

**TIS FOR MURPHY EXPRESS,
FREDERICKSBURG, VIRGINIA
(WARRENTON ROAD)**

Traffic Impact Study

MURPHY OIL USA, INC.

PREPARED: MARCH 30, 2016

REVISED: MAY 10, 2016

Prepared By:

Kimley»»Horn

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Prepared under the Supervision of:

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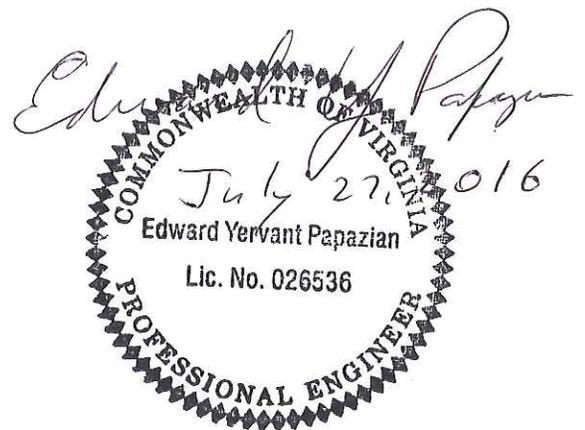
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INTRODUCTION AND SUMMARY

PURPOSE OF REPORT AND STUDY OBJECTIVES

This report presents the results of a traffic impact study for a Murphy Oil gasoline station on the southwest corner of Warrenton Road and Cardinal Forest Drive in Stafford County, Virginia. The gasoline station consists of 16 fueling positions and a convenience store with 1,200 square feet of gross floor area. The parcel of land that will contain the gasoline station has vacant land to the west, which will contain future development.

A previous traffic impact study¹ was prepared for an approved grocery store, on an adjacent parcel, and the gasoline station. The traffic study was reviewed by VDOT, and much of the data and trip generation produced through that study were repurposed for the analysis documented in this report. Due to the presence of vacant land on the parcel to contain the gasoline station, a new traffic study that includes future development was prepared.

The exact use is unknown at this time. However, a 3,300 square foot fast food restaurant with drive-through was assumed in order to establish a conservative estimate for trip generation. Most other land uses that would be appropriate for this location would generate fewer trips than a fast food restaurant with drive-through. Just north of the property is the approved grocery store that will consist of 36,170 square feet of gross floor area and will be located along the west side of Warrenton Road (US Route 17) opposite Cardinal Forest Drive. All three land uses mentioned were incorporated in the analysis for this study.

This report describes the area transportation system, existing traffic volumes and intersection analysis, the calculation of background traffic volumes, which includes the previously approved grocery store and gas station, and analysis for the build-out year of 2018, additional traffic generated by the potential development of the fast food restaurant, and the calculation of total future volumes and analysis. Since this site is adjacent to the proposed grocery store and will be served by the same intersection with Warrenton Road, it was agreed during the scoping that the gas station and fast food restaurant, and the grocery store projects will be included in this traffic study. At the project scoping meeting with representatives from the Virginia Department of Transportation (VDOT) and Stafford County, it was determined that intersection capacity and queueing analyses be performed during AM and PM commuter peak hours and the Saturday midday peak hour at the identified study intersection. It was also determined that a left-turn phasing study should be performed to determine the most appropriate phasing along Warrenton Road under build-out year traffic conditions. The previously prepared study resulted in the split phase operation of the east and west movements of the study area intersection. The analyses will be based on development of the grocery store, the gasoline station, and the fast food restaurant.

This report utilized the trip generation and distributions from the December 2015 study. Trip assignment has been modified for this report with the addition of a right-in-right-out driveway on the south side of the gas station parcel. The geometry and signal timing of the study intersection for total future conditions in

¹ Proposed Grocery Store on Warrenton Road, Stafford County, Virginia, Traffic Impact Study, Kimley-Horn, December 9, 2015

the December study were carried through as the background conditions of this study. This is because the grocery store and gas station are now approved from a traffic stand point, and this study is evaluating the impact of the third potential land use, fast food restaurant. The only change from total future conditions of the December study to the background conditions of this study was the addition of the right-in-right-out driveway and associated reassignment of the grocery store and gas station trips.

The following traffic study was prepared in accordance with a scoping agreement with VDOT and Stafford County. This study complies with the VDOT Traffic Impact Analysis Regulations 24 VAC 30-155 under Chapter 870 of the 2011 Code of Virginia.

EXECUTIVE SUMMARY

SITE LOCATION AND STUDY AREA

The gasoline station and proposed fast food parcel is located in the southwest quadrant of Warrenton Road and Cardinal Forest Drive in Stafford County, Virginia. The study area is bounded to the north by the parcel that has been approved for the future grocery store, and to the south by a forested area. The site location is shown in Figure 1. The intersection of Warrenton Road and Cardinal Forest Drive was identified for study during the scoping meeting. This traffic impact analysis will consider the approved grocery store to be located to the north, and the gasoline station, as part of the background, and the proposed fast food restaurant as total future development.

DESCRIPTION OF THE PROPOSED DEVELOPMENT

The gasoline station will consist of 16 fueling positions and a 1,200 square foot convenience store on the eastern part of the parcel. The proposed fast food restaurant, which was selected solely for the purpose of conservative trip generation, is located on the west end of the parcel. Total trip generation for these two land uses is shown in Table 1.

Land Use	AM			PM			SAT			Daily Total
	In	Out	Total	In	Out	Total	In	Out	Total	
16 Fueling Position Gasoline Station with Convenience Market – LU Code 945 ¹	82	81	163	108	108	216	152	151	303	2,604
Internal Capture (5%)	-4	-4	-8	-5	-6	-11	-8	-7	-15	
<i>Subtotal</i>	78	77	155	103	102	205	144	144	288	
Pass-By Trips (AM – 62%, PM – 56%, SAT – 59%)	-48	-48	-96	-58	-57	-115	-85	-85	-170	
Total Gasoline Station with Convenience Market Site Generated Primary Trips	30	29	59	45	45	90	59	59	118	
3,300 SF Fast-Food Restaurant with Drive-Through – LU Code 934 ³	76	74	150	56	52	108	99	96	195	1,637
Internal Capture (5%)	-4	-4	-8	-3	-2	-5	-5	-5	-10	
<i>Subtotal</i>	72	70	142	53	50	103	94	91	185	
Pass-By Trips (AM – 49%, PM – 50%, SAT – 49%)	-35	-35	-70	-26	-26	-52	-45	-46	-91	
Total Fast-Food Restaurant with Drive-Through Site Generated Primary Trips	37	35	72	27	24	51	49	45	94	
Total Site Generated Trips before Pass-by Adjustment	150	147	297	156	152	308	238	235	473	
Total Site Generated Primary Trips	67	64	131	72	69	141	108	104	212	4,241

The approved 36,170 square foot grocery store, to be included in this study, will occupy the adjacent parcel to the north. Vehicle access will be provided to all developments via a proposed driveway opposite Cardinal Forest Drive to be controlled by the existing traffic signal. The proposed driveway will be the fourth leg of the intersection. Additionally, a right-in-right-out driveway will be provided on the southern edge of the parcel that will contain the gasoline station and proposed fast-food restaurant.

PRINCIPAL FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

As a result of this study, it is concluded that the local roadway system will be able to accommodate the gasoline station, proposed fast food restaurant, and grocery store with signal timing optimization at the Warrenton Road and Cardinal Forest Drive intersection based on the introduction of the fourth leg. Following an analysis of conditions at the study intersection, no changes are recommended for the existing protected left turn phasing type along Warrenton Road. It is recommended that the minor approaches to the intersection operate under split phasing.

The study intersection will operate at LOS C or better in the 2018 total future scenario, and storage lengths for left turns provided at the intersection will accommodate 95th percentile queues with one exception. The exception is the northbound left turn lane along Warrenton Road in which the Saturday midday 95th percentile queue will exceed the available effective storage length by 155 feet. This turn lane should be extended to have an effective storage length of 460 feet in order to accommodate anticipated queueing in the midday Saturday peak hour. This condition, however, is only present with the inclusion of the fast food restaurant land use. Should a land use with lesser trip generation be implemented, this queue length may be reduced.

BACKGROUND INFORMATION

FUTURE TRANSPORTATION IMPROVEMENTS

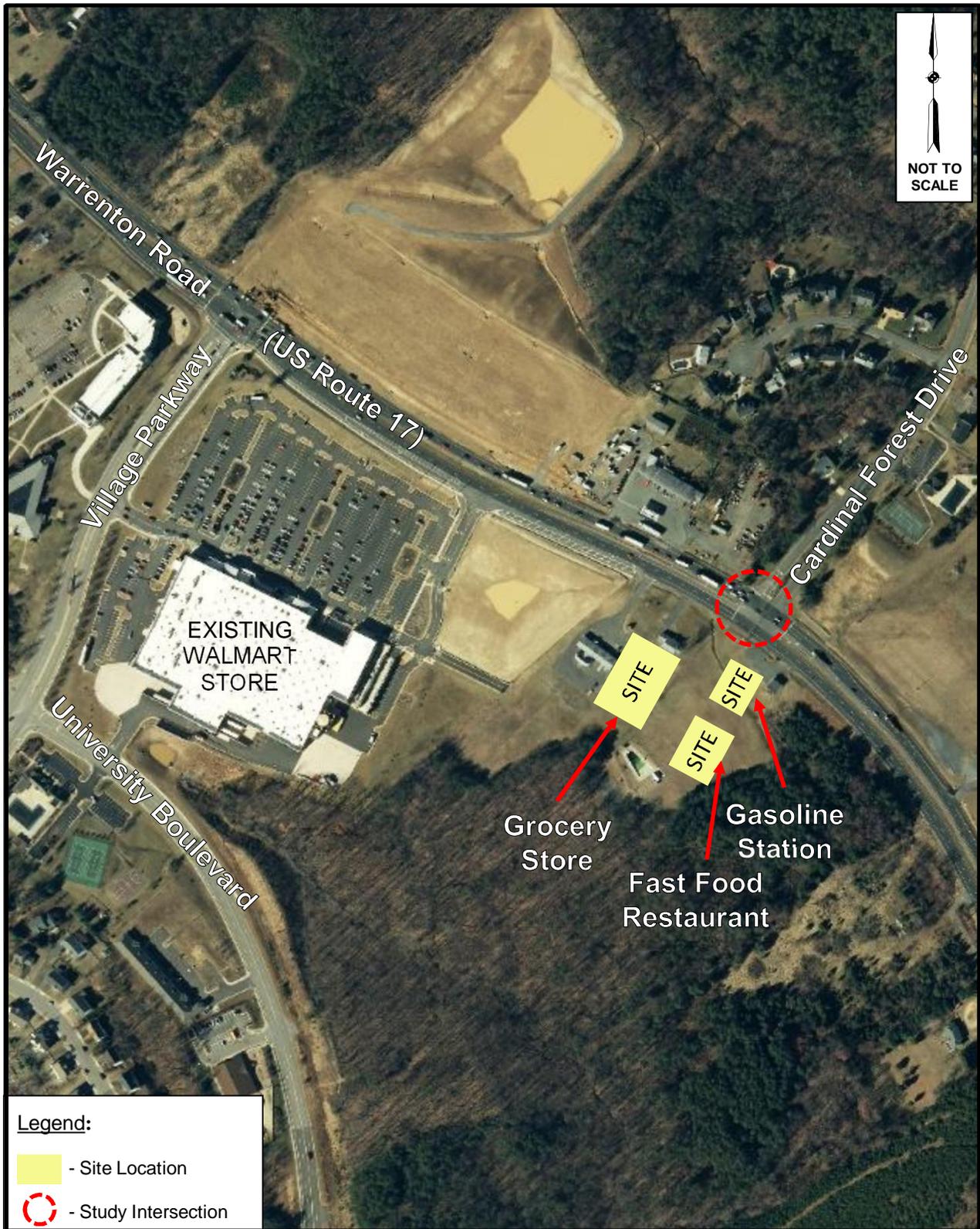
Currently there are no programmed roadway improvements within the study area.

DESCRIPTION OF ONSITE DEVELOPMENT

The property proposed for development is located along Warrenton Road in Stafford County, Virginia. The parcel is located in the southwest quadrant of the intersection at Warrenton Road (US Route 17) and Cardinal Forest Drive. The study area is bounded to the southwest by a forested area, and to the northwest by existing development which is proposed to be replaced by a grocery store. The site location is shown in Figure 1. The site plan is attached in Appendix A.

The proposed fast food restaurant will consist of 3,300 square feet of gross floor area. The gasoline station will consist of 16 fueling positions and a 1,200 square foot convenience store. The grocery store, on the adjacent parcel, will contain 36,170 square feet of gross floor area. Vehicle access will be provided to all developments via a proposed driveway opposite Cardinal Forest Drive to be controlled by the existing signal. The driveway will be the fourth leg of the intersection. Additionally, a right-in-right-out driveway will be provided along Warrenton Road, on the southern edge of the parcel that will contain the gasoline station and proposed fast-food restaurant.

The intersection of Warrenton Road and Cardinal Forest Drive was identified for study. Intersection capacity and queueing analyses were performed for weekday AM and PM and Saturday midday peak hours. These parameters were documented in the Post-Scope of Work Meeting Form, included in Appendix B.



EXISTING AREA ROADWAYS

Key roadways in the study area are Warrenton Road and Cardinal Forest Drive.

Warrenton Road (U.S. Route 17) - This is a four-lane divided principal arterial roadway that runs northwest-southeast through the study area. For the purpose of this study, this roadway is oriented north-south. To the south, Warrenton Road passes through an interchange with Interstate 95 en route to Falmouth. To the north, Warrenton Road continues toward the towns of Hartwood and Storck. The speed limit in the study area is 45 mph.

Cardinal Forest Drive - This is a local roadway that enters the study area from the northeast and terminates at Warrenton Road. For the purpose of this study, this roadway is oriented east-west. It has a two-lane cross section and includes turn lanes at its approach to Warrenton Road. To the east of Warrenton Road, Cardinal Forest Drive passes through a residential community before terminating at Norfolk Street near Truslow Road. The speed limit is 25 mph.

The proposed driveway along the west side of Warrenton Road will connect the gasoline station, the fast food restaurant, and grocery store opposite Cardinal Forest Drive.

Figure 2 shows the lane designations at the study intersection.

EXISTING AREA TRANSIT SERVICE

No transit service exists within the study area.



ANALYSIS OF EXISTING CONDITIONS

ANALYSIS METHODOLOGY

VDOT and Stafford County directed that intersection capacity analyses be performed for existing, background, and total future traffic volumes for the study area intersection. The analyses were performed using the Synchro Software Package (Version 9), which utilizes methodologies contained in the *Highway Capacity Manual (2000 Edition)* for signalized and unsignalized intersections. According to the HCM, capacity is defined as the maximum number of vehicles that can pass over a particular road segment or through a particular intersection within a fixed time duration. The capacity is described by Level of Service (LOS) to indicate the operating characteristics of a road segment or intersection. LOS is defined as a qualitative measure that describes operational conditions and motorist perceptions within a traffic stream. The *Highway Capacity Manual* defines six levels of service, LOS A through LOS F, with A corresponding to the lowest levels of delay and F corresponding to the highest levels of delay.

The ranges of delay for each level of service are shown in Table 2, below.

Level of Service (LOS)	Delay per Vehicle (seconds per vehicle)	
	Signalized Intersections	Unsignalized Intersections
A	≤ 10	≤ 10
B	> 10 -20	> 10 -15
C	> 20 – 35	> 15 – 25
D	> 35 – 55	> 25 – 35
E	> 55 – 80	> 35 – 50
F	> 80	> 50

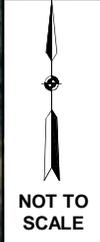
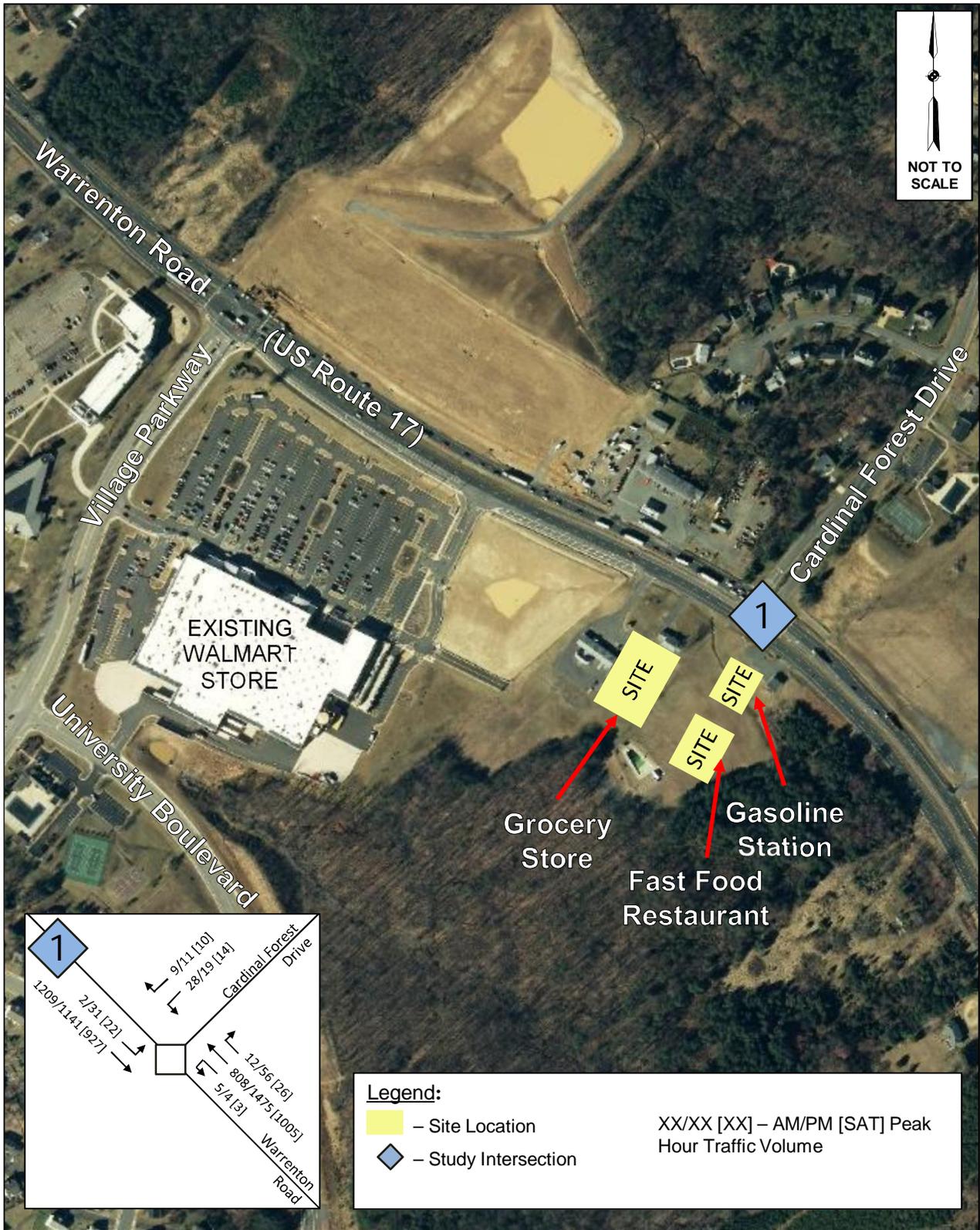
The study intersection is signalized and maintained by VDOT. Existing signal timings were provided by VDOT, and these timings were used for existing analysis. With the installation of a fourth leg of the intersection as a result of the grocery store, gasoline station, and fast food restaurant, signal timings and phasing order were modified for background and total future traffic analyses. Since the study intersection had a signal timing plan coordinated with adjacent signals on Warrenton Road, the existing cycle lengths were maintained so as not to significantly impact traffic progression along the roadway.

EXISTING TRAFFIC VOLUMES

Traffic volumes used in this study include existing traffic volumes, background traffic volumes, and total future traffic volumes. VDOT and Stafford County staff directed that the AM and PM commuter peak hours, as well as the Saturday midday peak hour, be analyzed for the study intersection of Warrenton Road and Cardinal Forest Drive.

Vehicle turning movement counts were collected on Tuesday, July 14, 2015 and on Saturday, July 11, 2015. Due to seasonal variation in traffic patterns, these counts were multiplied by day-of-week adjustment factors from July 2014 in order to more accurately reflect typical traffic conditions. Adjustment factors of 1.03 during the weekday peak hours and 0.66 during the Saturday peak hour were used to normalize the count volumes. These factors were based on data from the VDOT-operated permanent count station along Warrenton Road. A description of the count station, a copy of the July 2014 factors, sample calculations, and email correspondence concerning the data source are contained in Appendix D.

For the purposes of this study, the normalized traffic counts will represent existing 2015 conditions. Study peak hours were established by identifying the peak 60 minutes of vehicle traffic during each count period. The peak hours were determined to be 7:45 to 8:45 AM and 4:30 to 5:30 PM for the weekday AM and PM peak periods, and 12:30 to 1:30 PM for the Saturday peak period. The existing peak hour traffic volumes are shown at the study intersection in Figure 3. Full traffic count data is included as Appendix C.



