

Signal Warrant Analysis

McCulloch Road at Worchester Drive/Amour de Flame Way



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TTE 5204 Project No. 1

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February 22, 2021

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EXECUTIVE SUMMARY

The first project for TTE 5204 Traffic Engineering for Spring 2021 was to perform a signal warrant study at the intersection of McCulloch Road and Worchester Drive/Amour de Flame Way, Orange County, Florida. Based on the results of the analysis, field observations, and engineering judgment, the following recommendation and conclusion was developed: A traffic signal should not be installed as no warrants were satisfied.



INTRODUCTION

The first project for TTE 5204 Traffic Engineering for Spring 2021 was to perform a signal warrant study at the intersection of McCulloch Road and Worchester Drive/Amour de Flame Way, Orange County, Florida. See Figure 1 – Project Location. McCulloch Road is a discontinuous east-west roadway on the Orange – Seminole county line. McCulloch Road starts on the west end at Dean Road and goes almost due east where it terminates at the entrance to Iron Bridge (or the Little Econlockhatchee River) It then resumes at Rouse Road and continues east to its eastern terminus, Native Dancer Lane, an entrance to Rybolts Reserve (or the Econlockhatchee River) The road is maintained by both Orange and Seminole County but is maintained by Orange County within the project limits. Traffic data was obtained from both agencies and there is a significant difference between the two. Orange County reports an AADT of 24,800 in 2019 while Seminole County reports 19,900 for 2019 and 20,900 for 2020.

While conducting this study, the analysis methods are generally consistent with those set forth in the Manual on Uniform Traffic Control Devices (MUTCD 2009 Revision 2), the Manual on Uniform Traffic Studies (MUTS 2021) and the FDOT Traffic Engineering Manual (TEM 2021).

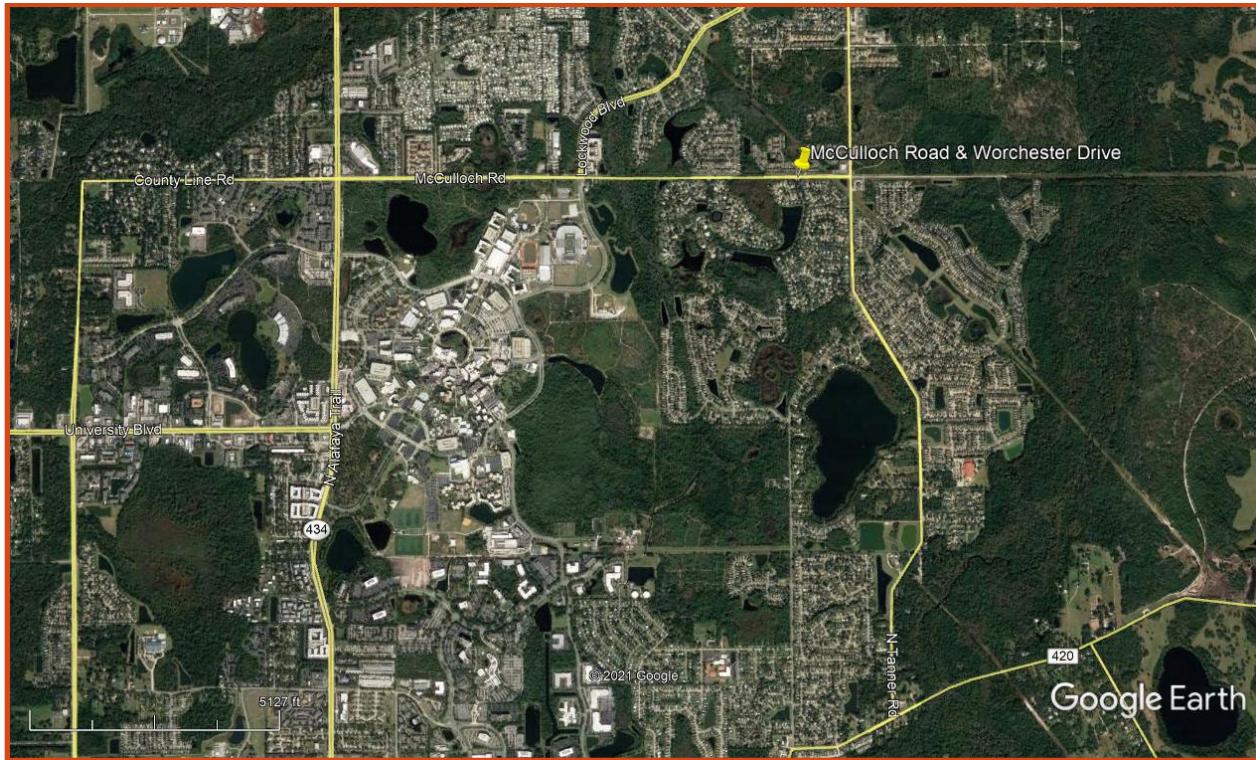


Figure 1 - Project Location

DATA COLLECTION

Field Inventory

Table 1 - Summary of Existing Conditions

Feature	Description
Main Street	McCulloch Road
Side Street	Amour de Flame Way (north side) Worchester Drive (south side)
Area Location	The intersection is located approximately 1.8 miles east of Alafaya Trail (SR 434).
Surrounding Development	Multi-family residential (north side) Single family residential (south side)
Land Uses at Intersection	Residential all quadrants
Pedestrian Generators	UCF <1mile
Traffic Control	The intersection side streets are stop controlled.
Adjacent Signalized Intersections	Worchester Dr/Keats Way and McCulloch Rd, 1830 feet to the west. Tanner Rd/Old Lockwood Rd and McCulloch Rd, 1090 feet to the east.
McCulloch Road	Function – County Road Connectivity – UCF to the west and a dead end (Econlockhatchee River) to the east Cross Section – two lane undivided with dedicated left turn lanes at major intersections Posted Speed Limit – 45 mph East Approach – One through lane with a dedicated left and right turn lane West Approach – One through lane with a dedicated left and right turn lane Alignment – Straight alignment Sidewalks – Both sides Utilities – Overhead power lines (transmission and distribution) on the north side of the roadway Street Lighting – Starting in the NW quadrant going west
Amour de Flame Way	Connectivity – Single entrance to Hawthorne Glen Cross Section – Two lane divided Posted Speed Limit – 10 mph North Approach – One left/right lane
Worchester Drive	Connectivity – Eastern entrance to University Estates Cross Section – Two lane divided at the intersection Posted Speed Limit – 25 mph South Approach – One through/left lane and one right turn lane
Other Distinct Features	N/A

Traffic Volumes

Traffic data was collected on February 2, 2021 for the hours of 6 A.M. to 6 P.M. The turning movement count reveals that the peak traffic volume at the intersection occurs from 5:00 to 6:00 PM with a total of 1,163 vehicles per hour (vph) approaching the intersection. The following tables summarize the combined passenger and heavy vehicle turning movement volumes during the twelve hours of data collection:

Table 2 - Turning Movement Count Summary for McCulloch Road

TIME	EASTBOUND				WESTBOUND				TOTAL
	BEGIN/END	L	T	R	TOT	L	T	R	TOT
6 - 7	2	71	3	76	5	225	3	233	309
7 - 8	12	112	4	128	6	441	5	452	580
8 - 9	9	192	9	210	9	492	5	506	716
9 - 10	16	174	9	199	12	307	7	326	525
10 - 11	22	205	13	240	10	253	6	269	509
11 - 12	26	253	13	292	9	315	8	332	624
12 - 1	31	311	24	366	13	329	10	352	718
1 - 2	33	311	19	363	8	332	10	350	713
2 - 3	33	370	21	424	22	348	13	383	807
3 - 4	36	441	22	499	11	324	15	350	849
4 - 5	39	461	26	526	21	343	18	382	908
5 - 6	67	569	24	660	21	376	19	416	1,076
TOTAL	326	3470	187	3983	147	4085	119	4351	8,334

Percentage	8.2%	87.1%	4.7%	100%	3.4%	93.9%	2.7%	100%	
Maximum	67	569	26		22	492	19		
Minimum	2	71	3		5	225	3		

Table 3 - Turning Movement Count Summary for Worchester Drive / Amour de Flame Way

TIME	NORTHBOUND				SOUTHBOUND				TOTAL
	BEGIN/END	L	T	R	TOT	L	T	R	TOT
6 - 7	14	0	8	22	5	1	22	28	50
7 - 8	27	0	12	39	9	0	28	37	76
8 - 9	18	0	19	37	9	0	41	50	87
9 - 10	22	0	12	34	9	0	38	47	81
10 - 11	35	0	16	51	6	0	26	32	83
11 - 12	19	0	15	34	15	0	44	59	93
12 - 1	27	1	11	39	8	0	45	53	92
1 - 2	17	0	13	30	19	0	45	64	94
2 - 3	20	0	16	36	12	0	39	51	87
3 - 4	21	0	10	31	5	0	49	54	85
4 - 5	14	0	18	32	8	0	44	52	84
5 - 6	13	0	12	25	17	0	45	62	87
TOTAL	247	1	162	410	122	1	466	589	999

Percentage	60.3%	0.2%	39.5%	100%	0%	100%	0%	100%	
Maximum	35	1	19		19	1	49		
Minimum	13	0	8		5	0	22		

Turning movement data and pedestrian counts are presented in further detail in Appendix A.

Delay Data

From the volume data, the AM peak hour was identified from 8-9 am and the PM peak hour was identified from 5-6 pm. Each peak hour had volume of 87 vehicle/hour on minor road. Stop-sign delay on minor road was obtained on February 11, 2021 for the AM and PM peak hours. Total vehicle hour delay (0.24 vehicle-hour) at PM peak was higher than AM peak (0.15 vehicle-hour). The results of the analysis are as follows:

Table 4 - Summary of Stop Delay

	Total Vehicle Count	Average Stopped Time (second)	Maximum Stopped Time (second)	Total Delay (second)	Total delay (vehicle hour)
AM Peak	47	11.23	54	528	0.15
PM Peak	79	10.91	67	862	0.24

Stopped delay raw data is presented in further detail in Appendix B.

