Facility Planning Study - Phase I

Goldsboro Road

Traffic Analysis Report

June 2013

Montgomery County Department of Transportation

Planning

Executive Summary

Montgomery County Department of Transportation (MCDOT) has initiated a Facility Planning, Phase I study for Goldsboro Road from MD 190 (River Road) to MacArthur Boulevard. The primary goal of this study is to support the development of bicycle and pedestrian improvement concepts.

This segment of Goldsboro Road consists of one (1) lane in both the northbound and southbound directions. Goldsboro Road has a posted speed limit of 35 mph within the study area. There is continuous overhead street lighting along the entire length of Goldsboro Road. The availability of sidewalks and shoulders varies along the segment.

Initial field visits were performed on two Tuesdays in January 2013 to observe pedestrian and bicyclist activity along the corridor. Pedestrian volumes were relatively low during these observation periods. However, most of the pedestrian activity was focused around the bus stops. Additional field visits were performed on a Friday and Saturday in late April 2013 to observe pedestrian and bicyclist activity under more pleasant weather conditions. The bicyclist activity was very high during these periods, and a significant number of pedestrians were seen as well.

Capacity analyses were performed at the two signalized intersections along Goldsboro Road using Synchro. The two signalized intersections are at River Road (MD 190) and at Massachusetts Avenue (MD 396). The results of the analyses showed that both of these intersections currently operate at level of service (LOS) D or better during both the AM and PM peak hours on a typical weekday. Analyses were also performed to determine if the proposed addition of pedestrian signal phasing at these two locations would have an adverse impact on peak hour vehicular traffic operations. The findings of those analyses indicated that the addition of pedestrian phasing would have no impact on intersection performance.

A review of the reported crashes along Goldsboro Road for a five year period covering 2007 through 2011 indicated there were no pedestrian-related crashes. There was a total of 22 crashes reported during this period. The predominant type of crash occurring along Goldsboro Road is the fixed-object/run-off-road collision. A second set of crash data was reviewed for the segment of MacArthur Boulevard from south/east of Goldsboro Road to Oxford Road, covering 2008 through 1012. Within this roadway segment, there were three (3) crashes involving vehicles striking bicyclists. Aside from the bicycle-related crashes, the most common crash type along this part of MacArthur Boulevard was the angle crash. A total of eight (8) crashes were reported along this segment during this 5-year study period.

Based on the findings of this study, the following improvements are recommended for implementation along Goldsboro Road:

- The installation of a continuous shoulder of consistent width, or a sidewalk, along at least one entire side of Goldsboro Road.
- The installation of pedestrian signal heads and addition of pushbutton-actuated pedestrian phasing with walk, flashing don't walk and don't walk intervals at both signalized intersections (MD 190 and MD 396).
- The installation of crosswalks is recommended at the River Road intersection.

- Marked crosswalk(s) are recommended at the MacArthur Boulevard/Goldsboro Road traffic circle.
- Improved pedestrian access is recommended for the bus stop adjacent to the gas station along Goldsboro Road.

Table of Contents

Index of Figures

Index of Tables

I. Introduction

This traffic study was performed as a part of Goldsboro Road Bicycle and Pedestrian Improvements Study. The primary goal of this study is to support the development of bicycle and pedestrian improvement concepts. The study reviewed the existing conditions along the segment of Goldsboro Road (MD 614) between MacArthur Boulevard and River Road (MD 190). This report includes a summary of traffic data and observations, capacity analysis, and crash trend analyses.

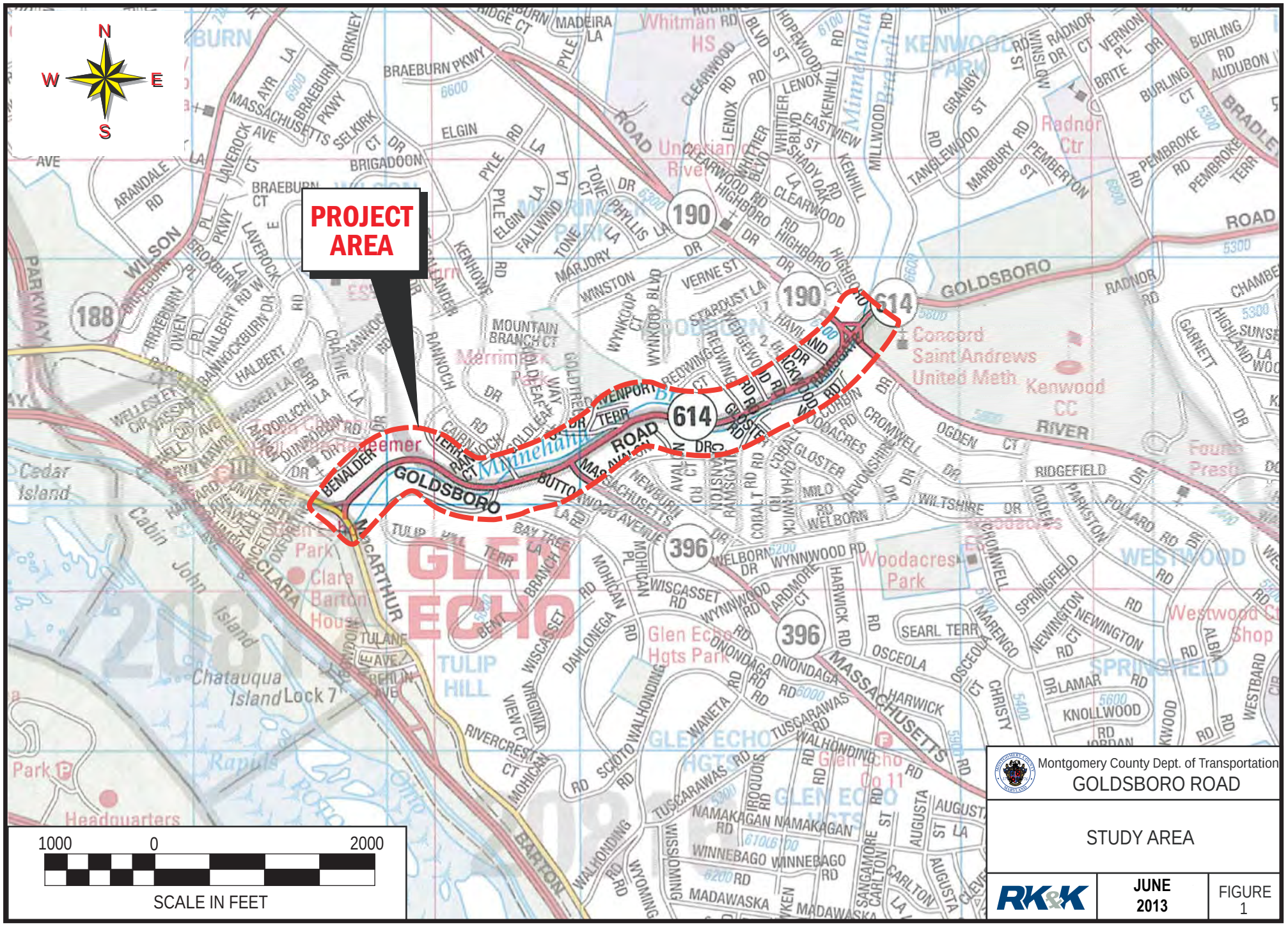
II. Site Description

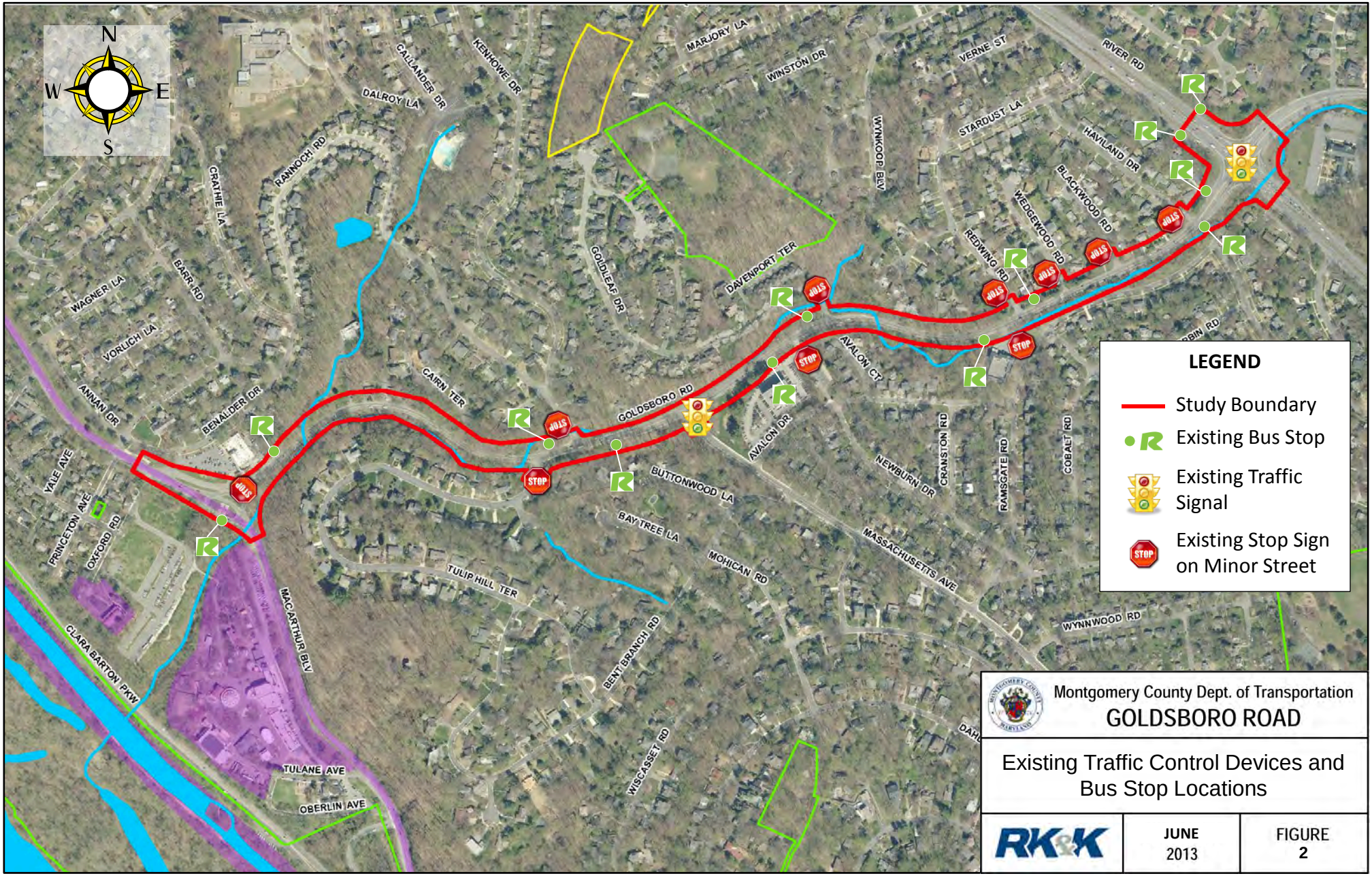
Goldsboro Road is designated by the Maryland State Highway Administration (SHA) as a north-south roadway. The segment of Goldsboro Road being evaluated is located in Montgomery County north of the Town of Glen Echo, between MacArthur Boulevard and River Road. This segment of Goldsboro Road is surrounded by homes and parks. The entrance to Clara Barton National Historic Site and Glen Echo Park are located just west of the intersection of Goldsboro Road and MacArthur Boulevard. The entrance to St. Andrews Cooperative Nursery School and the Kenwood Golf and Country Club is located in close proximity to the intersection of Goldsboro Road and River Road. See **Figure 1** for a map of the study area.

