

Signal Warrant Analysis

**Bluffton Parkway at Masters
Way/Crossings Blvd.
Beaufort County, SC**

Prepared for:
Beaufort County

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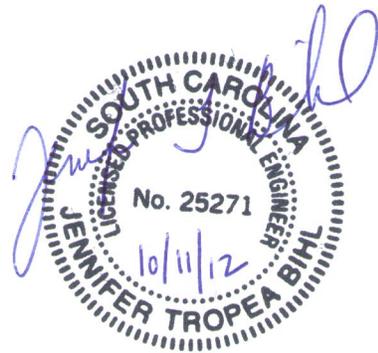
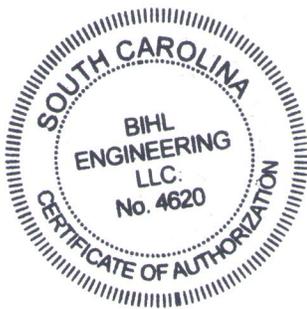
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Beaufort County, SC**

**Prepared for:
Beaufort County**

**Prepared by:
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1.0 Executive Summary

Bihl Engineering, LLC was retained to review the intersection of Bluffton Parkway at Masters Way/Crossings Blvd. for the appropriateness of traffic signal installation. Traffic signal installation is based on national standards outlined in the Manual on Uniform Traffic Control Devices, *Federal Highway Administration (2009, updated 2012)*.

The report reviews these standards and discusses other intersection observations.

Based on the review of the MUTCD traffic signal warrants, the intersection meets six of the required eight hours for the volume based Warrant 1 (from 7 – 9 AM and from 2 – 6 PM) and meets Warrants 2 and 3. Other studied hours did not meet the volume related warrants. No other warrants were considered to be met based on industry standards or were not applicable. Therefore, it is considered to be approaching MUTCD traffic signal warrants but does not appear favorable for signalization at this time.

Based on site observations, in addition to the traffic volume on Bluffton Parkway, there are a large number of right-turns from Masters Way as well as a large number of westbound left turns from Bluffton Parkway to access the school area.

The SCDOT Design Manual standards were reviewed regarding sight distance at the intersection. Stopping sight distance is available for the vertical curve east of the intersection. It appears that the intersection sight distance for vehicles exiting Crossings Blvd./Masters Way is shorter than recommended by the SCDOT Design Manual for the roadway conditions.

Based on this analysis, the following is recommended for the study area.

- Reduce speed limit on Bluffton Parkway to 35 mph in the vicinity of the intersection
- Install intersection warning signs on Bluffton Parkway prior to the intersection

Even with the reduction of speed limit, due to the large number of school turning traffic, it is also recommended that:

- Left-turn and through movements be restricted from side streets during the AM and PM school peak hours

Two additional recommendations based on site observations are:

- Review the height of the “Do Not Enter” sign just west of the intersection
- Request the Beaufort County School District prevent buses from performing left-turn or through movements at this intersection.

2.0 Introduction

Bihl Engineering, LLC was retained to review the intersection of Bluffton Parkway at Masters Way/Crossings Blvd. for the appropriateness of traffic signal installation.

Traffic signal installation is based on national standards outlined in the Manual on Uniform Traffic Control Devices (MUTCD), *Federal Highway Administration (2009, updated 2012)*.

The MUTCD outlines nine warrants that at minimum need to be met for a location to be considered for the installation of a traffic signal. The nine warrants are:

- Warrant 1, Eight-Hour Vehicular Volume
- Warrant 2, Four-Hour Vehicular Volume
- Warrant 3, Peak Hour
- Warrant 4, Pedestrian Volume
- Warrant 5, School Crossing
- Warrant 6, Coordinated Signal System
- Warrant 7, Crash Experience
- Warrant 8, Roadway Network
- Warrant 9, Intersection Near a Grade Crossing

Section 4.0 addresses each of these warrants, their applicability to this intersection and the satisfaction of the warrants.

Sight distance and intersection observations were also reviewed as part of this study.