Condition Diagram

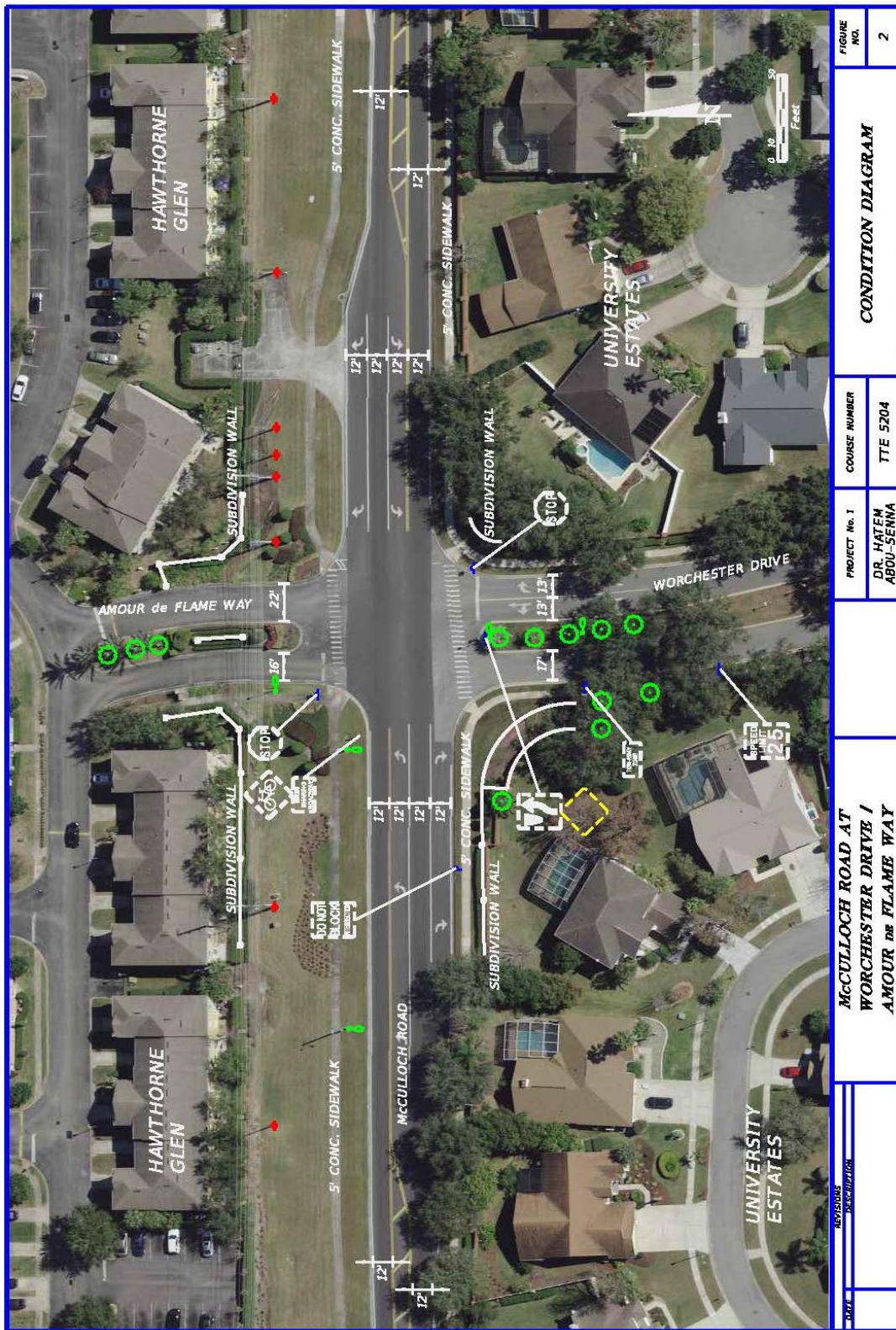


Figure 2 - Condition Diagram

Intersection Approach Photos

West Approach



Figure 3 - Looking east into the intersection from McCulloch Road



Figure 4 - Looking west from the intersection

East Approach

Figure 5 -Looking west into the intersection from McCulloch Road



Figure 6 - Looking east from the intersection

South Approach

Figure 7 - Looking north into the intersection from Worchester Drive



Figure 8 - Looking south from the intersection

North Approach

Figure 9 - Looking south into the intersection from Amour de Flame Way



Figure 10 - Looking north from the intersection

QUALITATIVE ASSESSMENT

AM Peak Period

Completed by another group.

MD Peak Period

Group 4 was responsible for data collection (both for turning movement traffic count and stopped delay count) during the mid-day period. Therefore, the qualitative assessment has been described on mid-day peak period, 11-12 pm.

Maximum traffic volume on the major road was observed in the westbound direction. Almost all traffic was through traffic. During this period, most of vehicles of minor road moved to southbound direction, of which maximum vehicle was turning right. These vehicles finally merged with westbound major road traffic. It was also observed that vehicles did not wait a long-time near stop sign for further maneuver.

PM Peak Period

Completed by another group.



CRASH DATA

There are several factors including roadway features, vehicular characteristics, driver behavior, pedestrian etc. are associated with traffic crashes. Analysis of crash data will provide necessary information regarding identification of crash patterns, mitigating crash severity and adopting viable countermeasures to reduce the number of crashes. Again, intersection is the most critical part of roadways in terms of traffic crashes. Installing adequate traffic signal at intersection plays a major role in reducing crashes at roadway intersection. Hence, crash data analysis will assist signal warrant analysis at our study area.

Crash Analysis

The crash records are collected from Signal four Analytics (S4A). The data provides crash information from May 2010 to November 2020. In this study, total nineteen (19) crashes occurred at the intersection with McCulloch Road and Worcester Drive/Amour de Flame Way. Out of the nineteen (19) crashes, fourteen (14) crashes occurred during daytime conditions whereas four (4) crashes occurred during nighttime condition and one was unknown. Moreover, five (5) of the nineteen (19) crashes occurred on wet pavement and the rest occurred on a dry pavement. In terms of weather condition, most of the crashes occurred in clear weather with total four (4) crashes in cloudy or rainy condition. It is also worth mentioning that twelve (12) out of the nineteen (19) crashes occurred in PM peak period (4-7 pm).

Table 5 summarizes the crash statistics as shown below.

A collision summary diagram is provided in Figure 11. Table 5 summarizes the crash statistics by year.

Table 5 - Crash Statistics Summary

Characteristics	Number of crashes			
Light condition	Daylight (14)	Dark -lighted (2)	Dark–not lighted (2)	Unknown (1)
Weather	Rainy (2)	Cloudy (4)	Clear (13)	
Pavement condition	Wet (5)	Dry (14)		

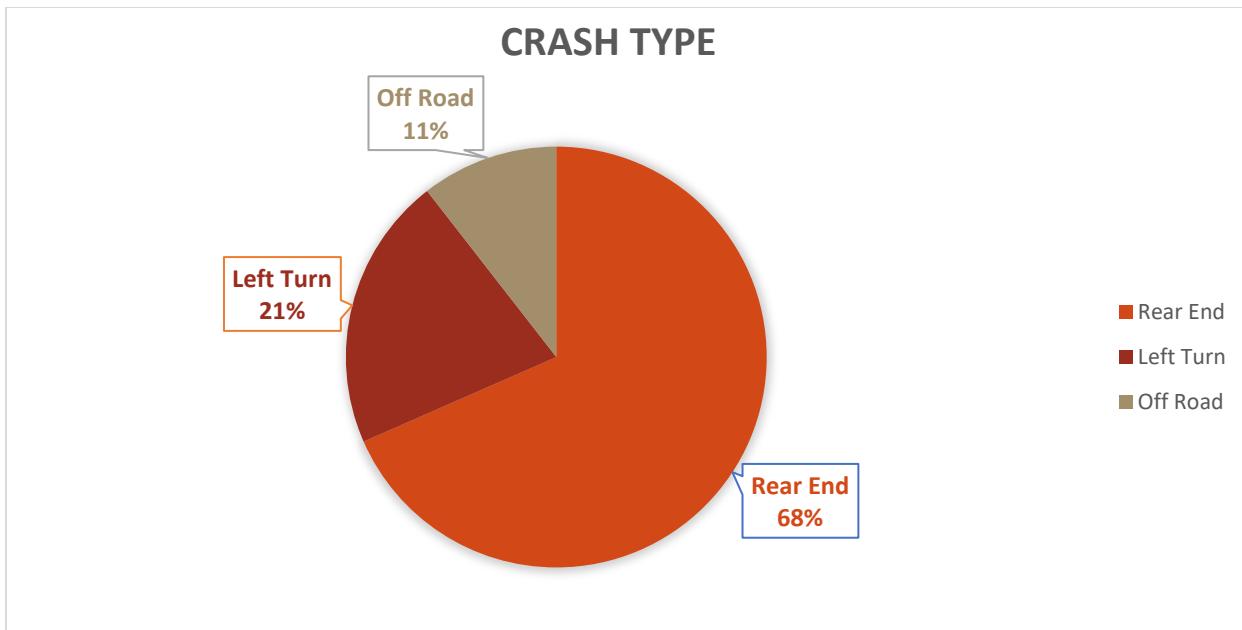


Figure 11 - Composition of Different Crash Types

From the analysis, we have found that the predominant crash type is rear-end in this intersection. The composition of crash type is shown in Figure 11.

The above figure illustrates that the percentage of rear-end crash is 68%, left turn crash 21% and off-road crash 11%. However, if we consider the volume of the major and minor streets as an exposure measure, the most predominant type of crash will be the rear-end crash. We found much higher percentage of volume counts in the major street (McCulloch Road) compared to the minor street (Worchester Drive/Amour de Flame Way).

Furthermore, we evaluated the total cost associated with each crash type in our study area.

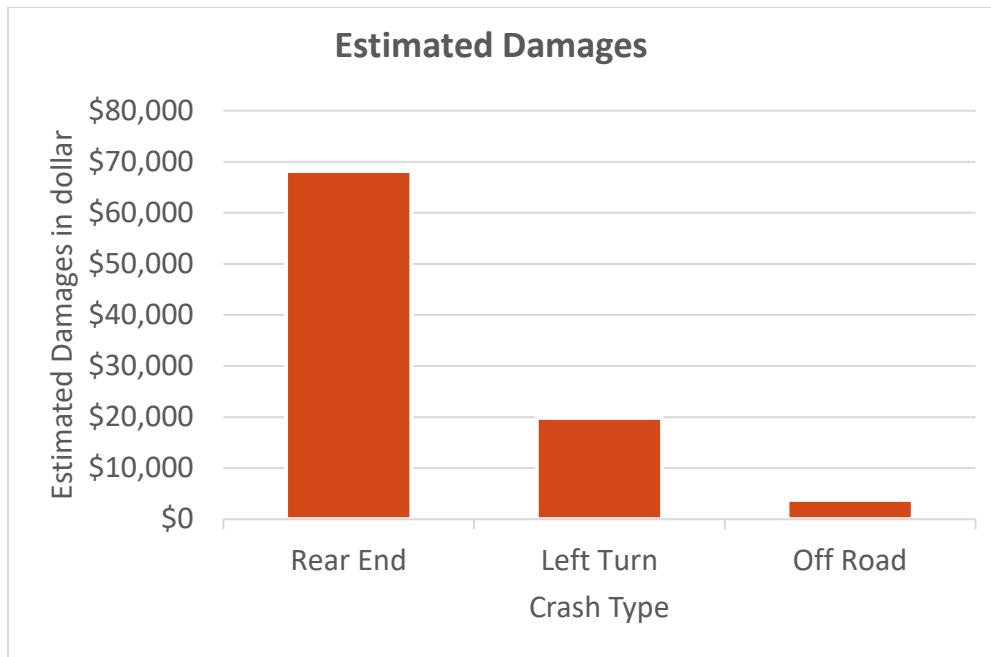


Figure 12 - Estimated Damages Associated with Different Crash Types

The above figure shows that the estimated damages for rear end crashes is predominant over other types of crashes. The estimated damages associated with rear end crashes is found to be 68,200 US dollar. The above bar chart also shows that the estimated damages for left turn, off road etc. are within the range of 20,000 US dollar.

In a summary, the studied stop-controlled intersection had the higher percentages of the rear-end crash in terms of crash frequency as well as estimated damages. From the data of last ten years, it has been observed crash frequency is not that much high in our study location. Most of the crashes were property damage only with some minor injury.



