn approaches experienced an average of 1.3 crashes per year, which translates to 9.2% of the total intersection crashes and 50% of all intersection sideswipe crashes. Accordingly, the differences in crash experience of double and triple left-turn approaches were significant. However, upon further investigation, the authors attributed the difference to the deficiency in the turning path geometry and the existence of downstream busy bus stops. The authors believed that in the absence of these adverse conditions, properly designed triple left-turn lanes would have experienced sideswipe crash rates similar to those of double left-turn lanes.

2.4 Survey of State Departments of Transportation

A request for information from the 50 State Departments of Transportation (DOTs) was conducted to obtain materials related to double and triple left-turn lanes and to learn about possible ongoing studies being conducted in other states. Twenty-three state DOTs responded to the request and the findings are summarized as below. Of those State DOTs responding, none indicated any on-going studies that attempted to develop guidelines for triple left-turn installations. Three responders indicated an interest in the results of this study.

2.4.1 Kansas

Kansas DOT reported that they were unaware of any intersections installed with triple left-turn lanes. For double left turns, a minimum of 300 left turns during the peak hour per the HCM is required for their installation. Its published Traffic Engineering Guidelines state that, for double left-turn lanes, the receiving width should be a minimum of 8 meters, and desirably 8.6 to 9 meters; that the width should be extended to at least 15 meters, preferably 30 meters, beyond the end of the design radius of the outer turn.

2.4.2 Kentucky

Kentucky DOT reported that it has not developed guidelines for multiple left-turn lanes but it follows the HCM and the AASHTO Green Book to determine the number of turn lanes necessary and the minimum taper lengths required for speed reduction.

2.4.3 Maryland

The State of Maryland reported that although it has both double and triple left-turn lanes, no formal guidelines have been established. The use of a triple left turn over a double left turn is mainly based on right-of-way availability and critical lane analysis, that it will use a triple left turn if the need is there and adequate room to construct it is available.

2.4.4 Minnesota

Minnesota DOT reported the following design guidelines for double left turns that are based mainly on those of the NCHRP Report 279:

1. The throat width for turning traffic is the most important design element. Drivers are most comfortable with extra space between the turning queues of traffic. Because of the off tracking characteristics of vehicles and the relative difficulty of two abreast turns, an 11 m throat width is desirable for acceptance of two lanes of turning traffic. In very constrained situations, a 9 m throat width is an acceptable minimum.

2. The designers should check for possible conflicts involving left turns opposing double left turns. For proper design, use the swept path of semi-trailer and a 4.2 m strip placed alongside on the inside of the turn for a passenger vehicle. Hard copy templates and turning templates in the CAD cell library should be used to check the design.

3. Consideration should be given to providing pavement markings to separate the turn lanes. The Minnesota MUTCD recommends 0.6 m long dashed lines with 1.2 m gaps to channel turning radius. These channelization lines should be carefully laid out to reflect off-tracking and driving characteristics.

2.4.5 Mississippi

Mississippi DOT reported that the state considers double left-turn lanes for left-turn volume greater than 300 vph and triple left-turn lanes for left-turn volume greater than 600 vph. It also reported two triple left turns that were proposed but not yet implemented at the time of the report.

2.4.6 Nebraska

Nebraska DOT reported a planned first triple left turn to be installed on Millard Avenue in Omaha, Nebraska.

2.4.7 New Mexico

New Mexico DOT reported that the state had just re-constructed the intersection of Cerrillos and Airport Road in Santa Fe, New Mexico with the geometric configuration needed for triple left turn for the east to north movement. The intersection was striped for double left turn but it was planned for re-striping in a few years to allow the installation of a triple left turn. The state also reported that a triple left turn was being designed for the 1-25 E. Frontage Rd./Paseo del Norte intersection in the Albuquerque District.

2.4.8 New York

The New York DOT reported the following design guidelines for double left turns:

1. Double left turn lanes should be considered at signalized intersections with high left-turn demands or where a reduction in green time allocated to that left-turn movement can significantly benefit the intersection operation. While capacity analysis identifies the need for and impact of double left-turn lanes, left-turn demands over 300 vph and/or storage needs should trigger consideration of them. Fully protected signal phasing shall be provided for double left turns.

2. Provide adequate throat width on the approach receiving the double left turns to compensate for off-tracking characteristics of turning vehicles and the relative difficulty of side-by-side left turns. A car and the design vehicle should be able to comfortably turn side-by-side. An 11-meter wide throat is desirable for double left turns with turning angles greater than 90^o. Narrower throats can be provided for more favorable turning angles. A 9-meter throat width may be adequate for 90' turns. In constrained situations with favorable turning angles less than 90^o, 8-meter throat widths may be acceptable. However, throat widths less than 9-meter should normally be avoided since they can

restrict turning traffic flow and reduce the operational benefit of double left-turn lanes. On the other hand, excessive pavement, which can mislead drivers, should also be avoided.

3. If practicable, the intersection should be designed to allow the double left turn to be executed concurrently with the opposing left turn. This allows the flexibility in the signal phasing to serve the double left-turn movement concurrently with either the opposing left turns or the adjacent through movement. If the turning paths of the double left and the opposing left turn overlap, the left turns cannot be served concurrently.

4. Dotted lines, in accordance with the New York State MUTCD, are the appropriate pavement markings used to separate the two-abreast turning lanes and especially opposing turning lanes. The dotted lines should reflect turning paths and have a gap of between 1.2 and 2.0 meters.

5. The design should prevent through traffic from accidentally entering and becoming trapped in the double left-turn lanes. The turning lanes should be fully shadowed wherever possible.

2.4.9 Oklahoma

Oklahoma DOT uses the following design guidelines for double left turns:

1. Warrant: Double left-turn lanes should be considered when:

   a. There is insufficient space to provide the necessary length of a single turn lane because of restrictive site conditions (e.g., closely spaced intersections);

   b. The necessary length of a single turn lane becomes prohibitive;

   c. As a general rule, there are 300 or more left-turning vehicles in the design hour; and/or

   d. The necessary time for a protected left-turn phase for a single lane becomes unattainable to meet the level-of-service criteria.

2. Throat Width: Because of the off-tracking characteristics of turning vehicles, the normal width of two travel lanes may be inadequate to properly receive two vehicles turning simultaneously. The throat width will be determined by the application of the turning templates for the design vehicles. The designer can expect that the receiving width for double left-turn lanes will be approximately 30-36 feet. For double right-turn lanes, a 36-feet throat width can be expected. When determining the available throat width, the designer can assume that a strengthened paved shoulder, if present at the receiving throat, can be used to accommodate double turns.

3. Pavement Marking: Pavement markings can effectively guide two lines of vehicles turning side-by-side. The Traffic Engineering Division will determine the selection and placement of any special pavement markings.

4. Opposing Left-Turn Traffic: If simultaneous, opposing double left turns will be allowed, the designer should ensure that there is sufficient space for all turning movements. This is a factor at all signalized intersections, but double left-turn lanes with their side-by-side vehicles can cause special problems. If space is unavailable, it may be necessary to alter the signal phasing to allow the two directions of traffic to move through the intersection on separate phases. As a recommendation, 30 feet should be available between opposing flows of traffic.

5. Turning Templates: All intersection design elements for double left-turn lanes should be checked by using the applicable turning templates. The designer should assume that the selected design vehicle will turn from the outside lane of the dual turn lane. Desirably, the inside vehicle should be a SU but, as a minimum, the other vehicle can be assumed to be a P vehicle turning side-by-side with the selected design vehicle. Ultimately, the final design and selected design vehicles will be determined on a case-by-case basis.

2.4.10 Oregon

Oregon DOT considers a double left-turn lane once the left-turning volume reaches 300 vehicles per hour. The final decision is based on an engineering study to review any safety problems that might result. The study may include the following items:

1. The engineering study may include a capacity analysis. The analysis must clearly demonstrate an improved level of service with multiple turning movements and/or with other considerations not to lower the level of service.

2. Delay and backup of traffic in the approach under consideration will be a factor in the engineering study to implement the multiple turn treatment.

3. The multiple-turn engineering study may involve turns from the local agency street or roadway system at the approaches to the State Highway System.

4. The engineering study will consider truck or other wide turning path vehicles and adequate multiple turning lane widths.

5. A part of every study will consider special striping or raised pavement markers to delineate the multiple-turning movement and advance signing as required.

2.4.11 North Carolina

North Carolina DOT reported that the following two intersections in the state were installed with a triple left turn:

1. US 401 (Skibo Road) and SR 1007 (All American Freeway) southbound exit ramp in the City of Fayetteville, Cumberland County. This intersection is a three-leg intersection that is operating with triple left-turn lanes off of the exit ramp. A crash analysis performed at this intersection utilizing information over a three-year period indicated that the intersection was operating fairly well.

2. US 401 Bus. at US 401 Byp. (Country Club Drive) and Tokay Drive is a basic four-leg intersection with triple eastbound left turn lanes. A crash analysis revealed a total of 35 crashes over a three-year period at the intersection, resulting in a total crash rate of 58.11 crashes per 100 million entering vehicles. Of the 35 crashes only a small portion was actually contributed by the triple left turn lanes.

2.4.12 North Dakota

North Dakota DOT reported that the state did not experience any identifiable crash problems for the numerous double left turns constructed, that a design factor requires that the receiving lanes be wider than the approaching left-turn lanes.

2.4.13 Pennsylvania

Pennsylvania DOT uses the Highway Capacity Software (HCS) or an optimization/simulation software to determine the need for a double left turn. It also reported that, in general, double left-turn lanes are considered if the length of a single turn lane would exceed 300 feet, or for left-turn volumes greater than 300 vehicles per hour. Protected/ prohibited left-turn phasing is the only type of signal operation used on approaches with double left-turn lanes.

2.4.14 South Carolina

The South Carolina Department of Highways and Public Transportation Highway Design Manual covers the premise for providing a double left turn. Although the manual permits for a throat width of 30 feet on the receiving end with a taper of 150 feet, the minimum run out on the receiving end we provide for, is at least 300 feet, if not more. In the design of double left-turn lanes the following rules of thumb are used:

1. A double left turn is considered when the turning volume approaches 300 vph.

2. A capacity analysis of the intersection is conducted and the benefits of providing the double left turns is evaluated based on levels of service analysis using one of the following software packages: HCS, SYNCRHO, PASSER, TRANSYT.
3. In the geometric design of the left-turn lanes, the turning templates developed by ITE is used to lay the intersection out.

4. The minimum design vehicles are SU-30 in the inside lane and WB-50 or WB-60 in the outside lane, turning simultaneously without any lane encroachment.

5. On an interstate interchange, designing for two WB-60's side-by-side is encouraged.

6. On a four-leg intersection where the demand on the opposing side does not require a double left-turn lane, the intersection is designed to permit the left-turn movements to turn simultaneously to avoid split phasing the intersection, i.e., matching geometric design on opposing approaches where right of way permits.

7. As a rule a permissive/protected phase in the signal timing for double left-turn lanes is not allowed.

8. At locations where double left-turn lanes are provided a 4-foot buffer is desired between opposing traffic.

2.4.15 South Dakota

South Dakota DOT does not have any written requirements of double left-turn lanes but the following rules have been followed:

1. A double left-turn is considered when left turns exceed 300 vph.

2. The minimum width for a double left-turn lane is 12 feet.

3. The lanes should be designed so that the vehicle can turn into its appropriate lane. The design vehicle to be used is according to DOT policies.

4. If a double left turn is opposed by a single left turn that can operate in the permissive mode the lane should be offset to line up with the inside left-turn lane for the double left turn. This allows the driver to see approaching traffic.

5. On the traffic side double left turns are protected only movements and have a dash line (5 feet long spaced 15 feet apart) between the turning vehicle to guide the vehicle through the intersection and into the proper lane. Each of the turn lanes also has its traffic signal indication in line with the drivers view. The traffic signal uses arrow indications and not programmable heads.

6. Pavement markings for the storage and taper areas are similar to that of a single left. Signing lane usage signs are used on the signal pole mast arm any other signing is per each installation.

2.4.16 Washington State

Washington DOT does not have any specific design guidelines for double and triple left turns, that the double left turns currently exist in the state have been constructed on a case-by-case basis based on the AASHTO design guidelines. The state also reported a planned triple left turn.

2.4.17 Virginia

Virginia DOT has installed triple left-turn lanes in the Northern Virginia area (Washington DC metro area). The use of double left-turn lanes is a very common practice and has proved to be an accepted means for improving intersection capacity. A minimum of 300 left turns during the peak hour is generally used as a rule of thumb for justifying a double left-turn lane. The storage needs are determined by a capacity analysis. Many of the double left turns are signed as U-turn and left-turn (inside left) and left-turn only (outside left).

2.4.18 Wyoming

Wyoming DOT reported that the state has a limited number of double left turns and no triple left turns, that a double left turn is considered when an intersection experience high a left-turn volume and other remedial alternatives did not work. The state uses NCHRP Report 279 for the design of double left-turn lanes.

2.4.19 Others

The following states responded to the request for information but indicated that their states did not have any intersections installed with a triple left turn: Alaska, Arkansas, Connecticut, Illinois, and Rhode Island. These states also did not provide any specific design information double left turns.

2.4.20 Summary

Only a few states, including California, Minnesota, New York, Nevada, North Carolina and Texas, reported to have at least one triple left turn currently functioning. Several states, including Maryland, Mississippi, Nebraska, New Mexico, Oregon and Washington, were planning to install intersections with triple left-turn lanes.

Most of the State DOTs surveyed did not have any studies on triple left-turn lanes, however, the use of double left turns was reported by almost all of the respondents. Most of the State DOTs reported that they use “in house” design guidelines based on the AASTHO standards for the design of double left-turn installations.

Up to date specific design guidelines for triple left turns were not reported by any state. However, states with double or triple left-turn lanes base their design on the following manuals:

- Highway Capacity Manual (TRB)
- Guidelines for Urban Major Street Design (ITE)
- Intersection Channelization Design Guide (NCHRP Report 279)
- A Policy on the Geometric Design of Highways and Streets (AASHTO)

State DOTs from California, Connecticut, Minnesota, New York, Oklahoma, South Dakota, Virginia and Washington reported having "in house" design guidelines that are applied to the design of both double and triple left turns.

Maryland and New York DOT base the installation of multiple left-turn lanes on major determining factors such as right of way, critical lane analysis, level of service and operational characteristics.

North Carolina reported triple left turns that operated well. Although crashes increased over the last three years in one location, only a small portion of the crashes was caused by the triple left turns.

2.5 Application of Traffic Models

Several general models have been developed for the analysis of traffic signal operation at intersections and on arterial streets. To this point, no model has been specifically formulated to deal with the unique characteristics of triple left turns. A brief description of the most common models will now be presented. All of these models are implemented in available software products

2.5.1 CORSIM

The CORSIM (**COR**ridor **SIM**ulation) model is a microscopic traffic simulation program that may be used for the general analysis of traffic control networks and freeways. It is a stochastic simulation model developed by the Federal Highway Administration. It is composed of two sub-models, FRESIM and NETSIM. FRESIM (**FRE**eway **SIM**ulation) is the component used to simulate freeways and basic uninterrupted flow facilities, while NETSIM (NETwork SIMulation) is used to simulate networks composed of surface streets. CORSIM uses very complex algorithms to reproduce traffic flow realistically under a wide range of traffic conditions.

CORSIM is also equipped with an output processor, TRAFVU. TRAFVU is a visualization software tool used to display the actual traffic operations in the animated simulation of the vehicles it has modeled.

2.5.2 HCS

HCS (**H**ighway **C**apacity **S**oftware) is a software product that implements the Highway Capacity Manual (HCM). The HCM is used in the design and analysis of all types of highway facilities. Of particular interest to this study is Chapter 16 of the HCM. It is dedicated to the analysis of signalized intersections. Chapter 16 provides guidelines and procedures for estimating the performance measures for each traffic movement at an intersection. The Florida DOT recognizes the HCM as the preferred method for estimating the level of service on all facilities.

2.5.3 SIDRA

SIDRA (**S**ignalized and Unsignalized **I**ntersection **D**esign and **R**esearch **A**id) is a traffic software product developed by the ARRB Transport Research Ltd as a tool for the design and evaluation of signalized intersections, roundabouts, all way stop control and yield sign control. The program utilizes analytical traffic models to calculate capacity and performance measures, such as delay, queue length, stop rate, fuel consumption, etc.

The features of SIDRA that are potentially useful to the analysis of triple left turns include the ability to perform a separate analysis for each approach lane, and to deal with "short lanes", including turn bays and downstream lane reductions

2.5.4 TRANSYT-7F

The TRANSYT-7F (**TRA**ffic **N**etwork **S**tudy **T**ool version **7F**l) is a traffic flow analysis and signal timing program developed by the Federal Highway Administration (FHWA). The program optimizes coordinated traffic signal systems to increase traffic progression in an attempt to reduce the measures of effectiveness (MOE's) such as delay, stops, and fuel consumption. It also has the capabilities to perform detailed operational studies. The delay estimates incorporated into the software are from the HCM. The traffic simulation model in TRANSYT-7F is a macroscopic model. This means that it considers platoons of traffic instead of looking at individual vehicles. However, TRANSYT-7F simulates traffic flow in small time increments so its evaluation of the traffic is more detailed than in other macroscopic simulation models. Recent versions of this model are able to deal with backup into an intersection from a downstream bottleneck.

3. TRAFFIC OPERATIONS STUDIES

Traffic operations studies were conducted at a number of double and triple left-turn lane sites to determine whether substantial increases in flows were achieved after the construction of a third turn lane. Separate analyses were conducted of each lane to determine if there were any conspicuous patterns between lanes and sites. Service (average weighted volume per cycle with trucks treated as equivalent to two passenger cars) and maximum flows (weighted saturation flow rates) were computed by lane for each site using measured headway data. The procedures used to obtain these measurements are detailed in APPENDIX A – Traffic Data Collection and Analysis Methodology.

The initial analyses included only double left turn lanes as illustrated in Figure 3-1. This analysis provided some baseline data for making subsequent comparisons of triple left-turn lanes and for developing profiles of the intersections. From the literature and our early experience, it became clear that there is considerable variation in the performance among sites with multiple left-turn lanes, between periods of the day, and even from one cycle to the next. Even so, there are some signatures including average headways for particular lanes and intersections. The effects of weather, trucks and other long wheelbase vehicles, pedestrian activity, etc. appear to have an affect on the service levels and maximum achievable flows, but the modest data collection efforts in this research were not sufficient to directly uncover these effects or the interaction of these variables with the features of the intersections.

The literature suggests that a number of geometric features and other situational variables will affect traffic performance. These features are incorporated into the model of triple left-turn intersections. At this stage we merely characterized the intersections by lane, the number of cars, trailers, trucks, the number of vehicles that formed queues or were free flowing and then completed the saturation flow rates for each intersection and their associated statistics. Figure 3-1 illustrates this process. For this example, the mean combined saturation flow rate of 1723 is within the range of values obtained in other studies. The outside lane (Lane 2) appears to experience slightly higher performance, but overall, the differences between cycle-to-cycle variations for the combined lanes are substantial (Minimum SAT = 986 and Maximum SAT = 1463). To obtain more reliable estimates would require considerable more data collection at this site.

Location: A1A AND SR40, Ormond Beach, FL **Reference: ORMO1**
Configuration: T intersection with 2 left-turn lanes, no median strip, pedestrian crossings, business driveways close to turning lanes
Number of Traffic Signal Cycles: 32
Date and Period of Data Collection: AM Peak
Date of Analysis: 7/27/99

A. Traffic and Vehicle Characteristics
B.

Lane	Number Cars	Number Trailers	Number Trucks	Vehicles in Queues	Free Flowing Vehicles	Average Headway
1	207	2	1	164	46	2.24
2	160	2	0	127	35	2.04

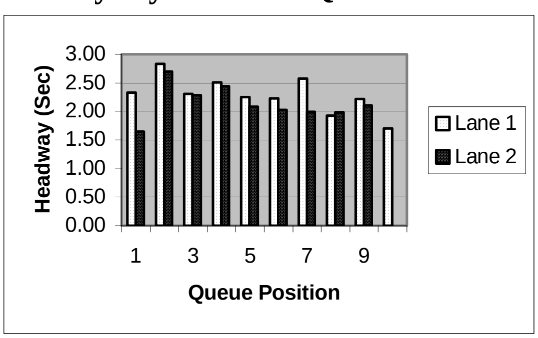
C. Snapshot from Surveillance Video

D. Saturation Flow Rate

Statistics (Combined Lanes)

Mean	1723.31
Standard Error	56.55
Median	1682.83
Mode	2250.00
Standard Deviation	309.73
Kurtosis	0.59
Skewness	0.21
Range	1462.68
Minimum	986.30
Maximum	2448.98
Count	30.00
Confidence Level (95.0%)	115.65

E. Headways by Lane and Queue Position



Comments:
Very few encroachments into adjacent lanes observed.

Several vehicles made U-turns from lane 2.

Figure 3-1. Summary Information From Analysis of Multiple Left-Turn Lane Site

The major thrust of this project was to determine what characteristics of triple left-turn lanes are associated with the greatest traffic service and flow benefits, without compromising safety. Accordingly, much of this research focused on the operations of existing triple left-turn lanes in Florida. The majority of these sites are located in South Florida. In Table 3-1 we provide summary data for the South Florida locations with the service index, "Average Weighted Volume/Cycle (average weighted volume per cycle with trucks treated as equivalent to two passenger cars)." In Table 3-2 we include the data obtained in the single northern location in Gainesville, FL at Archer Road and SW 16th Avenue.

Table 3-1. Summary of South Florida Triple Left-Turn Lane Data

Location	Lane	No. Cycles	Cars	Trailers	Trucks	Queued	Free	Ave. Wt. Vol/Cycle
Collins Ave @ SR826	1	10	89	0	3	91	1	9.50
Collins Ave @ SR826	2	17	165	0	8	158	15	10.65
Collins Ave @ SR826	3	32	307	0	12	291	28	10.34
Commercial Blvd @ Turnpike	1	23	355	2	10	333	34	16.48
Commercial Blvd @ Turnpike	2	34	506	0	5	478	33	15.18
Commercial Blvd @ Turnpike	3	37	626	1	18	554	91	17.95
Oakland Park Blvd@NW 50 AVE	1	31	205	0	1	200	6	6.68
Oakland Park Blvd@NW 50 AVE	2	18	136	0	5	118	23	8.11
Oakland Park Blvd@NW 50 AVE	3	36	288	0	3	273	18	8.17
NW 2 AVE @ US 441	1	51	608	19	49	676	0	14.59
NW 2 AVE @ US 441	2	38	438	0	16	450	4	12.37
NW 2 AVE @ US 441	3	37	278	0	1	279	0	7.57
US 1 @ SR 878	1	41	819	0	13	733	99	20.61
US 1 @ SR 878	2	40	862	0	4	751	115	21.75
US 1 @ SR 878	3	42	830	0	8	741	97	20.14
Sunrise @ Turnpike	1	13	96	0	1	94	3	7.54
Sunrise @ Turnpike	2	27	235	0	6	228	13	9.15
Sunrise @ Turnpike	3	30	279	0	0	273	6	9.30

We attempted to discern whether there were systematic trends in lane usage based on dispersed vehicles per signal cycle. For these six locations there is little evidence for general preferences for one lane over others. Our review suggests that preferences depend on many factors, including the existence of nearby intersections that "call for" lane preferences following movement through these intersections. Such conditions are most likely in dense urban areas where intersections such as NW 2nd Ave and US Highway 441 exist. The Gainesville location is not included in this set, but was subjected to a separate analysis because it appeared that there was a systematic preference for one lane over others. It will be discussed subsequently.

We also attempted to associate characteristics of the site with average lane saturation flows for taking into account all three lanes (i.e., combined). We obtained a range of "combined saturation flow rates" for the seven triple lane locations of 1544 to 2150. Because each of these locations had unique characteristics, we were unable to rigorously assess the relationship between specific features and flow rates. We should, however, note that Commercial Blvd at the Turnpike and Sunrise at the Turnpike has similar characteristics and they also yielded very similar saturation flow rates (i.e., and 1911 and 1942 pcphgpl.)

Table 3-2. Combined Saturation Flow Rates for Florida Intersections with Triple Left-Turn Lanes

Location	Combined Sat. Flow Rate
Collins Ave @ SR 826	1544
Commercial Blvd @ Turnpike	1911
Oakland Park Blvd @ NW 50 Ave	1718
NW 2 Ave @ US 441	1974
US 1 @ SR 878	2150
Sunrise @ Turnpike	1942
16th & Archer	1940

3.1 Specific Suggestions for Changes and Clarifications

The Y intersection at Archer Road and 16^{th} Avenue in Gainesville legally allowed only left turns, although we observed occasional vehicles making right turns. Accordingly, this intersection differed from all the others in the project. Observations at this location provided an opportunity to systematically assess service for different time periods and the relative efficiency of each of the three turning lanes. We calculated saturation flow rates that were compared with the intersections with triple left turn lanes at the South Florida locations.

Figure 3-2 shows the average number vehicle of vehicles serviced by each of the turning lanes for 4 time periods; the a.m. and p.m. peak and non-peak periods. Figure 3-3 provides greater detail and shows the starting delays and the individual lane and combined saturation flow rates. Although, statistical analysis was not conducted for Start Delays, there appears to be differences start delay times for the three lanes. The combined saturation flow rates range from 1,685 to 1,940 vphpgl; well within the range of the combined saturation flow rates for the locations in South Florida shown in Table 3-2. Of particular interest in this analysis was whether there were significant differences in service for the different time periods. A two-way Analysis of Variance was conducted on the weighted volumes (attributing an equivalence of two passenger cars for a truck). The results are shown in Table 3-3. Both of these factors showed significant differences, with the Time of Day being most profound (Significant at the .01 level); this effect being most attributable to the highest average saturation flow rate for the P.M. Peak period. The difference between lanes was marginal (Significant at the .05 level) and probably of little practical importance.

A rationale as to why the Collins Ave &@ SR 826 junction has a low saturation flow rate would be speculative. It should be noted, however, that this location is complex, in that it has an usually high number of traffic conflicts and sight distance appears to be poor from several of the approaches, yet it has not exhibited an usually high crash rate. Sunrise and Commercial intersections, off of the turnpike, have similar geometric characteristics with acute entry angles. In this respect Archer & 16^{th} is also similar; the saturation flow for the three of them are nearly identical.

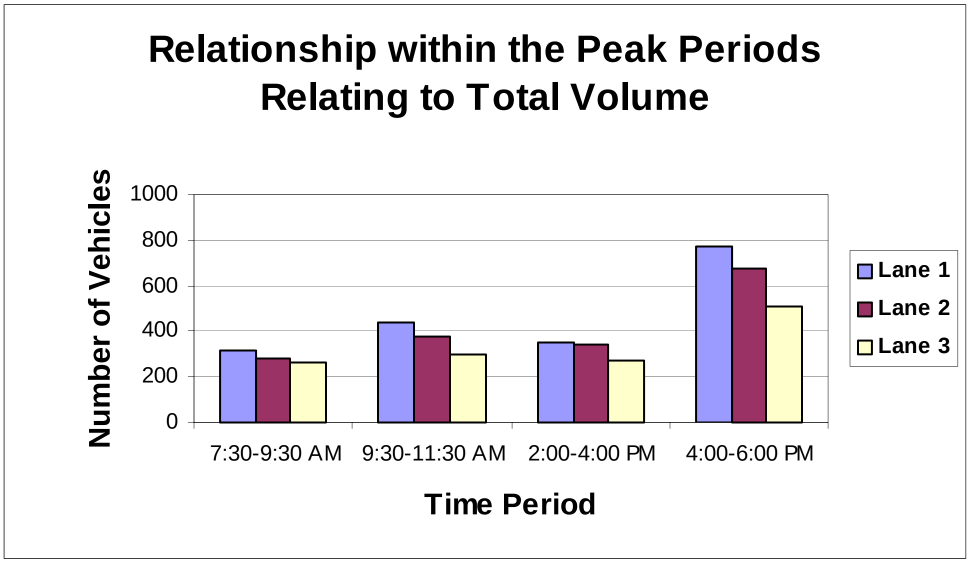


Figure 3-2. Service by Lane at Archer Road and SW 16th Avenue in Gainesville

Time of Day	Lane	Start Delay	Sat Flow Rate	Combined
A.M. Peak	1	0.32	1818	
	2	1.22	1885	1940
	3	2.14	2143	
A.M. Off Peak	1	0.33	1875	
	2	1.23	1809	1858
	3	2.48	1895	
P.M. Off Peak	1	0.41	1818	
	2	1.39	1739	1685
	3	2.32	1500	
P.M. Peak	1	0.14	1957	
	2	1.48	1925	1905
	3	2.15	1800	

Figure 3-3. Start Delays and Saturation Flow Rates for Archer Road and SW 16th Avenue in Gainesville

Table 3-3. Analysis of Variance for Weighted Volumes by Lane and Time of Day for SW 16th Avenue and Archer Road, Gainesville

SUMMARY	Count	Sum	Average	Variance
Lane 1	4.0000	25.6959	6.4240	15.0856
Lane 2	4.0000	23.1374	5.7844	11.1565
Lane 3	4.0000	18.8115	4.7029	6.1246
A.M. Peak	3.0000	11.5301	3.8434	0.1073
A.M. Non-Peak	3.0000	12.3404	4.1135	0.5344
P.M. Non-Peak	3.0000	12.3457	4.1152	0.3014
P.M. Peak	3.0000	31.4286	10.4762	3.7266

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Lanes	6.0545	2.0000	3.0272	5.5292	0.0435	5.1432
Time of Day	93.8154	3.0000	31.2718	57.1178	0.0001	4.7571
Error	3.2850	6.0000	0.5475			
Total	103.1548	11.0000				

3.2 Trucks Traversing Intersections

One safety concern associated with multilane intersections is the influence of trucks in the traffic stream. Serious incidents at intersections involving trucks are often associated with vehicle offtracking and rollovers. These factors should be considered when assessing the potential safety of triple left-turn lanes.

All road vehicles traveling through an intersection follow a circular path that is wider than the width of the vehicle. The driver can usually control the front end of a vehicle that follows a circular curve, but the following axles or trailers in a combination vehicle will swing inward toward the center of the curve sweeping a wide path defined by the wheel tracks of the outside front wheel and the inside rear wheel. The difference between the swept width and the vehicle width is referred to as off tracking. Low-speed offtracking that occurs for right angle turns often makes it necessary for the driver to swing wide into adjacent lanes in order to execute the turn. For long trucks or combinations, the encroachment may cover an entire adjacent lane.

Large trucks roll easily. This tendency to roll over can be measured by the force (g’s) needed to tip a vehicle while cornering - the higher, the safer. For example, the cornering force needed for tipping a full size car is about 1.3; for a pickup about 1.1; for jeep type vehicles, 0.8- 1.0; and for fully loaded combinations about 0.4 or lower. A half empty tanker with a poor suspension may require only 0.15 to tip.

In general, the risk of involvement is substantially higher for combination trucks and than for single unit trucks regardless of the type of roadway they are operating on.[2]

3.3 Determining Safety of Trucks at Intersections

To establish the impact of safety requires the use of substantial vehicle crash databases or the use of indirect indicators of increased crash risk derived from traffic operational data.

The risk of a crash may involve a truck alone, a truck in conjunction with other vehicles, or a truck may introduce turbulence due to both offtracking and lower acceleration resulting in nearby non-trucks only being involved in loss of control. Unfortunately, most crash data records are incomplete when reporting the effects of truck incidents when they are not directly involved in collisions. Accordingly, unless there is a very powerful negative effect on safety associated with operation of triple left-turn lanes, crash data will not be sufficient to unearth an effect.

When UF developed its work plan, the possibility of using crash surrogates was considered as a means of evaluating the safety of triple left-turn lanes. We believed we could use encroachments into adjacent lanes as one possible surrogate measure. From our review of our videotapes collected during the project, it now seems unlikely that we can use such encroachment data because: (1) there is limited field of view on some of these tapes, preventing us from determining whether there is encroachment into the nearest opposing lane during the transition from one roadway to another; (2) on some of the tapes, there is some lane changing within the intersection, but few of these events have been considered as hazardous situations; and (3) the coding with the Event Time Series (ETS) device makes it difficult to record all the headways, vehicle types, and subtle vehicle encroachments.

We have considered another possible surrogate…the stability of headways when large vehicles are discharged into the traffic stream. A truck entering one of the queues in a double or triple left-turn lane is expected to disturb both its lane and adjacent lanes, although the disturbance may not significantly impact these lanes. Intersections with wide lanes and large radius of curvature or an intersection with acute angle with only left-turn lanes in roadway, such as SW 16th & Archer in Gainesville, Florida, will probably be relatively insensitive to such a “disturbance” except under high flow conditions.

At the intersection of SW College Road (SR 200) and 17th Street in Ocala, Florida, passenger vehicle and truck traffic was recorded at the two 17th Street northbound left turn lanes as vehicles moved to go west onto College Road. As can be seen in Figure 3-4 the presence of trucks, compared to autos alone, in either or both turn lanes introduces a significant degree of increased variability in headways. As can be seen in this figure, trucks in Lane 1 had a greater effect. Such an effect has the potential for both reducing traffic flows and increases crashes. This argues for taking a closer look at headway variability for different locations, number of left-turn lanes, and the position of the trucks or trailers in the queues. Unfortunately, the acquisition and analysis of additional data of this type was beyond the scope of the project.

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[2] Miaou, S.; Hu, P.; Wright, T.; Davis, S.; and Rathi, A. "Development of the Relationship Between Truck Accidents and Geometric Design," Federal Highway Administration, August 1991.

This evaluation would be facilitated by having the means and standard deviations for individual lanes and individual cycles computed directly from the EIS data. In particular, the standard deviations of all non-zero, positive numbers (based on headways 4 through n), and the counts would allow us to compare cycles with and without large vehicles. If there were a simple way to determine which queue position is occupied by the truck or trailer, this would facilitate the analysis.

So what does this data on "resistance to disturbance" mean? First, we can calculate ranges of saturation flow for both "disturbed" and "non-disturbed" lanes and lane groups. This would also permit us to make projections of the saturation flow rates for intersections that may encounter, in the future, increasing amounts of truck traffic, i.e., "triples may provide greatly improved service when truck traffic is minimal, but little or no benefit when the percentage of truck traffic is high." Secondly, the variability of headways is an index of the smoothness or predictability of operation. In general, traffic movement with high variability in headways is less safe. Obviously, we will need to document this and convincingly show this relationship.

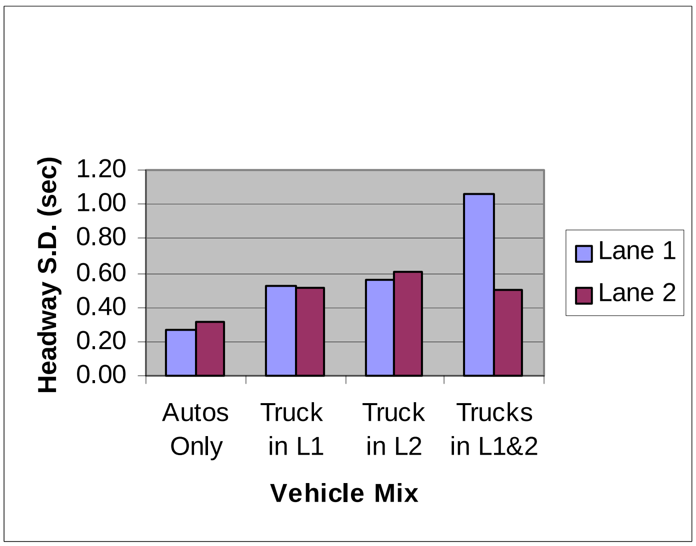


Figure 3-4. Headway Variability for Different Vehicle Mixes

4. MODELING OF TRIPLE LEFT TURNS

As pointed out in Chapter 2, several software products have emerged from the development of models for the design and evaluation of traffic signal operation. All of the commonly used programs are capable of modeling triple left turns in the sense that they accept three lanes as an input value for any movement, including left turns. The question at this point is whether or not the models recognize the unique properties of triple left turns, as opposed to three lanes that happen to be turning left.

The purpose of this chapter is to establish how realistically traffic models interpret a triple left turn and what changes can be incorporated to improve the programs' treatment of this configuration.

4.1 Unique Features of Triple Left Turns

4.1.1 Lane Utilization

In a triple lane left-turn movement, an important consideration is placed on how the lanes are utilized. The ideal case would be if all lanes were utilized equally. This would produce the highest capacity for the movement. However, this is not the case. Based on previous studies performed by Leonard (1994) and Jolicoeur (1999), the lane utilization of a triple lane left-turn movement is unique in the aspect that it cannot be obtained through the extension of any other facility. Although it resembles a dual lane left-turn movement with an additional lane, its behavior has been shown, in previous studies, to be quite different. The question that remains to be answered is whether or not the traffic models recognize a triple left turn to be a unique situation or do they try to model it as if it were a dual left turn.

4.1.2 Effect of Large Trucks

Another important factor in a triple lane left-turn movement is the percentage of heavy vehicles in the traffic stream. Trucks or trailers such as the WB 40+ design vehicle are of particular concern. The higher the proportion of heavy vehicles, the lower the capacity of the movement. The capacity reduction is due to the heavy vehicle's inability to 1) accelerate as quickly as a passenger car, and 2) maneuver as easily through the intersection due to its size. The slow progression of a heavy vehicle delays those vehicles behind it. The question is not whether high truck percentages lower the capacity of a triple left turn, but whether existing models treat this fact realistically.

4.1.3 Effect of the Turning Radius

The turning radius is another factor that warrants attention in the design of triple lanes. As evident in the study performed by Ackeret (1994), the smaller the radius, the lower the driver's perception of safety in successfully traversing the intersection. This is particularly true of drivers in the middle lane that fear being sideswiped by the vehicles traveling alongside them. In fact, with most values of the turning radius, it is impossible for three heavy vehicles to simultaneously negotiate a turn. The overlapping paths of three turning trucks are illustrated in Figure 4-1.

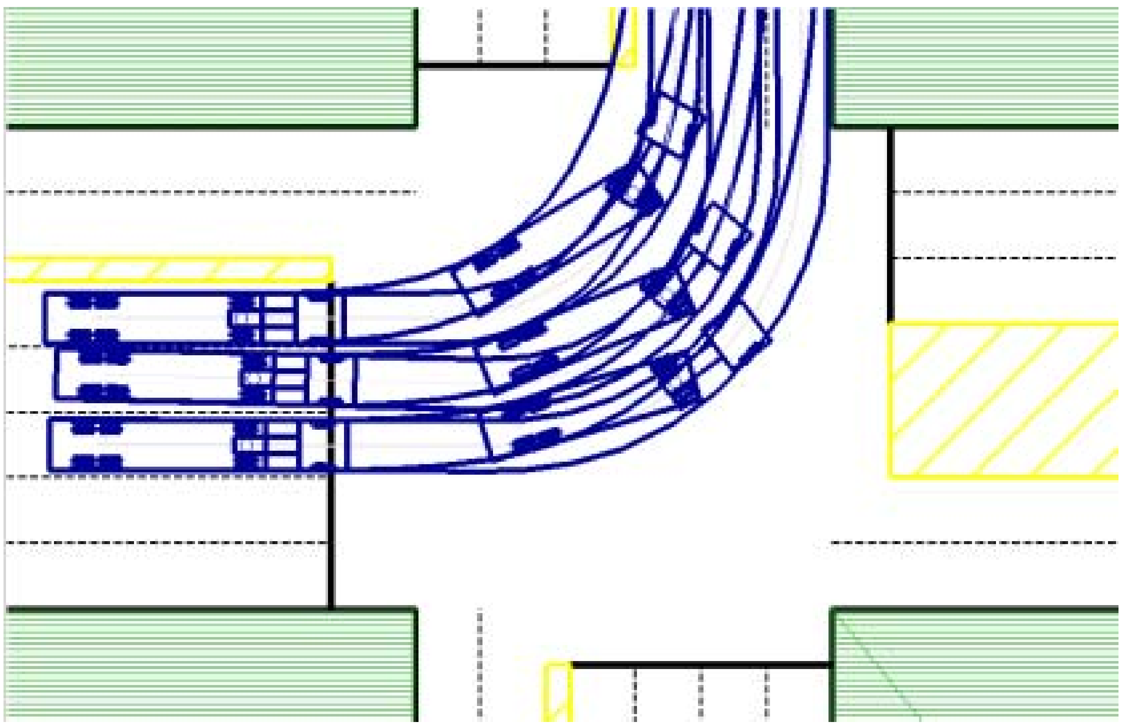


Figure 4-1. Illustration of the Turning Paths for Three WB-40s Attempting to Make a Left Turn Simultaneously

To compensate for their insecurity while progressing through the turn, drivers tend to travel at much slower speeds. This, in turn, leads to lower volumes on the movement. In fact, if the turning radius is too small then certain sized heavy vehicles will not be able to travel the link. The trend suggests that as the turning radius decreases, so does the capacity. However, the question that remains to be answered is whether the traffic models recognize this trend.

4.1.4 Effect of the Angle of Intersection

The angle of intersection of the two roadways is another important geometric consideration in a triple lane left-turn movement. The angle in question is formed by the link on which the triple lane left-turn movement is located and its downstream link where the traffic enters.

The most common angle is 90 degrees, however, there are some cases where the geometry of the intersection does not allow for this. In such cases the resulting design might produce an angle less than 90 degrees. This angle would be referred to as a "sharp" or acute angle. The sharper this angle the more difficult it becomes for a driver to negotiate the turn. This, in turn, forces the driver to travel at lower speeds than would normally be found at right-angled intersections. The lower travel speed reduces the capacity. The question that remains is whether or not the traffic models recognize this trend.

4.1.5 Upstream Lane Distribution

The upstream lane distribution is also an important factor. The distribution indicates the percentage of vehicles that occupy each lane. The ideal case (highest capacity) would be one in which the vehicles are equally dispersed among the three lanes. This would prevent large queues from building up in one lane while other lanes are not being utilized fully. It would also reduce the amount of upstream lane changing. Clearly, if all of the vehicles were in the lanes that they ultimately wanted to be in, then the number of lane changes would be zero. As the number of lane changes increases, the capacity of the movement decreases due to the perturbation resulting from each lane change. Again, the question that remains to be answered: Is this trend recognized in the traffic models?

4.1.6 Downstream Lanes Effects

The downstream effects of a triple lane left-turn movement are one of the most important considerations in the design and analysis of the movement. The conditions downstream have the potential to override all of the other operational characteristics thus far. If the downstream link becomes over saturated, then the potential for spillback (i.e., vehicles entering a link exceeds the storage capacity) occurs. If the spillback is severe then a phenomenon known as gridlock may occur. Gridlock results from the mutual interference of two movements, each of which prevents the other from proceeding. The question that remains is how the traffic models will address occurrences of spillback and gridlock in simulation.

4.2 Candidate Models

Four Traffic models that are commonly used for evaluating the operation of signalized intersections were described in Chapter 2:

- HCM/HCS
- SIDRA
- TRANSYT-7F
- CORSIM

A summary of the features of these models with respect to the important characteristics of triple left turns is presented in Table 4-1. The following general observations are offered:

- The HCM/HCS model is the simplest of the four candidates. Simplicity is a desirable characteristic whenever simple situations are being analyzed. The HCS offers a clear presentation of results that are easily understood. The HCM is recognized by the Florida DOT as a standard for estimating performance measures on transportation facilities. This method is a good choice for analyzing triple left-turn situations that are free of any complications resulting from unusual upstream or downstream conditions. Using the default lane utilization factor, the performance estimates will reflect the most critical lane, and not the average of the three lanes.

- For most purposes, SIDRA offers a functional equivalent to the HCM. It performs analysis on a lane-by-lane basis, and accepts user-specified proportions of vehicles in each of the turning lanes. Therefore, SIDRA is likely to be a better choice than the HCM when approach lane distributions are unbalanced due to upstream effects. SIDRA's increased capability is accompanied by a modest increase in the complexity of the user interface.

Table 4-1. Comparison of Traffic Model Characteristics and Features

Traffic Phenomenon	HCM/HCS	SIDRA	TRANSYT-7F	CORSIM
Lane Utilization and upstream lane distribution effects	Applies a general lane distribution factor to reduce the saturation flow rate. Uses the same factor for two or more lanes	Performs analysis on a lane-by lane basis. Accept the proportion of traffic in each lane as input	Assumes uniform distribution among all lanes on a link. Could be modified by coding parallel links	Complex interactions can produce uneven lane distribution, but only the FRESIM model in CORSIM accepts lane distribution as an input
Effect of Heavy Vehicles	Internal modification of saturation flow rate	Internal modification of saturation flow rate	No recognition of trucks. Saturation flow rate must be adjusted externally	Vehicle type is assigned upon entry into the system. Trucks are assigned different characteristics from passenger cars.
Effect of Turning Radius	None	None	None	None except for graphics display
Effect of the Angle of Intersection	None	None	None	None except for graphics display
Downstream Lane Effects	None.	None	Recognizes spillover macroscopically as a uniform phenomenon	Recognizes spillover microscopically as a stochastic phenomenon.

- Neither SIDRA nor the HCM recognize the effects of adjacent intersections, either upstream or downstream of the triple left-turn approach. Upstream intersections can cause unbalanced lane distributions, especially if a large proportion of the triple left-turn traffic enters the upstream segment as a turning movement from a single lane. Downstream signals can also create unbalanced lane distributions because of origin-destination patterns (e.g., if a large proportion of the triple left-turn traffic turns either right or left at a nearby downstream intersection).

- Upstream intersections can also produce heavily platooned arrivals that could affect the operation of a triple left turn lane adversely. Both upstream and downstream signals could have adverse signal timing offset relationships that could produce problems that are not recognized by either of these single intersection programs.

- If the downstream link, which carries traffic away from the triple left turn, has fewer than three lanes, then the operation requires a more detailed investigation than single intersection programs can provide. Under these conditions, the operational feasibility should be assessed with a multi-intersection model.

- While TRANSYT-7F and CORSIM have many features not found in the single intersection models, neither program was designed to deal explicitly with triple left turns.

- Before any guidelines on the choice between TRANSYT-7F and CORSIM can be offered, it is necessary to consider the workings of these two models in more detail, and to examine the results of some experiments that were performed in connection with this study.

4.3 Evaluation Framework

There are four different scenarios that will be created to evaluate these two models:

1. a triple left turn facility with a downstream lane reduction;
2. a triple left turn facility with a downstream exclusive right-turn lane;
3. a triple left-turn facility with a downstream exclusive left-turn lane; and
4. a triple left-turn facility with a closely spaced downstream signal.

The analysis of the downstream lane reduction scenario will center on establishing minimum merging section lengths for various traffic conditions. The analysis of the other three scenarios will center on how traffic models handle the effects of spillback and gridlock on the upstream intersection. Keep in mind that the main purpose of this chapter is to establish how realistically traffic models interpret a triple left-turn facility and what changes can be incorporated to improve the programs' simulation of such designs.

The initial data coding was carried out using the Arterial Analysis Package, version 2K (AAP2K). This is a new Windows-based version of the AAP, which is still under development. The development phase has created the opportunity to introduce a special facility configuration known as a "star-network." A star-network consists of one signalized intersection with an upstream "satellite" intersection on each approach. The results of star-network modeling are intended to provide insight into the effect of the satellite intersections on the subject intersection. A sample frame from the CORSIM animated graphics display is shown in Figure 4-2.

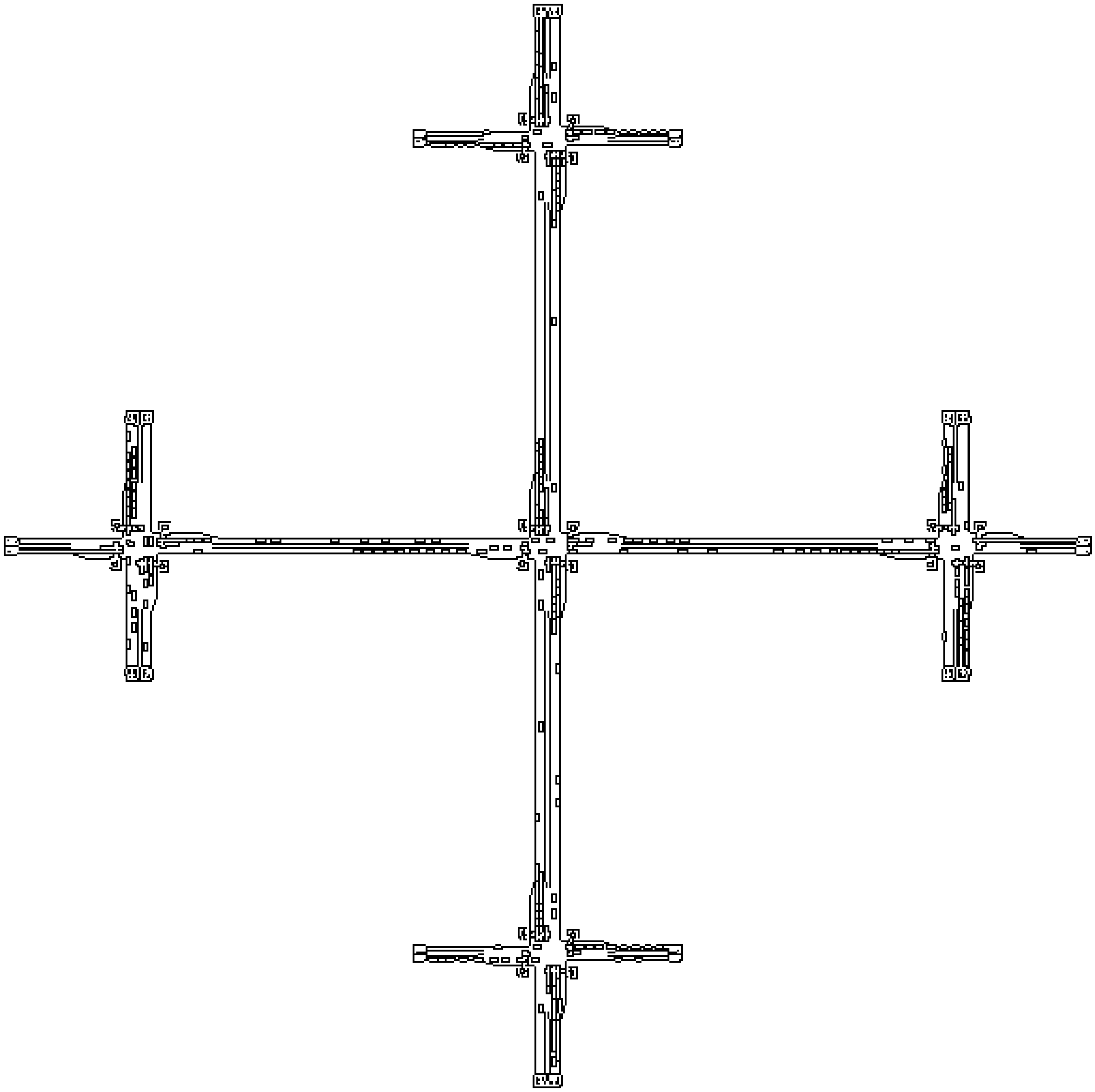


Figure 4-2. Example of a Star Network Display from CORSIM Animated Graphics

The AAP maps the node-link structure of a star-network to both CORSIM and TRANSYT-7F. The standard link-node structure for CORSIM is illustrated in Figure 4-3a. The corresponding structure for TRANSYT-7F is shown in Figure 4-3b. In both cases, the triple left-turn lane will be placed on the eastbound approach to the central intersection

The studies described in this chapter will use the AAP to investigate how well CORSIM and TRANSYT-7F can be made to model the specific characteristics associated with triple left-turn lanes. It should be noted, however, that the AAP by itself provides an excellent study tool for preparing data sets that model triple left-turn lanes. It should be used for analysis of potential sites whenever there are any complexities that would exceed the scope of isolated intersection models such as the HCM or SIDRA.