ANALYSIS OF EXISTING CONDITIONS

The existing conditions analyses were based on the existing traffic volumes and existing lane uses and traffic controls at the study area intersection. The existing peak hour factors by movement were calculated and used for this analysis. Mainline heavy vehicle percentages for Warrenton Road were calculated from the count data; for all other movements, a minimum heavy vehicle percentage of 2% was used.

The results of the intersection capacity analyses are summarized in Table 3. Analysis results show overall level of service and corresponding delay information for each intersection movement, approach, and the overall intersection. The Synchro analysis worksheets are contained in Appendix E.

Table 3: Summary of 2015 Existing Intersection Capacity Analysis Results Level of Service (Delay, Seconds per Vehicle)				
Intersection		Existing		
Approach	Movement	AM	PM	SAT
1. Warrenton Road and Cardinal Forest Drive/Commercial Driveway				
Northbound (Warrenton Road)	U	E (55.5)	F (88.2)	E (63.9)
	T	B (11.8)	B (17.4)	B (19.1)
	R	A (8.5)	A (8.0)	C (21.7)
	<i>Overall</i>	<i>B (12.1)</i>	<i>B (17.3)</i>	<i>B (19.4)</i>
Southbound (Warrenton Road)	L	D (54.7)	E (64.2)	E (78.9)
	TR	A (2.6)	A (2.5)	A (2.8)
	<i>Overall</i>	<i>A (2.7)</i>	<i>A (4.3)</i>	<i>A (5.2)</i>
Eastbound (Future Commercial Driveway)	L			
	TR			
	<i>Overall</i>			
Westbound (Cardinal Forest Drive)	L	E (63.8)	E (74.3)	E (75.9)
	R	E (60.4)	E (71.6)	E (73.2)
	<i>Overall</i>	<i>E (63.1)</i>	<i>E (73.2)</i>	<i>E (74.7)</i>
Overall Intersection		A (8.0)	B (12.4)	B (13.7)

Under existing conditions, the study intersection operates at a level of service B or better in the weekday AM and PM, and Saturday midday peak hours. The intersection movements with relatively small volumes (movements from Cardinal Forest Drive and U-turn and left turn movements along Warrenton Road) have LOS D, E, or F in order to provide adequate green time to the major north-south through movements along Warrenton Road, which account for over 95 percent of the total volume through the intersection.

ANALYSIS OF 2018 FUTURE CONDITIONS WITHOUT DEVELOPMENT

BACKGROUND TRAFFIC VOLUMES

Background traffic volumes represent future traffic that would travel through the area intersection without the proposed development. The background traffic volumes were developed by applying an annual growth rate of 2 percent per year to the existing volumes at the study intersection. This figure was agreed upon in the scoping meeting with VDOT and Stafford County. Figure 4 shows the 2018 base peak hour traffic volumes, which represent the existing traffic volumes increased by the annual traffic growth factor to the year 2018.

The aforementioned grocery store, which is undergoing approval through the application associated with the December traffic study, and the gasoline station, which was included in the traffic study, were incorporated into the background conditions for analysis. The trip generation for these two land uses were calculated in the December 9, 2015 traffic study, and are shown in Tables 4 and 4.

Table 4: Background Trip Generation: Grocery Store (Built by Others)

Land Use	AM			PM			SAT			Daily
	In	Out	Total	In	Out	Total	In	Out	Total	Total
36,170 SF Supermarket – LU Code 850 ¹	76	47	123	175	168	343	258	247	505	3,698
Internal Capture (5%)	-4	-2	-6	-9	-8	-17	-12	-13	-25	
<i>Subtotal</i>	72	45	117	166	160	326	246	234	480	
Pass-By Trips (AM – 0%, PM – 36%, SAT – 0%)	0	0	0	-60	-58	-118	0	0	0	
Total Supermarket Site Generated Primary Trips	72	45	117	106	102	208	246	234	480	

¹Trip generation for LUC 850 was calculated using the average rate for the weekday peak hours and the fitted curve equation for the Saturday peak hour.

Table 5: Proposed Site Trip Generation: Murphy Express – Warrenton Road

Land Use	AM			PM			SAT			Daily
	In	Out	Total	In	Out	Total	In	Out	Total	Total
16 Fueling Position Gasoline Station with Convenience Market – LU Code 945 ¹	82	81	163	108	108	216	152	151	303	2,604
Internal Capture (5%)	-4	-4	-8	-5	-6	-11	-8	-7	-15	
<i>Subtotal</i>	78	77	155	103	102	205	144	144	288	
Pass-By Trips (AM – 62%, PM – 56%, SAT – 59%)	-48	-48	-96	-58	-57	-115	-85	-85	-170	
Total Gasoline Station with Convenience Market Site Generated Primary Trips	30	29	59	45	45	90	59	59	118	

¹Trip generation for LUC 945 was calculated using the average rate. Because Saturday peak hour data is not available for LUC 945, Saturday trips were calculated based on the ratio of Saturday to PM peak hour trips for the related LUC 946 (Gasoline/Service Station with Convenience Market and Car Wash). This is a factor of 1.4.

These trips were assigned to the study area intersection, using the trip distributions shown in Figures 5 and 6. These assignments include the presence of the right-in-right-out driveway on the southern edge of the parcel. The resulting net trip assignments for both uses are shown in Figure 7. Full trip assignment details, including primary, pass-by, and net total trips, for each separate land use can be found in

Appendix G. These trips were then added to the 2018 base peak hour traffic volumes to obtain 2018 background peak hour traffic volumes, which are shown in Figure 8.

ANALYSIS OF 2018 BACKGROUND CONDITIONS

The traffic study submitted for the grocery store, which also incorporated the gasoline station, determined that split phased timing for the minor street movements of the study area intersection would serve the traffic and physical geometry of the intersection. The timings used in the total future conditions of the grocery store study were carried through for the 2018 background conditions of this traffic impact study.

The results of the intersection capacity analyses for the year 2018 are summarized in Table 6. Also shown on this table are the existing conditions results. Analysis results show overall level of service and delay information for each intersection for the background traffic volumes. The Synchro analysis worksheets are contained in Appendix E.

Table 6: Summary of Intersection Capacity Analysis Results							
Level of Service (Delay, Seconds per Vehicle)							
Intersection		Existing (2015)			Background (2018)		
Approach	Movement	AM	PM	SAT	AM	PM	SAT
1. Warrenton Road and Cardinal Forest Drive/Commercial Driveway							
Northbound (Warrenton Road)	U/L				D (52.7)	E (68.1)	E (65.8)
	T	B (11.8)	B (17.4)	B (19.1)	B (16.0)	B (19.6)	B (12.5)
	R	A (8.5)	A (8.0)	C (21.7)	A (5.9)	A (8.4)	A (8.8)
	Overall	B (12.1)	B (17.3)	B (19.4)	B (19.7)	C (24.2)	C (25.3)
Southbound (Warrenton Road)	L	D (54.7)	E (64.2)	E (78.9)	D (53.9)	E (66.4)	E (68.2)
	TR	A (2.6)	A (2.5)	A (2.8)	-	-	-
	T (Future)	-	-	-	A (6.0)	B (14.9)	C (21.5)
	R (Future)	-	-	-	A (4.5)	A (0.1)	A (1.6)
	Overall	A (2.7)	A (4.3)	A (5.2)	A (6.0)	B (15.4)	C (20.2)
Eastbound (Commercial Driveway)	LT	-	-	-	E (65.8)	E (74.1)	E (79.3)
	R	-	-	-	D (49.1)	D (45.7)	D (35.6)
	Overall	-	-	-	E (58.4)	E (60.7)	E (55.9)
Westbound (Cardinal Forest Drive)	LT	E (63.8)	E (74.3)	E (75.9)	E (65.6)	E (78.1)	E (79.7)
	R	E (60.4)	E (71.6)	E (73.2)	D (62.1)	E (73.4)	E (73.7)
	Overall	E (63.1)	E (73.2)	E (74.7)	E (64.8)	E (76.7)	E (78.1)
Overall Intersection		A (8.0)	B (12.4)	B (13.7)	B (14.1)	C (23.6)	C (27.8)

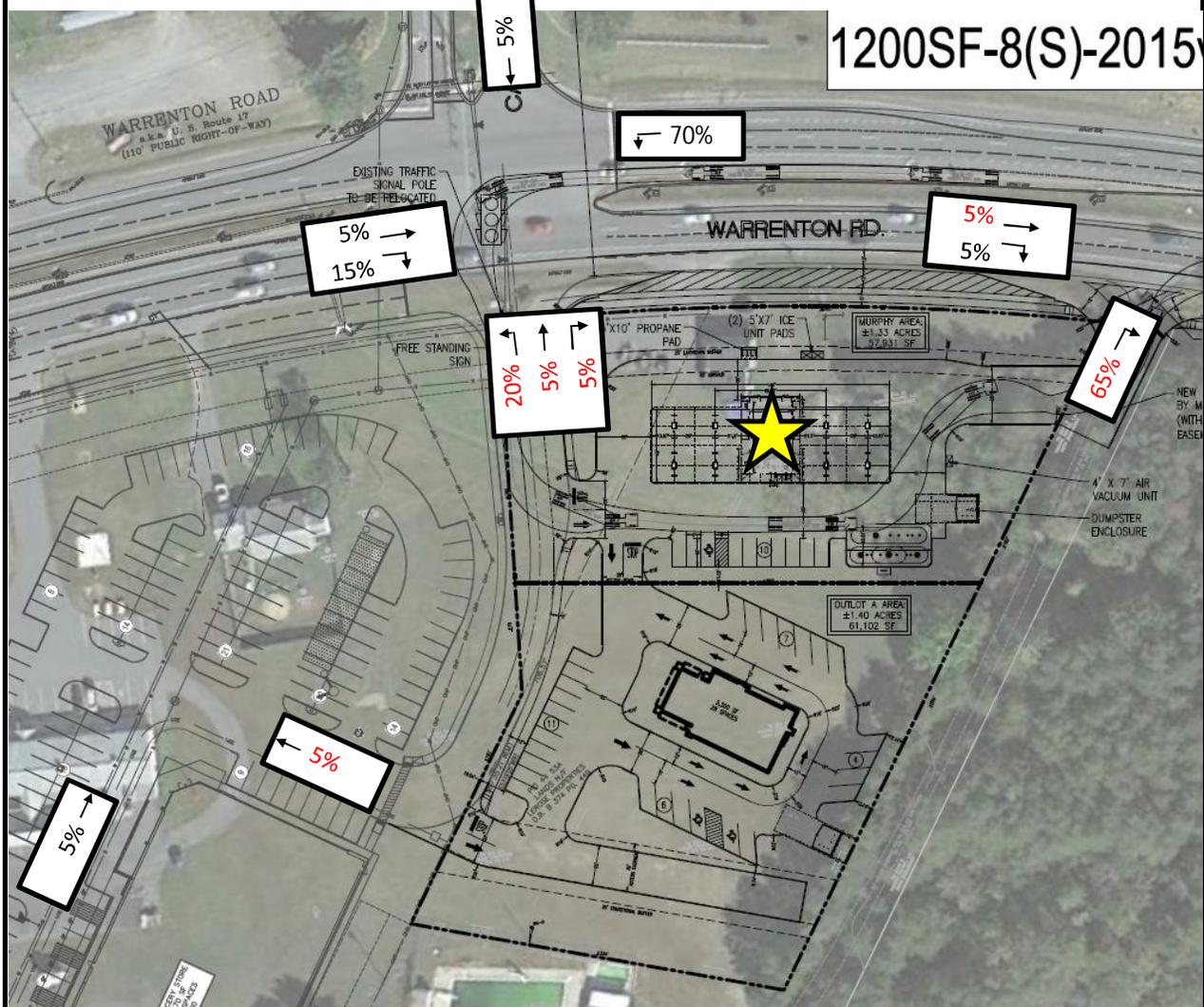
Under background conditions in 2018, the study intersection operates at a level of service C or better in the weekday AM and PM and Saturday midday peak hours. The overall level of service for each approach is maintained from existing to background conditions, with the exception of the following:

- Northbound approach operations change from LOS B to LOS C in the PM and Saturday midday peak hours.
- Southbound approach operations change from LOS A in the PM and Saturday midday peak hours to LOS B in the PM peak hour, and LOS C in the Saturday midday peak hour.

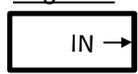




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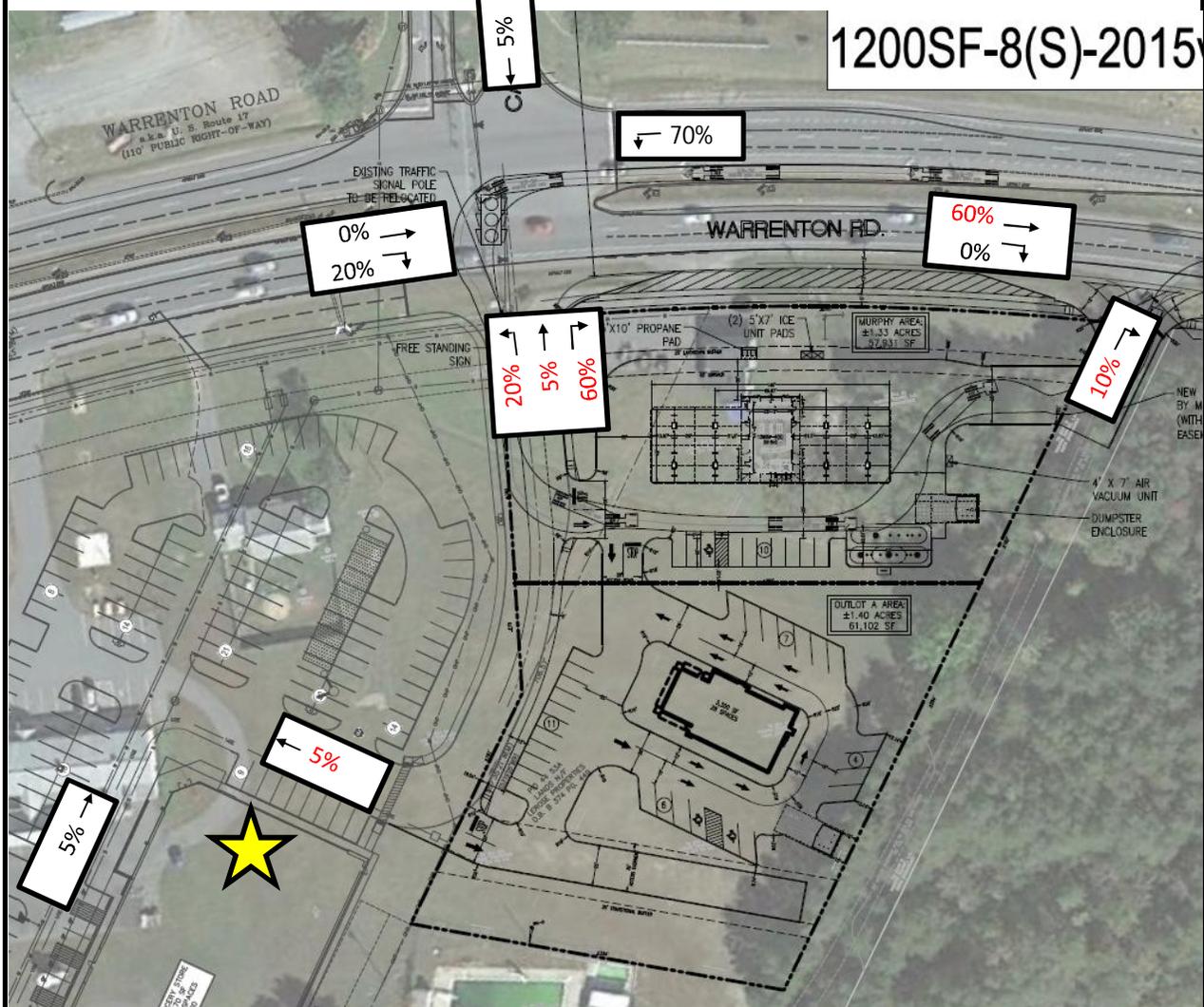


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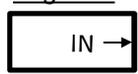


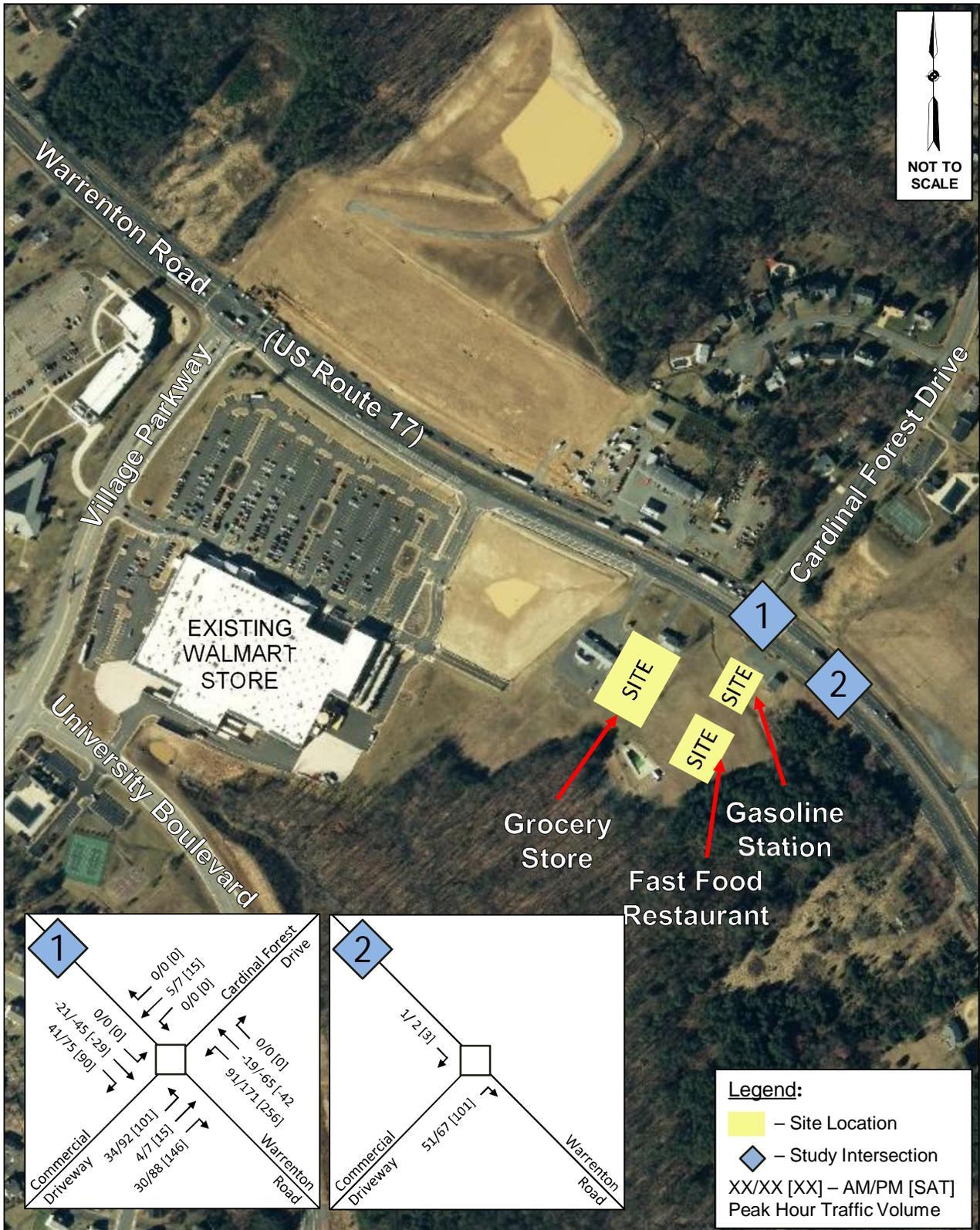


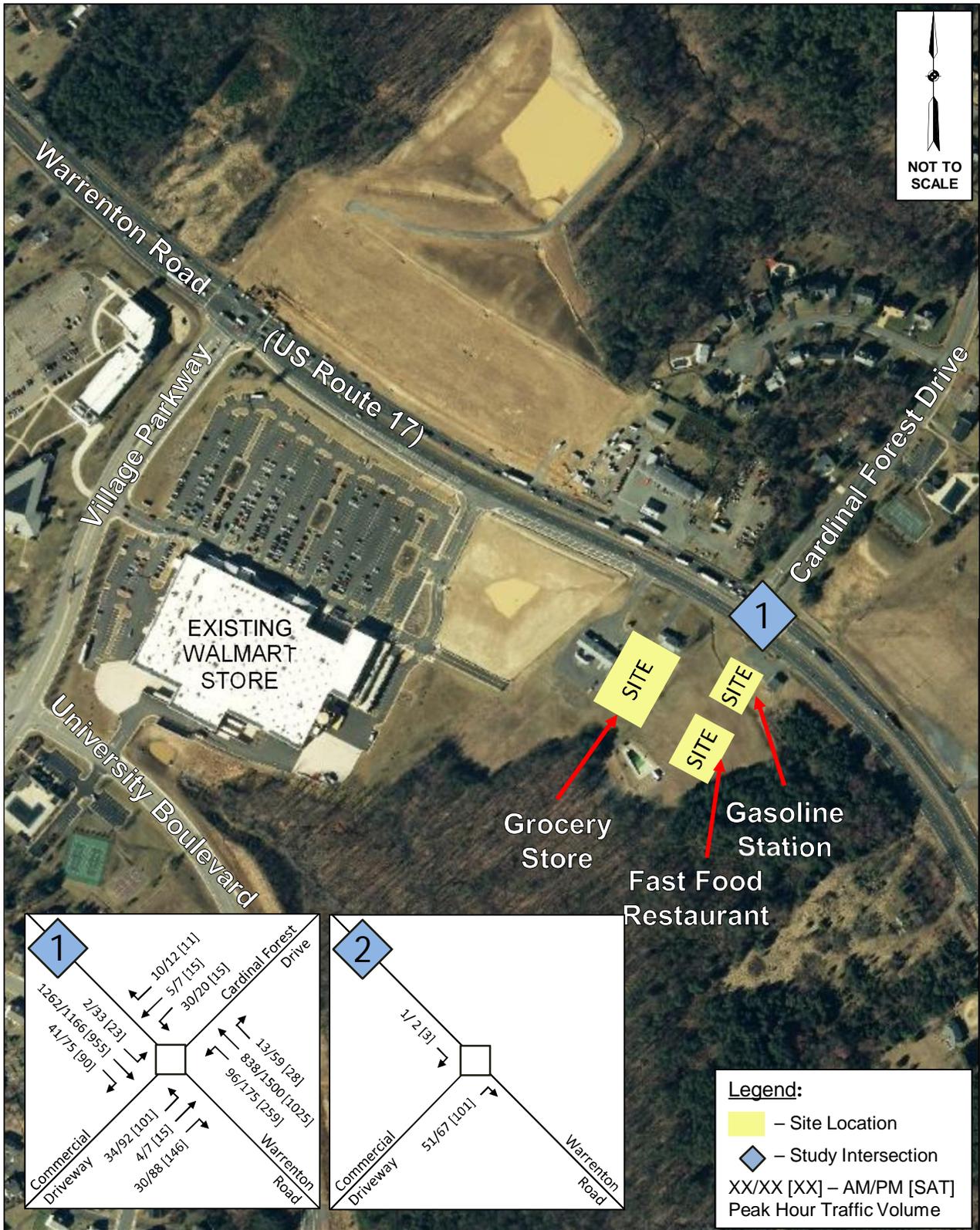
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SITE TRIP GENERATION

Trips generated by the proposed fast food restaurant were estimated based on the Institute of Transportation Engineers (ITE) Trip Generation Manual, 9th Edition. Land Use Code 934 (Fast-Food Restaurant with Drive-Through) was applied for the fast food land use. Average rates were used to calculate trip generation estimates for all peak hour scenarios.