Collision Diagram

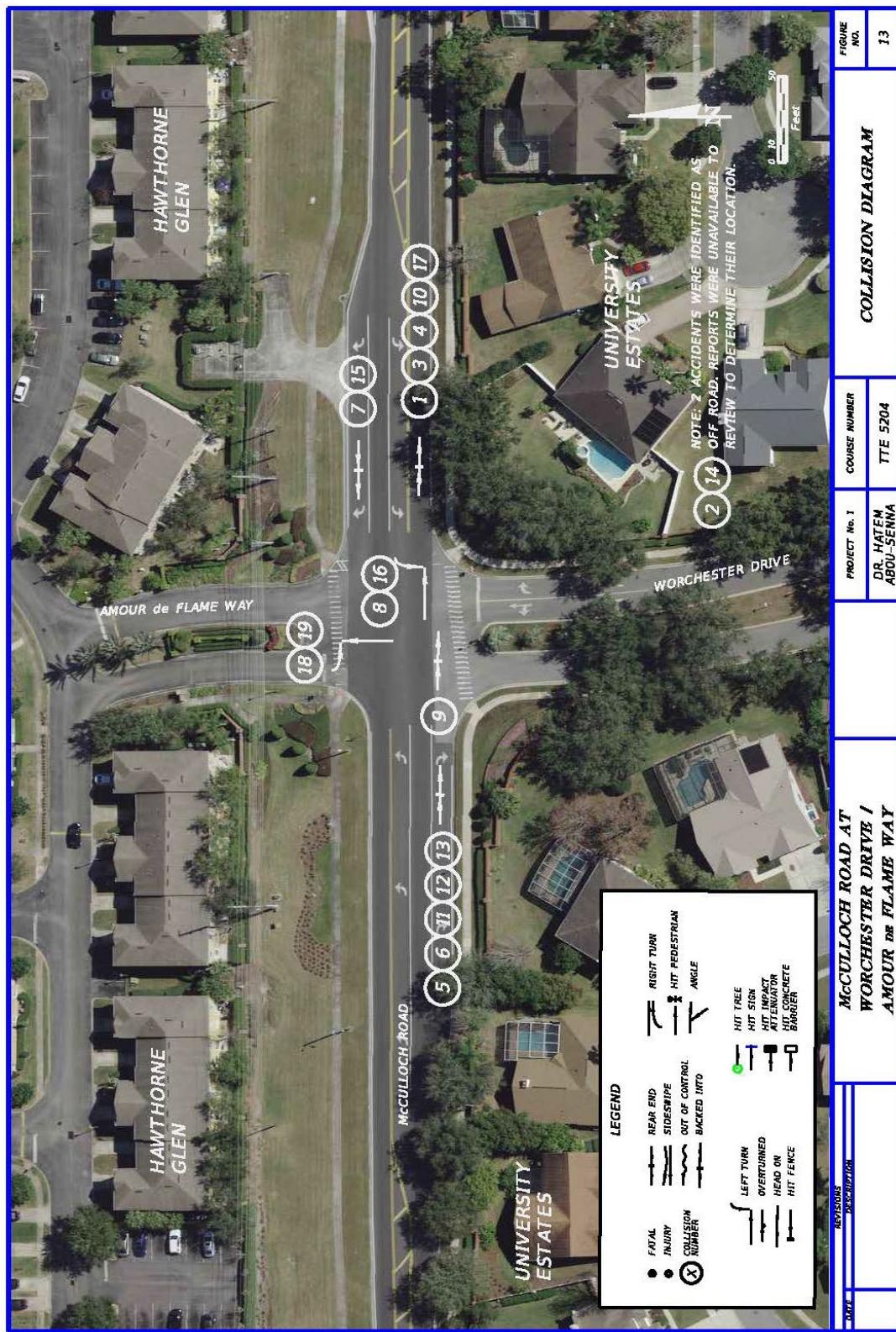


Figure 13 - Collision Diagram

Table 6 - Collision Summary

NO.	DATE	TIME	TYPE	WET/ DRY	DAY/ NIGHT	FATAL	INJURY	EST DAMAGES
1	5/6/2010	6:17 PM	RE	D	D	0	0	\$4,500
2	5/1/2011	8:23 AM	OFF	D	D	0	1	\$3,800
3	10/8/2012	4:45 PM	RE	D	D	0	0	\$4,000
4	8/19/2013	4:06 PM	RE	W	D	0	0	\$2,600
5	4/2/2014	5:34 PM	RE	D	D	0	1	\$10,000
6	7/28/2014	5:10 PM	RE	D	D	0	0	\$2,400
7	9/9/2014	8:15 AM	RE	D	D	0	0	\$11,000
8	1/27/2015	7:45 AM	LT	D	D	0	2	\$10,000
9	2/9/2015	5:59 PM	RE	W	D-NL	0	1	\$1,000
10	4/24/2015	5:20 PM	RE	D	D	0	0	\$4,500
11	8/17/2015	6:00 PM	RE	W	D	0	4	\$2,150
12	10/7/2015	5:34 PM	RE	D	D	0	0	\$500
13	10/28/2015	5:23 PM	RE	D	D	0	0	\$550
14	12/13/2015	4:00 AM	OFF	D	UNK	0	0	\$0
15	1/29/2017	7:25 PM	RE	D	D-L	0	0	\$7,500
16	4/4/2017	4:40 PM	LT	W	D	0	0	\$7,500
17	4/25/2019	5:23 PM	RE	D	D	0	0	\$20,000
18	7/16/2019	4:27 PM	LT	D	D	0	1	\$2,500
19	11/13/2020	10:08 PM	LT	D	D-L	0	1	\$12,000



SIGNAL WARRANT ANALYSIS

The traffic volumes and geometric conditions at the intersection were compared with the warrants for the installation of traffic signals contained in the Manual on Uniform Traffic Control Devices (MUTCD-2009) and Manual on Uniform Traffic Studies (MUTS).

For the purposes of the Signal Warrant Analysis, McCulloch Road is considered the major street and Worchester Drive / Amour de Flame Way the minor street. Based on the posted speed limit of 45 mph on McCulloch Road, the 70 percent volume criterion was applied to the analysis. The following table summarizes the results of the warrant analysis during the study hours:

Table 7 - Summary of Signal Warrant Analysis

Warrant		Applicable	Satisfied	Comments
1A	Minimum Vehicular Volume	Yes	No	The volume of the peak eight hours, chosen from 12 hours (6am-6pm) data does not satisfy for 100%, 80% and 70% traffic volumes in both conditions A and B.
1B	Interruption of Continuous Traffic	Yes	No	
2	Four-Hour Vehicular Volume	Yes	No	Using the 70% volume criteria, Warrant 2 is not satisfied as the points from the peak four-hour volume data points are located just below the curve except one point corresponding to 70% volume in figure 4C-2 of the design form. Here, the bottom curve (1 lane and 1 lane) has been considered.
3	Peak Hour	Yes	No	Warrant 3 is not satisfied. The plotted points lie below the bottom curve in figure 4C-4 (70% volume level) of the design form. Among the three criteria, only the total intersection entering volume criterion has been satisfied. However, Warrant 3 requires all three criteria to be satisfied to be warranted.
4A	Four Hour Pedestrian Volume	No	N/A	Warrant 4 is not applicable in this context of study as there was no crossings at the intersection of McCulloch Road & Amour de Flame Way/Worchester Drive. However, there were a few pedestrians who crossed McCulloch Road illegally on the day of the data collection. If we consider that illegal crossing of pedestrian, Warrant 4 is still not satisfied as the four highest pedestrian volumes lie below the curve.
4B	Peak Hour Pedestrian Volume	No	N/A	
5	School Crossing	No	N/A	This warrant is not applicable, as no school zone exists at the intersection.



6	Coordinated Signal System	Yes	No	This warrant is not satisfied as none of the criteria is met for the major road. The distance between existing signals is about 2,900 feet. Providing a signal at the intersection will split the section into two segments with lengths of 1,100 feet and 1,800 feet. Due to the close proximity of the nearest signalized intersections, installation of a signal will not be required to induce platooning
7	Crash Experience	Yes	No	As found in crash analysis and collision diagram, very few crashes occurred in this intersection. Also, from the nature of the crashes this intersection does not satisfy warrant 7.
8	Roadway Network	Yes	No	All data required to reach a decision are not available to check this warrant. However, from the available data, we have fulfilled some the portion but it is not sufficient to make a decision.
9	Railroad Grade Crossing	No	N/A	This warrant is not applicable as there is no railroad grade crossing within 140 feet of the intersection.

The completed sheets for the signal Warrant can be found in Appendix C.



CONCLUSION AND RECOMMENDATIONS

Based on the results of the signal warrant analysis, field observations, and engineering judgment, the following recommendation was developed: A traffic signal should not be installed because no warrants were satisfied.



APPENDIX

Appendix A – Turning Movement Count Raw Data



15 MINUTE TURNING MOVEMENT COUNTS (AUTOS)

DATE: 2/4/2021, 2/8/2021 (corrected)

LOCATION: Intersection of McCulloch Rd & Amour de Flame Way/Worchester Dr

Amour de Flame Way/Worchester Dr (Minor)

McCulloch Rd (Major)