3.0 Existing Conditions

Bluffton Parkway is a four-lane roadway with left-turn lanes and a 25-foot planted median in the vicinity of Masters Way/Crossings Blvd. It has a posted speed limit of 45 mph. Approximately 400 feet east of the intersection is a vertical curve, and approximately 1,200 feet west of the intersection is a horizontal curve.

Masters Way is a two-lane undivided roadway with no posted speed limit. At the intersection with Bluffton Parkway, it has a one-lane exiting approach with a short channelized right-turn lane at the intersection. This roadway provides access to Bluffton High School.

Crossings Blvd. is a two-lane undivided roadway with a posted speed of 20 mph. At the intersection with Bluffton Parkway it has a one-lane exiting approach with a short channelized right-turn lane at the intersection.

Figure 1 shows the location of the study area intersection, **Figure 2** shows a zoomed image of the intersection.

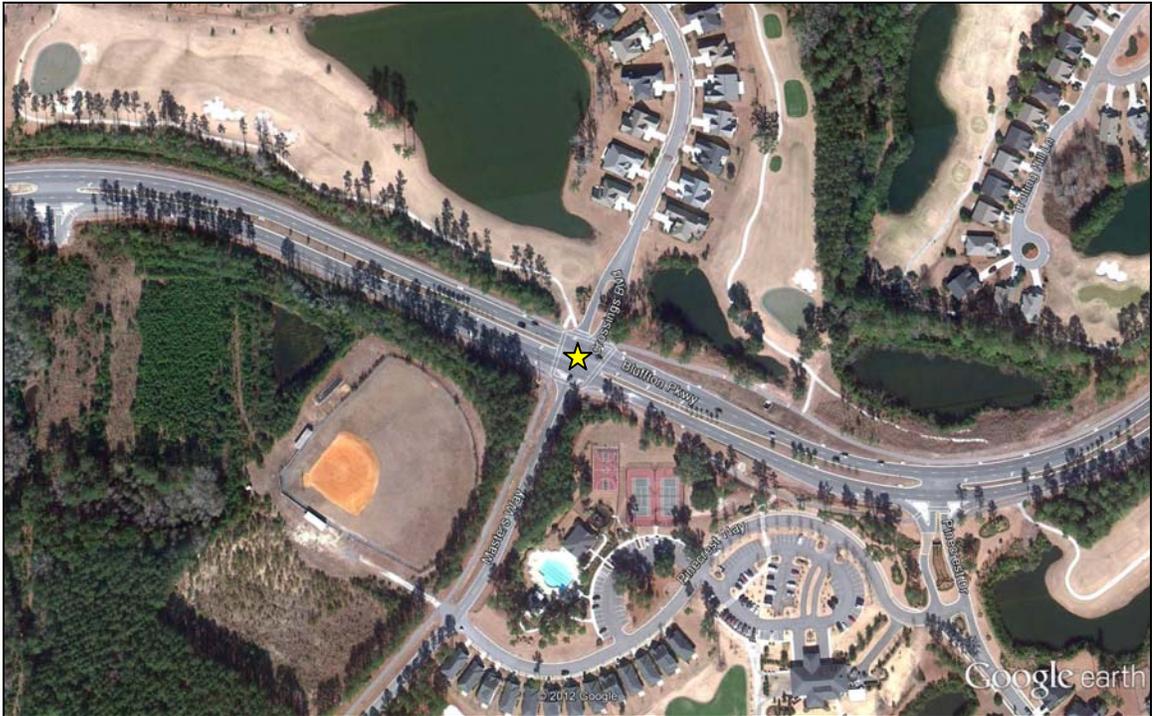


Figure 1: Intersection Location



Figure 2: Intersection Photo

Traffic counts were performed in September 2012 during the AM (7 AM – 9 AM), Midday (11:30 AM – 1:30 PM), and PM (2 PM – 6 PM) peak hours. It should be noted that there was a meet and greet event at Bluffton High School the evening of the traffic count. The raw count data is attached to this report.

