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Tyler Parkway and Burnt Boat Dr.

Intersection Analysis

Final Report

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Prepared for:
North Dakota Department of Transportation and City of Bismarck

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This report summarizes the findings of the traffic operations and safety analysis of the Tyler Parkway and Burnt Boat Dr. in Bismarck. The Advanced Traffic Analysis Center (ATAC) of North Dakota State University submitted several documents and presentations since the start of this study in December 2002. This document incorporates that material, as well as addresses comments from the City of Bismarck and North Dakota Department of Transportation (NDDOT).

1.0 INTRODUCTION

This study was conducted as a cooperative effort between the City of Bismarck and the NDDOT to examine traffic operations at the Tyler Parkway and Burnt Boat Dr. intersection in Bismarck. The study was motivated by several concerns about the intersection's safety and its traffic operations. Most of these concerns are related to traffic movements on the side street (Burnt Boat Dr) and their interaction with major street traffic (Tyler Parkway), especially the U-turns from the northbound approach. The NDDOT and the City of Bismarck requested the assistance of the ATAC to assess the operations of that intersection by using ATAC's traffic video data collection and traffic modeling capabilities.

2.0 OBJECTIVES

The purpose of this study was to assist the City of Bismarck and the NDDOT in assessing existing traffic operations and evaluating possible improvement strategies for the Tyler Parkway and Burnt Boat Dr intersection in Bismarck. The main objectives of this study may be summarized as follows:

1. Collect field traffic data at the intersection
   a. Traffic counts (for all approaches and movements)
   b. Delay measurements for Burnt Boat Dr (mainly eastbound approach)
   c. Video surveillance of the intersection and its vicinity

2. Evaluate traffic operations at the intersection using collected field data as well as crash data from the NDDOT

3. Examine other strategies that may potentially improve traffic operations and safety

4. Estimate the impacts of various strategies using traffic simulation

3.0 METHODOLOGY

Several tasks were required to address the objectives set for the study. Additional activities were conducted based on input from the City of Bismarck and the NDDOT. In general, the main activities for conducting the analysis may be described as follows:

1. Collect field data for an average 12-hour day (Tuesday, Dec. 3, 2002). The data collection consisted primarily of video taping the intersection using ATAC's Traffic Data Collection System.

2. Process video data to obtain the following data sets:
   a. Traffic counts (including turning movements) for all approaches
   b. U-turn on the northbound Tyler Parkway approach (and possibly the originating point)
   c. Traffic delay for the Burnt Boat Drive Approach

3. Use traffic simulation to estimate impacts of a traffic signal installation and other intersection changes for the following conditions (using existing traffic volumes):
   a. Base condition: existing intersection geometry
   b. Incorporating an exclusive right turn lane
   c. Removing the McDonald's/Conoco approach

d. A combination of b and c
e. Signalized with existing intersection geometry
f. Signalized with an exclusive right turn lane
g. Signalized with the removal of the McDonald's/Conoco approach
h. A combination of f and g
i. Incorporating a dual-lane roundabout intersection

4. Summarize results of the data collection and analysis

4.0 RESULTS

The following sections summarize the results from various analysis activities. Additional detailed results are included in the appendices.

4.1 Field Observations

There are several special conditions at that intersection that require additional analysis beyond the signal warrant requirements. Some of these conditions include:

1. Intersection geometry: the EB approach has a right-turn/through (RT/T) lane , a through lane (T), and an exclusive left-turn (LT) lane. When vehicles occupy all three lanes at the same time, visibility seems to be hindered, especially for the RT movement since LT traffic tends to pull-up beyond the crossbar. Further, the RT traffic must negotiate a relatively tight corner which contributes to slower speeds (and hence longer gap requirements).

2. U-turns: The NB approach of Tyler Parkway experiences frequent u-turn maneuvers which greatly inhibit operations for the EB Burnt Boat Road approach. The video data revealed an extra caution among drivers on that approach that may be due to their concerns about u-turns. This extra caution resulted in some drivers waiting until a conflicting LT turn was completed before they proceeded with their RT maneuver.

3. Stop sign violations: as the level of frustration among EB drivers grew, the video data revealed several violations of the stop sign. In some cases three or four vehicles would go through the stop sign at the same time, without stopping, when they perceived an adequate gap.