An internal capture trip reduction of 5 percent was applied. The internal capture trips represent patrons who would already be visiting the Walmart Supercenter, the grocery store, or the gas station and would patronize the fast food restaurant. Furthermore, a pass-by trip reduction of 49 percent during the AM peak hour, 50 percent during the PM peak hour, and 49 percent during the Saturday peak hour was applied to trips generated by the fast food restaurant. Pass-by trips represent restaurant patrons who would already be travelling along Warrenton Road and would make an intermediate stop at the proposed development en route to another destination. The use of the pass-by factor does not reduce the number of site trips at the study intersection. This is due to the study intersection serving as the driveway access to the fast food restaurant. The pass-by factors only affect the directionality of inbound and outbound trips. The internal capture and pass-by rates were agreed upon during the scoping process with VDOT and Stafford County.

A summary of the peak hour and daily trip generation is shown in Table 7.

Land Use	AM			PM			SAT			Daily
	In	Out	Total	In	Out	Total	In	Out	Total	Total
3,300 SF Fast-Food Restaurant with Drive-Through – LU Code 934 ¹	76	74	150	56	52	108	99	96	195	1,637
Internal Capture (5%)	-4	-4	-8	-3	-2	-5	-5	-5	-10	
<i>Subtotal</i>	72	70	142	53	50	103	94	91	185	
Pass-By Trips (AM – 49%, PM – 50%, SAT – 49%)	-35	-35	-70	-26	-26	-52	-45	-46	-91	
Total Fast-Food Restaurant with Drive-Through Site Generated Primary Trips	37	35	72	27	24	51	49	45	94	

¹Trip generation for LUC 934 was calculated using the average rate.

SITE TRAFFIC DISTRIBUTION AND ASSIGNMENT

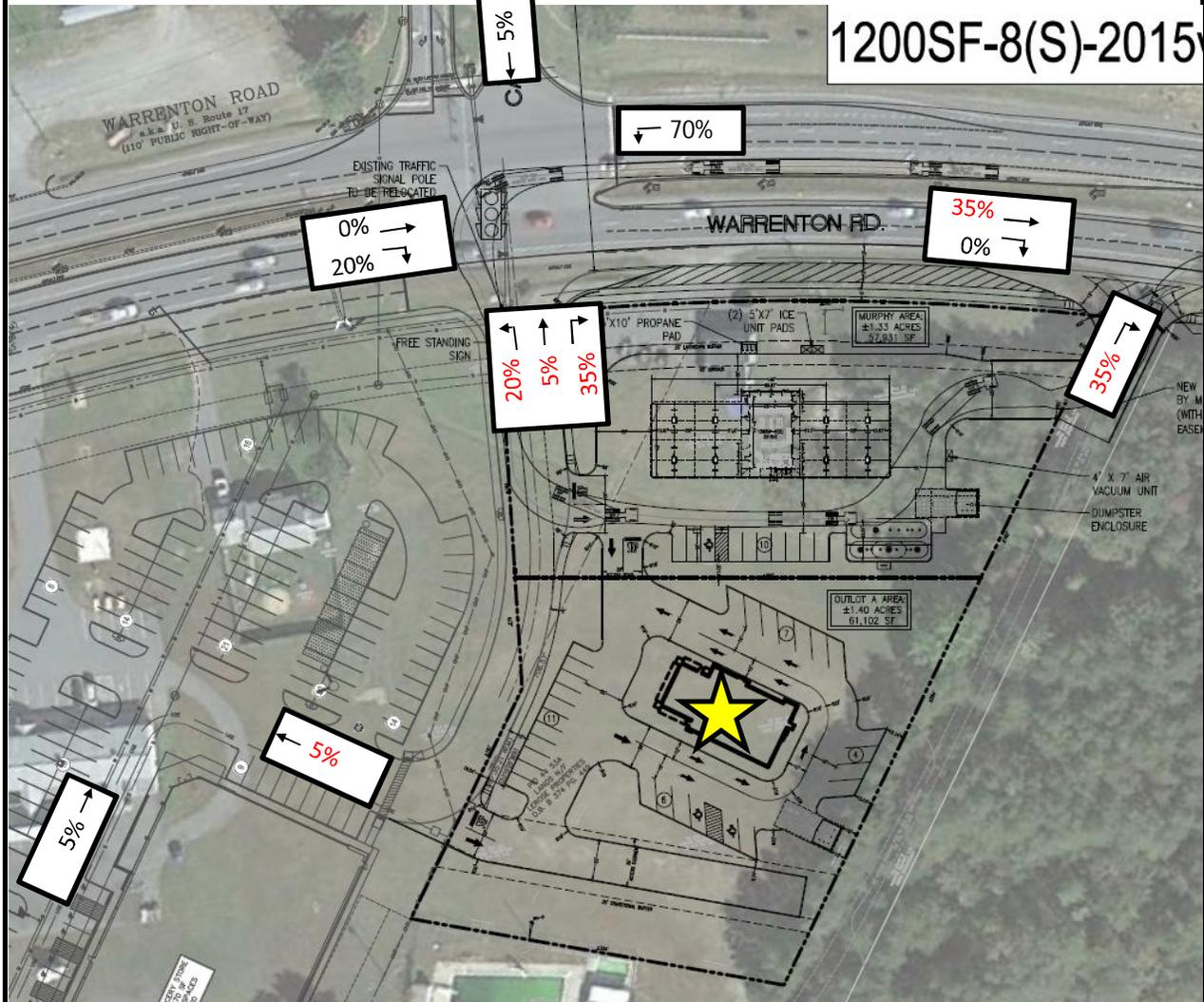
Site generated trips were assigned to the study area intersections based on a review of the density of development in areas surrounding the property. The distributions are summarized in Table 8. They are shown on the area road network in Figure 9. These distributions were reviewed and agreed to in the scoping process with VDOT and Stafford County.

Direction To/From	Percentage
To/From North on Warrenton Road	20%
To/From South on Warrenton Road	70%
To/From East on Cardinal Forest Drive	5%
To/From West on Village Parkway (via Walmart back entrance)*	5%

* The 5% to/from West represents the proportion of trips coming from University Boulevard and other points south. This figure is distinct from the 5% internal capture rate.

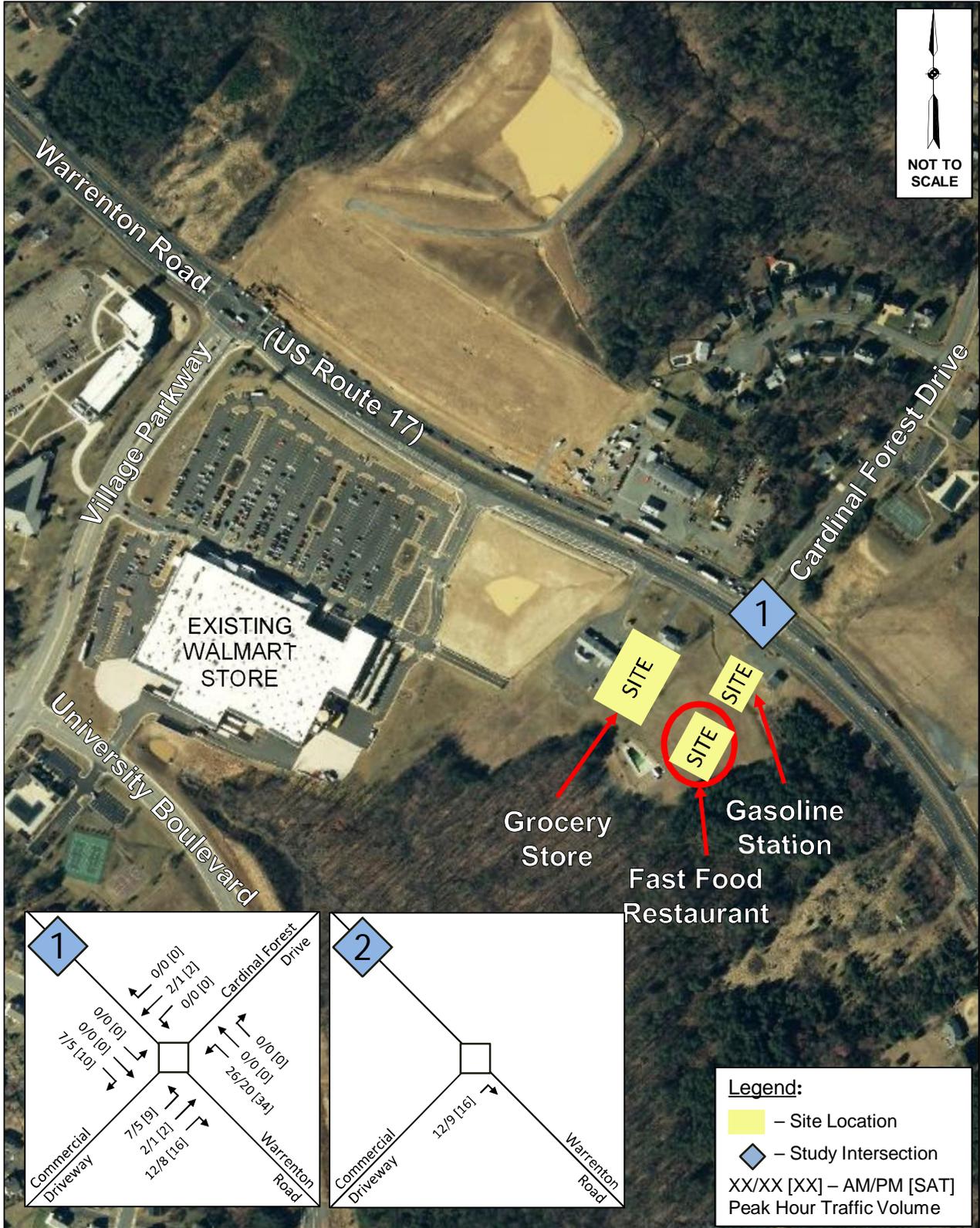
Traffic entering the site from Village Parkway via the Walmart back entrance would not pass through the study intersection, so the associated traffic volumes were not factored into the capacity analyses at the study intersection. Pass-by trips were routed from the north and south along Warrenton Road according to the proportion of existing traffic passing through each approach.

The assignments of trips generated by the proposed fast food restaurant are shown on Figures 10 through 12. These figures show the assignment of primary site generated trips, pass-by trips, and total site generated trips, respectively, to the fast food restaurant with the right-in-right-out driveway in place.

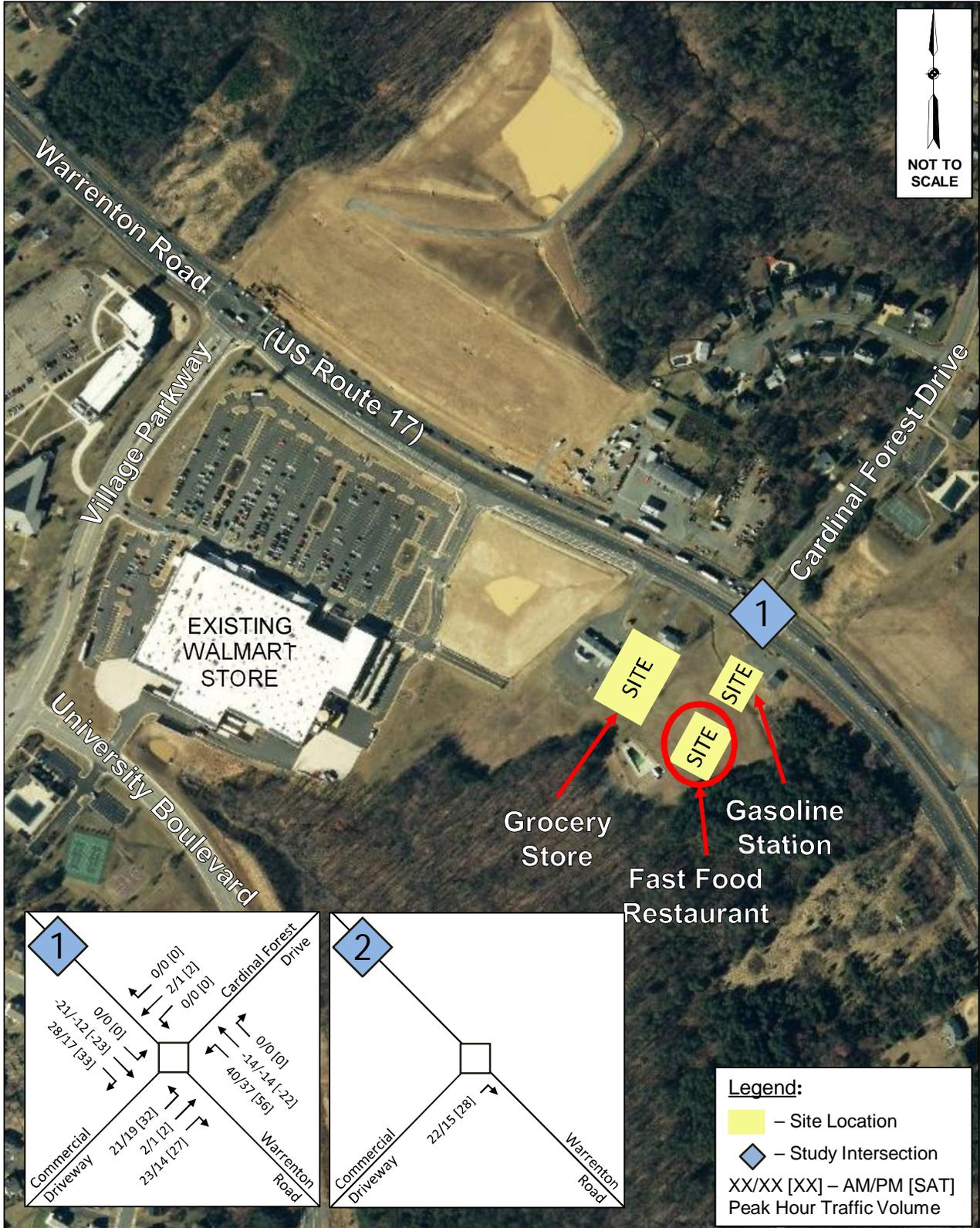


Legend:









ANALYSIS OF 2018 FUTURE CONDITIONS WITH DEVELOPMENT

INTERSECTION IMPROVEMENTS

As part of the proposed development of the fast food restaurant, grocery store and gasoline station, a driveway will be provided opposite Cardinal Forest Drive. The driveway will consist of a single lane inbound from Warrenton Road and two lanes outbound approaching Warrenton Road. The lane designations for the exiting approach are proposed to consist of a shared through and left turn lane and a separate right turn lane. The existing Cardinal Forest Drive approach will be restriped so that there is a shared through and left turn lane and a separate right turn lane. Warrenton Road currently has two through lanes in each direction in the study area. Pavement is in place for a third southbound lane along the retail property that contains the Wal-Mart. This additional pavement terminates at the proposed grocery store property. With the development of the grocery store property, pavement will be provided for two additional lanes along the property frontage. One lane will be for the future third through lane and the other will be for a future right turn lane into the proposed driveway. Prior to the future widening of Warrenton Road, one of the two added lanes along the grocery store frontage will serve as a right turn lane into the driveway. With the development of the gasoline station site, pavement for the third lane will be provided along the property frontage. Future lane designations and traffic control are shown in Figure 13.

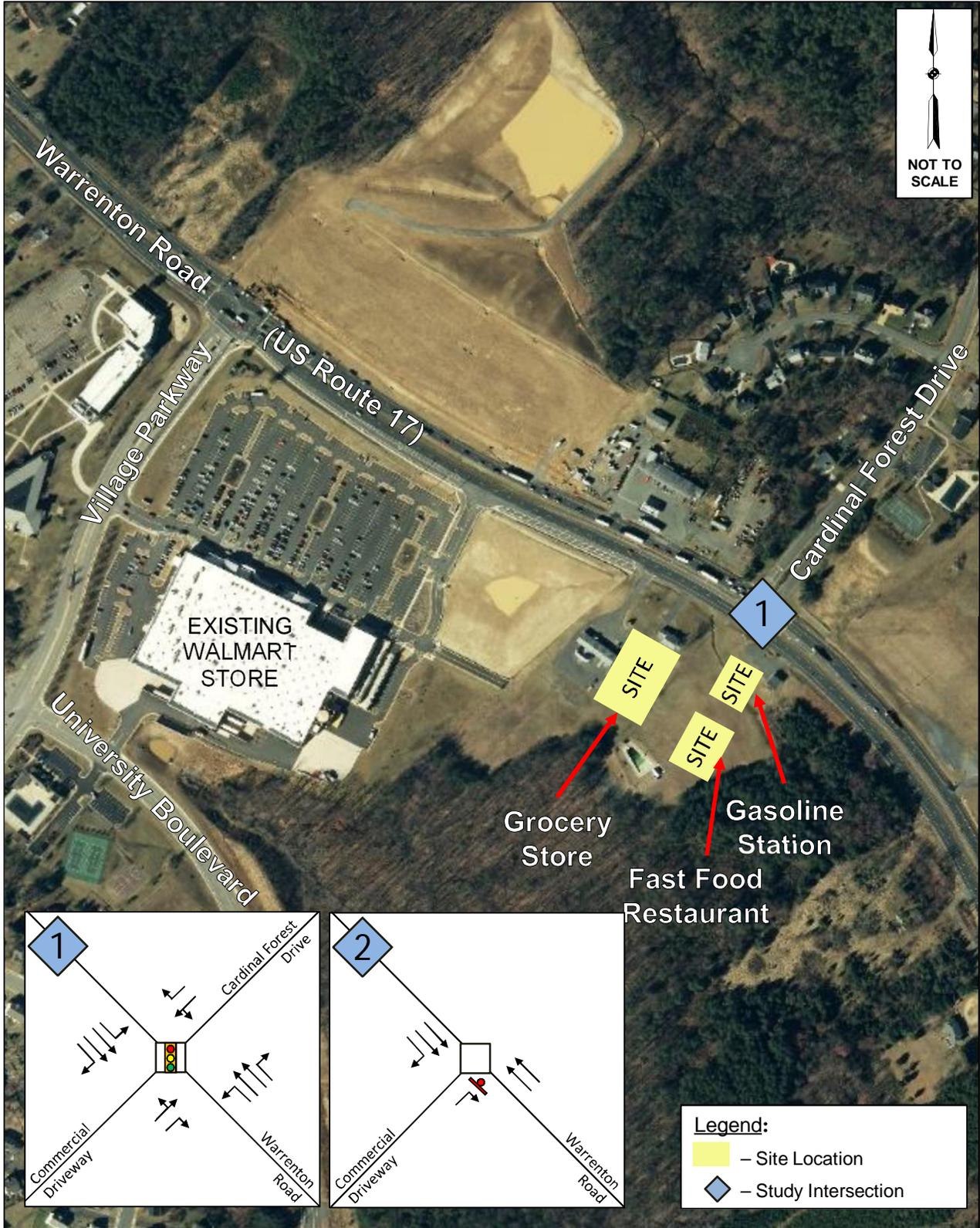
Changes to existing signal timings at the intersection were required due to the addition of the fourth leg of the intersection. A left turn phase selection assessment was conducted in the December 2015 grocery store TIA to determine the appropriate phasing treatments for the left turn movements at the study intersection. Currently, the northbound and southbound left turn movements are protected. Due to the 45 mph speed limit and the phasing used at adjacent signals along Warrenton Road, it was recommended that protected phasing be maintained. Data that informed the phasing decision can be referred to in Appendix G of that study.