During the study time periods, 77% of the side street traffic was right-turn movements (94% of the traffic on Masters Way and 34% of the traffic on Crossings Blvd.). 296 vehicles turned left or traveled through the intersection from the side streets during the eight-hour study period, for an average of 37 vehicles an hour, with a maximum of 58 vehicles from Crossings Blvd. and a maximum of 11 vehicles from Masters Way.

Intersection observations were performed during the last two weeks of September at various times of day to review operations. During the AM peak hour, an average delay of 53 seconds was observed for left turning or through vehicles exiting Crossings Blvd., with 50% of the vehicles experiencing a delay less than 40 seconds.

4.0 MUTCD Warrants

The Manual on Uniform Traffic Control Devices (MUTCD) identifies nine factors to be considered related to the “existing operation and safety at the study location and the potential to improve these conditions.” The MUTCD notes that “satisfaction of traffic signal warrant or warrants does not in itself require the installation of the traffic control signal.” The MUTCD cautions installation of a traffic signal when it is not warranted.

The MUTCD also provides guidance on the treatment of right turns in the analysis, stating “the study should consider the effects of the right-turn vehicles from the minor-street approaches. Engineering judgment should be used to determine what, if any, portion of the right-turn traffic is subtracted from the minor-street traffic count when evaluating the count against the signal warrants.”

The traffic volume on Masters Way has a heavy right turn volume during the peak hour. Based on site observations, approximately 30% experience some delay while performing their maneuver. However, to be conservative and account for fluctuations that occur day to day, 50% of the right-turns were considered in the minor street traffic volume for Warrants 1, 2, and 3.

4.1 Warrant 1 – Eight-Hour Vehicular Warrant

This warrant reviews the interaction of traffic on the major street along with the highest minor street approach. It reviews whether there is a large number of intersecting traffic or that the traffic flow on the major street causes excessive delay/conflict on the minor street.

70% values were used from Table 4C-1 (MUTCD) because the speed is higher than 40 mph in this area on the major street.

Table 1 shows the existing traffic volumes compared to the MUTCD standards.

Based on the results of the review of Warrant 1, the intersection meets warrants for six hours from 7 – 9 AM and from 2 – 6 PM but does not meet warrants during the midday time period. To meet the warrant, eight hours are required to be met.

4.2 Warrant 2 – Four-Hour Vehicular Warrant

This warrant reviews conditions “where the volume of intersecting traffic is the principal reason to consider installing a traffic signal.”

Table 1 shows the existing traffic volumes compared to the MUTCD standards.

Based on the results of Warrant 2, four of four required hours were met.

4.3 Warrant 3, Peak Hour

This warrant reviews conditions to see if the “minor-street traffic suffers undue delay when entering or crossing the major street.” Note that this warrant “shall be applied only in unusual cases, such as office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time” according to the MUTCD.

Table 1 shows the existing traffic volumes compared to the MUTCD standards.

This hourly warrant is met during two of the eight hours.

4.4 Warrant 4, Pedestrian Volume

This warrant reviews whether pedestrians experience excessive delay when trying to cross the intersection. During site observations, there were limited pedestrian crossings and the pedestrians were not observed to experience excessive delay.

Table 1: Signal Warrant Analysis

Intersection: Bluffton Parkway at Masters Way

Speed Limit of Major Street: 45 mph Greater than 40 mph? Y In an isolated community with population less than 10,000? N

Major Street: Bluffton Parkway # Approach Lanes: 2
 Minor Street: Masters Way # Approach Lanes: 1