This segment of Goldsboro Road consists of one (1) lane in both the northbound and southbound directions. Goldsboro Road has a posted speed limit of 35 mph within the study area. There is continuous overhead street lighting along the entire length of Goldsboro Road. The availability of sidewalks and shoulders varies along the segment. Some areas have paved shoulder only on one side of the road while other areas have paved shoulders on both sides of the road. Where there are paved shoulders, the shoulder width varies from two (2) feet to four (4) feet. The only area that currently has sidewalks is along the northbound side of Goldsboro Road approaching and departing the Massachusetts Avenue intersection. In terms of vertical geometry, Goldsboro Road goes downhill continuously from the River Road intersection south to MacArthur Boulevard. Horizontally, Goldsboro Road has many curves as it follows the alignment of Minnehaha Branch, a small, winding stream that leads to the Potomac River. See **Figure 2** for a map showing the locations of the existing stop-controlled minor streets, signalized intersections, and bus stops along Goldsboro Road. The intersection of Goldsboro Road at MacArthur Boulevard is a traffic circle. It is not a roundabout because traffic entering the circle along MacArthur Boulevard is not required to yield or stop, but circulating traffic inside the circle is required to yield at Yield signs. Traffic entering the circle from Goldsboro Road is required to stop at a Stop sign.

III. Site Observations

An initial field visit was performed along Goldsboro Road on Tuesday, January 22, 2013 to count and observe pedestrian and bicyclist activity. The temperature during the midday hours on this date was around 20°F and continued to fall throughout the afternoon hours. During this field visit, a total of 36 pedestrians were observed either walking along Goldsboro Road or waiting at bus stops between 6:00 AM and 7:00PM. Of these, 23 pedestrians were observed throughout the 13-hour study period at the bus stop near the Exxon gas station at the corner of Goldsboro Road and MacArthur Boulevard.


N
W
E
S
PROJECT AREA
GOLDSBORO ROAD
614
190
396
188
1000
0
2000
SCALE IN FEET
Montgomery County Dept. of Transportation
GOLDSBORO ROAD
STUDY AREA
RK&K
JUNE 2013
FIGURE 1



Montgomery County Dept. of Transportation

GOLDSBORO ROAD

Existing Traffic Control Devices and Bus Stop Locations

RK&K

JUNE 2013

FIGURE 2

The second most common location for pedestrians during this period was at the Rannoch Road bus stops along Goldsboro Road. A total of three (3) cyclists were observed along Goldsboro Road during the 13-hour observation period.

A second field visit was conducted along Goldsboro Road on Tuesday, January 29, 2013. The weather on this date was unseasonably warm, with a high of 70°F reached in the afternoon. The following observations were made between the hours of 2:45 PM and 4:30 PM for this study:

- **Goldsboro Road at MacArthur Boulevard:**
  - Pedestrians and cyclists were observed crossing MacArthur Boulevard west of the traffic circle at Goldsboro Road. The majority of these pedestrians crossed MacArthur Boulevard at the entrance to Glen Echo Park. The pedestrians walked to and from both the eastbound and westbound directions of the bicycle path. Pedestrians also walked to and from the entrance to Glen Echo Park.
  - Pedestrians were also observed crossing MacArthur Boulevard immediately east of the traffic circle at Goldsboro Road. The pedestrians walked between the Exxon parking lot and the bus stop on the southeast side of the traffic circle. The majority of these pedestrians were observed using the bus stop on the southeast corner of the traffic circle.
  - Cyclists were observed traveling eastbound and westbound along MacArthur Boulevard. The majority of the cyclists traveling on MacArthur Boulevard used the bicycle path, which is located along the south side of MacArthur Boulevard.
  - Cyclists were observed turning right onto westbound MacArthur Boulevard from southbound Goldsboro Road. Some of the cyclists were observed crossing MacArthur Road in front of the entrance to Glen Echo Park to access the bicycle path. There were cyclists that continued to travel on MacArthur Boulevard with motor vehicles.
  - Pedestrians were observed waiting at the bus stop just north of the Exxon Gas Station and at the bus stop on the south side of the traffic circle.
  - Motorists were observed disregarding the STOP sign on the southbound Goldsboro Road approach to the traffic circle at MacArthur Boulevard.
  - A bus was observed stopping at the bus stop on the southeast corner of the intersection. The bus idled at the bus stop for a few minutes which caused moderate queuing of traffic on eastbound MacArthur Boulevard during the PM peak hour.

- **Goldsboro Road at Massachusetts Avenue**
  - A pedestrian was observed crossing Massachusetts Avenue at Goldsboro Road. Although there are no pedestrian signals here currently, the pedestrian obeyed the traffic signal by waiting to cross Massachusetts Avenue during the green signal for Goldsboro Road.
  - A cyclist was observed traveling southbound on Goldsboro Road with motor vehicles from the intersection of River Road through the Massachusetts Avenue intersection.
  - One (1) pedestrian was observed crossing Goldsboro Road at the marked crosswalk near Wedgewood Road.

- **Goldsboro Road at River Road**
  - Pedestrians were observed waiting at the bus stop on the northwest side of the intersection of Goldsboro Road and River Road.

An additional site visit was conducted along Goldsboro Road on Friday, April 26, 2013 and Saturday, April 27, 2013 to count and observe pedestrian and bicyclist activity during more favorable weather conditions. The field visit included observations of pedestrians and cyclists traveling along Goldsboro Road between MacArthur Boulevard and River Road. Additional observations were performed at the MacArthur Road intersection to determine the number of bicyclists traveling to and from locations on Goldsboro Road and the percentage of pedestrians crossing MacArthur Road east or west of the traffic circle. The results of the study are summarized below.

- **Goldsboro Road at MacArthur Boulevard:**
  - During the field visit on Friday and Saturday, a total of 87 pedestrians were observed crossing MacArthur Road in the vicinity of the traffic circle. Of these, 52 pedestrians (60%) were observed crossing MacArthur Road east of the traffic circle. In addition, 35 pedestrians (40%) were observed crossing MacArthur Road west of the traffic circle.
  - During the field visit on Friday, a total of 219 bicyclists were observed traveling in the vicinity of the Goldsboro Road and MacArthur Boulevard intersection. Of these, 10 bicyclists (5%) were observed traveling from areas along Goldsboro Road and 20 bicyclists (9%) were observed traveling to destinations along Goldsboro Road.
  - During the field visit on Saturday, a total of 837 bicyclists were counted traveling in the vicinity of the intersection of the Goldsboro Road and MacArthur Boulevard intersection. Of these, 62 bicyclists (7%) were observed traveling from areas along Goldsboro Road and 33 bicyclists (4%) were observed traveling to destinations along Goldsboro Road.
  - Additional cyclists were *observed, but not counted,* during the Saturday visit – these observed cyclists were participants in a bicycle race that passed through the intersection along MacArthur Boulevard for a period of about 20 minutes during the 7:00-8:00 AM hour. The roads remained open to vehicular traffic during the race, but there was a traffic control officer present.

- **Goldsboro Road between MacArthur Boulevard and River Road:**
  - During the field visit on Friday, a total of 61 pedestrians and 17 bicyclists were observed walking, bicycling, or waiting at bus stops along Goldsboro Road between 7:00 AM and 7:00 PM.
  - During the field visit on Saturday, a total 38 pedestrians and 83 bicyclists were observed walking, bicycling, or waiting at bus stops along Goldsboro Road between 7:00 AM and 7:00 PM.

Tables summarizing the pedestrian and bicycle activity observed in April 2013 are provided in Appendix C.

IV. Capacity Analysis

Goldsboro Road (MD 614) at River Road (MD 190)

RK&K utilized traffic data provided by Maryland State Highway Administration to perform the capacity analysis at the River Road intersection. The latest 13-hour turning movement counts were taken at the intersection on Tuesday, August 31, 2010. The AM and PM peak hours were determined to be 7:45 to 8:45 AM and 5:15 to 6:15 PM. The turning movement volumes and number of pedestrians crossing during these peak hours are summarized in **Table 1** below. No growth rate was applied to these 2010 traffic volumes because the MWCOG regional travel demand model indicates an annual growth rate of less than 0.2 percent per year on Goldsboro Road, which is negligible.

Table 1
8/31/2010 Peak Hour Turning Movement Volumes *(Source: SHA)*

		Morning Peak Hour (7:45 – 8:45 AM)					Evening Peak Hour (5:15 – 6:15 PM)				
		L	T	R	PED	*Total*	L	T	R	PED	*Total*
MD 614 (Goldsboro Rd)	NB	223	305	143	0	***671***	453	312	109	0	***874***
	SB	121	186	150	1	***458***	113	387	282	1	***783***
MD 190 (River Rd)	EB	317	1,626	497	1	***2,441***	238	925	294	0	***1,457***
	WB	38	868	60	0	***966***	150	1,469	123	0	***1,742***

Using the volumes in **Table 1**, the level of service for the intersection was determined using Synchro, which is based on the methodology found in the *Highway Capacity Manual (HCM)*. The existing signal timings were obtained from Montgomery County DOT. The intersection was analyzed using the existing signal timings and using modified signal timings to include the proposed pedestrian phases. The following is a summary of the analysis results:

- Existing Signal Timing: The intersection currently operates at LOS C (with 31.3 sec/veh. of control delay) during the AM peak hour and LOS D (with 47.4 sec/veh. of control delay) during the PM peak hour.
- Proposed Signal Timing (With Pedestrian Phases): The intersection is projected to operate at LOS C (with 31.3 sec/veh. of control delay) during the AM peak hour and LOS D (with 49.4 sec/veh. of control delay) during the PM peak hour.
    - Based on a sensitivity analysis, there would need to be more than 400 pedestrians crossing at this intersection during the peak hours to cause this intersection to perform at an unacceptable LOS (i.e., LOS E or worse).
    - The higher pedestrian and bicyclist activity observed during April 2013 would still not be sufficient to cause this intersection to operate at an unacceptable LOS.
- The counts show that there were only two (2) pedestrians in the AM peak hour and one (1) pedestrian in the PM peak hour that crossed the intersection of Goldsboro Road and River Road during this August 31, 2010 count from SHA.

Goldsboro Road (MD 614) at Massachusetts Avenue (MD 396)

RK&K utilized traffic data provided by Maryland State Highway Administration to perform the capacity analysis at the Massachusetts Avenue intersection. The latest 13-hour turning movement counts were taken at the intersection on Wednesday, October 3, 2007. The AM and PM peak hours were determined to be 7:45 to 8:45 AM and 5:00 to 6:00 PM. The turning movement volumes and pedestrians crossing during these peak hours are summarized in **Table 2** below. No growth rate was applied to these 2007 traffic volumes because the MWCOG regional travel demand model indicates an annual growth rate of less than 0.2 percent per year on Goldsboro Road, which is negligible.