The configuration for testing the triple left turn with downstream lane reduction is composed of four sections as shown in Figure 4-4:

1. The approach Link includes the three left-turning lanes that are upstream of the intersection;

2. The merging link includes the three lanes immediately downstream of the intersection and the transition section before the two-lane section begins;

3. The departure link is the section in which the two-lane portion begins and continues on throughout the network; and

4. The opposing link carries through traffic at right angles to the triple left turn lane. Traffic on this link competes with the triple left turn movement for storage space in the merging link.

The schematic representation of Figure 4-4 will be referenced in describing characteristics and trends that emerge from the modeling analysis

The “base case” to be used in the comparisons presented in this chapter has the following characteristics:

- The triple left turn lanes are on the eastbound approach to the central intersection;

- The triple left turn movement entered three full lanes downstream that continued on throughout the network. In other words, there was no merging link of the type shown in Figure 4-4;

- There were two through lanes for westbound traffic and three through lanes for southbound traffic. Both of these movements were included to configure a complete intersection. They were given token volumes and did not affect the triple left turn operation; and

- Three through lanes supported the northbound traffic on the opposing link.

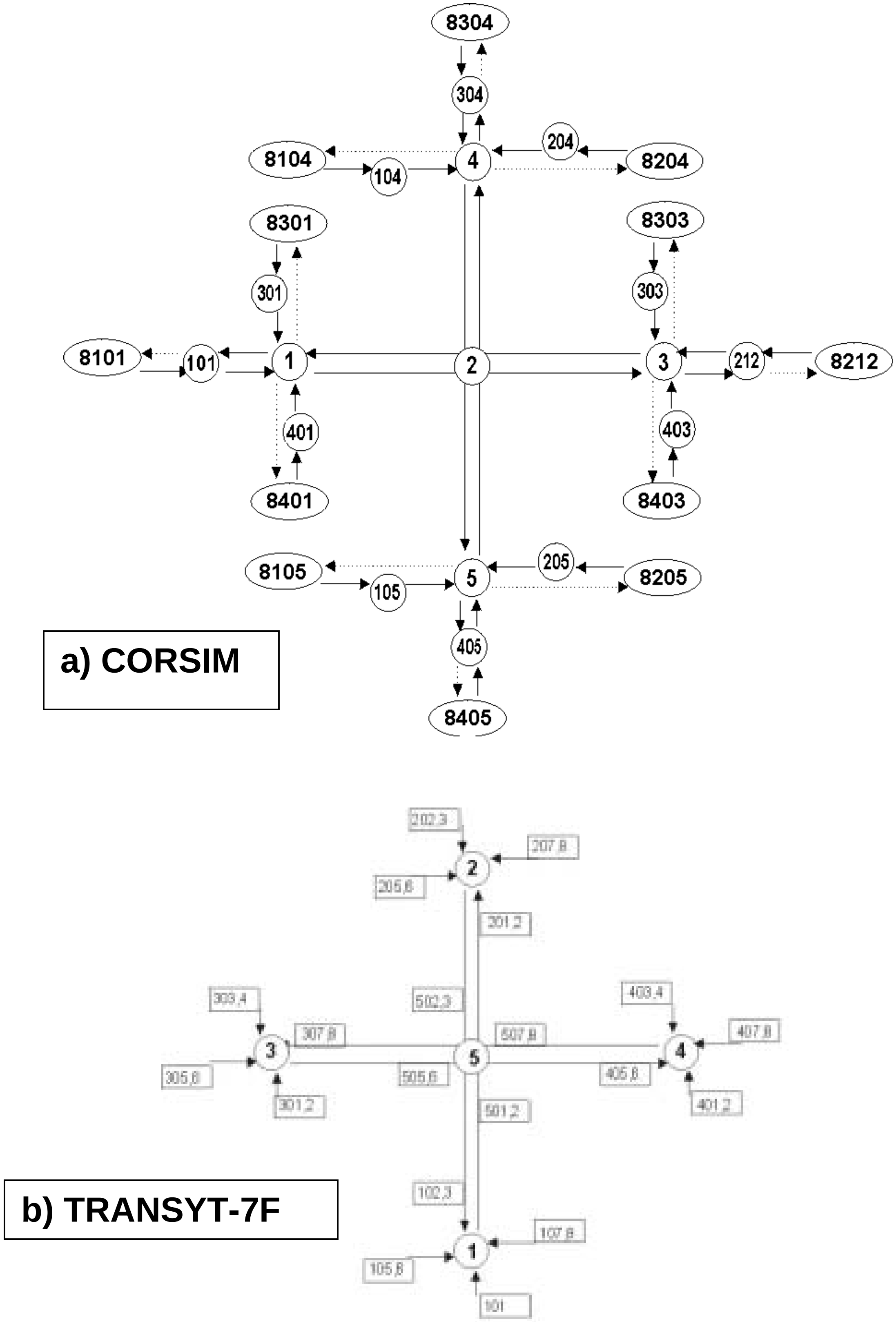


Figure 4-3. Link-node Structures for CORSIM and TRANSYT-7F Star Networks

4.4 CORSIM Input Data

CORSIM's data coding scheme is based on a "legacy" format of 80 column text records. The "type" of each record, indicated in the last three columns, determines the nature of the data being supplied to CORSIM. For example, the parameters that describe the physical characteristics of a link (e.g., length, number of lanes, etc.) are entered on Record Type 11. A given record type may contain either data or instructions that control the execution of the program. A summary of the record types that were involved in the study discussed in this chapter is presented in Table 4-2.

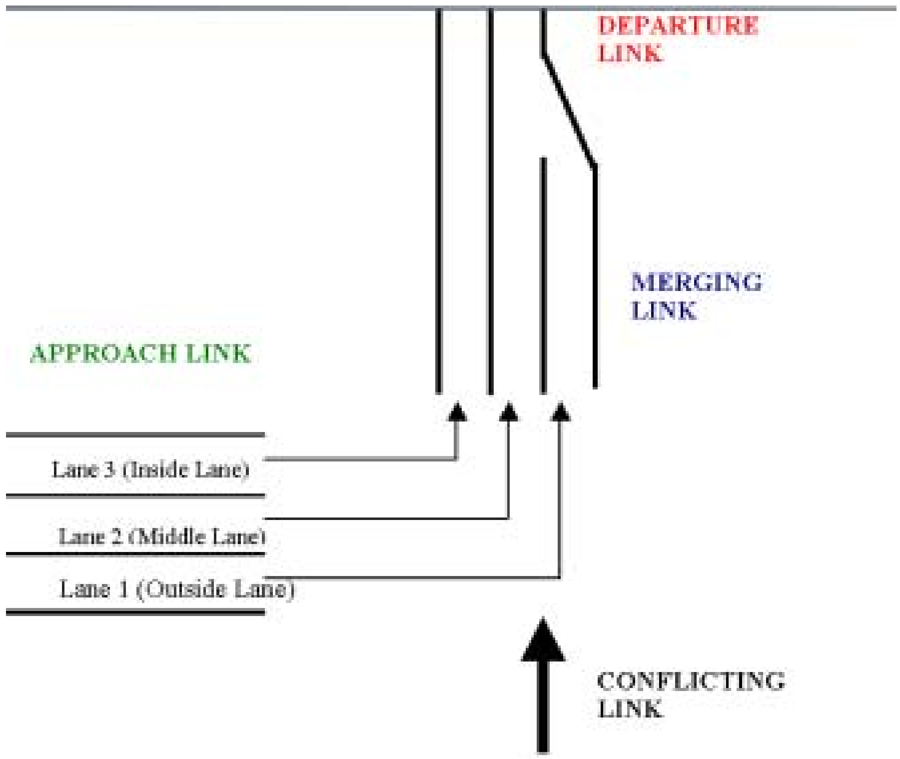


Figure 4-4. Schematic Representation of a Triple Left Turn with Downstream Lane Reduction

4.5 Summary of Studies Without Downstream Blockage

Several experiments were conducted with CORSIM to gain insight into its ability to model the more subtle aspects of triple left turns. The three primary questions in each case were

1. Does CORSIM provide enough realism so that the results could be generally useful?

2. Does the model distinguish between actual triple left-turn operations and three lanes of traffic that happen to be turning left?

3. Do the input data items that should affect triple left turns demonstrate their anticipated effect over a wide range of values?

Each of the CORSIM-related studies will be now be described separately.

Table 4-2. CORSIM Input Record Types with Potential Influence on Triple Left-Turn Operations

Traffic Parameter	**Record Type**	**Application to Triple-left Turns**
Headway and startup lost time	11	Used to calibrate the capacity of the lane group
Lane alignment	14	Determines the relationship between the approach lanes and the receiving lanes. Several different lane alignments were investigated to determine their effect on the triple left turn lane utilization
Proportion of trucks	58	The proportion of trucks was varied to investigate its effect on capacity.
Lane width	80	Wider lanes should increase capacity; more so for triple left turns than through movements.
Lane changing model parameters	81	Several parameters were varied to determine their effect on triple left turn lane utilization
Upstream distance at which a lane change begins	152	Investigated for its effect on triple left turn lane utilization
Drivers familiarity with the path	153	Investigated for its effect on triple left turn lane utilization
Demand volume entering a link	50	A key variable in the investigation of all phenomena
Link length	11	Determines the spacing between intersections for upstream and downstream storage
Probability of blocking an intersection	141	Investigated for its effect on gridlock
Angle of intersection	80,195	The documentation suggests that this information is only used for graphics plotting

Basic Capacity Studies: CORSIM is a microscopic simulation program that has no capacity computation capabilities analogous to its deterministic model counterparts. When more vehicles arrive than an approach can accommodate, the residual vehicles simply stay on the link until they are discharged. So the only indication of overcapacity operation is an input volume that exceeds the output volume. Capacity must be determined indirectly by a sequence of runs with increasing demand volume until the input begins to exceed the output. An example of capacity estimation by this process is shown in Figure 4-5.

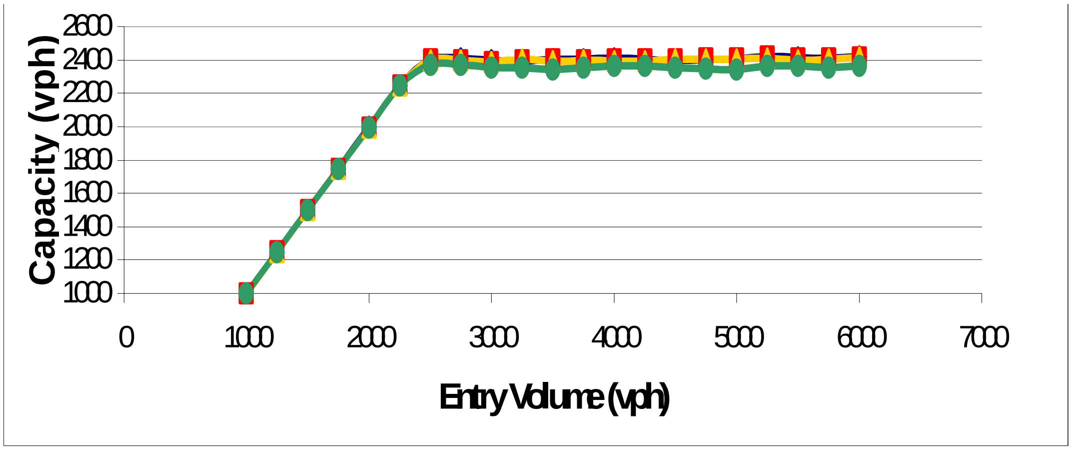


Figure 4-5. Illustration of Capacity Estimation with CORSIM

4.5.1 Proportion of Heavy Vehicles

One application of the capacity analysis technique just described is the investigation of the effect of trucks on capacity. To illustrate this effect, multiple CORSIM runs were made with increasing proportions of trucks. The results are presented in Figure 4-6. This graph illustrates the basic trend that an increase in the truck volumes lowers the overall capacity of the movement. This effect would be anticipated. However, the bigger question is whether or not there was a difference between a triple left-turn lane and three through lanes. The answer is that there was no difference, and it must be concluded that CORSIM does not recognize the unique problems of trucks having to make turns simultaneously in adjacent lanes.

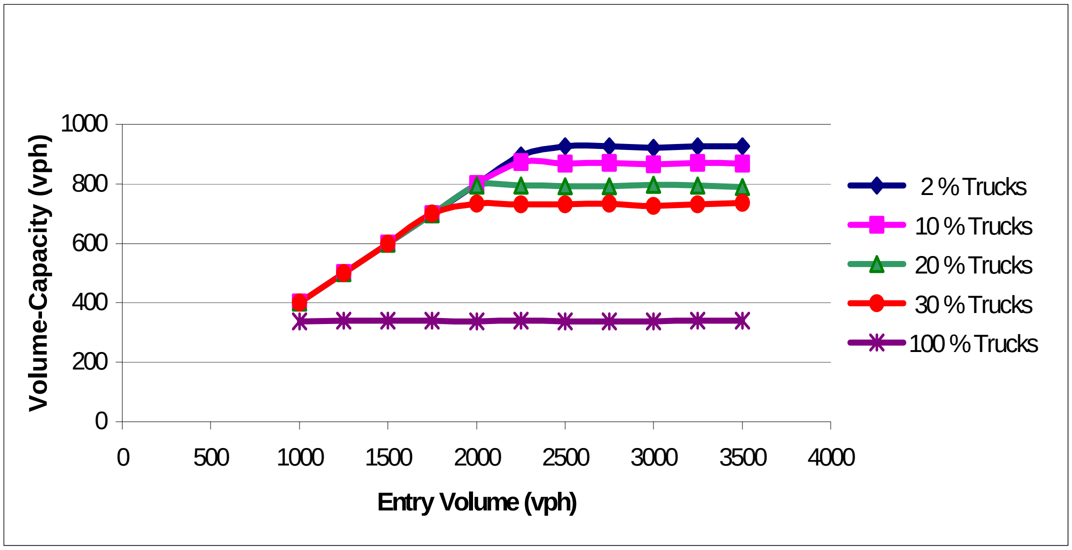


Figure 4-6. Effect of Heavy Vehicle Proportions on the Approach Capacity

4.5.2 Effect of Turning Radius

The size of the turning radius has a substantial impact on a driver's ability to negotiate a turning movement. This is particularly significant in the case of a triple left-turn movement. The simultaneous movement of three lanes abreast must be expected to lower the capacity. Conversely, the larger the radius, the easier it becomes for a driver to complete the maneuver. This improved level of comfort in turn increases the speeds of the motorist and thus, the saturation flow rate as well.

In CORSIM the widths of the of the lanes of the triple left-turn facility both upstream and downstream were increased in Record Type 80 from the default of 12 feet to the maximum 15 feet in 1-foot increments. The widths of the lanes were then increased from the minimum 8 feet back to the default value also in 1-foot increments. However, there were no differences in the capacities obtained in simulation as the lane widths changed.

4.5.3 Angle of Intersection

The angle of the intersection is another geometric design factor that significantly impacts the operation of a triple left-turn facility. The sharper the angle, the more difficult the maneuver becomes for the drivers. This results in lower capacities on the movement. In this analysis, the sharper angles used were acute angles, angles less than 90 degrees, ranging from 30 degrees to a maximum of 90 degrees in 5-degree increments. The angles were calculated by repositioning of downstream nodes in Record Type 195 while keeping the length of the downstream links constant for all angles.

Obtuse angles, angles greater than 90 degrees, were also used in the analysis to provide a contrast to the previous case. The obtuse angles used, which ranged from 90 degrees to a maximum of 150 degrees in 5-degree increments, were calculated and obtained in a similar fashion. Continuing an emerging pattern, the results from both the acute and obtuse angles showed there to be no difference in the capacities obtained in simulation as the angles changed.

4.5.4 Turning Volume Distribution by Lane

CORSIM handles all lane distributions internally through a combination of features that attempt 1) to get the vehicle into the proper lane as it enters the link, and 2) to cause it to change lanes if some advantage could be achieved. The freeway part of CORSIM (i.e., FRESIM) actually allows the lane distribution to be specified at the link entry point. However, the surface street portion (i.e., NETSIM) does not.

As indicated in Table 4-2, CORSIM provides several input parameters on Record Types 14, 81, 152 and 153 that could be expected to influence the lane changing behavior. All of these inputs were tested in connection with this study and, without belaboring the point further, no significant effects were found. It was noted that, with the default parameters, the middle lane utilization was slightly higher than either the inside or outside lanes. This is contrary to the results of field studies, which indicate a higher utilization of the inside lane. It was possible to cause a slight shift of traffic between lanes, but other compensating effects eliminated any overall influence on the total capacity of triple left turn lanes.

Based on the results of the study to this point, it would have to be concluded that CORSIM does not recognize the operational characteristics of triple left-turn lanes. There is also some question as to the effect of the input parameter adjustment on any aspect of the operation. All of the parameter adjustments discussed to this point are specific to CORSIM, and are too microscopic to be treated by TRANSYT. Most of the parameters would be expected to have some effect on the saturation flow rate, which is a user-specified input to TRANSYT. Therefore, no specific experiments were performed using TRANSYT on situations without downstream effects.

4.6 Downstream Lane Reductions

When traffic from three left-turn lanes must be accommodated in two lanes downstream, a tapered lane drop is required to allow the outside lane to merge into the through traffic. In this case, the length of the merge area becomes a major design concern. The primary research task for this problem is not the compilation of simulation runs, but trying to determine what to compile. There is no universal performance measure for the acceptability of a lane drop that can be obtained from a simulation model such as CORSIM.

4.6.1 Previous Modeling Approaches and Criteria

In an earlier attempt to address this problem, Shen (2001) conducted CORSIM simulation studies for a triple left-turn configuration with a downstream merging section. An example of the results of those studies is presented in Figure 4-7. Shen's guidelines for the minimum required merging section length were based on the overall average delay experienced by all of the vehicles involved in the merge. Other criteria will also be explored in the study described on this report.

4.6.2 Candidate Criteria

The operation of the merging section is conceptually simple. Vehicles in the outside lane will store in the merge area until they get a clear opportunity to enter the traffic stream. It is clearly necessary to avoid a situation in which a queue of vehicles would be expected to extend beyond the entry point to the merge area, because such vehicles would block the intersection. So the existence of spillback at any at any point in the cycle would be a reasonable criterion for determining minimum merge area length.

When spillback occurs, vehicles on one approach or another (not always the triple left-turn approach) will be unable to enter the intersection and a loss of capacity will result. So, another possible criterion for the minimum merge area length would be the maximization of capacity.

This is a multidimensional problem with many parameters including:

The number of lanes on the "opposing" approach, defined earlier as the approach to the right of the triple left turn, because traffic on this approach competes for capacity at the merge point with the triple left turn. Configurations with three lanes on the opposing approach pose a more critical situation than configurations with only two lanes;

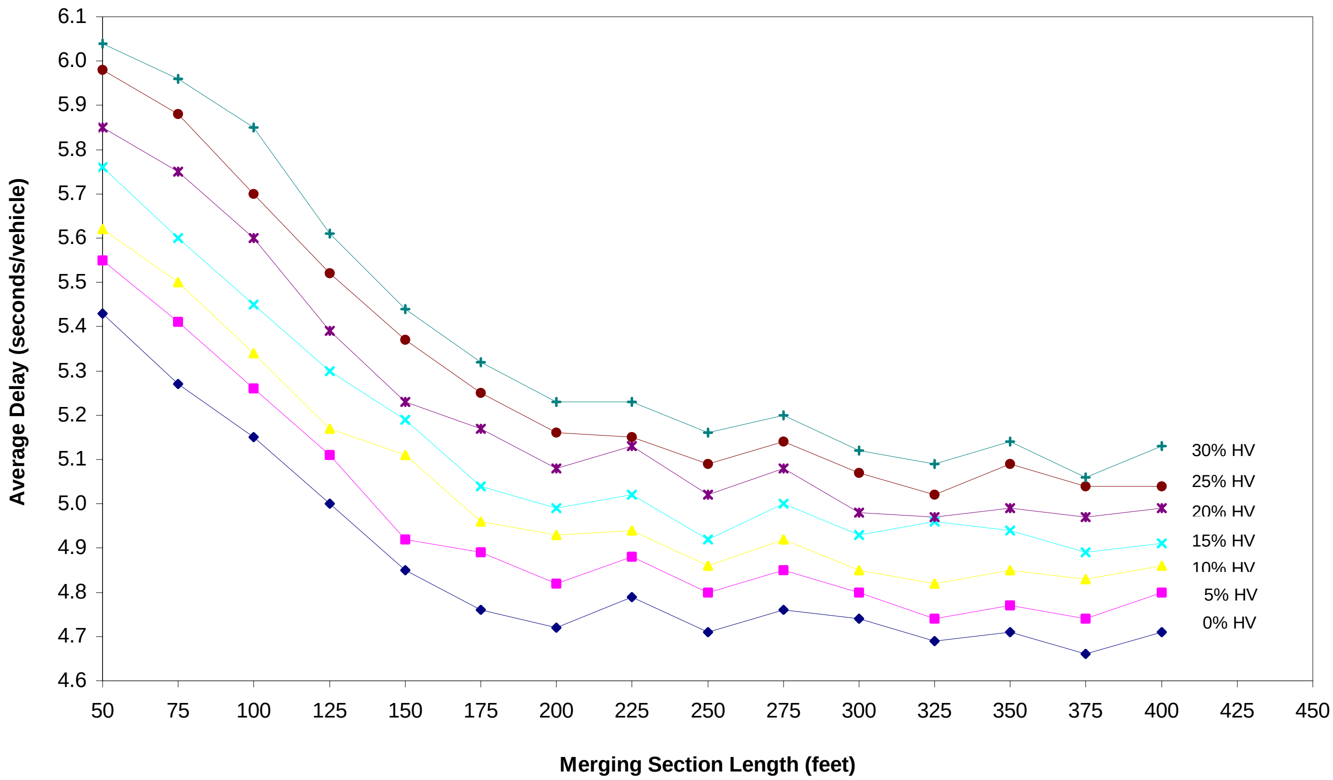


Figure 4-7. Average Overall Delay to All Vehicles as a Function of Merging Section Length (Shen 2001)

The traffic volumes on both the triple left turn approach and the opposing approach. The sum of these two volumes must pass through the merge point;

The cycle length can have a major impact, because it determines the duration through which the merge area flow rate could exceed its capacity. The relative green times will also have an influence on the operation; and

Progression considerations from an upstream intersection on either approach could influence the formation of platoons passing the merge point.

The combination of these parameters, added to the natural stochastic component of traffic flow, make this a very difficult problem to deal with analytically or to propose blanket guidelines. On the other hand, the star network and the level of detail of both CORSIM and TRANSYT create an excellent potential for a star-network application. The shortcomings of CORSIM identified earlier in this chapter are not as critical with respect to downstream effects because the ability to model the triple left turn operation explicitly is less of a drawback.

4.6.3 Maintenance of Capacity as a Criterion

The first of these two cases simulated in the Star Network simulation investigated how the triple left-turn facility operated with competing traffic volumes introduced opposing movement with two thru lanes. In this case the effect of the downstream lane reduction was primarily felt by the triple left-turn facility. Since there were only two lanes of competing traffic, there was no need for that traffic to use the auxiliary third merging lane.

As an example, a 90-sec cycle was used in which the green time was equally split between the triple left-turn facility and the competing through movement. Each phase was allotted 40 sec of green time with a 5 sec intergreen time. The intergreen time was divided into 3 sec and 4 sec of all-red time. This produced a 45 sec split for both movements. Using the green time provided for each movement and their respective ideal saturation flow rate, the capacity of each movement was determined. This was then utilized to determine the Entry Volume that would be coded in Record Type 50. Three different saturation conditions were initially considered: 1) under-saturated, 2) saturated, and 3) over-saturated. It was later determined that the significant results could not be attained from under-saturated condition 1, therefore conditions 2 and 3 were the primary focus.

Once the entry volume was established the merging distance then was increased from an initial value of 100 ft to a final value of 550 ft, in 50 ft increments. The total volume for the approach link, opposing link, merging link and exit link were recorded at each of the merging lane length distances. These volume values were then interpreted as the virtual capacity for each of the approach links. The volumes obtained were then compared against the volume values from earlier base case simulations that substituted the auxiliary third merging-lane with a full lane.

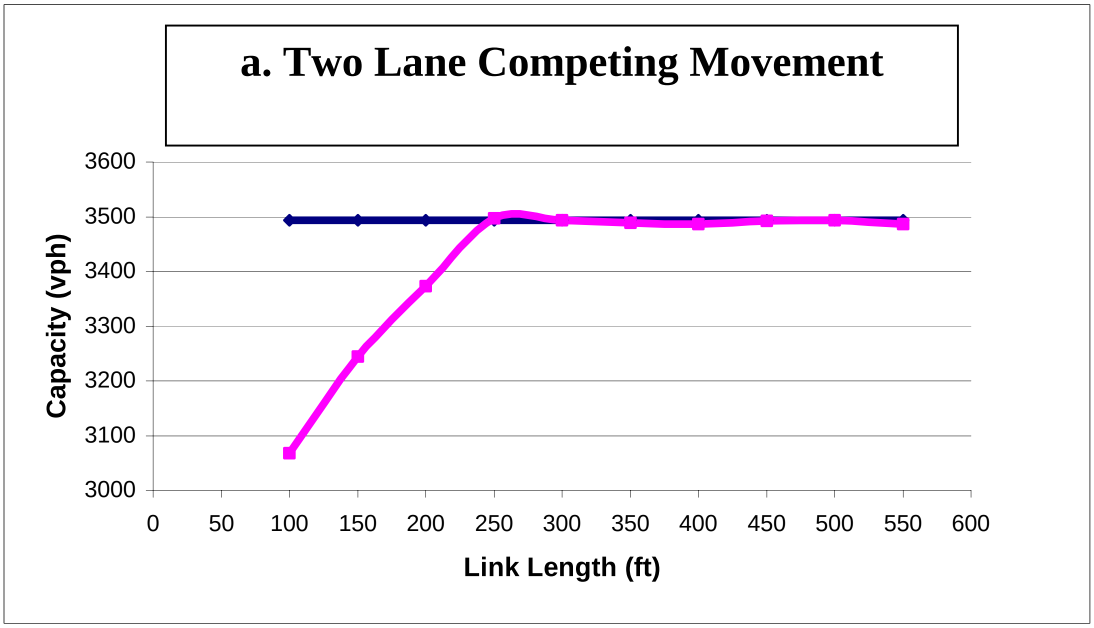
The results obtained from this first simulation experiment are summarized in Figure 4-8a. Note that the capacity with the lane drop reaches the base capacity (horizontal line) at approximately 250 ft of merge area length.

The corresponding situation for a competing movement with three lanes, and the same volume per lane, is presented in Figure 4-8b. Note that the minimum merging lane length required to maintain capacity is considerably higher in this case.

4.6.4 Avoidance of Spillback as a Criterion

Assuming that the reduction in capacity is caused by spillback from the merging section link, it follows that these two criteria would give approximately the same results for minimum merging section lengths. On the other hand, sporadic spillback for a few seconds during an occasional cycle may not produce a noticeable capacity reduction but it could be considered as a surrogate safety measure. Moreover, capacity reduction estimates require multiple runs of CORSIM to seek a balance between input and output volumes. It should be possible to identify spillback with a single CORSIM run.

The most reliable way to spot occasional spillback with CORSIM is to view the animated graphics display, which gives a second by second picture of queue formation and service. Spillback is illustrated in the example of the animated graphics presented in Figure 4-9.



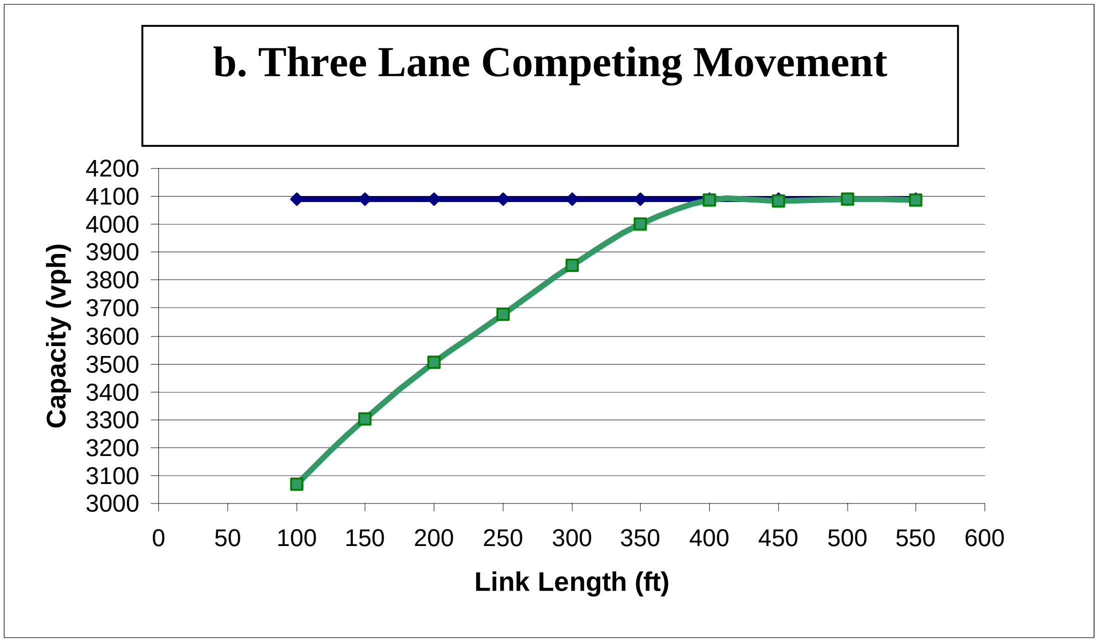


Figure 4-8. Merging Section Capacity with Two and Three Lanes of Competing Traffic

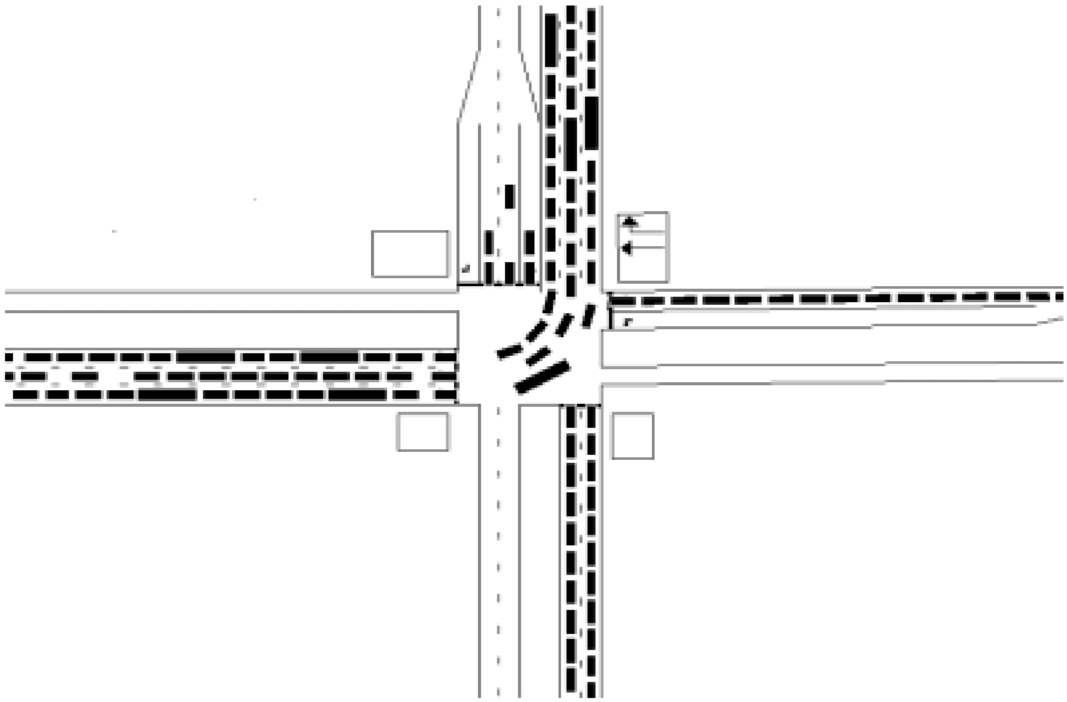


Figure 4-9. Visual Illustration of Spillback from CORSIM's Animated Graphics

4.6.5 Other Downstream Effects

Other downstream effects investigated in this study were associated with traffic signals located downstream and in close proximity to the subject intersection. Again, there are too many parameters to distill into general guidelines, but the star-network proved to be an excellent end-user tool for investigating these types of conditions. Examples of downstream situations that are amenable to star-network analysis include exclusive turn lanes (either right or left turns) that act as lane drops for a portion of the triple left-turn traffic. Spillback caused by a downstream intersection located very close to the subject intersection is also a good candidate.

4.7 Use of TRANSYT-7F to Assess Downstream Effects

TRANSYT-7F is a macroscopic model that deals in a much lower level of detail than CORSIM, which is microscopic. TRANSYT does not model vehicle interactions and is, therefore, not a candidate for investigating the unique stop-line phenomena of triple left turns. On the other hand, recent releases appear to deal realistically with the backup of traffic from downstream intersections.

TRANSYT offers the single-run simplicity of an analytical model. By updating the state of all links deterministically each second, it provides sufficient level of detail to assess spillover from downstream bottlenecks. A new graphics feature called "Spyglass" generates a wide variety of requested information for specified links. The Spyglass output can be imported into a spreadsheet for plotting. One piece of useful information is a flag that indicates when a link is full and spillover is occurring. By plotting this flag over the entire cycle, as shown in Figure 4-10, it is possible to determine easily when spillback has occurred.

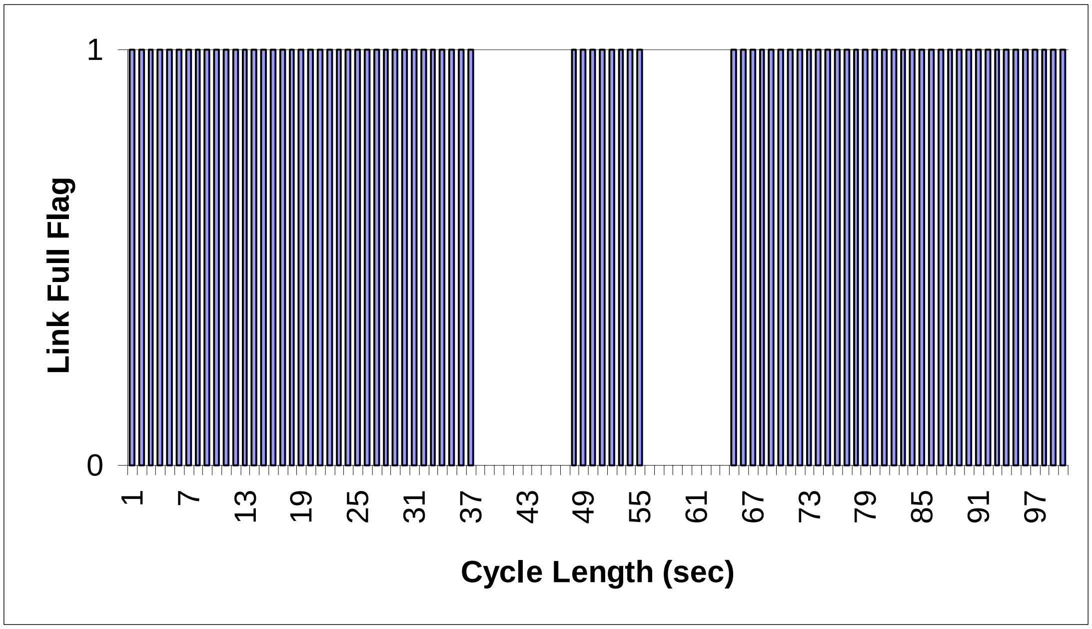


Figure 4-10. Example Spyglass Spreadsheet Graph Illustrating the "Link Full" Flag Status of Downstream Link

4.8 Conclusions and Recommendations

This section provides information on the strengths and weaknesses of the four traffic models used to evaluate the potential traffic flow benefits of a third left turn lane. No existing model could do the entire job, but in combination they provide a reasonable overall assessment of most intersection configurations. Within the limits of this study, the following conclusions are offered with respect to modeling triple left turns at signalized intersections:

1. None of the models investigated recognizes the unique characteristics of triple left turns. Instead, they all model triple left turns as three-lane movements that happen to be turning left. There is little or no difference between three-lane through movements and triple left turns;

2. The single intersection models, HCM and SIDRA, are easier to use and are probably adequate for the analysis of relatively simple triple left-turn situations. When complexities arise from upstream or downstream conditions, one of the signal network models (CORSIM or TRANSYT-7F) should be used;

3. The network models appear to do a reasonable job of modeling spillback into the intersection from downstream bottlenecks, but they are not able to recognize problems associated with such phenomena as multiple trucks turning simultaneously;

4. Maintenance of capacity (i.e., avoiding capacity reductions) is a promising criterion for determining the minimum merging section length when a triple left turn must enter a two-lane street. Avoidance of spillback may be a better criteria criterion, because of its increased sensitivity and potential as a safety surrogate. Both of these criteria require signalized intersection performance estimation software;

5. Both CORSIM and TRANSYT-7F are able to recognize spillover explicitly and to make adjustments to the effective capacity of an approach to reflect the blockage caused by spillback;

6. CORSIM has several parameters in its input data structure that should be useful in creating an operation that could represent triple left turns more realistically, but most of these items had no influence on the CORSIM performance estimations. This suggests that their effects are minimal, or that they are not implemented as per the CORSIM documentation; and

7. The star-network mapped into both CORSIM and TRANSYT-7F by the new version of the Arterial Analysis Package is an effective tool for analyzing most intersections that have triple left turns with adjacent intersection effects.

5. SAFETY ANALYSIS

This chapter analyzes the safety performance of the 11 triple left turns identified in the previous chapter based on crash data from the 1995-1997 period. Four different analyses are included. The first examines the crash experience of the individual triple left turns using condition and collision diagrams. The second involves examining the crash involvement of triple left-turn approach as a percentage of total intersection crashes in terms of crash type and crash severity. The third involves a similar analysis but based on groups of triple left-turn intersections with similar geometric and traffic conditions. The last involves a comparative analysis of the safety experience of double and triple left turns. The following sections present each of the four analysis approaches in detail.

5.1 Condition and Collision Diagrams for Individual Sites

In this analysis, condition and collision diagrams were created for each location to identify crash patterns and the associated intersection conditions. Crashes on the triple left-turn approach were identified using detailed police reports along with digital crash summary. The police reports provided details not available in the summary report. The description of the crash and the hand sketch of the crash scene were especially useful. Whenever the sketch was not clear enough the description of the crash assisted in providing a better idea of the event and the specific location of the crash.

The condition and collision diagrams were created using the Microstation CAD software. The format and content used in these diagrams are consistent with those used by the FDOT. The crash types are rear end, angle, sideswipe, left-turn, pedestrian, and fixed-object. Crash severity categories include fatal, injury and property-damage-only. Individual crashes on a collision diagram are numbered, with details for each of these crashes summarized in a corresponding table. The numbers on the collision diagram match those on the corresponding table.

For convenience the 11 triple left-turn intersections identified in the previous chapter are again listed below:

1. SR 7 (US 441) and NW 7th Avenue (SR 826 Off Ramp)
2. SR 90 (SW 8th St) and SW 4th Avenue
3. NW 12 Street and SR 869 (NW 72nd Avenue/Ives Dairy Road)
4. SR 878 (Snapper Creek Drive) and SR 5 (US 1)
5. SR 826 and SR A1A (Collins Avenue)
6. NE 2nd Street and Biscayne Boulevard (US 1/SR-5)
7. NE 4th Street and Biscayne Boulevard (US 1/SR-5)
8. SE 1st Street and Biscayne Boulevard (US 1/SR-5)
9. Florida Turnpike and Sunrise Boulevard (SR 838)
10. Oakland Park (SR 816) and NW 50th Avenue
11. Florida Turnpike and Commercial Boulevard (SR 870)

The following sections are presented in the order of the intersections listed above.

5.1.1 SR 7 (US 441) and NW 7^{th} Avenue (SR 826 Off Ramp)

The SR 7 (US 441) and NW 7^{th} Avenue (SR 826 off-ramp) is a “T” intersection situated in an industrial area. The triple left turn is on the SR 7 approach. The approach intersects SR 9 at an angle of about 50 degrees on a slight approaching downgrade. Figure 5-1 shows a picture of the triple left-turn approach. Figure 5-2 displays the condition diagrams for this intersection.

Table 5-1 provides a summary of the crashes occurred at the intersection. The collision diagram is shown in Figure 5-3. It can be seen from the diagram that most of the crashes were of the rear-end type (58%), with none of them occurred on the triple left-turn approach. On the other hand, angle crashes, accounting for 21%, were all located on the triple left-turn approach. There were relatively few sideswipe crashes over the three-year period at the intersection. This appears to be attributed to the wider and smoother turning path for the triple left-turn lanes created by the skewed intersection angle and the wide travel lanes (4.5 m). On the other hand, the wider and smoother turning path may have encouraged a higher turning speed, which may have contributed to the high percentage of injury crashes at the intersection (63%). Overall, the triple left-turn approach accounted for 33% of the total crashes experienced by the intersection.

Figure 5-1. SR 7 (US 441) and NW 7^{th} Avenue (SR 826 Off-Ramp)

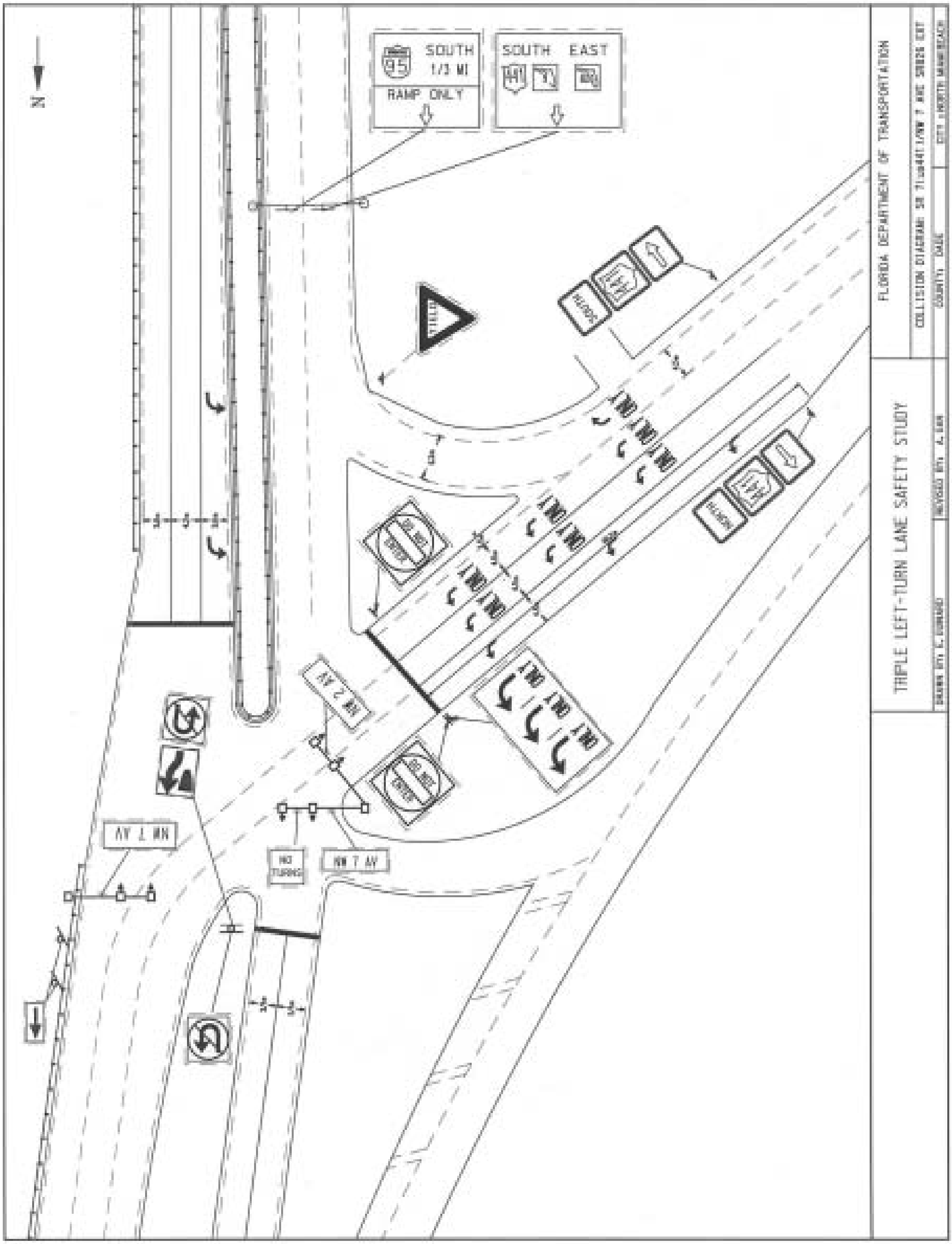


Figure 5-2. Condition Diagram for SR 7 (US 441) at NW 7th Avenue (SR 826 Off Ramp)

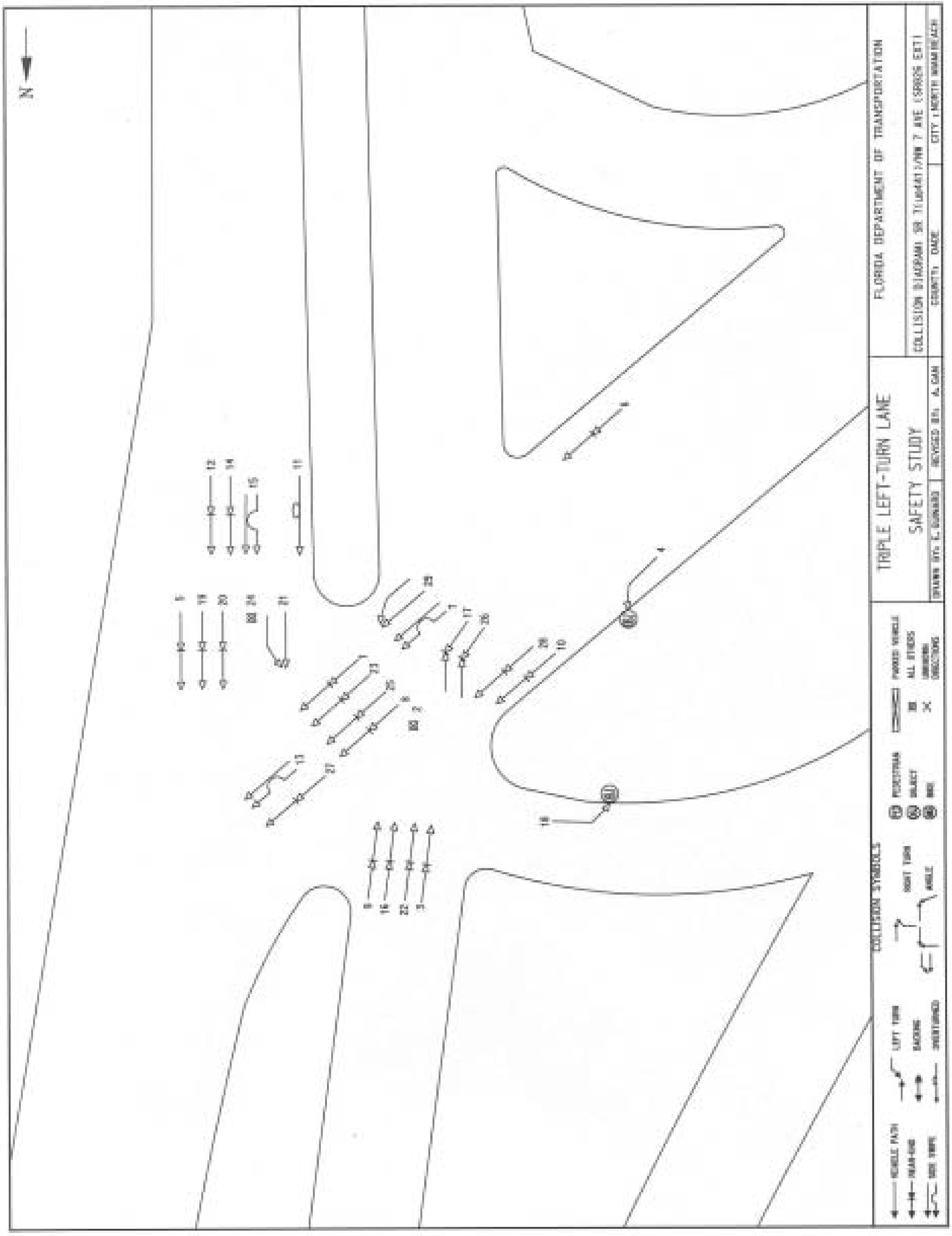


Figure 5-3. Collision Diagram for SR 7 (US 441) at NW 7th Avenue (SR 826 Off Ramp)

Table 5-1. Crash Summery Table for SR 7 (US 441) at NW 7th Avenue (SR 826 Off Ramp)

FLORIDA DEPARTMENT OF TRANSPORTATION
CRASH SUMMARY

SECTION: **87140000 & 87260000** STATE ROUTE: **SR 7 (US441) & SR 826**

INTERSECTING ROUTE: **SR 7(US441) & SR 826** M.P. **12.031 & 24.653** ENGINEER:

STUDY PERIOD: FROM **1/ 95** TO **12/ 97** COUNTY: **DADE**

No.	DATE	DAY	TIME	TYPE	FATAL	INJURY	PROP DAM	DAY / NT	WET / DRY	CONTRIBUTING CAUSE
1	1/14/95	Sat	1900	Rear End	0	1	0	Nite	Wet	Careless Driving
2	6/10/95	Sat	0	Other	0	0	1	Day	Dry	Careless Driving
3	8/7/95	Mon	900	Rear End	0	1	0	Day	Dry	Careless Driving
4	8/22/95	Tue	1100	Fixed Object	0	0	1	Unk	Dry	All Others
5	10/5/95	Thu	1000	Rear End	0	1	0	Day	Wet	Careless Driving
6	12/1/95	Fri	700	Rear End	0	1	0	Day	Dry	No Improper Driving
7	1/6/96	Sat	100	Sideswipe	0	1	0	Nite	Dry	Disregarded Traffic Signal
8	1/9/96	Tue	1800	Rear End	0	0	1	Nite	Dry	No Improper Driving
9	4/17/96	Wed	700	Rear End	0	0	1	Day	Dry	No Improper Driving
10	6/26/96	Wed	1100	Rear End	0	1	0	Day	Dry	Careless Driving
11	7/20/96	Sat	1600	Overturn	0	1	0	Day	Dry	Careless Driving
12	7/29/96	Mon	2000	Rear End	0	1	0	Nite	Wet	No Improper Driving
13	7/29/96	Mon	1000	Sideswipe	0	1	0	Day	Dry	Improper Lane Change
14	5/22/97	Thu	1700	Rear End	0	1	0	Day	Wet	Careless Driving
15	6/6/97	Fri	1700	Sideswipe	0	1	0	Day	Dry	Improper Turn
16	6/8/97	Sun	2200	Rear End	0	1	0	Nite	Wet	No Improper Driving
17	6/9/97	Mon	1500	Angle	0	1	0	Day	Wet	Disregarded Traffic Signal
18	7/1/97	Tue	600	Fixed Object	0	1	0	Day	Dry	All Others
19	7/14/97	Mon	1800	Rear End	0	1	0	Day	Wet	Careless Driving
20	7/18/97	Fri	900	Rear End	0	0	1	Day	Wet	Careless Driving
21	7/22/97	Tue	900	Angle	0	0	1	Day	Dry	Improper Lane Change
22	8/1/97	Fri	900	Rear End	0	0	1	Day	Dry	No Improper Driving
23	8/22/97	Fri	1900	Rear End	0	0	1	Nite	Dry	Careless Driving
24	9/4/97	Thu	2200	Other	0	0	1	Nite	Slippery	Careless Driving
25	10/6/97	Mon	2300	Rear End	0	1	0	Nite	Wet	Careless Driving
26	10/15/97	Wed	600	Angle	0	1	0	Nite	Dry	Disregarded Traffic Signal
27	11/19/97	Wed	1700	Rear End	0	1	0	Day	Wet	Careless Driving
28	12/17/97	Wed	1100	Rear End	0	0	1	Day	Dry	Careless Driving
29	12/29/97	Mon	1100	Angle	0	0	1	Day	Slippery	No Improper Driving
Total No.	Fatal	Injury	PDO	Angle	Left Turn	Right Turn	Rear End	Side swipe	Ped/Bike	All Others
29	**0**	**18**	**11**	**4**	**0**	**0**	**17**	**3**	**0**	**5**
	0.00%	*62.07%*	*37.93%*	*13.79%*	*0.00%*	*0.00%*	*58.62%*	*10.34%*	*0.00%*	*17.24%*
Day	Night	Wet	Dry	Failed to Maintain Equipment	No Improper Driving	Careless Driving	Improper Turn	Disregarded Traffic Signal	Improper Lane Change	All Others
19	**10**	**7**	**22**	**0**	**7**	**14**	**1**	**3**	**2**	**2**
65.52%	*34.48%*	*24.14%*	*75.86%*	*0.00%*	*24.14%*	*48.28%*	*3.45%*	*10.34%*	*6.90%*	*6.90%*

TOTAL VEHICLES ENTERING / ADT: **59,500** CRASH RATE: **0.445** /MV

5.1.2 SR 90 (SW 8th Street) and SW 4th Avenue

SR 90 and SW 4th Avenue is a right-angle intersection containing only two one-way approaches. The intersection is located several blocks west of Downtown Miami. Figure 5-4 shows a picture of vehicles making left turns at the intersection. Figure 5-5 shows the condition diagram for the intersection. As shown in the diagram, the triple left-turn traffic travels southbound on SW 4th Avenue and turns onto eastbound SR 90, which is a major route into Downtown Miami. The outside left-turn lane of the triple left turn is optional through. A special condition exists at the beginning of the receiving approach where an exclusive right-turn lane is used to serve traffic heading for the Interstate 95 on-ramp.