Count Date: 9/19/2012

Starting Hour	Ending Hour	Major Street Volumes (Both Approaches)	Minor Street (Highest Approach)	Warrant 1, Eight-Hour Condition A (Minimum Vehicular Volume)			Warrant 1, Eight Hour Condition B (Interruption of Continous Traffic)			Warrant 1, Eight Hour Combination						Warrant 2 (Four-Hour Vehicular Volume)	Warrant 3 (Peak Hour Volume)
				Major Street	Minor Street	Both Met?	Major Street	Minor Street	Both Met?	Condition A			Condition B				
										Major Street	Minor Street	Both Met?	Major Street	Minor Street	Both Met?		
				420	105		630	53		336	84		504	42			
7:00 AM	8:00 AM	1,465	104	Y			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
8:00 AM	9:00 AM	1,262	53	Y			Y	Y	Y	Y			Y	Y	Y		
9:00 AM	10:00 AM																
10:00 AM	11:00 AM																
11:00 AM	12:00 PM	1,078	21	Y			Y			Y			Y				
12:00 PM	1:00 PM	1,155	32	Y			Y			Y			Y				
1:00 PM	2:00 PM																
2:00 PM	3:00 PM	1,306	91	Y			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
3:00 PM	4:00 PM	1,434	60	Y			Y	Y	Y	Y			Y	Y	Y	Y	
4:00 PM	5:00 PM	1,609	58	Y			Y	Y	Y	Y			Y	Y	Y		
5:00 PM	6:00 PM	1,994	73	Y			Y	Y	Y	Y			Y	Y	Y	Y	
Hours Met				0			6			2			6			4	2
# of Hours Needed				8			8			8 of both conditions						4	1
Satisfied?				Not Satisfied			Not Satisfied			Not Satisfied						Satisfied	Satisfied

Six pedestrians were observed crossing Bluffton Parkway in either direction during the AM peak hour, two pedestrians were observed during the midday peak hour, and three pedestrians were observed during the PM peak hour.

The number of observed pedestrians does not meet the warrant standards of 75 pedestrians.

4.5 *Warrant 5, School Crossing*

“The School Crossing signal warrant is intended for the application when the fact that schoolchildren cross the major street is the principal reason to consider installing a traffic control signal.”

As presented in **Section 4.4**, very few pedestrians were observed crossing the intersection during the peak hours. There were fewer than 20 schoolchildren crossing during the highest crossing hour therefore this warrant is not met.

4.6 *Warrant 6, Coordinated Signal System*

This warrant reviews progressive movement in a coordinated signal system. This warrant is not applicable to this location.

4.7 *Warrant 7, Crash Experience*

This warrant reviews crash experience at the intersection and is “intended for application where the severity and frequency of crashes are the principal reasons to consider installing a traffic signal.”

Crash data was obtained from the Bluffton Police Department and the Beaufort County Sheriff’s Office from year 2008 through September 2012. There were nine crashes in the vicinity of the intersection and five crashes further south on of the intersection on Masters Way in the vicinity of the intersection of Masters Way at HE McCracken Circle or related to the operations at that intersection.

Table 2 provides a summary of those nine crashes. Based on the review of the crash data, two accidents since 2008 would be correctable with the installation of a traffic signal. The MUTCD standard is at least five correctable crashes within a year period. Therefore, this warrant is not met.

Table 2:
Crash Summary since 2008 at Bluffton Parkway at Masters Way/Crossings Blvd.

Crash Type	Number of Crashes
Correctable by a traffic signal	2 (1 sideswipe from Masters Way to Bluffton Parkway in 2009, 1 Failure to Yield Right of way in 2010)
Rear End on Northbound Masters Way	3
Rear End on Bluffton Parkway	1 (due to road debris)
Accident with Animal	2
Driver falling asleep	1

4.8 *Warrant 8, Roadway Network*

This warrant addresses the encouragement of “concentration and organization of traffic flow on a roadway network.” This warrant is not applicable.

4.9 *Warrant 9, Intersection Near a Grade Crossing*

This warrant is used when the other eight warrants are not met but the intersection is close to an at-grade crossing on a STOP/YIELD approach. This warrant is not applicable.

5.0 **Other Factors**

5.1 *Traffic Flow*

During the peak hours, Bluffton Parkway has a large number of vehicles traveling eastbound and westbound. Masters Way is used for access to Bluffton High School and during the AM and PM peak hours, there are a large number of westbound left turns and northbound right turns occurring at the intersection.