Table 2
10/3/2007 Peak Hour Turning Movement Volumes *(Source: SHA)*

		Morning Peak Hour (7:45 – 8:45 AM)					Evening Peak Hour (5:00 – 6:00 PM)				
		L	T	R	PED	*Total*	L	T	R	PED	*Total*
MD 614 (Goldsboro Rd)	NB	--	452	421	0	***873***	--	274	201	0	***479***
	SB	464	223	--	0	***687***	374	439	--	0	***813***
MD 396 (Mass. Ave)	WB	219	--	374	0	***593***	292	--	535	0	***827***

Using the volumes in **Table 2**, the level of service for the intersection was determined using Synchro, which is based on the methodology found in the Highway Capacity Manual (HCM). The existing signal timings were obtained from Montgomery County. The intersection was analyzed using the existing signal timings and using modified signal timings to include the proposed pedestrian phases. The following is a summary of the analysis results:

- Existing Signal Timing: The intersection currently operates at LOS C (with 26.5 sec/veh. of control delay) during the AM peak hour and LOS C (with 24.7 sec/veh. of control delay) during the PM peak hour.
- Proposed Signal Timing (With Pedestrian Phases): The intersection is projected to operate at LOS C (with 26.5 sec/veh. of control delay) during the AM peak hour and LOS C (with 24.7 sec/veh. of control delay) during the PM peak hour.
    - Based on a sensitivity analysis, there would need to be more than 400 pedestrians crossing at this intersection during the peak hours to cause this intersection to perform at an unacceptable LOS (i.e., LOS E or worse).
    - The higher pedestrian and bicyclist activity observed during April 2013 would still not be sufficient to cause this intersection to operate at an unacceptable LOS.
- The Synchro analysis indicates the average control delay and Level of Service would be the same as the existing condition.

Goldsboro Road (MD 614) @ MacArthur Boulevard

RK&K performed a 13-hour turning movement count at the intersection of Goldsboro Road and MacArthur Boulevard on Tuesday, January 22, 2013. The AM and PM peak hours were determined to be 8:00 to 9:00 AM and 5:00 to 6:00 PM. This count included pedestrians and cyclists traveling on the bicycle path south of the intersection. Cyclists that traveled with traffic were counted as vehicles and cyclists that traveled on the bicycle path were counted at pedestrians. Being an unconventional intersection design, the capacity of the intersection was not evaluated. The purpose of the traffic count at this location is to determine the best location for a proposed crosswalk based on pedestrian exposure to vehicle traffic. The turning movement volumes during these peak hours are summarized in **Table 3** below. As noted in Section II of this report, additional site observations performed during April 2013 showed a significantly higher number of pedestrian crossings compared to the January count data below.

Table 3
1/22/2013 Peak Hour Turning Movement Volumes *(Source: RK&K)*

		Morning Peak Hour (8:00 – 9:00 AM)					Evening Peak Hour (5:00 – 6:00 PM)				
		L	T	R	PED	*Total*	L	T	R	PED	*Total*
MD 614 (Goldsboro Rd)	**SB**	194	--	148	4	***346***	384	--	198	4	***586***
MacArthur Blvd	**EB**	508	518	--	0	***1,026***	194	461	--	3	***658***
	WB	--	66	226	1	***293***	--	188	138	0	***326***

V. Crash Trend Analysis

SHA provided crash data reported during a three year period from January 1, 2007 to December 31, 2011 for Goldsboro Road between MacArthur Boulevard and River Road. A summary of the data is shown in **Table 4**.

Table 4
Reported Crash Summary (2007-2011)
Goldsboro Road between MacArthur Boulevard and River Road

Year	Light		Severity			Surface		Collision Type								Driver		Time		Day		Total
	Day	Night	Property	Injury	Fatal	Wet	Dry	Opposite Direction	Rear-End	Sideswipe	Angle	Left-turn	Fixed-object	Ped/Bike	Other	Non-Alcohol	Alcohol	Weekday Peak*	Off-Peak	Weekday	Weekend	
2007	5	2	5	2	0	1	6	0	2	1	2	0	2	0	0	5	2	3	4	6	1	7
2008	3	1	4	0	0	2	2	1	0	0	2	0	1	0	0	4	0	3	1	3	1	4
2009	2	0	0	2	0	0	2	0	2	0	0	0	0	0	0	2	0	0	2	2	0	2
2010	5	0	4	1	0	2	3	1	0	1	0	1	1	0	1	5	0	2	3	4	1	5
2011	3	1	3	1	0	1	3	0	1	0	0	1	2	0	0	4	0	3	1	4	0	4
Total	18	4	16	6	0	6	16	2	5	2	4	2	6	0	1	20	2	11	11	19	3	22

*Peak period defined as 6:00 AM – 9:00 AM and 3:00 – 7:00 PM on weekdays only.

Analysis of the crash data for this segment of Goldsboro Road revealed the following trends during the five-year period from 2007 through 2011:

- There were no crashes involving pedestrians or bicyclists reported during the study period.
- Twenty-two (22) crashes were reported along Goldsboro Road between MacArthur Boulevard and River Road during the study period.
- None of the reported crashes resulted in a fatality.
- Eighteen percent (18%) of the crashes reported during the study period occurred at night.
- Run-off-the-road (ROR) / Hit-fixed-object (HFO) crashes were the predominant collision type resulting in twenty-seven (27%) of the total crashes. Rear end crashes resulted in twenty-three percent (23%) of the total crashes.
- The most common causes of crashes reported were "failure to give full attention" (5 crashes), and "failure to yield right-of-way" (3 crashes).
- Thirty-six percent (36%) of the crashes occurred during the peak periods.
- Twenty-seven percent (27%) of the crashes resulted in an injury.
- Twenty-seven percent (27%) of the crashes occurred on wet pavement surfaces.
- The month with the highest number of reported crashes was November (5 crashes).

SHA also provided crash data reported during a three year period from January 1, 2008 to December 31, 2012 for MacArthur Boulevard from south/east of Goldsboro Road to Oxford Road. A summary of the data is shown in **Table 5**.

Table 5
Reported Crash Summary (2008-2012)
MacArthur Boulevard from south/east of Goldsboro Road to Oxford Road

Year	Light		Severity			Surface		Collision Type								Driver		Time		Day		Total
	Day	Night	Property	Injury	Fatal	Wet	Dry	Opposite Direction	Rear-End	Sideswipe	Angle*	Left-turn	Fixed-object	Ped/Bike*	Other	Non-Alcohol	Alcohol	Weekday Peak**	Off-Peak	Weekday	Weekend	
2008	0	1	1	0	0	1	0	0	0	0	0	0	1	0	0	1	0	1	0	0	1	1
2009	2	0	2	0	0	1	1	0	0	0	2	0	0	0	0	2	0	0	2	1	1	2
2010	1	0	0	1	0	0	1	0	0	0	0	0	0	1	0	1	0	0	1	0	1	1
2011	2	0	1	1	0	1	1	0	0	0	2	0	0	0	0	2	0	0	2	2	0	2
2012	2	0	1	1	0	0	2	0	0	0	1	0	0	1	0	2	0	2	0	2	0	2
Total	7	1	5	3	0	3	5	0	0	0	5	0	1	2	0	8	0	3	5	5	3	8

* According to supplemental information provided by SHA, one (1) of the Angle crashes shown above in 2011 actually involved a vehicle and four (4) bicyclists, and the ped/bike crashes shown above in 2010 and 2012 each involved a vehicle and one (1) bicyclist.

**Peak period defined as 6:00 AM – 9:00 AM and 3:00 – 7:00 PM on weekdays only.

Analysis of the crash data for this segment of MacArthur Boulevard showed the following trends during the five-year period from 2008 through 2012:

- There were three (3) crashes involving vehicles striking bicyclists.
  - One occurred at the northwest part of the traffic circle in 2010.
  - One occurred along the south side of the traffic circle in 2012.

  - One occurred in 2011 along MacArthur Boulevard west of the traffic circle, at the shopping center entrance; this crash involved four (4) cyclists who were injured.
- Aside from the bicycle-involved crashes, the most common crash type was the angle crash.
- Most crashes occurred during off-peak daytime hours on weekdays under dry pavement conditions.
- Only the three (3) bicycle-involved crashes resulted in injuries; the remaining 5 crashes were property damage only.

VI. Conclusions and Recommendations

The following conclusions and recommendations were developed based on the data and analysis results presented in this report:

- The field observations conducted during pleasant weather on a Friday and Saturday in April showed very high pedestrian and bicyclist volumes along MacArthur Boulevard at the Goldsboro Road intersection.
  - The high pedestrian and bicycle usage (and the observed bicycle race) along MacArthur Boulevard indicate that this is a popular destination/facility for these activities; therefore, providing improved facilities along Goldsboro Road for pedestrians and bicyclists may significantly increase the number of pedestrians and bicyclists that would use Goldsboro Road to access MacArthur Boulevard.
- The lack of continuous paved shoulders or continuous sidewalks along either side of Goldsboro Road, combined with a curvy horizontal geometry, is potentially hazardous for pedestrians. Therefore, the installation of a continuous shoulder of consistent width, or a sidewalk, along at least one entire side of Goldsboro Road is recommended.
- The presence of bus stops near the River Road intersection and the Massachusetts Avenue intersection attracts pedestrian trips.
  - The installation of pedestrian signal heads and addition of pushbutton-actuated pedestrian phasing with walk, flashing don't walk and don't walk intervals is recommended at both signalized intersections.
  - The installation of crosswalks is recommended at the River Road intersection to accompany the recommended pedestrian signal heads, along with hatched crosswalks across the channelized right-turn lanes, with the appropriate pedestrian crossing signing per Maryland Manual on Uniform Traffic Control Devices (Md-MUTCD) standards.
- Marked crosswalks are recommended at the MacArthur Boulevard/Goldsboro Road traffic circle. Some observations are summarized below:
  - The east leg has a lower traffic volume than the west leg of this traffic circle during both the AM and PM peak hours.
  - Field observations on a Friday and Saturday in April showed that most pedestrians (60%) cross MacArthur Boulevard across the east leg, vs. only 40% across the west leg.
  - Crosswalks would improve access to the attractions at Glen Echo Park, which are located approximately 600 feet east of the traffic circle.

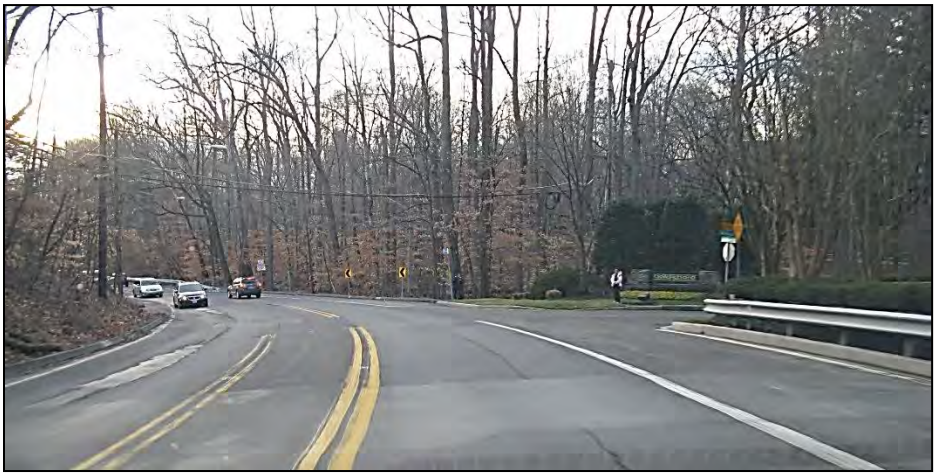
  - Crosswalks would improve access to the existing bus stop along the south side of MacArthur Boulevard in the traffic circle.
  - Since traffic along MacArthur Boulevard is not required to yield or stop upon entering the traffic circle, the recommended marked crosswalks would require the appropriate pedestrian crossing signing, including advance signing facing traffic approaching the crosswalks from the east and the west, adhering to Md-MUTCD standards for size and placement.
- Improved pedestrian access is recommended for the bus stop adjacent to the gas station along Goldsboro Road. Consider re-evaluating the type of traffic control at the Goldsboro Road/MacArthur Boulevard traffic circle to make this intersection perform like an actual roundabout, if available sight distance permits it.