Table 5-2 provides a summary of the crashes occurred at the intersection for the years 1995 – 1997. The corresponding collision diagram is given in Figure 5-6. Because the triple left turn is a major approach at the intersection, it accounted for a large percentage of the crashes at the intersection. The most common crashes reported were of the angle (56%) and sideswipe (33%) types. Eighty six percent of the angle crashes and 92% of the sideswipe crashes were related to the triple left-turn approach. Some angle crashes appear to have been caused by southbound vehicles attempting to perform a through maneuver from the middle left-turn lane and collided with left-turning vehicles from the outer left-turn lane. Sideswipe crashes appear to be a result of the sharp left-turn angle, coupled with the aforementioned special condition that created an unusually high number of weaving vehicles. Crashes attributable to left turns may have accounted for as much as 82% of the total crashes at the intersection, but because one of the three left turn lanes is a shared through lane, the percentage is probably less. Most of these crashes had resulted in only property damages with minimum injuries. High pedestrian activities were observed at the intersection but no severe pedestrian crashes were experienced.

Figure 5-4. SR 90 (SW 8th Street) and SW 4th Avenue

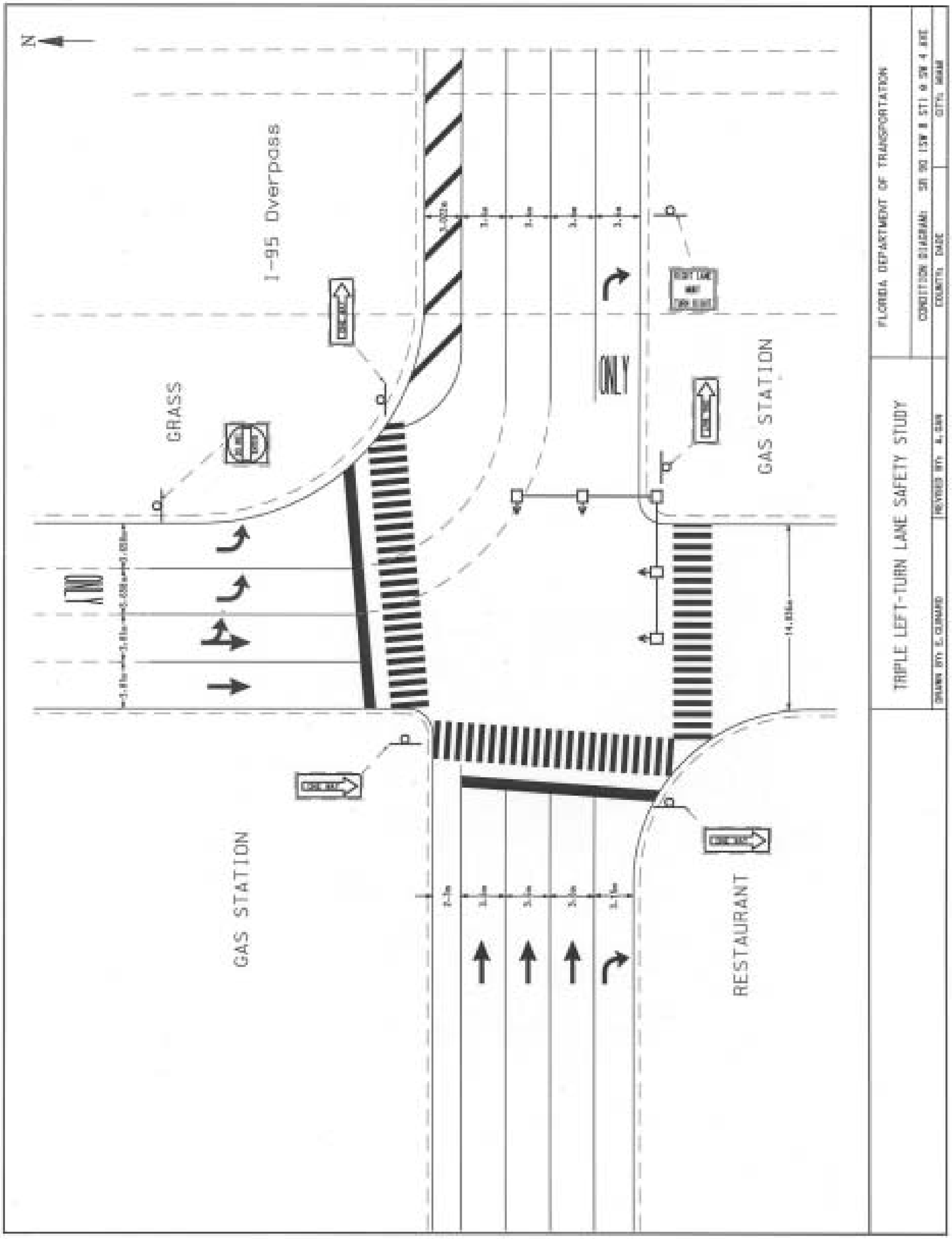


Figure 5-5. Condition Diagram for SR 90 (SW 8th Street) at SW 4th Avenue

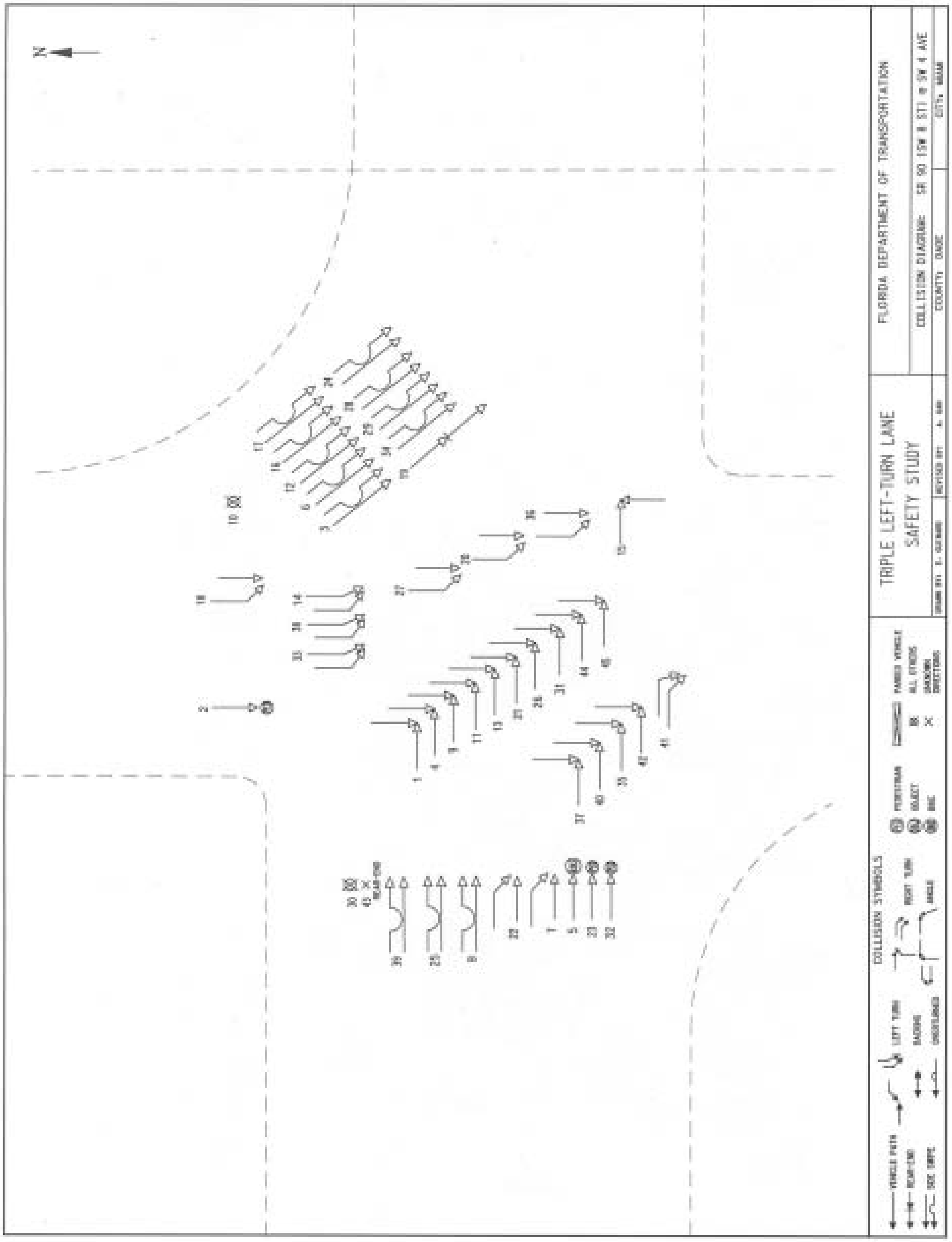


Figure 5-6. Collision Diagram for SR 90 (SW 8th Street) at SW 4th Avenue

Table 5-2. Crash Summary Table for SR 90 (SW 8th Street) at SW 4th Avenue

FLORIDA DEPARTMENT OF TRANSPORTATION

CRASH SUMMARY

SECTION: **87120000** STATE ROUTE: **SR90**

INTERSECTING ROUTE: **SW 4 AVE** M.P. **17.525** ENGINEER:

STUDY PERIOD: FROM **1/ 95** TO **12/ 97** COUNTY: **DADE**

No.	DATE	DAY	TIME	TYPE	FATAL	INJURY	PROP DAM	DAY / NT	WET / DRY	CONTRIBUTING CAUSE
1	1/9/95	Mon	2200	Angle	0	1	0	Nite	Dry	No Improper Driving
2	3/22/95	Wed	1300	Pedestrian	0	1	0	Day	Dry	No Improper Driving
3	3/27/95	Mon	2100	Sideswipe	0	0	1	Nite	Dry	No Improper Driving
4	4/4/95	Tue	2200	Angle	0	0	1	Nite	Dry	All Others
5	5/9/95	Tue	1600	Bicycle	0	1	0	Day	Dry	No Improper Driving
6	7/8/95	Sat	2200	Sideswipe	0	1	0	Nite	Dry	No Improper Driving
7	7/14/95	Fri	900	Angle	0	0	1	Day	Dry	No Improper Driving
8	7/27/95	Thu	800	Sideswipe	0	1	0	Day	Wet	No Improper Driving
9	7/28/95	Fri	1100	Angle	0	0	1	Day	Wet	No Improper Driving
10	8/7/95	Mon	1500	Fixed Object	0	0	1	Day	Dry	Improper Lane Change
11	8/7/95	Mon	1500	Angle	0	0	1	Day	Dry	No Improper Driving
12	8/10/95	Thu	900	Sideswipe	0	0	1	Day	Dry	No Improper Driving
13	8/25/95	Fri	1800	Angle	0	0	1	Day	Wet	No Improper Driving
14	8/26/95	Sat	1600	Left Turn	0	0	1	Day	Wet	No Improper Driving
15	9/3/95	Sun	2200	Angle	0	0	1	Nite	Dry	No Improper Driving
16	9/9/95	Sat	1200	Sideswipe	0	0	1	Day	Dry	No Improper Driving
17	9/13/95	Wed	900	Sideswipe	0	0	1	Day	Dry	No Improper Driving
18	10/5/95	Thu	1800	Angle	0	0	1	Day	Dry	No Improper Driving
19	11/6/95	Mon	0	Rear End	0	0	1	Day	Dry	Careless Driving
20	11/17/95	Fri	1200	Angle	0	0	1	Day	Dry	No Improper Driving
21	11/20/95	Mon	1600	Angle	0	1	0	Day	Dry	No Improper Driving
22	11/23/95	Thu	100	Angle	0	1	0	Nite	Dry	No Improper Driving
23	12/6/95	Wed	1700	Pedestrian	0	0	1	Day	Dry	No Improper Driving
24	1/23/96	Tue	1500	Sideswipe	0	0	1	Day	Dry	No Improper Driving
25	8/23/96	Fri	700	Sideswipe	0	1	0	Day	Dry	No Improper Driving
26	10/10/96	Thu	1200	Angle	0	0	1	Day	Dry	No Improper Driving
27	10/19/96	Sat	2000	Angle	0	0	1	Nite	Dry	No Improper Driving
28	10/21/96	Mon	900	Sideswipe	0	0	1	Day	Dry	All Others
29	10/24/96	Thu	1100	Sideswipe	0	0	1	Day	Dry	All Others
30	10/29/96	Tue	1000	Fixed Object	0	0	1	Unk	Other	No Improper Driving
31	12/17/96	Tue	1400	Angle	0	0	1	Day	Dry	No Improper Driving
32	12/18/96	Wed	1100	Pedestrian	0	1	0	Day	Dry	All Others
33	2/9/97	Sun	1000	Left Turn	0	0	1	Day	Dry	No Improper Driving

34	2/13/97	Thu	1700	Sideswipe	0	0	1	Day	Dry	No Improper Driving
35	3/23/97	Sun	100	Angle	0	0	1	Nite	Dry	No Improper Driving
36	3/26/97	Wed	1900	Angle	0	0	1	Nite	Dry	No Improper Driving
37	4/30/97	Wed	1700	Angle	0	1	0	Day	Dry	No Improper Driving
38	5/9/97	Fri	2200	Left Turn	0	0	1	Nite	Dry	No Improper Driving
39	5/11/97	Sun	800	Sideswipe	0	0	1	Day	Dry	No Improper Driving
40	6/29/97	Sun	1400	Angle	0	0	1	Day	Dry	No Improper Driving
41	8/16/97	Sat	1100	Angle	0	0	1	Day	Dry	No Improper Driving
42	9/12/97	Fri	200	Angle	0	0	1	Nite	Dry	No Improper Driving
43	9/13/97	Sat	400	Rear End	0	0	1	Nite	Dry	No Improper Driving
44	11/3/97	Mon	1200	Angle	0	0	1	Day	Dry	No Improper Driving
45	11/21/97	Fri	1400	Angle	0	0	1	Day	Wet	No Improper Driving
Total No.	Fatal	Injury	PDO	Angle	Left Turn	Right Turn	Rear End	Side Swipe	Ped/Bike	All Others
45	**0**	**10**	**35**	**22**	**3**	**0**	**2**	**12**	**4**	**2**
	0.00%	*22.22%*	*77.78%*	*48.89%*	*6.67%*	*0.00%*	*4.44%*	*26.67%*	*8.89%*	*4.44%*
Day	Night	Wet	Dry	Failed to Maintain Equipment	No Improper Driving	Careless Driving	Follow too Closely	Disregarded Traffic Signal	Improper Lane Change	All Others
32	**13**	**3**	**42**	**0**	**39**	**1**	**0**	**0**	**1**	**4**
71.11%	*28.89%*	*6.67%*	*93.33%*	*0.00%*	*86.67%*	*2.22%*	*0.00%*	*0.00%*	*2.22%*	*8.89%*
TOTAL VEHICLES ENTERING / ADT:			**14,167**		CRASH RATE:			**2.901** /MEV		

5.1.3 SR 969 (NW 72nd Avenue) and NW 12th Street

SR 969 and NW 12th Street is a four-leg, 90-degree intersection located in the outskirts of the Miami International Airport, near the Dolphin Expressway (SR 836), in an industrial/commercial area. It is the only triple left-turn site in this study that has (minor) opposing traffic. At the beginning of the study, the triple left-turn approach was removed and reconverted into a double left-turn approach. Figure 5-7 shows a view of the converted intersection. The reconstruction of the intersection was required in order to provide space for an additional left-turn lane in the opposite direction to serve the increasing volume that needs to get on to the Dolphin Expressway. Figure 5-8 shows a condition diagram of the intersection before the reconstruction.

Table 5-3 provides a summary of the crashes occurred at the intersection. The corresponding collision diagram is given in Figure 5-9. It shows that rear-end (28%) and left-turn (21%) crashes were the most predominant crash types on the triple left-turn approach. Triple left-turn crashes accounted for 42% of the total crashes and 92% of the total left-turn crashes. However, crashes are relatively evenly distributed across the three approaches. Injuries were involved in 38% of the crashes and none of the crashes involved fatalities.

Figure 5-7. SR 969 and NW 12th Street

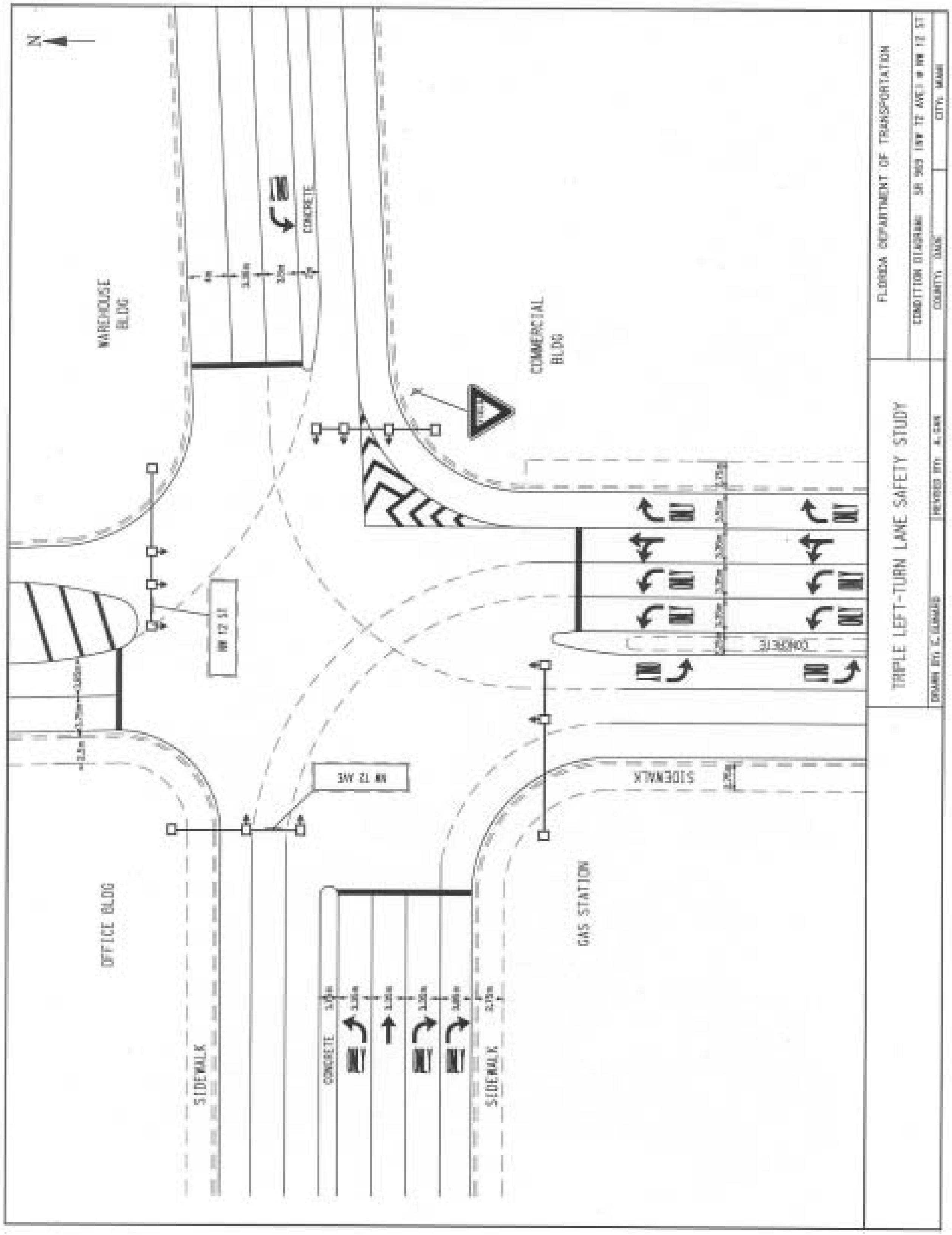


Figure 5-8. Condition Diagram for SR 969 (NW 72nd Avenue) at NW 12th Street

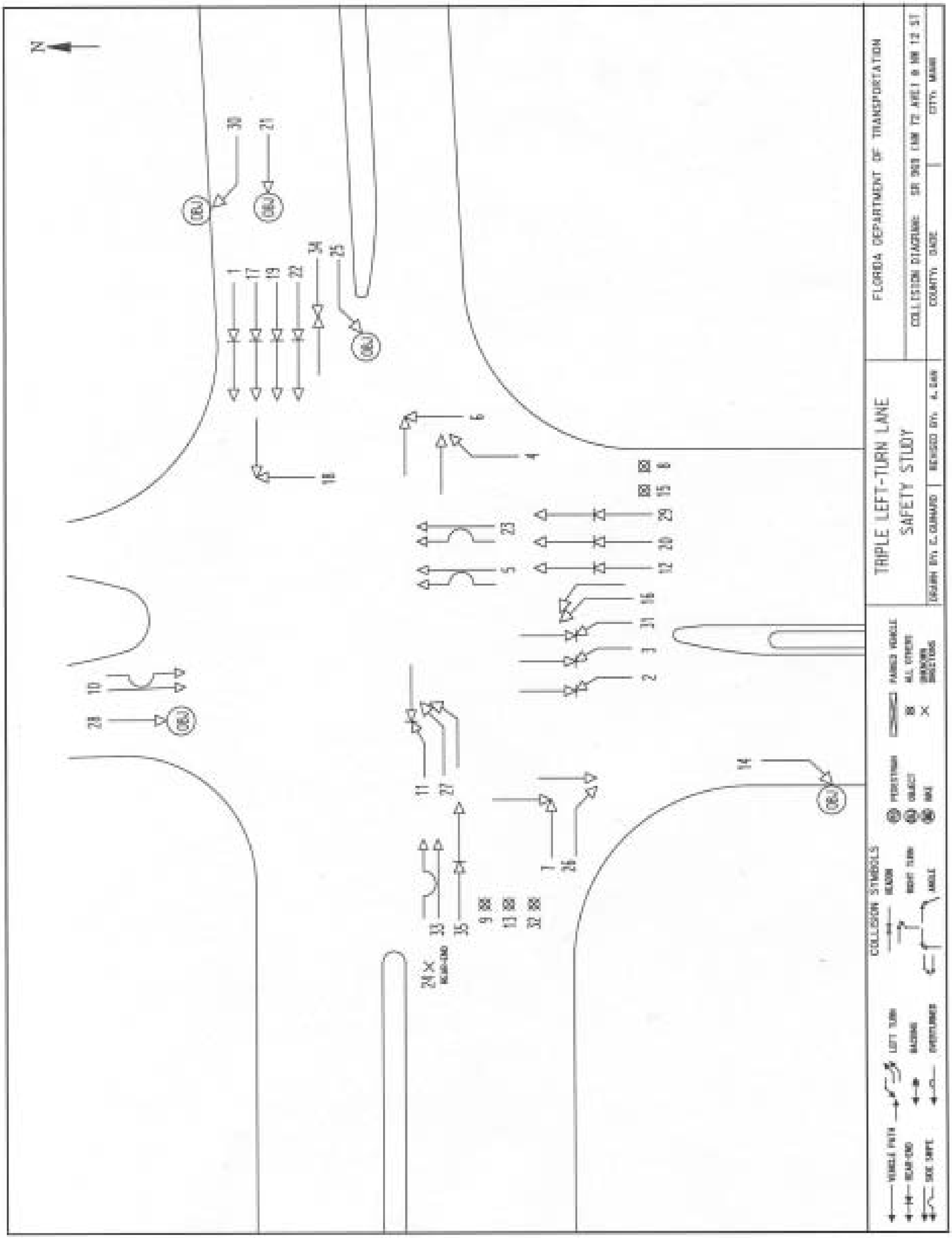


Figure 5-9. Collision Diagram for SR 969 (NW 72nd Avenue) at NW 12th Street

Table 5-3. Crash Summary Table for SR 969 (NW 72nd Avenue) at NW 12th Street

FLORIDA DEPARTMENT OF TRANSPORTATION
CRASH SUMMARY

SECTION: **87027000** STATE ROUTE: **SR 969**
INTERSECTING ROUTE: **NW 12 ST** M.P. **0.857** ENGINEER:
STUDY PERIOD: FROM **1/ 95** TO **12/ 97** COUNTY: **Dade**

No.	DATE	DAY	TIME	TYPE	FATAL	INJURY	PROP DAM	DAY / NT	WET / DRY	CONTRIBUTING CAUSE
1	1/14/95	Sat	900	Rear End	0	1	0	Day	Wet	No Improper Driving
2	2/20/95	Mon	1600	Left Turn	0	1	0	Day	Slippery	All Others
3	3/1/95	Wed	1500	Left Turn	0	0	1	Day	Dry	No Improper Driving
4	4/27/95	Thu	1700	Right Turn	0	0	1	Day	Dry	Careless Driving
5	5/6/95	Sat	1700	Sideswipe	0	0	1	Day	Dry	No Improper Driving
6	8/23/95	Wed	900	Angle	0	0	1	Day	Dry	No Improper Driving
7	8/28/95	Mon	1900	Angle	0	1	0	Nite	Wet	No Improper Driving
8	1/3/96	Wed	1800	Fixed Object	0	1	0	Day	Wet	No Improper Driving
9	2/29/96	Thu	1400	Fixed Object	0	0	1	Day	Dry	No Improper Driving
10	5/17/96	Fri	1500	Sideswipe	0	0	1	Day	Dry	No Improper Driving
11	7/22/96	Mon	1000	Left Turn	0	1	0	Day	Wet	All Others
12	8/16/96	Fri	1500	Rear End	0	0	1	Day	Dry	No Improper Driving
13	8/22/96	Thu	800	Other	0	1	0	Day	Dry	No Improper Driving
14	8/27/96	Tue	1900	Other	0	0	1	Nite	Wet	Careless Driving
15	10/18/96	Fri	2200	Other	0	1	0	Nite	Wet	No Improper Driving
16	10/23/96	Wed	900	Left Turn	0	0	1	Day	Dry	All Others
17	10/30/96	Wed	1200	Rear End	0	0	1	Day	Dry	No Improper Driving
18	11/2/96	Sat	1600	Angle	0	1	0	Day	Dry	No Improper Driving
19	12/10/96	Tue	800	Rear End	0	1	0	Day	Dry	Careless Driving
20	12/27/96	Fri	700	Rear End	0	0	1	Day	Wet	No Improper Driving
21	1/14/97	Tue	2000	Fixed Object	0	0	1	Nite	Slippery	No Improper Driving
22	5/1/97	Thu	1000	Rear End	0	1	0	Day	Dry	No Improper Driving
23	5/1/97	Thu	700	Sideswipe	0	0	1	Day	Dry	No Improper Driving
24	5/8/97	Thu	1700	Rear End	0	0	1	Day	Dry	No Improper Driving
25	6/3/97	Tue	1300	Fixed Object	0	0	1	Day	Wet	No Improper Driving
26	6/25/97	Wed	1500	Right Turn	0	0	1	Day	Dry	All Others
27	9/3/97	Wed	1700	Left Turn	0	0	1	Nite	Wet	No Improper Driving
28	9/16/97	Tue	1700	Other	0	0	1	Day	Dry	No Improper Driving
29	9/18/97	Thu	1500	Rear End	0	1	0	Day	Dry	No Improper Driving
30	9/24/97	Wed	1200	Fixed Object	0	0	1	Day	Dry	Failed to Maintain Equipment
31	11/12/97	Wed	1400	Left Turn	0	0	1	Day	Dry	All Others
32	11/27/97	Thu	1500	Fixed Object	0	1	0	Day	Dry	All Others
33	12/1/97	Mon	800	Sideswipe	0	0	1	Day	Dry	No Improper Driving
34	12/1/97	Mon	1500	Head On	0	0	1	Day	Dry	No Improper Driving
35	12/5/97	Fri	1700	Rear End	0	0	1	Nite	Dry	No Improper Driving
Total No.	Fatal	Injury	PDO	Angle	Left Turn	Right Turn	Rear End	Side swipe	Ped/Bike	All Others
35	**0**	**12**	**23**	**3**	**6**	**2**	**9**	**4**	**0**	**11**
	0.00%	*34.29%*	*65.71%*	*8.57%*	*17.14%*	*5.71%*	*25.71%*	*11.43%*	*0.00%*	*31.43%*
Day	Night	Wet	Dry	Failed to Maintain Equipment	No Improper Driving	Careless Driving	Follow too Closely	Disregarded Traffic Signal	Improper Lane Change	All Others
29	**6**	**7**	**28**	**1**	**25**	**3**	**0**	**0**	**0**	**6**
82.86%	*17.14%*	*20.00%*	*80.00%*	*2.86%*	*71.43%*	*8.57%*	*0.00%*	*0.00%*	*0.00%*	*17.14%*

TOTAL VEHICLES ENTERING / ADT: **34,167**   CRASH RATE: **0.936** /MEV

5.1.4 SR 878 and SR 5 (US 1)

SR 878 intersects SR 5 at a 35-degree angle at this intersection. Both intersecting roadways are major routes located in a highly congested commercial/residential area. Figure 5-10 shows a far view of the complete intersection. Figure 5-11 shows a detailed condition diagram for the intersection. The Miami Metro-Rail overpasses the triple left turn and runs parallel to SR-5. The east approach features an off-ramp crossroad terminal from SR 878 that reaches the intersection on a downgrade and levels off as it approaches the intersection with three exclusive left-turn lanes. Heavy left-turning volume on the triple left-turn approach builds up during the morning peak hour and throughout the morning.

Table 5-4 provides a summary of the crashes occurred at the intersection. The collision diagram is shown in Figure 5-12. As in the case of the SR 7/SR 9 intersection, this triple left-turn approach intersects the cross street at a favorable angle for the triple left-turn maneuvers. Rear-end crashes accounted for 68% of the total crashes of which, only one was reported to occur on the triple left-turn approach. Three angle crashes were related to the triple left turn. Most of the crashes were rear-end crashes on the south approach. Injury crashes account for a high 74% of the total crashes. The intersection appears to operate fairly well under the level of traffic volume it experienced. Even though the Metro Rail overpasses the triple left-turn approach, no major impact was exerted to the triple left-turn approach as far as visibility obstruction was concerned. Eighty four percent of the crashes coincide with the morning peak hour where the triple left turn experienced the highest amount of traffic flow traveling north.

Figure 5-10. SR 878 and SR 5 (US 1)

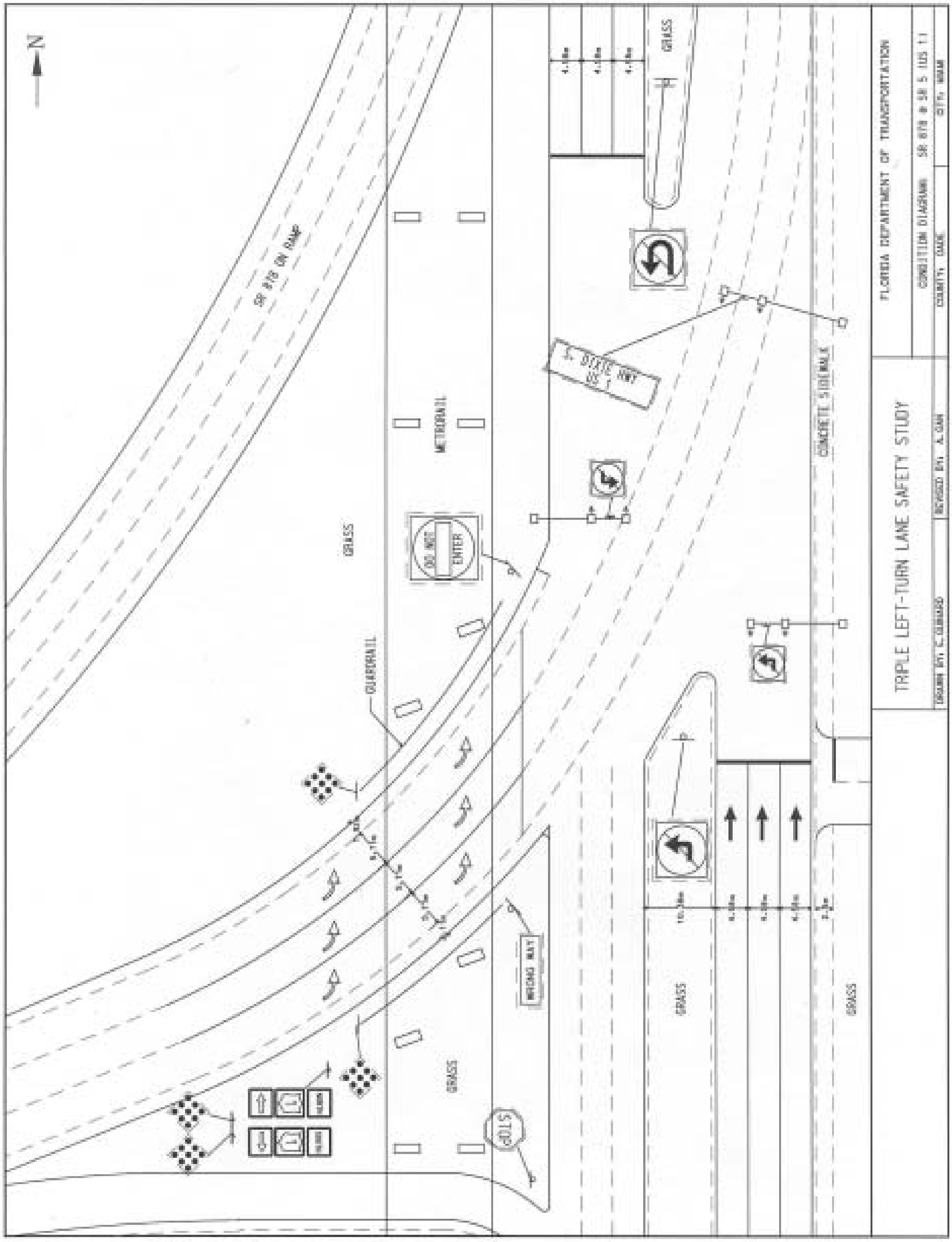


Figure 5-11. Condition Diagram for SR 878 at SR 5 (US 1)

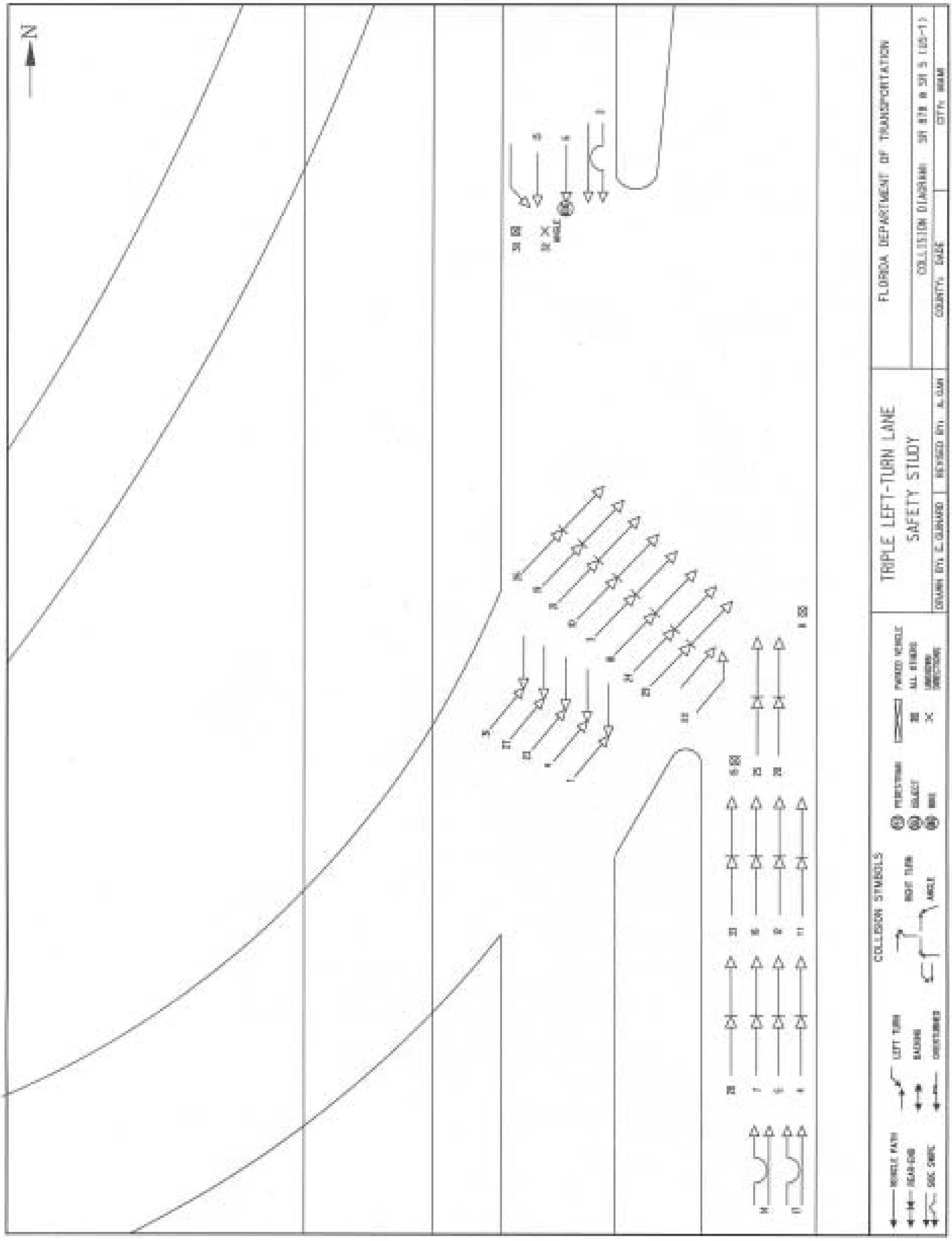


Figure 5-12. Collision Diagram for SR 878 at SR 5 (US 1)

Table 5-4. Crash Summary Table for SR 878 at SR 5 (US 1)

FLORIDA DEPARTMENT OF TRANSPORTATION

CRASH SUMMARY

SECTION:	**87030000 & 87021000**				STATE ROUTE:	**SR 5 (US1) & SR 878**	
INTERSECTING ROUTE:	**SR 5(US1) & SR 878**	M.P.	**1.312 / 2.725**		ENGINEER:		
STUDY PERIOD:	FROM	**1/ 95**	TO	**12/ 97**	COUNTY:	**Dade**	

No.	DATE	DAY	TIME	TYPE	FATAL	INJURY	PROP DAM	DAY / NT	WET / DRY	CONTRIBUTING CAUSE
1	2/1/95	Wed	1700	Angle	0	1	0	Day	Dry	Disregarded Traffic Signal
2	2/27/95	Mon	1400	Sideswipe	0	1	0	Day	Dry	Failed to Yield R/W
3	3/10/95	Fri	1000	Rear End	0	1	0	Day	Dry	Careless Driving
4	3/11/95	Sat	1400	Rear End	0	0	1	Day	Dry	Careless Driving
5	4/13/95	Thu	1300	Rear End	0	1	0	Day	Dry	Careless Driving
6	7/12/95	Wed	1900	Bicycle	0	1	0	Day	Wet	Improper Lane Change
7	8/17/95	Thu	1500	Rear End	0	0	1	Day	Slippery	Careless Driving
8	8/23/95	Wed	1700	Fixed Object	0	0	1	Unk	Other	All Others
9	10/10/95	Tue	1000	Angle	0	1	0	Day	Dry	Disregarded Traffic Signal
10	10/26/95	Thu	1500	Rear End	0	0	1	Day	Dry	Careless Driving
11	12/29/95	Fri	1700	Rear End	0	1	0	Day	Dry	Careless Driving
12	1/26/96	Fri	1200	Rear End	0	1	0	Day	Dry	Careless Driving
13	2/4/96	Sun	100	Angle	0	1	0	Nite	Wet	No Improper Driving
14	2/5/96	Mon	1000	Sideswipe	0	0	1	Day	Wet	No Improper Driving
15	7/12/96	Fri	0	Fixed Object	0	0	1	Unk	Unknown	Unknown
16	8/31/96	Sat	1600	Rear End	0	1	0	Day	Dry	No Improper Driving
17	10/4/96	Fri	700	Sideswipe	0	1	0	Day	Slippery	Careless Driving
18	10/26/96	Sat	1500	Rear End	0	0	1	Day	Dry	No Improper Driving
19	11/4/96	Mon	1700	Rear End	0	1	0	Nite	Wet	Careless Driving
20	1/25/97	Sat	1700	Rear End	0	1	0	Day	Dry	Careless Driving
21	4/6/97	Sun	1600	Rear End	0	1	0	Day	Dry	No Improper Driving
22	5/16/97	Fri	0	Angle	0	0	1	Nite	Dry	No Improper Driving
23	5/26/97	Mon	1600	Angle	0	1	0	Day	Wet	All Others
24	6/8/97	Sun	1800	Rear End	0	0	1	Day	Wet	No Improper Driving
25	6/23/97	Mon	1700	Rear End	0	1	0	Day	Dry	Careless Driving
26	9/6/97	Sat	1200	Rear End	0	1	0	Day	Slippery	Careless Driving
27	9/27/97	Sat	1600	Angle	0	1	0	Day	Dry	Disregarded Traffic Signal
28	10/30/97	Thu	1800	Rear End	0	1	0	Nite	Wet	Careless Driving
29	11/1/97	Sat	1100	Rear End	0	1	0	Day	Dry	No Improper Driving
30	11/5/97	Wed	0	Other	0	1	0	Nite	Wet	All Others
31	11/12/97	Wed	600	Angle	0	1	0	Nite	Wet	Careless Driving
32	12/4/97	Thu	1500	Angle	0	0	1	Day	Slippery	No Improper Driving
33	12/25/97	Thu	1100	Rear End	0	1	0	Day	Wet	Careless Driving
Total No.	Fatal	Injury	PDO	Angle	Left Turn	Right Turn	Rear End	Side swipe	Bicycle	All Others
33	**0**	**23**	**10**	**8**	**0**	**0**	**18**	**3**	**1**	**3**
	0.00%	*69.70%*	*30.30%*	*24.24%*	*0.00%*	*0.00%*	*54.55%*	*9.09%*	*3.03%*	*9.09%*
Day	Night	Wet	Dry	FTY R/W	No Improper Driving	Careless Driving	Unknown	Disregarded Traffic Signal	Improper Lane Change	All Others
25	**8**	**8**	**25**	**1**	**9**	**15**	**1**	**3**	**1**	**3**
75.76%	*24.24%*	*24.24%*	*75.76%*	*3.03%*	*27.27%*	*45.45%*	*3.03%*	*9.09%*	*3.03%*	*9.09%*

TOTAL VEHICLES ENTERING / ADT: **82,000**

CRASH RATE: **0.368** /MEV

5.1.5 SR 826 and SR A1A (Collins Avenue)

SR 826 and SR A1A is an intersection located in a tourist/commercial area in North Miami Beach. The triple left turn travels east on SR 826 and intersects SR A1A at a “T” intersection. The outer lane of the triple left turn is an optional through lane. On SR A1A the northbound and southbound lanes are divided by an overpass serving as a ramp turning left from SR A1A onto SR 826. Figure 5-13 shows a picture of the triple left-turn approach. As can be seen from the condition diagram shown in Figure 5-14, vehicles approaching the triple left-turn are trapped within the median. As a result, these vehicles have to negotiate a through movement across SR A1A to reach the triple left turn. A special condition exists at the receiving approach, where an exclusive left-turn lane causes encroachments between vehicles in the middle/outer lanes with vehicles in the inner lane.

Table 5-5 summaries crashes occurred at the intersection in a three-year period. Figure 5-15 shows the corresponding collision diagram for the intersection. It can be seen that a much higher number of crashes occurred on the section before the “median” section of the triple left-turn approach. Only a small fraction of the total crashes were directly related to the triple left turn. Most of the crashes were of the rear-end (41%) and angle (29%) types. The presence of an overpass may have increased the probabilities of fixed-object crashes on the northbound approach on SR A1A, as there were numerous posts, walls and guardrails around the intersection. Even though the intersection is located in a tourist area near the beach, crashes involving pedestrian were low. Appropriate crosswalk markings and signing were identified at all the approaches. Crashes resulting in injuries accounted for 55% of the crashes at the intersection.