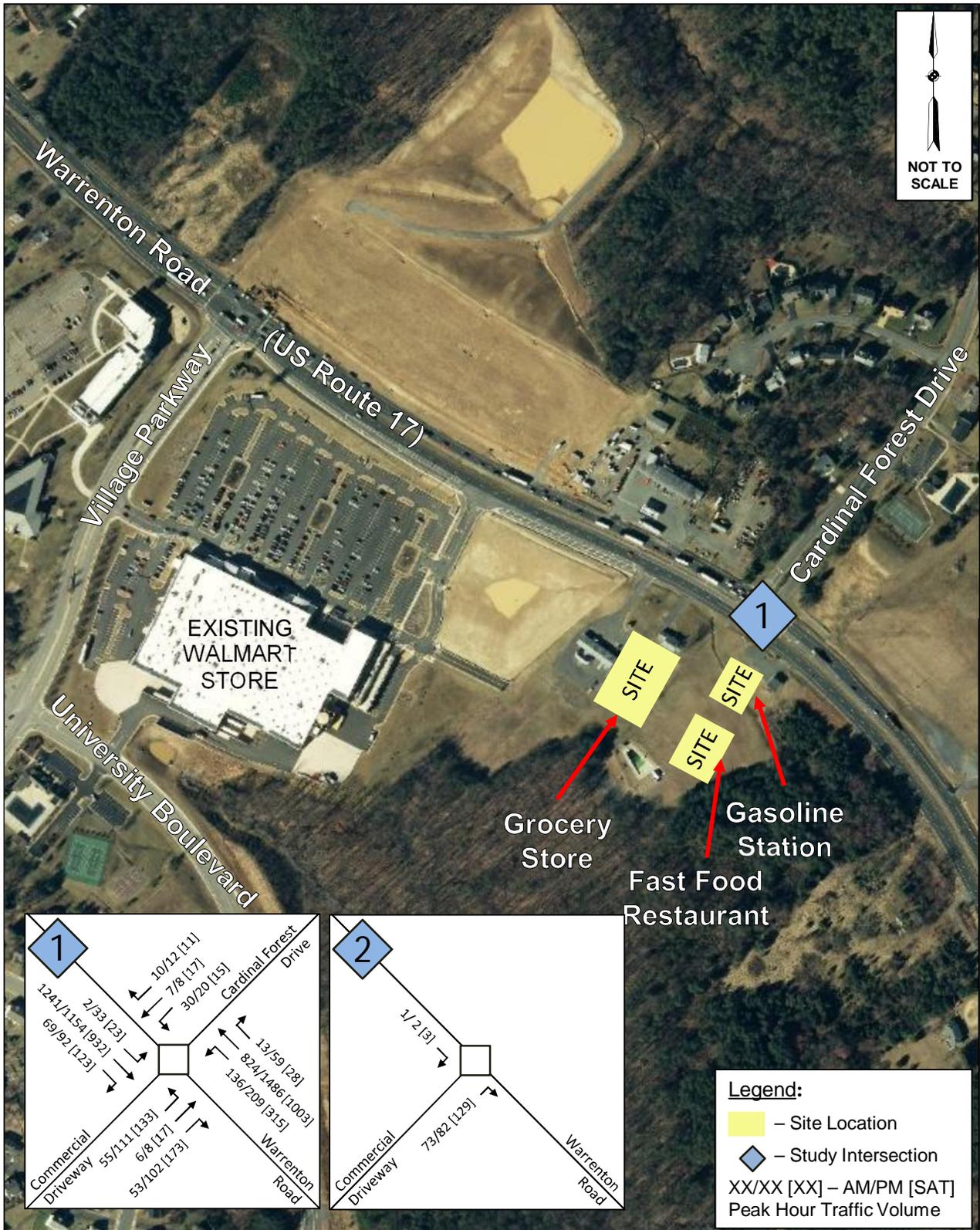
Sight distance limitations precluded the possibility of concurrent phasing for the eastbound and westbound approaches unless protected left turns were used. The December study compared LOS and queueing results for two phasing scenarios: one with concurrent protected left turn movements followed by concurrent through-right movements of the eastbound and westbound approaches, and another with split phasing of the eastbound and westbound approaches. As indicated by the lane designations in Figure 13, the split phase operation was recommended.

Signal splits and offsets were optimized to achieve a balance between LOS and queue lengths for each peak hour. The existing cycle lengths and lead-lag phasing of the northbound and southbound left turn movements were maintained.

TOTAL FUTURE TRAFFIC VOLUMES

Total future volumes represent future traffic volumes with the full build-out of the proposed fast food restaurant. This was calculated by adding the trips generated by the proposed development shown on Figure 12 to the background traffic volumes shown on Figure 8. Total future volumes were computed for the build-out year of 2018. The resulting 2018 total future traffic volumes at the study intersection are shown on Figure 14.





ANALYSIS OF 2018 TOTAL FUTURE CONDITIONS

Intersection capacity analyses were conducted for total future traffic volumes for the study area intersection in the year 2018. The total future conditions analyses were based on the total future traffic volumes with future proposed lane designations and signal timing. Peak hour factors and heavy vehicle percentages were the same as those used in the background analyses.

A comparison of the intersection capacity analysis results for the year 2018 total future conditions are summarized in Table 9. Also shown are the 2018 background conditions results and 2015 existing conditions results. Analysis results show overall level of service and delay information for each intersection. The Synchro analysis worksheets are contained in Appendix E.

Under 2018 total future conditions, in either phasing scenario, the study intersection performs at LOS C or better during all studied peak hours. All through movements along Warrenton Road continue to operate at LOS B or better during all studied peak hours. In the total future scenario, all eastbound and westbound movements perform at LOS D or better during all studied peak hours.

Table 9: Summary of Intersection Capacity Analysis Results										
Level of Service (Delay, Seconds per Vehicle)										
Intersection		Existing (2015)			Background (2018)			Total Future (2018)		
Approach	Movement	AM	PM	SAT	AM	PM	SAT	AM	PM	SAT
1. Warrenton Road and Cardinal Forest Drive/Commercial Driveway										
Northbound (Warrenton Road)	U/L	F (83.8)	F (95.5)	F (89.8)	D (52.7)	E (68.1)	E (65.8)	E (61.3)	E (72.6)	E (62.7)
	T	A (5.9)	B (13.7)	A (7.3)	B (16.0)	B (19.6)	B (12.5)	B (16.7)	B (19.8)	B (12.0)
	R	A (4.3)	B (11.7)	A (4.9)	A (5.9)	A (8.4)	A (8.8)	A (6.4)	A (8.6)	A (8.4)
	Overall	A (6.5)	B (14.0)	A (7.6)	B (19.7)	C (24.2)	C (25.3)	C (23.1)	C (25.9)	C (22.3)
Southbound (Warrenton Road)	L	E (69.1)	E (71.0)	E (70.5)	D (53.9)	E (66.4)	E (68.2)	D (53.6)	E (66.3)	E (68.2)
	TR	A (6.5)	A (5.5)	A (3.8)	-	-	-	-	-	-
	T (Future)	-	-	-	A (6.0)	B (14.9)	C (21.5)	A (6.5)	B (15.9)	B (18.3)
	R (Future)	-	-	-	A (4.5)	A (0.1)	A (1.6)	A (0.7)	A (0.1)	A (1.5)
	Overall	A (6.7)	A (7.5)	A (5.9)	A (6.0)	B (15.4)	C (20.2)	A (6.2)	B (16.0)	B (17.9)
Eastbound (Commercial Driveway)	LT	-	-	-	E (65.8)	E (74.1)	E (79.3)	E (67.9)	E (78.3)	E (73.7)
	R	-	-	-	D (49.1)	D (45.7)	D (35.6)	D (46.9)	D (43.6)	D (38.9)
	Overall	-	-	-	E (58.4)	E (60.7)	E (55.9)	E (58.1)	E (62.3)	D (54.3)
Westbound (Cardinal Forest Drive)	LT	E (67.2)	E (77.8)	F (80.3)	E (65.6)	E (78.1)	E (79.7)	E (65.8)	E (79.3)	E (77.6)
	R	E (62.3)	E (73.5)	E (75.1)	D (62.1)	E (73.4)	E (73.7)	E (62.0)	E (73.8)	E (73.0)
	Overall	E (66.2)	E (76.0)	E (78.0)	E (64.8)	E (76.7)	E (78.1)	E (65.0)	E (77.7)	E (76.3)
Overall Intersection		A (9.1)	A (8.2)	B (12.1)	B (14.1)	C (23.6)	C (27.8)	B (16.5)	C (22.2)	C (24.6)

QUEUING ANALYSIS

By request of VDOT and Stafford County staff, vehicle queue lengths were calculated for each of the movements at the study intersection using SimTraffic 9. Storage at the existing turn lanes was calculated as directed in the Traffic Operations Analysis Tool Guidebook as the existing full-width storage length plus half of the taper length. Particular attention was paid to the northbound left turn lane along Warrenton Road. This left turn movement will accommodate approximately 70 percent of the proposed development trips.

Vehicle queues were analyzed for existing, background, and total future conditions. HCM methodology was used in calculating the 95th percentile queue lengths for each approach, summarized in Table 10 below. The complete queuing analysis results are contained in Appendix F.

Table 10: Summary of 95 th Percentile Queuing Analysis Results										
Queue Length (Feet)										
Intersection		Existing (2015)			Background (2018)			Total Future (2018)		
Approach	Storage ¹	AM	PM	SAT	AM	PM	SAT	AM	PM	SAT
1. Warrenton Road and Cardinal Forest Drive/Commercial Driveway										
Northbound U-Left	305	22	22	17	143	278	319	205	320	460
Northbound Thru		97	389	210	263	382	348	284	397	535
Northbound Right	190	11	89	22	6	93	31	6	89	10
Southbound Left	510	13	81	74	12	76	54	7	80	61
Southbound Thru-Right		138	133	76	-	-	-	-	-	-
Southbound Thru (Future)		-	-	-	86	166	168	55	169	200
Southbound Right (Future)		-	-	-	9	19	20	11	18	40
Eastbound Left-Through		-	-	-	80	124	125	103	130	125
Eastbound Right	130	-	-	-	46	59	66	51	58	72
Westbound Left (Left-Thru in Future)		63	51	52	79	66	71	75	70	76
Westbound Right		26	31	29	21	28	23	21	21	23

¹ Storage lengths given as estimated full width lane area based on aerial imagery from Google Earth

The queuing analysis shows that most existing turn lanes will accommodate 95th percentile queue lengths in all scenarios. In the total future scenario, however, 95th percentile queues for the northbound left turn exceed existing available storage during the PM and Saturday peak hour.

CONCLUSIONS AND RECOMMENDATIONS

MITIGATION AND IMPROVEMENTS

The traffic generated as a result of the proposed fast-food restaurant development will create vehicle queues that exceed the existing storage length for the northbound left turn lane on Warrenton Road. In the total future traffic scenario, the Saturday peak 95th percentile queue length is 460 feet, which exceeds the 305 feet of effective storage currently available. To mitigate the potential for queue spillback onto through lanes along northbound Warrenton Road, this report recommends that the existing northbound left turn lane be extended so that it has a storage bay length of 360 feet and taper length of 200 feet. This modification would increase the effective storage of the turn lane to 460 feet, which would allow the turn lane to fully contain 95th percentile queues for every peak period studied in the total future scenario. This condition, however, is only applicable if the vacant land on the parcel is built out for fast-food restaurant with drive-through. Should a use with lesser trip generation be implemented, this storage length may not be necessary.

CONCLUSIONS

This study concludes that the local roadway system will be able to accommodate the proposed gasoline station and fast food restaurant.

The study intersection will operate at LOS C or better in the 2018 total future scenario. The existing turn lanes at the intersection will accommodate the 95th percentile queues under all conditions with the exception of the northbound left turn lane along Warrenton Road, which should be extended to have an effective storage length of 460 feet in order to accommodate anticipated queuing in the midday Saturday peak hour. The proposed site driveway will accommodate all 95th percentile queue lengths.

APPENDIX

APPENDIX A

Site Plan

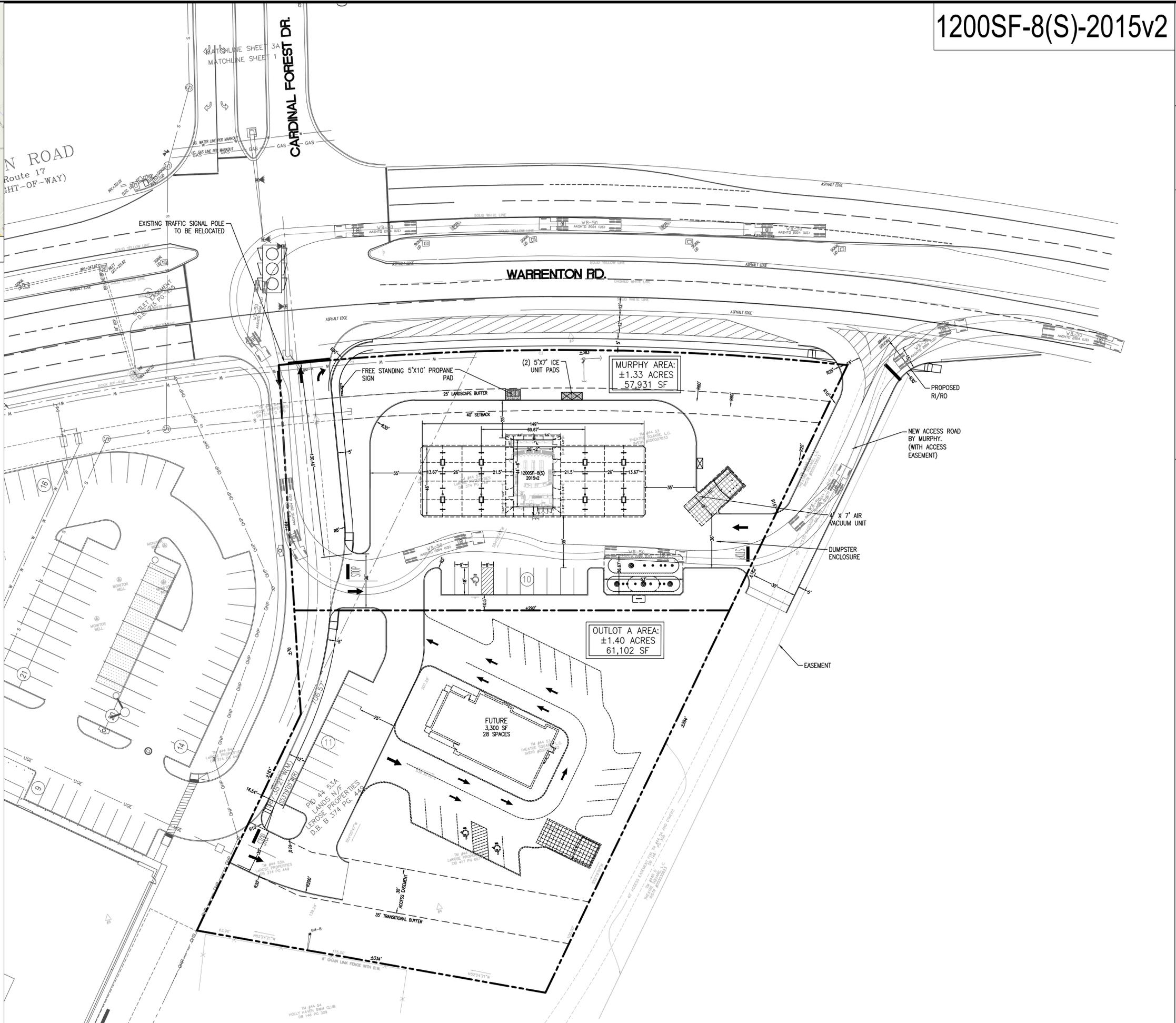
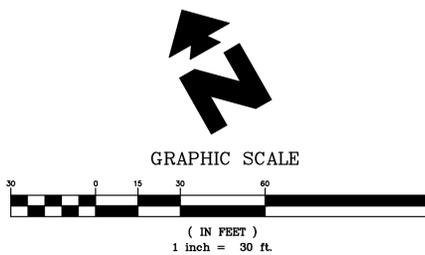


SITE LOCATION MAP
N.T.S.

PARCEL DATA		
	S.F.	ACRES
MURPHY AREA	57,931	1.33
OUTLOT A AREA	61,102	1.40
TOTAL AREA	119,033	2.73
MURPHY PARKING REQUIRED	1/200 SF = 6	
MURPHY PARKING PROVIDED	10	
ZONING	B-2 (URBAN COMMERCIAL)	
SETBACKS		
FRONT:	40'	
SIDE:	0'	
REAR:	25'	
LANDSCAPE / BUFFER		
FRONT:	25'	
SIDE:	0'	
TRANSITIONAL BUFFER REAR:	35'	

SIGNAGE
 ONE FREE-STANDING MONUMENT SIGN:
 THE HEIGHT OF SUCH SIGN SHALL NOT EXCEED MORE THAN EIGHT (8) FEET ABOVE GROUND LEVEL.
 THE AREA OF SUCH SIGN SHALL NOT EXCEED ONE SQUARE FOOT FOR EACH LINEAR FOOT OF BUILDING FRONTAGE.
 SIGNS SHALL BE EXEMPT FROM SETBACK REQUIREMENTS IN ALL DISTRICTS; PROVIDED, HOWEVER, THAT NO SIGN SHALL BE SO LOCATED AS TO INTERFERE WITH VEHICULAR CLEAR SIGHT TRIANGLE DISTANCE AT INTERSECTIONS OR TO CREATE A SAFETY HAZARD.
 FRONT AND SIDE WALL SIGNS MAY NOT EXCEED 2 SF PER EACH LINEAR FEET OF BUILDING FRONTAGE. REAR WALL SIGN 10 SF MAX.

CSP ASSUMPTIONS / POTENTIAL ISSUES:
 CONVENIENCE STORES WITH FUEL SALES ARE ALLOWED WITH A **CONDITIONAL USE PERMIT**.
 ZONING INFORMATION WAS VERIFIED WITH CALLS TO STAFFORD COUNTY PLANNING OFFICE.
 DETENTION WILL BE PROVIDED ONSITE USING A SHARED DETENTION POND OR ONSITE UNDERGROUND IF REQUIRED.
 LANDSCAPE STRIPS WILL BE REQUIRED AROUND THE PERIMETER IF THE SITE.
 BASE DATA WAS BASED ON A DRAWINGS RECEIVED FROM THE SELLER, GOOGLE AERIAL MAPS AND STAFFORD COUNTY GIS INFORMATION.



1200SF-8(S)-2015v2

SHEET NO.
SP8

DATE:
02-26-16

GENERAL DEVELOPMENT PLAN
MURPHY EXPRESS
SWQ OF WARRENTON RD. & CARDINAL DR.
FREDERICKSBURG VIRGINIA

Greenbergfarrow
 1430 W. PEACHTREE ST., NW SUITE 200
 ATLANTA, GA 30309
 PHONE: (404) 601 4000
 FAX: (404) 601 3970
 DWG NAME: FREDERICKSBURG, VA
 JOB NO.: 2015014

MURPHY OIL USA, INC.
MURPHY USA
 422 NORTH WASHINGTON
 EL DORADO, AR 71730

APPENDIX B

Post-Scope of Work Meeting Form



PRE-SCOPE OF WORK MEETING FORM

Information on the Project Traffic Impact Analysis Base Assumptions

The applicant is responsible for entering the relevant information and submitting the form to VDOT and the locality no less than three (3) business days prior to the meeting. If a form is not received by this deadline, the scope of work meeting may be postponed.