Appendix A:
Photos Along Goldsboro Road

#1: Looking north along MD 614 (Goldsboro Road) toward Goldleaf Drive (on left). Note the sidewalk on the northbound side. (January)

#2: Looking east along MacArthur Boulevard toward Goldsboro Road. Traffic volumes are highest on this leg of the traffic circle. (January)

#3: Looking west along MacArthur Boulevard toward Goldsboro Road. The recommended location for a marked crosswalk is across this leg of the traffic circle. (January)



#4: Looking south along Goldsboro Road at Goldleaf Drive. Several pedestrians are waiting near the bus stop here. (January)

#5: A family walking with bicycles along Goldsboro Road (April)

#6: A man with a child in a bike trailer riding along Goldsboro Road near Massachusetts Ave (April)

#7: Several cyclists riding along Goldsboro Road (April)

#8: A woman carrying a dog, walking with a child (behind her) along Goldsboro Road near Redwing Road (April)

#9: A platoon of cyclists riding north along Goldsboro Road (April)

#10: A school bus stopping to pick up passengers in the morning along Goldsboro Road (April)

#11: Cyclists riding on MacArthur Boulevard at Goldsboro Road (April)

#12: A pedestrian crossing MacArthur Boulevard east of the traffic circle at Goldsboro Road (April)

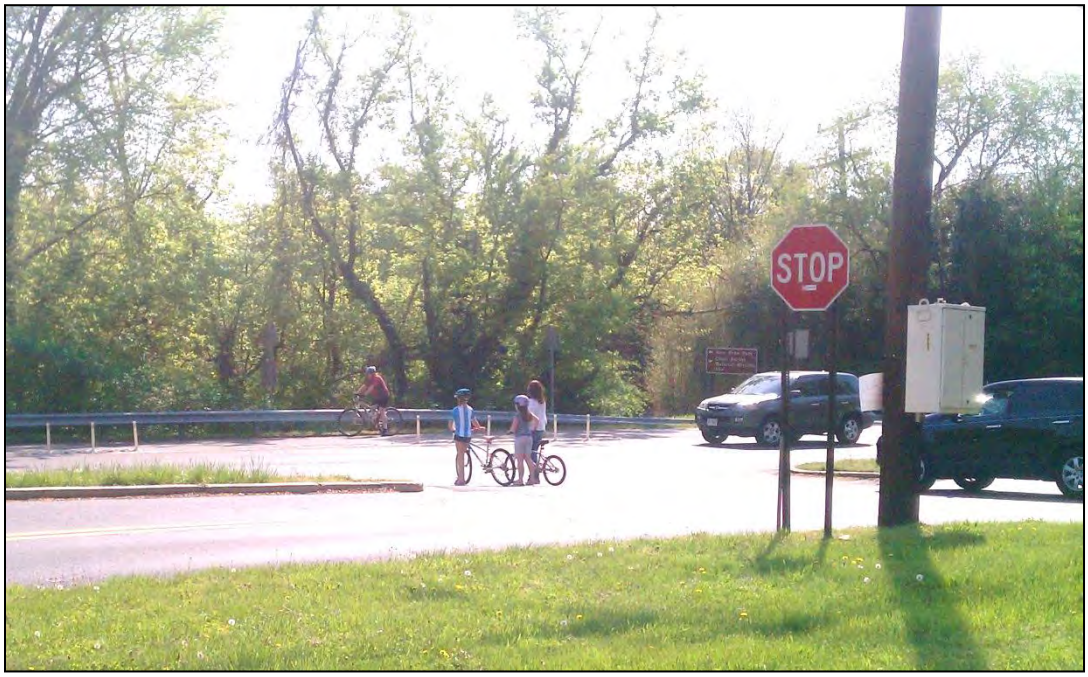
#13: Bicycle race participants along MacArthur Boulevard passing through the traffic circle at Goldsboro Road. A traffic control officer is present. The road remained open to vehicular traffic. (April)

#14: Cyclists riding south from Goldsboro Road onto MacArthur Boulevard (April)

#15: A pedestrian crossing MacArthur Boulevard east of the traffic circle at Goldsboro Road (April)

#16: A pedestrian crossing MacArthur Boulevard east of the traffic circle at Goldsboro Road (April)

#17: A pedestrian crossing MacArthur Boulevard east of Oxford Road (April)



#18: A family with bicycles crossing MacArthur Boulevard east of Oxford Road (April)

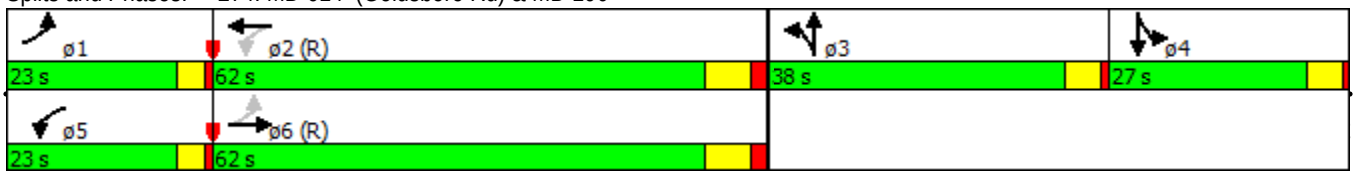
Appendix B:
Synchro Reports

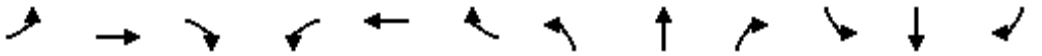
Existing 2013 Conditions

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	317	1626	497	38	868	60	223	305	143	121	186	150
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	0.91	0.91	1.00	0.91	0.91	1.00
Ped Bike Factor												
Frt			0.850			0.850			0.850			0.850
Flt Protected	0.950			0.950			0.950	0.991		0.950	0.995	
Satd. Flow (prot)	1770	3539	1583	1770	3539	1583	1610	3360	1583	1610	3373	1583
Flt Permitted	0.184			0.062			0.950	0.991		0.950	0.995	
Satd. Flow (perm)	343	3539	1583	115	3539	1583	1610	3360	1583	1610	3373	1583
Satd. Flow (RTOR)			153			131			147			155
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Adj. Flow (vph)	327	1676	512	39	895	62	230	314	147	125	192	155
Shared Lane Traffic (%)							32%			18%		
Lane Group Flow (vph)	327	1676	512	39	895	62	156	388	147	102	215	155
Turn Type	pm+pt	NA	Free	pm+pt	NA	Free	Split	NA	Free	Split	NA	Free
Protected Phases	1	6		5	2		3	3		4	4	
Permitted Phases	6		Free	2		Free			Free			Free
Total Split (s)	23.0	62.0		23.0	62.0		38.0	38.0		27.0	27.0	
Total Lost Time (s)	4.0	5.0		4.0	5.0		4.0	4.0		4.0	4.0	
Act Effct Green (s)	95.6	85.7	150.0	74.0	66.2	150.0	25.1	25.1	150.0	17.2	17.2	150.0
Actuated g/C Ratio	0.64	0.57	1.00	0.49	0.44	1.00	0.17	0.17	1.00	0.11	0.11	1.00
v/c Ratio	0.73	0.83	0.32	0.30	0.57	0.04	0.58	0.69	0.09	0.55	0.56	0.10
Control Delay	26.7	32.6	0.5	21.3	34.8	0.1	65.7	65.0	0.1	73.5	67.8	0.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	26.7	32.6	0.5	21.3	34.8	0.1	65.7	65.0	0.1	73.5	67.8	0.1
LOS	C	C	A	C	C	A	E	E	A	E	E	A
Approach Delay		25.3			32.1			51.4			46.8	
Approach LOS		C			C			D			D	

Intersection Summary	
Cycle Length: 150	
Actuated Cycle Length: 150	
Offset: 46 (31%), Referenced to phase 2:WBTL and 6:EBTL, Start of Green	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.83	
Intersection Signal Delay: 32.8	Intersection LOS: C
Intersection Capacity Utilization 78.2%	ICU Level of Service D
Analysis Period (min) 15	

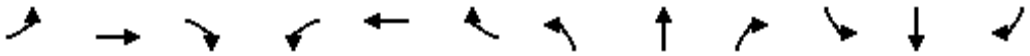
Splits and Phases: 274: MD 614 (Goldsboro Rd) & MD 190





Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	317	1626	497	38	868	60	223	305	143	121	186	150
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	5.0	4.0	4.0	5.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	0.91	0.91	1.00	0.91	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.99	1.00	0.95	0.99	1.00
Satd. Flow (prot)	1770	3539	1583	1770	3539	1583	1610	3358	1583	1610	3372	1583
Flt Permitted	0.18	1.00	1.00	0.06	1.00	1.00	0.95	0.99	1.00	0.95	0.99	1.00
Satd. Flow (perm)	343	3539	1583	116	3539	1583	1610	3358	1583	1610	3372	1583
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	327	1676	512	39	895	62	230	314	147	125	192	155
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	327	1676	512	39	895	62	156	388	147	102	215	155
Turn Type	pm+pt	NA	Free	pm+pt	NA	Free	Split	NA	Free	Split	NA	Free
Protected Phases	1	6		5	2		3	3		4	4	
Permitted Phases	6		Free	2		Free			Free			Free
Actuated Green, G (s)	92.7	83.0	150.0	69.9	64.2	150.0	24.1	24.1	150.0	16.2	16.2	150.0
Effective Green, g (s)	92.7	85.0	150.0	69.9	66.2	150.0	25.1	25.1	150.0	17.2	17.2	150.0
Actuated g/C Ratio	0.62	0.57	1.00	0.47	0.44	1.00	0.17	0.17	1.00	0.11	0.11	1.00
Clearance Time (s)	4.0	7.0		4.0	7.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)	445	2005	1583	116	1561	1583	269	561	1583	184	386	1583
v/s Ratio Prot	c0.12	c0.47		0.01	0.25		0.10	c0.12		0.06	c0.06	
v/s Ratio Perm	0.33		0.32	0.14		0.04			0.09			0.10
v/c Ratio	0.73	0.84	0.32	0.34	0.57	0.04	0.58	0.69	0.09	0.55	0.56	0.10
Uniform Delay, d1	19.6	26.8	0.0	27.6	31.3	0.0	57.6	58.8	0.0	62.8	62.8	0.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	6.2	4.3	0.5	1.7	1.5	0.0	3.6	4.0	0.1	4.4	2.1	0.1
Delay (s)	25.8	31.1	0.5	29.3	32.9	0.0	61.2	62.8	0.1	67.2	64.9	0.1
Level of Service	C	C	A	C	C	A	E	E	A	E	E	A
Approach Delay (s)		24.2			30.7			49.1			44.1	
Approach LOS		C			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	31.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	78.2%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	327	1676	512	39	895	62	156	388	147	102	215	155
v/c Ratio	0.73	0.83	0.32	0.30	0.57	0.04	0.58	0.69	0.09	0.55	0.56	0.10
Control Delay	26.7	32.6	0.5	21.3	34.8	0.1	65.7	65.0	0.1	73.5	67.8	0.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	26.7	32.6	0.5	21.3	34.8	0.1	65.7	65.0	0.1	73.5	67.8	0.1
Queue Length 50th (ft)	134	695	0	13	349	0	156	198	0	105	111	0
Queue Length 95th (ft)	#309	#1037	0	35	456	0	231	247	0	170	152	0
Internal Link Dist (ft)		320			770			920			920	
Turn Bay Length (ft)	250		250	250		250	250		250	350		350
Base Capacity (vph)	451	2022	1583	275	1560	1583	364	761	1583	246	517	1583
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.73	0.83	0.32	0.14	0.57	0.04	0.43	0.51	0.09	0.41	0.42	0.10