Figure 5-13. SR 826 and SR A1A (Collins Avenue)

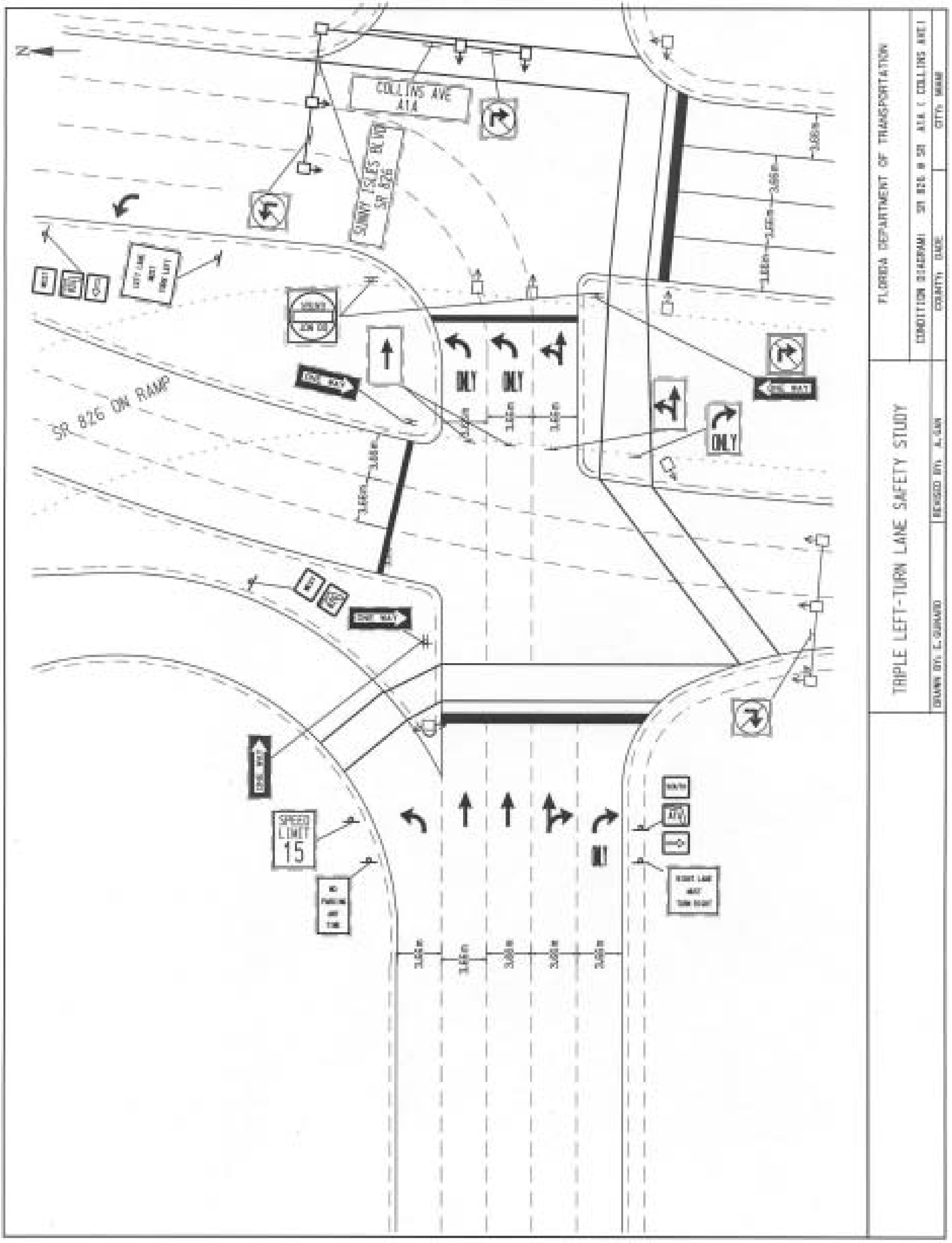


Figure 5-14. Condition Diagram for SR 826 at SR A1A (Collins Avenue)

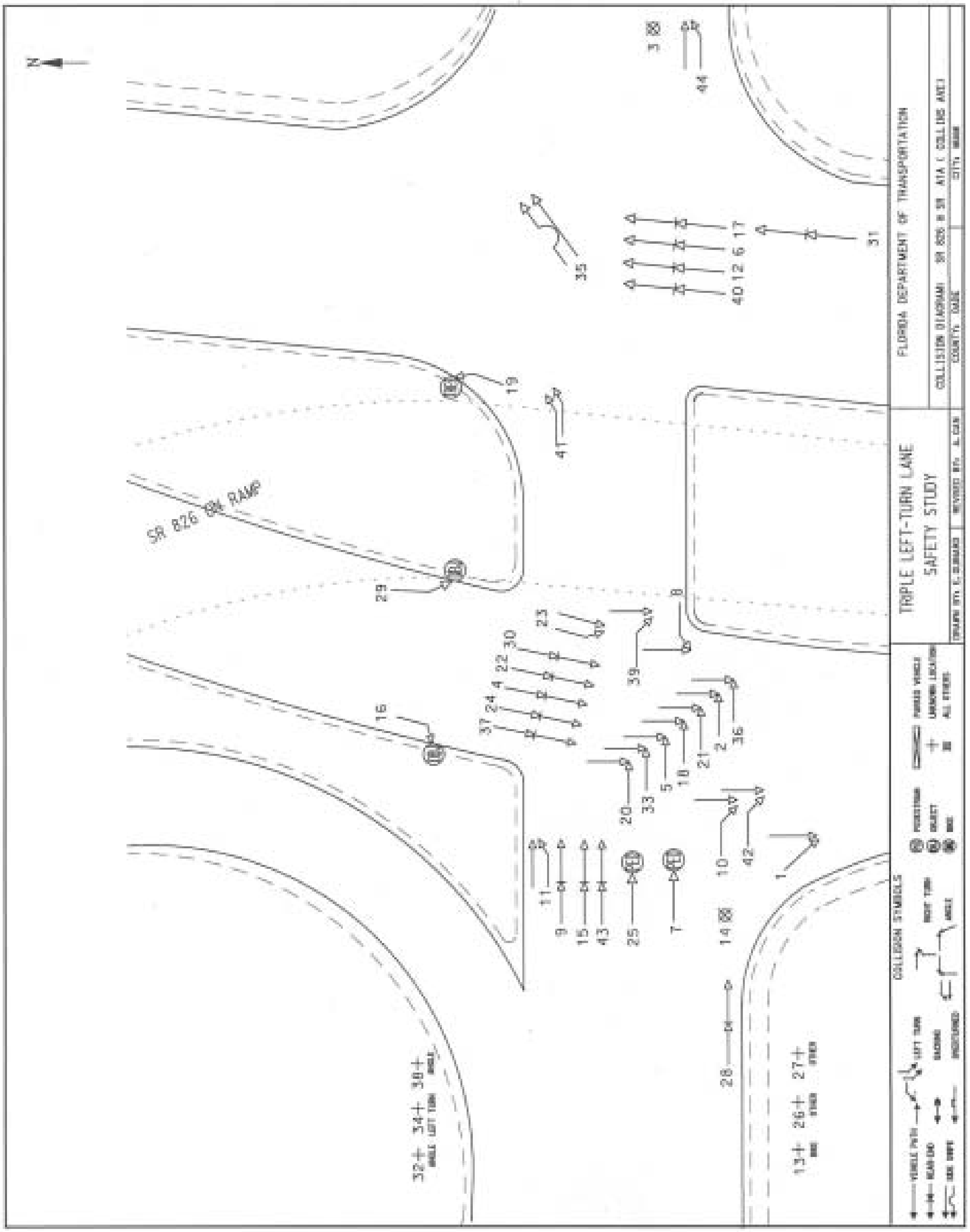


Figure 5-15. Collision Diagram for SR 826 at SR A1A (Collins Avenue)

Table 5-5. Crash Summary Table for SR 826 at SR A1A (Collins Avenue)

FLORIDA DEPARTMENT OF TRANSPORTATION

CRASH SUMMARY

SECTION: **87170000 & 87060000** STATE ROUTE: **SR 826 at SR A1A**

INTERSECTING ROUTE: **SR 826 at SR A1A** M.P. **5.727 & 14.588** ENGINEER:

STUDY PERIOD: FROM **1/ 95** TO **12/ 97** COUNTY: **Dade**

No.	DATE	DAY	TIME	TYPE	FATAL	INJURY	PROP DAM	DAY / NT	WET / DRY	CONTRIBUTING CAUSE
1	1/4/95	Wed	1700	Angle	0	1	0	Nite	Slippery	No Improper Driving
2	3/29/95	Wed	1600	Angle	0	1	0	Day	Dry	Failed to Yield R/W
3	4/25/95	Tue	1500	Fixed Object	0	0	1	Day	Wet	No Improper Driving
4	5/13/95	Sat	1900	Rear End	0	0	1	Day	Dry	No Improper Driving
5	5/28/95	Sun	300	Angle	0	1	0	Nite	Dry	All Others
6	7/21/95	Fri	500	Rear End	0	1	0	Day	Dry	Careless Driving
7	7/27/95	Thu	1000	Pedestrian	0	1	0	Day	Wet	Careless Driving
8	7/27/95	Thu	1300	Angle	0	0	1	Day	Slippery	Driving Wrong Side/Way
9	8/16/95	Wed	800	Rear End	0	1	0	Day	Dry	No Improper Driving
10	9/4/95	Mon	1600	Right Turn	0	0	1	Day	Dry	No Improper Driving
11	9/20/95	Wed	1300	Angle	0	1	0	Day	Dry	No Improper Driving
12	9/24/95	Sun	1400	Rear End	0	0	1	Day	Dry	No Improper Driving
13	10/7/95	Sat	1000	Bicycle	0	1	0	Day	Dry	Failed to Yield R/W
14	11/22/95	Wed	2200	Other	0	0	1	Nite	Dry	No Improper Driving
15	12/24/95	Sun	800	Rear End	0	0	1	Day	Dry	Followed to Closely
16	12/26/95	Tue	300	Fixed Object	0	0	1	Nite	Dry	Careless Driving
17	1/21/96	Sun	2000	Rear End	0	0	1	Nite	Wet	Careless Driving
18	2/11/96	Sun	1800	Angle	0	1	0	Nite	Dry	No Improper Driving
19	3/24/96	Sun	500	Other	0	1	0	Nite	Dry	Careless Driving
20	4/8/96	Mon	1800	Angle	0	1	0	Nite	Slippery	No Improper Driving
21	5/19/96	Sun	1000	Angle	0	1	0	Day	Dry	No Improper Driving
22	6/15/96	Sat	1100	Rear End	0	0	1	Day	Dry	No Improper Driving
23	7/18/96	Thu	1600	Angle	0	0	1	Day	Dry	No Improper Driving
24	8/7/96	Wed	1600	Rear End	0	1	0	Day	Dry	No Improper Driving
25	9/30/96	Mon	1600	Pedestrian	0	1	0	Day	Dry	No Improper Driving
26	10/5/96	Sat	700	Other	0	1	0	Day	Wet	No Improper Driving
27	11/8/96	Fri	400	Other	0	0	1	Nite	Dry	Careless Driving
28	11/9/96	Sat	1500	Rear End	0	1	0	Day	Dry	No Improper Driving
29	11/16/96	Sat	700	Fixed Object	0	0	1	Nite	Other	No Improper Driving
30	11/24/96	Sun	1800	Rear End	0	1	0	Nite	Dry	Careless Driving
31	1/1/97	Wed	2300	Rear End	0	1	0	Nite	Dry	No Improper Driving
32	1/13/97	Mon	1900	Angle	0	0	1	Nite	Slippery	No Improper Driving

33	2/10/97	Mon	1100	Angle	0	0	1	Day	Dry	Disregarded Traffic Signal
34	4/20/97	Sun	1900	Left Turn	1	1	0	Day	Dry	No Improper Driving
35	4/29/97	Tue	1500	Sideswipe	0	0	1	Day	Dry	No Improper Driving
36	5/13/97	Tue	1400	Angle	0	1	0	Day	Dry	No Improper Driving
37	5/13/97	Tue	1600	Rear End	0	0	1	Day	Dry	Improper Turn
38	5/26/97	Mon	700	Angle	0	0	1	Day	Dry	No Improper Driving
39	5/27/97	Tue	1700	Right Turn	0	0	1	Day	Dry	No Improper Driving
40	6/5/97	Thu	1800	Rear End	0	0	1	Day	Slippery	No Improper Driving
41	6/19/97	Thu	1800	Left Turn	0	0	1	Day	Dry	All Others
42	9/16/97	Tue	1900	Right Turn	0	0	1	Day	Dry	No Improper Driving
43	10/16/97	Thu	2000	Rear End	0	1	0	Nite	Dry	No Improper Driving
44	12/30/97	Tue	1400	Angle	0	0	1	Day	Dry	Exceeded Stated Safe Speed
Total No.	Fatal	Injury	PDO	Angle	Left Turn	Right Turn	Rear End	Side swipe	Ped/Bike	All Others
44	**1**	**20**	**23**	**14**	**2**	**3**	**14**	**1**	**3**	**7**
	2.27%	*45.45%*	*52.27%*	*31.82%*	*4.55%*	*6.82%*	*31.82%*	*2.27%*	*6.82%*	*15.91%*
Day	Night	Wet	Dry	Exceeded Speed	No Improper Driving	Careless Driving	Follow too Closely	Disregarded Traffic Signal	FTY R/W	All Others
27	**9**	**8**	**28**	**1**	**28**	**7**	**1**	**1**	**2**	**2**
61.36%	*20.45%*	*18.18%*	*63.64%*	*2.27%*	*63.64%*	*15.91%*	*2.27%*	*2.27%*	*4.55%*	*4.55%*
TOTAL VEHICLES ENTERING / ADT: **34,167**					CRASH RATE: **1.176** /MEV					

5.1.6 SR 5 (Biscayne Boulevard) and NE 2nd Street

SR 5 and NE 2nd Street is a "T" intersection located in the Miami Downtown area. Figure 5-16 shows a picture of the triple left-turn approach. As can be seen in the condition diagram shown in Figure 5-17 for the intersection, the triple left-turn approach is on the NE 2nd Street, which is an eastbound 3-lane one-way roadway that intersects SR 5. It can also be seen that SR 5 is an eight-lane divided highway, with the median area used to house commercial, outdoor parking lots. The intersection handles a considerable amount of both pedestrian and vehicle traffic. At the intersection the median is divided to provide access and storage to vehicles making a triple left turn maneuver onto SR 5 north.

Table 5-6 summaries crashes occurred at the intersection during the 1995-1997 period. As can be seen from the corresponding collision diagram shown in Figure 5-18, there were an insignificant number of crashes occurred on the triple left turn. The crash experience appears to be very similar to that at the SR 826/SR A1A intersection, where most of the crashes were reported to occur at the crossing prior to the triple left- turn approach. The collision diagram shows only a total of 17 crashes experienced by the intersection over the three-year period. Only four of the crashes were related to the triple left-turn approach. The most common type of crashes was the angle (47%), which appeared to have been caused mainly by vehicles entering the triple left-turn trap area from either the southbound or the eastbound approach. Sideswipe crashes (24%) were not strictly related to the triple left-turn approach, but rather were evenly distributed throughout the intersection. The fact that the receiving roadway is curved towards the triple left turn, making the turn to be greater than 90^o did not appear to contribute to crashes. The percentage of injury crashes at this intersection was at a low 35%, which may be attributable to the low speed limit used in the downtown area. There were no crashes that involved pedestrians even though significant pedestrian activities from the parking lots were present.

Figure 5-16. SR 5 (Biscayne Boulevard) at NE 2nd Street

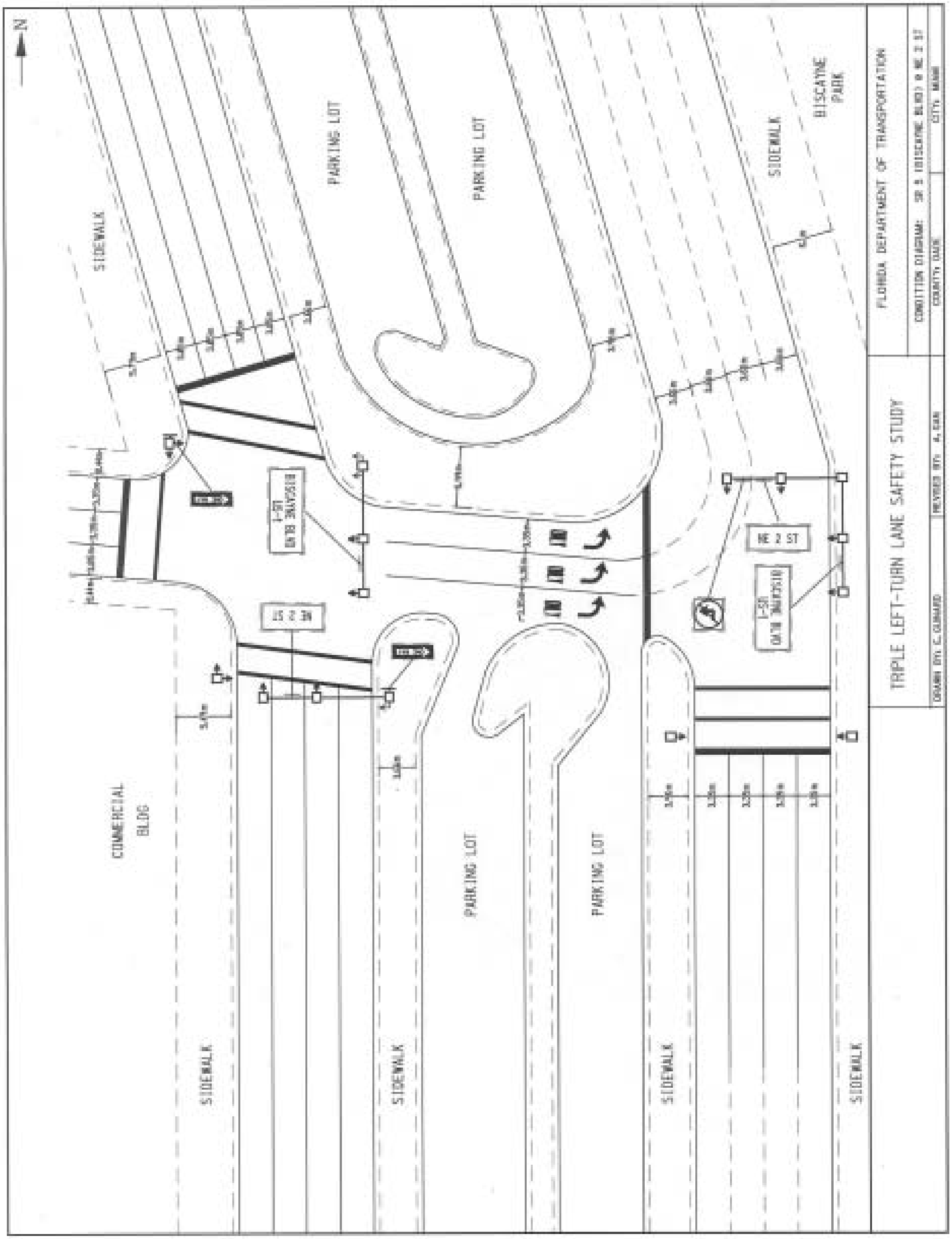


Figure 5-17. Condition Diagram for SR 5 (Biscayne Boulevard) at NE 2nd Street

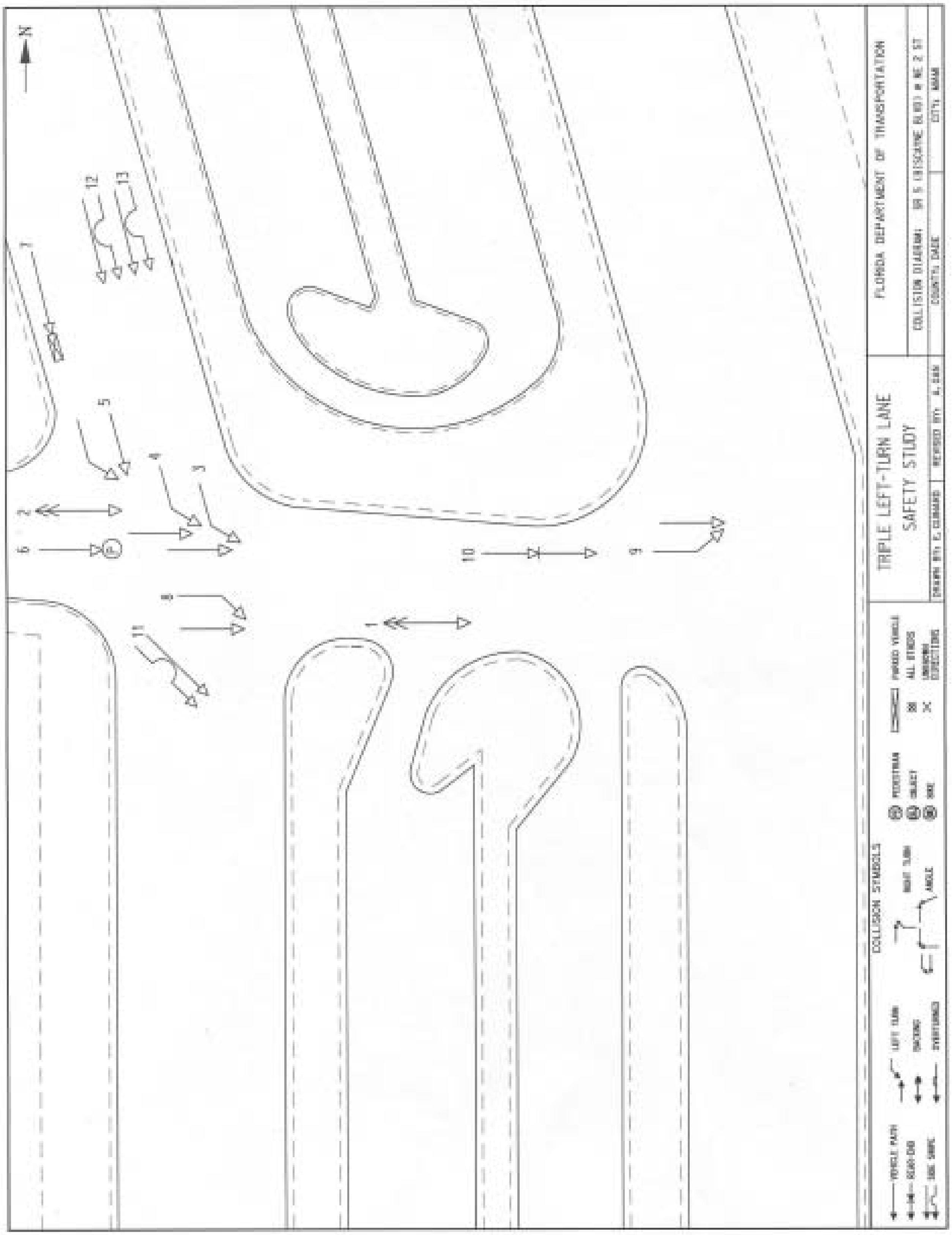


Figure 5-18. Collision Diagram for SR 5 (Biscayne Boulevard) at NE 2nd Street

Table 5-6. Crash Summary Table for SR 5 (Biscayne Boulevard) at NE 2nd Street

FLORIDA DEPARTMENT OF TRANSPORTATION

CRASH SUMMARY

SECTION: **87030000** STATE ROUTE: **5**

INTERSECTING ROUTE: **NE 2 ST** M.P. **11.071** ENGINEER:

STUDY PERIOD: FROM **1/ 95** TO **12/ 97** COUNTY: **Dade**

No.	DATE	DAY	TIME	TYPE	FATAL	INJURY	PROP DAM	DAY / NT	WET / DRY	CONTRIBUTING CAUSE
1	3/27/95	Mon	1300	Backing	0	0	1	Day	Dry	No Improper Driving
2	5/23/95	Tue	1300	Backing	0	0	1	Day	Dry	No Improper Driving
3	6/8/95	Thu	1600	Angle	0	0	1	Day	Dry	No Improper Driving
4	6/13/95	Tue	2100	Angle	0	1	0	Nite	Dry	No Improper Driving
5	9/10/95	Sun	1300	Angle	0	0	1	Day	Dry	No Improper Driving
6	11/10/95	Fri	1600	Pedestrian	0	1	0	Day	Dry	No Improper Driving
7	11/14/95	Tue	1500	Other	0	0	1	Day	Dry	No Improper Driving
8	12/19/95	Tue	1600	Angle	0	0	1	Day	Slippery	No Improper Driving
9	7/31/96	Wed	1300	Angle	0	0	1	Day	Dry	No Improper Driving
10	9/22/96	Sun	2000	Rear End	0	0	1	Nite	Dry	No Improper Driving
11	1/6/97	Mon	1500	Sideswipe	0	0	1	Day	Dry	No Improper Driving
12	11/2/97	Sun	2100	Sideswipe	0	1	0	Nite	Dry	Improper Lane Change
13	11/4/97	Tue	1200	Sideswipe	0	0	1	Day	Dry	No Improper Driving
Total No.	Fatal	Injury	PDO	Angle	Left Turn	Right Turn	Rear End	Side swipe	Ped/Bike	All Others
13	**0**	**3**	**10**	**5**	**0**	**0**	**1**	**3**	**1**	**3**
	0.00%	*23.08%*	*76.92%*	*38.46%*	*0.00%*	*0.00%*	*7.69%*	*23.08%*	*7.69%*	*23.08%*
Day	Night	Wet	Dry	Failed to Maintain Equipment	No Improper Driving	Careless Driving	Follow too Closely	Disregarded Traffic Signal	Improper Lane Change	All Others
10	**3**	**1**	**12**	**0**	**12**	**0**	**0**	**0**	**1**	**0**
76.92%	*23.08%*	*7.69%*	*92.31%*	*0.00%*	*92.31%*	*0.00%*	*0.00%*	*0.00%*	*7.69%*	*0.00%*

TOTAL VEHICLES ENTERING / ADT: **30,667** CRASH RATE: **0.387** /MEV

5.1.7 SR 5 (Biscayne Boulevard) and NE 4th Street

This intersection is located in the same area as the SR 5/NE 2nd Street intersection and has a similar intersection layout. Figure 5-19 shows a picture of the triple left-turn approach. Figure 5-20 shows a detailed condition diagram for the intersection. As can be seen, the triple left turn is located on the NE 46th Street within the limits of a median opening on SR 5. Similarly, this intersection also handles a considerable amount of pedestrians from the parking lots within the medians. Unlike the SR 5/NE 2nd Street intersection, however, this intersection is four-legged and has an opposing approach that allows only for a right turn maneuver. In addition, the outer lane of the triple left turn is an optional through.

A total of 20 crashes were reported at this intersection over the 1995-1997 period, as summarized in Table 5-7 and the corresponding collision diagram in Figure 5-21. The most predominant type of crashes recorded was angle at 75%. PDO crashes at 55% were a slightly higher than the injury crashes of 45%, while include one fatality that has little known information. One vehicle-bike crash and no pedestrian related crashes were reported at the intersection. On the triple left-turn approach there were two sideswipe crashes and four angle crashes. Of the two angle crashes, two were attributable to the optional through lane involving crossing traffic. These are also the only two injury crashes involving the triple left-turn approach. The intersection appears to operate fairly well, considering the fact that it is located in a high pedestrian area and serve a relatively high volume of traffic throughout the day.

Figure 5-19. SR 5 (Biscayne Boulevard) and NE 4th Street

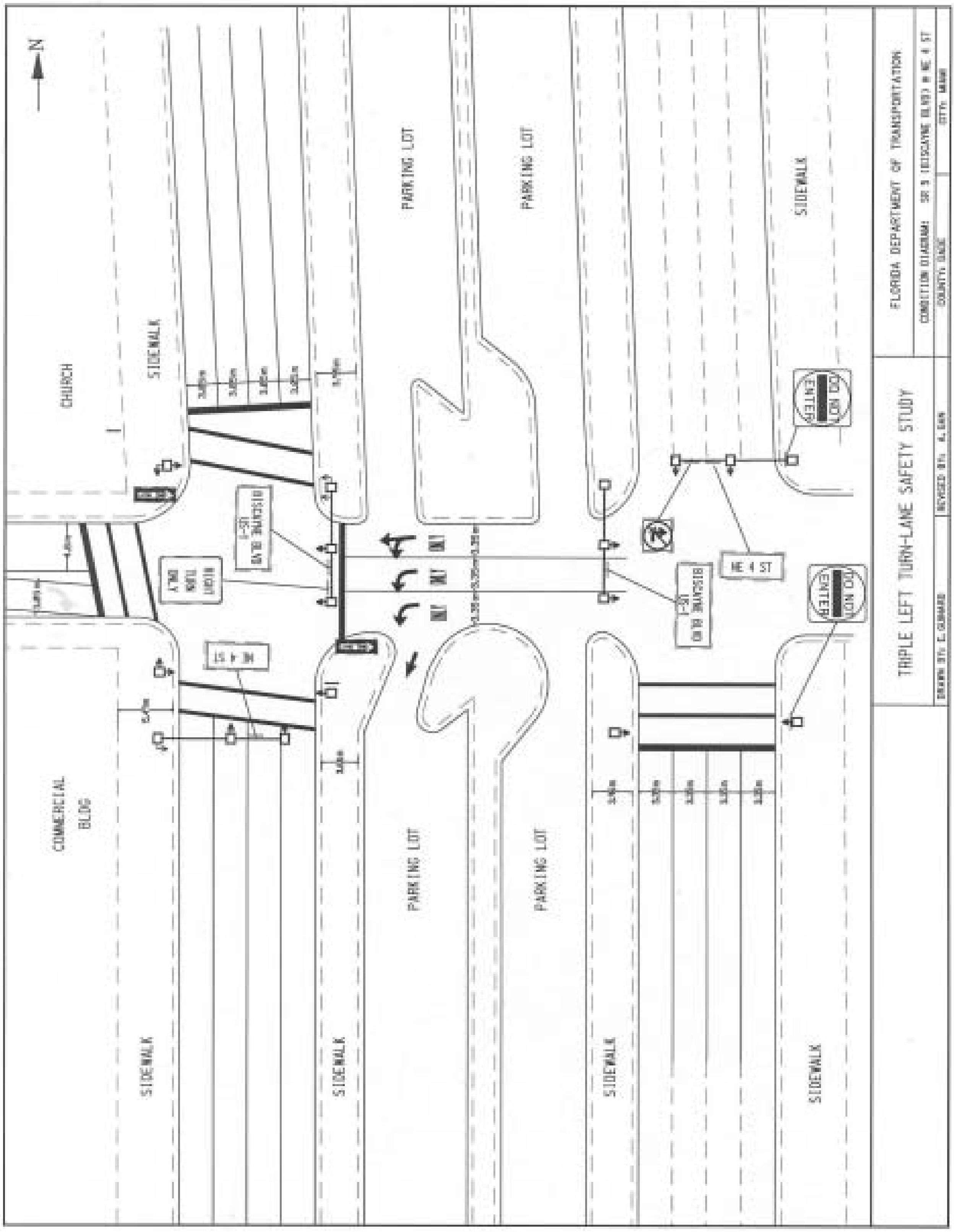


Figure 5-20. Condition Diagram for SR 5 (Biscayne Boulevard) at NE 4th Street

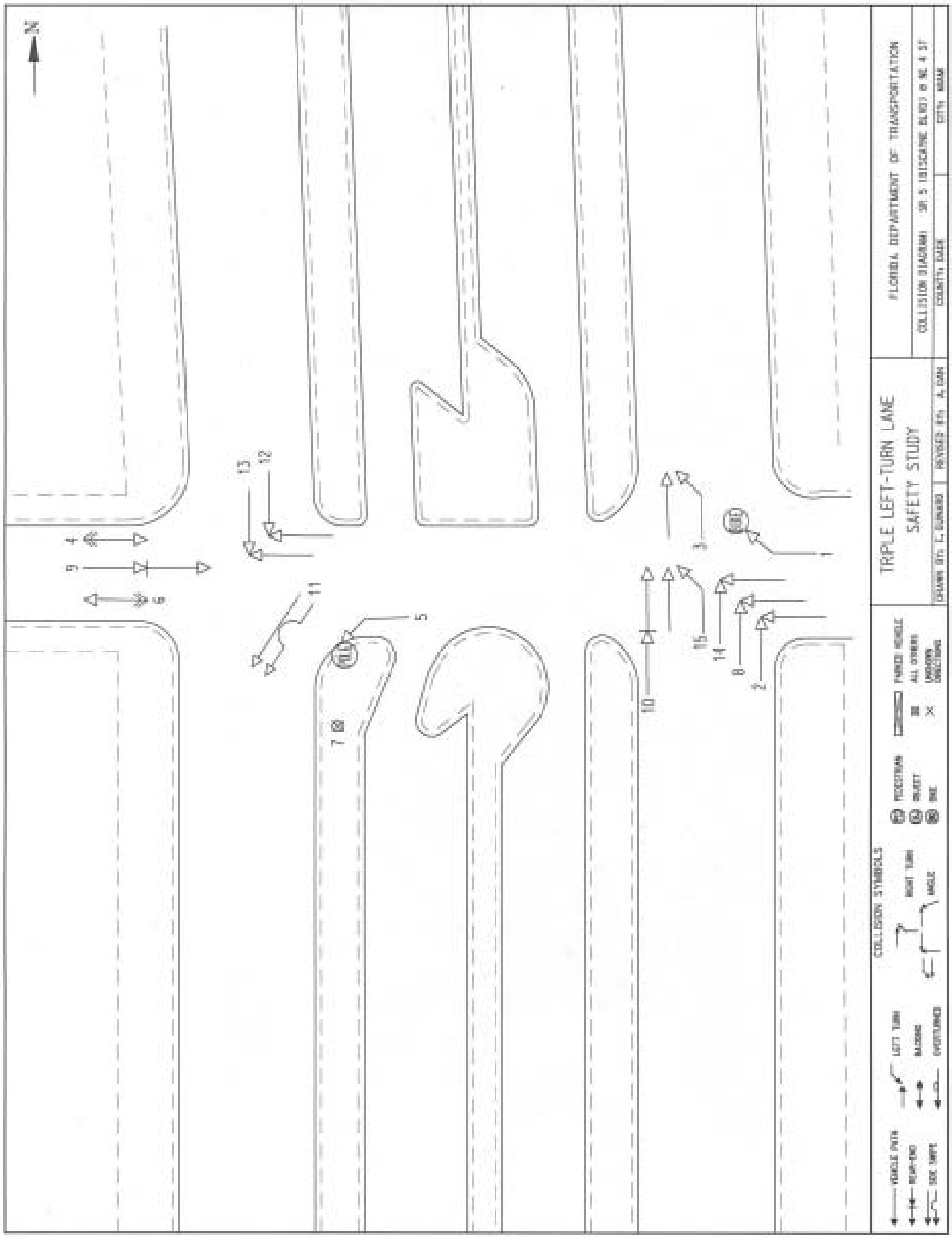


Figure 5-21. Collision Diagram for SR 5 (Biscayne Boulevard) at NE 4th Street

Table 5-7. Crash Summary Table for SR 5(Biscayne Boulevard) at NE 4th Street

FLORIDA DEPARTMENT OF TRANSPORTATION

CRASH SUMMARY

SECTION: **87030000** STATE ROUTE: **SR 5**

INTERSECTING ROUTE: **NE 4 ST** M.P. **11.244** ENGINEER:

STUDY PERIOD: FROM **1/ 97** TO **12/ 97** COUNTY: **Dade**

No.	DATE	DAY	TIME	TYPE	FATAL	INJURY	PROP DAM	DAY / NT	WET / DRY	CONTRIBUTING CAUSE
1	3/12/95	Sun	1400	Bicycle	0	1	0	Day	Wet	All Others
2	5/20/95	Sat	1600	Angle	0	0	1	Day	Wet	No Improper Driving
3	7/5/95	Wed	1200	Angle	0	0	1	Day	Dry	No Improper Driving
4	9/15/95	Fri	100	Backing	0	0	1	Nite	Dry	No Improper Driving
5	10/16/95	Mon	2200	Other	0	1	0	Nite	Slippery	Careless Driving
6	10/19/95	Thu	1300	Other	0	0	1	Day	Wet	No Improper Driving
7	2/14/96	Wed	1900	Other	0	0	1	Nite	Dry	No Improper Driving
8	6/12/96	Wed	1600	Angle	0	0	1	Day	Dry	No Improper Driving
9	8/16/96	Fri	900	Rear End	0	0	1	Day	Dry	No Improper Driving
10	8/19/96	Mon	1700	Rear End	0	0	1	Nite	Slippery	No Improper Driving
11	8/31/96	Sat	1800	Sideswipe	0	0	1	Day	Dry	No Improper Driving
12	1/27/97	Mon	1000	Angle	0	1	0	Day	Wet	Disregarded Traffic Signal
13	2/12/97	Wed	1100	Angle	0	1	0	Day	Dry	No Improper Driving
14	8/3/97	Sun	1500	Angle	0	0	1	Day	Dry	No Improper Driving
15	8/18/97	Mon	1100	Angle	0	0	1	Day	Dry	No Improper Driving
Total No.	Fatal	Injury	PDO	Angle	Left Turn	Right Turn	Rear End	Side swipe	Bicycle	All Others
15	**0**	**4**	**11**	**7**	**0**	**0**	**2**	**1**	**1**	**4**
	0.00%	*26.67%*	*73.33%*	*46.67%*	*0.00%*	*0.00%*	*13.33%*	*6.67%*	*6.67%*	*26.67%*
Day	Night	Wet	Dry	Failed to Maintain Equipment	No Improper Driving	Careless Driving	Follow too Closely	Disregarded Traffic Signal	Improper Lane Change	All Others
11	**4**	**2**	**13**	**0**	**12**	**1**	**0**	**1**	**0**	**1**
73.33%	*26.67%*	*13.33%*	*86.67%*	*0.00%*	*80.00%*	*6.67%*	*0.00%*	*6.67%*	*0.00%*	*6.67%*

TOTAL VEHICLES ENTERING / ADT: **36,833** CRASH RATE: **0.372** /MEV

5.1.8 SR 5 (Biscayne Boulevard) and SE 1st Street

This intersection is located in the same area as the previous two intersections. Figure 5-22 shows a picture of the triple left-turn approach, which is on the SE 1st Street. Figure 5-23 shows a detailed condition diagram for the intersection. As can be seen, the Miami Metro mover runs overpass the triple left-turn approach. There is a bus station next to the inside lane of the triple left turn. Also, next to the outer lane of the triple left turn, within the median limits, is an entrance/exit for access to/from a parking lot. The operation of the triple left-turn is subject to the impact by these facilities, as vehicles tend to slow down or weave in order to access either the parking lot or the bus station. Unlike NE 2nd Street intersection, this intersection has a pedestrian crosswalk at the triple left-turn.

Table 5-8 summaries crashes occurred at the intersection during the 1995-1997 period. As can be seen from the corresponding collision diagram shown in Figure 5-24, only a total of 17 crashes occurred at the intersection, with about a third of these involving injuries. A significant fraction of the crashes occurred at the triple-left approach. Apparently, vehicles traveling north seem to provoke conflict with vehicles making a left-turn from the triple left-turn approach. The fact that the receiving roadway is curved towards the triple left turn, making the turn to be greater than 90^{o} may have been a contributing factor. Angle crashes (47%) were attributable to the triple left-turn approach in 57% of the cases. Sideswipe and rear-end crashes contributed each with 18% of the total crashes. The intersection reported one crash involving pedestrians that is not related to the triple left-turn approach.

Figure 5-22. SR 5 (Biscayne Boulevard) and SE 1st Street

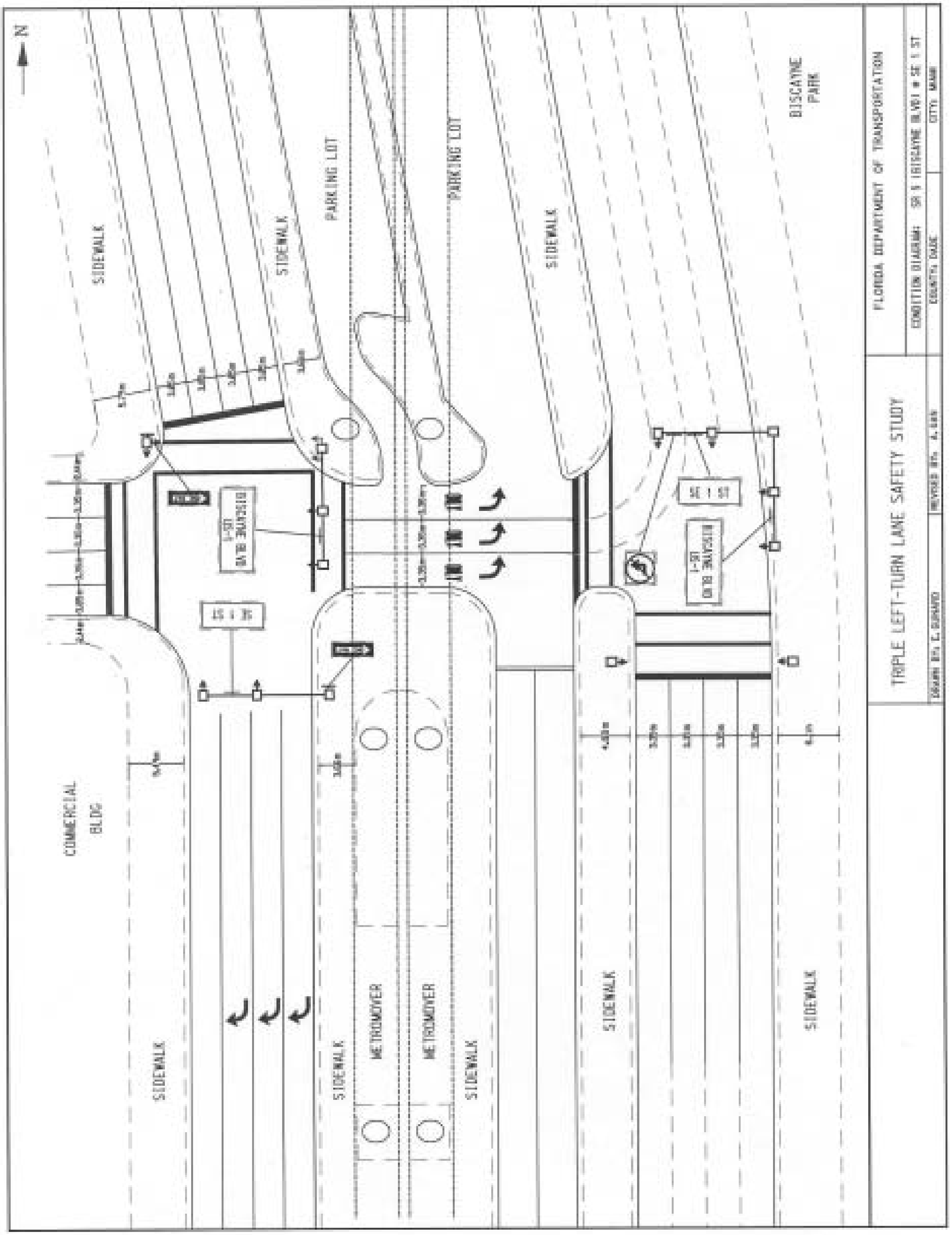


Figure 5-23. Condition Diagram for SR 5 (Biscayne Boulevard) at SE 1st Street

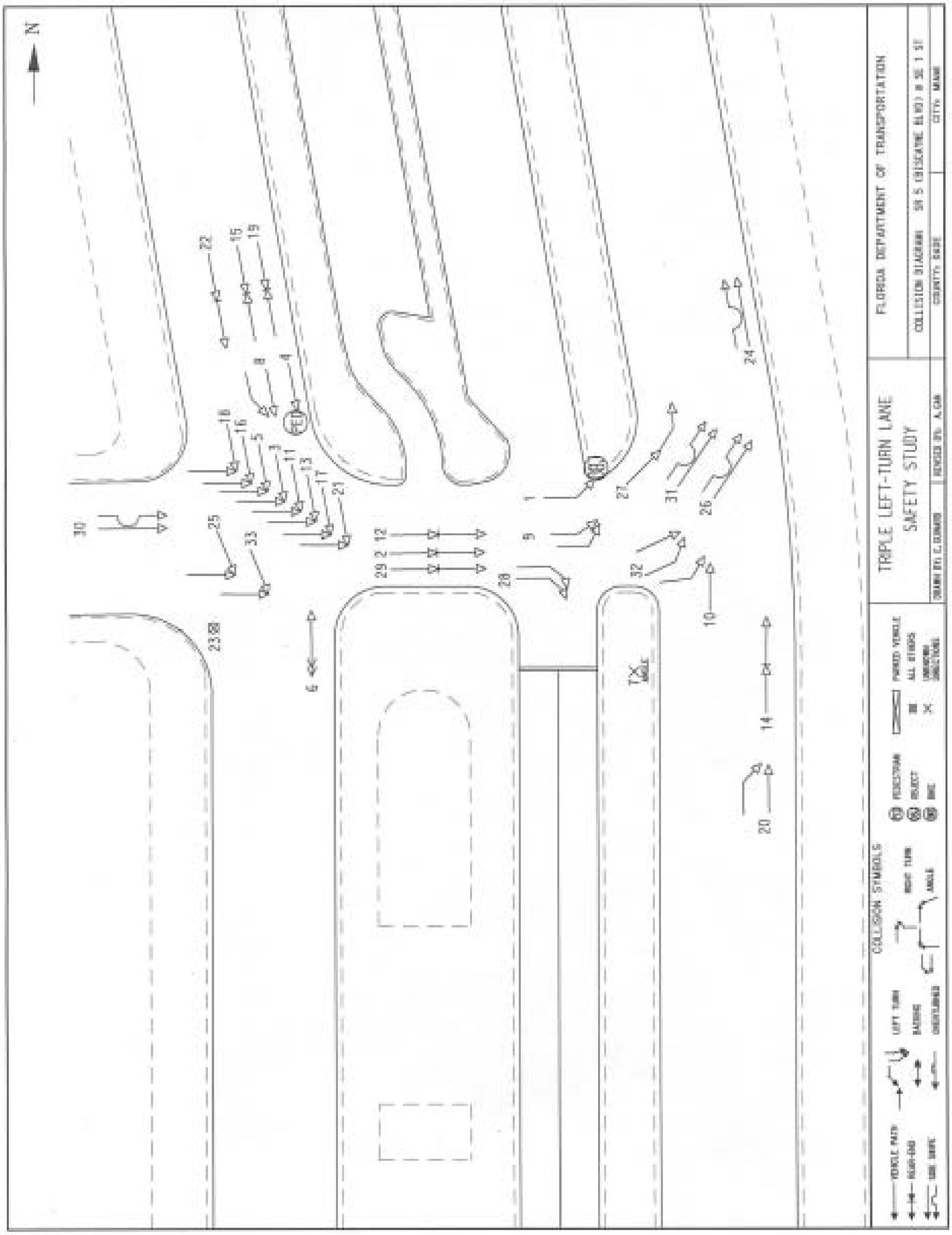


Figure 5-24. Collision Diagram for SR 5 (Biscayne Boulevard) at SE 1st Street

Table 5-8. Crash Summary Table for SR 5 (Biscayne Boulevard) at SE 1st Street

FLORIDA DEPARTMENT OF TRANSPORTATION

CRASH SUMMARY

SECTION: **87030000** STATE ROUTE: **SR 5** **Biscayne Blvd.**

INTERSECTING ROUTE: **SR 5 & SE 1 ST(SR 968)** M.P. **10.916 / 3.009** ENGINEER:

STUDY PERIOD: FROM **1/ 95** TO **12/ 97** COUNTY: **Dade**

No.	DATE	DAY	TIME	TYPE	FATAL	INJURY	PROP DAM	DAY / NT	WET / DRY	CONTRIBUTING CAUSE
1	1/3/95	Tue	600	Fixed Object	0	1	0	Unk	Dry	No Improper Driving
2	1/9/95	Mon	900	Rear End	0	1	0	Day	Dry	No Improper Driving
3	2/25/95	Sat	100	Angle	0	1	0	Nite	Dry	No Improper Driving
4	6/2/95	Fri	1700	Pedestrian	0	1	0	Day	Wet	All Others
5	6/17/95	Sat	900	Angle	0	1	0	Day	Dry	No Improper Driving
6	7/7/95	Fri	0	Other	0	0	1	Nite	Dry	No Improper Driving
7	9/29/95	Fri	1900	Angle	0	1	0	Nite	Dry	All Others
8	10/25/95	Wed	2200	Angle	0	0	1	Nite	Dry	Careless Driving
9	11/21/95	Tue	900	Left Turn	0	0	1	Day	Dry	No Improper Driving
10	11/24/95	Fri	1400	Angle	0	1	0	Day	Dry	No Improper Driving
11	1/1/96	Mon	200	Angle	0	0	1	Nite	Other	Disregarded Other Traffic
12	1/18/96	Thu	1700	Rear End	0	0	1	Nite	Wet	No Improper Driving
13	3/13/96	Wed	0	Angle	0	1	0	Nite	Dry	No Improper Driving
14	5/30/96	Thu	1600	Rear End	0	1	0	Day	Dry	No Improper Driving
15	7/5/96	Fri	2300	Head On	0	1	0	Nite	Dry	No Improper Driving
16	9/12/96	Thu	2300	Angle	0	0	1	Nite	Dry	No Improper Driving
17	9/13/96	Fri	800	Angle	0	0	1	Day	Dry	No Improper Driving
18	10/22/96	Tue	2400	Angle	0	0	1	Nite	Dry	No Improper Driving
19	12/4/96	Wed	1600	Head On	0	0	1	Day	Dry	No Improper Driving
20	12/14/96	Sat	1900	Angle	0	0	1	Nite	Dry	Improper Lane Change
21	2/16/97	Sun	0	Angle	0	1	0	Nite	Wet	No Improper Driving
22	2/22/97	Sat	2100	Rear End	0	0	1	Nite	Dry	No Improper Driving
23	2/22/97	Sat	800	Other	0	1	0	Day	Dry	No Improper Driving
24	3/9/97	Sun	2300	Sideswipe	0	1	0	Nite	Dry	No Improper Driving
25	6/12/97	Thu	0	Angle	0	1	0	Nite	Dry	No Improper Driving
26	6/22/97	Sun	1200	Sideswipe	0	0	1	Day	Slippery	No Improper Driving
27	7/15/97	Tue	1400	Rear End	0	1	0	Day	Dry	No Improper Driving
28	7/21/97	Mon	1400	Angle	0	0	1	Day	Dry	All Others
29	9/29/97	Mon	1600	Rear End	0	1	0	Day	Dry	No Improper Driving
30	9/30/97	Tue	1900	Sideswipe	0	0	1	Nite	Slippery	All Others
31	10/28/97	Tue	1900	Sideswipe	0	0	1	Day	Dry	All Others
32	11/17/97	Mon	1700	Angle	0	0	1	Nite	Dry	All Others
33	11/30/97	Sun	1200	Angle	0	0	1	Day	Dry	All Others
Total No.	Fatal	Injury	PDO	Angle	Left Turn	Right Turn	Rear End	Side swipe	Ped/Bike	All Others
33	**0**	**16**	**17**	**16**	**1**	**0**	**6**	**4**	**1**	**5**
	0.00%	*48.48%*	*51.52%*	*48.48%*	*3.03%*	*0.00%*	*18.18%*	*12.12%*	*3.03%*	*15.15%*
Day	Night	Wet	Dry	Failed to Maintain Equipment	No Improper Driving	Careless Driving	Follow too Closely	Disregarded Other Traffic	Improper Lane Change	All Others
15	**18**	**5**	**28**	**0**	**23**	**1**	**0**	**1**	**1**	**7**
45.45%	*54.55%*	*15.15%*	*84.85%*	*0.00%*	*69.70%*	*3.03%*	*0.00%*	*3.03%*	*3.03%*	*21.21%*

TOTAL VEHICLES ENTERING / ADT: **30,667** CRASH RATE: **0.983** /MEV

5.1.9 SR 821 (Turnpike) and SR 838 (Sunrise Boulevard)

Sunrise Boulevard is a six-lane roadway in a suburban area. Figure 5-25 shows a picture of the triple left-turn approach, which serves off-ramp traffic to Sunrise Boulevard from the Florida Turnpike. Figure 5-26 shows a detailed condition diagram for the ramp terminal. Most of the traffic at this intersection is composed of commuters with a relatively high percentage of heavy vehicles. The intersection operates under high volume conditions during peak hours. The triple left-turn approach curves onto Sunrise Boulevard with a wide radius of turn, making the turn relatively smooth.

Table 5-9 summaries crashes occurred at the intersection during the 1995-1997 period. A total of 53 crashes were reported over the period. As can be seen from the corresponding collision diagram shown in Figure 5-27, an unusually high proportion (83%) of crashes involved rear-end collisions, with none of them occurred on the triple left-turn approach. The most common type of crashes experienced by the triple left-turn approach was the sideswipe representing only 6% of the total crashes within the whole intersection. Angle crashes accounted for only 11% of the total crashes. Crashes during daytime (77%) were found to occur more often when peak hour volumes were present in the intersection. Contrary to triple left turn on Commercial Boulevard ramp terminal, this intersection did not show major impact from upstream intersection conditions.