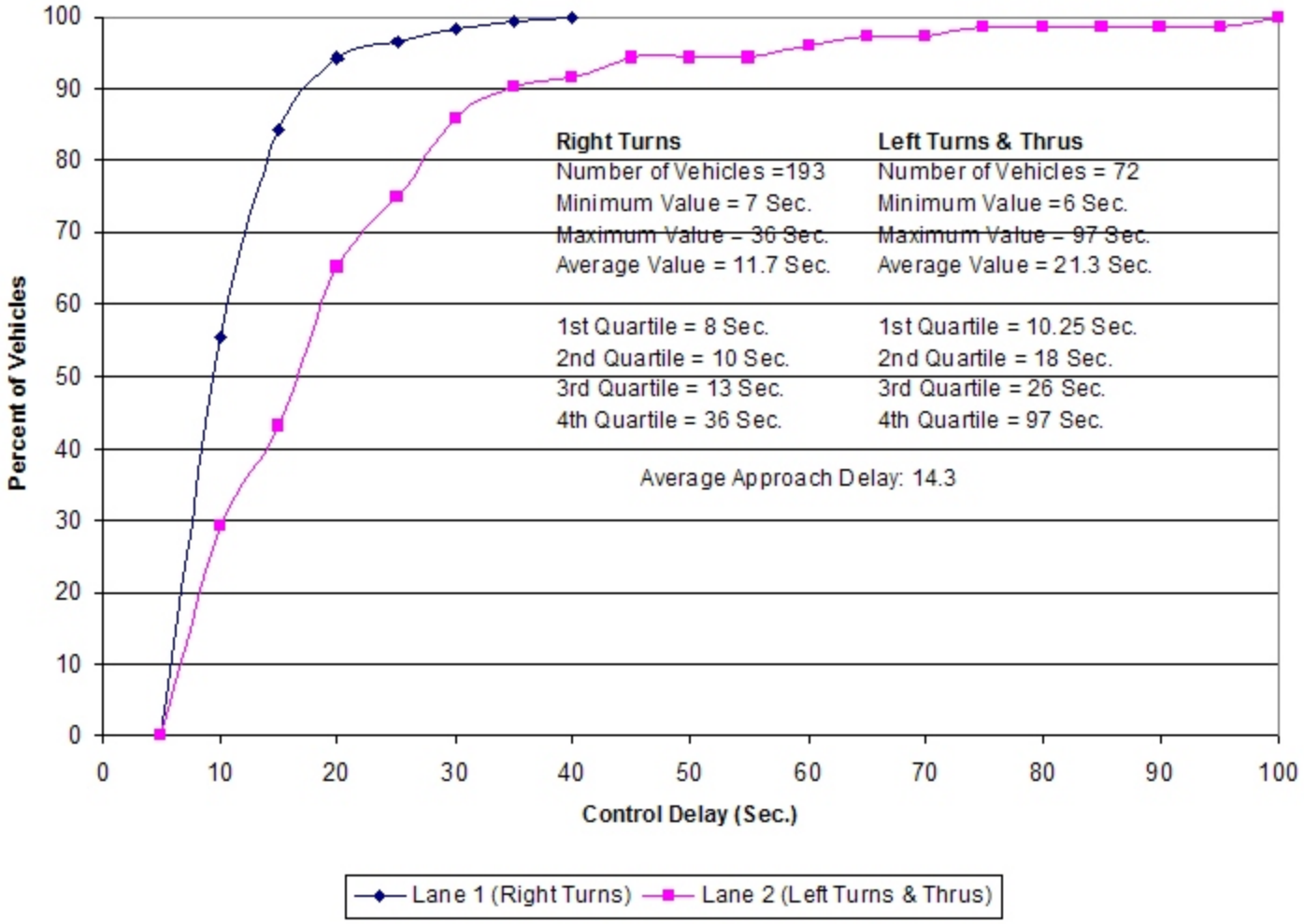
It should be pointed out that these observations apply only to the two short AM and PM periods. However, the safety of the intersection is severely impacted during those periods.