TIME BEGIN	NORTHBOUND					SOUTHBOUND					N/S TOT	EASTBOUND					WESTBOUND					E/W TOT	GRAND TOTAL
	L	T	R	PEDS	TOT	L	T	R	PEDS	TOT		L	T	R	PEDS	TOT	L	T	R	PEDS	TOT		
6:00:00 AM	0	0	3	0	3	0	0	2	0	2	5	0	9	1	0	10	1	39	0	0	40	50	55
6:15:00 AM	3	0	0	0	3	0	0	6	0	6	9	1	19	1	0	21	4	39	1	0	44	65	74
6:30:00 AM	5	0	2	0	7	3	1	6	0	10	17	0	25	0	1	25	0	61	2	0	63	88	105
6:45:00 AM	6	0	3	0	9	2	0	8	0	10	19	1	18	1	2	20	0	86	0	0	86	106	125
TOTAL	14	0	8	0	22	5	1	22	0	28	50	2	71	3	3	76	5	225	3	0	233	309	359
7:00:00 AM	6	0	3	0	9	4	0	8	0	12	21	4	26	1	0	31	2	86	0	0	88	119	140
7:15:00 AM	6	0	2	0	8	3	0	10	0	13	21	4	25	2	2	31	2	96	3	0	101	132	153
7:30:00 AM	6	0	3	0	9	1	0	4	0	5	14	4	31	0	0	35	1	116	0	0	117	152	166
7:45:00 AM	9	0	4	1	13	1	0	6	0	7	20	0	30	1	11	31	1	143	2	0	146	177	197
TOTAL	27	0	12	1	39	9	0	28	0	37	76	12	112	4	13	128	6	441	5	0	452	580	656
8:00:00 AM	3	0	6	14	9	2	0	12	0	14	23	1	37	1	0	39	3	124	1	0	128	167	190
8:15:00 AM	5	0	2	0	7	3	0	8	0	11	18	3	52	3	1	58	3	108	1	0	112	170	188
8:30:00 AM	8	0	5	0	13	3	0	9	4	12	25	3	48	1	0	52	2	129	2	0	133	185	210
8:45:00 AM	2	0	6	0	8	1	0	12	0	13	21	2	55	4	0	61	1	131	1	0	133	194	215
TOTAL	18	0	19	14	37	9	0	41	4	50	87	9	192	9	1	210	9	492	5	0	506	716	803
9:00:00 AM	8	0	2	0	10	2	0	9	0	11	21	7	45	4	0	56	6	91	3	0	100	156	177
9:15:00 AM	4	0	3	0	7	4	0	10	0	14	21	4	45	0	1	49	0	73	1	0	74	123	144
9:30:00 AM	5	0	3	0	8	2	0	8	0	10	18	2	53	2	0	57	3	73	0	0	76	133	151
9:45:00 AM	5	0	4	0	9	1	0	11	0	12	21	3	31	3	0	37	3	70	3	0	76	113	134
TOTAL	22	0	12	0	34	9	0	38	0	47	81	16	174	9	1	199	12	307	7	0	326	525	606
10:00:00 AM	10	0	2	1	12	1	0	5	0	6	18	5	47	2	0	54	4	62	3	0	69	123	141
10:15:00 AM	6	0	3	0	9	0	0	11	1	11	20	6	51	3	1	60	2	75	0	0	77	137	157
10:30:00 AM	8	0	6	0	14	4	0	6	0	10	24	5	47	2	0	54	2	56	1	0	59	113	137
10:45:00 AM	11	0	5	2	16	1	0	4	1	5	21	6	60	6	0	72	2	60	2	0	64	136	157
TOTAL	35	0	16	3	51	6	0	26	2	32	83	22	205	13	1	240	10	253	6	0	269	509	592
11:00:00 AM	4	0	2	1	6	1	0	10	0	11	17	2	63	4	0	69	4	78	0	0	82	151	168
11:15:00 AM	7	0	7	0	14	6	0	10	0	16	30	9	57	1	0	67	3	82	1	0	86	153	183
11:30:00 AM	3	0	3	3	6	6	0	16	0	22	28	8	73	5	0	86	2	70	2	0	74	160	188
11:45:00 AM	5	0	3	1	8	2	0	8	0	10	18	7	60	3	1	70	0	85	5	0	90	160	178
TOTAL	19	0	15	5	34	15	0	44	0	59	93	26	253	13	1	292	9	315	8	0	332	624	717
12:00:00 PM	7	0	5	1	12	2	0	11	2	13	25	7	73	7	0	87	4	83	3	1	90	177	202
12:15:00 PM	5	0	2	2	7	0	0	10	0	10	17	9	78	7	1	94	4	85	2	0	91	185	202
12:30:00 PM	9	0	3	3	12	1	0	17	0	18	30	7	74	8	1	89	3	79	3	0	85	174	204
12:45:00 PM	6	1	1	0	8	5	0	7	0	12	20	8	86	2	0	96	2	82	2	0	86	182	202
TOTAL	27	1	11	6	39	8	0	45	2	53	92	31	311	24	2	366	13	329	10	1	352	718	810
1:00:00 PM	5	0	3	0	8	2	0	10	3	12	20	6	70	8	0	84	4	81	6	2	91	175	195
1:15:00 PM	5	0	2	0	7	6	0	9	0	15	22	9	83	3	1	95	0	75	0	0	75	170	192
1:30:00 PM	3	0	5	1	8	4	0	13	2	17	25	9	67	6	0	82	2	85	3	1	90	172	197
1:45:00 PM	4	0	3	1	7	7	0	13	0	20	27	9	91	2	0	102	2	91	1	1	94	196	223
TOTAL	17	0	13	2	30	19	0	45	5	64	94	33	311	19	1	363	8	332	10	4	350	713	807
2:00:00 PM	8	0	3	0	11	2	0	10	0	12	23	11	80	9	0	100	2	73	1	1	76	176	199
2:15:00 PM	5	0	6	0	11	5	0	8	0	13	24	5	90	4	0	99	5	92	7	0	104	203	227
2:30:00 PM	2	0	4	1	6	1	0	13	0	14	20	10	100	4	1	114	11	93	4	0	108	222	242
2:45:00 PM	5	0	3	1	8	4	0	8	0	12	20	7	100	4	2	111	4	90	1	3	95	206	226
TOTAL	20	0	16	2	36	12	0	39	0	51	87	33	370	21	3	424	22	348	13	4	383	807	894
3:00:00 PM	3	0	4	2	7	2	0	12	0	14	21	2	98	7	0	107	6	87	3	0	96	203	224
3:15:00 PM	9	0	4	1	13	1	0	16	0	17	30	13	126	8	4	147	1	74	5	0	80	227	257
3:30:00 PM	5	0	2	1	7	1	0	15	3	16	23	15	108	2	1	125	2	83	4	0	89	214	237
3:45:00 PM	4	0	0	2	4	1	0	6	1	7	11	6	109	5	0	120	2	80	3	1	85	205	216
TOTAL	21	0	10	6	31	5	0	49	4	54	85	36	441	22	5	499	11	324	15	1	350	849	934
4:00:00 PM	6	0	5	2	11	1	0	9	3	10	21	16	93	4	0	113	5	92	4	0	101	214	235
4:15:00 PM	1	0	5	2	6	0	0	10	0	10	16	6	120	4	1	130	7	77	3	1	87	217	233
4:30:00 PM	2	0	3	2	5	3	0	15	2	18	23	9	138	10	3	157	3	95	5	0	103	260	283
4:45:00 PM	5	0	5	3	10	4	0	10	3	14	24	8	110	8	2	126	6	79	6	2	91	217	241
TOTAL	14	0	18	9	32	8	0	44	8	52	84	39	461	26	6	526	21	343	18	3	382	908	992

Appendix B – Stopped Delay Raw Data



8 AM - 9 AM					
Vehicle Number	Joined Queue	Released from Queue	Time in Queue		
1	8:02:10 AM	8:02:17 AM	7	Total Vehicle Count	47
2	8:03:07 AM	8:03:15 AM	8	Delayed Vehicle Count	47
3	8:06:11 AM	8:06:22 AM	11	Through Vehicle Count	0
4	8:11:18 AM	8:11:28 AM	10	Average Stopped Time	11.23
5	8:13:41 AM	8:14:19 AM	38	Maximum Stopped Time	54
6	8:14:09 AM	8:14:24 AM	15	Min. Secs. For Delay	0
7	8:15:08 AM	8:16:02 AM	54	Average Queue	0.15
8	8:16:12 AM	8:16:16 AM	4	Queue Density	1.16
9	8:16:27 AM	8:17:07 AM	40	Maximum Queue	3
10	8:17:56 AM	8:17:59 AM	3	Delay in Vehicle Hour	0.16
11	8:21:04 AM	8:21:08 AM	4	Total Delay	528
12	8:22:08 AM	8:22:12 AM	4		
13	8:22:16 AM	8:22:25 AM	9		
14	8:22:19 AM	8:22:37 AM	18		
15	8:22:32 AM	8:22:40 AM	8		
16	8:22:46 AM	8:22:49 AM	3		
17	8:23:39 AM	8:23:48 AM	9		
18	8:23:51 AM	8:23:53 AM	2		
19	8:25:04 AM	8:25:11 AM	7		
20	8:25:16 AM	8:25:19 AM	3		
21	8:26:00 AM	8:26:05 AM	5		
22	8:26:51 AM	8:26:55 AM	4		
23	8:28:27 AM	8:28:39 AM	12		
24	8:30:40 AM	8:31:13 AM	33		
25	8:30:41 AM	8:31:24 AM	43		
26	8:33:11 AM	8:33:15 AM	4		
27	8:33:21 AM	8:33:24 AM	3		
28	8:33:32 AM	8:33:35 AM	3		
29	8:33:37 AM	8:33:44 AM	7		
30	8:33:41 AM	8:33:46 AM	5		
31	8:36:47 AM	8:36:55 AM	8		
32	8:36:49 AM	8:36:57 AM	8		
33	8:36:52 AM	8:36:59 AM	7		
34	8:37:46 AM	8:37:53 AM	7		
35	8:38:21 AM	8:38:57 AM	36		
36	8:39:25 AM	8:39:29 AM	4		
37	8:39:53 AM	8:39:54 AM	1		
38	8:44:28 AM	8:44:38 AM	10		
39	8:45:22 AM	8:45:23 AM	1		
40	8:46:47 AM	8:47:08 AM	21		
41	8:47:01 AM	8:47:14 AM	13		
42	8:48:04 AM	8:48:15 AM	11		
43	8:48:48 AM	8:48:50 AM	2		
44	8:56:42 AM	8:56:44 AM	2		
45	8:58:07 AM	8:58:09 AM	2		
46	8:58:29 AM	8:58:33 AM	4		
47	8:58:39 AM	8:58:54 AM	15		

11 AM - 12 PM					
Vehicle Number	Joined Queue	Released from Queue	Time in Queue		
1	11:00:01 AM	11:00:04 AM	3	Total Vehicle Count	48
2	11:04:17 AM	11:04:24 AM	7	Delayed Vehicle Count	48
3	11:07:32 AM	11:07:38 AM	6	Through Vehicle Count	0
4	11:07:58 AM	11:08:02 AM	4	Average Stopped Time	4.98
5	11:08:15 AM	11:08:17 AM	2	Maximum Stopped Time	25
6	11:08:48 AM	11:08:50 AM	2	Min. Secs. For Delay	0
7	11:09:01 AM	11:09:07 AM	6	Average Queue	0.07
8	11:10:33 AM	11:10:34 AM	1	Queue Density	1.06
9	11:11:23 AM	11:11:24 AM	1	Maximum Queue	3
10	11:13:35 AM	11:13:37 AM	2	Delay in Vehicle Hour	0.07
11	11:16:55 AM	11:17:20 AM	25	Total Delay	239
12	11:19:44 AM	11:19:46 AM	2		
13	11:19:48 AM	11:19:57 AM	9		
14	11:21:59 AM	11:22:09 AM	10		
15	11:23:32 AM	11:23:34 AM	2		
16	11:27:32 AM	11:27:34 AM	2		
17	11:28:30 AM	11:28:36 AM	6		
18	11:29:09 AM	11:29:11 AM	2		
19	11:30:30 AM	11:30:34 AM	4		
20	11:30:53 AM	11:30:55 AM	2		
21	11:32:30 AM	11:32:33 AM	3		
22	11:33:31 AM	11:33:34 AM	3		
23	11:34:34 AM	11:34:39 AM	5		
24	11:35:00 AM	11:35:01 AM	1		
25	11:37:48 AM	11:37:51 AM	3		
26	11:37:55 AM	11:38:12 AM	17		
27	11:38:05 AM	11:38:13 AM	8		
28	11:38:10 AM	11:38:18 AM	8		
29	11:38:38 AM	11:38:42 AM	4		
30	11:39:01 AM	11:39:02 AM	1		
31	11:39:28 AM	11:39:50 AM	22		
32	11:41:14 AM	11:41:18 AM	4		
33	11:41:33 AM	11:41:34 AM	1		
34	11:42:18 AM	11:42:20 AM	2		
35	11:44:25 AM	11:44:27 AM	2		
36	11:47:42 AM	11:47:45 AM	3		
37	11:47:43 AM	11:47:50 AM	7		
38	11:48:59 AM	11:49:00 AM	1		
39	11:49:01 AM	11:49:05 AM	4		
40	11:49:55 AM	11:50:00 AM	5		
41	11:50:01 AM	11:50:09 AM	8		
42	11:51:51 AM	11:51:52 AM	1		
43	11:52:59 AM	11:53:02 AM	3		
44	11:55:03 AM	11:55:08 AM	5		
45	11:55:06 AM	11:55:11 AM	5		
46	11:56:00 AM	11:56:03 AM	3		
47	11:57:22 AM	11:57:25 AM	3		
48	11:59:19 AM	11:59:28 AM	9		