Figure 5-25. SR 821 (Turnpike Ramp Terminal) and SR 838 (Sunrise Boulevard)

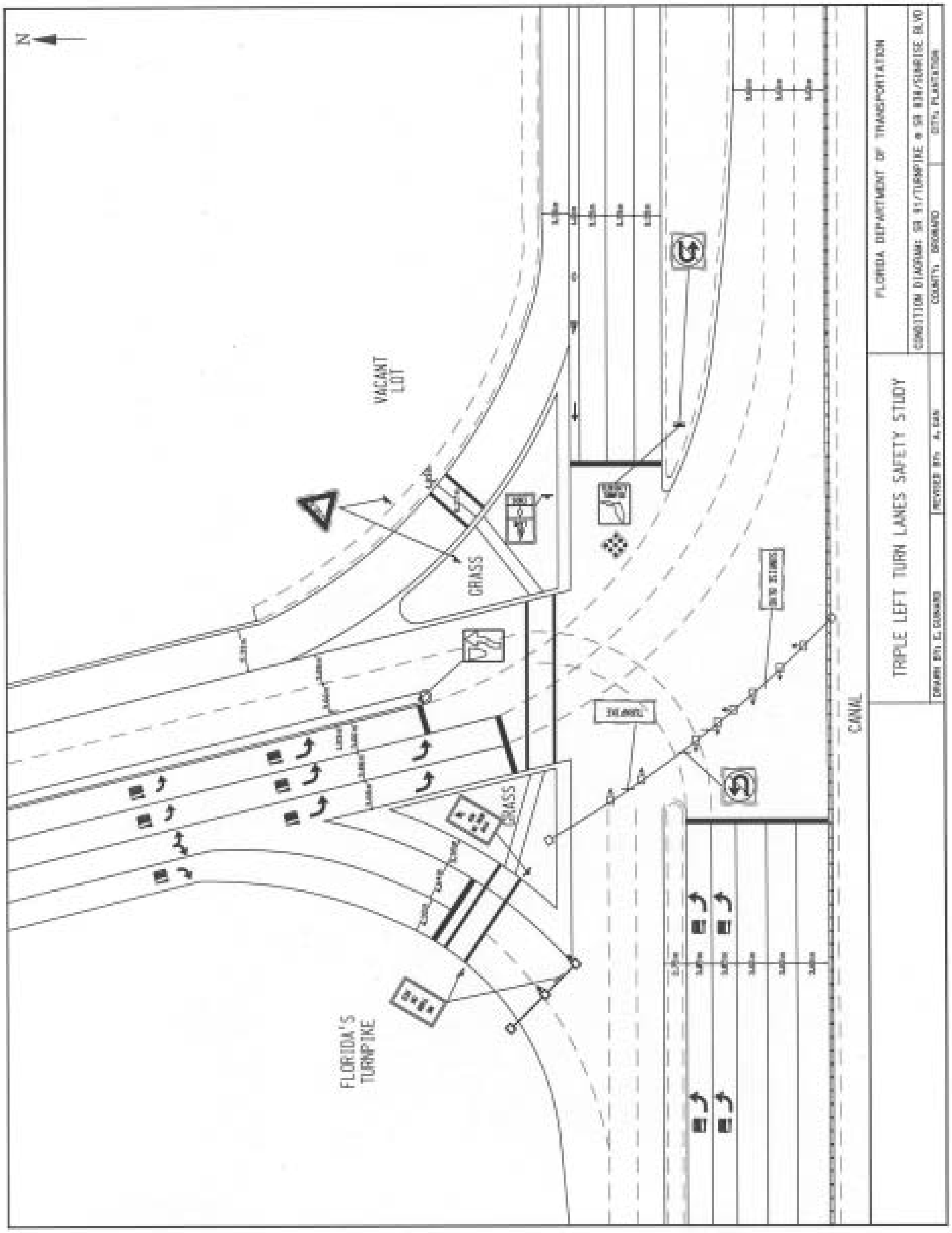


Figure 5-26. Condition Diagram for SR 821 (Turnpike Ramp Terminal) at SR 838 (Sunrise Boulevard)

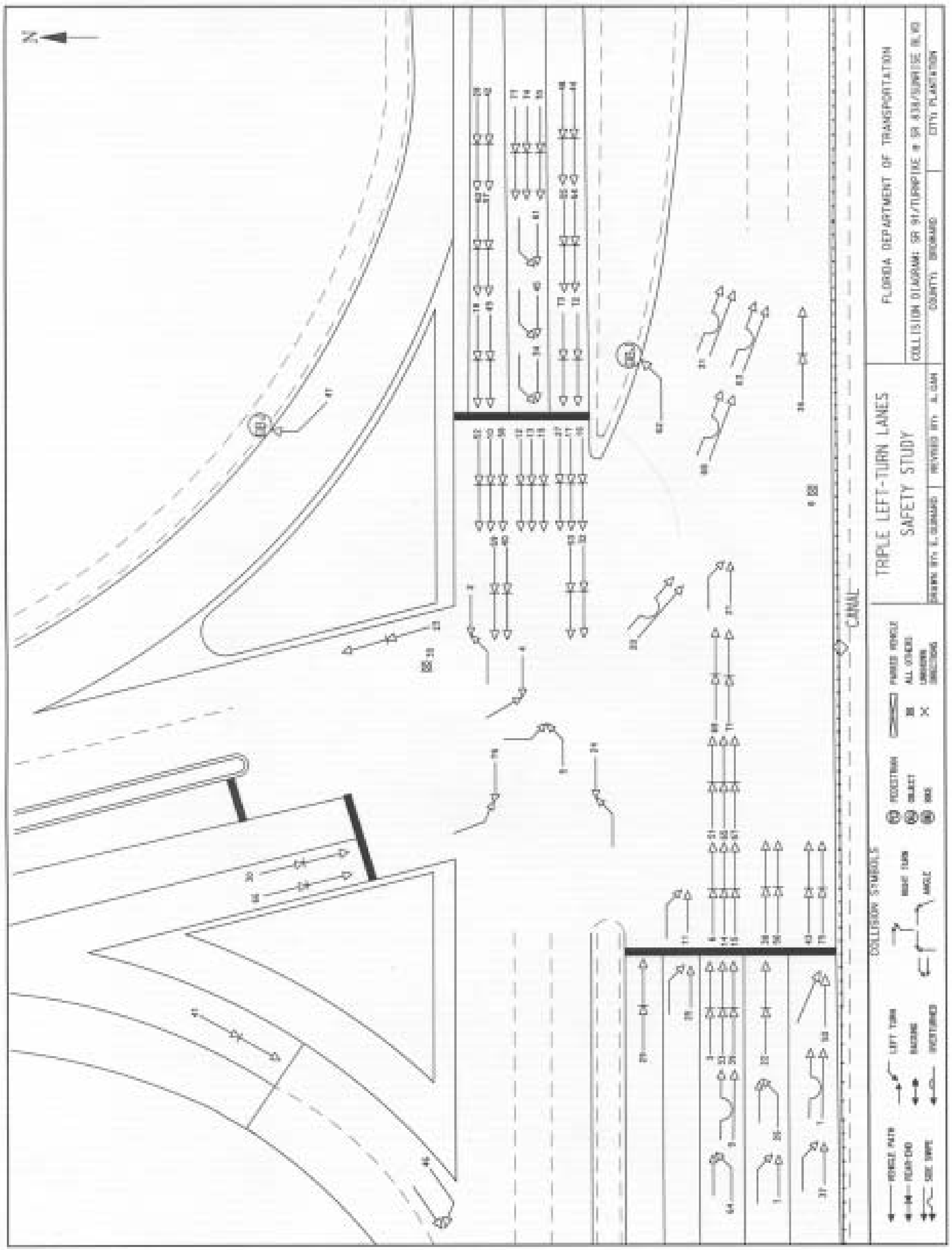


Figure 5-27. Collision Diagram for SR 821 (Turnpike Ramp Terminal) at SR 838 (Sunrise Boulevard)

Table 5-9. Crash Summary Table for SR 821 (Turnpike Ramp Terminal) at SR 838 (Sunrise Boulevard)

FLORIDA DEPARTMENT OF TRANSPORTATION
CRASH SUMMARY

SECTION: **86110000** STATE ROUTE: **SR 838** **Sunrise BLVD.**
INTERSECTING ROUTE: **Turnpike** M.P. **3.156** ENGINEER:
STUDY PERIOD: FROM **1/ 95** TO **12/ 97** COUNTY: **Broward**

No.	DATE	DAY	TIME	TYPE	FATAL	INJURY	PROP DAM	DAY / NT	WET / DRY	CONTRIBUTING CAUSE
1	1/4/95	Wed	1500	Sideswipe	0	0	1	Day	Wet	Improper Lane Change
2	1/13/95	Fri	1500	Left Turn	0	1	0	Day	Dry	Disregarded Traffic Signal
3	1/14/95	Sat	2100	Rear End	0	1	0	Nite	Dry	All Others
4	2/1/95	Wed	700	Angle	0	1	0	Day	Dry	All Others
5	2/28/95	Tue	1600	Left Turn	0	1	0	Day	Dry	No Improper Driving
6	4/7/95	Fri	1200	Rear End	0	1	0	Day	Dry	All Others
7	4/22/95	Sat	2000	Angle	0	0	1	Nite	Dry	Improper Passing
8	4/26/95	Wed	1700	Fixed Object	0	1	0	Day	Dry	All Others
9	5/17/95	Wed	1200	Sideswipe	0	0	1	Day	Dry	Improper Lane Change
10	5/19/95	Fri	2100	Rear End	0	0	1	Nite	Dry	All Others
11	5/20/95	Sat	800	Angle	0	1	0	Day	Wet	All Others
12	6/5/95	Mon	1300	Rear End	0	1	0	Day	Slippery	All Others
13	6/5/95	Mon	1300	Rear End	0	1	0	Day	Slippery	All Others
14	6/15/95	Thu	700	Rear End	0	0	1	Day	Dry	All Others
15	8/11/95	Fri	1300	Rear End	0	0	1	Day	Dry	No Improper Driving
16	8/14/95	Mon	1300	Rear End	0	1	0	Day	Dry	All Others
17	8/14/95	Mon	1200	Rear End	0	0	1	Day	Dry	No Improper Driving
18	9/2/95	Sat	1300	Rear End	0	1	0	Day	Wet	Careless Driving
19	9/5/95	Tue	700	Rear End	0	0	1	Day	Dry	All Others
20	10/9/95	Mon	1200	Sideswipe	0	0	1	Day	Wet	All Others
21	10/9/95	Mon	1500	Angle	0	1	0	Day	Wet	All Others
22	10/14/95	Sat	2000	Rear End	0	0	1	Nite	Slippery	All Others
23	10/16/95	Mon	800	Rear End	0	1	0	Day	Slippery	Failed to Maintain Equipment
24	10/17/95	Tue	1000	Left Turn	0	1	0	Day	Wet	All Others
25	10/31/95	Tue	1600	Angle	0	0	1	Day	Wet	Improper Lane Change
26	11/6/95	Mon	1600	Angle	0	0	1	Day	Dry	All Others
27	11/13/95	Mon	1800	Rear End	0	0	1	Nite	Dry	All Others
28	11/18/95	Sat	1800	Rear End	0	1	0	Nite	Dry	All Others
29	11/28/95	Tue	1700	Rear End	0	1	0	Nite	Dry	Careless Driving
30	11/28/95	Tue	1400	Rear End	0	1	0	Day	Slippery	Improper Parking
31	12/1/95	Fri	1700	Sideswipe	0	1	0	Nite	Dry	Followed to Closely
32	12/30/95	Sat	1800	Rear End	0	1	0	Nite	Dry	Disregarded Other Traffic
33	1/12/96	Fri	1500	Rear End	0	1	0	Day	Slippery	All Others
34	1/19/96	Fri	600	Angle	0	1	0	Nite	Dry	All Others
35	1/21/96	Sun	900	Fixed Object	0	1	0	Day	Dry	All Others
36	1/26/96	Fri	900	Rear End	0	1	0	Day	Slippery	All Others
37	1/29/96	Mon	1600	Angle	0	0	1	Day	Wet	All Others
38	2/4/96	Sun	1100	Rear End	0	1	0	Day	Wet	All Others
39	2/20/96	Tue	1600	Rear End	0	1	0	Day	Wet	All Others

40	2/20/96	Tue	2300	Rear End	0	1	0	Nite	Dry	Careless Driving
41	2/21/96	Wed	1000	Rear End	0	0	1	Day	Dry	Careless Driving
42	5/14/96	Tue	0	Rear End	0	1	0	Nite	Slippery	All Others
43	5/21/96	Tue	700	Rear End	0	0	1	Day	Dry	All Others
44	5/27/96	Mon	1600	Rear End	0	1	0	Day	Slippery	All Others
45	6/7/96	Fri	800	Angle	0	0	1	Day	Dry	Improper Lane Change
46	6/24/96	Mon	200	Right Turn	0	0	1	Nite	Dry	Improper Turn
47	8/3/96	Sat	1300	Fixed Object	0	1	0	Day	Slippery	No Improper Driving
48	8/27/96	Tue	1000	Rear End	0	0	1	Day	Slippery	Followed to Closely
49	10/7/96	Mon	600	Rear End	0	0	1	Nite	Slippery	All Others
50	11/14/96	Thu	1400	Angle	0	0	1	Day	Slippery	Exceeded Safe Speed
51	12/2/96	Mon	1200	Rear End	0	1	0	Day	Slippery	All Others
52	12/6/96	Fri	2300	Rear End	0	0	1	Nite	Dry	All Others
53	2/15/97	Sat	1600	Rear End	0	1	0	Day	Wet	No Improper Driving
54	2/15/97	Sat	1600	Rear End	0	1	0	Day	Wet	Followed to Closely
55	2/25/97	Tue	1400	Rear End	0	0	1	Day	Dry	All Others
56	3/14/97	Fri	1500	Rear End	0	1	0	Day	Slippery	All Others
57	3/17/97	Mon	1400	Rear End	0	1	0	Day	Dry	Followed to Closely
58	3/28/97	Fri	800	Rear End	0	1	0	Nite	Wet	All Others
59	5/13/97	Tue	700	Rear End	0	1	0	Day	Dry	All Others
60	5/21/97	Wed	900	Rear End	0	0	1	Day	Dry	All Others
61	5/25/97	Sun	2100	Angle	0	0	1	Nite	Dry	All Others
62	5/28/97	Wed	100	Other	0	0	1	Nite	Slippery	All Others
63	6/22/97	Sun	1000	Sideswipe	0	0	1	Day	Wet	All Others
64	6/26/97	Thu	1100	Angle	0	1	0	Day	Dry	Improper Lane Change
65	7/19/97	Sat	1700	Rear End	0	1	0	Day	Slippery	All Others
66	8/2/97	Sat	800	Rear End	0	0	1	Day	Dry	Disregarded Traffic Signal
67	8/6/97	Wed	1500	Rear End	0	1	0	Day	Slippery	All Others
68	8/9/97	Sat	1900	Sideswipe	0	1	0	Day	Wet	Failed to Maintain Equipment
69	8/22/97	Fri	1700	Rear End	0	0	1	Day	Slippery	Followed to Closely
70	9/20/97	Sat	2100	Rear End	0	1	0	Nite	Dry	No Improper Driving
71	9/25/97	Thu	1800	Rear End	0	1	0	Day	Dry	All Others
72	10/14/97	Tue	1800	Rear End	0	1	0	Day	Wet	All Others
73	10/26/97	Sun	1400	Rear End	0	1	0	Day	Dry	All Others
74	11/21/97	Fri	800	Rear End	0	1	0	Day	Slippery	No Improper Driving
75	12/9/97	Tue	900	Rear End	0	1	0	Day	Dry	No Improper Driving
76	12/19/97	Fri	1500	Left Turn	0	1	0	Day	Dry	All Others
77	12/24/97	Wed	700	Rear End	0	1	0	Day	Dry	All Others
Total No.	Fatal	Injury	PDO	Angle	Left Turn	Right Turn	Rear End	Side swipe	Ped/Bike	All Others
77	**0**	**48**	**29**	**12**	**4**	**1**	**50**	**6**	**0**	**4**
	0.00%	*62.34%*	*37.66%*	*15.58%*	*5.19%*	*1.30%*	*64.94%*	*7.79%*	*0.00%*	*5.19%*
Day	Night	Wet	Dry	Failed to Maintain Equipment	No Improper Driving	Careless Driving	Follow too Closely	Disregarded Traffic Signal	Improper Lane Change	All Others
58	**19**	**30**	**47**	**2**	**8**	**4**	**5**	**2**	**5**	**46**
75.32%	*24.68%*	*38.96%*	*61.04%*	*2.60%*	*10.39%*	*5.19%*	*6.49%*	*2.60%*	*6.49%*	*59.74%*
TOTAL VEHICLES ENTERING / ADT : **52,333**					CRASH RATE: **1.222** /MEV					

5.1.10 SR 816 (Oakland Park Boulevard) and NW 50th Avenue

NW 50th Avenue is an access road that carries traffic into a residential area to the north of the intersection and into a business area to the south. Oakland Park Boulevard is a major six-lane roadway that intersects NW 50th Avenue at a right angle. Figure 5-28 shows a picture of the triple left-turn approach. As can be seen from the condition diagram in Figure 5-1, the westbound approach contains an exclusive left-turn lane turning onto a single departure lane in the triple left-turn approach. The triple left-turn storage area is curved but intersects SR 816 at right angle. The triple left-turn approach was widened to three lanes from two lanes as it approaches the intersection. Through movements from the triple left turn are also restricted.

Table 5-10 summaries crashes occurred at the intersection during the 1995-1997 period. A high total of 138 crashes were reported over the period. As can be seen from the corresponding collision diagram shown in Figure 5-30, rear-end crashes accounted for the majority of the crashes at 65% while other crash types range from 3 to 9%. Only 6% of the crashes involved sideswipe and 9% involved angle. Other crashes that accounted each for less than 6% of the total intersection included left-turn, right-turn, and fixed-object. On the triple left turn the panorama indicated that angle and rear-end crashes were experienced on a larger basis than sideswipe crashes. As shown in the condition diagram, the triple left-turn provides with sufficient lane width and radius of turn to generate safe conditions in the event of sideswipe crashes. Also, upstream conditions contribute to making the traffic flow less susceptible to incur in sideswipe crashes, as there are no potential weaving areas or intersections with backed up queues. Injury crashes of 59% rank this intersection high in crash severity. Crashes occurred during daytime (64%) and nighttime (28%).

Figure 5-28. SR 860 (Oakland Park Boulevard) and NW 50th Avenue

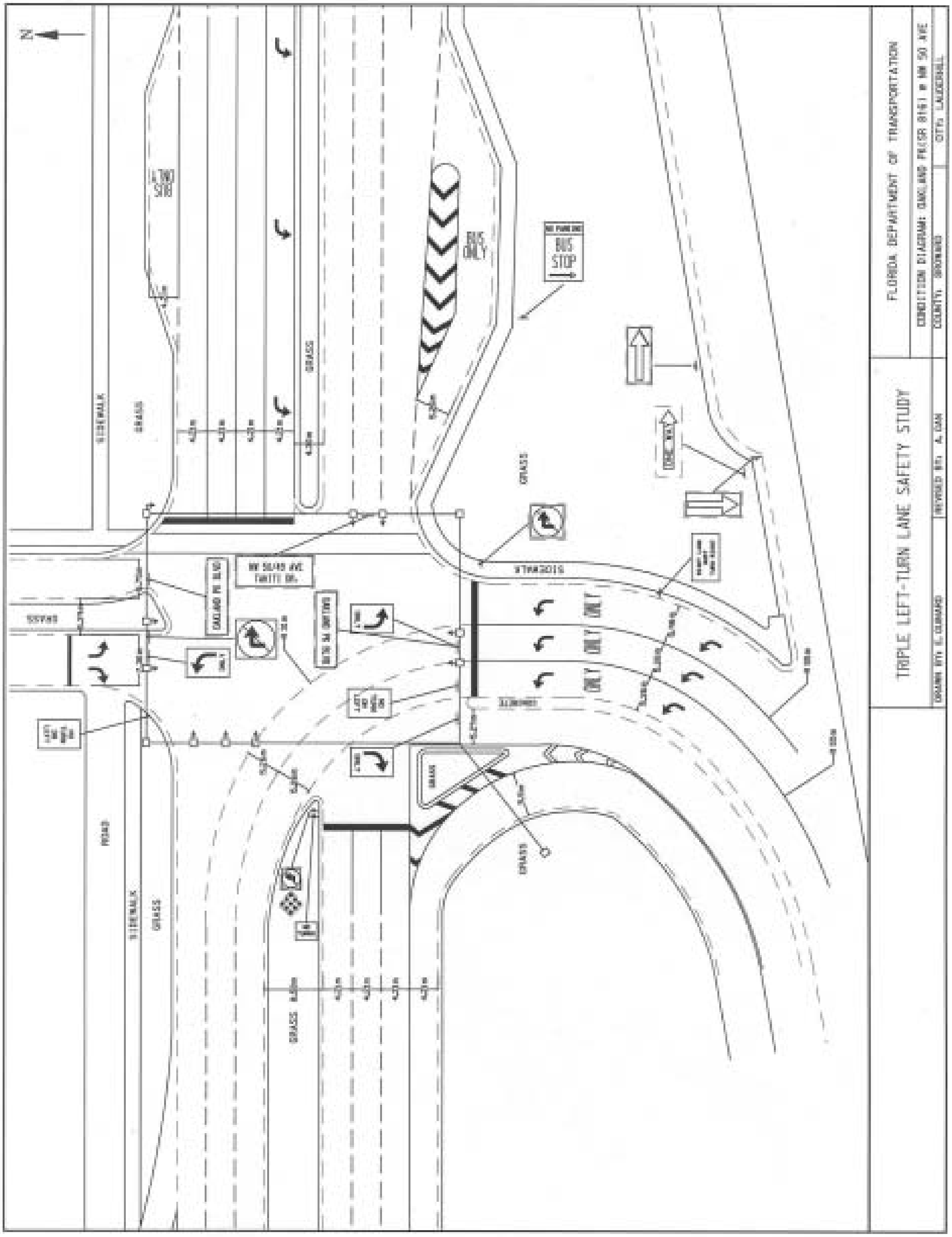


Figure 5-29. Condition Diagram for SR 860 (Oakland Park Boulevard) at NW 50th Avenue

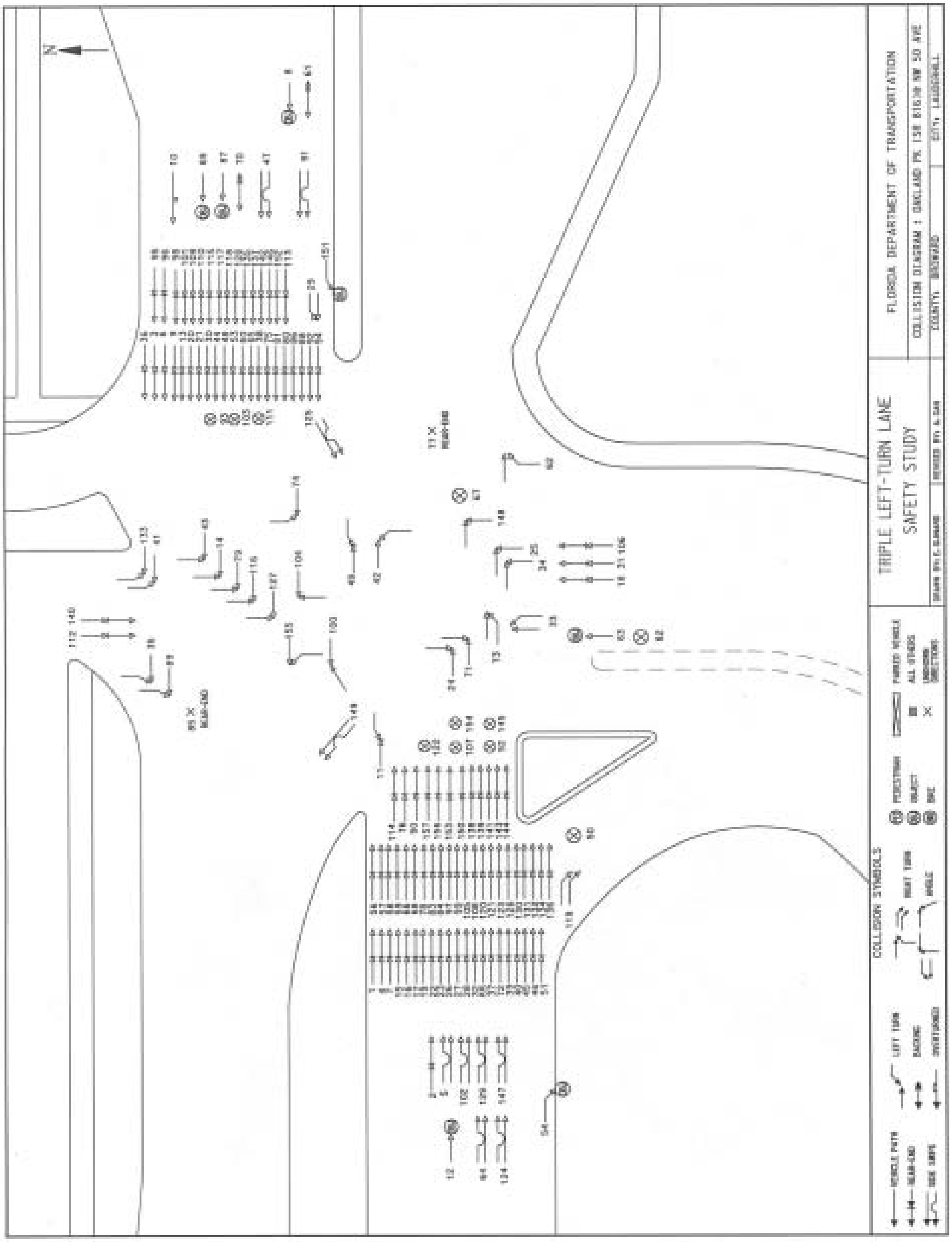


Figure 5-30. Collision Diagram for SR 860 (Oakland Park Boulevard) at NW 50th Avenue

Table 5-10. Crash Summary Table for SR 860 (Oakland Park Blvd) at NW 50th Avenue

FLORIDA DEPARTMENT OF TRANSPORTATION

CRASH SUMMARY

SECTION: **86090000** STATE ROUTE: **SR 816** **Oakland PK**

INTERSECTING ROUTE: **NW 50 Ave** M.P. **2.517** ENGINEER:

STUDY PERIOD: FROM **1/ 95** TO **12/ 97** COUNTY: **Broward**

No.	DATE	DAY	TIME	TYPE	FATAL	INJURY	PROP DAM	DAY / NT	WET / DRY	CONTRIBUTING CAUSE
1	1/6/95	Fri	1800	Rear End	0	0	1	Nite	Dry	All Others
2	1/16/95	Mon	2100	Rear End	0	1	0	Nite	Dry	No Improper Driving
3	1/16/95	Mon	1700	Rear End	0	1	0	Day	Dry	No Improper Driving
4	1/16/95	Mon	1800	Rear End	0	0	1	Nite	Dry	All Others
5	1/30/95	Mon	2100	Sideswipe	0	0	1	Nite	Wet	All Others
6	1/30/95	Mon	1400	Rear End	0	1	0	Day	Slippery	No Improper Driving
7	2/21/95	Tue	900	Rear End	0	0	1	Day	Dry	No Improper Driving
8	3/18/95	Sat	200	Other	0	1	0	Nite	Slippery	Careless Driving
9	3/23/95	Thu	2100	Rear End	0	1	0	Nite	Dry	Failed to Maintain Equipment
10	4/6/95	Thu	2100	Fixed Object	0	0	1	Nite	Wet	Failed to Maintain Equipment
11	4/27/95	Thu	2200	Left Turn	0	1	0	Nite	Slippery	No Improper Driving
12	5/3/95	Wed	200	Fixed Object	0	0	1	Nite	Dry	Exceeded Safe Speed
13	5/21/95	Sun	1200	Rear End	0	0	1	Day	Slippery	No Improper Driving
14	5/26/95	Fri	0	Angle	0	0	1	Nite	Wet	Failed to Yield R/W
15	5/29/95	Mon	600	Rear End	0	0	1	Nite	Dry	No Improper Driving
16	6/10/95	Sat	2000	Rear End	0	1	0	Day	Dry	Careless Driving
17	6/13/95	Tue	1700	Rear End	0	1	0	Unk	Slippery	No Improper Driving
18	6/13/95	Tue	1000	Rear End	0	1	0	Day	Dry	No Improper Driving
19	6/13/95	Tue	1400	Rear End	0	0	1	Day	Slippery	All Others
20	6/20/95	Tue	800	Rear End	0	0	1	Day	Wet	Careless Driving
21	6/21/95	Wed	1000	Rear End	0	1	0	Day	Wet	No Improper Driving
22	6/30/95	Fri	2200	Rear End	0	0	1	Nite	Slippery	No Improper Driving
23	6/30/95	Fri	2300	Rear End	0	1	0	Nite	Slippery	Followed to Closely
24	6/30/95	Fri	2200	Angle	0	1	0	Nite	Wet	Disregarded Traffic Signal
25	7/4/95	Tue	800	Angle	0	1	0	Day	Dry	No Improper Driving
26	7/18/95	Tue	700	Rear End	0	1	0	Nite	Slippery	No Improper Driving
27	7/23/95	Sun	1500	Rear End	0	1	0	Day	Slippery	No Improper Driving
28	7/29/95	Sat	1700	Rear End	0	1	0	Day	Wet	No Improper Driving
29	7/31/95	Mon	1100	Angle	0	1	0	Day	Wet	No Improper Driving
30	8/4/95	Fri	1800	Rear End	0	1	0	Day	Dry	Careless Driving
31	9/8/95	Fri	800	Rear End	0	1	0	Day	Wet	No Improper Driving
32	9/9/95	Sat	1500	Rear End	0	1	0	Day	Wet	Careless Driving
33	9/16/95	Sat	700	Angle	0	1	0	Day	Dry	No Improper Driving
34	9/23/95	Sat	700	Angle	0	1	0	Day	Wet	No Improper Driving
35	9/26/95	Tue	2000	Right Turn	0	0	1	Nite	Dry	All Others
36	10/6/95	Fri	2200	Rear End	0	0	1	Nite	Wet	Careless Driving
37	10/9/95	Mon	1600	Rear End	0	0	1	Day	Slippery	Failed to Maintain Equipment
38	10/13/95	Fri	1400	Rear End	0	0	1	Day	Slippery	No Improper Driving
39	10/17/95	Tue	1000	Rear End	0	1	0	Day	Wet	No Improper Driving

40	10/19/95	Thu	800	Rear End	0	0	1	Day	Wet	No Improper Driving
41	10/25/95	Wed	2100	Angle	0	0	1	Nite	Dry	Disregarded Traffic Signal
42	10/27/95	Fri	1400	Left Turn	0	1	0	Day	Dry	Failed to Yield R/W
43	10/28/95	Sat	1600	Angle	0	1	0	Day	Dry	No Improper Driving
44	11/3/95	Fri	1200	Rear End	0	0	1	Day	Dry	No Improper Driving
45	11/8/95	Wed	1200	Rear End	0	0	1	Day	Wet	No Improper Driving
46	11/13/95	Mon	1700	Rear End	0	0	1	Day	Wet	Followed to Closely
47	11/18/95	Sat	800	Sideswipe	0	1	0	Day	Dry	Disregarded Traffic Signal
48	11/22/95	Wed	2300	Rear End	0	1	0	Nite	Dry	Careless Driving
49	11/24/95	Fri	0	Left Turn	0	0	1	Nite	Dry	Disregarded Traffic Signal
50	11/28/95	Tue	2200	Fixed Object	0	0	1	Nite	Slippery	All Others
51	11/29/95	Wed	1300	Rear End	0	1	0	Day	Slippery	No Improper Driving
52	12/9/95	Sat	2100	Fixed Object	0	1	0	Nite	Dry	Disregarded Traffic Signal
53	12/10/95	Sun	1900	Rear End	0	0	1	Nite	Wet	Followed to Closely
54	12/13/95	Wed	1600	Other	0	1	0	Day	Dry	All Others
55	12/14/95	Thu	1800	Rear End	0	1	0	Nite	Dry	No Improper Driving
56	1/3/96	Wed	700	Rear End	0	0	1	Day	Wet	All Others
57	1/5/96	Fri	2200	Rear End	0	1	0	Nite	Dry	Careless Driving
58	1/6/96	Sat	1200	Rear End	0	1	0	Day	Dry	No Improper Driving
59	1/19/96	Fri	700	Rear End	0	0	1	Day	Wet	No Improper Driving
60	1/19/96	Fri	1100	Rear End	0	1	0	Day	Wet	No Improper Driving
61	1/24/96	Wed	1800	Other	0	1	0	Nite	Dry	Improper Parking
62	1/27/96	Sat	1100	Right Turn	0	0	1	Day	Dry	No Improper Driving
63	2/7/96	Wed	1700	Other	0	1	0	Day	Dry	All Others
64	3/27/96	Wed	1700	Sideswipe	0	1	0	Day	Dry	Careless Driving
65	4/3/96	Wed	1800	Rear End	0	1	0	Day	Dry	No Improper Driving
66	4/4/96	Thu	1100	Rear End	0	1	0	Day	Dry	Careless Driving
67	4/6/96	Sat	2000	Fixed Object	0	1	0	Nite	Slippery	All Others
68	4/7/96	Sun	1200	Rear End	0	1	0	Day	Slippery	No Improper Driving
69	4/8/96	Mon	1600	Fixed Object	0	1	0	Day	Slippery	All Others
70	4/9/96	Tue	1200	Other	0	0	1	Day	Slippery	No Improper Driving
71	4/10/96	Wed	2000	Angle	0	1	0	Nite	Dry	Disregarded Traffic Signal
72	4/14/96	Sun	2300	Rear End	0	0	1	Nite	Dry	Careless Driving
73	4/23/96	Tue	1600	Angle	0	0	1	Day	Dry	Careless Driving
74	5/10/96	Fri	1500	Left Turn	0	1	0	Day	Dry	Disregarded Traffic Signal
75	5/21/96	Tue	1400	Rear End	0	1	0	Day	Slippery	No Improper Driving
76	6/5/96	Wed	2100	Rear End	0	1	0	Nite	Dry	Careless Driving
77	6/10/96	Mon	2300	Rear End	0	1	0	Day	Dry	All Others
78	6/27/96	Thu	2100	Rear End	0	1	0	Nite	Wet	Followed to Closely
79	7/1/96	Mon	1100	Angle	0	0	1	Day	Wet	No Improper Driving
80	7/12/96	Fri	1500	Rear End	0	0	1	Day	Wet	Careless Driving
81	7/29/96	Mon	0	Rear End	0	1	0	Nite	Wet	No Improper Driving
82	7/31/96	Wed	1300	Rear End	0	1	0	Day	Dry	All Others
83	8/26/96	Mon	1800	Rear End	0	1	0	Day	Slippery	Exceeded Safe Speed
84	9/8/96	Sun	100	Rear End	0	1	0	Nite	Wet	All Others
85	9/9/96	Mon	2200	Rear End	0	0	1	Nite	Slippery	All Others
86	9/12/96	Thu	1000	Rear End	0	1	0	Day	Dry	No Improper Driving

87	10/2/96	Wed	1100	Fixed Object	0	0	1	Day	Wet	All Others
88	10/4/96	Fri	1300	Rear End	0	1	0	Day	Wet	Followed to Closely
89	10/15/96	Tue	1100	Right Turn	0	0	1	Day	Dry	Improper Turn
90	10/22/96	Tue	1400	Rear End	0	0	1	Day	Dry	Followed to Closely
91	11/6/96	Wed	1500	Sideswipe	0	1	0	Day	Dry	Careless Driving
92	11/9/96	Sat	1300	Rear End	0	1	0	Day	Dry	Followed to Closely
93	11/24/96	Sun	2000	Fixed Object	0	1	0	Unk	Other	Disregarded Traffic Signal
94	11/27/96	Wed	800	Rear End	0	1	0	Day	Dry	Failed to Maintain Equipment
95	11/30/96	Sat	1300	Rear End	0	1	0	Day	Dry	No Improper Driving
96	12/5/96	Thu	1800	Rear End	0	1	0	Nite	Wet	Followed to Closely
97	12/21/96	Sat	1800	Rear End	0	1	0	Nite	Wet	Careless Driving
98	12/23/96	Mon	800	Rear End	0	0	1	Day	Dry	All Others
99	12/26/96	Thu	1400	Rear End	0	1	0	Day	Dry	Careless Driving
100	12/31/96	Tue	1100	Angle	0	1	0	Day	Dry	Disregarded Other Traffic
101	1/9/97	Thu	1800	Rear End	0	1	0	Nite	Dry	Careless Driving
102	1/17/97	Fri	1700	Sideswipe	0	0	1	Nite	Dry	Improper Lane Change
103	1/18/97	Sat	400	Other	0	1	0	Nite	Dry	Careless Driving
104	1/19/97	Sun	2300	Angle	0	0	1	Nite	Dry	Disregarded Traffic Signal
105	1/24/97	Fri	1600	Rear End	0	0	1	Day	Dry	Careless Driving
106	1/25/97	Sat	700	Rear End	0	0	1	Day	Wet	No Improper Driving
107	1/27/97	Mon	1400	Fixed Object	0	1	0	Day	Slippery	All Others
108	2/9/97	Sun	2100	Rear End	0	1	0	Nite	Wet	No Improper Driving
109	2/16/97	Sun	1900	Rear End	0	1	0	Nite	Slippery	Careless Driving
110	2/20/97	Thu	1300	Rear End	0	1	0	Day	Dry	Careless Driving
111	2/24/97	Mon	800	Fixed Object	0	1	0	Day	Slippery	All Others
112	2/24/97	Mon	1700	Rear End	0	1	0	Day	Wet	Careless Driving
113	2/24/97	Mon	800	Rear End	0	1	0	Day	Slippery	No Improper Driving
114	2/25/97	Tue	1700	Rear End	0	0	1	Day	Dry	No Improper Driving
115	2/28/97	Fri	1300	Rear End	0	1	0	Day	Dry	No Improper Driving
116	3/9/97	Sun	200	Angle	0	0	1	Nite	Dry	All Others
117	3/28/97	Fri	1700	Rear End	0	1	0	Day	Dry	Careless Driving
118	4/9/97	Wed	0	Rear End	0	1	0	Nite	Slippery	Failed to Yield R/W
119	4/10/97	Thu	1500	Right Turn	0	1	0	Unk	Dry	Improper Lane Change
120	4/10/97	Thu	1900	Rear End	0	1	0	Day	Wet	Careless Driving
121	4/14/97	Mon	1200	Rear End	0	1	0	Day	Slippery	All Others
122	4/16/97	Wed	2100	Fixed Object	0	1	0	Nite	Wet	Followed to Closely
123	5/6/97	Tue	1500	Rear End	0	1	0	Day	Dry	Careless Driving
124	5/7/97	Wed	1800	Sideswipe	0	0	1	Day	Dry	Careless Driving
125	5/10/97	Sat	1100	Sideswipe	0	0	1	Day	Wet	Improper Turn
126	5/17/97	Sat	1200	Rear End	0	1	0	Day	Wet	Careless Driving
127	5/17/97	Sat	900	Angle	0	1	0	Day	Dry	No Improper Driving
128	5/17/97	Sat	200	Rear End	0	1	0	Nite	Dry	Alcohol - Under Influence
129	5/17/97	Sat	1000	Sideswipe	0	0	1	Day	Wet	Careless Driving
130	5/26/97	Mon	2000	Rear End	0	0	1	Unk	Slippery	All Others
131	6/2/97	Mon	1800	Rear End	0	1	0	Day	Wet	Careless Driving
132	6/2/97	Mon	1800	Rear End	0	0	1	Day	Wet	Careless Driving
133	6/12/97	Thu	1400	Left Turn	0	1	0	Day	Slippery	Failed to Yield R/W

134	7/9/97	Wed	900	Rear End	0	0	1	Day	Dry	All Others
135	8/1/97	Fri	1400	Rear End	0	1	0	Day	Wet	No Improper Driving
136	8/2/97	Sat	2300	Rear End	0	0	1	Nite	Dry	Followed to Closely
137	8/5/97	Tue	1400	Rear End	0	0	1	Day	Dry	No Improper Driving
138	8/7/97	Thu	0	Rear End	0	0	1	Day	Wet	Careless Driving
139	8/7/97	Thu	1800	Rear End	0	1	0	Day	Wet	Careless Driving
140	8/25/97	Mon	1200	Rear End	0	1	0	Day	Dry	All Others
141	9/8/97	Mon	600	Rear End	0	1	0	Day	Dry	Careless Driving
142	9/20/97	Sat	1500	Rear End	0	0	1	Day	Dry	No Improper Driving
143	9/27/97	Sat	1400	Rear End	0	1	0	Day	Slippery	Followed to Closely
144	9/30/97	Tue	700	Rear End	0	1	0	Unk	Slippery	All Others
145	10/1/97	Wed	0	Fixed Object	0	0	1	Unk	Unknown	Unknown
146	10/12/97	Sun	1000	Rear End	0	1	0	Day	Dry	No Improper Driving
147	10/16/97	Thu	1000	Sideswipe	0	1	0	Day	Slippery	No Improper Driving
148	10/19/97	Sun	0	Angle	0	0	1	Nite	Dry	All Others
149	10/26/97	Sun	1800	Sideswipe	0	0	1	Nite	Dry	Failed to Yield R/W
150	11/1/97	Sat	1400	Rear End	0	0	1	Day	Dry	No Improper Driving
151	11/14/97	Fri	800	Other	0	0	1	Unk	Slippery	Careless Driving
152	11/21/97	Fri	1900	Rear End	0	0	1	Nite	Slippery	All Others
153	11/29/97	Sat	2000	Rear End	0	0	1	Day	Slippery	Careless Driving
154	11/29/97	Sat	2000	Fixed Object	0	0	1	Nite	Wet	Improper Parking
155	11/30/97	Sun	900	Left Turn	0	1	0	Day	Wet	No Improper Driving
156	12/4/97	Thu	1800	Rear End	0	0	1	Nite	Dry	Followed to Closely
157	12/4/97	Thu	1100	Rear End	0	0	1	Day	Slippery	Followed to Closely
Total No.	Fatal	Injury	PDO	Angle	Left Turn	Right Turn	Rear End	Side Swipe	Ped/Bike	All Others
157	**0**	**94**	**63**	**16**	**6**	**4**	**101**	**10**	**0**	**20**
	0.00%	*59.87%*	*40.13%*	*10.19%*	*3.82%*	*2.55%*	*64.33%*	*6.37%*	*0.00%*	*12.74%*
Day	Night	Wet	Dry	FTY R/W	No Improper Driving	Careless Driving	Follow too Closely	Disregarded Traffic Signal	Failed to Maintain Equipment	All Others
98	**59**	**70**	**87**	**5**	**52**	**36**	**13**	**9**	**4**	**27**
62.42%	*37.58%*	*44.59%*	*55.41%*	*3.18%*	*33.12%*	*22.93%*	*8.28%*	*5.73%*	*2.55%*	*17.20%*
TOTAL VEHICLES ENTERING / ADT : **47,000**					CRASH RATE: **3.051** /MEV					

5.1.11 SR 821 (Turnpike) and SR 870 (Commercial Boulevard)

Commercial Boulevard is a six-lane roadway with configuration similar to that of the Sunrise Boulevard. The eastbound exclusive double left-turn provides with an access to the Florida Turnpike. Figure 5-31 shows a picture of the triple left-turn approach. As can be seen from the condition diagram in Figure 5-32, Florida Turnpike junction is linked to Commercial Boulevard through a “T” signalized intersection at an angle of approximately 80° and located in a suburban area. The intersection has been found to operate at an unacceptable level of service during the morning peak hours. Downstream conditions were found to exert great impact on the intersection performance as backed up queues interfered with left-turning vehicles causing these to weave as back up vehicles piled up all the way down to the triple left-turn approach.

Table 5-11 summaries crashes occurred at the intersection during the 1995-1997 period. A total of 78 crashes were reported over the period. As can be seen from the corresponding collision diagram shown in Figure 5-33, eighty five percent of the crashes were related to the rear end type, with about 65% of them resulting in injuries. Only one sideswipe and one angle crashes were attributable to the triple left turn. Eighty five percent of the crashes occurred during daytime peak hours. Crashes resulting in injuries accounted for 49% of the total crashes, which translates to medium severity, not as critical as that on Sunrise Boulevard.

Figure 5-31. SR 821 (Turnpike Ramp Terminal) and SR 870 (Commercial Boulevard)

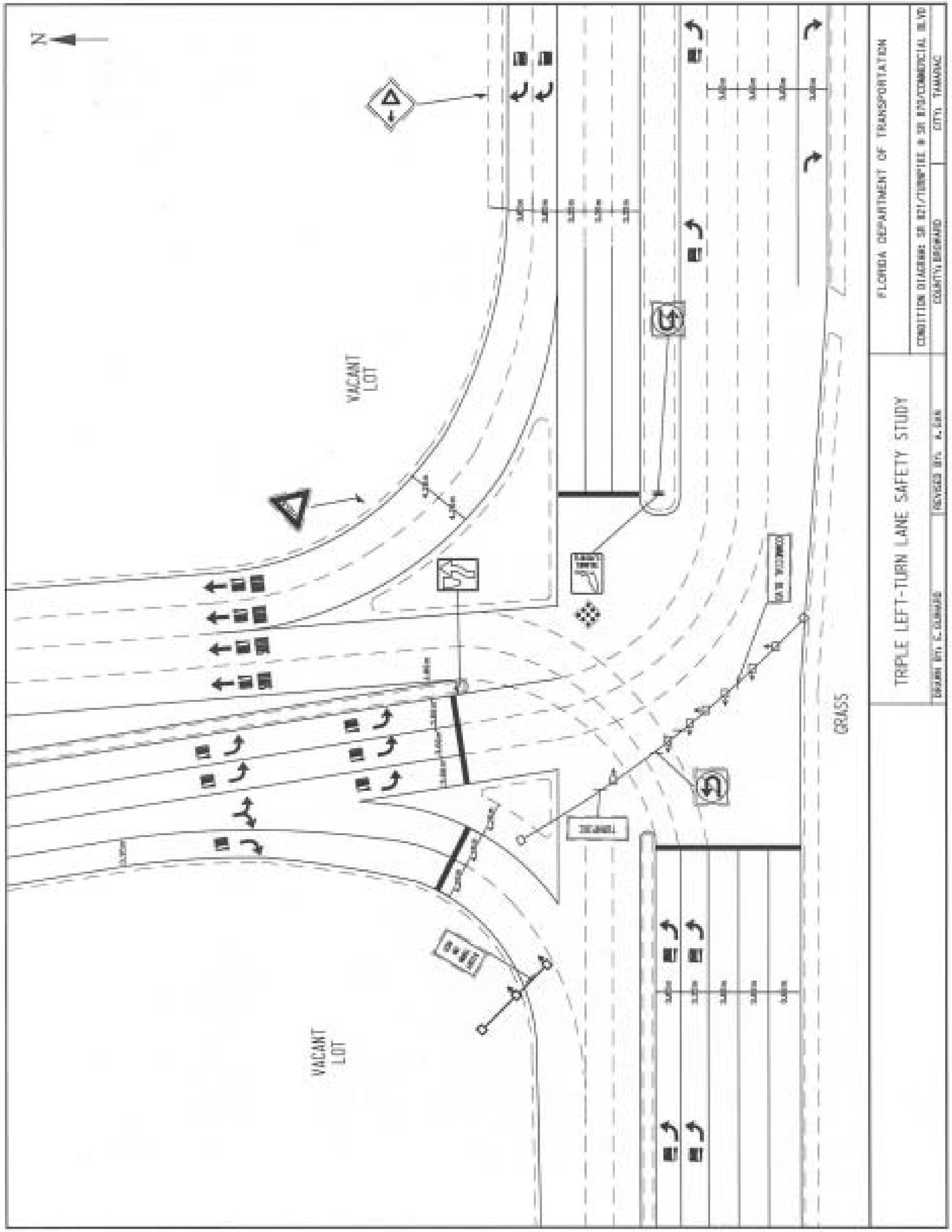


Figure 5-32. Condition Diagram for SR 821 (Turnpike Ramp Terminal) at SR 870 (Commercial Boulevard)

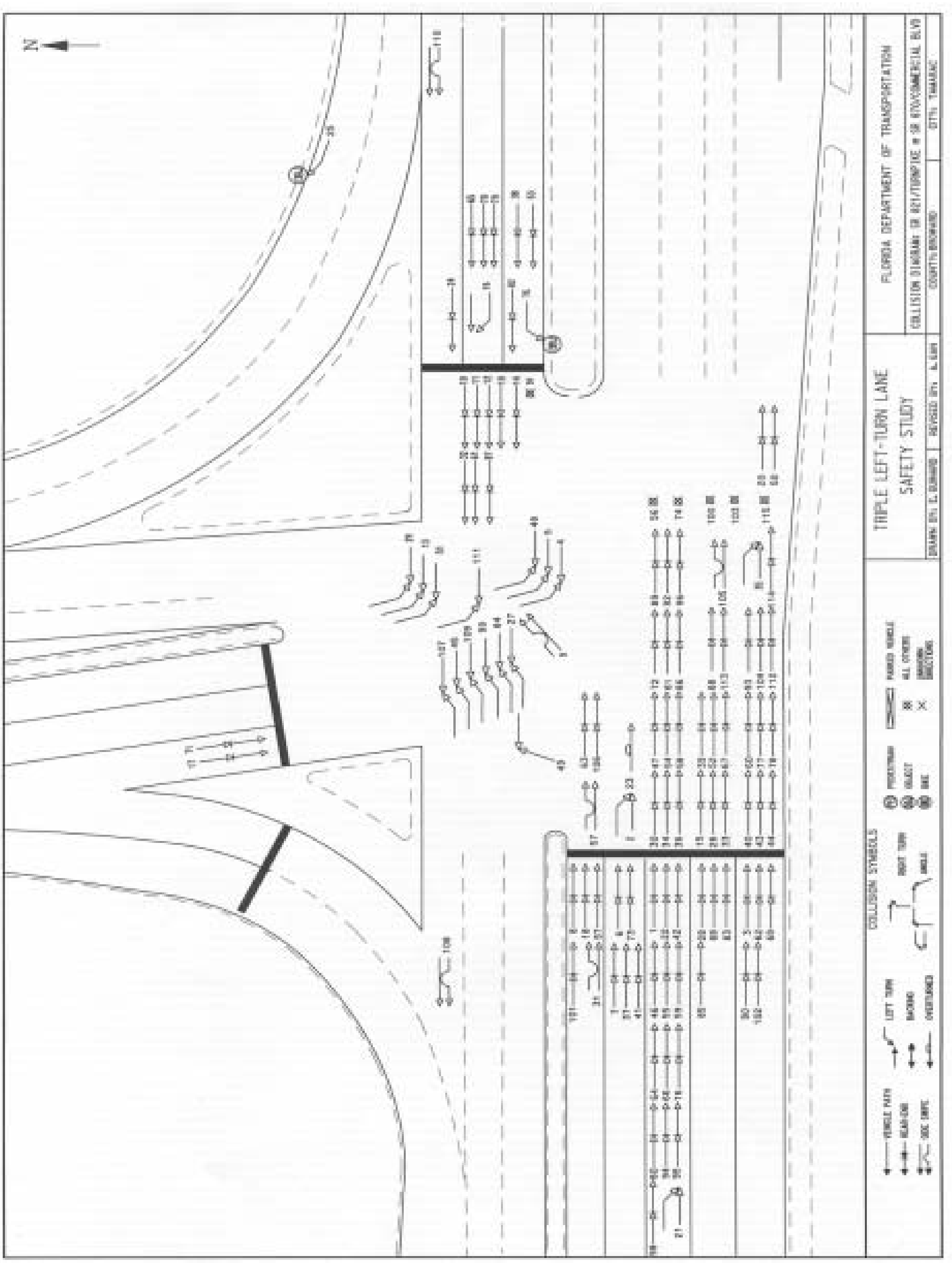


Figure 5-33. Collision Diagram for SR 821 (Turnpike Ramp Terminal) at SR 870 (Commercial Boulevard)

Table 5-11. Crash Summary Table for SR 821 (Turnpike Ramp Terminal) at SR 870 (Commercial Boulevard)

FLORIDA DEPARTMENT OF TRANSPORTATION

CRASH SUMMARY

SECTION:	**86014000**			STATE ROUTE:	**SR 870**	**Commercial Blvd.**	
INTERSECTING ROUTE:	**Turnpike**	M.P.	**2.748**	ENGINEER:			
STUDY PERIOD: FROM	**1/ 95**	TO	**12/ 97**	COUNTY:	**Broward**		

No.	DATE	DAY	TIME	TYPE	FATAL	INJURY	PROP DAM	DAY / NT	WET / DRY	CONTRIBUTING CAUSE
1	1/5/95	Thu	600	Rear End	0	0	1	Nite	Slippery	Exceeded Safe Speed
2	1/14/95	Sat	1300	Angle	0	1	0	Day	Slippery	All Others
3	1/14/95	Sat	1300	Rear End	0	1	0	Day	Slippery	All Others
4	1/25/95	Wed	800	Left Turn	0	1	0	Day	Dry	Disregarded Traffic Signal
5	1/26/95	Thu	2300	Left Turn	0	1	0	Nite	Dry	Disregarded Traffic Signal
6	3/10/95	Fri	1600	Rear End	0	0	1	Day	Slippery	No Improper Driving
7	5/2/95	Tue	1800	Rear End	0	1	0	Day	Wet	Careless Driving
8	5/9/95	Tue	700	Rear End	0	1	0	Day	Slippery	No Improper Driving
9	5/9/95	Tue	1600	Sideswipe	0	0	1	Day	Dry	Careless Driving
10	5/16/95	Tue	1500	Rear End	0	1	0	Day	Dry	All Others
11	6/20/95	Tue	2400	Rear End	0	0	1	Nite	Dry	No Improper Driving
12	7/9/95	Sun	200	Rear End	0	1	0	Nite	Dry	Alcohol - Under Influence
13	7/19/95	Wed	1400	Angle	0	0	1	Day	Dry	Disregarded Traffic Signal
14	8/2/95	Wed	1500	Rear End	0	0	1	Day	Slippery	All Others
15	8/4/95	Fri	1300	Rear End	0	0	1	Day	Wet	All Others
16	8/19/95	Sat	1100	Angle	0	0	1	Day	Dry	Improper Lane Change
17	9/22/95	Fri	1700	Rear End	0	0	1	Day	Dry	Followed to Closely
18	9/28/95	Thu	1000	Rear End	0	0	1	Day	Dry	All Others
19	10/5/95	Thu	2000	Rear End	0	0	1	Nite	Slippery	Careless Driving
20	10/9/95	Mon	1800	Rear End	0	1	0	Day	Wet	All Others
21	10/15/95	Sun	1500	Angle	0	0	1	Day	Slippery	Careless Driving
22	10/16/95	Mon	600	Rear End	0	0	1	Nite	Slippery	All Others
23	10/17/95	Tue	1500	Fixed Object	0	1	0	Day	Slippery	Careless Driving
24	10/21/95	Sat	800	Rear End	0	0	1	Day	Dry	All Others
25	10/26/95	Thu	800	Fixed Object	0	0	1	Day	Wet	All Others
26	10/31/95	Tue	1000	Rear End	0	1	0	Day	Wet	All Others
27	11/2/95	Thu	1000	Left Turn	0	1	0	Day	Dry	Disregarded Traffic Signal
28	11/4/95	Sat	1300	Rear End	0	1	0	Day	Dry	All Others
29	11/8/95	Wed	1500	Angle	0	0	1	Day	Dry	Disregarded Traffic Signal
30	12/22/95	Fri	1800	Rear End	0	0	1	Nite	Slippery	All Others
31	12/27/95	Wed	1200	Sideswipe	0	1	0	Day	Wet	All Others
32	1/18/96	Thu	1600	Rear End	0	1	0	Day	Dry	Followed to Closely