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Lanes, Volumes, Timings
Goldsboro Road (MD 614) @ River Road (MD 190)

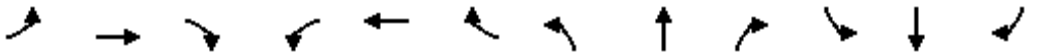
2013 Existing Phasing
PM Peak

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	238	925	294	150	1469	123	453	312	109	113	387	282
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	0.91	0.91	1.00	0.91	0.91	1.00
Ped Bike Factor												
Frt			0.850			0.850			0.850			0.850
Flt Protected	0.950			0.950			0.950	0.979		0.950		
Satd. Flow (prot)	1770	3539	1583	1770	3539	1583	1610	3319	1583	1610	3390	1583
Flt Permitted	0.057			0.229			0.950	0.979		0.950		
Satd. Flow (perm)	106	3539	1583	427	3539	1583	1610	3319	1583	1610	3390	1583
Satd. Flow (RTOR)			159			131			131			291
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Adj. Flow (vph)	245	954	303	155	1514	127	467	322	112	116	399	291
Shared Lane Traffic (%)							50%			0%		
Lane Group Flow (vph)	245	954	303	155	1514	127	233	556	112	116	399	291
Turn Type	pm+pt	NA	Free	pm+pt	NA	Free	Split	NA	Free	Split	NA	Free
Protected Phases	1	6		5	2		3	3		4	4	
Permitted Phases	6		Free	2		Free			Free			Free
Total Split (s)	25.0	71.0		25.0	71.0		33.0	33.0		21.0	21.0	
Total Lost Time (s)	4.0	5.0		4.0	5.0		4.0	4.0		4.0	4.0	
Act Effct Green (s)	92.0	75.9	150.0	79.8	67.7	150.0	28.6	28.6	150.0	17.4	17.4	150.0
Actuated g/C Ratio	0.61	0.51	1.00	0.53	0.45	1.00	0.19	0.19	1.00	0.12	0.12	1.00
v/c Ratio	0.88	0.53	0.19	0.48	0.95	0.08	0.76	0.88	0.07	0.62	1.02	0.18
Control Delay	72.6	26.7	0.3	18.2	52.9	0.1	74.1	75.0	0.1	78.9	113.4	0.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	72.6	26.7	0.3	18.2	52.9	0.1	74.1	75.0	0.1	78.9	113.4	0.3
LOS	E	C	A	B	D	A	E	E	A	E	F	A
Approach Delay		28.9			46.1			65.4			67.6	
Approach LOS		C			D			E			E	

Intersection Summary

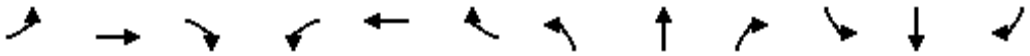
Cycle Length: 150
Actuated Cycle Length: 150
Offset: 82 (55%), Referenced to phase 2:WBTL and 6:EBTL, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.02
Intersection Signal Delay: 47.9 — Intersection LOS: D
Intersection Capacity Utilization 93.2% — ICU Level of Service F
Analysis Period (min) 15

Splits and Phases: 274: MD 614 (Goldsboro Rd) & MD 190



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	238	925	294	150	1469	123	453	312	109	113	387	282
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	5.0	4.0	4.0	5.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	0.91	0.91	1.00	0.91	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.98	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	3539	1583	1770	3539	1583	1610	3320	1583	1610	3390	1583
Flt Permitted	0.06	1.00	1.00	0.23	1.00	1.00	0.95	0.98	1.00	0.95	1.00	1.00
Satd. Flow (perm)	107	3539	1583	427	3539	1583	1610	3320	1583	1610	3390	1583
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	245	954	303	155	1514	127	467	322	112	116	399	291
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	245	954	303	155	1514	127	233	556	112	116	399	291
Turn Type	pm+pt	NA	Free	pm+pt	NA	Free	Split	NA	Free	Split	NA	Free
Protected Phases	1	6		5	2		3	3		4	4	
Permitted Phases	6		Free	2		Free			Free			Free
Actuated Green, G (s)	89.0	73.9	150.0	76.8	65.7	150.0	27.6	27.6	150.0	16.4	16.4	150.0
Effective Green, g (s)	89.0	75.9	150.0	76.8	67.7	150.0	28.6	28.6	150.0	17.4	17.4	150.0
Actuated g/C Ratio	0.59	0.51	1.00	0.51	0.45	1.00	0.19	0.19	1.00	0.12	0.12	1.00
Clearance Time (s)	4.0	7.0		4.0	7.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)	277	1790	1583	318	1597	1583	306	633	1583	186	393	1583
v/s Ratio Prot	c0.11	0.27		0.04	c0.43		0.14	c0.17		0.07	c0.12	
v/s Ratio Perm	0.41		0.19	0.21		0.08			0.07			0.18
v/c Ratio	0.88	0.53	0.19	0.49	0.95	0.08	0.76	0.88	0.07	0.62	1.02	0.18
Uniform Delay, d1	49.4	25.1	0.0	20.7	39.5	0.0	57.5	59.0	0.0	63.2	66.3	0.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	26.6	1.1	0.3	1.2	13.2	0.1	11.3	13.5	0.1	7.2	49.3	0.3
Delay (s)	76.0	26.2	0.3	21.9	52.6	0.1	68.8	72.5	0.1	70.4	115.6	0.3
Level of Service	E	C	A	C	D	A	E	E	A	E	F	A
Approach Delay (s)		29.1			46.3			62.5			67.5	
Approach LOS		C			D			E			E	

Intersection Summary			
HCM 2000 Control Delay	47.4	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	93.2%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	245	954	303	155	1514	127	233	556	112	116	399	291
v/c Ratio	0.88	0.53	0.19	0.48	0.95	0.08	0.76	0.88	0.07	0.62	1.02	0.18
Control Delay	72.6	26.7	0.3	18.2	52.9	0.1	74.1	75.0	0.1	78.9	113.4	0.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	72.6	26.7	0.3	18.2	52.9	0.1	74.1	75.0	0.1	78.9	113.4	0.3
Queue Length 50th (ft)	182	324	0	61	754	0	239	292	0	120	~230	0
Queue Length 95th (ft)	#324	406	0	95	#925	0	#365	#390	0	#201	#347	0
Internal Link Dist (ft)		320			770			920			920	
Turn Bay Length (ft)	250		250	250		250	250		250	350		350
Base Capacity (vph)	297	1791	1583	441	1597	1583	311	641	1583	186	393	1583
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.82	0.53	0.19	0.35	0.95	0.08	0.75	0.87	0.07	0.62	1.02	0.18

Intersection Summary

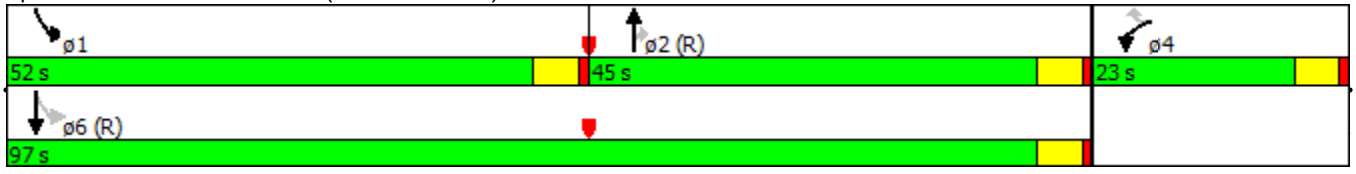
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	219	374	452	421	464	223
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor				0.98	1.00	
Frt		0.850		0.850		
Flt Protected	0.950				0.950	
Satd. Flow (prot)	1770	1583	1827	1583	1770	1827
Flt Permitted	0.950				0.342	
Satd. Flow (perm)	1770	1583	1827	1549	637	1827
Satd. Flow (RTOR)		390		336		
Confl. Peds. (#/hr)				1	1	
Confl. Bikes (#/hr)						
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	4%	2%	2%	4%
Bus Blockages (#/hr)	0	0	0	0	0	0
Parking (#/hr)						
Mid-Block Traffic (%)	0%		0%			0%
Adj. Flow (vph)	228	390	471	439	483	232
Shared Lane Traffic (%)						
Lane Group Flow (vph)	228	390	471	439	483	232
Turn Type	NA	Perm	NA	Perm	pm+pt	NA
Protected Phases	4		2		1	6
Permitted Phases		4		2	6	
Total Split (s)	23.0	23.0	45.0	45.0	52.0	97.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Act Effct Green (s)	17.6	17.6	62.1	62.1	92.4	92.4
Actuated g/C Ratio	0.15	0.15	0.52	0.52	0.77	0.77
v/c Ratio	0.88	0.69	0.50	0.46	0.66	0.17
Control Delay	82.3	11.6	23.5	7.0	9.3	4.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	82.3	11.6	23.5	7.0	9.3	4.0
LOS	F	B	C	A	A	A
Approach Delay	37.7		15.5			7.5
Approach LOS	D		B			A

Intersection Summary	
Cycle Length: 120	
Actuated Cycle Length: 120	
Offset: 14 (12%), Referenced to phase 2:NBT and 6:SBTL, Start of Green	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.88	
Intersection Signal Delay: 19.1	Intersection LOS: B
Intersection Capacity Utilization 74.1%	ICU Level of Service D
Analysis Period (min) 15	

Splits and Phases: 2: MD 614 (Goldsboro Road) & MD 396



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	219	374	452	421	464	223
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00	0.98	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	1827	1550	1769	1827
Flt Permitted	0.95	1.00	1.00	1.00	0.34	1.00
Satd. Flow (perm)	1770	1583	1827	1550	638	1827
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	228	390	471	439	483	232
RTOR Reduction (vph)	0	333	0	162	0	0
Lane Group Flow (vph)	228	57	471	277	483	232
Confl. Peds. (#/hr)				1	1	
Heavy Vehicles (%)	2%	2%	4%	2%	2%	4%
Turn Type	NA	Perm	NA	Perm	pm+pt	NA
Protected Phases	4		2		1	6
Permitted Phases		4		2	6	
Actuated Green, G (s)	17.6	17.6	62.1	62.1	92.4	92.4
Effective Green, g (s)	17.6	17.6	62.1	62.1	92.4	92.4
Actuated g/C Ratio	0.15	0.15	0.52	0.52	0.77	0.77
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	4.0	4.0	6.0	6.0	4.0	6.0
Lane Grp Cap (vph)	259	232	945	802	729	1406
v/s Ratio Prot	c0.13		0.26		c0.14	0.13
v/s Ratio Perm		0.04		0.18	c0.37	
v/c Ratio	0.88	0.25	0.50	0.35	0.66	0.17
Uniform Delay, d1	50.2	45.3	18.8	17.0	8.1	3.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	28.0	0.8	1.9	1.2	2.5	0.3
Delay (s)	78.2	46.1	20.7	18.2	10.6	3.9
Level of Service	E	D	C	B	B	A
Approach Delay (s)	57.9		19.5			8.4
Approach LOS	E		B			A