2 PM - 3 PM					
Vehicle Number	Joined Queue	Released from Queue	Time in Queue		
1	2:00:01 PM	2:00:32 PM	31	Total Vehicle Count	57
2	2:00:37 PM	2:00:41 PM	4	Delayed Vehicle Count	57
3	2:02:50 PM	2:02:58 PM	8	Through Vehicle Count	0
4	2:03:13 PM	2:03:16 PM	3	Average Stopped Time	11.58
5	2:04:45 PM	2:04:59 PM	14	Maximum Stopped Time	46
6	2:05:23 PM	2:05:36 PM	13	Min. Secs. For Delay	0
7	2:05:24 PM	2:05:41 PM	17	Average Queue	0.19
8	2:07:07 PM	2:07:12 PM	5	Queue Density	1.12
9	2:08:04 PM	2:08:12 PM	8	Maximum Queue	3
10	2:10:08 PM	2:10:11 PM	3	Delay in Vehicle Hour	0.19
11	2:11:50 PM	2:12:16 PM	26	Total Delay	660
12	2:13:35 PM	2:13:42 PM	7		
13	2:14:13 PM	2:14:20 PM	7		
14	2:14:59 PM	2:15:04 PM	5		
15	2:15:01 PM	2:15:08 PM	7		
16	2:15:16 PM	2:15:20 PM	4		
17	2:15:41 PM	2:15:50 PM	9		
18	2:16:00 PM	2:16:03 PM	3		
19	2:16:45 PM	2:16:49 PM	4		
20	2:17:00 PM	2:17:05 PM	5		
21	2:19:01 PM	2:19:35 PM	34		
22	2:21:27 PM	2:21:52 PM	25		
23	2:23:38 PM	2:23:41 PM	3		
24	2:24:06 PM	2:24:31 PM	25		
25	2:25:29 PM	2:25:32 PM	3		
26	2:26:58 PM	2:27:02 PM	4		
27	2:28:24 PM	2:28:28 PM	4		
28	2:29:50 PM	2:30:10 PM	20		
29	2:30:15 PM	2:30:25 PM	10		
30	2:33:37 PM	2:33:40 PM	3		
31	2:34:22 PM	2:34:26 PM	4		
32	2:34:32 PM	2:34:38 PM	6		
33	2:34:37 PM	2:34:51 PM	14		
34	2:36:50 PM	2:37:04 PM	14		
35	2:37:48 PM	2:38:03 PM	15		
36	2:38:09 PM	2:38:12 PM	3		
37	2:39:00 PM	2:39:10 PM	10		
38	2:40:23 PM	2:40:26 PM	3		
39	2:41:37 PM	2:41:39 PM	2		
40	2:41:58 PM	2:42:14 PM	16		
41	2:42:29 PM	2:42:33 PM	4		
42	2:44:38 PM	2:44:47 PM	9		
43	2:45:51 PM	2:45:55 PM	4		
44	2:46:10 PM	2:46:53 PM	43		
45	2:46:21 PM	2:46:23 PM	2		
46	2:46:52 PM	2:47:00 PM	8		
47	2:48:12 PM	2:48:58 PM	46		
48	2:48:31 PM	2:49:03 PM	32		
49	2:48:44 PM	2:49:14 PM	30		
50	2:51:06 PM	2:51:21 PM	15		
51	2:51:38 PM	2:51:44 PM	6		

52	2:54:31 PM	2:54:32 PM	1
53	2:55:53 PM	2:56:03 PM	10
54	2:55:56 PM	2:56:05 PM	9
55	2:56:08 PM	2:56:31 PM	23
56	2:57:10 PM	2:57:21 PM	11
57	2:59:03 PM	2:59:09 PM	6

5 PM - 6 PM					
Vehicle Number	Joined Queue	Released from Queue	Time in Queue		
1	5:00:05 PM	5:00:21 PM	16	Total Vehicle Count	79
2	5:00:56 PM	5:00:57 PM	1	Delayed Vehicle Count	79
3	5:01:19 PM	5:01:19 PM	0	Through Vehicle Count	0
4	5:01:28 PM	5:01:35 PM	7	Average Stopped Time	10.91
5	5:02:27 PM	5:02:27 PM	0	Maximum Stopped Time	67
6	5:03:35 PM	5:03:42 PM	7	Min. Secs. For Delay	0
7	5:03:39 PM	5:03:43 PM	4	Average Queue	0.24
8	5:04:51 PM	5:05:01 PM	10	Queue Density	1.15
9	5:05:16 PM	5:05:18 PM	2	Maximum Queue	5
10	5:06:06 PM	5:06:27 PM	21	Delay in Vehicle Hour	0.24
11	5:06:36 PM	5:06:38 PM	2	Total Delay	862
12	5:06:45 PM	5:06:54 PM	9		
13	5:07:08 PM	5:07:10 PM	2		
14	5:07:32 PM	5:08:30 PM	58		
15	5:07:35 PM	5:08:31 PM	56		
16	5:08:55 PM	5:08:58 PM	3		
17	5:11:04 PM	5:11:28 PM	24		
18	5:12:11 PM	5:12:14 PM	3		
19	5:12:28 PM	5:12:29 PM	1		
20	5:12:53 PM	5:13:30 PM	37		
21	5:13:34 PM	5:13:35 PM	1		
22	5:14:02 PM	5:14:03 PM	1		
23	5:14:26 PM	5:14:27 PM	1		
24	5:15:09 PM	5:15:10 PM	1		
25	5:15:53 PM	5:15:54 PM	1		
26	5:16:00 PM	5:16:29 PM	29		
27	5:18:28 PM	5:18:34 PM	6		
28	5:18:35 PM	5:18:45 PM	10		
29	5:20:00 PM	5:20:02 PM	2		
30	5:21:03 PM	5:21:04 PM	1		
31	5:22:32 PM	5:23:15 PM	43		
32	5:23:03 PM	5:23:20 PM	17		
33	5:23:10 PM	5:23:51 PM	41		
34	5:23:52 PM	5:23:58 PM	6		
35	5:24:01 PM	5:24:02 PM	1		
36	5:24:13 PM	5:24:15 PM	2		
37	5:24:40 PM	5:24:42 PM	2		
38	5:25:00 PM	5:25:33 PM	33		
39	5:25:08 PM	5:25:53 PM	45		
40	5:26:30 PM	5:26:33 PM	3		
41	5:26:37 PM	5:26:39 PM	2		
42	5:27:00 PM	5:27:22 PM	22		
43	5:28:39 PM	5:28:40 PM	1		
44	5:28:47 PM	5:29:13 PM	26		
45	5:30:37 PM	5:30:43 PM	6		
46	5:32:09 PM	5:32:18 PM	9		
47	5:33:38 PM	5:33:39 PM	1		
48	5:36:33 PM	5:36:34 PM	1		
49	5:37:38 PM	5:37:39 PM	1		
50	5:37:41 PM	5:37:50 PM	9		
51	5:39:27 PM	5:39:33 PM	6		

52	5:39:43 PM	5:39:46 PM	3
53	5:41:05 PM	5:41:13 PM	8
54	5:42:13 PM	5:42:15 PM	2
55	5:42:53 PM	5:42:55 PM	2
56	5:44:09 PM	5:44:10 PM	1
57	5:44:12 PM	5:44:13 PM	1
58	5:44:16 PM	5:44:17 PM	1
59	5:44:37 PM	5:44:39 PM	2
60	5:46:13 PM	5:46:16 PM	3
61	5:48:45 PM	5:48:59 PM	14
62	5:49:12 PM	5:49:30 PM	18
63	5:49:24 PM	5:49:34 PM	10
64	5:49:27 PM	5:49:37 PM	10
65	5:49:36 PM	5:49:58 PM	22
66	5:49:40 PM	5:50:01 PM	21
67	5:50:59 PM	5:51:02 PM	3
68	5:52:21 PM	5:52:38 PM	17
69	5:52:26 PM	5:53:33 PM	67
70	5:53:11 PM	5:53:36 PM	25
71	5:53:19 PM	5:53:41 PM	22
72	5:54:36 PM	5:54:36 PM	0
73	5:54:54 PM	5:55:07 PM	13
74	5:55:31 PM	5:55:32 PM	1
75	5:55:37 PM	5:55:37 PM	0
76	5:55:39 PM	5:55:40 PM	1
77	5:55:47 PM	5:55:48 PM	1
78	5:58:45 PM	5:58:45 PM	0
79	5:59:51 PM	5:59:52 PM	1

Appendix C – Complete Signal Warrant Sheets



TRAFFIC SIGNAL WARRANT SUMMARY

Introduction

- The Signal Warrant Analysis Spreadsheets are a tool for assisting traffic engineers when evaluating the need for a traffic signal installation

- The filled spreadsheets can be used as part of the supporting documents for the signal warrant evaluation

Note: These templates are a useful resource, but it remains necessary to apply engineering judgment and to consider specific environmental, traffic, geometric, and operational conditions

Instructions

Fill in "Orange" areas only

Automated cells based on input Data in "orange" cells

General Information

Fill in below the general information including:

District, County (drop-down menu)

City, Engineer, Date

Major and Minor Street with corresponding number of lanes and speed limits

Enter Eight Hour Volumes

Any 8 hours of an average day. Major-street and minor-street volumes shall be for the same 8 hours; however, the 8 hours satisfied in Condition A shall **not** be required to be the same 8 hours satisfied in Condition B **for 80% columns only**. On the minor street, the higher volume shall not be required to be on the same approach during each of the 8 hours.

Enter Four Hour Volumes

Any 4 hours of an average day. Vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only, not required to be on the same approach during each of the 4 hours)

Enter Pedestrian Volumes (4-t) Pedestrians per hour crossing the major street (total of all crossings)

Enter Peak Hour Volumes

Vehicular: Any four consecutive 15-minute periods of an average day

Pedestrian: Any four consecutive 15-minute periods of an average day representing the vehicles per hour on the major street (total of both approaches) and the corresponding pedestrians per hour crossing the major street (total of all crossings)

Input Data

Form 750-020-01
TRAFFIC ENGINEERING
October 2020

City: **Orlando**
County: **75 – Orange**
District:

Engineer: **Group 4**
Date: **February 4, 2021**

Major Street: **McCulloch Road**
Minor Street: **Flame Way/Worc**

Major Street # Lanes: **2**
Minor Street # Lanes: **2**

Major Approach Speed: **45mph**
Minor Approach Speed: **25mph**

Eight Hour Volumes (Condition A)		For Warrant 7	
Hours	Major Street (total of both approaches)	Minor Street (one direction only)	Ped Crossings on Major Street
8:00-9:00 AM	716	50	1
11:00-12:00 PM	624	59	5
12:00-1:00 PM	718	53	8
1:00-2:00 PM	713	64	7
2:00-3:00 PM	807	51	2
3:00-4:00 PM	849	54	10
4:00-5:00 PM	908	52	17
5:00-6:00 PM	1076	62	9

Eight Hour Volumes (Condition B)		
Hours	Major Street (total of both approaches)	Minor Street (one direction only)
8:00-9:00 AM	716	50
11:00-12:00 PM	624	59
12:00-1:00 PM	718	53
1:00-2:00 PM	713	64
2:00-3:00 PM	807	51
3:00-4:00 PM	849	54
4:00-5:00 PM	908	52
5:00-6:00 PM	1076	62

Highest Four Hour Vehicular Volumes		
Hours	Major Street (total of both approaches)	Minor Street (one direction only)
2:00-3:00 PM	807	51
3:00-4:00 PM	849	54
4:00-5:00 PM	908	52
5:00-6:00 PM	1076	62

Highest Four Hour Pedestrian Volumes		
Hours	Major Street (total of both approaches)	Pedestrian Crossings on Major Street
2:00-3:00 PM	807	2
3:00-4:00 PM	849	10
4:00-5:00 PM	908	17
5:00-6:00 PM	1076	9

Vehicular Peak Hour Volumes			
Peak Hour	Major Street (total of both approaches)	Minor Street (one direction only)	Total Entering Volume
5:00-6:00 PM	1076	62	1163

Pedestrian Peak Hour Volumes		
Peak Hour	Major Street (total of both approaches)	Pedestrian Crossing Volumes on Major Street
5:00-6:00 PM	1076	17