33	1/20/96	Sat	700	Rear End	0	1	0	Day	Slippery	Careless Driving
34	1/27/96	Sat	1700	Rear End	0	1	0	Nite	Dry	Improper Lane Change
35	1/29/96	Mon	1400	Angle	0	1	0	Day	Slippery	All Others
36	1/29/96	Mon	1400	Rear End	0	0	1	Day	Slippery	Improper Lane Change
37	1/30/96	Tue	600	Rear End	0	0	1	Nite	Wet	All Others
38	2/16/96	Fri	1100	Rear End	0	0	1	Day	Dry	Followed to Closely
39	3/2/96	Sat	1100	Rear End	0	0	1	Day	Slippery	Careless Driving
40	3/10/96	Sun	1100	Rear End	0	1	0	Day	Slippery	All Others
41	3/10/96	Sun	1200	Rear End	0	1	0	Day	Slippery	Careless Driving
42	3/27/96	Wed	900	Rear End	0	1	0	Day	Dry	All Others
43	3/29/96	Fri	1400	Rear End	0	1	0	Day	Dry	All Others
44	5/2/96	Thu	1300	Rear End	0	1	0	Nite	Wet	Careless Driving
45	6/8/96	Sat	1200	Left Turn	0	1	0	Day	Dry	Disregarded Traffic Signal
46	6/12/96	Wed	700	Rear End	0	0	1	Day	Wet	Followed to Closely
47	7/2/96	Tue	1800	Rear End	0	1	0	Day	Slippery	All Others
48	7/23/96	Tue	1500	Left Turn	0	1	0	Day	Dry	All Others
49	8/5/96	Mon	1300	Angle	0	1	0	Day	Dry	Disregarded Traffic Signal
50	8/9/96	Fri	1200	Rear End	0	1	0	Day	Slippery	Careless Driving
51	8/17/96	Sat	1800	Angle	0	1	0	Day	Dry	Disregarded Traffic Signal
52	8/25/96	Sun	1600	Rear End	0	0	1	Day	Slippery	All Others
53	8/27/96	Tue	800	Rear End	0	1	0	Day	Wet	Followed to Closely
54	10/3/96	Thu	1700	Rear End	0	0	1	Day	Slippery	All Others
55	10/6/96	Sun	1200	Rear End	0	1	0	Day	Slippery	All Others
56	10/7/96	Mon	1400	Fixed Object	0	1	0	Day	Wet	All Others
57	10/12/96	Sat	1800	Sideswipe	0	1	0	Nite	Wet	Careless Driving
58	11/2/96	Sat	1800	Rear End	0	1	0	Day	Dry	All Others
59	11/5/96	Tue	700	Rear End	0	0	1	Day	Slippery	Followed to Closely
60	11/7/96	Thu	1500	Rear End	0	1	0	Day	Dry	Followed to Closely
61	11/8/96	Fri	1600	Rear End	0	0	1	Day	Dry	All Others
62	11/16/96	Sat	1500	Rear End	0	0	1	Day	Wet	Followed to Closely
63	12/2/96	Mon	1200	Rear End	0	1	0	Day	Slippery	Careless Driving
64	12/5/96	Thu	1600	Rear End	0	0	1	Day	Slippery	All Others
65	12/6/96	Fri	1900	Rear End	0	0	1	Nite	Dry	All Others
66	12/9/96	Mon	900	Rear End	0	1	0	Day	Dry	Followed to Closely
67	12/20/96	Fri	1100	Rear End	0	1	0	Day	Dry	All Others
68	1/27/97	Mon	1200	Rear End	0	0	1	Day	Slippery	Failed to Yield R/W
69	1/27/97	Mon	1200	Rear End	0	1	0	Day	Slippery	All Others
70	1/27/97	Mon	600	Rear End	0	0	1	Day	Wet	All Others
71	2/17/97	Mon	800	Rear End	0	0	1	Day	Wet	Careless Driving
72	2/19/97	Wed	700	Rear End	0	0	1	Nite	Slippery	Failed to Maintain Equipment
73	3/5/97	Wed	700	Rear End	0	0	1	Day	Dry	Failed to Yield R/W

74	3/5/97	Wed	1500	Fixed Object	0	0	1	Day	Dry	No Improper Driving
75	3/7/97	Fri	2200	Fixed Object	0	0	1	Nite	Dry	Improper Turn
76	3/18/97	Tue	700	Rear End	0	1	0	Day	Dry	All Others
77	4/10/97	Thu	1700	Rear End	0	0	1	Day	Slippery	All Others
78	4/23/97	Wed	2200	Rear End	0	1	0	Nite	Slippery	All Others
79	4/28/97	Mon	2100	Rear End	0	1	0	Nite	Wet	Careless Driving
80	5/10/97	Sat	1800	Rear End	0	0	1	Day	Dry	All Others
81	5/17/97	Sat	1500	Rear End	0	0	1	Day	Slippery	Careless Driving
82	5/18/97	Sun	1600	Rear End	0	0	1	Day	Dry	Careless Driving
83	5/19/97	Mon	1600	Rear End	0	0	1	Day	Wet	Followed to Closely
84	5/27/97	Tue	600	Left Turn	0	1	0	Day	Dry	Failed to Yield R/W
85	5/29/97	Thu	600	Rear End	0	0	1	Day	Dry	Followed to Closely
86	6/2/97	Mon	1800	Rear End	0	0	1	Day	Wet	No Improper Driving
87	6/15/97	Sun	100	Rear End	0	1	0	Nite	Slippery	All Others
88	7/15/97	Tue	1300	Rear End	0	1	0	Day	Slippery	All Others
89	7/15/97	Tue	1400	Rear End	0	1	0	Day	Wet	Exceeded Safe Speed
90	7/16/97	Wed	1100	Rear End	0	1	0	Day	Slippery	All Others
91	7/22/97	Tue	1400	Fixed Object	0	0	1	Day	Slippery	All Others
92	7/22/97	Tue	1500	Rear End	0	0	1	Day	Dry	No Improper Driving
93	7/30/97	Wed	900	Rear End	0	0	1	Day	Wet	Exceeded Safe Speed
94	8/3/97	Sun	1300	Rear End	0	1	0	Day	Slippery	Followed to Closely
95	8/3/97	Sun	1300	Rear End	0	0	1	Day	Slippery	Careless Driving
96	8/3/97	Sun	1300	Rear End	0	0	1	Day	Slippery	All Others
97	8/4/97	Mon	1700	Rear End	0	1	0	Day	Slippery	All Others
98	8/8/97	Fri	1500	Rear End	0	1	0	Day	Slippery	Followed to Closely
99	8/9/97	Sat	700	Left Turn	0	1	0	Day	Dry	Disregarded Traffic Signal
100	8/25/97	Mon	1600	Fixed Object	0	0	1	Day	Wet	Improper Lane Change
101	8/31/97	Sun	1000	Rear End	0	0	1	Day	Slippery	Careless Driving
102	9/2/97	Tue	900	Rear End	0	0	1	Day	Dry	Careless Driving
103	9/4/97	Thu	1100	Fixed Object	0	0	1	Day	Wet	All Others
104	9/5/97	Fri	1400	Rear End	0	1	0	Day	Slippery	No Improper Driving
105	9/9/97	Tue	1200	Sideswipe	0	1	0	Day	Dry	All Others
106	9/12/97	Fri	1500	Rear End	0	1	0	Day	Slippery	Followed to Closely
107	9/22/97	Mon	200	Left Turn	0	1	0	Nite	Wet	Disregarded Traffic Signal
108	9/23/97	Tue	700	Sideswipe	0	0	1	Nite	Dry	No Improper Driving
109	10/16/97	Thu	2300	Left Turn	0	0	1	Nite	Dry	Disregarded Traffic Signal
110	10/21/97	Tue	1200	Sideswipe	0	0	1	Day	Dry	Disregarded Traffic Signal
111	11/2/97	Sun	1000	Angle	0	1	0	Day	Dry	No Improper Driving
112	11/18/97	Tue	1400	Rear End	0	0	1	Day	Dry	Followed to Closely
113	11/28/97	Fri	1300	Rear End	0	0	1	Day	Dry	Careless Driving
114	12/27/97	Sat	1200	Rear End	0	0	1	Day	Wet	Exceeded Safe Speed

115	12/30/97	Tue	1200	Other	0	0	1	Day	Dry	Careless Driving
Total No.	Fatal	Injury	PDO	Angle	Left Turn	Right Turn	Rear End	Side swipe	Ped/Bike	All Others
115	**0**	**56**	**59**	**9**	**9**	**0**	**82**	**6**	**0**	**9**
	0.00%	*48.70%*	*51.30%*	*7.83%*	*7.83%*	*0.00%*	*71.30%*	*5.22%*	*0.00%*	*7.83%*
Day	Night	Wet	Dry	Improper Lane Change	No Improper Driving	Careless Driving	Follow too Closely	Disregarded Traffic Signal	Exceeded Speed	All Others
95	**20**	**60**	**55**	**4**	**9**	**21**	**15**	**12**	**4**	**44**
82.61%	*17.39%*	*52.17%*	*47.83%*	*3.48%*	*7.83%*	*18.26%*	*13.04%*	*10.43%*	*3.48%*	*38.26%*
TOTAL VEHICLES ENTERING / ADT : **58,167**					CRASH RATE: **1.806** /MEV					

5.2 Crash Experience of Overall Triple Left-Turn Intersections

In the previous section, the crash experience of individual triple left-turn intersections was studied. This section summarizes the overall safety performance of the 11 triple left turns selected in this study. Crash summary data for these intersections were first combined and then separated into those that involved the triple left-turn traffic and those that did not. Crashes involving the triple left-turn traffic were then computed as a percentage of the total intersection crashes. This analysis approach has the advantage of comparing the overall crash experience of triple left-turn movements with that of the single and double left turns at the same study sites to allow for comparisons that are based on the same site conditions.

Table 5-12 summarizes by crash type the crash experience of triple left-turn movements in terms of the share of triple left-turn crashes as a percentage of the total intersection crashes. As can be seen, about 20% of the total crashes involved vehicles using the 11 triple left-turn approaches.[3]

[3] The crash summary reports contain two following variables that allowed us to determine this whether a vehicle was turning of going straight ahead. They included:

a. Direction: E, W, N, S, U(nknown)
b. Vehicle Movement:
1. Straight ahead
2. Slowing/Stopping/Stalled
3. Making left turn
4. Backing
5. Making Right Turn
6. Changing Lanes
7. Entering/Leaving Parking
8. Properly parked
9. Improperly parked
10. Making U-Turn
11. Passing
12 Driverless or runaway vehicle
77. All others
88 Unknown

Of particular interest were the percentages of crashes associated with left-turning traffic, including left-turn (51.6%), sideswipe (43.4%) and angle crashes (24.1%). Since the 11 triple left-turn intersections have an average number of less than two left-turn (single, double, and triple) movements per intersection, these percentages, suggest that triple left-turn movements did not contribute a disproportionately higher number of crashes compared to the single or double left-turn at the same sites. This indication is further strengthened when considering that the triple left-turn movements, on average, serve a significantly higher amount of left-turn volume than the single and double left-turn movements at the same intersections.

Table 5-12. Summary of Overall Crashes at Triple Left Turn Intersections

Approach Crashes	Rear-End	Angle	Side-swipe	Left-Turn	Right-Turn	Ped/Bike	All Other	Total
Crashes involving all traffic	302	116	53	31	10	11	73	596
Crashes involving non-triple-left traffic	267	88	30	15	8	10	60	478
Crashes involving triple-left traffic	35	28	23	16	2	1	13	118
Percent crashes involving triple-left traffic	11.6%	24.1%	43.4%	51.6%	20.0%	9.1%	17.8%	19.8%

Table 5-13 summarizes crash experience based on crash severity. It shows that, overall, triple left-turn vehicles contributed to 19.1% of the total injury crashes and 20.6% of the total PDO crashes, that crashes involving triple left-turn vehicles, at 49.2%, are not more serious than crashes involving the non-triple left-turn vehicles, at 51.5%.

Table 5-13. Overall Crashes by Crash Severity at Triple Left-Turn Intersections

Approach	Fatalities	Injury	Property Damage Only	Percent of Injury
Crashes involving all traffic	1	304	291	51.0%
Crashes involving non-triple-left traffic	1	246	231	51.5%
Crashes involving triple-left traffic	0	58	60	49.2%
Percent crashes involving triple-left traffic	0	19.1%	20.6%	-

5.3 Crash Experience of Grouped Triple Left-Turn Intersections

It can be seen from the condition diagrams presented in Section 5.1 that the 11 triple left-turn intersections vary widely in their geometric conditions. In this section, these intersections are

c. Accident lane number of crash
d. Site location: At intersection, driveway access, influenced by intersection, etc.
e: Roadside: Intersection, Left, right, median, etc.

.

grouped into three groups based on their similarities in geometric configuration, turning angle, presence of opposing traffic, and approach speed and volume.

Table 5-14 lists for each group the intersections in each group and the features associated with each intersection. Group 1 consists of four 3-legged intersections that serve high left-turn volume with medium to high approach speed. The triple left-turn approaches in this group are also skewed to favor the left-turn movements. The second group has four intersections and is characterized by triple left-turn storage areas that are “trapped” within a wide median area. These intersections also have low approach speed and approach volume. The last group is made up of three 4-legged intersections that have minor opposing movements and have moderate to high approach speed and volume.

Table 5-14. Summary of the Intersections Grouped by Intersection Characteristics

Group	Triple Left-Turn Intersections	Configu-ration	Triple Left Storage Area Trapped Between One-Way Pair?	Turn Angle (o)	Opposing Traffic?	App-roach Volume	App-roach Speed
1	SR 821 at SR 870	Y	No	75	None	High	Medium
	SR 821 at SR 838	Y	No	75	None	High	Medium
	SR 5 at SR 878	Y	No	65	None	High	High
	SR 7 at NW 7 Ave	Y	No	65	None	High	High
2	SR 5 at SE 1 St	T	Yes	90	None	Low	Low
	SR 5 at NE 2 St	T	Yes	90	None	Low	Low
	SR 5 at NE 4 St	4-leg	Yes	90	None	Low	Low
	SR 826 at SR A1A	T	Yes	90	None	Low	Low
3	SR 816 at NW 50 Ave	4-leg	No	90	Minor	High	Medium
	SR 969 at NW 12 St	4-leg	No	90	Minor	Medium	Medium
	SR 90 at SW 4 Ave	4-leg	Yes*	90	None	Medium	Medium

* Unlike the other intersections in the same group, which has their trap area within a median opening, the trap area of this intersection occupies a street block.

After the intersections were grouped, crash data were summarized for each group. Table 5-15 summarizes the crash experience by crash type for each group. Since the focus of this study is on crashes directly related to the triple left turns, only angle, sideswipe, left-turn, and rear-end crashes are included. As shown in the table, for the Group 1 intersections, the percentages of crashes involving triple left-turn traffic were not over-represented for each of the four crash types, especially considering that triple left-turns served a majority of the left-turn traffic at these intersections. Although the “Y” configuration associated with this group may have provided a favorable condition for sideswipe crashes, the third group, despite its 90^o turn angle, also did not have over-represented sideswipe crashes. For the Group 2 intersections, the percentages of sideswipe and left-turn crashes appear to be over-represented. However, it is also recognized at these intersections the triple left turn is the only left-turn movement. Thus, the percentages would tend to be higher.

Table 5-15. Summary of Crashes by Crash Type for Each Group

Approach	Angle	Sideswipe	Left-Turn	Rear-End
Group 1				
Crashes involving all traffic	33	18	13	167
Crashes involving non-triple-left traffic	19	12	8	146
Crashes involving triple-left traffic	14	6	5	21
Percent crashes involving triple-left traffic	42.4	33.3%	38.5%	12.6%
Group 2				
Crashes involving all traffic	42	9	3	23
Crashes involving non-triple-left traffic	38	4	1	18
Crashes involving triple-left traffic	4	5	2	5
Percent crashes involving triple-left traffic	9.5%	55.6%	66.7%	21.7%
Group 3				
Crashes involving all traffic	41	26	15	112
Crashes involving non-triple-left traffic	31	14	6	103
Crashes involving triple-left traffic	10	12	9	9
Percent crashes involving triple-left traffic	24.4%	46.2%	60.0%	8.0%

Table 5-16 summarizes crash experience by crash severity for each of the three triple left-turn intersection groups. For Group 1, the table shows that 64.7% of the crashes involving triple left-turn traffic resulted in an injury, compared to 55.2% of those crashes involving non-triple-left traffic. This suggests that, when a crash occurs, it is about 10% more likely to result in an injury if the crash involves vehicles from the triple left-turn approach. This over-representation is likely a result of the higher approach speed associated with the Group 1 triple left-turn movements. On the other hand, statistics for Group 2 shows comparable percentages of injury, at about 40%. For Group 3 intersections, the statistics show that crashes involving triple left-turn traffic were less likely to result in an injury.

Table 5-16. Overall Crashes by Crash Severity at Triple Left-Turn Intersections

Approach	Fatalities	Injury	Property Damage Only	Percent of Injury
Group 1				
Crashes involving all traffic	0	145	109	57.1
Crashes involving non-triple-left traffic	0	112	91	55.2
Crashes involving triple-left traffic	0	33	18	64.7
Percent crashes involving triple-left traffic	0	22.8	16.5	-
Group 2				
Crashes involving all traffic	1	43	61	41.0
Crashes involving non-triple-left traffic	1	35	50	40.7
Crashes involving triple-left traffic	0	8	11	42.1
Percent crashes involving triple-left traffic	0%	18.6%	18.2%	-
Group 3				
Crashes involving all traffic	0	116	121	44.9
Crashes involving non-triple-left traffic	0	99	90	52.4
Crashes involving triple-left traffic	0	17	31	35.4
Percent crashes involving triple-left traffic	0	14.7	25.6	-

5.4 Comparison of "T" Double and Triple Left-Turn Movements and Intersections

This section compares the safety experience of the Group 1 triple left turns to similar double left turns in the same study area by crash type, crash severity, time of day (day versus night), and surface condition (dry versus wet).[4] Crash experience involving pedestrians cannot be evaluated because of the very low pedestrian activities at most of the study sites. A total of 13 double left-turn intersections in Dade and Broward counties of conditions similar to those of Group 1 triple left-turn intersections were used in the comparison.

[4] The double left turn sites resulted from a search for similar intersections at freeways in Dade, Broward, and small part of Palm Beach counties. We checked every interchange that looked like a potential site. When the site matched our criteria, it was selected. The criteria included T configurations, no driveways or other ramp entrance/exit within about 250 feet. Most of the intersections appeared to have high traffic volumes. There were neither exact measurements taken nor sketches made of these intersections.

5.4.1 Comparison Based on Average Intersection Crash Rates

Table 5-17 compares the average intersection crash rates for double and triple left-turn intersections by crash type, crash severity, time of day, and road surface condition. The table shows that triple left-turn intersections experienced a higher average crash rate for the following crash categories: total, injury, rear-end, sideswipe, daytime, and wet surface. Among them the wet surface and sideswipe crash categories show a significant difference in crash rates. However, two-sample "t" statistical tests at the 95 percent confidence level indicate no statistical differences between the two groups of intersections for all crash categories. Note that average crash rates based on turning movement cannot be performed in this study due to the unavailability of turning movement counts.

Table 5-17. Statistical Comparison of Average Intersection Crash Rates

Crash Category	Triple Left-Turn Intersections (n=4)		Double Left-Turn Intersections (n=13)		t-value**	Significant at 95% (Yes/No)
	Total Crashes	Average Crash Rate	Total Crashes	Average Crash Rate		
Total	254	0.990	723	0.964	0.083	No
Fatal	0	0.000	1	0.001	-0.542	No
Injury	145	0.562	392	0.524	0.230	No
PDO	109	0.428	330	0.438	-0.060	No
Left-Turn	13	0.053	99	0.132	-1.249	No
Angle	33	0.125	114	0.155	-0.562	No
Rear-End	167	0.655	394	0.524	0.618	No
Sideswipe	18	0.081	38	0.048	1.424	No
Others	23	0.088	78	0.104	-0.411	No
Daytime	197	0.768	457	0.613	0.699	No
Nighttime	57	0.222	266	0.351	-1.066	No
Wet Surface	105	0.415	155	0.209	1.714	No
Dry Surface	149	0.575	568	0.755	-0.800	No

*** Crash Rate = Total Crashes/Total Exposure; Total Exposure = AADT *3*365/1000000**
**** For 95% confidence level the critical t-value is 2.131 at 15 degree of freedom**

5.4.2 Comparison Based on Average Percentages of Crashes Involving Left-Turn Traffic

Table 5-18 compares the average percentages of crashes involving double and triple left-turn vehicles. The statistical tests show that, in terms of percentages of crashes contributed by left-turn vehicles to the total number of intersection crashes, there were no differences in crash experience between double and triple left turns for all crash categories. In terms of total crashes, both double and triple left turns contributed to about 30% of the total intersection crashes. The numbers by crash severity for the two groups are also very closed. In terms of crash type, triple left-turn vehicles experienced more sideswipe and rear-end crashes and less left-turn and angle crashes than their double left-turn counterpart. In terms of time of day, there was no significant difference between the two groups. For surface condition, triple left-turn vehicles experienced about 10% more crashes than double left turn on wet surfaces, while essentially no difference was observed for dry surfaces.

Table 5-18. Statistical Comparison of Percent of Crashes Involving Left-Turn Traffic

Crash Category	**Triple Left-Turn Intersections (n=4)**		**Double Left-Turn Intersections (n=13)**		**t-value****	**Significant at 95% (Yes/No)**
	Total Crashes	**Average Percentages of Crashes**	**Total Crashes**	**Average Percentages of Crashes**		
Total	254	29.7	723	30.3	-0.084	No
Fatal	0	0.0*	1	0.0*		No
Injury	145	30.3	392	32.7	-0.278	No
PDO	109	28.8	330	27.5	0.147	No
Left-Turn	13	20.8	99	49.9	-1.282	No
Angle	33	50.7	114	63.1	-0.895	No
Rear-End	167	25.0	394	18.3	0.801	No
Sideswipe	18	33.3	38	24.9	0.484	No
Others	23	25.0	78	35.9	-0.633	No
Daytime	197	29.7	457	28.8	0.124	No
Nighttime	57	30.8	266	33.9	-0.298	No
Wet Surface	105	38.9	155	29.1	0.745	No
Dry Surface	149	27.7	568	31.4	-0.591	No

*** t-value cannot be computed because the standard deviations of both groups are 0.**
** For 95% confidence level t critical value = 2.131 at degree of freedom =15

The sample size is admittedly small, so it is not possible to make inferences about whether there are differences between comparable double and triple left turn lane locations. We did note that two of the triple left lane locations had high crash rates, although none of the double left turn locations were excessive. The basis for this inference is based the determination that crash rates at two of the locations exceeded the computed confidence limits for both the entire set of intersections (doubles and triples) and just those in the set of triples locations.

As shown in Table 5-19, two of the locations stand out and exceed the computed upper confidence limits (N=11, p=0.9995) using a conservative testing procedure. SR 816 (Oakland Park Blvd)/NW 50th Ave and SR90/SW 4th Ave has been previously documented as a high crash intersection. The SR90/SW 4th Ave site may show an erroneously high crash rate due to our inability to obtain the ADT for the SW 4th Ave that is not a state road. The crash rate is based on the ADT for SR 90 only. In any event these two locations deserve additional analysis that is beyond the scope of the present study.

Table 5-19. Crash Rates for Triple Left Turn Lanes

Location of 3LTLs	Computer Crash Rate
SR 870 & SR 821	1.806
SR 816 & NW 50th Ave	3.051*
SR 838 & SR 821	1.344
SR 5 & SR 968	0.983
SR 5 & NE 4th St	0.372
SR 5 & NE 2nd St	0.387
SR 826 & SR A1A	1.176
SR 5 & SR 878	0.368
SR 969 & NW 12th St	0.936
SR 90 & SW 4th Ave	2.901*
SR 7 & SR 826	0.445
Mean	**1.252**
Standard Deviation	**0.970**
Upper Confidence Limit	**2.59**

5.5 Other Factors That May Influence Safety of Multiple Left Turn Lanes

The crash data analyzed in these study did not allow us to test various hypotheses that we found in the literature during our review. The most predominant hypotheses relate to both measurable characteristics of the intersection and traffic performance. The increased demand of higher volume intersections and increased numbers of turning traffic increase the need for higher tire-pavement traction (affected by super elevation and pavement skid resistance). Locations where there are mixtures of turning and non-turning vehicles and where there is hesitancy of drivers (for whatever reasons) suggest a greater danger at these sites. Likewise a high proportion of large trucks, with their off-tracking disadvantage, are expected to add to the difficulty of safe movement of vehicles in multiple left turn lanes. Other factors associated with drivers are undoubtedly important but are hard to establish with the types of field data normally collected. For example, it has been established that many older drivers have difficulty in making left turns, especially at T and cross intersections.

6. OVERALL ASSESSMENT

This project has reviewed several considerations associated with triple left-turn lanes, including:

- Previously published literature on multiple left turn studies and experience;
- Experience of other states with double and triple left turns;
- Operational studies at intersections in Florida;
- Crash experience at intersections in Florida and
- Traffic model applications for multiple left turns.

None of these sources of information indicated the existence of universally accepted standards for triple left-turn lane design and operation, although Ackeret's 1994 guidelines are fairly complete and well recognized.

6.1 General Observations

Based on the information compiled by the study the following general observations are offered:

1. Although the developers of the models investigated for this project do appear to have envisioned triple left turn lanes, all the models can be used to represent triple left turn lanes as three-lane movements that happen to be turning left. Several states that have constructed triple-left turn lanes extrapolate the guidelines developed for double left-turn lanes. Guidance has been derived primarily from NCHRP Report No 279 or the use of the Highway Capacity Manual or other performance evaluation models. Several of the state responses suggest that vehicle hourly left-turn volumes must exceed 600 to be considered as a candidates for adding a third left turning lane.

2. The combined saturation flow rates measured at a single location in Gainesville and six locations in South Florida varied from 1544 to 2150 pcphgpl. Analysis suggests that the best performers are at Y and T intersections with simple geometrics. These results are generally consistent with the few other operational studies of the ideal capacity of triple left turn lanes. There is sufficient variation in the types triple left turn configurations. Accordingly we believe more analysis is required before developing a table of capacity adjustments for triple left turn lanes.

3. Although the literature suggests that, in general, one lane or another may service more vehicles than the other two, the data we obtained did not appear to support such a hypothesis. It would appear that the location of nearby intersections and specific geometrics (e.g., number of intersection legs, angle of intersecting roadways), and other traffic factors determine lane preferences.

4. Analysis of crash data from eleven intersections with triple left turning lanes indicated that, in general, safety is not compromised. When crash rates at these locations are

compared with intersections with double left turn lanes with similar characteristics, there are no significant differences in the crash rates.

5. Crash rates are high at a few of the study locations. These appear related to conflicting vehicle movements due to closely spaced intersections and complex geometric designs.

6.2 Existing Design Guidelines and Issues for Double Left Turns

The NCHRP 279 criteria form the basis for design in several states. A value of 300 vehicles per hour is a common threshold for the consideration of double left-turn lanes. The consensus appears to favor a 30 ft throat width for receiving the turning traffic, but a range of 26 to 36 feet was reported.

Two design criteria for accommodating large vehicles were mentioned. The first would accommodate two WB 50 vehicles turning simultaneously and the second would accommodate one WB50 and one SU 30 vehicle.

6.3 Existing Design Guidelines for Triple Left Turns

Ackeret's guidelines developed in 1994 are widely recognized and are a good candidate for at least an interim standard. These guidelines begin by suggesting that the following conditions are inappropriate for triple left-turn lane installations:

- There is a potential for higher number of pedestrian-vehicle conflicts;
- Left-turning vehicles are not anticipated to queue uniformly within the provided left-turn storage due to downstream conditions;
- Conditions exist that obscure, or result in, confusing pavement markings within the intersection;
- Right-of-way restrictions prohibit adequate design-vehicle turning maneuver space within the intersection; and
- The installation is not economically justified when compared with other alternatives to improve intersection capacity.

Ackeret's recommendations on the geometric design of triple left turns include the following recommendations:

1. Select the design vehicle governed by single-unit truck/bus for roadways on truck-restricted areas, or by WB-50 otherwise;

2. The lateral clearance between the running design vehicles should be maintained with a minimum clearance of 2 feet on each side of the design vehicle overhang limits within turning maneuvers;
3. Concurrent opposing left turns should have at least 10 feet vehicle clearance between opposing left turns;
4. Left-turn approach lane widths should have at least 11 feet in width with a desirable width of 12 feet;
5. The downstream departure lane widths should have an absolute minimum of 11 feet with a desirable width of 12 feet;
6. The receiving leg should have a raised median island of at least 2 feet in width to provide drivers on the inside lane with a visual point of reference to guide the vehicle through the left-turn maneuver;
7. Determine storage bay length based on anticipated left-turn arrival rates, cycle length, need to prevent spillover to thru lanes, and presence of adjacent upstream intersections and driveways;
8. Determine approach taper length based on design speed and local preference for reverse curves versus taper sections;
9. Advance overhead should be used to inform drivers of lane options. These signs should be supplemented with appropriate downstream lane destination messages if they will reduce downstream weaving maneuvers; and
10. Skip lines, preferably comprised of raised markers, should be used through the intersection with appropriate spacing to control the multiple turning path and keep each vehicle within its lane.

6.4 Traffic Model Applications

The value of traffic models in analyzing triple left-turn operations is well recognized, especially when any complications are present from upstream or downstream intersections. An investigation of the most common software products that model signalized intersection operations suggested the following:

1. None of the models investigated recognizes the unique characteristics of triple left turns. Instead, they all model triple left turns as three-lane movements that happen to be turning left. There is little or no difference between three-lane through movements and triple left turns;
2. The single intersection models, HCM and SIDRA, are easier to use and are probably adequate for the analysis of relatively simple triple left turn situations. When complexities arise from upstream or downstream conditions, one of the signal network models (CORSIM or TRANSYT-7F) should be used;

3. The network models appear to do a reasonable job of modeling spillback into the intersection from downstream bottlenecks, but they are not able to recognize problems associated with such phenomena as multiple trucks turning simultaneously;

4. Maintenance of capacity (i.e., avoiding capacity reductions) is a promising criterion for determining the minimum merging section length when a triple left turn must enter a two-lane street. Avoidance of spillback may be a better criteria criterion, because of its increased sensitivity and potential as a safety surrogate. Both of these criteria require signalized intersection performance estimation software (Star Network Simulation);

5. Both CORSIM and TRANSYT-7F are able to recognize spillover explicitly and to make adjustment to the effective capacity of an approach to reflect the blockage caused by spillback;

6. CORSIM has several parameters in its input data structure that should be useful in creating an operation that could represent triple left turns more realistically, but most of these items had no influence on the CORSIM performance estimations. This suggests that heir effects are minimal, or that they are not implemented as per the CORSIM documentation; and

7. The star-network mapped into both CORSIM and TRANSYT-7F by the new version of the Arterial Analysis Package is an effective tool for analyzing most intersections that have triple left turns with adjacent-intersection effects.

6.5 Additional Analysis Needed

The data collected in this study provides a clear indication that the third lane for a triple left-turn lane configuration increases the capacity of the intersection by approximately one-third. We did not have a direct basis for making a comparison between two and three left-turn lanes. Accordingly, we can not say with confidence that the addition of a third turn lane to an existing configuration or building a new left turn lane configuration with three lanes would provide such an increase. Existing literature suggests that the improvement would be somewhat less than a full one-third increase in the number of vehicles serviced for each traffic signal cycle. Empirically, the only way to establish the magnitude of the increase is to obtain before and after data for a variety of configurations that are upgraded. Because the number of such projects is expected to be limited in the near future, uniform data would have to drawn from the nation, rather than Florida alone.

The crash data in this study is limited but does suggest that for certain configurations, such as Y junctions, triple left turn lanes has no adverse influence of safety. For locations with more complex intersections (e.g., roads with medians, closely spaced adjacent intersection, 4-leg intersections) there is a hint that triple left-turn lanes may reduce safety. Again, without direct “before-after” comparisons for upgraded intersections or analyses using rigid control of geometric and traffic characteristics, there is no empirical way to establish the impact triples will make on safety.

For moderate to high traffic volume facilities, it is hard to conceive of situations where triple left-turn lanes will not increase the intersection capacity over single or double left-turn lanes. If safety is indeed compromised for more complex road environments then some form of tradeoff analysis is warranted. Without more empirical data, modeling of both service and safety appears to be only practical way to assess the impacts of triples. We expect that a comprehensive analysis using the models used in this study will yield mixed results because different models make different assumptions, but can provide a more sensitive decision tool to judge whether road users are best served by the construction of triple left-turn configurations.

6.6 Recommended Modifications to the Traffic Engineering Manual

The FDOT has developed the *Traffic Engineering Manual* (TEM) to provide traffic engineering standards and guidelines to be used on the State Highway System by the Department's District Traffic Operations Offices. To fulfill the technology transfer requirements of this research project, it is recommended that the coverage of the TEM be extended to include requirements and guidelines for multiple left turns. It is also recommended that material covering triple left turn lanes be added to the FDOT *Design Standards.* Specifically, Index 17346, Sheet 8 of 13 now covers markings for single and double left turn lanes. This treatment should be extended to cover triple left turn lanes.

The current version of the TEM covers left turn treatments at signalized intersections in Section 3.2. The following text is recommended for addition to Section 3.2 as Section 3.2.7:

> ***MULTIPLE LEFT TURN LANES***
>
> *It is common practice at signalized intersections on the state highway system to provide an exclusive lane for left-turning traffic unless the volume of left turns is negligible. At intersections with heavy left turns, it may be necessary to consider providing more than one left turn lane to accommodate a given movement. Double left turn lanes are commonly used for this purpose. Triple left turn lanes have been implemented successfully throughout the state, but are much less common.*
>
> *Multiple left turn lanes provide additional capacity for left turning movements and will usually produce an improvement in the overall intersection delay and level of service. The operational benefits are offset to some extent by additional exposure for cyclists and pedestrians, and by a generally increased complexity of the driving task. The operational benefits are relatively easy to estimate using accepted analysis techniques. The effect on driver performance and on safety to all road users is much harder to quantify. With this in mind, the following guidelines are offered:*

Double Left Turn Lanes

Double left turn lanes may be used for specific movements when the following conditions apply:

1. *An operational analysis of the intersection indicates that the provision of a double left turn lane would correct a situation in which the overall capacity of the intersection is not sufficient to meet the demand.*

2. *Two downstream lanes are available to receive the left turning traffic for at least 300 feet from the intersection.*

3. *No problems are evident with respect to bicycle and pedestrian safety.*

In addition, the following conditions are desirable for double left turn lanes:

1. *Continuous downstream receiving lanes should be provided to avoid a lane drop.*

2. *Left turn lanes should be fully shadowed by storage bays whenever possible.*

3. *The signal timing plan should provide adequate clearance times for bicycles and pedestrians*

4. *Lane line extensions should normally be used to delineate the proper turning path through the intersection for the double left-turn maneuver to reduce the sideswipe collision potential and to promote efficient double left-turn operations. The markings should be carefully planned to coincide closely with normal vehicular turning paths*

5. *Lane lines (or guide lines) and width requirements should be determined by plotting the swept paths of the selected design vehicles. For most intersections on the State Highway System, design of double lane turns should consider as a minimum an SU vehicle and P vehicle turning simultaneously. More guidance on the determination of turning radii and other geometric design parameters is given in Chapter 3 of the Florida Department of Transportation Intersection Design Guide.*

6. *Concurrent opposing left turns should have at least 8 feet clearance between opposing left turns. If adequate separation cannot be achieved, separate left turn phases for each direction will be necessary.*

Triple Left Turn Lanes

Triple left turn lanes require more specific justification and more attention to detail in the design. All of the requirements listed above for double left turn lanes apply to triple left turn lanes. The following additional requirements should be met for triple left turn lanes, and their use should only be considered when the following conditions are fully met:

1. *An operational analysis of the intersection indicates that the provision of a triple left turn lane would correct a situation in which the overall capacity of the intersection would be seriously deficient, and that no other geometric or signal modifications would correct the deficiency. The operational analysis must take into account the effects of adjacent intersections, including:*

    a. *Backup from a downstream signal on the receiving roadway*

    b. *Relative turning movement distribution at a downstream intersection that would compromise the ability of the receiving lanes to store the left turning vehicles*

    c. *Heavy volumes from other approaches that are also accommodated by the roadway that receives the left turns.*

    d. *Upstream effects that could make it difficult to distribute the approaching left turns over the three left turning lanes (e.g. a heavy single lane exit ramp from a freeway).*

    The Highway Capacity Manual should be used for operational analysis only when there are no complicating factors of the type listed above. If there are any upstream or downstream influences, a microscopic simulation should be performed.

2. *Lane lines (or guide lines) and width requirements should be determined by plotting the swept paths of the selected design vehicles. For most intersections on the State Highway System, design of triple lane turns should consider as a minimum an SU vehicle and two P vehicles turning simultaneously with a minimum 4 feet separation between the swept paths of the vehicles. The SU vehicle should be able to turn in all lanes. More guidance on the determination of turning radii and other geometric design parameters is given in Chapter 3 of the Florida Department of Transportation Intersection Design Guide.*

3. *Three downstream lanes are available to receive the left turning traffic for at least 300 feet from the intersection, and at least two continuous downstream lanes exist beyond that point.*

4. *There are no conditions that obscure, or result in, confusing pavement markings within the intersection.*

5. *The safety record (number and type of collisions) at the intersection suggests that the proposed operation would not aggravate a demonstrated safety problem.*

6. *No problems are evident with respect to bicycle and pedestrian safety.*

7. *The signal-timing plan must be able to provide adequate walk and don't walk clearance intervals for all phases that accommodate through movements, taking the increased roadway width into account.*

In addition, the following conditions are desirable for triple left turn lanes:

1. *Continuous downstream receiving lanes should be provided to avoid a lane drop.*

2. *The literature (Ackeret, Reference 1) identifies three categories of triple left turn configurations illustrated in the figure on the next page.:*

   - *Type A: Three exclusive left turn bays*
   - *Type B: Two exclusive left turn bays plus an exclusive left turn trap lane*
   - *Type C: Two exclusive left turn bays plus an optional through-left lane*

   The Type A configuration should be used whenever possible to avoid the trap lanes associated with Type B configurations and to avoid the operational complexities of an optional through and left turn lane associated with Type C configurations.

3. *Ackeret's 1994 guidelines should be followed where applicable*

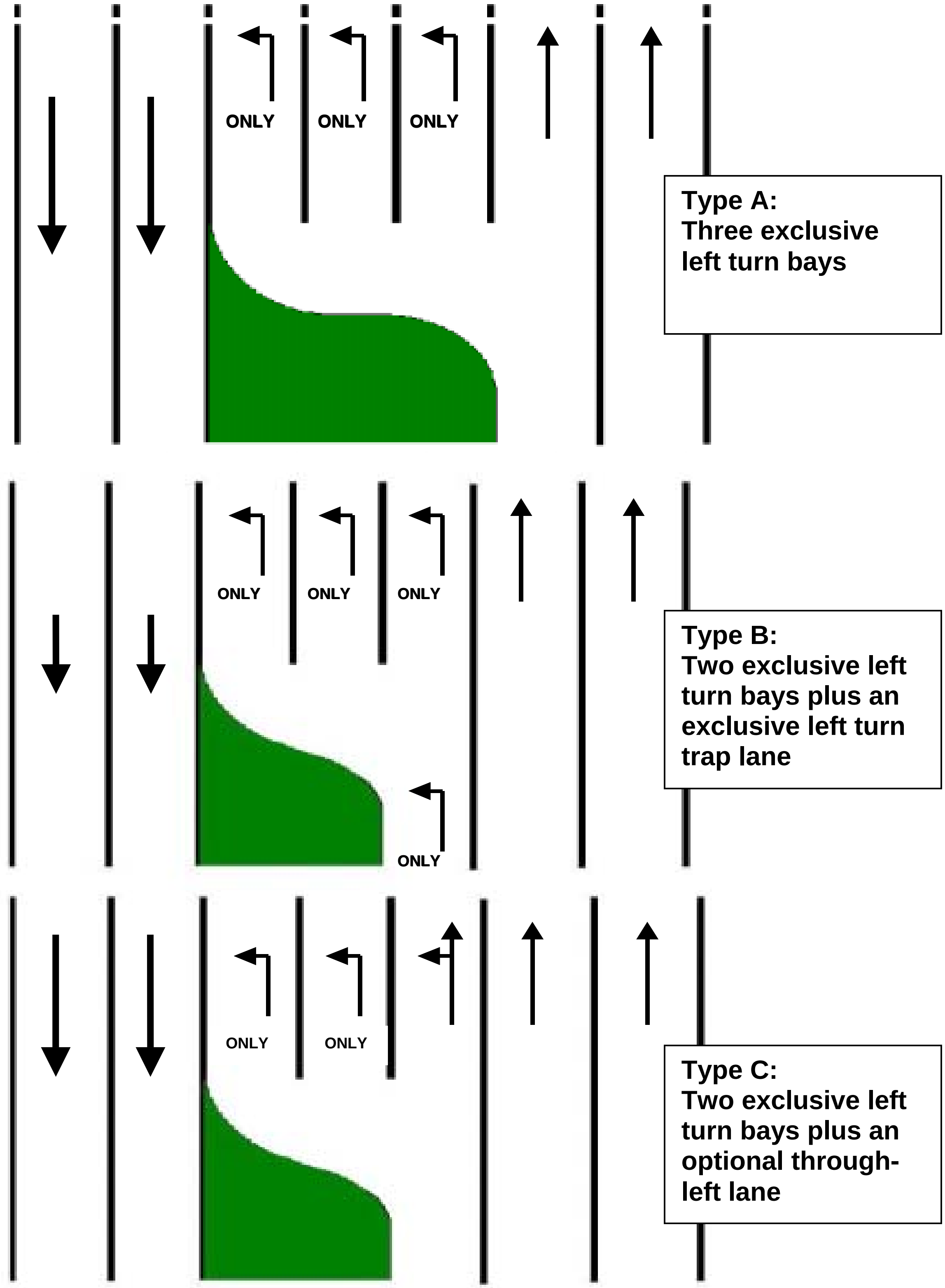
4. *All configurations require adequate signing and marking to make the intended operation clear to every road user. Each turn lane should be marked with turn arrows and "ONLY" legends as appropriate Type B and C configurations require special attention because of their potential for confusing drivers*

5. *The receiving leg should have a raised median island of at least 2 feet in width to provide drivers on the inside lane with a visual point of reference to guide the vehicle through the left-turn maneuver.*

6. *Special attention should be given to the signal timing intervals that are sensitive to bicycle and pedestrian requirements, including the walk and don't walk clearance intervals for pedestrians and the yellow and all-red intervals for bicycles.*

Reference

1. *Ackeret, K. W., "Criteria for the Geometric Design of Triple Left-Turn Lanes," ITE Journal, Institute of Transportation Engineers, vol. 64, no. 12, pp. 27-33, December 1994.*



Ackeret's three types of triple left turn lane configurations

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APPENDIX A – TRAFFIC DATA COLLECTION AND ANALYSIS METHODOLOGY

Several methods have to be performed in order to do a study of multiple left-turn lanes. The steps of the methodology to be followed are: the site selection, the data collection that involves the camera selection, the installation of the sound transmitter and the setup of the system, the data reduction, the data analysis and the data flow infrastructure.

SITE SELECTION

Appropriate sites for this study are busy intersections with multiple left-turn lanes. The intersection should have long queues of cars waiting to make a left turn, there should be some unusual events happening at the intersection involving different types of vehicles. The Multiple Left-Turn Lane Site Selection Summary Form presented in Figure A-1 should be used to confirm that the selected site fits the requirements for the study. The form includes some general information about the name and the location of the intersection, the peak hour times, the percentages of trucks and the presence of pedestrian accommodations. The form also asks for some approach and exit parameters. The last important item in the selection of the site form is the "Vantage Point Characteristics for Video Taping." One of the objectives of the study is to test different video cameras. A good location must be available to install the camera so that it gives a good view of the whole intersection. Usually the far-right corner from the approach is a good position to install the camera. There must not be any visibility problems and no physical obstructions to the camera view.

DATA COLLECTION

The data for the study are obtained by installing a video camera at the selected intersection and recording left-turn activities at desired time, usually during peak periods. The camera is mounted either on a concrete or wooden pole and placed on the far-right side of the intersection from the approach. The camera should have a lens with a wide enough angle to cover both the approach and exit sections. Different types of cameras can be used to do this study. A sound transmitter is used to register the periodic changes in the signal phases. Both the camera and the sound transmitter are connected to a VCR that records the activities. A 12-Volt battery supplies power to the whole system.

Multiple Left-turn Lane Site Selection Summary

District ______ City ___________________________ Area Type CBD Suburban Other

Approach St. ___________________ SR ____ Cross St. _____________________________ SR ____

Reason for multiple LT lane ____

Periods of congested operation____

Periods of heavy pedestrian conflict ____

Approximate truck percentages during peak periods ____

Pedestrian accommodations (crosswalks, signal phases, etc.) __________________________________

Approach Parameters				Exit Parameters			
Lane	Use LTR	Width	Bay Length	Terminal Treatment	Distance	Access Features	Distance
1							
2							
3							
4							
5							
6							

Treatment Codes
- **L**eft only
- **R**ight only
- **S**ignalized
- **U**nsignalized
- **D**rop

Access Codes
- **M**edian opening
- **D**riveway
- **P**arking

Direction: NB SB EB WB

Configuration: 4 leg T Y

Distance to upstream signal _____

Inside turn lane radius _______

Approach angle ________

Opposing lanes _________

Adjacent lanes __________

Cross section 1 way
2 way undivided 2 way divided

Unusual features, problems and concerns:

Figure A-1. Multiple Left-Turn Site Selection Form

Vantage Point Characteristics for Video Taping (Far-right corner from approach)

Visibility problems____

Pole/structure type _______________________ Signal controller location __________________

Observer security? ____

Camera Selection

Once a site has been selected for the study, the next thing to do is find a camera that will record the activities at the intersection. The first thing that should be done is check for the existence of a permanent camera that could avoid the need for a special installation. If a permanent camera is not present, a special installation is required. The special installation involves mounting a little camera (spy camera) on a pole and placing it at a good vantage point.

The permanent camera is usually installed by local jurisdictions at the desired location, usually near the top of a utility pole. The recording unit is located inside the signal controller cabinet and is connected to the camera by cables. Whenever a recording is to be made, a tape is inserted in a VCR in the controller cabinet and it is used to record activities at the intersection for the desired duration. The camera is put in a box to protect it against adverse environmental conditions. The advantage of using a permanent camera is that it gives the best picture quality with the least effort on the part of researchers. The only drawback is that since it's a little more sophisticated; it needs costly maintenance of the glass protecting the lens.

If a permanent camera is not available, a "spy" camera also works well study purposes. This is a special installation that requires a little more effort. The "spy" camera is mounted on a pole and a good vantage point in the intersection has to be located to place the camera. The camera is positioned in a way that the lenses will cover both approach and exit sections of the intersection. The spy camera has high-resolution and is fully waterproof. There are two different models of spy camera that are used for the study.

Figure A-2. Weatherproof Camera

The first kind of spy camera is called the weatherproof camera (
Figure A-2). Its characteristics are 1 lux, black and white 380 TV lines of resolution, -4F ~ 140F working temperature, 90 degrees or 2.9mm wide-angle lens, built-in heater.

Figure A-3. Weatherproof Bullet Camera

The second kind of spy camera is called the weatherproof bullet camera (
Figure A-3). Its characteristics are 0.2 lux, black and white 380 TV lines of resolution, Macro Focus, 14F ~ 140F working temperature, 75 degrees or 3.8mm wide-angle lens. The weatherproof bullet camera also can be used with an angle lens of 6 mm.

The perspectives and the picture quality are disadvantages of using a “spy” camera. The viewpoint is at an angle upon which only three approaches can be viewed. Since the two types of camera record in black and white, the picture quality is not the best. Due to poor contrast in film, at times it is difficult to recognize when a vehicle is crossing the stop line or the pedestrian crosswalk.

Sound Transmitter

The Sound Transmitter objective is to send a message to the recorder and tells the researcher that the signal light has turned green. The whole system for the transmitter can be seen in Figure A-4.

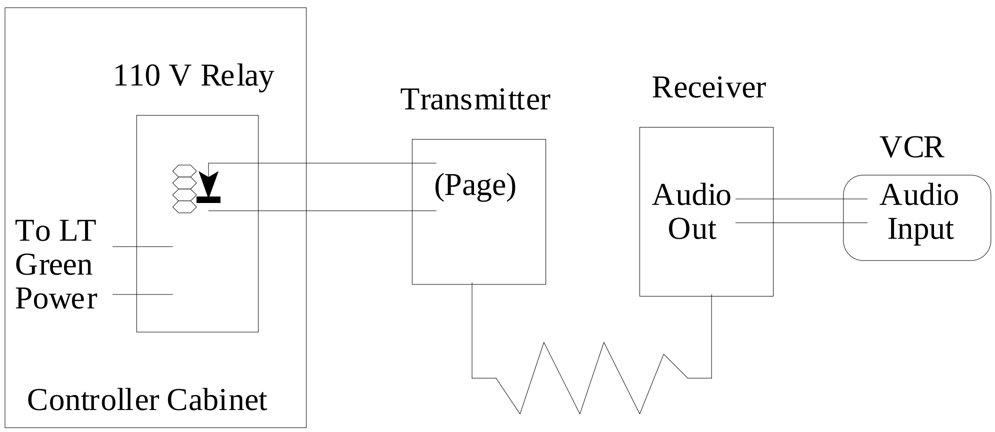

Figure A-4. Signal Interconnection Requirements for Recording

The operating agency is asked to connect a relay to the load switch for the green signal displayed to the left turn movement. A small transmitter is installed in the controller cabinet to provide an indication of when the signal is green. The overall system consists of two parts, a radio receiver and a radio transmitter. The transmitter gets the signal from the relay that there is a change in the signal phase and gets it to the receiver. Upon receiving the signal from the transmitter, the receiver picks up a high pitch sound. The beginning of the sound means the start of the yellow interval and the end of the sound means the signal has just turned red. The receiver is connected to the VCR for the sound to be recorded.

System Setup

When the camera has been selected for the desired location and the relay has been connected in the controller box, it is time to setup the whole system that will record the activities at the intersection. The camera needs to be installed at the vantage point selected. The camera is usually mounted on a concrete or wooden utility pole. Bungee cords and chains are used to hold the pole firm. The camera should not be moving at all. The camera is connected to a portable TV that helps to make sure that the camera is in the correct position (view of the whole intersection.) The camera is also connected to a VCR to record the activities. The equipment operates on a 12 Volt DC battery; therefore no external power source is required.

For protection and security reasons, the whole equipment is placed in a suitcase that is closed with two locks and chained to the utility pole during the time of the study. To do an efficient study, it is always good to be able to get data from both the morning and afternoon peaks. The setup of the whole equipment featuring the sound transmitter, the portable television, the VCR, all in the suitcase can be seen in Figure A-5.

Figure A-5. Setup of Recording Equipment

DATA REDUCTION

After the data from the videotape has been collected, it needs to be reduced. An Event Time Series (ETS) program was created specifically to reduce the data obtained. The ETS program is an MSDOS application that creates a text file containing a record of keystrokes entered by an observer over a period of time. The events describing the process are summarized in Figure A-6. The coding covers only actions during the turn phase. Each phase is treated as a separate data series.

The study starts when the "Esc" key is struck, and it ends when the "Star" key is struck. The cycle for each phase begins when the "Space Bar" is struck and continues until the "Enter" key is struck representing the apparent end of phase. The coding requires that all the turn lanes and the vehicles in each of these lanes be specified. Lane 1 refers to the left-most turning lane, Lane 2 and Lane 3 progress to the right.

Three types of vehicles are considered for this study. Automobiles, vans, and motorcycles are considered a single type. Recreational vehicles, pickup trucks, and station wagons, which are hauling a second vehicle, trailer or boat, are in the second category. Vehicles with long wheelbases, primarily tractor-trailers, bus-type recreation vehicles hauling a trailer or boat constitute the third category. It should be noted that entry point must be defined and used consistently for each location (usually the stop line or the pedestrian crosswalk.) It is essential that all vehicles entering the intersection be counted.