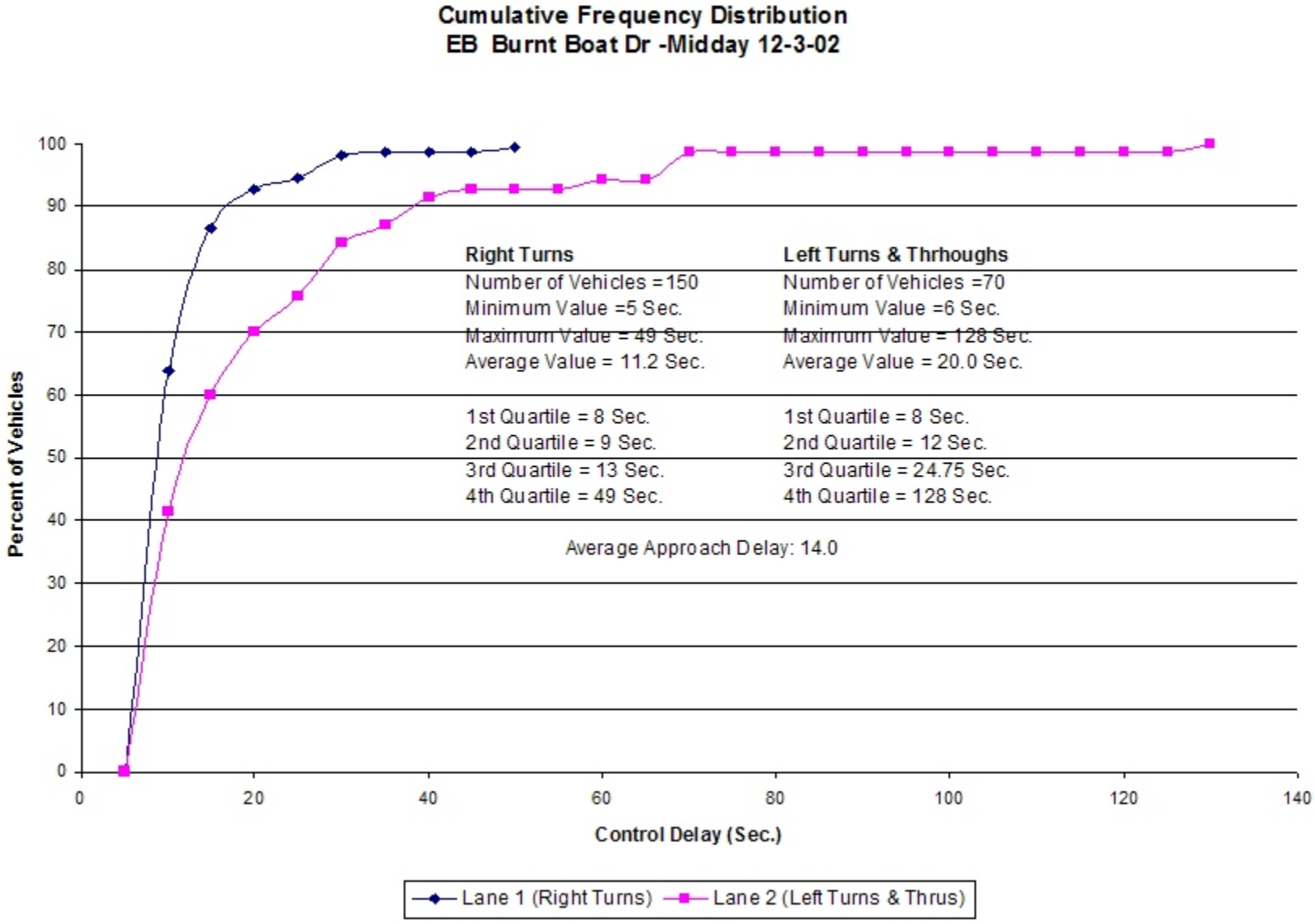
4.2 Traffic Delay Data

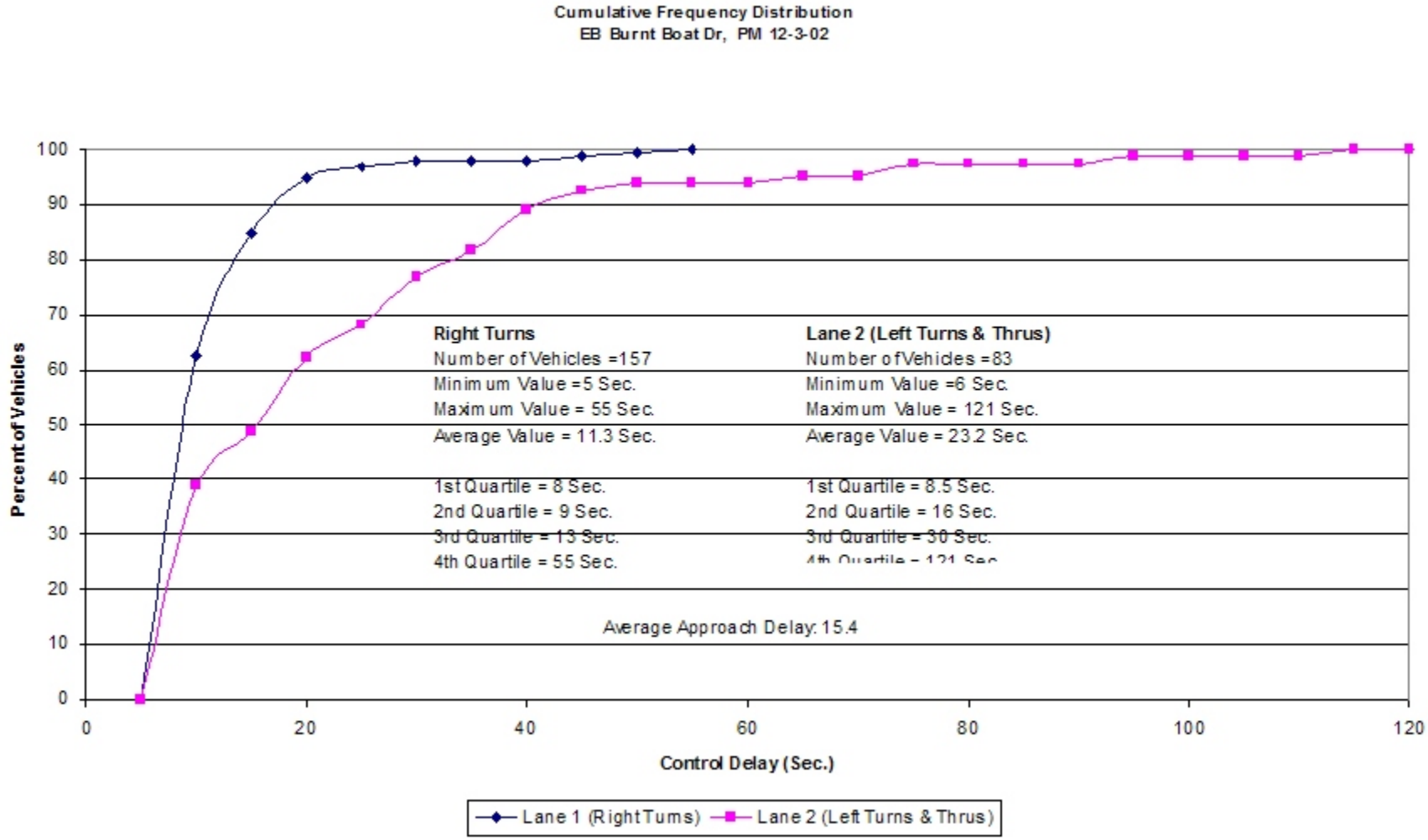
Control delay was estimated from the surveillance video for the EB approach of Burnt Boat Drive for the same 12-hour period for which traffic counts were developed. That approach was the main area of concern for the analysis. Further, the WB approach of Burnt Boat Drive experiences minimal traffic. Tyler Parkway has free movement for the most part, except for the northbound LT (and u-turns) which experienced some queuing.

Three periods were considered in the control delay estimation, including morning, mid-day, and afternoon peak periods. The data indicate that the maximum delay experienced for the EB approach is 128 seconds and was experienced during the mid-day period. The highest average delay was 23.2 seconds per vehicle which was experienced during the afternoon period (for 157 vehicles). The following charts show the cumulative distribution of delay for the three periods.

Cumulative Frequency Distribution
EB Burnt Boat Dr - AM 12-3-02




Cumulative Frequency Distribution
EB Burnt Boat Dr -Midday 12-3-02
Percent of Vehicles
100
90
80
70
60
50
40
30
20
10
0
0
20
40
60
80
100
120
140
Control Delay (Sec.)
Right Turns
Number of Vehicles =150
Minimum Value =5 Sec.
Maximum Value = 49 Sec.
Average Value = 11.2 Sec.
1st Quartile = 8 Sec.
2nd Quartile = 9 Sec.
3rd Quartile = 13 Sec.
4th Quartile = 49 Sec.
Left Turns & Thrhoughs
Number of Vehicles =70
Minimum Value =6 Sec.
Maximum Value = 128 Sec.
Average Value = 20.0 Sec.
1st Quartile = 8 Sec.
2nd Quartile = 12 Sec.
3rd Quartile = 24.75 Sec.
4th Quartile = 128 Sec.
Average Approach Delay: 14.0
Lane 1 (Right Turns)
Lane 2 (Left Turns & Thrus)