TRAFFIC SIGNAL WARRANT SUMMARY

City: Orlando
 County: 75 – Orange
 District: _____

Engineer: Group 4
 Date: February 4, 2021

Major Street: McCulloch Road Lanes: 2 Major Approach Speed: 45mph
 Minor Street: Amour de Flame Way/Worchester Dr Lanes: 2 Minor Approach Speed: 25mph

MUTCD Electronic Reference to Chapter 4:

Volume Level Criteria

1. Is the posted speed or 85th-percentile of major street > 40 mph? Yes No
2. Is the intersection in a built-up area of an isolated community with a population < 10,000? Yes No

"70%" volume level **may** be used if Question 1 **or** 2 above is answered "Yes" MAY 70% 100%

WARRANT 1 - EIGHT-HOUR VEHICULAR VOLUME

*Warrant 1 is satisfied if Condition A **or** Condition B is "100%" satisfied for eight hours.* Yes No

*Warrant 1 is also satisfied if both Condition A **and** Condition B are "80%" satisfied (should only be applied after an adequate trial of other alternatives that could cause less delay and inconvenience to traffic has failed to solve the traffic problems).* Yes No

*Warrant 1 is satisfied if Condition A **or** Condition B is "70%" satisfied for eight hours.* Yes No

Condition A - Minimum Vehicular Volume

Applicable: Yes No

100% Satisfied: Yes No

80% Satisfied: Yes No

70% Satisfied: Yes No

Number of Lanes for moving traffic on each approach		Vehicles per hour on major-street (total of both approaches)			Vehicles per hour on minor-street (one direction only)		
Major	Minor	100% ^a	80% ^b	70% ^c	100% ^a	80% ^b	70% ^c
1	1	500	400	350	150	120	105
2 or more	1	600	480	420	150	120	105
2 or more	2 or more	600	480	420	200	160	140
1	2 or more	500	400	350	200	160	140

^a Basic Minimum hourly volume

^b Used for combination of Conditions A and B after adequate trial of other remedial measures

^c May be used when the major-street speed exceeds 40 mph or in an isolated community with a population of less than 10,000

Record 8 highest hours and the corresponding major-street and minor-street volumes in the Instructions Sheet.

Street	Eight Highest Hours						
	8:00-9:00 AM	11:00-12:00 PM	12:00-1:00 PM	1:00-2:00 PM	2:00-3:00 PM	3:00-4:00 PM	4:00-5:00 PM
Major	716	624	718	713	807	849	908
Minor	50	59	53	64	51	54	52

Existing Volumes

State of Florida Department of Transportation
TRAFFIC SIGNAL WARRANT SUMMARY

Form 750-020-01
 TRAFFIC ENGINEERING
 October 2020

Condition B - Interruption of Continuous Traffic

Condition B is intended for application where Condition A is not satisfied and the traffic volume on a major street is so heavy that traffic on the minor intersecting street suffers excessive delay or conflict in entering or crossing the major street.

Applicable: Yes No

100% Satisfied: Yes No

80% Satisfied: Yes No

70% Satisfied: Yes No

Number of Lanes for moving traffic on each approach		Vehicles per hour on major-street (total of both approaches)			Vehicles per hour on minor-street (one direction only)		
Major	Minor	100% ^a	80% ^b	70% ^c	100% ^a	80% ^b	70% ^c
1	1	750	600	525	75	60	53
2 or more	1	900	720	630	75	60	53
2 or more	2 or more	900	720	630	100	80	70
1	2 or more	750	600	525	100	80	70

^a Basic Minimum hourly volume

^b Used for combination of Conditions A and B after adequate trial of other remedial measures

^c May be used when the major-street speed exceeds 40 mph or in an isolated community with a population of less than 10,000

Record 8 highest hours and the corresponding major-street and minor-street volumes in the Instructions Sheet.

Eight Highest Hours									
Street	8:00-9:00 AM	11:00-12:00 PM	12:00-1:00 PM	1:00-2:00 PM	2:00-3:00 PM	3:00-4:00 PM	4:00-5:00 PM	5:00-6:00 PM	
Major	716	624	718	713	807	849	908	1,076	
Minor	50	59	53	64	51	54	52	62	

Existing Volumes

TRAFFIC SIGNAL WARRANT SUMMARY

City: **Orlando**
 County: **75 – Orange**
 District:

Engineer: **Group 4**
 Date: **February 4, 2021**

Major Street: **McCulloch Road** Lanes: **2** Major Approach Speed: **45mph**
 Minor Street: **Amour de Flame Way/Worchester Dr** Lanes: **2** Minor Approach Speed: **25mph**

MUTCD Electronic Reference to Chapter 4: <http://mutcd.fhwa.dot.gov/pdfs/2009r1r2/part4.pdf>

Volume Level Criteria

1. Is the posted speed or 85th-percentile of major street > 40 mph? Yes No
2. Is the intersection in a built-up area of an isolated community with a population < 10,000? Yes No

"70%" volume level **may** be used if Question 1 **or** 2 above is answered "Yes" MAY 70% 100%

WARRANT 2 - FOUR-HOUR VEHICULAR VOLUME

If all four points lie above the appropriate line, then the warrant is satisfied.

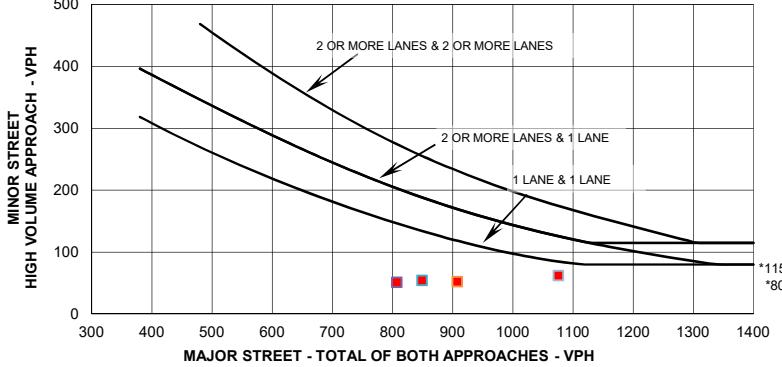
Applicable: Yes No

Satisfied: Yes No

Plot four volume combinations on the applicable figure below.

100% Volume Level

Four Highest Hours	Volumes	
	Major Street	Minor Street
2:00-3:00 PM	807	51
3:00-4:00 PM	849	54
4:00-5:00 PM	908	52
5:00-6:00 PM	1076	62

FIGURE 4C-1: Criteria for "100%" Volume Level

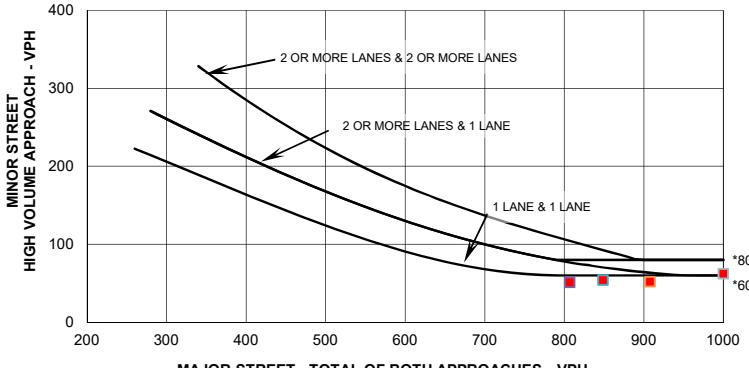
* Note: 115 ph. applies as the lower threshold volume for a minor street approach with two or more lanes and 80 mph applies as the lower threshold volume threshold for a minor street approach with one lane.

70% Volume Level

Four Highest Hours	Volumes	
	Major Street	Minor Street
2:00-3:00 PM	807	51
3:00-4:00 PM	849	54
4:00-5:00 PM	908	52
5:00-6:00 PM	1076	62

FIGURE 4C-2: Criteria for "70%" Volume Level

(Community Less than 10,000 population or above 70 km/hr. (40 mph) on Major Street)



* Note: 80 ph. applies as the lower threshold volume for a minor street approach with two or more lanes and 60 ph. applies as the lower threshold volume threshold for a minor street approach with one lane.

TRAFFIC SIGNAL WARRANT SUMMARY

City: Orlando
 County: 75 - Orange
 District: _____

Engineer: Group 4
 Date: February 4, 2021

Major Street: McCulloch Road Lanes: 2 Major Approach Speed: 45mph
 Minor Street: Amour de Flame Way/Worchester Dr Lanes: 2 Minor Approach Speed: 25mph

MUTCD Electronic Reference to Chapter 4: <http://mutcd.fhwa.dot.gov/pdfs/2009r1r2/part4.pdf>

Volume Level Criteria

1. Is the posted speed or 85th-percentile of major street > 40 mph? Yes No
2. Is the intersection in a built-up area of an isolated community with a population < 10,000? Yes No

"70%" volume level **may** be used if Question 1 **or** 2 above is answered "Yes" MAY

70% 100%

WARRANT 3 - PEAK HOUR

If all three criteria are fulfilled **or** the plotted point lies above the appropriate line, then the warrant is satisfied.

Applicable: Yes No
 Satisfied: Yes No

Unusual condition justifying use of warrant:
Industrial Complex
 -

Record hour when criteria are fulfilled and the corresponding delay or volume in boxes provided.

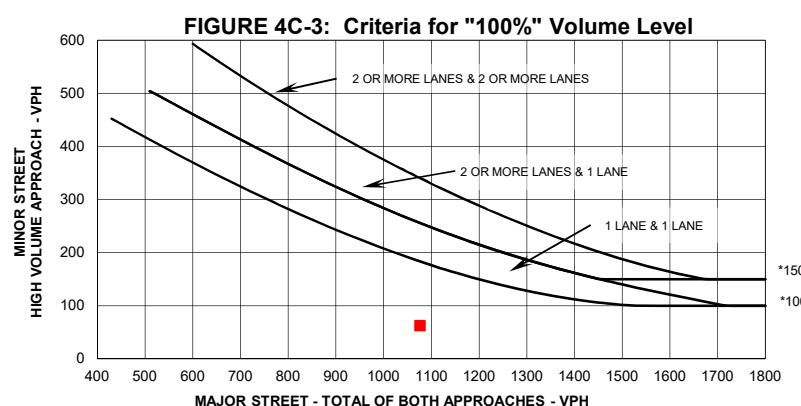
Peak Hour 100% Volume		
Time	Major Vol.	Minor Vol.
5:00-6:00 PM	1076	62

Peak Hour 70% Volume		
Time	Major Vol.	Minor Vol.
5:00-6:00 PM	1076	62

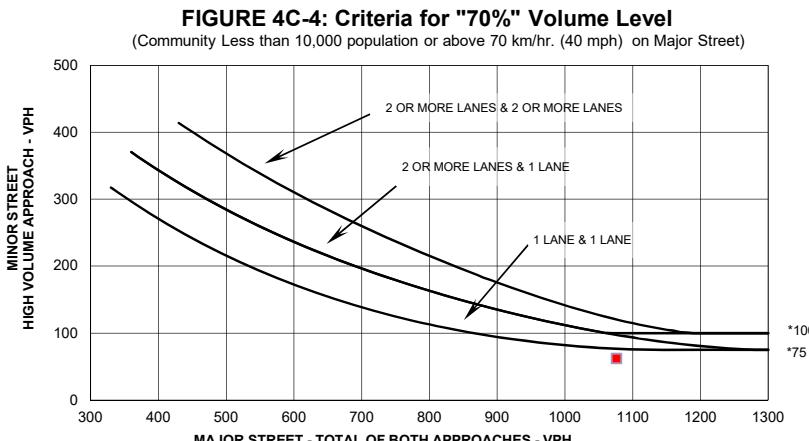
Criteria		
1. Delay on Minor Approach *(vehicle-hours)		
Approach Lanes	1	2
Delay Criteria*	4.0	5.0
Delay*	0.2	
Fulfilled?:	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No

2. Volume on Minor Approach One-Direction *(vehicles per hour)		
Approach Lanes	1	2
Volume Criteria*	100	150
Volume*	62	
Fulfilled?:	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No

3. Total Intersection Entering Volume *(vehicles per hour)		
No. of Approaches	3	4
Volume Criteria*	650	800
Volume*		1,138
Fulfilled?:	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No



* Note: 150 vph applies as the lower threshold volume for a minor street approach with two or more lanes and 100 vph applies as the lower threshold volume threshold for a minor street approach with one lane.