Figure A-6. Summary of ETS Events for Multiple Left-Turn Operations

Event	**Lane**			**Comment**
	1	**2**	**3**	
Single unit enters intersection. Entry point must be defined and used consistently for each location (usually the stop line).	1	2	3	It is essential that all vehicles entering the intersection be counted.
Vehicle with trailer enters intersection	q	w	e	
Large Semi-Trailer enters intersection	a	s	d	
End of queue in lane for this cycle	z	x	c	
Start of queue backup into intersection	F1	F2	F3	
Encroachment or lane change to left within intersection	Left Arrow			
Encroachment or lane change to right within intersection	Right Arrow			
Interference with turning traffic from bicycle or pedestrian in crosswalk.	\			
Movement in undefined lane	Ins			
Encroachment into opposing lane	Tab			
Unusual event noted on audio tape	Plus			
Begin cycle	Space			Use exact times if audio phase data are included, otherwise these events must be approximated
Apparent end of phase	Enter			
Cancel last keystroke	Backspace			
Cancel last cycle	Del			
Pause/restart tape	Esc			
End study	Star			

In this study we are also interested in finding out how long the queue is in each lane. Therefore, there is a special key that can be struck as soon as the queue has been serviced. The study is also looking at some unusual events happening at the intersection. Such events include start of queue backup into the intersection, encroachment or lane change to right or left within the intersection, bicycle and pedestrians interfering with the turning movements and any unusual event noted on the audiotape. A specific key is assigned for each event to be recorded. For example, a single vehicle entering the intersection in lane 1, a “1” would be struck on the keyboard and the corresponding number that would appear on the ETS program is 49. To end the study, the “*” key would be struck and the corresponding number that appears is 42.

The opening screen of the Event Time Series (ETS) program asks for the name of the study which is (MULTS) for multiple left-turns study, the data file name, usually the date that the recording was done, the elapsed time for the each cycle and the entire study, the cycle number, the event number and the number that associated with the key that was struck on the keyboard. An observer watches the videotape and records the left-turn activities in each lane for all the cycle. Each time a vehicle crossed the desired entry point in each of the left-turn lanes, a specific key is struck. When the data from the tape has been entered, the program produces an output that contains the tile "ETS DATA TYPE MULTS," the name of the file, the date and time that the data was reduced, each event key number and the time that key was struck on the keyboard for each cycle. The output of the ETS program is a text file with the extension "ETS."

DATA ANALYSIS

Once the data from the videotape has been collected and reduced through the ETS program, the next step is to analyze that data. A program called MULTS for (multiple left-turns) was created in the QBASIC programming language to analyze the data from the ETS file. The purpose of the program is to take the information given in the output of the ETS file and obtain some parameters such as average headways, vehicle type, and lane distribution. Figure A-7 shows a part of the output from the MULTS Program.

Before running the program, a few questions are asked like the name of the file with extension (ETS), and the number of lanes involved. If both entries are correct, the program runs and produces a comma delimited text file. If one of the entries is incorrect, an error message pops up. The comma delimited text file can be opened in excel for better observations. Following are some of the information contained in the excel output file: cycle number, lane number, start delay, relative start, number of cars, trucks and trailers, number of vehicles in the queue, number of vehicles after the queue as been serviced, average headway and headway for each vehicle.

The last two rows of the output show the average values of all the cycles for the start delay, relative start and average headway for lane 1 and 2. The last two rows also show the total number of each type of vehicles that turned left at the intersection, the total number of queued vehicles and total number of vehicles after the queue has been serviced. One of the most important for the study is the average headway. From this value the saturation flow rate for each lane can be found. Other things that are important from the output are lost time, lane distribution, and vehicle classification.

Figure A-7. Sample Output from the MULTS Program

Cycle	Lane	StartDel	RelSLT	Cars	Trailers	Trucks	Queued	Free	Av Hdwy
1	1	1.4	0	9	0	0	9	0	1.92
1	2	1.4	0.4	10	0	0	6	4	1.6
2	1	1.5	0.8	9	0	0	9	0	2.2
2	2	1.5	0	10	0	0	8	2	1.95
3	1	0.9	0	7	1	0	8	0	2.25
3	2	0.9	0.7	7	0	0	7	0	2.1
4	1	1.8	0.2	13	0	1	14	0	1.87
4	2	1.8	0	12	0	1	12	1	1.83
5	1	1.5	2	12	0	0	11	1	2.31
5	2	1.5	0	14	0	0	12	2	2.03
6	1	1.3	0.8	14	0	0	9	5	1.8
6	2	1.3	0	12	0	0	7	5	1.7
7	1	1.3	0	0	0	0	0	0	0
7	2	1.3	0	0	0	0	0	0	0
8	1	1.2	0.8	8	0	0	8	0	2.03
8	2	1.2	0	4	0	0	3	1	0
9	1	1.4	1.2	11	0	0	11	0	1.74
9	2	1.4	0	8	0	0	8	0	2.1
10	1	1.2	0.4	10	0	0	9	1	2.06
10	2	1.2	0	11	0	0	10	1	1.87
11	1	1.6	0	11	0	0	10	1	2.1
11	2	1.6	0.8	9	0	0	9	0	2.04
12	1	1.1	1.2	15	0	0	15	0	1.68
12	2	1.1	0	14	0	0	14	0	1.85
13	1	1.3	0.6	13	0	0	12	1	1.89
13	2	1.3	0	11	0	0	10	1	1.55
14	1	1.3	0.6	14	0	0	14	0	1.83
14	2	1.3	0	12	0	0	12	0	1.89
15	1	0.9	0.5	13	0	0	12	1	1.66
15	2	0.9	0	13	0	0	12	1	1.7
16	1	1.8	0.6	9	0	0	8	1	1.8
16	2	1.8	0	8	0	0	7	1	1.7
17	1	1.9	0	7	0	1	8	0	1.88
17	2	1.9	0.4	7	0	0	7	0	2.07
18	1	1.4	0	9	0	0	8	1	2.92
18	2	1.4	2.8	6	0	0	5	1	2
19	1	1.2	0.2	8	0	1	9	0	2.5
19	2	1.2	0	10	0	0	10	0	1.98
20	1	0.9	0	6	0	0	5	1	2
20	2	0.9	1.4	5	0	0	4	1	0
Ave	1	1.34	0.5	198	1	3	189	13	1.92
Ave	2	1.34	0.32	183	0	1	163	21	1.6

DATA FLOW INFRASTRUCTURE

This section of the report gives a good overview of the steps that are followed in order to go through a study of multiple left-turn lanes (Figure A-8).

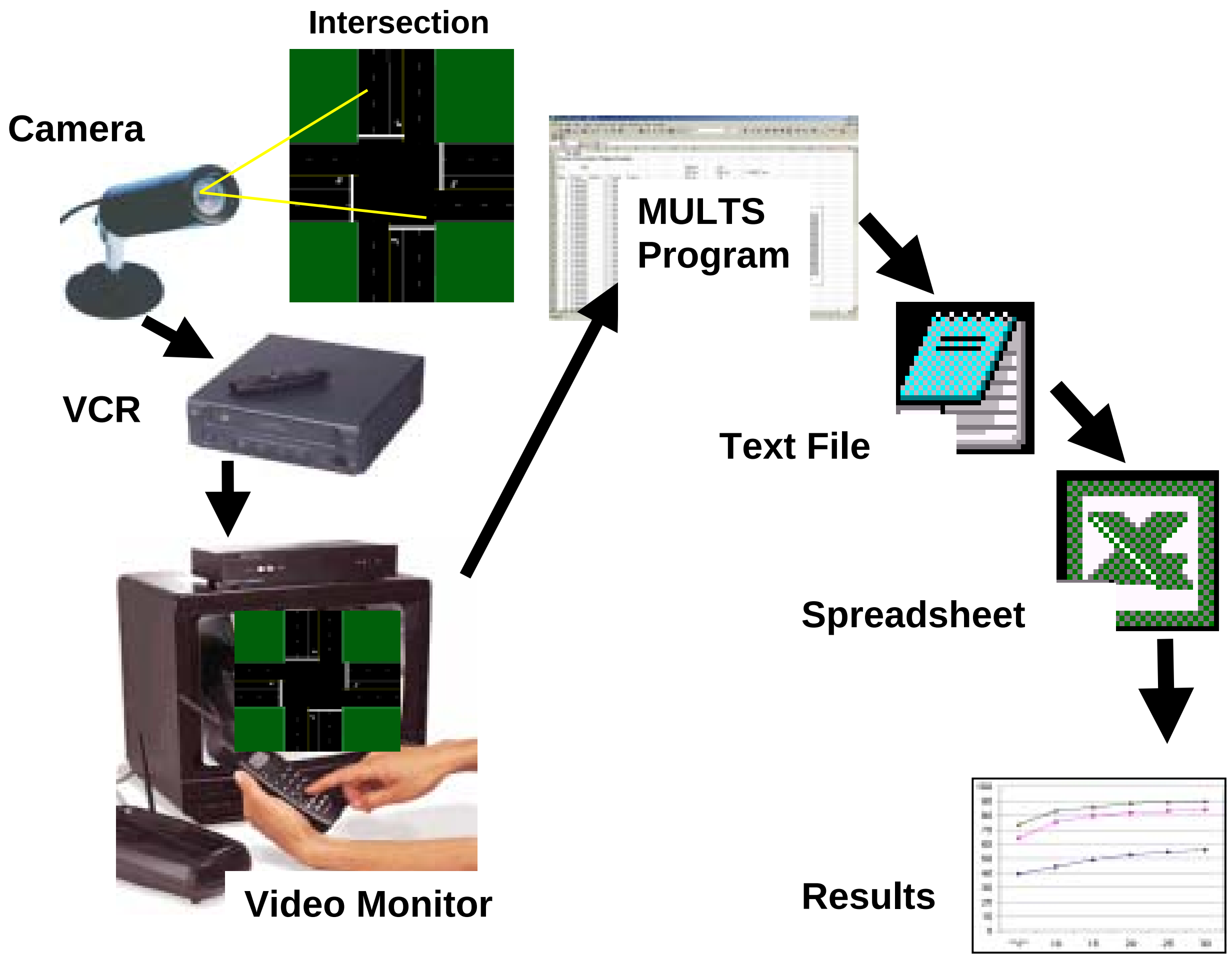

Figure A-8. Data Flow Diagram of Methodology

A video camera is installed at a selected intersection to record the activities during peak periods. An observer then views the tape and the data obtained is reduced using the Event Times Series (ETS) program. An ETS file is obtained from the reduced file and ran through a QBASIC program called MULTS in order to get the total number of each type of vehicles and their headways in each lane. The program's output is a comma delimited text file that can be opened in excel and be analyzed. Results and conclusions can be drawn from the analysis.

STUDY PRODUCT

The example location illustrated here is an intersection located in Ormond Beach that is being studied for its double left-turn. The major street is Highway A1A and the minor street is State Road 40. The double left-turn approach section is from south to north and the exit section is from west to east. The northbound direction has a double-left turn lane, two through lanes and a right turn lane. All approaches have left-turn signal phase. The signal phase for the north-south movement is protected and the signal for the east-west movement is protected plus permitted. All approaches have pedestrian accommodations.

A good vantage point was located at the far right corner from the approach section of the intersection. A spy camera was mounted on a pole and attached to a fixed structure. The model of the spy camera that worked better for this intersection was the weatherproof camera with wide-angle lens of 2.9 mm. Figure A-9 shows a camera view of the intersection. The sound transmitter was not available for this location because the relay was not connected in the controller cabinet. This did not create a problem in obtaining average headways. On the other hand, an accurate value for the lost time was hard to get because the observer did not know exactly when the signal light turned green. The observer considered the light to be green when the vehicles started moving. The camera was connected to a 12-Volt DC battery and a VCR. All the equipment was put in a suitcase and locked for protection and security purposes. The VCR recorded from 4:30 pm to 6:30 pm to capture the afternoon peak for this location.

Figure A-9. Camera View of the Intersection of SR 40 and A1A

The videotape for this location was observed and using the Event Times Series (ETS) program the data was reduced. The ETS data file was ran through the QBASIC program to get some information in a comma delimited text format. This text document was opened in excel and several parameters mentioned in the objective was obtained. The most important parameters taken from the output were the average headway for each left-turn lane, vehicle classification and lane distribution. The headway was used to calculate the saturation flow rate in each lane.

CONCLUSION

The purpose of this procedural study was to test emerging technology, video taping, and to propose an efficient methodology to study the relative effectiveness of multiple left-turn lanes in handling traffic. The methodology developed is appropriate for analyzing traffic service and flow levels at high volume intersections with multiple left-turn lanes.

APPENDIX B – CRASH SUMMARY TABLES FOR DOUBLE LEFT-TURN INTERSECTIONS

Table B-1. Crash Summary Table for SR 814 (Atlantic Blvd.) at SR 849

FLORIDA DEPARTMENT OF TRANSPORTATION

CRASH SUMMARY

SECTION: **86130000** STATE ROUTE: **814 (Atlantic Blvd.)**

INTERSECTING ROUTE: **SR 849** M.P. **3.228** ENGINEER:

STUDY PERIOD: FROM **1/ 95** TO **12/ 97** COUNTY: **Broward**

No.	DATE	DAY	TIME	TYPE	FATAL	INJURY	PROP DAM	DAY / NT	WET / DRY	CONTRIBUTING CAUSE
1	3/19/95	Sun	1900	Rear End	0	0	1	Nite	Dry	No Improper Driving
2	4/21/95	Fri	2300	Rear End	0	0	1	Nite	Dry	No Improper Driving
3	4/24/95	Mon	2100	Angle	0	0	1	Nite	Dry	No Improper Driving
4	6/9/95	Fri	1500	Rear End	0	0	1	Day	Dry	No Improper Driving
5	7/7/95	Fri	1100	Rear End	0	0	1	Day	Dry	No Improper Driving
6	7/26/95	Wed	1300	Angle	0	0	1	Day	Wet	Failed to Yield R/W
7	7/31/95	Mon	2100	Rear End	0	0	1	Nite	Wet	No Improper Driving
8	8/21/95	Mon	800	Rear End	0	0	1	Day	Dry	Followed to Closely
9	8/28/95	Mon	700	Rear End	0	0	1	Day	Dry	No Improper Driving
10	10/19/95	Thu	400	Pedestrian	0	1	0	Nite	Wet	No Improper Driving
11	10/29/95	Sun	2100	Rear End	0	0	1	Nite	Dry	All Others
12	12/1/95	Fri	2100	Sideswipe	0	0	1	Nite	Dry	No Improper Driving
13	12/4/95	Mon	1600	Angle	0	0	1	Day	Dry	All Others
14	12/7/95	Thu	1500	Angle	0	0	1	Day	Dry	Failed to Yield R/W
15	12/16/95	Sat	800	Rear End	0	1	0	Day	Dry	No Improper Driving
16	1/2/96	Tue	1000	Rear End	0	0	1	Day	Dry	No Improper Driving
17	1/28/96	Sun	100	Left Turn	0	1	0	Nite	Dry	All Others
18	2/29/96	Thu	1400	Left Turn	0	1	0	Day	Dry	Failed to Yield R/W
19	4/19/96	Fri	2100	Rear End	0	1	0	Nite	Dry	All Others
20	4/24/96	Wed	0	Left Turn	0	0	1	Day	Slippery	Improper Turn
21	4/26/96	Fri	900	Rear End	0	1	0	Day	Dry	Followed to Closely
22	5/24/96	Fri	1200	Rear End	0	1	0	Day	Dry	All Others
23	6/1/96	Sat	0	Rear End	0	0	1	Nite	Dry	No Improper Driving
24	7/5/96	Fri	0	Sideswipe	0	0	1	Nite	Dry	No Improper Driving
25	7/9/96	Tue	700	Left Turn	0	1	0	Day	Dry	Disregarded Traffic Signal
26	7/12/96	Fri	1400	Left Turn	0	0	1	Day	Dry	Failed to Yield R/W
27	9/1/96	Sun	200	Rear End	0	0	1	Nite	Wet	Alcohol - Under Influence
28	9/26/96	Thu	700	Angle	0	0	1	Day	Dry	Failed to Yield R/W
29	10/26/96	Sat	1200	Rear End	0	0	1	Day	Dry	No Improper Driving
30	11/8/96	Fri	1400	Rear End	0	1	0	Day	Dry	Followed to Closely
31	12/7/96	Sat	1500	Rear End	0	0	1	Day	Dry	No Improper Driving
32	12/7/96	Sat	2300	Rear End	0	0	1	Nite	Slippery	All Others
33	12/8/96	Sun	0	Rear End	0	1	0	Nite	Wet	Followed to Closely
34	12/11/96	Wed	2000	Head On	0	1	0	Nite	Dry	Failed to Yield R/W
35	12/31/96	Tue	2200	Left Turn	0	1	0	Nite	Dry	No Improper Driving

36	1/10/97	Fri	1800	Rear End	0	0	1	Nite	Dry	Followed to Closely
37	2/7/97	Fri	1600	Rear End	0	0	1	Day	Wet	No Improper Driving
38	2/27/97	Thu	900	Left Turn	0	1	0	Day	Wet	Failed to Yield R/W
39	3/11/97	Tue	800	Angle	0	0	1	Day	Wet	Failed to Yield R/W
40	3/27/97	Thu	1900	Angle	0	1	0	Nite	Dry	Failed to Yield R/W
41	4/1/97	Tue	1900	Left Turn	0	1	0	Nite	Dry	No Improper Driving
42	4/7/97	Mon	1400	Angle	0	1	0	Day	Dry	No Improper Driving
43	4/11/97	Fri	1000	Angle	0	1	0	Day	Wet	Failed to Yield R/W
44	4/14/97	Mon	900	Sideswipe	0	0	1	Day	Dry	No Improper Driving
45	5/12/97	Mon	1300	Left Turn	0	0	1	Day	Slippery	No Improper Driving
46	7/20/97	Sun	100	Other	0	1	0	Nite	Dry	Careless Driving
47	7/30/97	Wed	700	Rear End	0	1	0	Day	Dry	Failed to Maintain Equipment
48	8/12/97	Tue	1100	Rear End	0	0	1	Day	Wet	All Others
49	8/28/97	Thu	1000	Angle	0	1	0	Day	Dry	No Improper Driving
50	10/13/97	Mon	1200	Left Turn	0	0	1	Day	Dry	No Improper Driving
51	10/29/97	Wed	1900	Right Turn	0	0	1	Nite	Dry	All Others
52	11/16/97	Sun	0	Fixed Object	0	0	1	Unk	Unknown	Unknown
53	12/18/97	Thu	2300	Sideswipe	0	0	1	Nite	Dry	All Others

Total No.	Fatal	Injury	PDO	Angle	Left Turn	Right Turn	Rear End	Side swipe	Ped/Bike	Other
53	**0**	**20**	**33**	**10**	**10**	**1**	**24**	**4**	**1**	**3**
	0.00%	*37.74%*	*62.26%*	*18.87%*	*18.87%*	*1.89%*	*45.28%*	*7.55%*	*1.89%*	*5.66%*
Day	Night	Wet	Dry	Improper Turn	No Improper Driving	Careless Driving	Follow too Closely	Disregarded Traffic Signal	FTY R/W	All Others
30	**23**	**11**	**42**	**1**	**23**	**1**	**5**	**1**	**10**	**9**
56.60%	*43.40%*	*20.75%*	*79.25%*	*1.89%*	*43.40%*	*1.89%*	*9.43%*	*1.89%*	*18.87%*	*16.98%*

TOTAL VEHICLES ENTERING / ADT : **47,736**	CRASH RATE: **1.014** /MEV

Table B-2. Crash Summary Table for SR 814 (Atlantic Blvd.) at I-95 NB Off Ramp

FLORIDA DEPARTMENT OF TRANSPORTATION

CRASH SUMMARY

SECTION: **86130000** STATE ROUTE: **814 (Atlantic Blvd.)**

INTERSECTING ROUTE: **I-95 NB off Ramp** M.P. **5.174** ENGINEER:

STUDY PERIOD: FROM **1/ 95** TO **12/ 97** COUNTY: **Broward**

No.	DATE	DAY	TIME	TYPE	FATAL	INJURY	PROP DAM	DAY / NT	WET / DRY	CONTRIBUTING CAUSE
1	1/12/95	Thu	1900	Angle	0	0	1	Day	Dry	Failed to Maintain Equipment
2	1/21/95	Sat	1800	Rear End	0	1	0	Nite	Dry	Careless Driving
3	2/14/95	Tue	1700	Rear End	0	1	0	Day	Dry	Careless Driving
4	3/13/95	Mon	1600	Rear End	0	0	1	Day	Slippery	No Improper Driving
5	3/15/95	Wed	1300	Rear End	0	0	1	Day	Dry	Careless Driving
6	4/1/95	Sat	1600	Head On	0	0	1	Day	Slippery	No Improper Driving
7	4/28/95	Fri	800	Rear End	0	0	1	Day	Dry	No Improper Driving
8	6/13/95	Tue	1400	Rear End	0	1	0	Day	Slippery	Obstructing Traffic
9	6/29/95	Thu	1300	Rear End	0	1	0	Day	Wet	Improper Lane Change
10	7/2/95	Sun	1200	Rear End	0	1	0	Day	Wet	No Improper Driving
11	7/10/95	Mon	1300	Fixed Object	0	0	1	Day	Dry	All Others
12	7/17/95	Mon	1800	Rear End	0	0	1	Day	Slippery	No Improper Driving
13	7/18/95	Tue	900	Rear End	0	1	0	Day	Slippery	All Others
14	7/20/95	Thu	2100	Rear End	0	1	0	Nite	Dry	No Improper Driving
15	7/28/95	Fri	1300	Rear End	0	0	1	Day	Slippery	No Improper Driving
16	8/2/95	Wed	1200	Rear End	0	0	1	Day	Slippery	All Others
17	8/3/95	Thu	1200	Angle	0	1	0	Day	Slippery	All Others
18	8/8/95	Tue	1600	Rear End	0	0	1	Day	Dry	Followed to Closely
19	8/9/95	Wed	1900	Angle	0	0	1	Day	Dry	No Improper Driving
20	8/12/95	Sat	1200	Rear End	0	0	1	Day	Dry	Followed to Closely
21	8/12/95	Sat	2000	Angle	0	1	0	Nite	Dry	Disregarded Traffic Signal
22	8/17/95	Thu	1900	Rear End	0	0	1	Nite	Dry	Followed to Closely
23	8/18/95	Fri	1500	Rear End	0	0	1	Day	Dry	Followed to Closely
24	8/18/95	Fri	1800	Rear End	0	0	1	Day	Dry	No Improper Driving
25	9/8/95	Fri	1900	Rear End	0	0	1	Nite	Slippery	Disregarded Traffic Signal
26	9/9/95	Sat	1500	Fixed Object	0	0	1	Day	Slippery	No Improper Driving
27	9/12/95	Tue	0	Rear End	0	1	0	Nite	Dry	Followed to Closely
28	9/19/95	Tue	1800	Left Turn	0	0	1	Day	Slippery	Failed to Yield R/W
29	9/22/95	Fri	900	Rear End	0	0	1	Day	Slippery	No Improper Driving
30	9/25/95	Mon	1800	Rear End	0	0	1	Day	Dry	No Improper Driving
31	10/30/95	Mon	1300	Rear End	0	1	0	Day	Dry	Careless Driving
32	10/30/95	Mon	800	Rear End	0	0	1	Day	Wet	Careless Driving
33	11/1/95	Wed	1400	Rear End	0	1	0	Day	Wet	All Others
34	11/21/95	Tue	1100	Rear End	0	0	1	Day	Wet	No Improper Driving
35	12/10/95	Sun	0	Left Turn	0	1	0	Nite	Dry	Disregarded Other Traffic
36	12/10/95	Sun	2100	Rear End	0	1	0	Nite	Wet	All Others
37	12/17/95	Sun	1600	Rear End	0	1	0	Day	Dry	No Improper Driving
38	1/17/96	Wed	1400	Angle	0	0	1	Day	Dry	Improper Lane Change
39	1/28/96	Sun	1800	Rear End	0	0	1	Nite	Wet	All Others

40	2/2/96	Fri	2300	Other	0	1	0	Nite	Dry	Disregarded Traffic Signal
41	2/10/96	Sat	1700	Sideswipe	0	0	1	Nite	Dry	No Improper Driving
42	2/16/96	Fri	1200	Rear End	0	1	0	Day	Slippery	Obstructing Traffic
43	3/15/96	Fri	100	Other	0	0	1	Nite	Dry	Careless Driving
44	4/8/96	Mon	1300	Rear End	0	0	1	Day	Slippery	No Improper Driving
45	4/20/96	Sat	1600	Rear End	0	0	1	Day	Dry	All Others
46	4/20/96	Sat	100	Fixed Object	0	0	1	Nite	Dry	No Improper Driving
47	4/25/96	Thu	1600	Rear End	0	1	0	Day	Dry	No Improper Driving
48	5/4/96	Sat	100	Other	0	0	1	Nite	Dry	No Improper Driving
49	5/11/96	Sat	100	Rear End	0	0	1	Nite	Dry	All Others
50	5/12/96	Sun	1700	Rear End	0	0	1	Day	Dry	All Others
51	5/15/96	Wed	1500	Rear End	0	1	0	Day	Dry	All Others
52	5/15/96	Wed	1600	Rear End	0	0	1	Day	Wet	Careless Driving
53	5/18/96	Sat	1200	Rear End	0	0	1	Day	Dry	All Others
54	6/24/96	Mon	1800	Rear End	0	0	1	Day	Dry	No Improper Driving
55	7/1/96	Mon	1600	Rear End	0	1	0	Day	Dry	All Others
56	7/18/96	Thu	1300	Rear End	0	0	1	Day	Dry	Followed to Closely
57	7/21/96	Sun	1100	Rear End	0	1	0	Day	Dry	Disregarded Traffic Signal
58	8/18/96	Sun	1600	Angle	0	1	0	Day	Dry	No Improper Driving
59	8/30/96	Fri	900	Rear End	0	1	0	Day	Dry	Disregarded Other Traffic
60	8/31/96	Sat	0	Rear End	0	1	0	Nite	Dry	No Improper Driving
61	9/8/96	Sun	1900	Rear End	0	0	1	Day	Wet	Followed to Closely
62	10/7/96	Mon	1400	Rear End	0	0	1	Day	Dry	All Others
63	10/9/96	Wed	1700	Other	0	1	0	Day	Dry	No Improper Driving
64	10/30/96	Wed	1300	Head On	0	0	1	Day	Dry	All Others
65	11/3/96	Sun	400	Fixed Object	0	0	1	Nite	Dry	No Improper Driving
66	11/12/96	Tue	1300	Rear End	0	0	1	Day	Dry	No Improper Driving
67	12/13/96	Fri	0	Fixed Object	0	1	0	Nite	Wet	All Others
68	12/27/96	Fri	1200	Fixed Object	0	0	1	Day	Dry	All Others
69	3/6/97	Thu	100	Other	0	1	0	Nite	Dry	Careless Driving
70	3/20/97	Thu	2300	Rear End	0	1	0	Nite	Dry	No Improper Driving
71	4/14/97	Mon	1500	Sideswipe	0	0	1	Day	Slippery	Careless Driving
72	5/3/97	Sat	1900	Sideswipe	0	0	1	Nite	Slippery	Careless Driving
73	5/5/97	Mon	900	Rear End	0	0	1	Day	Dry	All Others
74	5/26/97	Mon	1300	Rear End	0	1	0	Day	Dry	All Others
75	6/7/97	Sat	1300	Left Turn	0	0	1	Day	Dry	No Improper Driving
76	6/18/97	Wed	1500	Rear End	0	1	0	Day	Dry	All Others
77	6/20/97	Fri	800	Rear End	0	0	1	Day	Dry	Followed to Closely
78	7/1/97	Tue	1900	Fixed Object	0	0	1	Nite	Slippery	All Others
79	7/11/97	Fri	1700	Rear End	0	1	0	Day	Dry	No Improper Driving
80	7/19/97	Sat	900	Rear End	0	1	0	Day	Dry	Failed to Maintain Equipment
81	7/29/97	Tue	1600	Rear End	0	1	0	Day	Dry	No Improper Driving
82	7/30/97	Wed	1100	Rear End	0	1	0	Day	Dry	Followed to Closely
83	8/8/97	Fri	1600	Rear End	0	1	0	Day	Slippery	Obstructing Traffic
84	8/10/97	Sun	0	Rear End	0	0	1	Nite	Dry	No Improper Driving
85	9/4/97	Thu	700	Rear End	0	1	0	Day	Dry	Followed to Closely
86	9/22/97	Mon	1600	Rear End	0	1	0	Day	Dry	Careless Driving

87	10/13/97	Mon	1700	Angle	0	0	1	Nite	Slippery	No Improper Driving
Total No.	Fatal	Injury	PDO	Angle	Left Turn	Right Turn	Rear End	Side swipe	Ped/Bike	Other
87	**0**	**37**	**50**	**7**	**3**	**0**	**60**	**3**	**0**	**14**
	0.00%	*42.53%*	*57.47%*	*8.05%*	*3.45%*	*0.00%*	*68.97%*	*3.45%*	*0.00%*	*16.09%*
Day	Night	Wet	Dry	Improper Lane Change	No Improper Driving	Careless Driving	Follow too Closely	Disregarded Traffic Signal	Obstructing Traffic	All Others
63	**24**	**23**	**64**	**2**	**31**	**11**	**10**	**4**	**3**	**21**
72.41%	*27.59%*	*26.44%*	*73.56%*	*2.30%*	*35.63%*	*12.64%*	*11.49%*	*4.60%*	*3.45%*	*24.14%*
TOTAL VEHICLES ENTERING / ADT : **54,500**					CRASH RATE: **1.458** /MEV					

Table B-3. Crash Summary Table for SR 816 (Oakland Park Blvd.) at I-95 SB Off Ramp

FLORIDA DEPARTMENT OF TRANSPORTATION

CRASH SUMMARY

SECTION: **86090000** STATE ROUTE: **816 (Oakland Park)**

INTERSECTING ROUTE: **I-95 SB Off Ramp** M.P. **5.965** ENGINEER:

STUDY PERIOD: FROM **1/ 95** TO **12/ 97** COUNTY: **Broward**

No.	DATE	DAY	TIME	TYPE	FATAL	INJURY	PROP DAM	DAY / NT	WET / DRY	CONTRIBUTING CAUSE
1	1/9/95	Mon	1900	Rear End	0	0	1	Nite	Dry	Followed to Closely
2	1/14/95	Sat	1200	Other	0	1	0	Day	Wet	Improper Lane Change
3	2/2/95	Thu	700	Rear End	0	0	1	Day	Dry	All Others
4	2/13/95	Mon	1000	Fixed Object	0	1	0	Day	Dry	No Improper Driving
5	2/23/95	Thu	800	Rear End	0	0	1	Day	Wet	All Others
6	3/6/95	Mon	1900	Rear End	0	0	1	Day	Dry	No Improper Driving
7	3/13/95	Mon	1500	Rear End	0	1	0	Day	Slippery	Failed to Maintain Equipment
8	3/25/95	Sat	1700	Rear End	0	1	0	Day	Dry	All Others
9	4/1/95	Sat	2100	Rear End	0	0	1	Nite	Wet	All Others
10	4/6/95	Thu	1700	Angle	0	0	1	Day	Slippery	Improper Passing
11	4/18/95	Tue	2300	Fixed Object	0	1	0	Nite	Dry	All Others
12	4/24/95	Mon	1700	Rear End	0	1	0	Day	Dry	No Improper Driving
13	4/29/95	Sat	2200	Other	0	1	0	Nite	Wet	All Others
14	5/11/95	Thu	1600	Rear End	0	0	1	Day	Dry	Careless Driving
15	5/19/95	Fri	1400	Rear End	0	1	0	Day	Dry	All Others
16	5/31/95	Wed	800	Rear End	0	1	0	Day	Dry	No Improper Driving
17	6/13/95	Tue	1500	Rear End	0	0	1	Day	Slippery	No Improper Driving
18	7/20/95	Thu	1500	Rear End	0	0	1	Day	Wet	All Others
19	7/31/95	Mon	1900	Left Turn	0	1	0	Nite	Slippery	No Improper Driving
20	8/4/95	Fri	1600	Rear End	0	1	0	Day	Dry	All Others
21	8/4/95	Fri	1700	Rear End	0	1	0	Day	Dry	All Others
22	8/9/95	Wed	0	Other	0	1	0	Nite	Dry	All Others
23	8/18/95	Fri	1500	Rear End	0	1	0	Day	Dry	All Others
24	8/24/95	Thu	1700	Sideswipe	0	0	1	Day	Slippery	All Others
25	9/19/95	Tue	1700	Rear End	0	0	1	Nite	Slippery	No Improper Driving
26	9/23/95	Sat	2200	Fixed Object	0	1	0	Nite	Wet	Exceeded Safe Speed
27	9/26/95	Tue	1700	Rear End	0	1	0	Day	Dry	All Others
28	10/2/95	Mon	900	Rear End	0	0	1	Day	Dry	No Improper Driving
29	10/15/95	Sun	800	Other	0	0	1	Day	Slippery	Careless Driving
30	10/17/95	Tue	900	Rear End	0	0	1	Day	Slippery	No Improper Driving
31	10/18/95	Wed	800	Sideswipe	0	0	1	Day	Slippery	Improper Lane Change
32	10/25/95	Wed	1600	Rear End	0	1	0	Day	Dry	Careless Driving
33	10/31/95	Tue	1200	Rear End	0	1	0	Day	Wet	All Others
34	10/31/95	Tue	700	Rear End	0	1	0	Day	Dry	All Others
35	11/13/95	Mon	700	Rear End	0	1	0	Day	Dry	No Improper Driving
36	11/21/95	Tue	1700	Rear End	0	1	0	Nite	Dry	No Improper Driving
37	12/1/95	Fri	1100	Rear End	0	1	0	Day	Dry	All Others
38	12/4/95	Mon	900	Sideswipe	0	0	1	Day	Dry	Improper Lane Change
39	12/10/95	Sun	1800	Rear End	0	1	0	Nite	Dry	Careless Driving

40	12/10/95	Sun	2300	Rear End	0	0	1	Nite	Dry	Followed to Closely
41	12/14/95	Thu	800	Rear End	0	1	0	Day	Dry	No Improper Driving
42	1/1/96	Mon	200	Rear End	0	0	1	Nite	Wet	No Improper Driving
43	1/10/96	Wed	2300	Fixed Object	0	0	1	Nite	Dry	Improper Turn
44	1/22/96	Mon	1500	Rear End	0	1	0	Day	Dry	Followed to Closely
45	1/24/96	Wed	1300	Angle	0	1	0	Day	Dry	All Others
46	1/27/96	Sat	0	Rear End	0	0	1	Day	Dry	All Others
47	1/28/96	Sun	0	Left Turn	0	1	0	Nite	Dry	Disregarded Traffic Signal
48	2/4/96	Sun	1900	Rear End	0	1	0	Nite	Dry	Followed to Closely
49	2/7/96	Wed	1300	Rear End	0	1	0	Day	Dry	Careless Driving
50	2/9/96	Fri	1100	Rear End	0	1	0	Day	Dry	Careless Driving
51	2/15/96	Thu	2100	Rear End	0	0	1	Nite	Dry	Followed to Closely
52	2/27/96	Tue	1700	Rear End	0	0	1	Day	Dry	No Improper Driving
53	3/4/96	Mon	600	Rear End	0	0	1	Day	Dry	All Others
54	3/26/96	Tue	2000	Rear End	0	1	0	Nite	Dry	Careless Driving
55	4/21/96	Sun	2100	Rear End	0	0	1	Nite	Dry	No Improper Driving
56	4/24/96	Wed	600	Rear End	0	1	0	Day	Dry	Followed to Closely
57	4/24/96	Wed	700	Fixed Object	0	1	0	Day	Dry	No Improper Driving
58	5/14/96	Tue	1300	Sideswipe	0	1	0	Day	Dry	Improper Lane Change
59	5/24/96	Fri	900	Rear End	0	1	0	Day	Dry	Followed to Closely
60	6/4/96	Tue	1000	Rear End	0	1	0	Day	Slippery	Followed to Closely
61	6/5/96	Wed	2100	Left Turn	0	1	0	Nite	Dry	Disregarded Traffic Signal
62	6/8/96	Sat	2100	Left Turn	0	0	1	Day	Dry	All Others
63	7/23/96	Tue	1700	Rear End	0	1	0	Day	Dry	No Improper Driving
64	7/30/96	Tue	2200	Fixed Object	0	1	0	Nite	Dry	No Improper Driving
65	8/2/96	Fri	1500	Rear End	0	1	0	Day	Dry	Followed to Closely
66	8/16/96	Fri	1500	Rear End	0	1	0	Day	Wet	No Improper Driving
67	8/23/96	Fri	1700	Rear End	0	1	0	Day	Wet	Followed to Closely
68	8/26/96	Mon	1600	Rear End	0	0	1	Day	Slippery	Careless Driving
69	9/5/96	Thu	2200	Left Turn	0	0	1	Nite	Dry	Improper Turn
70	9/12/96	Thu	700	Rear End	0	0	1	Day	Dry	Followed to Closely
71	9/21/96	Sat	1800	Rear End	0	1	0	Nite	Wet	Careless Driving
72	9/24/96	Tue	2000	Rear End	0	1	0	Nite	Dry	No Improper Driving
73	10/28/96	Mon	800	Rear End	0	0	1	Day	Dry	No Improper Driving
74	11/7/96	Thu	1900	Rear End	0	0	1	Nite	Dry	Careless Driving
75	11/13/96	Wed	900	Angle	0	0	1	Day	Dry	Improper Lane Change
76	11/14/96	Thu	1500	Angle	0	1	0	Day	Wet	Disregarded Traffic Signal
77	11/16/96	Sat	700	Rear End	0	0	1	Day	Wet	Followed to Closely
78	11/19/96	Tue	1700	Angle	0	0	1	Nite	Dry	All Others
79	11/20/96	Wed	1400	Rear End	0	1	0	Day	Dry	Exceeded Safe Speed
80	11/21/96	Thu	700	Angle	0	0	1	Day	Dry	Failed to Yield R/W
81	11/23/96	Sat	1700	Angle	0	0	1	Nite	Dry	Disregarded Other Traffic
82	11/24/96	Sun	2200	Angle	0	1	0	Nite	Dry	No Improper Driving
83	12/9/96	Mon	1800	Rear End	0	1	0	Nite	Dry	No Improper Driving
84	12/11/96	Wed	1800	Sideswipe	0	0	1	Day	Dry	Improper Passing
85	12/22/96	Sun	1900	Left Turn	0	1	0	Nite	Dry	All Others
86	12/22/96	Sun	200	Left Turn	0	0	1	Nite	Dry	No Improper Driving

87	1/6/97	Mon	0	Other	0	0	1	Nite	Dry	Improper Parking
88	1/14/97	Tue	2200	Head On	0	0	1	Nite	Slippery	No Improper Driving
89	1/15/97	Wed	1700	Rear End	0	1	0	Nite	Slippery	Followed to Closely
90	1/20/97	Mon	1800	Rear End	0	0	1	Nite	Dry	Followed to Closely
91	2/14/97	Fri	1000	Rear End	0	1	0	Day	Dry	Failed to Maintain Equipment
92	2/21/97	Fri	400	Rear End	0	1	0	Nite	Dry	All Others
93	3/1/97	Sat	800	Sideswipe	0	1	0	Day	Dry	No Improper Driving
94	3/2/97	Sun	0	Angle	0	1	0	Day	Dry	All Others
95	3/25/97	Tue	900	Rear End	0	1	0	Day	Dry	No Improper Driving
96	3/26/97	Wed	2100	Sideswipe	0	0	1	Day	Dry	No Improper Driving
97	4/7/97	Mon	1200	Rear End	0	1	0	Day	Dry	All Others
98	4/16/97	Wed	900	Rear End	0	0	1	Day	Dry	No Improper Driving
99	4/17/97	Thu	1900	Rear End	0	1	0	Unk	Dry	All Others
100	4/17/97	Thu	1500	Sideswipe	0	0	1	Day	Dry	Disregarded Traffic Signal
101	4/24/97	Thu	1500	Rear End	0	0	1	Day	Dry	Followed to Closely
102	4/30/97	Wed	1400	Angle	0	1	0	Day	Dry	Disregarded Traffic Signal
103	5/1/97	Thu	900	Rear End	0	0	1	Day	Dry	Followed to Closely
104	5/5/97	Mon	0	Left Turn	0	1	0	Nite	Dry	Disregarded Stop Sign
105	5/14/97	Wed	1100	Rear End	0	1	0	Day	Dry	Followed to Closely
106	5/19/97	Mon	1200	Rear End	0	0	1	Day	Dry	No Improper Driving
107	5/28/97	Wed	0	Fixed Object	0	0	1	Nite	Slippery	Failed to Maintain Equipment
108	6/1/97	Sun	1100	Rear End	0	1	0	Day	Dry	Followed to Closely
109	6/4/97	Wed	1700	Left Turn	0	1	0	Day	Dry	Disregarded Traffic Signal
110	6/5/97	Thu	700	Rear End	0	0	1	Day	Wet	All Others
111	6/28/97	Sat	1300	Rear End	0	0	1	Day	Dry	Careless Driving
112	6/28/97	Sat	100	Left Turn	0	1	0	Nite	Dry	All Others
113	7/7/97	Mon	1600	Rear End	0	0	1	Day	Dry	No Improper Driving
114	7/10/97	Thu	1700	Rear End	0	0	1	Day	Dry	Failed to Maintain Equipment
115	7/18/97	Fri	2100	Left Turn	0	0	1	Nite	Dry	Failed to Yield R/W
116	7/28/97	Mon	2000	Rear End	0	0	1	Day	Dry	All Others
117	7/31/97	Thu	2100	Angle	0	1	0	Nite	Slippery	Disregarded Traffic Signal
118	8/2/97	Sat	1600	Rear End	0	0	1	Day	Wet	No Improper Driving
119	8/7/97	Thu	1500	Rear End	0	0	1	Day	Slippery	All Others
120	8/11/97	Mon	1100	Rear End	0	1	0	Day	Dry	All Others
121	8/12/97	Tue	1400	Rear End	0	1	0	Day	Dry	All Others
122	8/14/97	Thu	1400	Rear End	0	0	1	Day	Dry	Failed to Yield R/W
123	8/21/97	Thu	600	Left Turn	0	0	1	Day	Dry	No Improper Driving
124	8/26/97	Tue	1600	Rear End	0	0	1	Day	Dry	Exceeded Stated Safe Speed
125	8/26/97	Tue	1500	Angle	0	0	1	Day	Dry	Improper Lane Change
126	9/3/97	Wed	1000	Rear End	0	1	0	Day	Dry	Followed to Closely
127	9/11/97	Thu	500	Left Turn	0	1	0	Nite	Dry	Disregarded Traffic Signal
128	9/14/97	Sun	1600	Rear End	0	1	0	Day	Dry	Careless Driving
129	9/14/97	Sun	1400	Left Turn	0	1	0	Day	Wet	Disregarded Traffic Signal
130	10/15/97	Wed	800	Rear End	0	0	1	Day	Dry	Careless Driving
131	10/25/97	Sat	1800	Rear End	0	0	1	Day	Dry	Followed to Closely
132	11/4/97	Tue	1800	Rear End	0	0	1	Nite	Wet	Followed to Closely
133	11/17/97	Mon	1200	Sideswipe	0	0	1	Day	Dry	All Others

134	11/23/97	Sun	200	Sideswipe	0	1	0	Nite	Wet	No Improper Driving
135	12/2/97	Tue	500	Rear End	0	0	1	Nite	Wet	No Improper Driving
136	12/13/97	Sat	2200	Angle	0	0	1	Nite	Dry	No Improper Driving
137	12/26/97	Fri	400	Left Turn	0	1	0	Nite	Dry	No Improper Driving
138	12/30/97	Tue	1000	Sideswipe	0	0	1	Day	Dry	Improper Lane Change
Total No.	Fatal	Injury	PDO	Angle	Left Turn	Right Turn	Rear End	Side swipe	Ped/Bike	Other
138	**0**	**72**	**66**	**13**	**15**	**0**	**86**	**11**	**0**	**13**
	0.00%	*52.17%*	*47.83%*	*9.42%*	*10.87%*	*0.00%*	*62.32%*	*7.97%*	*0.00%*	*9.42%*
Day	Night	Wet	Dry	Improper Lane Change	No Improper Driving	Careless Driving	Follow too Closely	Disregarded Traffic Signal	FTY R/W	All Others
91	**47**	**27**	**111**	**7**	**37**	**13**	**21**	**9**	**3**	**34**
65.94%	*34.06%*	*19.57%*	*80.43%*	*5.07%*	*26.81%*	*9.42%*	*15.22%*	*6.52%*	*2.17%*	*24.64%*
TOTAL VEHICLES ENTERING / ADT : **64,500**					CRASH RATE: **1.954** /MEV					

Table B-4. Crash Summary Table for SR 834 (Sample Road) at Turnpike Off Ramp

FLORIDA DEPARTMENT OF TRANSPORTATION

CRASH SUMMARY

SECTION: **86028000** STATE ROUTE: **834 (Sample Road)**

INTERSECTING ROUTE: **Turnpike SB & NB Off Ramp** M.P. **5.25** ENGINEER:

STUDY PERIOD: FROM **1/ 95** TO **12/ 97** COUNTY: **Broward**

No.	DATE	DAY	TIME	TYPE	FATAL	INJURY	PROP DAM	DAY / NT	WET / DRY	CONTRIBUTING CAUSE
1	3/13/95	Mon	1300	Sideswipe	0	0	1	Day	Slippery	All Others
2	3/20/95	Mon	1300	Angle	0	1	0	Day	Wet	No Improper Driving
3	5/6/95	Sat	600	Rear End	0	1	0	Day	Dry	Careless Driving
4	5/28/95	Sun	800	Rear End	0	1	0	Day	Dry	Careless Driving
5	6/9/95	Fri	1700	Rear End	0	1	0	Day	Dry	All Others
6	6/14/95	Wed	1100	Rear End	0	1	0	Day	Wet	All Others
7	6/17/95	Sat	300	Sideswipe	0	0	1	Nite	Wet	Improper Lane Change
8	6/17/95	Sat	300	Rear End	0	1	0	Nite	Wet	No Improper Driving
9	7/28/95	Fri	1900	Angle	0	1	0	Day	Dry	Improper Lane Change
10	8/10/95	Thu	1700	Rear End	0	1	0	Day	Wet	All Others
11	8/31/95	Thu	1700	Rear End	0	1	0	Day	Dry	Failed to Maintain Equipment
12	9/24/95	Sun	600	Rear End	0	1	0	Day	Dry	No Improper Driving
13	10/13/95	Fri	200	Head On	0	1	0	Nite	Dry	Careless Driving
14	11/18/95	Sat	1200	Rear End	0	1	0	Day	Dry	All Others
15	12/9/95	Sat	0	Other	0	0	1	Nite	Dry	Improper Parking
16	1/31/96	Wed	1800	Rear End	0	1	0	Nite	Dry	Careless Driving
17	2/10/96	Sat	2300	Rear End	0	0	1	Nite	Dry	Careless Driving
18	3/2/96	Sat	100	Rear End	0	1	0	Nite	Dry	Careless Driving
19	3/11/96	Mon	2200	Angle	0	0	1	Nite	Slippery	Failed to Yield R/W
20	4/11/96	Thu	1700	Sideswipe	0	1	0	Day	Wet	Improper Lane Change
21	6/1/96	Sat	600	Rear End	0	1	0	Day	Dry	All Others
22	7/4/96	Thu	1600	Rear End	0	1	0	Day	Wet	All Others
23	7/10/96	Wed	1600	Rear End	0	1	0	Day	Dry	All Others
24	9/13/96	Fri	900	Rear End	0	1	0	Day	Dry	All Others
25	9/20/96	Fri	900	Angle	0	1	0	Day	Wet	All Others
26	10/21/96	Mon	800	Rear End	0	1	0	Day	Dry	Careless Driving
27	10/25/96	Fri	900	Rear End	0	1	0	Day	Dry	Careless Driving
28	11/5/96	Tue	700	Rear End	0	0	1	Day	Slippery	Followed to Closely
29	11/18/96	Mon	700	Rear End	0	1	0	Day	Dry	All Others
30	12/2/96	Mon	1500	Rear End	0	1	0	Day	Wet	All Others
31	12/2/96	Mon	1800	Rear End	0	1	0	Nite	Dry	Obstructing Traffic
32	12/10/96	Tue	1400	Bicycle	0	1	0	Day	Dry	Disregarded Traffic Signal
33	12/13/96	Fri	1800	Rear End	0	0	1	Nite	Dry	All Others
34	5/31/97	Sat	1600	Rear End	0	1	0	Day	Slippery	All Others
35	7/16/97	Wed	1700	Rear End	0	1	0	Day	Dry	All Others
36	8/22/97	Fri	1800	Angle	0	1	0	Day	Dry	Disregarded Traffic Signal
37	11/17/97	Mon	1100	Rear End	0	1	0	Day	Dry	All Others
38	11/20/97	Thu	1100	Rear End	0	1	0	Day	Dry	All Others
39	11/21/97	Fri	1300	Angle	0	1	0	Day	Wet	Disregarded Traffic Signal

Total No.	Fatal	Injury	PDO	Angle	Left Turn	Right Turn	Rear End	Side swipe	Ped/Bike	Other
39	**0**	**32**	**7**	**6**	**0**	**0**	**27**	**3**	**1**	**2**
	0.00%	*82.05%*	*17.95%*	*15.38%*	*0.00%*	*0.00%*	*69.23%*	*7.69%*	*2.56%*	*5.13%*
Day	Night	Wet	Dry	Improper Lane Change	No Improper Driving	Careless Driving	Follow too Closely	Disregarded Traffic Signal	FTY R/W	All Others
29	**10**	**7**	**32**	**3**	**3**	**8**	**1**	**3**	**1**	**17**
74.36%	*25.64%*	*17.95%*	*82.05%*	*7.69%*	*7.69%*	*20.51%*	*2.56%*	*7.69%*	*2.56%*	*43.59%*
TOTAL VEHICLES ENTERING / ADT : **52,500**					CRASH RATE: **0.678** /MEV					

Table B-5. Crash Summary Table for SR 820 (Pines Blvd.) at Turnpike Off Ramp

FLORIDA DEPARTMENT OF TRANSPORTATION
CRASH SUMMARY

SECTION: **86040000** STATE ROUTE: **820 (Pines Blvd)**
INTERSECTING ROUTE: **Turnpike Off Ramp** M.P. **13.679** ENGINEER:
STUDY PERIOD: FROM **1/ 95** TO **12/ 97** COUNTY: **Broward**

No.	DATE	DAY	TIME	TYPE	FATAL	INJURY	PROP DAM	DAY / NT	WET / DRY	CONTRIBUTING CAUSE
1	1/12/95	Thu	300	Rear End	0	0	1	Nite	Slippery	Careless Driving
2	3/7/95	Tue	800	Rear End	0	1	0	Day	Dry	Careless Driving
3	3/8/95	Wed	700	Rear End	0	1	0	Day	Dry	Careless Driving
4	4/5/95	Wed	900	Sideswipe	0	0	1	Day	Wet	Failed to Yield R/W
5	6/24/95	Sat	600	Left Turn	0	1	0	Day	Other	Failed to Yield R/W
6	8/23/95	Wed	0	Fixed Object	0	0	1	Unk	Unknown	Unknown
7	9/22/95	Fri	100	Rear End	0	1	0	Nite	Slippery	All Others
8	12/26/95	Tue	1000	Angle	0	0	1	Day	Dry	Disregarded Traffic Signal
9	12/31/95	Sun	2000	Rear End	0	1	0	Nite	Wet	Followed to Closely
10	1/19/96	Fri	800	Rear End	0	1	0	Day	Wet	All Others
11	2/19/96	Mon	400	Other	0	0	1	Nite	Dry	Improper Parking
12	4/13/96	Sat	1000	Right Turn	0	1	0	Day	Dry	All Others
13	5/23/96	Thu	900	Rear End	0	1	0	Day	Other	All Others
14	1/13/97	Mon	400	Rear End	0	0	1	Day	Slippery	Followed to Closely
15	1/16/97	Thu	1400	Rear End	0	0	1	Day	Dry	Followed to Closely
16	1/16/97	Thu	800	Angle	0	1	0	Day	Dry	Failed to Maintain Equipment
17	1/27/97	Mon	1300	Rear End	0	0	1	Day	Wet	Careless Driving
18	2/9/97	Sun	1100	Rear End	0	1	0	Day	Dry	Followed to Closely
19	2/11/97	Tue	800	Rear End	0	0	1	Day	Dry	All Others
20	2/21/97	Fri	200	Rear End	0	1	0	Nite	Wet	Careless Driving
21	3/7/97	Fri	800	Rear End	0	1	0	Day	Slippery	Careless Driving
22	3/9/97	Sun	0	Pedestrian	0	1	0	Day	Dry	Failed to Yield R/W
23	3/30/97	Sun	2100	Rear End	0	1	0	Nite	Dry	Careless Driving
24	4/18/97	Fri	900	Angle	0	0	1	Day	Dry	Failed to Yield R/W
25	4/29/97	Tue	1100	Angle	0	1	0	Day	Dry	Disregarded Traffic Signal
26	5/2/97	Fri	800	Rear End	0	1	0	Day	Dry	All Others
27	5/9/97	Fri	2000	Rear End	0	1	0	Day	Dry	Followed to Closely
28	6/5/97	Thu	1800	Angle	0	0	1	Day	Dry	All Others
29	6/9/97	Mon	1400	Rear End	0	1	0	Day	Slippery	No Improper Driving
30	10/14/97	Tue	1000	Fixed Object	0	0	1	Day	Wet	All Others
31	10/24/97	Fri	600	Angle	0	0	1	Nite	Wet	Improper Turn
32	10/27/97	Mon	2200	Fixed Object	0	0	1	Nite	Wet	Driving Wrong Side/Way
33	11/1/97	Sat	0	Bicycle	0	1	0	Nite	Dry	Followed to Closely
34	11/11/97	Tue	1600	Angle	0	0	1	Day	Dry	Improper Turn
35	11/30/97	Sun	2100	Angle	0	1	0	Nite	Slippery	All Others
36	12/21/97	Sun	1700	Left Turn	0	0	1	Nite	Dry	Careless Driving