Contact Information	
Consultant Name:	Edward Y. Papazian, P.E., Kimley-Horn & Associates, Inc.
Tele:	(703) 674-1307
E-mail:	ed.papazian@kimley-horn.com
Developer/Owner Name:	Trae Rushing, P.E., GreenbergFarrow
Tele:	(404) 601-4000 ext. 7320
E-mail:	trushing@greenbergfarrow.com

Project Information	
Project Name:	Murphy Express - Warrenton Road
Project Location: <small>(Attach regional and site specific location map)</small>	Warrenton Road, Fredericksburg, VA 22406
Project Description: <small>Including type of application (rezoning, subdivision, site plan), acreage, business square ft, number of dwelling units, access location, etc. Attach additional sheet if necessary)</small>	Rezoning application for the proposed development of a 1,200 square foot (16 feuling position) Murphy Express gas station and convenience store located along the south side of Warrenton Road (US Route 17) opposite Cardinal Forest Drive. The site will be accessed via a proposed driveway opposite Cardinal Forest Drive to be incorporated with the existing signal and via the existing Holly Haven Drive to the east, which will be repurposed into a right-in/right-out driveway. The traffic impact analysis will also consider a proposed Lidl grocery store (36,170 SF) to be located in the adjacent parcel to the west. A traffic study dated December 9, 2015 was submitted and approved for the Lidl development. Given the shared access at the signalized intersection, the previous study included the gas station trips in the analysis. This study will therefore be similar, but will include the right-in/right-out driveway. Additionally, the study will account for potential future development on the residual area of the Murphy property to the south. In order to be conservative on the high side, a 3,300 square foot fast-food restaurant with drive-through will be tested. The developments are shown in the included general development plan. Note that an independent application for the grocery store has been submitted separately from the Murphy Express gas station/fast-food restaurant.
Locality/County:	Stafford County
Proposed Use: <small>(Check all that apply; attach additional pages as necessary)</small>	Residential <input type="checkbox"/> Commercial <input checked="" type="checkbox"/> Mixed Use <input type="checkbox"/> Other <input type="checkbox"/>

It is important for the applicant to provide sufficient information to county and VDOT staff so that questions regarding geographic scope, alternate methodology, or other issues can be answered at the scoping meeting.

	Residential # of Units: _____ Commercial Use Sq Ft: - 16 Fueling Positions (gas station) - 36,170 SF (grocery store) - 3,300 SF (fast-food) ITE LU Code(s): 945 (Gasoline Station with Convenience Market) 850 (Supermarket) 934 (Fast-Food Restaurant with Drive-Through) _____	Mixed Use: # Res. Units: _____ ITE LU Code(s): _____ Commercial Use Sq Ft: _____ ITE LU Code(s): _____ Other: _____ ITE LU Code(s): _____ Sq Ft: _____
--	--	---

Traffic Impact Analysis Assumptions

Study Period	Existing Year: 2015 (date of existing counts)	Build-out Year: 2018	Design Year: N/A		
Study Area Boundaries (Attach map)	North: Warrenton Road	South: Wooded Area			
	East: Warrenton Road/Wooded Area	West: Walmart Supercenter Access Road			
External Factors That Could Affect Project (Planned road improvements, other nearby developments)	The proposed Lidl grocery store to the west was approved on the condition of a number of roadway improvements: 1. Adding pavement along the property frontage for two additional lanes (a future third through lane and right turn lane). 2. Modification of the existing traffic signal at Warrenton Road and Cardinal Forest Drive to accommodate the fourth leg of the intersection. 3. Extension of the northbound left turn lane along Warrenton Road. The responsibility for implementing these improvements will be shared between Lidl and Murphy Oil.				
Consistency With Comprehensive Plan	The property is zoned B-2 (Urban Commercial). A convenience store with fuel sales is allowed with a conditional use permit.				
Available Traffic Data (Historical, forecasts)	Vehicle turning movement counts were collected for the previously approved Lidl development TIA in July of 2015. Seasonal adjustment factors, calculated with data from the VDOT-operated permanent count station along Warrenton Road, were applied. Existing traffic counts were scaled by 1.03 in the weekday peak hours and 0.66 in the Saturday peak hour. These volumes will be used for this study.				
Trip Distribution (Attach sketch)	Road Name: Warrenton Road	N 20%	S 70%	E _____%	W _____%
	Road Name: Cardinal Forest Drive	N _____%	S _____%	E 5%	W _____%
	Road Name: Village Parkway (via the Walmart back entrance)	N _____%	S _____%	E _____%	W 5%

It is important for the applicant to provide sufficient information to county and VDOT staff so that questions regarding geographic scope, alternate methodology, or other issues can be answered at the scoping meeting.

	Road Name:	N ____%	S ____%	E ____%	W ____%
Annual Vehicle Trip Growth Rate:		Peak Period for Study (check all that apply)	<input checked="" type="checkbox"/> AM	<input checked="" type="checkbox"/> PM	<input checked="" type="checkbox"/> SAT
Study Intersections and/or Road Segments (Attach additional sheets as necessary)	1. Warrenton Road & Cardinal Forest Drive/Proposed Driveway	6.			
	2. Warrenton Road & Holly Haven Drive (proposed right-in/right-out driveway)	7.			
	3.	8.			
	4.	9.			
	5.	10.			
Trip Adjustment Factors	Internal allowance: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Reduction: 5% trips	Pass-by allowance: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Reduction: See Note 3% trips			
Software Methodology	<input checked="" type="checkbox"/> Synchro <input type="checkbox"/> HCS (v.2000/+) <input type="checkbox"/> aaSIDRA <input type="checkbox"/> CORSIM <input type="checkbox"/> Other ____				
Traffic Signal Proposed or Affected (Analysis software to be used, progression speed, cycle length)	The addition of the site driveway will add a fourth leg to the intersection at Warrenton Road & Cardinal Forest Drive and thus will require a signal modification. Synchro 9 software will be used to analyze this signal. SimTraffic will be used in the event of excessive queuing and congestion.				
Improvement(s) Assumed or to be Considered	<ul style="list-style-type: none"> - Signal modification at Warrenton Road & Cardinal Forest Drive/ Proposed Site Driveway. -Northbound left turn lane to be extended along Warrenton Road to accommodate any additional queueing generated by the proposed developments. -Extension of southbound right turn lane and auxiliary lane from the existing right-in/right-out driveway at the Walmart Supercenter to the signalized site driveway. - Sidewalks will be constructed along the property frontage. 				
Background Traffic Studies Considered	No additional background developments have been identified.				
Plan Submission	<input type="checkbox"/> Master Development Plan (MDP) <input type="checkbox"/> Generalized Development Plan (GDP) <input type="checkbox"/> Preliminary/Sketch Plan <input checked="" type="checkbox"/> Other Plan type (Final Site, Subd. Plan)				
Additional Issues to be addressed	<input checked="" type="checkbox"/> Queuing analysis <input type="checkbox"/> Actuation/Coordination <input type="checkbox"/> Weaving analysis <input type="checkbox"/> Merge analysis <input checked="" type="checkbox"/> Bike/Ped Accommodations <input type="checkbox"/> Intersection(s) <input type="checkbox"/> TDM Measures <input type="checkbox"/> Other ____				

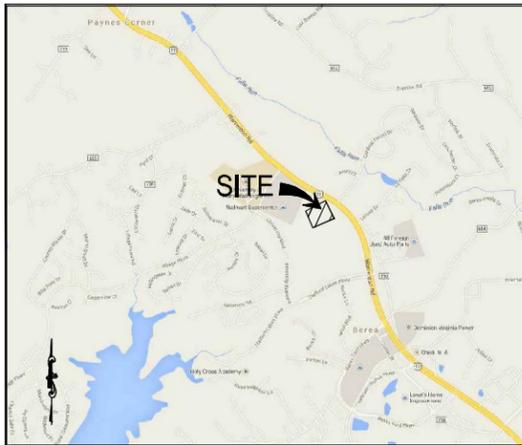
It is important for the applicant to provide sufficient information to county and VDOT staff so that questions regarding geographic scope, alternate methodology, or other issues can be answered at the scoping meeting.

NOTES on ASSUMPTIONS: 1. Pass-by allowance percentages given as the average during the specified peak hour as listed in the ITE Trip Generation Handbook, 3rd Edition (pass-by data is unavailable for LUC 945 and LUC 934 during the Saturday peak hour, therefore an average of the AM and PM weekday peak hours will be applied): LUC 945- 62% (AM), 56% (PM), 59% (SAT), LUC 850- 36% (PM), LUC 934 - 49% (AM), 50% (PM), 49% (SAT)

SIGNED: _____ DATE: _____
Applicant or Consultant

PRINT NAME: _____
Applicant or Consultant

It is important for the applicant to provide sufficient information to county and VDOT staff so that questions regarding geographic scope, alternate methodology, or other issues can be answered at the scoping meeting.



SITE LOCATION MAP
N.T.S.

PARCEL DATA		
	S.F.	ACRES
MURPHY AREA	57,931	1.33
OUTLOT A AREA	61,102	1.40
TOTAL AREA	119,033	2.73
MURPHY PARKING REQUIRED	1/200 SF = 6	
MURPHY PARKING PROVIDED	10	
ZONING	B-2 (URBAN COMMERCIAL)	
SETBACKS		
FRONT:	40'	
SIDE:	0'	
REAR:	25'	
LANDSCAPE / BUFFER		
FRONT:	25'	
SIDE:	0'	
TRANSITIONAL BUFFER REAR:	35'	
SIGNAGE		
ONE FREE-STANDING MONUMENT SIGN: THE HEIGHT OF SUCH SIGN SHALL NOT EXCEED MORE THAN EIGHT (8) FEET ABOVE GROUND LEVEL. THE AREA OF SUCH SIGN SHALL NOT EXCEED ONE SQUARE FOOT FOR EACH LINEAR FOOT OF BUILDING FRONTAGE.		
SIGNS SHALL BE EXEMPT FROM SETBACK REQUIREMENTS IN ALL DISTRICTS; PROVIDED, HOWEVER, THAT NO SIGN SHALL BE SO LOCATED AS TO INTERFERE WITH VEHICULAR CLEAR SIGHT TRIANGULAR DISTANCE AT INTERSECTIONS OR TO CREATE A SAFETY HAZARD.		
FRONT AND SIDE WALL SIGNS MAY NOT EXCEED 2 SF PER EACH LINEAR FOOT OF BUILDING FRONTAGE. REAR WALL SIGN 10 SF MAX.		

CSP ASSUMPTIONS / POTENTIAL ISSUES:

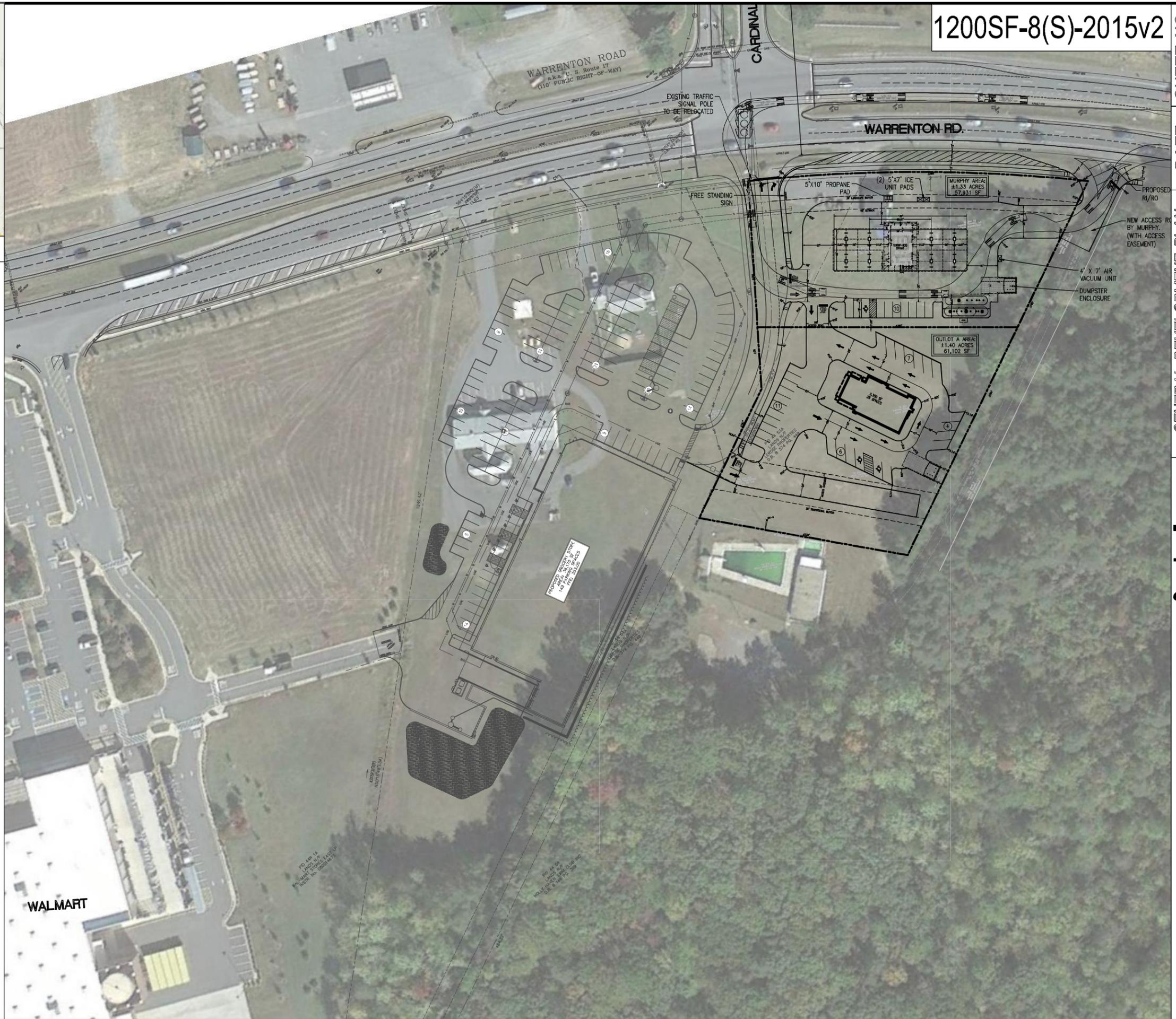
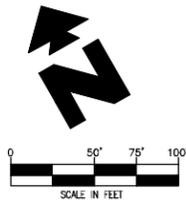
CONVENIENCE STORES WITH FUEL SALES ARE ALLOWED WITH A **CONDITIONAL USE PERMIT**.

ZONING INFORMATION WAS VERIFIED WITH CALLS TO STAFFORD COUNTY PLANNING OFFICE.

DETENTION WILL BE PROVIDED ONSITE USING A SHARED DETENTION POND OR ONSITE UNDERGROUND IF REQUIRED.

LANDSCAPE STRIPS WILL BE REQUIRED AROUND THE PERIMETER IF THE SITE.

BASE DATA WAS BASED ON A DRAWINGS RECEIVED FROM THE SELLER, GOOGLE AERIAL MAPS AND STAFFORD COUNTY GIS INFORMATION.



1200SF-8(S)-2015v2

GENERAL DEVELOPMENT PLAN

MURPHY OIL USA, INC.

MURPHY EXPRESS

SWQ OF WARRENTON RD. & CARDINAL DR.

FREDERICKSBURG VIRGINIA

GreenbergFarrow

1430 W. PEACHTREE ST., NW SUITE 200
ATLANTA, GA 30360
PHONE: (404) 601-4000
FAX: (404) 601-3970

DWG NAME: FREDERICKSBURG, VA
JOB NO.: 2015044

MURPHY OIL USA, INC.

MURPHY USA

422 NORTH WASHINGTON
EL DORADO, AR 71730

SHEET NO. OSP7

DATE: 02-19-16

Proposed Site Trip Generation: Murphy Express – Warrenton Road										
Land Use	AM			PM			SAT			Daily
	In	Out	Total	In	Out	Total	In	Out	Total	Total
16 Fueling Position Gasoline Station with Convenience Market – LU Code 945	82	81	163	108	108	216	152	151	303	2,604
Internal Capture (5%)	-4	-4	-8	-5	-6	-11	-8	-7	-15	
Subtotal	78	77	155	103	102	205	144	144	288	
Pass-By Trips (AM – 62%, PM – 56%, SAT – 59%)	-48	-48	-96	-58	-57	-115	-85	-85	-170	
Total Gasoline Station with Convenience Market Site Generated Primary Trips	30	29	59	45	45	90	59	59	118	
36,170 SF Supermarket – LU Code 850	76	47	123	175	168	343	258	247	505	3,698
Internal Capture (5%)	-4	-2	-6	-9	-8	-17	-12	-13	-25	
Subtotal	72	45	117	166	160	326	246	234	480	
Pass-By Trips (AM – 0%, PM – 36%, SAT – 0%)	0	0	0	-60	-58	-118	0	0	0	
Total Supermarket Site Generated Primary Trips	72	45	117	106	102	208	246	234	480	
3,300 SF Fast-Food Restaurant with Drive-Through – LU Code 934	76	74	150	56	52	108	99	96	195	1,637
Internal Capture (5%)	-4	-4	-8	-3	-2	-5	-5	-5	-10	
Subtotal	72	70	142	53	50	103	94	91	185	
Pass-By Trips (AM – 49%, PM – 50%, SAT – 49%)	-35	-35	-70	-26	-26	-52	-45	-46	-91	
Total Fast-Food Restaurant with Drive-Through Site Generated Primary Trips	37	35	72	27	24	51	49	45	94	
Total Site Generated Trips before Pass-by Adjustment	222	192	414	322	312	634	484	469	953	
Total Site Generated Primary Trips	139	109	248	178	171	349	354	338	692	7,939

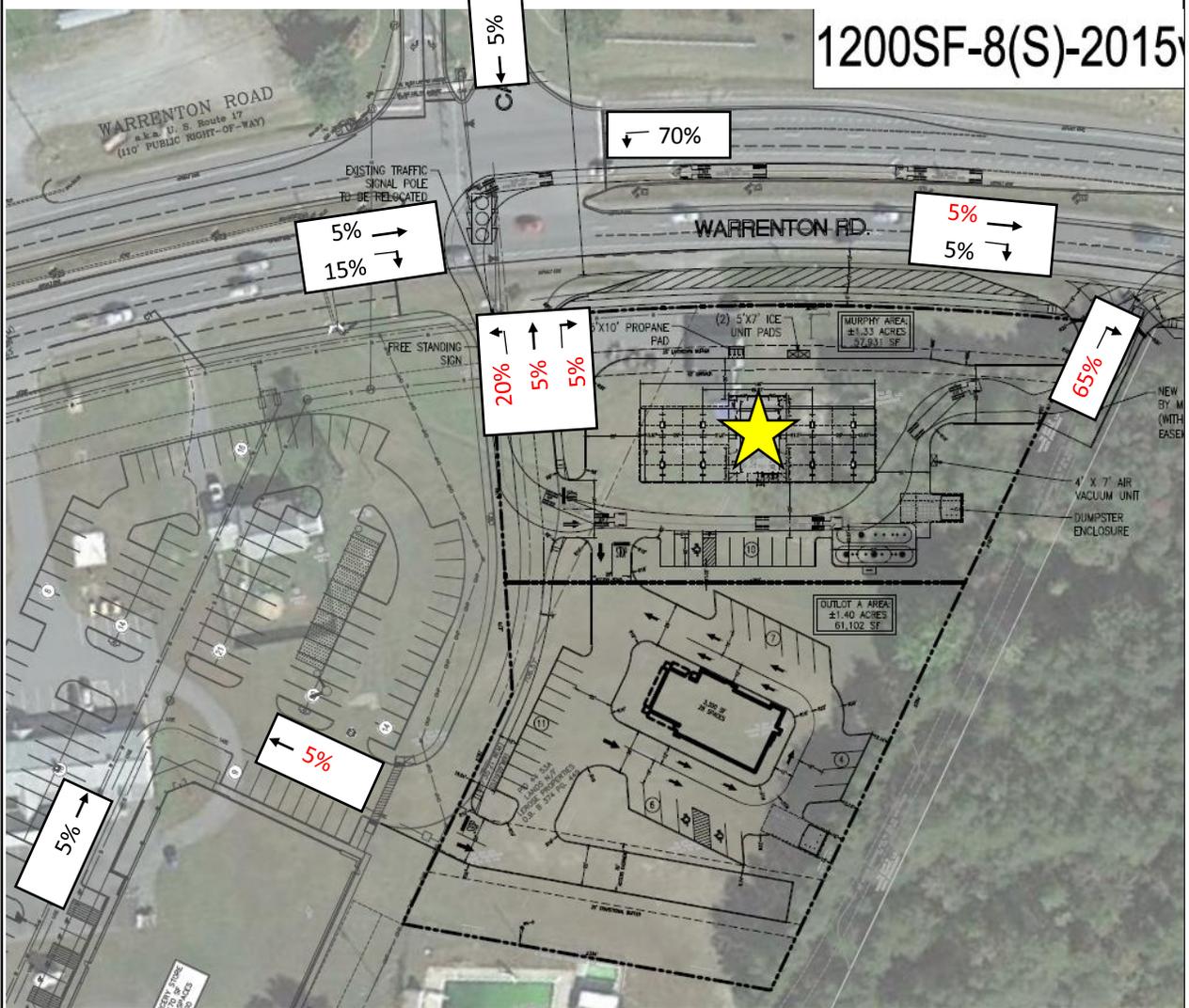
Trip generation for LUC 945 was calculated using the average rate. Because Saturday peak hour data is not available for LUC 945, Saturday trips were calculated based on the ratio of Saturday to PM peak hour trips for the related LUC 946 (Gasoline/Service Station with Convenience Market and Car Wash). This is a factor of 1.4.

Trip generation for LUC 850 was calculated using the average rate for the weekday peak hours and the fitted curve equation for the Saturday peak hour.

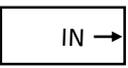
Trip generation for LUC 934 was calculated using the average rate.