Intersection Summary			
HCM 2000 Control Delay	26.5	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	74.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	228	390	471	439	483	232
v/c Ratio	0.88	0.69	0.50	0.46	0.66	0.17
Control Delay	82.3	11.6	23.5	7.0	9.3	4.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	82.3	11.6	23.5	7.0	9.3	4.0
Queue Length 50th (ft)	174	0	229	40	102	41
Queue Length 95th (ft)	#315	95	408	142	143	62
Internal Link Dist (ft)	913		769			937
Turn Bay Length (ft)		200		175	200	
Base Capacity (vph)	265	568	945	963	934	1406
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.86	0.69	0.50	0.46	0.52	0.17

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	292	535	275	201	374	439
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor				0.98	1.00	
Frt		0.850		0.850		
Flt Protected	0.950				0.950	
Satd. Flow (prot)	1770	1583	1827	1553	1736	1827
Flt Permitted	0.950				0.490	
Satd. Flow (perm)	1770	1583	1827	1520	895	1827
Satd. Flow (RTOR)		563		212		
Confl. Peds. (#/hr)				1	1	
Confl. Bikes (#/hr)						
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	4%	4%	4%	4%
Bus Blockages (#/hr)	0	0	0	0	0	0
Parking (#/hr)						
Mid-Block Traffic (%)	0%		0%			0%
Adj. Flow (vph)	307	563	289	212	394	462
Shared Lane Traffic (%)						
Lane Group Flow (vph)	307	563	289	212	394	462
Turn Type	NA	Perm	NA	Perm	pm+pt	NA
Protected Phases	4		2		1	6
Permitted Phases		4		2	6	
Total Split (s)	32.0	32.0	49.0	49.0	39.0	88.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Act Effct Green (s)	26.3	26.3	63.5	63.5	85.7	85.7
Actuated g/C Ratio	0.22	0.22	0.53	0.53	0.71	0.71
v/c Ratio	0.79	0.72	0.30	0.23	0.51	0.35
Control Delay	59.5	8.9	18.2	3.0	9.2	7.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	59.5	8.9	18.2	3.0	9.2	7.8
LOS	E	A	B	A	A	A
Approach Delay	26.8		11.8			8.4
Approach LOS	C		B			A

Intersection Summary	
Cycle Length: 120	
Actuated Cycle Length: 120	
Offset: 14 (12%), Referenced to phase 2:NBT and 6:SBTL, Start of Green	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.79	
Intersection Signal Delay: 16.4	Intersection LOS: B
Intersection Capacity Utilization 61.4%	ICU Level of Service B
Analysis Period (min) 15	

Splits and Phases: 2: MD 614 (Goldsboro Road) & MD 396

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	292	535	275	201	374	439
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00	0.98	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	1827	1520	1735	1827
Flt Permitted	0.95	1.00	1.00	1.00	0.49	1.00
Satd. Flow (perm)	1770	1583	1827	1520	894	1827
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	307	563	289	212	394	462
RTOR Reduction (vph)	0	440	0	100	0	0
Lane Group Flow (vph)	307	123	289	112	394	462
Confl. Peds. (#/hr)				1	1	
Heavy Vehicles (%)	2%	2%	4%	4%	4%	4%
Turn Type	NA	Perm	NA	Perm	pm+pt	NA
Protected Phases	4		2		1	6
Permitted Phases		4		2	6	
Actuated Green, G (s)	26.3	26.3	63.5	63.5	85.7	85.7
Effective Green, g (s)	26.3	26.3	63.5	63.5	85.7	85.7
Actuated g/C Ratio	0.22	0.22	0.53	0.53	0.71	0.71
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lane Grp Cap (vph)	387	346	966	804	766	1304
v/s Ratio Prot	c0.17		0.16		c0.08	0.25
v/s Ratio Perm		0.08		0.07	c0.29	
v/c Ratio	0.79	0.36	0.30	0.14	0.51	0.35
Uniform Delay, d1	44.3	39.7	15.8	14.4	7.1	6.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	12.2	1.3	0.8	0.4	1.2	0.8
Delay (s)	56.4	41.0	16.6	14.7	8.3	7.3
Level of Service	E	D	B	B	A	A
Approach Delay (s)	46.4		15.8			7.8
Approach LOS	D		B			A

Intersection Summary			
HCM 2000 Control Delay	24.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	61.4%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	307	563	289	212	394	462
v/c Ratio	0.79	0.72	0.30	0.23	0.51	0.35
Control Delay	59.5	8.9	18.2	3.0	9.2	7.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	59.5	8.9	18.2	3.0	9.2	7.8
Queue Length 50th (ft)	222	0	124	0	106	129
Queue Length 95th (ft)	#334	104	207	42	153	182
Internal Link Dist (ft)	913		769			937
Turn Bay Length (ft)		200		175	200	
Base Capacity (vph)	413	801	966	904	884	1304
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.74	0.70	0.30	0.23	0.45	0.35

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Year 2013 Conditions with Pedestrian Signals & Timing

Lanes, Volumes, Timings
Goldsboro Road (MD 614) @ River Road (MD 190)

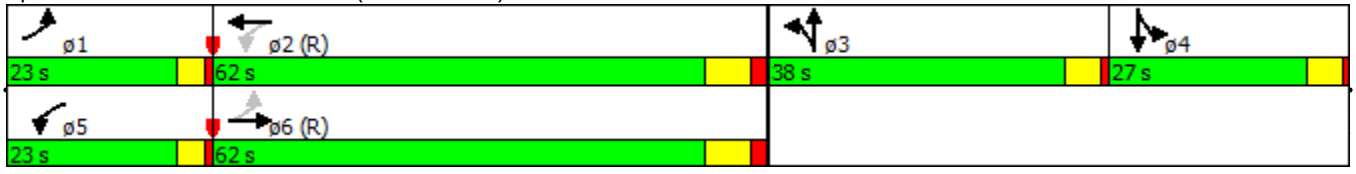
2013 Proposed
AM Peak

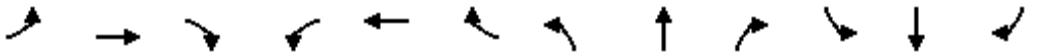
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	317	1626	497	38	868	60	223	305	143	121	186	150
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	0.91	0.91	1.00	0.91	0.91	1.00
Ped Bike Factor												
Frt			0.850			0.850			0.850			0.850
Flt Protected	0.950			0.950			0.950	0.991		0.950	0.995	
Satd. Flow (prot)	1770	3539	1583	1770	3539	1583	1610	3360	1583	1610	3373	1583
Flt Permitted	0.184			0.062			0.950	0.991		0.950	0.995	
Satd. Flow (perm)	343	3539	1583	115	3539	1583	1610	3360	1583	1610	3373	1583
Satd. Flow (RTOR)			153			131			147			155
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Adj. Flow (vph)	327	1676	512	39	895	62	230	314	147	125	192	155
Shared Lane Traffic (%)							32%			18%		
Lane Group Flow (vph)	327	1676	512	39	895	62	156	388	147	102	215	155
Turn Type	pm+pt	NA	Free	pm+pt	NA	Free	Split	NA	Free	Split	NA	Free
Protected Phases	1	6		5	2		3	3		4	4	
Permitted Phases	6		Free	2		Free			Free			Free
Total Split (s)	23.0	62.0		23.0	62.0		38.0	38.0		27.0	27.0	
Total Lost Time (s)	4.0	5.0		4.0	5.0		4.0	4.0		4.0	4.0	
Act Effct Green (s)	95.6	85.7	150.0	74.0	66.2	150.0	25.1	25.1	150.0	17.2	17.2	150.0
Actuated g/C Ratio	0.64	0.57	1.00	0.49	0.44	1.00	0.17	0.17	1.00	0.11	0.11	1.00
v/c Ratio	0.73	0.83	0.32	0.30	0.57	0.04	0.58	0.69	0.09	0.55	0.56	0.10
Control Delay	26.7	32.6	0.5	21.3	34.8	0.1	65.7	65.0	0.1	73.5	67.8	0.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	26.7	32.6	0.5	21.3	34.8	0.1	65.7	65.0	0.1	73.5	67.8	0.1
LOS	C	C	A	C	C	A	E	E	A	E	E	A
Approach Delay		25.3			32.1			51.4			46.8	
Approach LOS		C			C			D			D	

Intersection Summary

Cycle Length: 150
Actuated Cycle Length: 150
Offset: 46 (31%), Referenced to phase 2:WBTL and 6:EBTL, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.83
Intersection Signal Delay: 32.8 — Intersection LOS: C
Intersection Capacity Utilization 78.2% — ICU Level of Service D
Analysis Period (min) 15

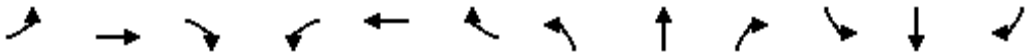
Splits and Phases: 274: MD 614 (Goldsboro Rd) & MD 190





Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	317	1626	497	38	868	60	223	305	143	121	186	150
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	5.0	4.0	4.0	5.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	0.91	0.91	1.00	0.91	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.99	1.00	0.95	0.99	1.00
Satd. Flow (prot)	1770	3539	1583	1770	3539	1583	1610	3358	1583	1610	3372	1583
Flt Permitted	0.18	1.00	1.00	0.06	1.00	1.00	0.95	0.99	1.00	0.95	0.99	1.00
Satd. Flow (perm)	343	3539	1583	116	3539	1583	1610	3358	1583	1610	3372	1583
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	327	1676	512	39	895	62	230	314	147	125	192	155
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	327	1676	512	39	895	62	156	388	147	102	215	155
Turn Type	pm+pt	NA	Free	pm+pt	NA	Free	Split	NA	Free	Split	NA	Free
Protected Phases	1	6		5	2		3	3		4	4	
Permitted Phases	6		Free	2		Free			Free			Free
Actuated Green, G (s)	92.7	83.0	150.0	69.9	64.2	150.0	24.1	24.1	150.0	16.2	16.2	150.0
Effective Green, g (s)	92.7	85.0	150.0	69.9	66.2	150.0	25.1	25.1	150.0	17.2	17.2	150.0
Actuated g/C Ratio	0.62	0.57	1.00	0.47	0.44	1.00	0.17	0.17	1.00	0.11	0.11	1.00
Clearance Time (s)	4.0	7.0		4.0	7.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)	445	2005	1583	116	1561	1583	269	561	1583	184	386	1583
v/s Ratio Prot	c0.12	c0.47		0.01	0.25		0.10	c0.12		0.06	c0.06	
v/s Ratio Perm	0.33		0.32	0.14		0.04			0.09			0.10
v/c Ratio	0.73	0.84	0.32	0.34	0.57	0.04	0.58	0.69	0.09	0.55	0.56	0.10
Uniform Delay, d1	19.6	26.8	0.0	27.6	31.3	0.0	57.6	58.8	0.0	62.8	62.8	0.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	6.2	4.3	0.5	1.7	1.5	0.0	3.6	4.0	0.1	4.4	2.1	0.1
Delay (s)	25.8	31.1	0.5	29.3	32.9	0.0	61.2	62.8	0.1	67.2	64.9	0.1
Level of Service	C	C	A	C	C	A	E	E	A	E	E	A
Approach Delay (s)		24.2			30.7			49.1			44.1	
Approach LOS		C			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	31.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	78.2%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	327	1676	512	39	895	62	156	388	147	102	215	155
v/c Ratio	0.73	0.83	0.32	0.30	0.57	0.04	0.58	0.69	0.09	0.55	0.56	0.10
Control Delay	26.7	32.6	0.5	21.3	34.8	0.1	65.7	65.0	0.1	73.5	67.8	0.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	26.7	32.6	0.5	21.3	34.8	0.1	65.7	65.0	0.1	73.5	67.8	0.1
Queue Length 50th (ft)	134	695	0	13	349	0	156	198	0	105	111	0
Queue Length 95th (ft)	#309	#1037	0	35	456	0	231	247	0	170	152	0
Internal Link Dist (ft)		320			770			920			920	
Turn Bay Length (ft)	250		250	250		250	250		250	350		350
Base Capacity (vph)	451	2022	1583	275	1560	1583	364	761	1583	246	517	1583
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.73	0.83	0.32	0.14	0.57	0.04	0.43	0.51	0.09	0.41	0.42	0.10