Cumulative Frequency Distribution
EB Burnt Boat Dr, PM 12-3-02
Percent of Vehicles
100
90
80
70
60
50
40
30
20
10
0
0
20
40
60
80
100
120
Control Delay (Sec.)
Right Turns
Number of Vehicles =157
Minimum Value =5 Sec.
Maximum Value = 55 Sec.
Average Value = 11.3 Sec.
1st Quartile = 8 Sec.
2nd Quartile = 9 Sec.
3rd Quartile = 13 Sec.
4th Quartile = 55 Sec.
Lane 2 (Left Turns & Thrus)
Number of Vehicles =83
Minimum Value =6 Sec.
Maximum Value = 121 Sec.
Average Value = 23.2 Sec.
1st Quartile = 8.5 Sec.
2nd Quartile = 16 Sec.
3rd Quartile = 30 Sec.
Average Approach Delay: 15.4
Lane 1 (Right Turns)
Lane 2 (Left Turns & Thrus)

4.3 Impact Analysis of Alternatives

This section summarizes the results of evaluating various improvement strategies (as listed under task 4 in Section 3.0 Methodology). The main criterion use for the evaluation is the impacts of various strategies on intersection delay (i.e. traffic operations). There are other factors that will influence the strategies adopted by the relevant agencies, including impacts on safety which are hard to quantify, cost of implementing the strategies, and public acceptance of strategies.

The base value of control delay was estimated from the surveillance video for the EB approach of Burnt Boat Dr for the same 12-hour period for which traffic counts were developed. That approach was the main area of concern for the analysis. Further, the WB approach of Burnt Boat Drive experiences minimal traffic. Tyler Parkway has free movement for the most part, except for the northbound LT and U-turns which experience some queuing. Simulation delay for the whole intersection was then compared for the various scenarios.

The VISSIM traffic simulation model was used to estimate traffic delay for each strategy and for three periods, including morning, mid-day, and afternoon peak periods. Field data indicate that the maximum delay experienced for the EB approach is 128 seconds and was experienced during the mid-day period. The critical delay for the day was found to occur during the PM peak with an average eastbound approach delay of 15.4 sec/veh. This period was used to compare the delay from the various scenarios (Table 2).

Table 2 Average PM Delays and LOS

Scenario	Delay				Total		Level of Service			
	EB	WB	NB	SB	S/veh	veh-hr	EB	WB	NB	SB
existing	15.36	17.63	1.15	0.15	3.60	1.38	B	B	A	A
free right	6.95	21.07	1.57	0.09	2.53	0.96	A	C	A	A
Free right & no approach	6.59	19.83	0.89	0.11	2.40	0.95	A	B	A	A
No approach	12.22	22.45	1.30	0.11	3.59	1.42	A	C	A	A
signalized	12.70	22.94	2.91	0.59	4.30	1.67	B	C	A	A
signalized & free right	8.02	23.76	2.44	0.30	3.26	1.25	A	C	A	A
signalized & no approach	13.78	24.34	1.56	0.98	4.35	1.69	B	C	A	A
signalized, no approach, & free right	7.58	24.59	1.46	0.48	3.16	1.24	A	C	A	A
roundabout	1.27	2.18	1.41	1.13	**1.32**	**0.5**	A	A	A	A

As can be seen in this table, the roundabout design is far superior to the others, giving not only a smaller overall delay, but also a much higher LOS. The highest delay occurs when a signal is implemented into the simulation. It should also be pointed out that removing the McDonald's/Conoco approach does not significantly affect the intersection delay.

The "roundabout" intersection was a special scenario which has been applied because of documented success in remedying the types of problems experienced by this intersection.

Some appropriate locations or conditions for roundabout installation that apply to this case include the following:

1. Locations with high delays.
2. Locations where traffic signals are not warranted.
3. Intersections where U-turns are frequent or desirable.

5.0 SUMMARY/RECOMMENDATIONS

This study evaluated the traffic operations of the intersection of Tyler Parkway and Burnt Boat Drive. Several tasks were performed to evaluate the existing conditions and several traffic control alternatives. The analysis consisted for field delay measurements and traffic simulation. The field delay analysis determined that the Burnt Boat Drive delay is not excessive overall, however, during short peak periods the delay experienced by the left and through movements may exceed one minute. The simulation analysis determined the potential effects of modifying traffic control. Although some benefits are realized for the side-street approaches for some alternatives, the adverse effects to the major-street approaches significantly outweigh those benefits. In addition, NDDOT has indicated that Burnt Boat Drive has experienced only a few crashes over the past several years.

Based on the analysis of traffic delays under several alternatives, using a roundabout intersection minimizes overall delay at the intersection. It should be mentioned that this recommendation is based on a generic design. Proper roundabout design will be key to successful operations.

The following picture is an image of the roundabout used for simulation overlaid on an image containing the pavement edges and right-of-way lines of the area. It should be kept in mind that this drawing was used for simulation purposes only.