* Note: 100 ph. applies as the lower threshold volume for a minor street approach with two or more lanes and 75 phi applies as the lower threshold volume threshold for a minor street approach with one lane.

TRAFFIC SIGNAL WARRANT SUMMARY

City: **Orlando**
 County: **75 – Orange**
 District:

Engineer: **Group 4**
 Date: **February 4, 2021**

Major Street: **McCulloch Road** Lanes: **2** Major Approach Speed: **45mph**
 Minor Street: **Amour de Flame Way/Worchester Dr** Lanes: **2** Minor Approach Speed: **25mph**

MUTCD Electronic Reference to Chapter 4: <http://mutcd.fhwa.dot.gov/pdfs/2009r1r2/part4.pc>

Volume Level Criteria

1. Is the posted speed or 85th-percentile of major street > 35 mph? Yes No
2. Is the intersection in a built-up area of an isolated community with a population < 10,000? Yes No

"70%" volume level **may** be used if Question 1 **or** 2 above is answered "Yes" MAY

70% 100%

Option

Pedestrian volume crossing the major street **may** be reduced as much as 50% if the 15th-percentile crossing speed of pedestrians is less than 3.5 ft/sec. A walking speed study was conducted which reported a pedestrian speed less than 3.5 ft/sec for the 15th percentile.

Yes No

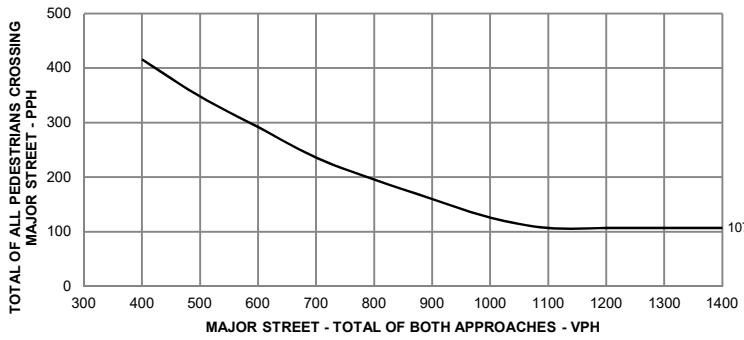
WARRANT 4 - PEDESTRIAN VOLUME

For each of any 4 hours of an average day, the plotted points lie above the appropriate line, then the warrant is satisfied.

Applicable: Yes No
 Satisfied: Yes No

Plot four volume combinations on the applicable figure below.

Figure 4C-5. Criteria for "100%" Volume Level

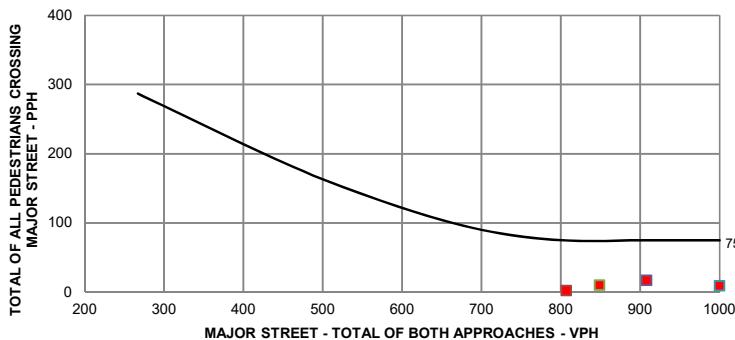


* Note: 107 pph applies as the lower threshold volume for 100% volume level

70% Volume Level

Four Highest Hours	Volumes	
	Major Street	Pedestrian Total

Figure 4C-6 Criteria for "70%" Volume Level



* Note: 75 pph applies as the lower threshold volume for 70% volume level

WARRANT 4 - PEDESTRIAN VOLUME

For 1 hour (any four consecutive 15-minute periods) of an average day, the plotted point falls above the appropriate line, then the warrant is satisfied.

Applicable: Yes No

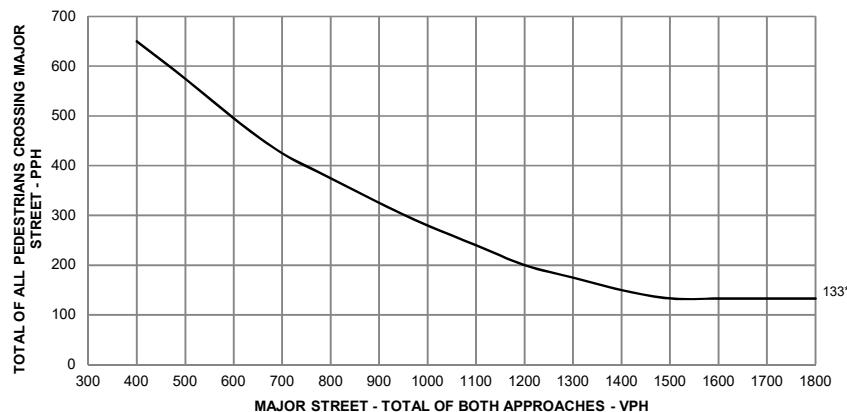
Satisfied: Yes No

Plot one volume combination on the applicable figure below.

100% Volume Level

Peak Hour	Volumes	
	Major Street	Pedestrian Total

Figure 4C-7. Criteria for "100%" Volume Level - Peak Hour

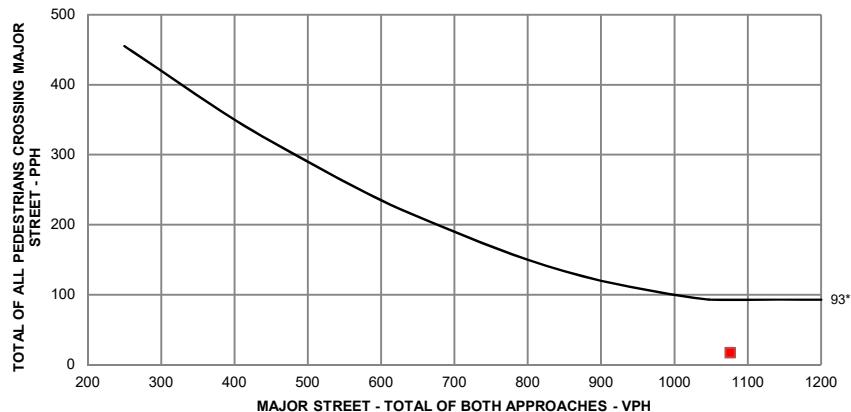


* Note: 133 pph applies as the lower threshold volume

70% Volume Level

Peak Hour	Volumes	
	Major Street	Pedestrian Total
5:00-6:00 PM	1076	17

Figure 4C-8 Criteria for "70%" Volume Level - Peak Hour



* Note: 93 pph applies as the lower threshold volume

State of Florida Department of Transportation
TRAFFIC SIGNAL WARRANT SUMMARY

Form 750-020-01
 TRAFFIC ENGINEERING
 October 2020

City: Orlando
 County: 75 – Orange
 District:

Engineer: Group 4
 Date: February 4, 2021

Major Street: McCulloch Road Lanes: 2 Major Approach Speed: 45mph
 Minor Street: Amour de Flame Way/Worchester Dr Lanes: 2 Minor Approach Speed: 25mph

MUTCD Electronic Reference to Chapter 4: <http://mutcd.fhwa.dot.gov/pdfs/2009r1r2/part4.pdf>

WARRANT 5 - SCHOOL CROSSING

Record hours where criteria are fulfilled and the corresponding volume or gap frequency in the boxes provided. The warrant is satisfied if all three of the criteria are fulfilled.

Applicable: Yes No

Satisfied: Yes No

Criteria	Fulfilled?	
	Yes	No
1. There are a minimum of 20 students crossing the major street during the highest crossing hour.	Students:	Hour:
2. There are fewer adequate gaps in the major street traffic stream during the period when the children are using the established school crossing than the number of minutes in the same period.	Minutes:	Gaps:
3. The nearest traffic signal along the major street is located more than 300 ft. (90 m) away, or the nearest signal is within 300 ft. (90 m) but the proposed traffic signal will not restrict the progressive movement of traffic.		

TRAFFIC SIGNAL WARRANT SUMMARY

City: **Orlando**
 County: **75 – Orange**
 District:

Engineer: **Group 4**
 Date: **February 4, 2021**

Major Street: **McCulloch Road**
 Minor Street: **Amour de Flame Way/Worchester Dr**

Lanes: **2**
 Major Approach Speed: **45mph**
 Lanes: **2**
 Minor Approach Speed: **25mph**

MUTCD Electronic Reference to Chapter 4: <http://mutcd.fhwa.dot.gov/pdfs/2009r1r2/part4.pdf>

WARRANT 6 - COORDINATED SIGNAL SYSTEM

Indicate if the criteria are fulfilled in the boxes provided. The warrant is satisfied if either criterion is fulfilled. This warrant should not be applied when the resulting signal spacing would be less than 300 m (1,000 ft.).

Applicable: Yes No
 Satisfied: Yes No

Criteria	Fulfilled?	
	Yes	No
1. On a one-way street or a street that has traffic predominately in one direction, the adjacent signals are so far apart that they do not provide the necessary degree of vehicle platooning.		No
2. On a two-way street, adjacent signals do not provide the necessary degree of platooning, and the proposed and adjacent signals will collectively provide a progressive operation.		No

State of Florida Department of Transportation
TRAFFIC SIGNAL WARRANT SUMMARY

Form 750-020-01
TRAFFIC ENGINEERING
October 2020

City: Orlando
County: 75 – Orange
District:

Engineer: Group 4
Date: February 4, 2021

Major Street: McCulloch Road Lanes: 2 Major Approach Speed: 45mph
Minor Street: Amour de Flame Way/Worchester Dr Lanes: 2 Minor Approach Speed: 25mph

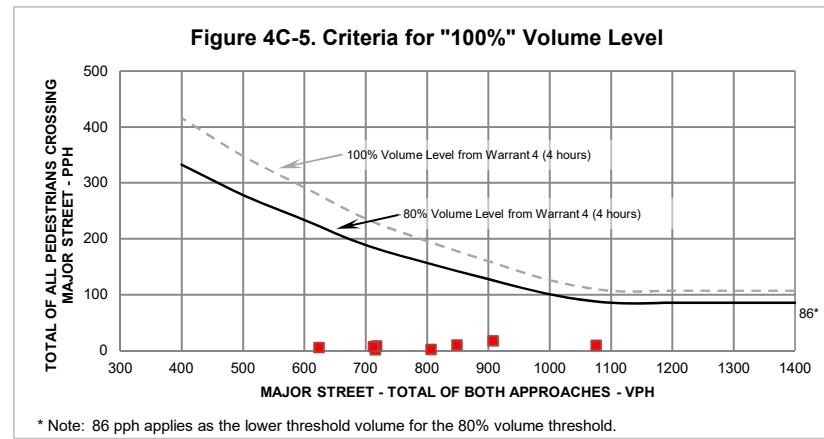
MUTCD Electronic Reference to Chapter 4: <http://mutcd.fhwa.dot.gov/pdfs/2009r1r2/part4.pdf>

WARRANT 7 - CRASH EXPERIENCE

Record hours where criteria are fulfilled, the corresponding volume, and other information in the boxes provided. The warrant is satisfied if all three of the criteria are fulfilled.