1200SF-8(S)-2015

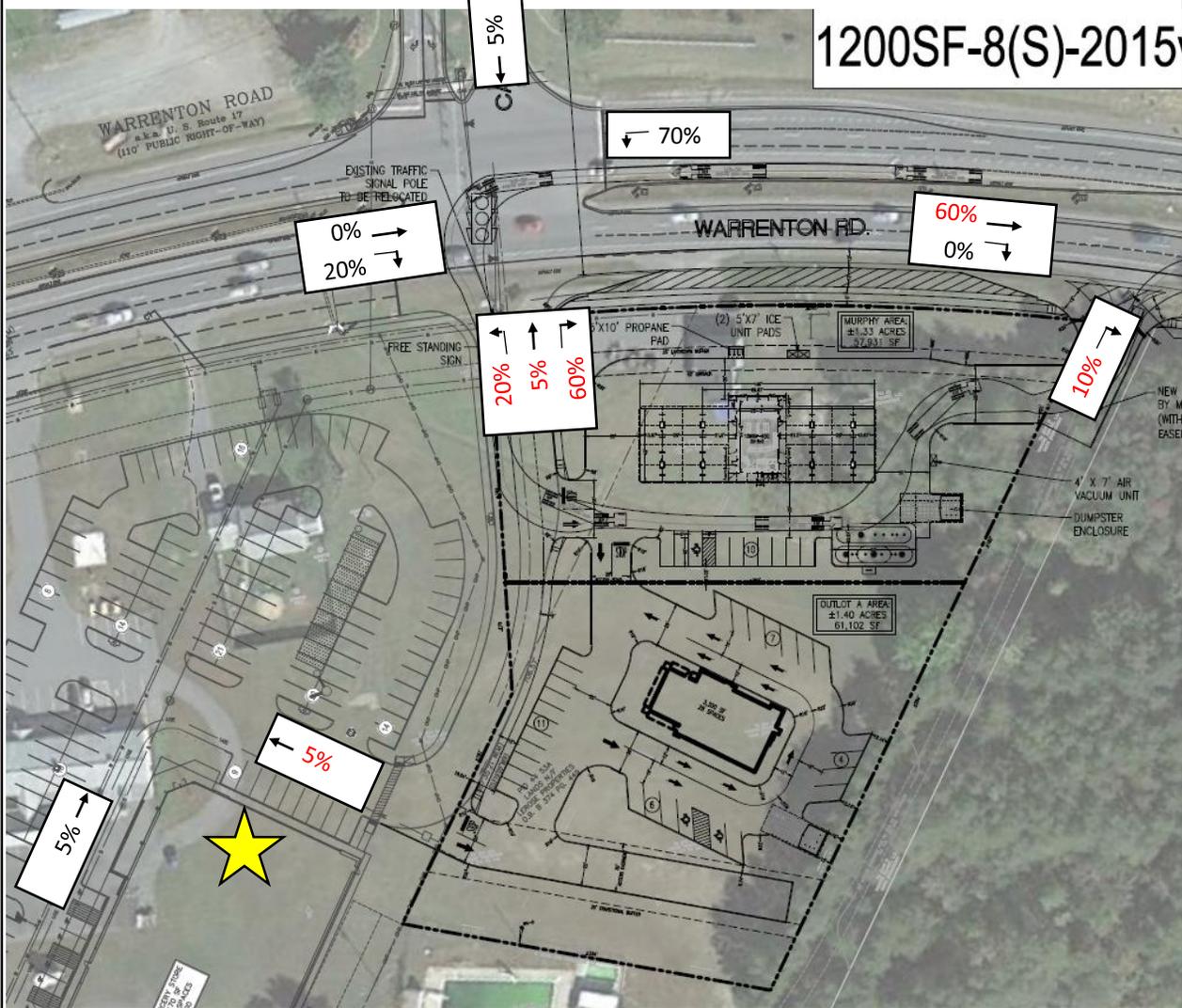


Legend:

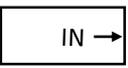




1200SF-8(S)-2015

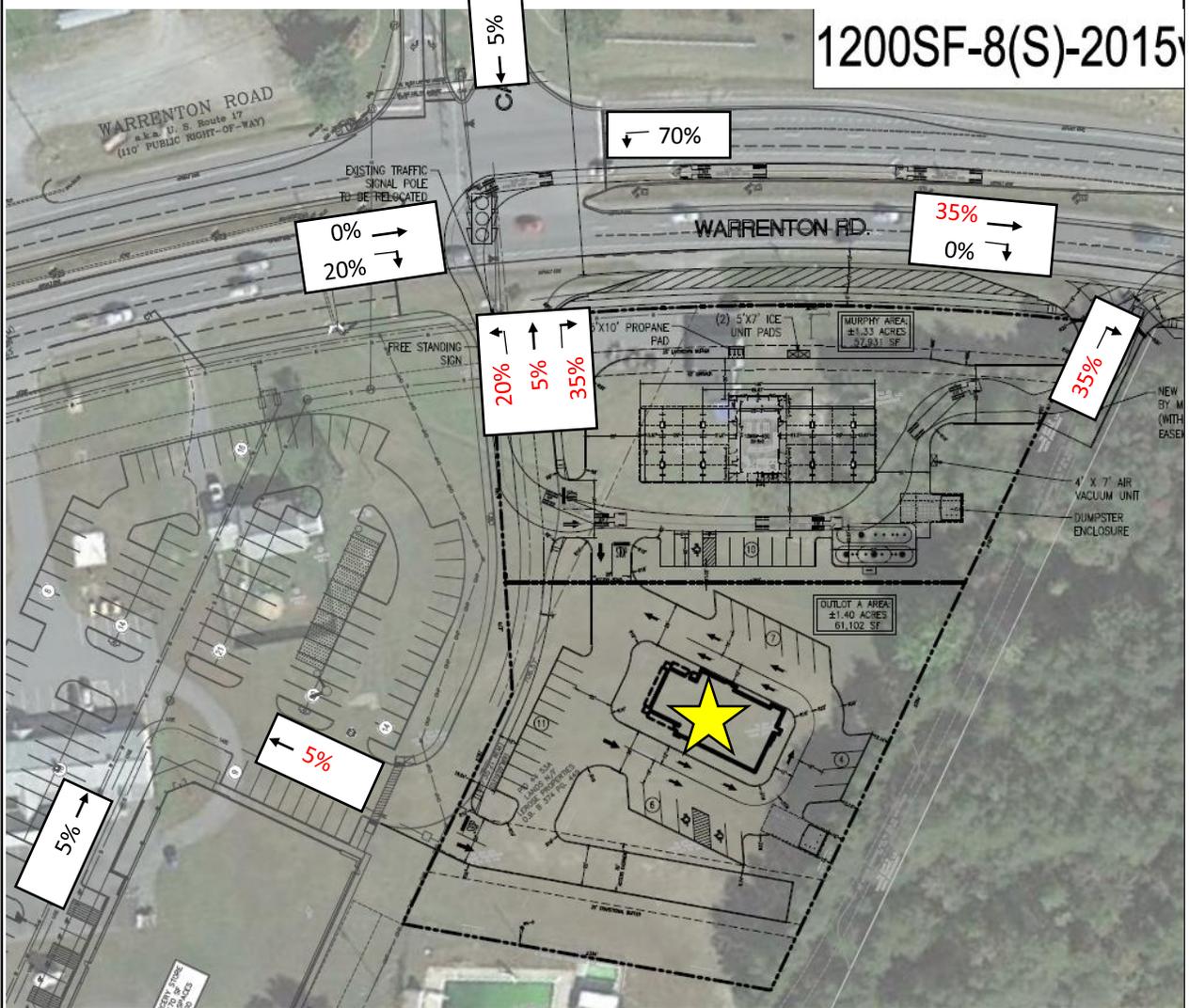


Legend:

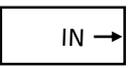




1200SF-8(S)-2015



Legend:



<p>SCOPE OF WORK MEETING CONCLUSIONS</p> <p>ADDITIONS TO THE VDOT REQUIRED ELEMENTS, CHANGES TO THE METHODOLOGY OR STANDARD ASSUMPTIONS, AND SIGNATURE PAGE</p>

Any additions to the VDOT Required Elements or changes to the Methodology or Standard Assumptions due to special circumstances that are approved by VDOT:

This revised scoping document takes into account VDOT and Stafford County comments from the 03/01/16 scoping meeting. This includes:

- Adding a statement to clarify that the grocery store and the Murphy Express gas station/ fast food restaurant will be submitted as separate applications.

The applicant will contact VDOT and the locality prior to the preparation of the traffic impact analysis study in the event there are any substantial changes in the existing conditions that will affect the scope of the study.

AGREED: Edward Y. Papazian DATE: March 1, 2016
 Applicant or Consultant

PRINT NAME: Edward Y. Papazian
 Applicant or Consultant

SIGNED: David L. Beale DATE: 3/31/16
 VDOT Representative

PRINT NAME: DAVID L. BEALE
 VDOT Representative

SIGNED: Charles J. Hess DATE: 3/31/16
 Local Government Representative

PRINT NAME: Charles J. Hess
 Local Government Representative

APPENDIX C

Traffic Count Summaries

Peggy Malone & Associates, Inc.
(888) 247-8602

File Name : Cardinal Forest and Warrenton TUE AM
Site Code :
Start Date : 7/14/2015
Page No : 1

Groups Printed- Car

Start Time	Warrenton Rd. Southbound					Cardinal Forest Dr. Westbound					Warrenton Rd. Northbound					Eastbound					Int. Total	
	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total		
06:00 AM	0	172	0	4	176	1	0	6	4	11	1	71	0	0	72	0	0	0	0	0	0	259
06:15 AM	0	196	0	0	196	2	0	12	0	14	2	113	0	0	115	0	0	0	0	0	0	325
06:30 AM	0	230	0	0	230	0	0	6	0	6	0	138	0	0	138	0	0	0	0	0	0	374
06:45 AM	0	248	1	0	249	1	0	7	0	8	2	117	0	0	119	0	0	0	0	0	0	376
Total	0	846	1	4	851	4	0	31	4	39	5	439	0	0	444	0	0	0	0	0	0	1334
07:00 AM	0	224	0	0	224	2	0	8	0	10	2	169	0	0	171	0	0	0	0	0	0	405
07:15 AM	0	275	0	0	275	3	0	13	0	16	2	172	2	0	176	0	0	0	0	0	0	467
07:30 AM	0	261	2	0	263	1	0	13	0	14	2	184	2	0	188	0	0	0	0	0	0	465
07:45 AM	0	254	1	0	255	2	0	4	0	6	2	159	1	0	162	0	0	0	0	0	0	423
Total	0	1014	3	0	1017	8	0	38	0	46	8	684	5	0	697	0	0	0	0	0	0	1760
08:00 AM	0	248	0	0	248	2	0	11	0	13	2	169	0	0	171	0	0	0	0	0	0	432
08:15 AM	0	277	0	0	277	3	0	8	0	11	8	149	2	0	159	0	0	0	0	0	0	447
08:30 AM	0	286	1	0	287	2	0	4	0	6	0	171	1	0	172	0	0	0	0	0	0	465
08:45 AM	0	248	4	0	252	5	0	11	0	16	3	154	1	0	158	0	0	0	0	0	0	426
Total	0	1059	5	0	1064	12	0	34	0	46	13	643	4	0	660	0	0	0	0	0	0	1770
Grand Total	0	2919	9	4	2932	24	0	103	4	131	26	1766	9	0	1801	0	0	0	0	0	0	4864
Apprch %	0	99.6	0.3	0.1		18.3	0	78.6	3.1		1.4	98.1	0.5	0		0	0	0	0	0	0	
Total %	0	60	0.2	0.1	60.3	0.5	0	2.1	0.1	2.7	0.5	36.3	0.2	0	37	0	0	0	0	0	0	

Start Time	Warrenton Rd. Southbound				Cardinal Forest Dr. Westbound				Warrenton Rd. Northbound				Eastbound				Int. Total
	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:15 AM																	
07:15 AM	0	275	0	275	3	0	13	16	2	172	2	176	0	0	0	0	467
07:30 AM	0	261	2	263	1	0	13	14	2	184	2	188	0	0	0	0	465
07:45 AM	0	254	1	255	2	0	4	6	2	159	1	162	0	0	0	0	423
08:00 AM	0	248	0	248	2	0	11	13	2	169	0	171	0	0	0	0	432
Total Volume	0	1038	3	1041	8	0	41	49	8	684	5	697	0	0	0	0	1787
% App. Total	0	99.7	0.3		16.3	0	83.7		1.1	98.1	0.7		0	0	0		
PHF	.000	.944	.375	.946	.667	.000	.788	.766	1.00	.929	.625	.927	.000	.000	.000	.000	.957

Peggy Malone & Associates, Inc.
(888) 247-8602

File Name : Cardinal Forest and Warrenton TUE PM
Site Code :
Start Date : 7/14/2015
Page No : 1

Groups Printed- Car

Start Time	Warrenton Rd. Southbound					Cardinal Forest Dr. Westbound					Warrenton Rd. Northbound					Eastbound					Int. Total
	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	
04:00 PM	0	239	6	0	245	2	0	4	0	6	9	278	1	0	288	0	0	0	0	0	539
04:15 PM	0	257	4	0	261	5	0	4	0	9	13	291	0	0	304	0	0	0	0	0	574
04:30 PM	0	295	10	0	305	5	0	7	0	12	18	320	2	0	340	0	0	0	0	0	657
04:45 PM	0	245	9	0	254	4	0	7	0	11	17	343	0	0	360	0	0	1	0	1	626
Total	0	1036	29	0	1065	16	0	22	0	38	57	1232	3	0	1292	0	0	1	0	1	2396
05:00 PM	0	207	5	0	212	1	0	2	0	3	7	327	0	0	334	0	0	0	0	0	549
05:15 PM	0	248	6	0	254	1	0	3	0	4	11	334	2	0	347	0	0	0	0	0	605
05:30 PM	0	225	3	0	228	7	0	6	0	13	15	339	2	0	356	0	0	0	0	0	597
05:45 PM	0	253	8	0	261	6	0	8	0	14	14	318	1	0	333	0	0	0	0	0	608
Total	0	933	22	0	955	15	0	19	0	34	47	1318	5	0	1370	0	0	0	0	0	2359
06:00 PM	0	283	6	0	289	3	0	3	0	6	16	283	0	0	299	0	0	0	1	1	595
06:15 PM	0	228	6	0	234	1	0	4	0	5	9	322	1	0	332	0	0	0	0	0	571
06:30 PM	0	232	7	0	239	1	0	3	0	4	10	253	0	0	263	0	0	0	0	0	506
06:45 PM	0	207	5	0	212	3	0	4	0	7	19	247	1	0	267	0	0	0	0	0	486
Total	0	950	24	0	974	8	0	14	0	22	54	1105	2	0	1161	0	0	0	1	1	2158
Grand Total	0	2919	75	0	2994	39	0	55	0	94	158	3655	10	0	3823	0	0	1	1	2	6913
Apprch %	0	97.5	2.5	0		41.5	0	58.5	0		4.1	95.6	0.3	0		0	0	50	50		
Total %	0	42.2	1.1	0	43.3	0.6	0	0.8	0	1.4	2.3	52.9	0.1	0	55.3	0	0	0	0	0	

Start Time	Warrenton Rd. Southbound					Cardinal Forest Dr. Westbound					Warrenton Rd. Northbound					Eastbound					Int. Total
	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	
Peak Hour Analysis From 04:00 PM to 06:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:30 PM																					
04:30 PM	0	295	10	0	305	5	0	7	0	12	18	320	2	0	340	0	0	0	0	0	657
04:45 PM	0	245	9	0	254	4	0	7	0	11	17	343	0	0	360	0	0	1	0	1	626
05:00 PM	0	207	5	0	212	1	0	2	0	3	7	327	0	0	334	0	0	0	0	0	549
05:15 PM	0	248	6	0	254	1	0	3	0	4	11	334	2	0	347	0	0	0	0	0	605
Total Volume	0	995	30	0	1025	11	0	19	0	30	53	1324	4	0	1381	0	0	1	0	1	2437
% App. Total	0	97.1	2.9	0		36.7	0	63.3	0		3.8	95.9	0.3	0		0	0	100			
PHF	.000	.843	.750	0	.840	.550	.000	.679	0	.625	.736	.965	.500	0	.959	.000	.000	.250	0	.250	.927

Peggy Malone & Associates, Inc.
(888) 247-8602

File Name : Cardinal Forest and Warrenton TUE PM
Site Code :
Start Date : 7/14/2015
Page No : 1

Groups Printed- Truck

Start Time	Warrenton Rd. Southbound					Cardinal Forest Dr. Westbound					Warrenton Rd. Northbound					Eastbound					Int. Total
	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	
04:00 PM	0	25	0	0	25	0	0	0	0	0	0	28	0	0	28	0	0	0	0	0	0
04:15 PM	0	22	0	0	22	0	0	0	0	0	0	19	0	0	19	0	0	0	0	0	0
04:30 PM	0	30	0	0	30	0	0	0	0	0	0	31	0	0	31	0	0	0	0	0	0
04:45 PM	0	30	0	0	30	0	0	0	0	0	1	38	0	0	39	0	0	0	0	0	0
Total	0	107	0	0	107	0	0	0	0	0	1	116	0	0	117	0	0	0	0	0	0
05:00 PM	0	25	0	0	25	0	0	0	0	0	0	17	0	0	17	0	0	0	0	0	0
05:15 PM	0	33	0	0	33	0	0	0	0	0	1	28	0	0	29	0	0	0	0	0	0
05:30 PM	0	24	0	0	24	0	0	1	0	1	0	20	0	0	20	0	0	0	0	0	0
05:45 PM	0	29	0	0	29	0	0	0	0	0	0	17	0	0	17	0	0	0	0	0	0
Total	0	111	0	0	111	0	0	1	0	1	1	82	0	0	83	0	0	0	0	0	0
06:00 PM	0	20	0	0	20	0	0	0	0	0	0	22	0	0	22	0	0	0	0	0	0
06:15 PM	0	26	0	0	26	0	0	0	0	0	0	23	0	0	23	0	0	0	0	0	0
06:30 PM	0	22	0	0	22	0	0	0	0	0	0	17	0	0	17	0	0	0	0	0	0
06:45 PM	0	41	0	0	41	0	0	0	0	0	0	9	0	0	9	0	0	0	0	0	0
Total	0	109	0	0	109	0	0	0	0	0	0	71	0	0	71	0	0	0	0	0	0
Grand Total	0	327	0	0	327	0	0	1	0	1	2	269	0	0	271	0	0	0	0	0	0
Apprch %	0	100	0	0		0	0	100	0		0.7	99.3	0	0		0	0	0	0		
Total %	0	54.6	0	0	54.6	0	0	0.2	0	0.2	0.3	44.9	0	0	45.2	0	0	0	0	0	0

Start Time	Warrenton Rd. Southbound					Cardinal Forest Dr. Westbound					Warrenton Rd. Northbound					Eastbound					Int. Total
	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	
Peak Hour Analysis From 04:00 PM to 06:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:30 PM																					
04:30 PM	0	30	0	0	30	0	0	0	0	0	0	31	0	0	31	0	0	0	0	0	0
04:45 PM	0	30	0	0	30	0	0	0	0	0	1	38	0	0	39	0	0	0	0	0	0
05:00 PM	0	25	0	0	25	0	0	0	0	0	0	17	0	0	17	0	0	0	0	0	0
05:15 PM	0	33	0	0	33	0	0	0	0	0	1	28	0	0	29	0	0	0	0	0	0
Total Volume	0	118	0	0	118	0	0	0	0	0	2	114	0	0	116	0	0	0	0	0	0
% App. Total	0	100	0	0		0	0	0	0		1.7	98.3	0	0		0	0	0	0		
PHF	.000	.894	.000	.000	.894	.000	.000	.000	.000	.000	.500	.750	.000	.744	.000	.000	.000	.000	.000	.848	

Peggy Malone & Associates, Inc.
(888) 247-8602

File Name : Cardinal Forest and Warrenton TUE PM
Site Code :
Start Date : 7/14/2015
Page No : 1

Groups Printed- Combined

Start Time	Warrenton Rd. Southbound					Cardinal Forest Dr. Westbound					Warrenton Rd. Northbound					Eastbound					Int. Total
	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	
04:00 PM	0	264	6	0	270	2	0	4	0	6	9	306	1	0	316	0	0	0	0	0	592
04:15 PM	0	279	4	0	283	5	0	4	0	9	13	310	0	0	323	0	0	0	0	0	615
04:30 PM	0	325	10	0	335	5	0	7	0	12	18	351	2	0	371	0	0	0	0	0	718
04:45 PM	0	275	9	0	284	4	0	7	0	11	18	381	0	0	399	0	0	1	0	1	695
Total	0	1143	29	0	1172	16	0	22	0	38	58	1348	3	0	1409	0	0	1	0	1	2620
05:00 PM	0	232	5	0	237	1	0	2	0	3	7	344	0	0	351	0	0	0	0	0	591
05:15 PM	0	281	6	0	287	1	0	3	0	4	12	362	2	0	376	0	0	0	0	0	667
05:30 PM	0	249	3	0	252	7	0	7	0	14	15	359	2	0	376	0	0	0	0	0	642
05:45 PM	0	282	8	0	290	6	0	8	0	14	14	335	1	0	350	0	0	0	0	0	654
Total	0	1044	22	0	1066	15	0	20	0	35	48	1400	5	0	1453	0	0	0	0	0	2554
06:00 PM	0	303	6	0	309	3	0	3	0	6	16	305	0	0	321	0	0	0	1	1	637
06:15 PM	0	254	6	0	260	1	0	4	0	5	9	345	1	0	355	0	0	0	0	0	620
06:30 PM	0	254	7	0	261	1	0	3	0	4	10	270	0	0	280	0	0	0	0	0	545
06:45 PM	0	248	5	0	253	3	0	4	0	7	19	256	1	0	276	0	0	0	0	0	536
Total	0	1059	24	0	1083	8	0	14	0	22	54	1176	2	0	1232	0	0	0	1	1	2338
Grand Total	0	3246	75	0	3321	39	0	56	0	95	160	3924	10	0	4094	0	0	1	1	2	7512
Apprch %	0	97.7	2.3	0		41.1	0	58.9	0		3.9	95.8	0.2	0		0	0	50	50		
Total %	0	43.2	1	0	44.2	0.5	0	0.7	0	1.3	2.1	52.2	0.1	0	54.5	0	0	0	0	0	