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

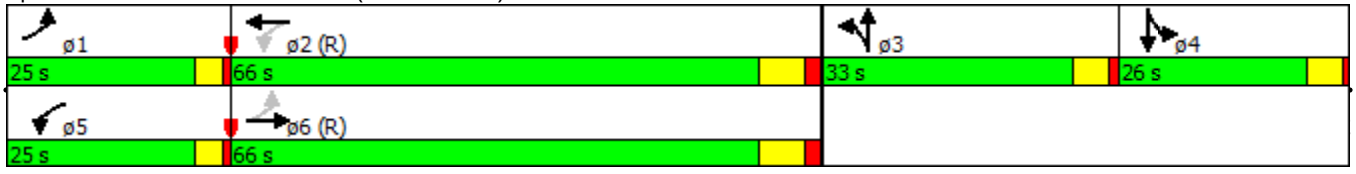
Lanes, Volumes, Timings
Goldsboro Road (MD 614) @ River Road (MD 190)

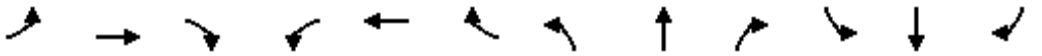
2013 Proposed
PM Peak

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	238	925	294	150	1469	123	453	312	109	113	387	282
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	0.91	0.91	1.00	0.91	0.91	1.00
Ped Bike Factor												
Frt			0.850			0.850			0.850			0.850
Flt Protected	0.950			0.950			0.950	0.979		0.950		
Satd. Flow (prot)	1770	3539	1583	1770	3539	1583	1610	3319	1583	1610	3390	1583
Flt Permitted	0.061			0.214			0.950	0.979		0.950		
Satd. Flow (perm)	114	3539	1583	399	3539	1583	1610	3319	1583	1610	3390	1583
Satd. Flow (RTOR)			159			131			131			291
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Adj. Flow (vph)	245	954	303	155	1514	127	467	322	112	116	399	291
Shared Lane Traffic (%)							50%			0%		
Lane Group Flow (vph)	245	954	303	155	1514	127	233	556	112	116	399	291
Turn Type	pm+pt	NA	Free	pm+pt	NA	Free	Split	NA	Free	Split	NA	Free
Protected Phases	1	6		5	2		3	3		4	4	
Permitted Phases	6		Free	2		Free			Free			Free
Total Split (s)	25.0	66.0		25.0	66.0		33.0	33.0		26.0	26.0	
Total Lost Time (s)	4.0	5.0		4.0	5.0		4.0	4.0		4.0	4.0	
Act Effct Green (s)	87.9	71.3	150.0	76.2	63.6	150.0	28.6	28.6	150.0	21.5	21.5	150.0
Actuated g/C Ratio	0.59	0.48	1.00	0.51	0.42	1.00	0.19	0.19	1.00	0.14	0.14	1.00
v/c Ratio	0.88	0.57	0.19	0.50	1.01	0.08	0.76	0.88	0.07	0.50	0.82	0.18
Control Delay	71.6	30.4	0.3	21.1	68.0	0.1	74.1	75.0	0.1	67.4	76.8	0.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	71.6	30.4	0.3	21.1	68.0	0.1	74.1	75.0	0.1	67.4	76.8	0.3
LOS	E	C	A	C	E	A	E	E	A	E	E	A
Approach Delay		31.1			59.1			65.4			47.8	
Approach LOS		C			E			E			D	

Intersection Summary	
Cycle Length: 150	
Actuated Cycle Length: 150	
Offset: 82 (55%), Referenced to phase 2:WBTL and 6:EBTL, Start of Green	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 1.01	
Intersection Signal Delay: 50.0	Intersection LOS: D
Intersection Capacity Utilization 93.2%	ICU Level of Service F
Analysis Period (min) 15	

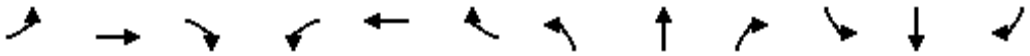
Splits and Phases: 274: MD 614 (Goldsboro Rd) & MD 190





Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	238	925	294	150	1469	123	453	312	109	113	387	282
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	5.0	4.0	4.0	5.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	0.91	0.91	1.00	0.91	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.98	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	3539	1583	1770	3539	1583	1610	3320	1583	1610	3390	1583
Flt Permitted	0.06	1.00	1.00	0.21	1.00	1.00	0.95	0.98	1.00	0.95	1.00	1.00
Satd. Flow (perm)	113	3539	1583	398	3539	1583	1610	3320	1583	1610	3390	1583
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	245	954	303	155	1514	127	467	322	112	116	399	291
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	245	954	303	155	1514	127	233	556	112	116	399	291
Turn Type	pm+pt	NA	Free	pm+pt	NA	Free	Split	NA	Free	Split	NA	Free
Protected Phases	1	6		5	2		3	3		4	4	
Permitted Phases	6		Free	2		Free			Free			Free
Actuated Green, G (s)	84.9	69.4	150.0	73.2	61.7	150.0	27.6	27.6	150.0	20.5	20.5	150.0
Effective Green, g (s)	84.9	71.4	150.0	73.2	63.7	150.0	28.6	28.6	150.0	21.5	21.5	150.0
Actuated g/C Ratio	0.57	0.48	1.00	0.49	0.42	1.00	0.19	0.19	1.00	0.14	0.14	1.00
Clearance Time (s)	4.0	7.0		4.0	7.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)	276	1684	1583	299	1502	1583	306	633	1583	230	485	1583
v/s Ratio Prot	c0.11	0.27		0.04	c0.43		0.14	c0.17		0.07	c0.12	
v/s Ratio Perm	0.39		0.19	0.21		0.08			0.07			0.18
v/c Ratio	0.89	0.57	0.19	0.52	1.01	0.08	0.76	0.88	0.07	0.50	0.82	0.18
Uniform Delay, d1	48.8	28.2	0.0	23.0	43.1	0.0	57.5	59.0	0.0	59.3	62.4	0.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	27.1	1.4	0.3	1.5	25.2	0.1	11.3	13.5	0.1	2.4	11.3	0.3
Delay (s)	75.9	29.6	0.3	24.5	68.3	0.1	68.8	72.5	0.1	61.7	73.7	0.3
Level of Service	E	C	A	C	E	A	E	E	A	E	E	A
Approach Delay (s)		31.2			59.7			62.5			45.4	
Approach LOS		C			E			E			D	

Intersection Summary			
HCM 2000 Control Delay	49.4	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	93.2%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	245	954	303	155	1514	127	233	556	112	116	399	291
v/c Ratio	0.88	0.57	0.19	0.50	1.01	0.08	0.76	0.88	0.07	0.50	0.82	0.18
Control Delay	71.6	30.4	0.3	21.1	68.0	0.1	74.1	75.0	0.1	67.4	76.8	0.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	71.6	30.4	0.3	21.1	68.0	0.1	74.1	75.0	0.1	67.4	76.8	0.3
Queue Length 50th (ft)	182	351	0	67	~847	0	239	292	0	116	210	0
Queue Length 95th (ft)	#324	438	0	105	#987	0	#365	#390	0	192	#280	0
Internal Link Dist (ft)		320			770			920			920	
Turn Bay Length (ft)	250		250	250		250	250		250	350		350
Base Capacity (vph)	298	1683	1583	418	1501	1583	311	641	1583	236	497	1583
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.82	0.57	0.19	0.37	1.01	0.08	0.75	0.87	0.07	0.49	0.80	0.18

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

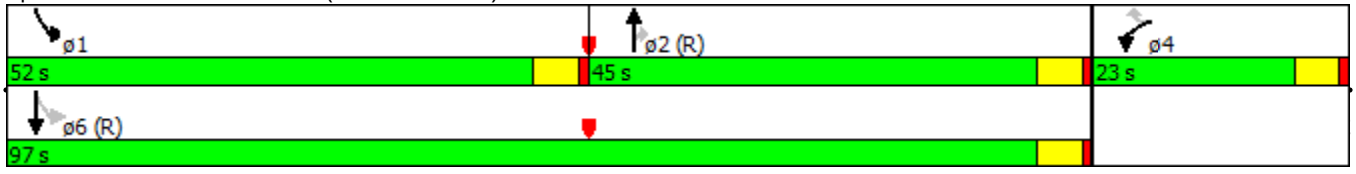
Lanes, Volumes, Timings
Goldsboro Road (MD 614) @ Massachussetts Blvd.