Applicable: Yes No
Satisfied: Yes No

Criteria				Fulfilled?				
		Yes	No					
1. Adequate trial of other remedial measure has failed to reduce crash frequency.	Measure tried:	Stop Sign. Proven to be effective as there are very few crashes in recent years.			No			
2. Five or more reported crashes, of types susceptible to correction by signal, have occurred within a 12-month period.	Observed Crash Types:	Most of the crashes are property damage only	Number of crashes per 12 months:	2	No			
3. One of the following volume warrants is met:				Met?				
Warrant 1, Condition A (80% satisfied), or				No				
Warrant 1, Condition B (80% satisfied), or				No				
Warrant 4, Pedestrian Volume satisfied at 80% of volume requirements for any 8 hours of an average day.		Hour	Major Street Volume	Ped Crossings Volume				
		3:00-9:00 AM	716	1	No			
		1:00-12:00 P	624	5				
		2:00-1:00 PI	718	8				
		1:00-2:00 PM	713	7				
		2:00-3:00 PM	807	2				
		3:00-4:00 PM	849	10				
		4:00-5:00 PM	908	17				
		5:00-6:00 PM	1076	9				



TRAFFIC SIGNAL WARRANT SUMMARY

City: Orlando
 County: 75 – Orange
 District:

Engineer: Group 4
 Date: February 4, 2021

Major Street: McCulloch Road Lanes: 2 Major Approach Speed: 45mph
 Minor Street: Amour de Flame Way/Worchester Dr Lanes: 2 Minor Approach Speed: 25mph

MUTCD Electronic Reference to Chapter 4: <http://mutcd.fhwa.dot.gov/pdfs/2009r1r2/part4.pdf>

WARRANT 8 - ROADWAY NETWORK

Record hours where criteria are fulfilled, and the corresponding volume or other information in the boxes provided. The warrant is satisfied if at least one of the criteria is fulfilled and if all intersecting routes have one or more of the Major Route characteristics listed.

Applicable: Yes No
 Satisfied: Yes No

Criteria					Met?		Fulfilled?	
					Yes	No	Yes	No
1. Both of the criteria to the right are met.	a. Total entering volume of at least 1,000 veh/hr during a typical weekday peak hour.			Entering Volume:		Yes		
				1,163				
	b. Five-year projected volumes that satisfy one or more of Warrants 1, 2, or 3.			Warrant:	1	2	3	
			Satisfied?:	NA	NA	NA		
2. Total entering volume at least 1,000 veh/hr for each of any 5 hrs of a non-normal business day (Sat. or Sun.)			NA	NA	NA	← Hour		
			NA	NA	NA	← Volume		

Characteristics of Major Routes						Met?		Fulfilled?	
						Yes	No	Yes	No
1. Part of the street or highway system that serves as the principal roadway network for through traffic flow.						Major Street:		No	
						Minor Street:		No	
2. Rural or suburban highway outside of, entering, or traversing a city.						Major Street:		No	
						Minor Street:		No	
3. Appears as a major route on an official plan.						Major Street:		No	
						Minor Street:		No	

TRAFFIC SIGNAL WARRANT SUMMARY

City: Orlando
 County: 75 – Orange
 District: _____

Engineer: Group 4
 Date: February 4, 2021

Major Street: McCulloch Road
 Minor Street: Amour de Flame Way/Worchester Dr

Lanes: 2 Major Approach Speed: 45mph
 Lanes: 2 Minor Approach Speed: 25mph

MUTCD Electronic Reference to Chapter 4: <http://mutcd.fhwa.dot.gov/pdfs/2009r1r2/part4.pdf>

Approach Lane Criteria

1. How many approach lanes are there at the track crossing?

1 2 or more

If there is 1 lane, use Figure 4C-9 and if there are 2 or more, use Figure 4C-10.

Fig 4C-9 Fig 4C-10

WARRANT 9 - INTERSECTION NEAR A GRADE CROSSING

This signal warrant should be applied only after adequate consideration has been given to other alternatives or after a trial of an alternative has failed to alleviate the safety concerns associated with the grade crossing.

Indicate if both criteria are fulfilled in the boxes provided. The warrant is satisfied if both criteria are met.

Applicable: Yes No

Satisfied: Yes No

Criteria	Fulfilled?	
	Yes	No
1. A grade crossing exists on an approach controlled by a STOP or YIELD sign and the center of the track nearest to the intersection is within 140 feet of the stop line or yield line on the approach; and	<input type="checkbox"/>	<input type="checkbox"/>
2. During the highest traffic volume hour during which the rail uses the crossing, the plotted point falls above the applicable curve for the existing combination of approach lanes over the track and the distance D (clear storage distance).	<input type="checkbox"/>	<input type="checkbox"/>

Use the following tables (4C-2, 4C-3, and 4C-4 to appropriately adjust the minor-street approach volume).

Inputs

Occurrences of Rail traffic per day

Adjustment Factors from Tables

% of High Occupancy Buses on Approach Lane at Track Crossing

	1.00

Enter D (feet)

% of Tractor-Trailer Trucks on Approach Lane at Track Crossing

0.50

Table 4C-2. Adjustment Factor for Daily Frequency of Rail Traffic

Rail Traffic per Day	Adjustment Factor
1	0.67
2	0.91
3 to 5	1.00
6 to 8	1.18
9 to 11	1.25
12 or more	1.33

Table 4C-3. Adjustment Factor for Percentage of High-Occupancy Buses

% of High-Occupancy Buses* on Minor Street Approach	Adjustment Factor
0%	1.00
2%	1.09
4%	1.19
6% or more	1.32

* A high-occupancy bus is defined as a bus occupied by at least 20 people

Table 4C-4. Adjustment Factor for Percentage of Tractor-Trailer Trucks

% of Tractor-Trailer Trucks on Minor Street Approach	Adjustment Factor	
	D less than 70 feet	D of 70 feet or more
0% to 2.5%	0.50	0.50
2.6% to 7.5%	0.75	0.75
7.6% to 12.5%	1.00	1.00
12.6% to 17.5%	2.30	1.15
17.6% to 22.5%	2.70	1.35
22.6% to 27.5%	3.28	1.64
More than 27.5%	4.18	2.09

Input the major and minor street volumes before adjustment factors are applied

1 Approach Lane		
D (ft)	Major Vol.	Minor Vol.

After adjustment factors are applied

1 Approach Lane w/Factors		
D (ft)	Major Vol.	Minor Vol.

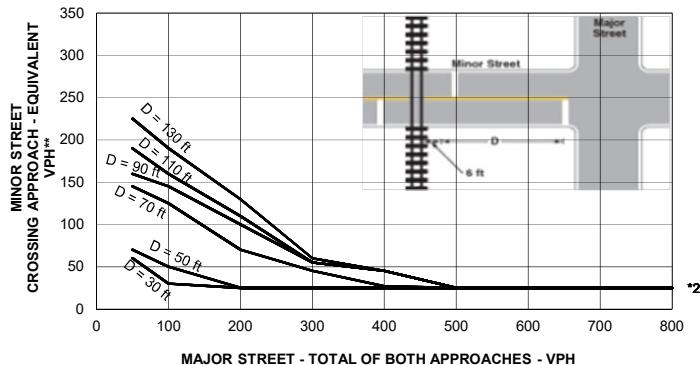
Input D and the major and minor street volumes before adjustment factors are applied

2 or more Approach Lanes		
D (ft)	Major Vol.	Minor Vol.

After adjustment factors are applied

2+ Approach Lane w/Factors		
D (ft)	Major Vol.	Minor Vol.

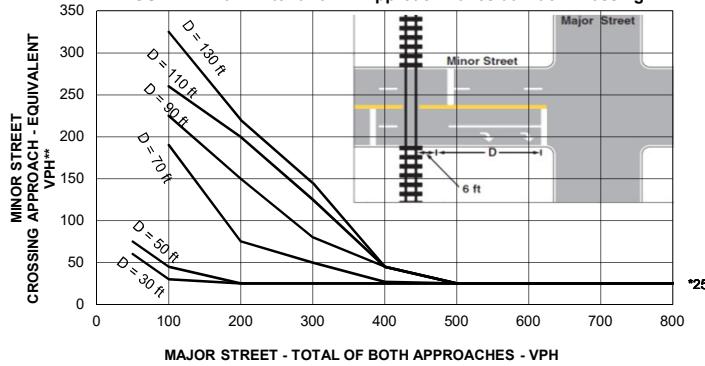
FIGURE 4C-9: Criteria for 1 Approach Lane at the Track Crossing



* Note: 25 vph applies as the lower threshold volume

* *Note: VPH after applying the adjustment factors in Tables 4C-2, 4C, and or 4C-4, if appropriate

FIGURE 4C-10: Criteria for 2+ Approach Lanes at Track Crossing



* Note: 25 vph applies as the lower threshold volume

* *Note: VPH after applying the adjustment factors in Tables 4C-2, 4C, and or 4C-4, if appropriate

TRAFFIC SIGNAL WARRANT SUMMARYCity: Orlando
County: 75 – Orange
District: _____Engineer: Group 4
Date: February 4, 2021Major Street: McCulloch Road
Minor Street: Amour de Flame Way/Worchester Dr
Lanes: 2 Major Approach Speed: 45mph
Lanes: 2 Minor Approach Speed: 25mphMUTCD Electronic Reference to Chapter 4: <http://mutcd.fhwa.dot.gov/pdfs/2009r1r2/part4.pdf>**CONCLUSIONS**Remarks: No signal warrant was satisfied, therefore we do not recommend a signal at this intersection.

WARRANTS SATISFIED:

Warrant 1	<input type="checkbox"/> Not Applicable	<input type="checkbox"/> Met	<input checked="" type="checkbox"/> Not Met
Warrant 2	<input type="checkbox"/> Not Applicable	<input type="checkbox"/> Met	<input checked="" type="checkbox"/> Not Met
Warrant 3	<input type="checkbox"/> Not Applicable	<input type="checkbox"/> Met	<input checked="" type="checkbox"/> Not Met
Warrant 4	<input checked="" type="checkbox"/> Not Applicable	<input type="checkbox"/> Met	<input type="checkbox"/> Not Met
Warrant 5	<input checked="" type="checkbox"/> Not Applicable	<input type="checkbox"/> Met	<input type="checkbox"/> Not Met
Warrant 6	<input type="checkbox"/> Not Applicable	<input type="checkbox"/> Met	<input checked="" type="checkbox"/> Not Met
Warrant 7	<input type="checkbox"/> Not Applicable	<input type="checkbox"/> Met	<input checked="" type="checkbox"/> Not Met
Warrant 8	<input type="checkbox"/> Not Applicable	<input type="checkbox"/> Met	<input checked="" type="checkbox"/> Not Met
Warrant 9	<input checked="" type="checkbox"/> Not Applicable	<input type="checkbox"/> Met	<input type="checkbox"/> Not Met