Start Time	Warrenton Rd. Southbound					Cardinal Forest Dr. Westbound					Warrenton Rd. Northbound					Eastbound					Int. Total
	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	
Peak Hour Analysis From 04:00 PM to 06:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:30 PM																					
04:30 PM	0	325	10	0	335	5	0	7	0	12	18	351	2	0	371	0	0	0	0	0	718
04:45 PM	0	275	9	0	284	4	0	7	0	11	18	381	0	0	399	0	0	1	0	1	695
05:00 PM	0	232	5	0	237	1	0	2	0	3	7	344	0	0	351	0	0	0	0	0	591
05:15 PM	0	281	6	0	287	1	0	3	0	4	12	362	2	0	376	0	0	0	0	0	667
Total Volume	0	1113	30	0	1143	11	0	19	0	30	55	1438	4	0	1497	0	0	1	0	1	2671
% App. Total	0	97.4	2.6	0		36.7	0	63.3	0		3.7	96.1	0.3	0		0	0	100			
PHF	.000	.856	.750	0	.853	.550	.000	.679	0	.625	.764	.944	.500	0	.938	.000	.000	.250	0	.250	.930

Peggy Malone & Associates, Inc.
(888) 247-8602

File Name : Cardinal Forest and Warrenton SAT
Site Code :
Start Date : 7/11/2015
Page No : 1

Groups Printed- Car

Start Time	Warrenton Rd. Southbound					Cardinal Forest Dr. Westbound					Warrenton Rd. Northbound					Eastbound					Int. Total
	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	
11:00 AM	0	295	25	0	320	4	0	3	0	7	9	304	0	0	313	0	0	0	0	0	640
11:15 AM	0	291	32	0	323	3	0	4	0	7	15	342	0	0	357	0	0	0	0	0	687
11:30 AM	0	337	25	0	362	3	0	4	0	7	4	354	0	0	358	0	0	0	0	0	727
11:45 AM	0	330	28	0	358	4	0	2	0	6	6	351	0	0	357	0	0	0	0	0	721
Total	0	1253	110	0	1363	14	0	13	0	27	34	1351	0	0	1385	0	0	0	0	0	2775
12:00 PM	0	306	21	0	327	5	0	6	0	11	6	313	0	0	319	0	0	0	1	1	658
12:15 PM	0	330	12	0	342	3	0	3	0	6	6	338	1	0	345	0	0	0	0	0	693
12:30 PM	0	351	12	0	363	1	0	8	0	9	14	385	1	0	400	0	0	0	0	0	772
12:45 PM	0	321	6	0	327	6	0	5	0	11	6	390	0	0	396	0	0	0	0	0	734
Total	0	1308	51	0	1359	15	0	22	0	37	32	1426	2	0	1460	0	0	0	1	1	2857
01:00 PM	0	331	7	0	338	3	0	5	0	8	8	336	2	0	346	0	0	0	0	0	692
01:15 PM	0	358	8	0	366	5	0	3	0	8	12	376	2	0	390	0	0	0	0	0	764
01:30 PM	0	316	6	0	322	4	0	5	0	9	8	384	1	0	393	0	0	0	0	0	724
01:45 PM	0	283	10	0	293	3	0	7	0	10	8	349	0	0	357	0	0	0	0	0	660
Total	0	1288	31	0	1319	15	0	20	0	35	36	1445	5	0	1486	0	0	0	0	0	2840
Grand Total	0	3849	192	0	4041	44	0	55	0	99	102	4222	7	0	4331	0	0	0	1	1	8472
Apprch %	0	95.2	4.8	0		44.4	0	55.6	0		2.4	97.5	0.2	0		0	0	0	100		
Total %	0	45.4	2.3	0	47.7	0.5	0	0.6	0	1.2	1.2	49.8	0.1	0	51.1	0	0	0	0	0	

Start Time	Warrenton Rd. Southbound					Cardinal Forest Dr. Westbound					Warrenton Rd. Northbound					Eastbound					Int. Total
	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	
Peak Hour Analysis From 11:00 AM to 01:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 12:30 PM																					
12:30 PM	0	351	12		363	1	0	8		9	14	385	1		400	0	0	0		0	772
12:45 PM	0	321	6		327	6	0	5		11	6	390	0		396	0	0	0		0	734
01:00 PM	0	331	7		338	3	0	5		8	8	336	2		346	0	0	0		0	692
01:15 PM	0	358	8		366	5	0	3		8	12	376	2		390	0	0	0		0	764
Total Volume	0	1361	33		1394	15	0	21		36	40	1487	5		1532	0	0	0		0	2962
% App. Total	0	97.6	2.4			41.7	0	58.3			2.6	97.1	0.3			0	0	0			
PHF	.000	.950	.688		.952	.625	.000	.656		.818	.714	.953	.625		.958	.000	.000	.000		.000	.959

Peggy Malone & Associates, Inc.
(888) 247-8602

File Name : Cardinal Forest and Warrenton SAT
Site Code :
Start Date : 7/11/2015
Page No : 1

Groups Printed- Combined

Start Time	Warrenton Rd. Southbound					Cardinal Forest Dr. Westbound					Warrenton Rd. Northbound					Eastbound					Int. Total
	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	
11:00 AM	0	312	25	0	337	4	0	3	0	7	9	319	0	0	328	0	0	0	0	0	672
11:15 AM	0	308	32	0	340	3	0	4	0	7	15	355	0	0	370	0	0	0	0	0	717
11:30 AM	0	347	25	0	372	3	0	4	0	7	4	358	0	0	362	0	0	0	0	0	741
11:45 AM	0	344	28	0	372	4	0	2	0	6	6	358	0	0	364	0	0	0	0	0	742
Total	0	1311	110	0	1421	14	0	13	0	27	34	1390	0	0	1424	0	0	0	0	0	2872
12:00 PM	0	318	21	0	339	5	0	6	0	11	7	328	0	0	335	0	0	0	1	1	686
12:15 PM	0	334	12	0	346	3	0	3	0	6	7	348	1	0	356	0	0	0	0	0	708
12:30 PM	0	357	12	0	369	1	0	8	0	9	14	392	1	0	407	0	0	0	0	0	785
12:45 PM	0	339	6	0	345	6	0	5	0	11	6	397	0	0	403	0	0	0	0	0	759
Total	0	1348	51	0	1399	15	0	22	0	37	34	1465	2	0	1501	0	0	0	1	1	2938
01:00 PM	0	339	7	0	346	3	0	5	0	8	8	346	2	0	356	0	0	0	0	0	710
01:15 PM	0	369	8	0	377	5	0	3	0	8	12	387	2	0	401	0	0	0	0	0	786
01:30 PM	0	335	6	0	341	4	0	5	0	9	8	391	1	0	400	0	0	0	0	0	750
01:45 PM	0	297	10	0	307	3	0	7	0	10	8	360	0	0	368	0	0	0	0	0	685
Total	0	1340	31	0	1371	15	0	20	0	35	36	1484	5	0	1525	0	0	0	0	0	2931
Grand Total	0	3999	192	0	4191	44	0	55	0	99	104	4339	7	0	4450	0	0	0	1	1	8741
Apprch %	0	95.4	4.6	0		44.4	0	55.6	0		2.3	97.5	0.2	0		0	0	0	100		
Total %	0	45.7	2.2	0	47.9	0.5	0	0.6	0	1.1	1.2	49.6	0.1	0	50.9	0	0	0	0	0	

Start Time	Warrenton Rd. Southbound				Cardinal Forest Dr. Westbound				Warrenton Rd. Northbound				Eastbound				Int. Total
	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	
Peak Hour Analysis From 11:00 AM to 01:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 12:30 PM																	
12:30 PM	0	357	12	369	1	0	8	9	14	392	1	407	0	0	0	0	785
12:45 PM	0	339	6	345	6	0	5	11	6	397	0	403	0	0	0	0	759
01:00 PM	0	339	7	346	3	0	5	8	8	346	2	356	0	0	0	0	710
01:15 PM	0	369	8	377	5	0	3	8	12	387	2	401	0	0	0	0	786
Total Volume	0	1404	33	1437	15	0	21	36	40	1522	5	1567	0	0	0	0	3040
% App. Total	0	97.7	2.3		41.7	0	58.3		2.6	97.1	0.3		0	0	0		
PHF	.000	.951	.688	.953	.625	.000	.656	.818	.714	.958	.625	.963	.000	.000	.000	.000	.967

APPENDIX D

Day of Week Conversion Factors and Sample Calculations

Frank, Kelley

From: Strong, Anna
Sent: Thursday, September 03, 2015 2:01 PM
To: Frank, Kelley
Subject: FW: Warrenton Road MGP Seasonal Adjustment Factor
Attachments: Link.csv; FactorValueSeasonal.csv

From: Schinkel, Thomas O. (VDOT) [mailto:Tom.Schinkel@VDOT.Virginia.gov]
Sent: Thursday, July 09, 2015 8:58 AM
To: Strong, Anna <Anna.Strong@kimley-horn.com>
Subject: RE: Warrenton Road MGP Seasonal Adjustment Factor

This file set has the traffic link location associated with your address and the combined month & day-of-week factor that VDOT would use for a short-term count collected at your location. Let me know if you have questions.

Tom

From: Anna.Strong@kimley-horn.com [mailto:Anna.Strong@kimley-horn.com]
Sent: Wednesday, July 08, 2015 5:04 PM
To: Schinkel, Thomas O. (VDOT)
Subject: Warrenton Road MGP Seasonal Adjustment Factor

Hello Tom,

Thank you for speaking with me on the phone earlier. The details of the project are below:

Developer: MGP Retail Consulting
Project Location: 1183 Warrenton Road, Fredericksburg, VA 22406
County: Stafford County
The count station is on US Route 17 (Warrenton Road)

Please let me know if you need anything else and thank you for all of your help!

Anna

Kimley»»Horn

Anna Strong, EIT

Kimley-Horn | 11400 Commerce Park Dr., Suite 400, Reston, VA 20191

Direct: (703) 674-1343 | Mobile: (586) 610-9572

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Celebrating eight years as one of FORTUNE's 100 Best Companies to Work For

Permanent Count Station Information

Link ID: 60118	End Node: 621290
Maintenance Jurisdiction: 89	Start Milepost: 184.73
Route Prefix: US	End Milepost: 185.43
Route Number: 17	Functional Class: 2
Route Alias: Warrenton Rd	Pavement: P
Start Label: Urban Boundary; 89-1491 Cardinal Forest Dr	HPMS Designation: -1
Start Node: 709572	NHS Designation: -1
End Label: 89-655 Holly Corner Rd	Data Type: 4
	Factor Group Number: 70268

July 2014 Seasonal Factor Values

FACTOR DATE	YEAR	MONTH	DAY	FACTOR VALUE
07/01/2014	2014	JULY		0.85191507
07/01/2014	2014	JULY	SUN	0.81023663
07/01/2014	2014	JULY	MON	0.95797348
07/01/2014	2014	JULY	TUE	1.0255893
07/01/2014	2014	JULY	WED	0.95103248
07/01/2014	2014	JULY	THU	0.86420498
07/01/2014	2014	JULY	FRI	0.6940601
07/01/2014	2014	JULY	SAT	0.66030854

Sample Calculations

Southbound on Warrenton Road (Weekday AM Peak Hour):

$$1179 \frac{veh}{hr} * 1.025589 = 1209 \frac{veh}{hr}$$

Southbound on Warrenton Road (Saturday Peak Hour):

$$1404 \frac{veh}{hr} * 0.660309 = 927 \frac{veh}{hr}$$

APPENDIX E

Intersection Capacity Analysis Worksheets

HCM Signalized Intersection Capacity Analysis
 1: Warrenton Rd (Rte.17) & Cardinal Forest Drive

Existing 2015 - AM
 11/22/2015



Movement	WBL	WBR	NBU	NBT	NBR	SBL	SBT
Lane Configurations	↶	↷	↷	↶↶	↷	↶	↶↶
Volume (vph)	28	9	5	808	12	2	1209
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900
Grade (%)	2%			1%			-1%
Total Lost time (s)	5.0	5.0	5.0	6.0	6.0	5.0	6.0
Lane Util. Factor	1.00	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	0.95	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1752	1567	1761	3044	1575	1778	3298
Flt Permitted	0.95	1.00	0.95	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1752	1567	1761	3044	1575	1778	3298
Peak-hour factor, PHF	0.61	0.75	0.60	0.96	0.38	0.50	0.94
Adj. Flow (vph)	46	12	8	842	32	4	1286
RTOR Reduction (vph)	0	11	0	0	7	0	0
Lane Group Flow (vph)	46	1	8	842	25	4	1286
Heavy Vehicles (%)	2%	2%	2%	18%	2%	2%	10%
Turn Type	Prot	Prot	Prot	NA	Perm	Prot	NA
Protected Phases	3	3	1	6		5	2
Permitted Phases					6		
Actuated Green, G (s)	8.0	8.0	1.5	107.4	107.4	2.6	108.5
Effective Green, g (s)	10.0	10.0	3.5	109.4	109.4	4.6	110.5
Actuated g/C Ratio	0.07	0.07	0.02	0.78	0.78	0.03	0.79
Clearance Time (s)	7.0	7.0	7.0	8.0	8.0	7.0	8.0
Vehicle Extension (s)	3.0	3.0	3.0	5.0	5.0	3.0	5.0
Lane Grp Cap (vph)	125	111	44	2378	1230	58	2603
v/s Ratio Prot	c0.03	0.00	0.00	c0.28		0.00	c0.39
v/s Ratio Perm					0.02		
v/c Ratio	0.37	0.01	0.18	0.35	0.02	0.07	0.49
Uniform Delay, d1	62.0	60.4	66.8	4.6	3.4	65.6	5.1
Progression Factor	1.00	1.00	0.80	2.46	2.50	0.83	0.39
Incremental Delay, d2	1.8	0.0	1.9	0.4	0.0	0.4	0.6
Delay (s)	63.8	60.4	55.5	11.8	8.5	54.7	2.6
Level of Service	E	E	E	B	A	D	A
Approach Delay (s)	63.1			12.1			2.7
Approach LOS	E			B			A

Intersection Summary			
HCM 2000 Control Delay	8.0	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	46.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
 1: Warrenton Rd (Rte.17) & Cardinal Forest Drive

Existing 2015 - PM

11/22/2015



Movement	WBL	WBR	NBU	NBT	NBR	SBL	SBT
Lane Configurations	↶	↶	↶	↷	↷	↶	↷
Volume (vph)	19	11	4	1475	56	31	1141
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900
Grade (%)	2%			1%			-1%
Total Lost time (s)	5.0	5.0	5.0	6.0	6.0	5.0	6.0
Lane Util. Factor	1.00	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	0.95	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1752	1567	1761	3326	1545	1778	3269
Flt Permitted	0.95	1.00	0.95	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1752	1567	1761	3326	1545	1778	3269
Peak-hour factor, PHF	0.68	0.55	0.50	0.94	0.76	0.75	0.86
Adj. Flow (vph)	28	20	8	1569	74	41	1327
RTOR Reduction (vph)	0	19	0	0	18	0	0
Lane Group Flow (vph)	28	1	8	1569	56	41	1327
Heavy Vehicles (%)	2%	2%	2%	8%	4%	2%	11%
Turn Type	Prot	Prot	Prot	NA	Perm	Prot	NA
Protected Phases	3	3	1	6		5	2
Permitted Phases					6		
Actuated Green, G (s)	6.8	6.8	1.6	118.9	118.9	12.3	129.6
Effective Green, g (s)	8.8	8.8	3.6	120.9	120.9	14.3	131.6
Actuated g/C Ratio	0.06	0.06	0.02	0.76	0.76	0.09	0.82
Clearance Time (s)	7.0	7.0	7.0	8.0	8.0	7.0	8.0
Vehicle Extension (s)	3.0	3.0	3.0	5.0	5.0	3.0	5.0
Lane Grp Cap (vph)	96	86	39	2513	1167	158	2688
v/s Ratio Prot	c0.02	0.00	0.00	c0.47		0.02	c0.41
v/s Ratio Perm					0.04		
v/c Ratio	0.29	0.01	0.21	0.62	0.05	0.26	0.49
Uniform Delay, d1	72.6	71.5	76.8	9.0	5.0	67.9	4.2
Progression Factor	1.00	1.00	1.12	1.82	1.61	0.93	0.44
Incremental Delay, d2	1.7	0.1	2.1	0.9	0.1	0.8	0.6
Delay (s)	74.3	71.6	88.2	17.4	8.0	64.2	2.5
Level of Service	E	E	F	B	A	E	A
Approach Delay (s)	73.2			17.3			4.3
Approach LOS	E			B			A

Intersection Summary

HCM 2000 Control Delay	12.4	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	54.1%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
 1: Warrenton Rd (Rte.17) & Cardinal Forest Drive

Existing 2015 - SAT
 11/22/2015



Movement	WBL	WBR	NBU	NBT	NBR	SBL	SBT
Lane Configurations	↙	↗	↻	↑↑	↗	↙	↑↑
Volume (vph)	14	10	3	1005	26	22	927
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900
Grade (%)	2%			1%			-1%
Total Lost time (s)	5.0	5.0	5.0	6.0	6.0	5.0	6.0
Lane Util. Factor	1.00	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	0.95	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1752	1567	1761	3522	1575	1778	3522
Flt Permitted	0.95	1.00	0.95	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1752	1567	1761	3522	1575	1778	3522
Peak-hour factor, PHF	0.66	0.62	0.62	0.96	0.71	0.69	0.95
Adj. Flow (vph)	21	16	5	1047	37	32	976
RTOR Reduction (vph)	0	15	0	0	9	0	0
Lane Group Flow (vph)	21	1	5	1047	28	32	976
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	3%
Turn Type	Prot	Prot	Prot	NA	Perm	Prot	NA
Protected Phases	3	3	1	6		5	2
Permitted Phases					6		
Actuated Green, G (s)	5.1	5.1	1.4	120.8	120.8	12.1	131.5
Effective Green, g (s)	7.1	7.1	3.4	122.8	122.8	14.1	133.5
Actuated g/C Ratio	0.04	0.04	0.02	0.77	0.77	0.09	0.83
Clearance Time (s)	7.0	7.0	7.0	8.0	8.0	7.0	8.0
Vehicle Extension (s)	3.0	3.0	3.0	5.0	5.0	3.0	5.0
Lane Grp Cap (vph)	77	69	37	2703	1208	156	2938
v/s Ratio Prot	c0.01	0.00	0.00	c0.30		0.02	c0.28
v/s Ratio Perm					0.02		
v/c Ratio	0.27	0.01	0.14	0.39	0.02	0.21	0.33
Uniform Delay, d1	74.0	73.1	76.9	6.2	4.4	67.7	3.0
Progression Factor	1.00	1.00	0.81	3.04	4.92	1.15	0.83
Incremental Delay, d2	1.9	0.1	1.6	0.4	0.0	0.6	0.3
Delay (s)	75.9	73.2	63.9	19.1	21.7	78.9	2.8
Level of Service	E	E	E	B	C	E	A
Approach Delay (s)	74.7			19.4			5.2
Approach LOS	E			B			A

Intersection Summary			
HCM 2000 Control Delay	13.7	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.38		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	41.1%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis