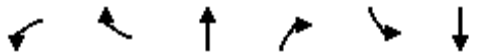
2013 Proposed
AM Peak

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	219	374	452	421	464	223
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor				0.98		
Frt		0.850		0.850		
Flt Protected	0.950				0.950	
Satd. Flow (prot)	1770	1583	1827	1583	1770	1827
Flt Permitted	0.950				0.342	
Satd. Flow (perm)	1770	1583	1827	1546	637	1827
Satd. Flow (RTOR)		390		336		
Confl. Peds. (#/hr)				1	1	
Confl. Bikes (#/hr)						
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	4%	2%	2%	4%
Bus Blockages (#/hr)	0	0	0	0	0	0
Parking (#/hr)						
Mid-Block Traffic (%)	0%		0%			0%
Adj. Flow (vph)	228	390	471	439	483	232
Shared Lane Traffic (%)						
Lane Group Flow (vph)	228	390	471	439	483	232
Turn Type	NA	Perm	NA	Perm	pm+pt	NA
Protected Phases	4		2		1	6
Permitted Phases		4		2	6	
Total Split (s)	23.0	23.0	45.0	45.0	52.0	97.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Act Effct Green (s)	17.6	17.6	62.1	62.1	92.4	92.4
Actuated g/C Ratio	0.15	0.15	0.52	0.52	0.77	0.77
v/c Ratio	0.88	0.69	0.50	0.46	0.66	0.17
Control Delay	82.3	11.6	23.5	7.0	9.3	4.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	82.3	11.6	23.5	7.0	9.3	4.0
LOS	F	B	C	A	A	A
Approach Delay	37.7		15.6			7.5
Approach LOS	D		B			A

Intersection Summary	
Cycle Length: 120	
Actuated Cycle Length: 120	
Offset: 14 (12%), Referenced to phase 2:NBT and 6:SBTL, Start of Green	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.88	
Intersection Signal Delay: 19.1	Intersection LOS: B
Intersection Capacity Utilization 74.1%	ICU Level of Service D
Analysis Period (min) 15	

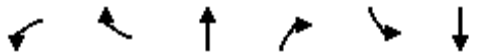
Splits and Phases: 2: MD 614 (Goldsboro Road) & MD 396





Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	219	374	452	421	464	223
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00	0.98	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	1827	1546	1770	1827
Flt Permitted	0.95	1.00	1.00	1.00	0.34	1.00
Satd. Flow (perm)	1770	1583	1827	1546	638	1827
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	228	390	471	439	483	232
RTOR Reduction (vph)	0	333	0	162	0	0
Lane Group Flow (vph)	228	57	471	277	483	232
Confl. Peds. (#/hr)				1	1	
Heavy Vehicles (%)	2%	2%	4%	2%	2%	4%
Turn Type	NA	Perm	NA	Perm	pm+pt	NA
Protected Phases	4		2		1	6
Permitted Phases		4		2	6	
Actuated Green, G (s)	17.6	17.6	62.1	62.1	92.4	92.4
Effective Green, g (s)	17.6	17.6	62.1	62.1	92.4	92.4
Actuated g/C Ratio	0.15	0.15	0.52	0.52	0.77	0.77
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	4.0	4.0	6.0	6.0	4.0	6.0
Lane Grp Cap (vph)	259	232	945	800	729	1406
v/s Ratio Prot	c0.13		0.26		c0.14	0.13
v/s Ratio Perm		0.04		0.18	c0.37	
v/c Ratio	0.88	0.25	0.50	0.35	0.66	0.17
Uniform Delay, d1	50.2	45.3	18.8	17.0	8.1	3.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	28.0	0.8	1.9	1.2	2.5	0.3
Delay (s)	78.2	46.1	20.7	18.2	10.6	3.9
Level of Service	E	D	C	B	B	A
Approach Delay (s)	57.9		19.5			8.4
Approach LOS	E		B			A

Intersection Summary			
HCM 2000 Control Delay	26.5	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	74.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			



Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	228	390	471	439	483	232
v/c Ratio	0.88	0.69	0.50	0.46	0.66	0.17
Control Delay	82.3	11.6	23.5	7.0	9.3	4.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	82.3	11.6	23.5	7.0	9.3	4.0
Queue Length 50th (ft)	174	0	229	40	102	41
Queue Length 95th (ft)	#315	95	408	143	143	62
Internal Link Dist (ft)	913		769			937
Turn Bay Length (ft)		200		175	200	
Base Capacity (vph)	265	568	945	962	934	1406
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.86	0.69	0.50	0.46	0.52	0.17

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	292	535	275	201	374	439
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor				0.98	1.00	
Frt		0.850		0.850		
Flt Protected	0.950				0.950	
Satd. Flow (prot)	1770	1583	1827	1553	1736	1827
Flt Permitted	0.950				0.490	
Satd. Flow (perm)	1770	1583	1827	1516	894	1827
Satd. Flow (RTOR)		563		212		
Confl. Peds. (#/hr)				1	1	
Confl. Bikes (#/hr)						
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	4%	4%	4%	4%
Bus Blockages (#/hr)	0	0	0	0	0	0
Parking (#/hr)						
Mid-Block Traffic (%)	0%		0%			0%
Adj. Flow (vph)	307	563	289	212	394	462
Shared Lane Traffic (%)						
Lane Group Flow (vph)	307	563	289	212	394	462
Turn Type	NA	Perm	NA	Perm	pm+pt	NA
Protected Phases	4		2		1	6
Permitted Phases		4		2	6	
Total Split (s)	32.0	32.0	49.0	49.0	39.0	88.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Act Effct Green (s)	26.3	26.3	63.5	63.5	85.7	85.7
Actuated g/C Ratio	0.22	0.22	0.53	0.53	0.71	0.71
v/c Ratio	0.79	0.72	0.30	0.24	0.52	0.35
Control Delay	59.5	8.9	18.2	3.0	9.2	7.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	59.5	8.9	18.2	3.0	9.2	7.8
LOS	E	A	B	A	A	A
Approach Delay	26.8		11.8			8.4
Approach LOS	C		B			A

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 14 (12%), Referenced to phase 2:NBT and 6:SBTL, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.79
Intersection Signal Delay: 16.4 — Intersection LOS: B
Intersection Capacity Utilization 61.4% — ICU Level of Service B
Analysis Period (min) 15

Splits and Phases: 2: MD 614 (Goldsboro Road) & MD 396

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	292	535	275	201	374	439
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00	0.98	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	1827	1516	1734	1827
Flt Permitted	0.95	1.00	1.00	1.00	0.49	1.00
Satd. Flow (perm)	1770	1583	1827	1516	894	1827
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	307	563	289	212	394	462
RTOR Reduction (vph)	0	440	0	100	0	0
Lane Group Flow (vph)	307	123	289	112	394	462
Confl. Peds. (#/hr)				1	1	
Heavy Vehicles (%)	2%	2%	4%	4%	4%	4%
Turn Type	NA	Perm	NA	Perm	pm+pt	NA
Protected Phases	4		2		1	6
Permitted Phases		4		2	6	
Actuated Green, G (s)	26.3	26.3	63.5	63.5	85.7	85.7
Effective Green, g (s)	26.3	26.3	63.5	63.5	85.7	85.7
Actuated g/C Ratio	0.22	0.22	0.53	0.53	0.71	0.71
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lane Grp Cap (vph)	387	346	966	802	765	1304
v/s Ratio Prot	c0.17		0.16		c0.08	0.25
v/s Ratio Perm		0.08		0.07	c0.29	
v/c Ratio	0.79	0.36	0.30	0.14	0.52	0.35
Uniform Delay, d1	44.3	39.7	15.8	14.4	7.1	6.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	12.2	1.3	0.8	0.4	1.2	0.8
Delay (s)	56.4	41.0	16.6	14.7	8.3	7.3
Level of Service	E	D	B	B	A	A
Approach Delay (s)	46.4		15.8			7.8
Approach LOS	D		B			A

Intersection Summary			
HCM 2000 Control Delay	24.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	61.4%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	307	563	289	212	394	462
v/c Ratio	0.79	0.72	0.30	0.24	0.52	0.35
Control Delay	59.5	8.9	18.2	3.0	9.2	7.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	59.5	8.9	18.2	3.0	9.2	7.8
Queue Length 50th (ft)	222	0	124	0	106	129
Queue Length 95th (ft)	#334	104	207	42	153	182
Internal Link Dist (ft)	913		769			937
Turn Bay Length (ft)		200		175	200	
Base Capacity (vph)	413	801	966	901	883	1304
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.74	0.70	0.30	0.24	0.45	0.35

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Appendix C:
Pedestrian and Bicyclist Counts from April 26 and 27, 2013

Glen Echo Bike/Ped Survey
Compiled Results - Pedestrians

Date: Friday 4/26 and Saturday 4/27 Combined

Pedestrians Crossing MacArthur Blvd East of the traffic circle

OD	#
BH	1
CO	7
EC	2
EH	1
GA	1
HE	1
HO	23
IE	1
IO	3
LJ	1
OC	2
OH	9
Total	52

Date: Friday 4/26 and Saturday 4/27

Pedestrians Crossing MacArthur Blvd West of the traffic circle

OD	#
AF	2
FL	13
HL	6
IL	3
LF	4
LH	1
LI	1
MH	2
OF	3
Total	35

Date: Friday 4/26 and Saturday 4/27 Combined

Pedestrian Crossing Location Summary

Pedestrian Crossing Location Summary				
Total # of crossings	East of Circle		West of Circle	
	Volume	%	Volume	%
87	52	60%	35	40%

Glen Echo Bike/Ped Survey
Compiled Results - Bicycles

Date: Friday 4/26
From Goldsboro Road

OD	#
HB	2
HF	5
HL	1
HO	2
Total	10

Date: Friday 4/26
To Goldsboro Road

OD	#
AC	9
GC	6
JC	3
LC	2
Total	20

Date: Friday 4/26
Bicycle Volume Summary

Total Volume	From Goldsboro Rd		To Goldsboro Rd	
	Volume	%	Volume	%
219	10	5%	20	9%

Date: Saturday 4/27
From Goldsboro Road

OD	#
HA	2
HB	8
HF	49
HL	1
HO	2
Total	62

Date: Saturday 4/27
To Goldsboro Road

OD	#
AC	18
BC	1
FH	1
GC	8
OC	4
OH	1
Total	33

Date: Saturday 4/27
Bicycle Volume Summary

Total Volume	From Goldsboro Rd		To Goldsboro Rd	
	Volume	%	Volume	%
837	62	7%	33	4%

Goldsboro Road Pedestrian and Bicycle Survey Data: Friday, April 26, 2013

Hourly Volumes: Bicycles	
Hour	**Hourly Total**
7:00 AM - 8:00 AM	2
8:00 AM - 9:00 AM	1
9:00 AM - 10:00 AM	2
10:00 AM - 11:00 AM	0
11:00 AM - 12:00 PM	0
12:00 PM - 1:00 PM	0
1:00 PM - 2:00 PM	8
2:00 PM - 3:00 PM	0
3:00 PM - 4:00 PM	0
4:00 PM - 5:00 PM	1
5:00 PM - 6:00 PM	2
6:00 PM - 7:00 PM	1
Total	17

Hourly Volumes: Pedestrians	
Hour	**Hourly Total**
7:00 AM - 8:00 AM	14
8:00 AM - 9:00 AM	2
9:00 AM - 10:00 AM	4
10:00 AM - 11:00 AM	0
11:00 AM - 12:00 PM	0
12:00 PM - 1:00 PM	3
1:00 PM - 2:00 PM	3
2:00 PM - 3:00 PM	0
3:00 PM - 4:00 PM	5
4:00 PM - 5:00 PM	18
5:00 PM - 6:00 PM	11
6:00 PM - 7:00 PM	1
Total	61

Goldsboro Road Pedestrian and Bicycle Survey Data: Saturday, April 27, 2013

Hourly Volumes: Bicycles	
Hour	**Hourly Total**
7:00 AM - 8:00 AM	17
8:00 AM - 9:00 AM	12
9:00 AM - 10:00 AM	20
10:00 AM - 11:00 AM	11
11:00 AM - 12:00 PM	2
12:00 PM - 1:00 PM	3
1:00 PM - 2:00 PM	1
2:00 PM - 3:00 PM	10
3:00 PM - 4:00 PM	4
4:00 PM - 5:00 PM	1
5:00 PM - 6:00 PM	0
6:00 PM - 7:00 PM	2
Total	83

Hourly Volumes: Pedestrians	
Hour	**Hourly Total**
7:00 AM - 8:00 AM	3
8:00 AM - 9:00 AM	4
9:00 AM - 10:00 AM	6
10:00 AM - 11:00 AM	1
11:00 AM - 12:00 PM	0
12:00 PM - 1:00 PM	5
1:00 PM - 2:00 PM	1
2:00 PM - 3:00 PM	4
3:00 PM - 4:00 PM	3
4:00 PM - 5:00 PM	2
5:00 PM - 6:00 PM	2
6:00 PM - 7:00 PM	7
Total	38