5.2 *Sight Distance Calculations and Observations*

Horizontal and vertical curves occur in the vicinity of this intersection. A vertical curve due to a golf cart tunnel occurs approximately 400 feet east of the intersection on Bluffton Parkway (see photo in **Figure 3**). A horizontal curve occurs in the roadway approximately 1,200 feet west of the intersection on Bluffton Parkway (see photo in **Figure 4**).



Figure 3: Vertical Curve (from Crossings Blvd.)



Figure 4: Horizontal Curve (from Masters Way)

The median is approximately 25 feet at the intersection. Per the SCDOT Design Manual, a 26-foot median is required to consider two-step maneuvers from the side streets – 20 feet plus 3 feet on both sides. It was observed that some vehicles considered 25 feet acceptable to perform a two-step left-turn maneuver.

5.2.1 Vertical Curve Sight Distance and Intersection Crossing Distance

Stopping sight distance on westbound Bluffton Parkway for vehicles entering the intersection from Crossings Blvd. as well as intersection sight distance from Crossings Blvd. looking eastbound on Bluffton Parkway was measured on the plan/profile sheets for Bluffton Parkway to be approximately 495 feet.

The standard based on the SCDOT Design Manual is 380 feet for 45 mph condition considering a 3% downgrade. Therefore, the SCDOT standard for stopping sight distance is met.

Based on SCDOT Design Manual formulas (Intersection sight distance = $1.47 * \text{Speed} * \text{Gap Acceptance}$), intersection sight distance for a left-turn from Crossings Blvd. to eastbound Bluffton Parkway was calculated to be 598 feet. This assumes a 9.04 second gap acceptance based on SCDOT gap acceptance formulas assuming the turn will be performed in one maneuver. Assuming a two-step maneuver, the intersection sight distance was calculated to be 529 feet with an 8 second gap acceptance. During field observations, there was approximately a 7 – 9 second gap in the westbound vehicles. Based on the results of the analysis, it is recommended that the speed limit in this section be reduced to 35 mph where the intersection sight distance required is 465 feet.

5.2.2 Horizontal Curve Sight Distance

Horizontal curve sight distance appears to be sufficient. There is approximately 1,200 feet between the intersection and the horizontal curve.

It is noted that the County should check the height of the “Do Not Enter” sign as it appears to be mounted low and may obstruct the view of the turning drivers until they proceed past the sign (see **Figure 4**).

5.3 School Bus Movements

It was observed that one school bus turned left from Masters Way to westbound Bluffton Parkway during the AM peak hour and one bus traveled through the intersection from Masters Way to Crossings Blvd. during the PM peak hour. It is recommended that the County notify the Beaufort County School District of these operations and request other routes be used.

6.0 Recommendations

Based on the review of the MUTCD traffic signal warrants, the intersection meets six of the required eight hours for the volume based Warrant 1 (from 7 – 9 AM and from 2 – 6 PM) and meets Warrants 2 and 3. Other studied hours did not meet the volume related warrants. No other warrants were considered to be met based on industry standards or were not applicable. Therefore, it is considered to be approaching MUTCD traffic signal warrants but does not appear favorable for signalization at this time.

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Based on this analysis, the following is recommended for the study area.

- Reduce speed limit on Bluffton Parkway to 35 mph in the vicinity of the intersection
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Even with the reduction of speed limit, due to the large number of school turning traffic, it is also recommended that:

- Left-turn and through movements be restricted from side streets during the AM and PM school peak hours

Two additional recommendations based on site observations are:

- Review the height of the “Do Not Enter” sign just west of the intersection
- Request the Beaufort County School District prevent buses from performing left-turn or through movements at this intersection.