Total No.	Fatal	Injury	PDO	Angle	Left Turn	Right Turn	Rear End	Side swipe	Ped/Bike	Other
36	**0**	**20**	**16**	**8**	**2**	**1**	**18**	**1**	**2**	**4**

	0.00%	*55.56%*	*44.44%*	*22.22%*	*5.56%*	*2.78%*	*50.00%*	*2.78%*	*5.56%*	*11.11%*
Day	Night	Wet	Dry	Improper Turn	No Improper Driving	Careless Driving	Follow too Closely	Disregarded Traffic Signal	FTY R/W	All Others
24	**12**	**11**	**25**	**2**	**1**	**8**	**6**	**2**	**4**	**9**
66.67%	*33.33%*	*30.56%*	*69.44%*	*5.56%*	*2.78%*	*22.22%*	*16.67%*	*5.56%*	*11.11%*	*25.00%*
TOTAL VEHICLES ENTERING / ADT : **35,833**					CRASH RATE: **0.917** /MEV					

Table B-6. Crash Summary Table for SR 838 (Sunrise Blvd.) at I-95 SB Off Ramp

FLORIDA DEPARTMENT OF TRANSPORTATION

CRASH SUMMARY

SECTION: **86110000** STATE ROUTE: **838 (Sunrise Blvd.)**

INTERSECTING ROUTE: **I-95 SB Off Ramp** M.P. **6.074** ENGINEER:

STUDY PERIOD: FROM **1/ 95** TO **12/ 97** COUNTY: **Broward**

No.	DATE	DAY	TIME	TYPE	FATAL	INJURY	PROP DAM	DAY / NT	WET / DRY	CONTRIBUTING CAUSE
1	1/8/95	Sun	100	Angle	0	0	1	Nite	Dry	Driving Wrong Side/Way
2	1/21/95	Sat	500	Sideswipe	0	1	0	Nite	Dry	Disregarded Traffic Signal
3	1/23/95	Mon	500	Left Turn	0	0	1	Nite	Dry	Failed to Yield R/W
4	1/30/95	Mon	0	Rear End	0	0	1	Nite	Wet	Careless Driving
5	1/30/95	Mon	500	Rear End	0	0	1	Nite	Slippery	Careless Driving
6	1/30/95	Mon	0	Rear End	0	1	0	Nite	Dry	All Others
7	2/9/95	Thu	500	Rear End	0	1	0	Nite	Dry	All Others
8	3/13/95	Mon	1600	Rear End	0	0	1	Day	Slippery	No Improper Driving
9	3/16/95	Thu	1700	Rear End	0	1	0	Nite	Dry	All Others
10	3/21/95	Tue	1700	Right Turn	0	1	0	Day	Dry	All Others
11	3/22/95	Wed	1600	Fixed Object	0	0	1	Day	Dry	No Improper Driving
12	3/24/95	Fri	100	Angle	0	0	1	Nite	Dry	Disregarded Traffic Signal
13	3/26/95	Sun	200	Angle	0	0	1	Nite	Wet	Failed to Yield R/W
14	3/26/95	Sun	1400	Rear End	0	1	0	Day	Dry	All Others
15	4/13/95	Thu	2000	Angle	0	0	1	Nite	Dry	All Others
16	5/11/95	Thu	900	Rear End	0	1	0	Day	Dry	All Others
17	5/20/95	Sat	2300	Angle	0	0	1	Nite	Dry	All Others
18	5/24/95	Wed	1700	Left Turn	0	1	0	Day	Dry	All Others
19	5/25/95	Thu	600	Angle	0	1	0	Nite	Wet	All Others
20	5/28/95	Sun	1300	Pedestrian	0	1	0	Day	Dry	All Others
21	6/18/95	Sun	0	Rear End	0	1	0	Nite	Dry	Followed to Closely
22	7/1/95	Sat	2100	Angle	0	1	0	Nite	Dry	All Others
23	7/1/95	Sat	1600	Angle	0	0	1	Day	Dry	All Others
24	7/10/95	Mon	1400	Left Turn	0	1	0	Day	Dry	No Improper Driving
25	7/22/95	Sat	1500	Rear End	0	0	1	Day	Dry	All Others
26	8/1/95	Tue	1300	Left Turn	0	1	0	Day	Wet	Improper Turn
27	8/3/95	Thu	1800	Rear End	0	0	1	Day	Wet	All Others
28	8/13/95	Sun	0	Rear End	0	1	0	Nite	Dry	No Improper Driving
29	8/29/95	Tue	1500	Rear End	0	0	1	Day	Dry	All Others
30	8/30/95	Wed	2200	Angle	0	1	0	Nite	Dry	All Others
31	8/31/95	Thu	1200	Rear End	0	0	1	Unk	Wet	Followed to Closely
32	9/7/95	Thu	1200	Rear End	0	1	0	Day	Dry	All Others
33	10/14/95	Sat	1400	Rear End	0	1	0	Day	Wet	No Improper Driving
34	10/14/95	Sat	2300	Left Turn	1	1	0	Nite	Slippery	All Others
35	11/4/95	Sat	2100	Rear End	0	0	1	Nite	Dry	Disregarded Traffic Signal
36	11/7/95	Tue	1100	Rear End	0	1	0	Day	Dry	Failed to Maintain Equipment
37	11/10/95	Fri	2300	Angle	0	1	0	Nite	Dry	Failed to Yield R/W
38	12/11/95	Mon	2100	Rear End	0	1	0	Nite	Dry	Failed to Maintain Equipment

39	12/23/95	Sat	200	Rear End	0	0	1	Nite	Slippery	All Others
40	1/22/96	Mon	0	Rear End	0	0	1	Nite	Dry	No Improper Driving
41	1/23/96	Tue	1000	Rear End	0	1	0	Day	Dry	Careless Driving
42	1/24/96	Wed	1700	Bicycle	0	1	0	Nite	Wet	All Others
43	1/26/96	Fri	600	Rear End	0	1	0	Day	Slippery	All Others
44	2/6/96	Tue	1200	Angle	0	1	0	Day	Dry	No Improper Driving
45	2/12/96	Mon	100	Left Turn	0	0	1	Nite	Dry	Disregarded Traffic Signal
46	3/11/96	Mon	0	Left Turn	0	0	1	Nite	Slippery	All Others
47	4/3/96	Wed	800	Rear End	0	1	0	Day	Dry	All Others
48	4/7/96	Sun	1800	Rear End	0	1	0	Day	Dry	Disregarded Traffic Signal
49	5/14/96	Tue	400	Fixed Object	0	0	1	Nite	Slippery	No Improper Driving
50	5/15/96	Wed	1500	Sideswipe	0	0	1	Day	Dry	Disregarded Traffic Signal
51	5/16/96	Thu	1200	Rear End	0	1	0	Day	Dry	All Others
52	6/1/96	Sat	2300	Rear End	0	1	0	Nite	Dry	All Others
53	6/8/96	Sat	1400	Left Turn	0	0	1	Day	Wet	Disregarded Traffic Signal
54	6/21/96	Fri	1700	Angle	0	0	1	Day	Slippery	All Others
55	6/23/96	Sun	600	Angle	0	0	1	Nite	Wet	Improper Turn
56	6/28/96	Fri	200	Other	0	0	1	Nite	Dry	Careless Driving
57	7/8/96	Mon	700	Fixed Object	0	0	1	Day	Wet	All Others
58	7/19/96	Fri	900	Rear End	0	0	1	Day	Dry	No Improper Driving
59	8/1/96	Thu	1400	Angle	0	1	0	Day	Dry	All Others
60	8/17/96	Sat	1500	Left Turn	0	1	0	Day	Wet	Failed to Yield R/W
61	8/30/96	Fri	1300	Rear End	0	1	0	Day	Dry	All Others
62	8/31/96	Sat	1400	Rear End	0	1	0	Day	Wet	Followed to Closely
63	9/9/96	Mon	0	Other	0	0	1	Nite	Slippery	All Others
64	9/10/96	Tue	700	Left Turn	0	0	1	Day	Slippery	Improper Turn
65	9/23/96	Mon	1800	Rear End	0	0	1	Day	Dry	Careless Driving
66	9/24/96	Tue	100	Pedestrian	0	1	0	Nite	Dry	No Improper Driving
67	10/9/96	Wed	1600	Left Turn	0	1	0	Day	Dry	Disregarded Traffic Signal
68	10/11/96	Fri	2300	Left Turn	0	1	0	Nite	Dry	Disregarded Traffic Signal
69	10/22/96	Tue	1900	Rear End	0	1	0	Day	Dry	All Others
70	10/26/96	Sat	1200	Left Turn	0	1	0	Day	Wet	Disregarded Traffic Signal
71	10/27/96	Sun	1900	Sideswipe	0	1	0	Nite	Dry	Alcohol - Under Influence
72	10/30/96	Wed	2200	Left Turn	0	1	0	Nite	Dry	Disregarded Traffic Signal
73	11/29/96	Fri	800	Rear End	0	1	0	Day	Wet	Followed to Closely
74	12/5/96	Thu	1700	Rear End	0	1	0	Nite	Wet	Followed to Closely
75	12/5/96	Thu	1700	Angle	0	1	0	Nite	Wet	All Others
76	12/16/96	Mon	1900	Left Turn	0	1	0	Nite	Dry	Disregarded Traffic Signal
77	1/15/97	Wed	600	Rear End	0	0	1	Day	Slippery	All Others
78	1/18/97	Sat	2300	Rear End	0	1	0	Day	Dry	Obstructing Traffic
79	1/23/97	Thu	1200	Angle	0	1	0	Day	Dry	Improper Lane Change
80	1/31/97	Fri	0	Sideswipe	0	0	1	Nite	Dry	Improper Lane Change
81	2/17/97	Mon	1200	Rear End	0	0	1	Day	Dry	No Improper Driving
82	2/24/97	Mon	1000	Left Turn	0	1	0	Day	Slippery	Disregarded Traffic Signal
83	2/25/97	Tue	1000	Angle	0	1	0	Day	Dry	Improper Turn
84	3/3/97	Mon	1500	Rear End	0	0	1	Day	Dry	All Others
85	3/7/97	Fri	1500	Rear End	0	1	0	Day	Dry	Careless Driving

86	3/22/97	Sat	2200	Rear End	0	1	0	Nite	Dry	All Others
87	3/28/97	Fri	900	Rear End	0	1	0	Day	Dry	No Improper Driving
88	4/3/97	Thu	800	Rear End	0	0	1	Day	Dry	Careless Driving
89	4/5/97	Sat	2000	Angle	0	0	1	Nite	Dry	All Others
90	4/6/97	Sun	1200	Left Turn	0	1	0	Day	Dry	Careless Driving
91	4/14/97	Mon	600	Angle	0	1	0	Day	Dry	Disregarded Traffic Signal
92	4/18/97	Fri	2100	Angle	0	1	0	Nite	Dry	All Others
93	4/18/97	Fri	800	Left Turn	0	0	1	Day	Dry	No Improper Driving
94	4/28/97	Mon	1100	Rear End	0	1	0	Day	Dry	All Others
95	5/9/97	Fri	2300	Rear End	0	1	0	Nite	Dry	Improper Lane Change
96	5/23/97	Fri	400	Angle	0	0	1	Nite	Dry	No Improper Driving
97	6/9/97	Mon	1800	Rear End	0	0	1	Nite	Slippery	Careless Driving
98	6/9/97	Mon	1600	Rear End	0	1	0	Day	Slippery	Exceeded Safe Speed
99	6/10/97	Tue	1700	Sideswipe	0	0	1	Day	Dry	All Others
100	6/21/97	Sat	1300	Rear End	0	1	0	Day	Dry	No Improper Driving
101	6/22/97	Sun	1300	Angle	0	1	0	Day	Dry	All Others
102	7/2/97	Wed	1100	Rear End	0	1	0	Day	Wet	Followed to Closely
103	7/4/97	Fri	1600	Rear End	0	1	0	Day	Dry	No Improper Driving
104	7/4/97	Fri	1400	Rear End	0	0	1	Day	Dry	All Others
105	7/13/97	Sun	300	Left Turn	0	1	0	Nite	Dry	Disregarded Traffic Signal
106	8/2/97	Sat	1300	Rear End	0	1	0	Nite	Wet	Followed to Closely
107	8/11/97	Mon	2200	Rear End	0	0	1	Nite	Dry	Careless Driving
108	8/19/97	Tue	1600	Rear End	0	0	1	Day	Dry	All Others
109	8/21/97	Thu	600	Angle	0	1	0	Day	Wet	All Others
110	10/2/97	Thu	2300	Other	0	0	1	Nite	Wet	Careless Driving
111	10/3/97	Fri	700	Fixed Object	0	1	0	Unk	Other	Disregarded Traffic Signal
112	10/11/97	Sat	500	Rear End	0	1	0	Nite	Dry	Followed to Closely
113	11/22/97	Sat	400	Left Turn	0	1	0	Nite	Slippery	No Improper Driving
114	11/29/97	Sat	1200	Rear End	0	1	0	Day	Slippery	All Others
115	12/9/97	Tue	0	Fixed Object	0	0	1	Unk	Unknown	Unknown
116	12/27/97	Sat	1500	Rear End	0	0	1	Day	Dry	No Improper Driving

Total No.	Fatal	Injury	PDO	Angle	Left Turn	Right Turn	Rear End	Side swipe	Ped/Bike	Other
116	**1**	**68**	**47**	**23**	**20**	**1**	**56**	**5**	**3**	**8**
	0.86%	*58.62%*	*40.52%*	*19.83%*	*17.24%*	*0.86%*	*48.28%*	*4.31%*	*2.59%*	*6.90%*

Day	Night	Wet	Dry	Improper Turn	No Improper Driving	Careless Driving	Follow too Closely	Disregarded Traffic Signal	FTY R/W	All Others
62	**54**	**23**	**93**	**4**	**18**	**11**	**8**	**16**	**4**	**45**
53.45%	*46.55%*	*19.83%*	*80.17%*	*3.45%*	*15.52%*	*9.48%*	*6.90%*	*13.79%*	*3.45%*	*38.79%*

TOTAL VEHICLES ENTERING / ADT : **54,167**	CRASH RATE: **1.956** /MEV

Table B-7. Crash Summary Table for SR 842 (Broward Blvd.) at I-95 NB Off Ramp

FLORIDA DEPARTMENT OF TRANSPORTATION
CRASH SUMMARY

SECTION: **86006000** STATE ROUTE: **842 (Broward Blvd.)**
INTERSECTING ROUTE: **I-95 NB off Ramp** M.P. **5.252** ENGINEER:
STUDY PERIOD: FROM **1/ 95** TO **12/ 97** COUNTY: **Broward**

No.	DATE	DAY	TIME	TYPE	FATAL	INJURY	PROP DAM	DAY / NT	WET / DRY	CONTRIBUTING CAUSE
1	1/4/95	Wed	1000	Angle	0	1	0	Day	Wet	Improper Lane Change
2	1/15/95	Sun	400	Rear End	0	1	0	Nite	Dry	Exceeded Safe Speed
3	1/18/95	Wed	2200	Angle	0	1	0	Nite	Dry	All Others
4	3/15/95	Wed	2300	Angle	0	0	1	Nite	Slippery	Disregarded Traffic Signal
5	4/23/95	Sun	0	Rear End	0	0	1	Day	Dry	All Others
6	5/5/95	Fri	1500	Sideswipe	0	0	1	Day	Dry	No Improper Driving
7	5/10/95	Wed	1600	Rear End	0	1	0	Day	Dry	No Improper Driving
8	5/20/95	Sat	900	Left Turn	0	1	0	Day	Wet	Disregarded Traffic Signal
9	5/31/95	Wed	2200	Rear End	0	0	1	Nite	Dry	All Others
10	7/18/95	Tue	1100	Left Turn	0	1	0	Day	Wet	Disregarded Traffic Signal
11	8/10/95	Thu	800	Rear End	0	0	1	Day	Wet	All Others
12	8/12/95	Sat	500	Rear End	0	1	0	Nite	Dry	No Improper Driving
13	8/13/95	Sun	2300	Fixed Object	0	0	1	Nite	Dry	No Improper Driving
14	9/10/95	Sun	2300	Rear End	0	1	0	Nite	Wet	All Others
15	10/7/95	Sat	1200	Other	0	0	1	Day	Wet	All Others
16	12/29/95	Fri	1500	Angle	0	0	1	Day	Other	Improper Lane Change
17	1/9/96	Tue	1600	Rear End	0	1	0	Day	Dry	All Others
18	1/17/96	Wed	1800	Rear End	0	1	0	Nite	Dry	Followed to Closely
19	1/17/96	Wed	1800	Rear End	0	1	0	Nite	Dry	All Others
20	3/11/96	Mon	1100	Rear End	0	0	1	Day	Slippery	All Others
21	3/31/96	Sun	1900	Pedestrian	0	1	0	Nite	Wet	No Improper Driving
22	4/1/96	Mon	1700	Angle	0	1	0	Day	Wet	Disregarded Traffic Signal
23	6/9/96	Sun	2300	Left Turn	0	1	0	Nite	Slippery	Disregarded Traffic Signal
24	6/17/96	Mon	2000	Rear End	0	0	1	Day	Dry	All Others
25	7/2/96	Tue	2300	Angle	0	0	1	Nite	Dry	Disregarded Traffic Signal
26	8/31/96	Sat	1500	Angle	0	1	0	Day	Dry	No Improper Driving
27	9/4/96	Wed	2200	Rear End	0	0	1	Nite	Dry	All Others
28	9/5/96	Thu	2000	Left Turn	0	1	0	Nite	Wet	Disregarded Traffic Signal
29	10/6/96	Sun	1600	Left Turn	0	1	0	Day	Slippery	Disregarded Traffic Signal
30	10/18/96	Fri	2200	Other	0	0	1	Nite	Wet	Disregarded Traffic Signal
31	11/20/96	Wed	1700	Rear End	0	0	1	Nite	Dry	All Others
32	12/24/96	Tue	1100	Rear End	0	1	0	Day	Dry	No Improper Driving
33	1/6/97	Mon	900	Rear End	0	1	0	Day	Dry	All Others
34	2/5/97	Wed	2000	Angle	0	1	0	Nite	Dry	Failed to Yield R/W
35	3/10/97	Mon	1600	Rear End	0	1	0	Day	Dry	Careless Driving
36	3/22/97	Sat	1700	Left Turn	0	1	0	Day	Dry	All Others
37	3/24/97	Mon	900	Rear End	0	1	0	Day	Dry	No Improper Driving
38	3/30/97	Sun	2300	Rear End	0	1	0	Nite	Dry	All Others

39	4/23/97	Wed	900	Angle	0	0	1	Day	Dry	No Improper Driving
40	5/26/97	Mon	1500	Angle	0	1	0	Day	Dry	Failed to Yield R/W
41	6/1/97	Sun	1400	Angle	0	1	0	Day	Slippery	No Improper Driving
42	7/29/97	Tue	1200	Other	0	1	0	Day	Dry	Failed to Maintain Equipment
43	8/20/97	Wed	0	Fixed Object	0	0	1	Unk	Unknown	Unknown
44	8/31/97	Sun	2300	Rear End	0	1	0	Nite	Dry	All Others
45	9/20/97	Sat	200	Other	0	0	1	Nite	Wet	Careless Driving
46	9/20/97	Sat	1000	Rear End	0	1	0	Day	Dry	All Others
47	10/13/97	Mon	0	Angle	0	0	1	Nite	Slippery	No Improper Driving
48	10/19/97	Sun	1100	Rear End	0	1	0	Day	Wet	No Improper Driving
49	10/24/97	Fri	2300	Other	0	0	1	Nite	Dry	Improper Lane Change
50	11/15/97	Sat	900	Fixed Object	0	0	1	Day	Dry	No Improper Driving
51	12/31/97	Wed	2300	Angle	0	1	0	Day	Dry	Disregarded Traffic Signal
Total No.	Fatal	Injury	PDO	Angle	Left Turn	Right Turn	Rear End	Side swipe	Ped/Bike	Other
51	**0**	**31**	**20**	**13**	**6**	**0**	**22**	**1**	**1**	**8**
	0.00%	*60.78%*	*39.22%*	*25.49%*	*11.76%*	*0.00%*	*43.14%*	*1.96%*	*1.96%*	*15.69%*
Day	Night	Wet	Dry	Improper Lane Change	No Improper Driving	Careless Driving	Follow too Closely	Disregarded Traffic Signal	FTY R/W	All Others
28	**23**	**14**	**37**	**3**	**13**	**2**	**1**	**10**	**2**	**17**
54.90%	*45.10%*	*27.45%*	*72.55%*	*5.88%*	*25.49%*	*3.92%*	*1.96%*	*19.61%*	*3.92%*	*33.33%*
TOTAL VEHICLES ENTERING / ADT : **61,167**					CRASH RATE: **0.761** /MEV					

Table B-8. Crash Summary Table for SR 860 (Miami Garden Dr.) at I-95 NB Off Ramp

FLORIDA DEPARTMENT OF TRANSPORTATION
CRASH SUMMARY

SECTION: **87026000** STATE ROUTE: **860(Miami Garden DR.)**
INTERSECTING ROUTE: **I-95 NB off Ramp** M.P. **6.763** ENGINEER:
STUDY PERIOD: FROM **1/ 95** TO **12/ 97** COUNTY: **Dade**

No.	DATE	DAY	TIME	TYPE	FATAL	INJURY	PROP DAM	DAY / NT	WET / DRY	CONTRIBUTING CAUSE
1	3/3/95	Fri	400	Rear End	0	1	0	Day	Dry	Careless Driving
2	4/25/95	Tue	700	Rear End	0	1	0	Day	Dry	No Improper Driving
3	6/19/95	Mon	1500	Rear End	0	1	0	Day	Dry	Careless Driving
4	7/1/95	Sat	2300	Rear End	0	0	1	Nite	Wet	All Others
5	8/27/95	Sun	200	Left Turn	0	0	1	Nite	Wet	Failed to Yield R/W
6	1/27/96	Sat	1800	Fixed Object	0	1	0	Nite	Wet	Improper Load
7	6/28/96	Fri	1900	Rear End	0	1	0	Day	Wet	Careless Driving
8	9/16/96	Mon	600	Sideswipe	0	1	0	Day	Dry	All Others
9	10/18/96	Fri	2200	Other	0	0	1	Nite	Dry	Careless Driving
10	11/6/96	Wed	1500	Rear End	0	1	0	Day	Dry	Careless Driving
11	11/29/96	Fri	1500	Rear End	0	1	0	Day	Wet	Careless Driving
12	12/28/96	Sat	1500	Rear End	0	1	0	Day	Dry	Careless Driving
13	1/23/97	Thu	900	Sideswipe	0	0	1	Day	Dry	Improper Lane Change
14	2/12/97	Wed	500	Angle	0	1	0	Nite	Dry	Disregarded Traffic Signal
15	2/14/97	Fri	700	Rear End	0	1	0	Day	Dry	Careless Driving
16	2/16/97	Sun	1000	Other	0	0	1	Day	Slippery	Improper Parking
17	4/9/97	Wed	1800	Rear End	0	0	1	Nite	Dry	Careless Driving
18	5/1/97	Thu	600	Rear End	0	0	1	Day	Dry	Careless Driving
19	5/5/97	Mon	1900	Sideswipe	0	0	1	Day	Dry	Improper Lane Change
20	6/26/97	Thu	1600	Rear End	0	0	1	Day	Dry	All Others
21	7/2/97	Wed	700	Rear End	0	1	0	Day	Dry	Careless Driving
22	11/9/97	Sun	100	Left Turn	0	1	0	Nite	Dry	Failed to Yield R/W
23	11/20/97	Thu	2300	Rear End	0	1	0	Nite	Dry	Careless Driving
24	12/26/97	Fri	1000	Rear End	0	0	1	Day	Dry	Careless Driving
25	12/30/97	Tue	1200	Rear End	0	1	0	Day	Dry	Followed to Closely

Total No.	Fatal	Injury	PDO	Angle	Left Turn	Right Turn	Rear End	Side swipe	Ped/Bike	Other
25	**0**	**15**	**10**	**1**	**2**	**0**	**16**	**3**	**0**	**3**
	0.00%	*60.00%*	*40.00%*	*4.00%*	*8.00%*	*0.00%*	*64.00%*	*12.00%*	*0.00%*	*12.00%*

Day	Night	Wet	Dry	Improper Lane Change	No Improper Driving	Careless Driving	Follow too Closely	Disregarded Traffic Signal	FTY R/W	All Others
17	**8**	**2**	**23**	**2**	**1**	**13**	**1**	**1**	**2**	**3**
68.00%	*32.00%*	*8.00%*	*92.00%*	*8.00%*	*4.00%*	*52.00%*	*4.00%*	*4.00%*	*8.00%*	*12.00%*

TOTAL VEHICLES ENTERING / ADT : **39,833**

CRASH RATE: **0.573** /MEV

Table B-9. Crash Summary Table for SR 870 (Commercial Blvd.) at I-95 NB Off Ramp

FLORIDA DEPARTMENT OF TRANSPORTATION
CRASH SUMMARY

SECTION: **86014000** STATE ROUTE: **870 (Commercial Blvd.)**
INTERSECTING ROUTE: **I-95 NB Off Ramp** M.P. **6.495** ENGINEER:
STUDY PERIOD: FROM **1/ 95** TO **12/ 97** COUNTY: **Broward**

No.	DATE	DAY	TIME	TYPE	FATAL	INJURY	PROP DAM	DAY / NT	WET / DRY	CONTRIBUTING CAUSE
1	1/7/95	Sat	800	Left Turn	0	1	0	Day	Dry	All Others
2	1/17/95	Tue	1700	Rear End	0	0	1	Day	Dry	All Others
3	1/18/95	Wed	1500	Rear End	0	0	1	Day	Dry	No Improper Driving
4	3/11/95	Sat	200	Other	0	1	0	Nite	Dry	Failed to Maintain Equipment
5	3/20/95	Mon	2100	Left Turn	0	1	0	Nite	Dry	Improper Turn
6	3/28/95	Tue	1400	Rear End	0	0	1	Day	Dry	All Others
7	4/30/95	Sun	2300	Left Turn	0	1	0	Nite	Slippery	Failed to Yield R/W
8	6/10/95	Sat	1500	Other	0	1	0	Day	Dry	No Improper Driving
9	6/16/95	Fri	2200	Rear End	0	1	0	Nite	Dry	No Improper Driving
10	7/29/95	Sat	600	Left Turn	0	1	0	Nite	Slippery	All Others
11	8/11/95	Fri	2000	Rear End	0	0	1	Nite	Wet	All Others
12	8/15/95	Tue	1500	Rear End	0	1	0	Day	Dry	All Others
13	9/14/95	Thu	1600	Rear End	0	1	0	Day	Dry	All Others
14	10/14/95	Sat	1900	Rear End	0	0	1	Nite	Slippery	No Improper Driving
15	10/21/95	Sat	1000	Left Turn	0	1	0	Day	Dry	No Improper Driving
16	10/27/95	Fri	2300	Left Turn	0	1	0	Nite	Dry	Failed to Yield R/W
17	11/21/95	Tue	700	Other	0	0	1	Day	Wet	Careless Driving
18	11/22/95	Wed	700	Left Turn	0	1	0	Nite	Dry	All Others
19	12/21/95	Thu	2100	Sideswipe	0	0	1	Nite	Wet	Improper Turn
20	12/26/95	Tue	1800	Angle	0	1	0	Nite	Dry	All Others
21	1/12/96	Fri	100	Angle	0	1	0	Nite	Dry	Failed to Yield R/W
22	1/18/96	Thu	1900	Rear End	0	1	0	Nite	Dry	Followed to Closely
23	1/25/96	Thu	1600	Other	0	0	1	Day	Slippery	All Others
24	2/3/96	Sat	800	Left Turn	0	0	1	Day	Dry	Failed to Yield R/W
25	2/3/96	Sat	1200	Fixed Object	0	1	0	Nite	Wet	All Others
26	2/8/96	Thu	1800	Sideswipe	0	0	1	Nite	Dry	No Improper Driving
27	3/28/96	Thu	2200	Left Turn	0	1	0	Nite	Wet	Disregarded Traffic Signal
28	3/28/96	Thu	2300	Left Turn	0	0	1	Nite	Dry	No Improper Driving
29	5/17/96	Fri	1800	Sideswipe	0	0	1	Day	Dry	No Improper Driving
30	5/29/96	Wed	1500	Rear End	0	1	0	Day	Wet	Careless Driving
31	6/22/96	Sat	400	Sideswipe	0	1	0	Nite	Dry	Failed to Yield R/W
32	7/9/96	Tue	1400	Rear End	0	0	1	Day	Dry	All Others
33	7/19/96	Fri	800	Angle	0	1	0	Day	Dry	No Improper Driving
34	7/20/96	Sat	400	Left Turn	0	1	0	Nite	Dry	Failed to Yield R/W
35	8/26/96	Mon	1300	Angle	0	0	1	Day	Dry	Exceeded Safe Speed
36	9/23/96	Mon	1600	Rear End	0	1	0	Day	Dry	Followed to Closely
37	9/27/96	Fri	1900	Left Turn	0	1	0	Nite	Other	No Improper Driving
38	9/28/96	Sat	2100	Fixed Object	0	0	1	Day	Dry	Improper Lane Change
39	10/9/96	Wed	1700	Left Turn	0	1	0	Day	Dry	Failed to Yield R/W

40	11/21/96	Thu	2300	Angle	0	0	1	Nite	Dry	Disregarded Traffic Signal
41	12/4/96	Wed	1400	Rear End	0	1	0	Day	Wet	Careless Driving
42	12/8/96	Sun	1800	Rear End	0	0	1	Nite	Dry	Failed to Maintain Equipment
43	12/27/96	Fri	1200	Rear End	0	1	0	Day	Wet	Failed to Maintain Equipment
44	1/7/97	Tue	2200	Rear End	0	0	1	Nite	Dry	No Improper Driving
45	1/28/97	Tue	1300	Rear End	0	1	0	Day	Dry	Exceeded Safe Speed
46	1/29/97	Wed	1900	Rear End	0	1	0	Nite	Wet	All Others
47	2/4/97	Tue	1000	Rear End	0	0	1	Day	Wet	No Improper Driving
48	2/6/97	Thu	2000	Rear End	0	0	1	Day	Dry	No Improper Driving
49	3/10/97	Mon	2000	Rear End	0	1	0	Nite	Dry	Careless Driving
50	4/23/97	Wed	1100	Rear End	0	0	1	Day	Dry	Careless Driving
51	4/28/97	Mon	2000	Other	0	0	1	Nite	Wet	Exceeded Safe Speed
52	5/25/97	Sun	600	Left Turn	0	1	0	Nite	Dry	Failed to Yield R/W
53	6/7/97	Sat	800	Rear End	0	0	1	Day	Dry	No Improper Driving
54	6/16/97	Mon	200	Left Turn	0	1	0	Nite	Dry	Failed to Yield R/W
55	7/14/97	Mon	700	Angle	0	0	1	Day	Dry	No Improper Driving
56	8/30/97	Sat	0	Left Turn	0	0	1	Unk	Dry	Failed to Yield R/W
57	9/14/97	Sun	1200	Angle	0	0	1	Day	Wet	No Improper Driving
58	10/13/97	Mon	600	Left Turn	0	0	1	Nite	Dry	Failed to Yield R/W
59	10/22/97	Wed	1300	Rear End	0	1	0	Day	Dry	Careless Driving
60	11/1/97	Sat	1500	Left Turn	0	0	1	Day	Dry	Disregarded Traffic Signal
61	11/21/97	Fri	1100	Rear End	0	1	0	Day	Wet	All Others
62	12/4/97	Thu	1000	Left Turn	0	0	1	Day	Slippery	All Others
63	12/31/97	Wed	2300	Angle	0	0	1	Nite	Dry	Improper Lane Change

Total No.	Fatal	Injury	PDO	Angle	Left Turn	Right Turn	Rear End	Side swipe	Ped/Bike	Other
63	**0**	**33**	**30**	**8**	**19**	**0**	**25**	**4**	**0**	**7**
	0.00%	*52.38%*	*47.62%*	*12.70%*	*30.16%*	*0.00%*	*39.68%*	*6.35%*	*0.00%*	*11.11%*

Day	Night	Wet	Dry	Improper Turn	No Improper Driving	Careless Driving	Follow too Closely	Disregarded Traffic Signal	FTY R/W	All Others
32	**31**	**13**	**50**	**2**	**16**	**6**	**2**	**3**	**11**	**15**
50.79%	*49.21%*	*20.63%*	*79.37%*	*3.17%*	*25.40%*	*9.52%*	*3.17%*	*4.76%*	*17.46%*	*23.81%*

TOTAL VEHICLES ENTERING / ADT : **63,500**	CRASH RATE: **0.906** /MEV

Table B-10. Crash Summary Table for SR 870 (Commercial Blvd.) at I-95 SB Off Ramp

FLORIDA DEPARTMENT OF TRANSPORTATION
CRASH SUMMARY

SECTION: **86014000** STATE ROUTE: **870 (Commercial Blvd.)**
INTERSECTING ROUTE: **I-95 SB Off Ramp** M.P. **6.408** ENGINEER:
STUDY PERIOD: FROM **1/ 95** TO **12/ 97** COUNTY: **Broward**

No.	DATE	DAY	TIME	TYPE	FATAL	INJURY	PROP DAM	DAY / NT	WET / DRY	CONTRIBUTING CAUSE
1	1/26/95	Thu	1600	Sideswipe	0	0	1	Day	Dry	No Improper Driving
2	3/8/95	Wed	2200	Head On	0	1	0	Nite	Wet	Disregarded Traffic Signal
3	3/18/95	Sat	1300	Rear End	0	1	0	Day	Slippery	Failed to Yield R/W
4	4/25/95	Tue	1700	Rear End	0	0	1	Day	Slippery	No Improper Driving
5	5/12/95	Fri	1300	Rear End	0	1	0	Day	Icy	Followed to Closely
6	5/16/95	Tue	0	Rear End	0	1	0	Nite	Dry	All Others
7	5/23/95	Tue	1300	Sideswipe	0	0	1	Day	Dry	Careless Driving
8	6/12/95	Mon	1600	Rear End	0	0	1	Day	Dry	No Improper Driving
9	6/14/95	Wed	2300	Left Turn	0	1	0	Nite	Dry	Disregarded Traffic Signal
10	6/20/95	Tue	1500	Rear End	0	1	0	Day	Slippery	All Others
11	7/20/95	Thu	2000	Rear End	0	0	1	Nite	Wet	All Others
12	7/31/95	Mon	1800	Angle	0	1	0	Day	Wet	No Improper Driving
13	8/2/95	Wed	1800	Rear End	0	0	1	Day	Wet	All Others
14	9/21/95	Thu	1600	Rear End	0	0	1	Day	Dry	No Improper Driving
15	11/14/95	Tue	1000	Rear End	0	1	0	Day	Dry	All Others
16	12/4/95	Mon	1900	Sideswipe	0	0	1	Nite	Dry	Improper Lane Change
17	12/10/95	Sun	600	Rear End	0	1	0	Day	Dry	All Others
18	12/31/95	Sun	900	Angle	0	0	1	Day	Wet	Disregarded Traffic Signal
19	2/20/96	Tue	1900	Rear End	0	1	0	Nite	Wet	Careless Driving
20	3/2/96	Sat	800	Rear End	0	1	0	Day	Wet	All Others
21	3/5/96	Tue	1300	Rear End	0	1	0	Day	Dry	All Others
22	3/9/96	Sat	1800	Rear End	0	1	0	Nite	Dry	Careless Driving
23	4/12/96	Fri	1900	Rear End	0	0	1	Nite	Dry	All Others
24	5/9/96	Thu	1200	Angle	0	1	0	Day	Dry	Improper Lane Change
25	6/15/96	Sat	1200	Other	0	0	1	Day	Wet	Improper Parking
26	8/24/96	Sat	1400	Rear End	0	1	0	Day	Dry	No Improper Driving
27	9/12/96	Thu	1500	Rear End	0	0	1	Day	Wet	No Improper Driving
28	9/12/96	Thu	1600	Rear End	0	1	0	Day	Slippery	All Others
29	11/11/96	Mon	800	Rear End	0	1	0	Day	Dry	No Improper Driving
30	12/27/96	Fri	1300	Rear End	0	0	1	Day	Wet	Careless Driving
31	1/8/97	Wed	1100	Angle	0	0	1	Day	Dry	No Improper Driving
32	1/8/97	Wed	1300	Rear End	0	0	1	Day	Dry	All Others
33	2/25/97	Tue	2200	Angle	0	1	0	Nite	Dry	Exceeded Safe Speed
34	3/6/97	Thu	1600	Other	0	0	1	Day	Dry	Followed to Closely
35	3/9/97	Sun	1800	Rear End	0	0	1	Nite	Wet	Careless Driving
36	3/26/97	Wed	2000	Angle	0	0	1	Day	Dry	Improper Lane Change
37	4/8/97	Tue	700	Rear End	0	0	1	Day	Dry	No Improper Driving
38	4/29/97	Tue	800	Angle	0	0	1	Day	Dry	Failed to Maintain Equipment
39	6/6/97	Fri	1100	Rear End	0	1	0	Day	Dry	No Improper Driving

40	6/8/97	Sun	1200	Rear End	0	0	1	Day	Slippery	No Improper Driving
41	6/12/97	Thu	1400	Rear End	0	0	1	Day	Wet	Careless Driving
42	6/26/97	Thu	1400	Rear End	0	1	0	Day	Slippery	All Others
43	7/7/97	Mon	800	Rear End	0	1	0	Day	Dry	Careless Driving
44	8/1/97	Fri	2200	Rear End	0	1	0	Unk	Dry	Followed to Closely
45	8/13/97	Wed	1700	Rear End	0	1	0	Day	Dry	No Improper Driving
46	8/27/97	Wed	1500	Rear End	0	1	0	Day	Dry	No Improper Driving
47	10/21/97	Tue	600	Rear End	0	1	0	Nite	Dry	Followed to Closely
Total No.	Fatal	Injury	PDO	Angle	Left Turn	Right Turn	Rear End	Side swipe	Ped/Bike	Other
47	**0**	**25**	**22**	**7**	**1**	**0**	**33**	**3**	**0**	**3**
	0.00%	*53.19%*	*46.81%*	*14.89%*	*2.13%*	*0.00%*	*70.21%*	*6.38%*	*0.00%*	*6.38%*
Day	Night	Wet	Dry	Improper Lane Change	No Improper Driving	Careless Driving	Follow too Closely	Disregarded Traffic Signal	FTY R/W	All Others
35	**12**	**12**	**35**	**3**	**14**	**7**	**4**	**3**	**1**	**12**
74.47%	*25.53%*	*25.53%*	*74.47%*	*6.38%*	*29.79%*	*14.89%*	*8.51%*	*6.38%*	*2.13%*	*25.53%*
TOTAL VEHICLES ENTERING / ADT : **63,500**					CRASH RATE: **0.676** /MEV					

Table B-11. Crash Summary Table for SR 90 (SW 8 Street) at Turnpike NB Off Ramp

FLORIDA DEPARTMENT OF TRANSPORTATION
CRASH SUMMARY

SECTION: **87120000** STATE ROUTE: **90 (Tamiami or SW 8 ST)**
INTERSECTING ROUTE: **Turnpike NB Off Ramp** M.P. **6.198** ENGINEER:
STUDY PERIOD: FROM **1/ 95** TO **12/ 97** COUNTY: **Dade**

No.	DATE	DAY	TIME	TYPE	FATAL	INJURY	PROP DAM	DAY / NT	WET / DRY	CONTRIBUTING CAUSE
1	1/9/95	Mon	1500	Left Turn	0	0	1	Day	Dry	No Improper Driving
2	1/24/95	Tue	2000	Rear End	0	1	0	Nite	Dry	Careless Driving
3	2/9/95	Thu	2100	Left Turn	0	1	0	Day	Dry	Failed to Yield R/W
4	4/10/95	Mon	800	Left Turn	0	0	1	Day	Wet	No Improper Driving
5	5/6/95	Sat	2200	Left Turn	0	1	0	Nite	Wet	Careless Driving
6	7/25/95	Tue	1100	Left Turn	0	0	1	Day	Wet	Disregarded Traffic Signal
7	9/9/95	Sat	900	Left Turn	0	1	0	Day	Dry	No Improper Driving
8	11/26/95	Sun	1100	Angle	0	1	0	Day	Wet	Failed to Yield R/W
9	12/11/95	Mon	2000	Left Turn	0	1	0	Nite	Dry	Failed to Yield R/W
10	12/22/95	Fri	2000	Angle	0	0	1	Nite	Slippery	No Improper Driving
11	12/22/95	Fri	2000	Rear End	0	1	0	Nite	Slippery	No Improper Driving
12	1/7/96	Sun	1500	Angle	0	1	0	Day	Dry	Disregarded Traffic Signal
13	2/13/96	Tue	0	Rear End	0	0	1	Day	Dry	Improper Lane Change
14	2/18/96	Sun	1000	Angle	0	0	1	Day	Wet	No Improper Driving
15	4/2/96	Tue	900	Rear End	0	1	0	Day	Wet	No Improper Driving
16	6/20/96	Thu	700	Rear End	0	1	0	Day	Wet	No Improper Driving
17	8/15/96	Thu	2200	Left Turn	0	0	1	Nite	Dry	Failed to Yield R/W
18	10/30/96	Wed	600	Left Turn	0	1	0	Day	Wet	Improper Turn
19	11/4/96	Mon	800	Rear End	0	0	1	Day	Wet	Followed to Closely
20	11/18/96	Mon	800	Angle	0	0	1	Unk	Wet	Disregarded Traffic Signal
21	11/21/96	Thu	1200	Angle	0	1	0	Day	Wet	Improper Turn
22	11/23/96	Sat	100	Fixed Object	0	0	1	Unk	Dry	No Improper Driving
23	12/12/96	Thu	1900	Left Turn	0	0	1	Nite	Dry	Improper Turn
24	1/30/97	Thu	900	Left Turn	0	1	0	Day	Wet	All Others
25	2/10/97	Mon	800	Angle	0	0	1	Day	Wet	No Improper Driving
26	2/10/97	Mon	900	Rear End	0	0	1	Day	Wet	Careless Driving
27	3/14/97	Fri	1500	Left Turn	0	1	0	Day	Dry	Improper Turn
28	3/22/97	Sat	100	Angle	0	1	0	Day	Dry	No Improper Driving
29	3/28/97	Fri	900	Left Turn	0	1	0	Day	Dry	No Improper Driving
30	4/10/97	Thu	1700	Rear End	0	1	0	Day	Slippery	No Improper Driving
31	5/21/97	Wed	1300	Left Turn	0	1	0	Day	Wet	Failed to Yield R/W
32	5/27/97	Tue	1800	Angle	0	1	0	Day	Wet	All Others
33	9/17/97	Wed	800	Angle	0	1	0	Day	Dry	Careless Driving
34	9/22/97	Mon	700	Angle	0	0	1	Day	Dry	Improper Turn
35	11/11/97	Tue	700	Rear End	0	0	1	Day	Dry	No Improper Driving
36	11/11/97	Tue	700	Rear End	0	0	1	Day	Dry	No Improper Driving
37	11/18/97	Tue	1800	Angle	0	1	0	Nite	Wet	No Improper Driving
38	12/4/97	Thu	2000	Angle	0	1	0	Nite	Slippery	Disregarded Traffic Signal
Total No.	Fatal	Injury	PDO	Angle	Left Turn	Right Turn	Rear End	Side swipe	Ped/Bike	Other

38	**0**	**22**	**16**	**13**	**14**	**0**	**10**	**0**	**0**	**1**
	0.00%	*57.89%*	*42.11%*	*34.21%*	*36.84%*	*0.00%*	*26.32%*	*0.00%*	*0.00%*	*2.63%*
Day	Night	Wet	Dry	Improper Turn	No Improper Driving	Careless Driving	Follow too Closely	Disregarded Traffic Signal	FTY R/W	All Others
27	**11**	**6**	**32**	**5**	**16**	**4**	**1**	**4**	**5**	**2**
71.05%	*28.95%*	*15.79%*	*84.21%*	*13.16%*	*42.11%*	*10.53%*	*2.63%*	*10.53%*	*13.16%*	*5.26%*
TOTAL VEHICLES ENTERING / ADT : **43,333**					CRASH RATE: **0.801** /MEV					

Table B-12. Crash Summary Table for SR 976 (Bird Road) at Turnpike SB Off Ramp

FLORIDA DEPARTMENT OF TRANSPORTATION
CRASH SUMMARY

SECTION: **87044000** STATE ROUTE: **976 (Bird Road)**
INTERSECTING ROUTE: **Turnpike SB Off Ramp** M.P. **0.012** ENGINEER:
STUDY PERIOD: FROM **1/ 95** TO **12/ 97** COUNTY: **Dade**

No.	DATE	DAY	TIME	TYPE	FATAL	INJURY	PROP DAM	DAY / NT	WET / DRY	CONTRIBUTING CAUSE
1	1/20/95	Fri	900	Rear End	0	1	0	Day	Dry	Careless Driving
2	5/14/95	Sun	2000	Left Turn	0	1	0	Nite	Dry	Disregarded Other Traffic
3	9/5/95	Tue	1700	Angle	0	1	0	Day	Wet	Improper Turn
4	9/12/95	Tue	900	Angle	0	0	1	Day	Dry	No Improper Driving
5	1/17/96	Wed	2200	Left Turn	0	0	1	Nite	Dry	No Improper Driving
6	4/26/96	Fri	900	Left Turn	0	1	0	Day	Dry	No Improper Driving
7	5/6/96	Mon	1500	Rear End	0	1	0	Day	Dry	No Improper Driving
8	8/28/96	Wed	2300	Left Turn	0	1	0	Nite	Dry	All Others
9	12/19/96	Thu	600	Left Turn	0	0	1	Nite	Dry	No Improper Driving
10	2/3/97	Mon	1600	Rear End	0	1	0	Day	Dry	No Improper Driving
11	3/6/97	Thu	2100	Rear End	0	0	1	Nite	Dry	No Improper Driving
12	3/14/97	Fri	700	Rear End	0	0	1	Day	Wet	No Improper Driving
13	7/2/97	Wed	1300	Left Turn	0	0	1	Day	Dry	No Improper Driving
14	7/19/97	Sat	1800	Rear End	0	1	0	Day	Dry	Careless Driving
15	11/22/97	Sat	1800	Angle	0	1	0	Nite	Dry	Improper Turn
16	11/23/97	Sun	100	Angle	0	1	0	Nite	Dry	Failed to Yield R/W
17	11/25/97	Tue	2000	Left Turn	0	0	1	Nite	Dry	All Others
18	12/12/97	Fri	1200	Rear End	0	0	1	Day	Dry	No Improper Driving

Total No.	Fatal	Injury	PDO	Angle	Left Turn	Right Turn	Rear End	Side swipe	Ped/Bike	Other
18	**0**	**10**	**8**	**4**	**7**	**0**	**7**	**0**	**0**	**0**
	0.00%	*55.56%*	*44.44%*	*22.22%*	*38.89%*	*0.00%*	*38.89%*	*0.00%*	*0.00%*	*0.00%*
Day	Night	Wet	Dry	Improper Turn	No Improper Driving	Careless Driving	Follow too Closely	Disregarded Other Traffic	FTY R/W	All Others
10	**8**	**1**	**17**	**2**	**10**	**2**	**0**	**1**	**1**	**2**
55.56%	*44.44%*	*5.56%*	*94.44%*	*11.11%*	*55.56%*	*11.11%*	*0.00%*	*5.56%*	*5.56%*	*11.11%*

TOTAL VEHICLES ENTERING / ADT : **41,500** CRASH RATE: **0.396** /MEV

Table B-13. Crash Summary Table for SR 990 (SW 104 Street) at SR 874 (Don Shula Expressway)

FLORIDA DEPARTMENT OF TRANSPORTATION
CRASH SUMMARY

SECTION: **87046000** STATE ROUTE: **990 (Killian PKWY or SW 104 ST)**
INTERSECTING ROUTE: **SR 874 Don Shula EPWY** M.P. **0.37** ENGINEER:
STUDY PERIOD: FROM **1/ 95** TO **12/ 97** COUNTY: **Dade**

No.	DATE	DAY	TIME	TYPE	FATAL	INJURY	PROP DAM	DAY / NT	WET / DRY	CONTRIBUTING CAUSE
1	10/12/95	Thu	1700	Rear End	0	1	0	Day	Dry	Careless Driving
2	4/8/96	Mon	1400	Rear End	0	0	1	Day	Slippery	Careless Driving
3	4/30/96	Tue	1800	Rear End	0	1	0	Day	Slippery	Careless Driving
4	6/18/96	Tue	800	Rear End	0	0	1	Day	Wet	No Improper Driving
5	8/2/96	Fri	2100	Rear End	0	1	0	Nite	Dry	Careless Driving
6	10/1/96	Tue	1400	Rear End	0	0	1	Day	Slippery	Careless Driving
7	12/16/96	Mon	700	Angle	0	1	0	Day	Dry	Disregarded Traffic Signal
8	1/11/97	Sat	1300	Rear End	0	1	0	Day	Wet	Careless Driving
9	1/15/97	Wed	1900	Rear End	0	0	1	Nite	Slippery	Careless Driving
10	8/6/97	Wed	1400	Rear End	0	0	1	Day	Dry	No Improper Driving
11	9/7/97	Sun	1300	Rear End	0	1	0	Day	Dry	Careless Driving
12	10/19/97	Sun	2200	Other	0	1	0	Nite	Dry	Careless Driving
Total No.	Fatal	Injury	PDO	Angle	Left Turn	Right Turn	Rear End	Side swipe	Ped/Bike	Other
12	**0**	**7**	**5**	**1**	**0**	**0**	**10**	**0**	**0**	**1**
	0.00%	*58.33%*	*41.67%*	*8.33%*	*0.00%*	*0.00%*	*83.33%*	*0.00%*	*0.00%*	*8.33%*
Day	Night	Wet	Dry	Improper Lane Change	No Improper Driving	Careless Driving	Follow too Closely	Disregarded Traffic Signal	FTY R/W	All Others
9	**3**	**5**	**7**	**0**	**2**	**9**	**0**	**1**	**0**	**0**
75.00%	*25.00%*	*41.67%*	*58.33%*	*0.00%*	*16.67%*	*75.00%*	*0.00%*	*8.33%*	*0.00%*	*0.00%*

TOTAL VEHICLES ENTERING / ADT : **24,800** CRASH RATE: **0.442** /MEV