Appendix

Raw Traffic Count Data

Start Date: 9/19/2012
 Start Time: 7:00:00 AM
 Site Code: 0000000

Start Time	Crossings Blvd. From North				Bluffton Parkway From East				Masters Way From South				Bluffton Parkway From West				15-min volume	Total
	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds		
07:00 AM	4	1	9	0	102	105	2	0	0	0	47	0	0	151	4	0	425	
07:15 AM	2	2	8	4	66	111	10	1	2	3	75	0	3	178	4	0	464	
07:30 AM	2	1	12	0	66	104	3	1	0	1	46	0	3	199	3	0	440	
07:45 AM	11	5	7	2	12	114	1	0	0	2	21	0	7	214	3	3	397	1726
08:00 AM	14	6	3	0	9	129	1	2	0	1	27	0	3	186	4	0	383	1684
08:15 AM	6	8	4	0	15	91	1	2	0	3	23	1	3	207	2	2	363	1583
08:30 AM	4	4	1	0	21	121	3	3	0	2	23	0	2	153	1	2	335	1478
08:45 AM	7	1	6	0	15	110	5	3	0	1	15	1	2	177	1	3	340	1421
11:30 AM	6	0	3	0	5	131	5	3	2	0	6	0	3	126	3	0	290	
11:45 AM	4	1	4	0	11	128	4	0	1	0	13	0	3	120	1	0	290	
12:00 PM	4	0	1	0	10	118	5	3	0	0	7	0	3	112	4	0	264	
12:15 PM	10	0	4	1	18	132	5	2	0	0	8	0	3	126	2	0	308	1152
12:30 PM	5	0	4	1	12	121	10	1	2	0	16	0	4	120	2	1	296	1158
12:45 PM	4	0	3	0	13	136	4	1	0	0	9	0	4	135	4	0	312	1180
01:00 PM	2	0	1	0	8	178	5	2	1	2	16	0	3	114	1	0	331	1247
01:15 PM	7	0	3	0	8	143	3	1	1	0	9	0	1	124	2	0	301	1240
02:00 PM	5	0	1	0	13	137	5	2	1	0	11	0	2	131	0	1	306	
02:15 PM	4	2	2	0	31	141	5	1	0	0	9	0	3	137	2	0	336	
02:30 PM	3	3	3	0	43	165	10	0	4	2	90	0	3	113	3	0	442	
02:45 PM	4	0	6	0	30	162	10	0	1	2	50	0	3	156	1	0	425	1509
03:00 PM	6	3	4	0	31	167	3	2	0	0	20	0	4	107	4	0	349	1552
03:15 PM	7	2	2	0	27	165	7	0	0	2	32	0	5	139	2	0	390	1606
03:30 PM	5	1	6	0	19	206	9	2	1	2	31	1	4	136	4	0	424	1588
03:45 PM	5	0	5	0	33	194	5	2	0	1	24	0	11	148	4	0	430	1593
04:00 PM	5	2	3	0	38	206	5	1	0	0	29	0	4	123	4	1	419	1663
04:15 PM	8	3	0	0	25	177	9	0	0	1	31	0	9	135	3	2	401	1674
04:30 PM	2	3	3	0	21	234	10	3	1	1	26	0	8	180	6	0	495	1745
04:45 PM	11	2	5	0	42	213	7	2	3	0	16	1	4	141	5	1	449	1764
05:00 PM	5	1	2	0	59	295	7	1	2	0	25	0	6	171	4	1	577	1922
05:15 PM	8	1	3	0	43	269	12	0	1	1	37	0	10	169	7	1	561	2082
05:30 PM	9	0	4	0	47	239	4	2	2	1	30	2	4	183	4	2	527	2114
05:45 PM	9	1	4	1	48	220	9	0	1	1	34	0	5	176	3	0	511	2176

Peak Hours	Crossings Blvd.				Bluffton Parkway				Masters Way				Bluffton Parkway			
	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds
am	19	9	36	6	246	434	16	2	2	6	189	0	13	742	14	3
mid	21	0	12	2	51	567	24	6	3	2	49	0	14	495	9	1
pm	31	3	13	1	197	1023	32	3	6	3	126	2	25	699	18	4

total

10/11/2012