1: Warrenton Rd (Rte.17) & Cardinal Forest Drive

Background 2018 - AM



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕	↗		↕	↗	↘	↕↕	↗	↘	↕↕	↗
Traffic Volume (vph)	34	4	30	30	5	10	96	838	13	2	1262	41
Future Volume (vph)	34	4	30	30	5	10	96	838	13	2	1262	41
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			2%			1%			-1%	
Total Lost time (s)		5.0	5.0		5.0	5.0	5.0	6.0	6.0	5.0	6.0	5.0
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.96	1.00		0.96	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1782	1583		1767	1567	1761	3044	1575	1778	3298	1591
Flt Permitted		0.96	1.00		0.96	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		1782	1583		1767	1567	1761	3044	1575	1778	3298	1591
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.96	0.92	0.92	0.94	0.92
Adj. Flow (vph)	37	4	33	33	5	11	104	873	14	2	1343	45
RTOR Reduction (vph)	0	0	28	0	0	10	0	0	4	0	0	14
Lane Group Flow (vph)	0	41	5	0	38	1	104	873	10	2	1343	31
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	18%	2%	2%	10%	2%
Turn Type	Split	NA	pm+ov	Split	NA	Perm	Prot	NA	Perm	Prot	NA	pm+ov
Protected Phases	3	3	1	4	4		1	6		5	2	3
Permitted Phases			3			4			6			2
Actuated Green, G (s)		6.3	19.0		6.2	6.2	12.7	97.5	97.5	1.0	85.8	92.1
Effective Green, g (s)		8.3	23.0		8.2	8.2	14.7	99.5	99.5	3.0	87.8	96.1
Actuated g/C Ratio		0.06	0.16		0.06	0.06	0.10	0.71	0.71	0.02	0.63	0.69
Clearance Time (s)		7.0	7.0		7.0	7.0	7.0	8.0	8.0	7.0	8.0	7.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0	3.0	5.0	5.0	3.0	5.0	3.0
Lane Grp Cap (vph)		105	260		103	91	184	2163	1119	38	2068	1092
v/s Ratio Prot		c0.02	0.00		c0.02		c0.06	0.29		0.00	c0.41	0.00
v/s Ratio Perm			0.00			0.00			0.01			0.02
v/c Ratio		0.39	0.02		0.37	0.01	0.57	0.40	0.01	0.05	0.65	0.03
Uniform Delay, d1		63.4	49.1		63.4	62.1	59.6	8.2	5.9	67.1	16.4	7.0
Progression Factor		1.00	1.00		1.00	1.00	0.82	1.89	1.00	0.80	0.28	0.64
Incremental Delay, d2		2.4	0.0		2.2	0.0	3.8	0.5	0.0	0.5	1.4	0.0
Delay (s)		65.8	49.1		65.6	62.1	52.7	16.0	5.9	53.9	6.0	4.5
Level of Service		E	D		E	E	D	B	A	D	A	A
Approach Delay (s)		58.4			64.8			19.7			6.0	
Approach LOS		E			E			B			A	

Intersection Summary

HCM 2000 Control Delay	14.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	21.0
Intersection Capacity Utilization	62.3%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis

1: Warrenton Rd (Rte.17) & Cardinal Forest Drive

Background 2018 - PM



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕	↗		↕	↗	↖	↕↕	↗	↖	↕↕	↗
Traffic Volume (vph)	92	7	88	20	7	12	175	1500	59	33	1166	75
Future Volume (vph)	92	7	88	20	7	12	175	1500	59	33	1166	75
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			2%			1%			-1%	
Total Lost time (s)		5.0	5.0		5.0	5.0	5.0	6.0	6.0	5.0	6.0	5.0
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.96	1.00		0.96	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1780	1583		1779	1567	1761	3044	1575	1778	3298	1591
Flt Permitted		0.96	1.00		0.96	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		1780	1583		1779	1567	1761	3044	1575	1778	3298	1591
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.96	0.92	0.92	0.94	0.92
Adj. Flow (vph)	100	8	96	22	8	13	190	1562	64	36	1240	82
RTOR Reduction (vph)	0	0	72	0	0	12	0	0	20	0	0	26
Lane Group Flow (vph)	0	108	24	0	30	1	190	1563	44	36	1240	56
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	18%	2%	2%	10%	2%
Turn Type	Split	NA	pm+ov	Split	NA	Perm	Prot	NA	Perm	Prot	NA	pm+ov
Protected Phases	3	3	1	4	4		1	6		5	2	3
Permitted Phases			3			4			6			2
Actuated Green, G (s)		14.2	36.1		4.8	4.8	21.9	107.2	107.2	4.8	90.1	104.3
Effective Green, g (s)		16.2	40.1		6.8	6.8	23.9	109.2	109.2	6.8	92.1	108.3
Actuated g/C Ratio		0.10	0.25		0.04	0.04	0.15	0.68	0.68	0.04	0.58	0.68
Clearance Time (s)		7.0	7.0		7.0	7.0	7.0	8.0	8.0	7.0	8.0	7.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0	3.0	5.0	5.0	3.0	5.0	3.0
Lane Grp Cap (vph)		180	396		75	66	263	2077	1074	75	1898	1076
v/s Ratio Prot		c0.06	0.01		c0.02		0.11	c0.51		0.02	c0.38	0.01
v/s Ratio Perm			0.01			0.00			0.03			0.03
v/c Ratio		0.60	0.06		0.40	0.01	0.72	0.75	0.04	0.48	0.65	0.05
Uniform Delay, d1		68.8	45.6		74.6	73.4	64.9	16.6	8.3	74.9	23.1	8.7
Progression Factor		1.00	1.00		1.00	1.00	0.91	1.03	1.00	0.83	0.58	0.01
Incremental Delay, d2		5.3	0.1		3.5	0.1	9.4	2.6	0.1	4.3	1.6	0.0
Delay (s)		74.1	45.7		78.1	73.4	68.1	19.6	8.4	66.4	14.9	0.1
Level of Service		E	D		E	E	E	B	A	E	B	A
Approach Delay (s)		60.7			76.7			24.2			15.4	
Approach LOS		E			E			C			B	

Intersection Summary

HCM 2000 Control Delay	23.6	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	21.0
Intersection Capacity Utilization	71.1%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis

1: Warrenton Rd (Rte.17) & Cardinal Forest Drive

Background 2018 - Mid Day



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕	↗		↕	↗	↘	↕↕	↗	↘	↕↕	↗
Traffic Volume (vph)	101	15	146	15	15	11	259	1025	28	23	955	90
Future Volume (vph)	101	15	146	15	15	11	259	1025	28	23	955	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			2%			1%			-1%	
Total Lost time (s)		5.0	5.0		5.0	5.0	5.0	6.0	6.0	5.0	6.0	5.0
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.96	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1785	1583		1799	1567	1761	3044	1575	1778	3298	1591
Flt Permitted		0.96	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		1785	1583		1799	1567	1761	3044	1575	1778	3298	1591
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.96	0.92	0.92	0.94	0.92
Adj. Flow (vph)	110	16	159	16	16	12	282	1068	30	25	1016	98
RTOR Reduction (vph)	0	0	93	0	0	11	0	0	10	0	0	37
Lane Group Flow (vph)	0	126	66	0	32	1	282	1068	20	25	1016	61
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	18%	2%	2%	10%	2%
Turn Type	Split	NA	pm+ov	Split	NA	Perm	Prot	NA	Perm	Prot	NA	pm+ov
Protected Phases	3	3	1	4	4		1	6		5	2	3
Permitted Phases			3			4			6			2
Actuated Green, G (s)		16.1	46.9		5.2	5.2	30.8	106.7	106.7	3.0	78.9	95.0
Effective Green, g (s)		18.1	50.9		7.2	7.2	32.8	108.7	108.7	5.0	80.9	99.0
Actuated g/C Ratio		0.11	0.32		0.05	0.05	0.20	0.68	0.68	0.03	0.51	0.62
Clearance Time (s)		7.0	7.0		7.0	7.0	7.0	8.0	8.0	7.0	8.0	7.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0	3.0	5.0	5.0	3.0	5.0	3.0
Lane Grp Cap (vph)		201	503		80	70	361	2068	1070	55	1667	984
v/s Ratio Prot		c0.07	0.03		c0.02		c0.16	0.35		0.01	c0.31	0.01
v/s Ratio Perm			0.01			0.00			0.01			0.03
v/c Ratio		0.63	0.13		0.40	0.01	0.78	0.52	0.02	0.45	0.61	0.06
Uniform Delay, d1		67.7	38.8		74.3	73.0	60.2	12.7	8.3	76.2	28.3	12.1
Progression Factor		1.00	1.00		1.00	1.00	0.87	0.88	1.00	0.83	0.59	0.12
Incremental Delay, d2		6.0	0.1		3.3	0.0	10.4	0.9	0.0	5.1	1.5	0.0
Delay (s)		73.7	38.9		77.6	73.0	62.7	12.0	8.4	68.2	18.3	1.5
Level of Service		E	D		E	E	E	B	A	E	B	A
Approach Delay (s)		54.3			76.3			22.3			17.9	
Approach LOS		D			E			C			B	

Intersection Summary

HCM 2000 Control Delay	24.6	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	21.0
Intersection Capacity Utilization	67.1%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis

1: Warrenton Rd (Rte.17) & Cardinal Forest Drive

Total Future 2018 - AM

													
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Lane Configurations													
Traffic Volume (vph)	55	6	53	30	7	10	136	824	13	2	1241	69	
Future Volume (vph)	55	6	53	30	7	10	136	824	13	2	1241	69	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	
Grade (%)		0%			2%			1%				-1%	
Total Lost time (s)		5.0	5.0		5.0	5.0	5.0	6.0	6.0	5.0	6.0	5.0	
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	
Flt Protected		0.96	1.00		0.96	1.00	0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (prot)		1783	1583		1773	1567	1761	3044	1575	1778	3298	1591	
Flt Permitted		0.96	1.00		0.96	1.00	0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (perm)		1783	1583		1773	1567	1761	3044	1575	1778	3298	1591	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.96	0.92	0.92	0.94	0.92	
Adj. Flow (vph)	60	7	58	33	8	11	148	858	14	2	1320	75	
RTOR Reduction (vph)	0	0	47	0	0	10	0	0	4	0	0	24	
Lane Group Flow (vph)	0	67	11	0	41	1	148	858	10	2	1320	51	
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	18%	2%	2%	10%	2%	
Turn Type	Split	NA	pm+ov	Split	NA	Perm	Prot	NA	Perm	Prot	NA	pm+ov	
Protected Phases	3	3	1	4	4		1	6		5	2	3	
Permitted Phases			3			4			6			2	
Actuated Green, G (s)		7.7	21.9		6.3	6.3	14.2	96.0	96.0	1.0	82.8	90.5	
Effective Green, g (s)		9.7	25.9		8.3	8.3	16.2	98.0	98.0	3.0	84.8	94.5	
Actuated g/C Ratio		0.07	0.18		0.06	0.06	0.12	0.70	0.70	0.02	0.61	0.68	
Clearance Time (s)		7.0	7.0		7.0	7.0	7.0	8.0	8.0	7.0	8.0	7.0	
Vehicle Extension (s)		3.0	3.0		3.0	3.0	3.0	5.0	5.0	3.0	5.0	3.0	
Lane Grp Cap (vph)		123	292		105	92	203	2130	1102	38	1997	1073	
v/s Ratio Prot		c0.04	0.00		c0.02		c0.08	0.28		0.00	c0.40	0.00	
v/s Ratio Perm			0.00			0.00			0.01			0.03	
v/c Ratio		0.54	0.04		0.39	0.01	0.73	0.40	0.01	0.05	0.66	0.05	
Uniform Delay, d1		63.0	46.8		63.4	62.0	59.8	8.8	6.3	67.1	18.1	7.6	
Progression Factor		1.00	1.00		1.00	1.00	0.83	1.84	1.00	0.79	0.27	0.08	
Incremental Delay, d2		4.9	0.1		2.4	0.0	11.9	0.5	0.0	0.5	1.5	0.0	
Delay (s)		67.9	46.9		65.8	62.0	61.3	16.7	6.4	53.6	6.5	0.7	
Level of Service		E	D		E	E	E	B	A	D	A	A	
Approach Delay (s)		58.1			65.0			23.1			6.2		
Approach LOS		E			E			C			A		
Intersection Summary													
HCM 2000 Control Delay			16.5									HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio			0.64										
Actuated Cycle Length (s)			140.0									Sum of lost time (s)	21.0
Intersection Capacity Utilization			65.2%									ICU Level of Service	C
Analysis Period (min)			15										

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis

1: Warrenton Rd (Rte.17) & Cardinal Forest Drive

Total Future 2018 - PM

													
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Lane Configurations													
Traffic Volume (vph)	111	8	102	20	8	12	209	1486	59	33	1154	92	
Future Volume (vph)	111	8	102	20	8	12	209	1486	59	33	1154	92	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	
Grade (%)		0%			2%			1%			-1%		
Total Lost time (s)		5.0	5.0		5.0	5.0	5.0	6.0	6.0	5.0	6.0	5.0	
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	
Flt Protected		0.96	1.00		0.97	1.00	0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (prot)		1780	1583		1781	1567	1761	3044	1575	1778	3298	1591	
Flt Permitted		0.96	1.00		0.97	1.00	0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (perm)		1780	1583		1781	1567	1761	3044	1575	1778	3298	1591	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.96	0.92	0.92	0.94	0.92	
Adj. Flow (vph)	121	9	111	22	9	13	227	1548	64	36	1228	100	
RTOR Reduction (vph)	0	0	81	0	0	12	0	0	21	0	0	33	
Lane Group Flow (vph)	0	130	30	0	31	1	227	1548	43	36	1228	67	
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	18%	2%	2%	10%	2%	
Turn Type	Split	NA	pm+ov	Split	NA	Perm	Prot	NA	Perm	Prot	NA	pm+ov	
Protected Phases	3	3	1	4	4		1	6		5	2	3	
Permitted Phases			3			4			6			2	
Actuated Green, G (s)		15.2	39.1		4.4	4.4	23.9	106.6	106.6	4.8	87.5	102.7	
Effective Green, g (s)		17.2	43.1		6.4	6.4	25.9	108.6	108.6	6.8	89.5	106.7	
Actuated g/C Ratio		0.11	0.27		0.04	0.04	0.16	0.68	0.68	0.04	0.56	0.67	
Clearance Time (s)		7.0	7.0		7.0	7.0	7.0	8.0	8.0	7.0	8.0	7.0	
Vehicle Extension (s)		3.0	3.0		3.0	3.0	3.0	5.0	5.0	3.0	5.0	3.0	
Lane Grp Cap (vph)		191	426		71	62	285	2066	1069	75	1844	1060	
v/s Ratio Prot		c0.07	0.01		c0.02		0.13	c0.51		0.02	c0.37	0.01	
v/s Ratio Perm			0.01			0.00			0.03			0.04	
v/c Ratio		0.68	0.07		0.44	0.01	0.80	0.75	0.04	0.48	0.67	0.06	
Uniform Delay, d1		68.8	43.5		75.0	73.8	64.5	16.8	8.5	74.9	24.8	9.3	
Progression Factor		1.00	1.00		1.00	1.00	0.91	1.03	1.00	0.83	0.57	0.01	
Incremental Delay, d2		9.6	0.1		4.3	0.1	14.2	2.5	0.1	4.3	1.7	0.0	
Delay (s)		78.3	43.6		79.3	73.8	72.6	19.8	8.6	66.3	15.9	0.1	
Level of Service		E	D		E	E	E	B	A	E	B	A	
Approach Delay (s)		62.3			77.7			25.9			16.0		
Approach LOS		E			E			C			B		
Intersection Summary													
HCM 2000 Control Delay			25.2									HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio			0.73										
Actuated Cycle Length (s)			160.0									Sum of lost time (s)	21.0
Intersection Capacity Utilization			71.8%									ICU Level of Service	C
Analysis Period (min)			15										

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis

1: Warrenton Rd (Rte.17) & Cardinal Forest Drive

Total Future 2018 - Mid Day



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕	↗		↕	↗	↘	↕↕	↗	↘	↕↕	↗
Traffic Volume (vph)	133	17	173	15	17	11	315	1003	28	23	932	123
Future Volume (vph)	133	17	173	15	17	11	315	1003	28	23	932	123
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			2%			1%				-1%
Total Lost time (s)		5.0	5.0		5.0	5.0	5.0	6.0	6.0	5.0	6.0	5.0
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.96	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1783	1583		1802	1567	1761	3044	1575	1778	3298	1591
Flt Permitted		0.96	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		1783	1583		1802	1567	1761	3044	1575	1778	3298	1591
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.96	0.92	0.92	0.94	0.92
Adj. Flow (vph)	145	18	188	16	18	12	342	1045	30	25	991	134
RTOR Reduction (vph)	0	0	88	0	0	12	0	0	10	0	0	54
Lane Group Flow (vph)	0	163	100	0	34	0	342	1045	20	25	991	80
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	18%	2%	2%	10%	2%
Turn Type	Split	NA	pm+ov	Split	NA	Perm	Prot	NA	Perm	Prot	NA	pm+ov
Protected Phases	3	3	1	4	4		1	6		5	2	3
Permitted Phases			3			4			6			2
Actuated Green, G (s)		18.0	52.9		4.5	4.5	34.9	105.5	105.5	3.0	73.6	91.6
Effective Green, g (s)		20.0	56.9		6.5	6.5	36.9	107.5	107.5	5.0	75.6	95.6
Actuated g/C Ratio		0.12	0.36		0.04	0.04	0.23	0.67	0.67	0.03	0.47	0.60
Clearance Time (s)		7.0	7.0		7.0	7.0	7.0	8.0	8.0	7.0	8.0	7.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0	3.0	5.0	5.0	3.0	5.0	3.0
Lane Grp Cap (vph)		222	562		73	63	406	2045	1058	55	1558	950
v/s Ratio Prot		c0.09	0.04		c0.02		c0.19	0.34		0.01	c0.30	0.01
v/s Ratio Perm			0.02			0.00			0.01			0.04
v/c Ratio		0.73	0.18		0.47	0.01	0.84	0.51	0.02	0.45	0.64	0.08
Uniform Delay, d1		67.4	35.5		75.1	73.7	58.8	13.1	8.7	76.2	31.8	13.6
Progression Factor		1.00	1.00		1.00	1.00	0.87	0.88	1.00	0.83	0.62	0.12
Incremental Delay, d2		11.9	0.2		4.6	0.0	14.5	0.9	0.0	5.1	1.7	0.0
Delay (s)		79.3	35.6		79.7	73.7	65.8	12.5	8.8	68.2	21.5	1.6
Level of Service		E	D		E	E	E	B	A	E	C	A
Approach Delay (s)		55.9			78.1			25.3			20.2	
Approach LOS		E			E			C			C	

Intersection Summary

HCM 2000 Control Delay	27.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	21.0
Intersection Capacity Utilization	71.5%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

APPENDIX F

Queueing Analysis Worksheets

Intersection: 1: Warrenton Rd (Rte.17) & Cardinal Forest Drive

Movement	WB	WB	NB	NB	NB	NB	SB	SB
Directions Served	L	R	U	T	T	R	L	T
Maximum Queue (ft)	81	33	35	206	165	23	21	34
Average Queue (ft)	21	5	4	70	39	2	2	1
95th Queue (ft)	58	21	21	178	121	12	13	15
Link Distance (ft)	788	788		1951	1951			955
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)			275			190	510	
Storage Blk Time (%)					0			
Queuing Penalty (veh)					0			

Intersection: 1: Warrenton Rd (Rte.17) & Cardinal Forest Drive

Movement	WB	WB	NB	NB	NB	NB	SB	SB	SB
Directions Served	L	R	U	T	T	R	L	T	T
Maximum Queue (ft)	71	43	29	330	332	82	99	70	20
Average Queue (ft)	18	8	3	77	68	6	30	7	1
95th Queue (ft)	52	29	18	229	214	47	75	37	9
Link Distance (ft)	788	788		1951	1951			955	955
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)			275			190	510		
Storage Blk Time (%)				0	1				
Queuing Penalty (veh)				0	1				

Intersection: 1: Warrenton Rd (Rte.17) & Cardinal Forest Drive

Movement	WB	WB	NB	NB	NB	NB	SB	SB	SB
Directions Served	L	R	U	T	T	R	L	T	T
Maximum Queue (ft)	54	46	23	406	319	57	82	35	16
Average Queue (ft)	12	8	2	104	61	4	23	2	1
95th Queue (ft)	39	28	16	296	197	35	60	17	10
Link Distance (ft)	788	788		1951	1951			955	955
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)			275			190	510		
Storage Blk Time (%)				1	1				
Queuing Penalty (veh)				0	0				

Intersection: 1: Warrenton Rd (Rte.17) & Cardinal Forest Drive

Movement	EB	EB	WB	WB	NB	NB	NB	NB	SB	SB	SB	SB
Directions Served	LT	R	LT	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	99	52	98	26	181	306	229	12	22	147	130	18
Average Queue (ft)	35	18	33	6	72	117	51	1	2	19	19	1
95th Queue (ft)	80	46	79	21	143	263	156	6	12	86	81	9
Link Distance (ft)	98	98	791	791		413	413			950	950	950
Upstream Blk Time (%)	1					0						
Queuing Penalty (veh)	0					1						
Storage Bay Dist (ft)					275			190	510			
Storage Blk Time (%)						1	0					
Queuing Penalty (veh)						1	0					

Intersection: 1: Warrenton Rd (Rte.17) & Cardinal Forest Drive

Movement	B35	B35
Directions Served	T	T
Maximum Queue (ft)	48	49
Average Queue (ft)	2	2
95th Queue (ft)	49	50
Link Distance (ft)	509	509
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 1: Warrenton Rd (Rte.17) & Cardinal Forest Drive

Movement	EB	EB	WB	WB	NB	NB	NB	NB	SB	SB	SB	SB
Directions Served	LT	R	LT	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	113	80	82	37	338	410	382	148	90	166	186	38
Average Queue (ft)	80	31	28	8	165	228	168	13	33	89	95	4
95th Queue (ft)	124	59	66	28	278	382	348	93	76	155	166	19
Link Distance (ft)	98	98	791	791		415	415			950	950	950
Upstream Blk Time (%)	14	0			0	0	0					
Queuing Penalty (veh)	13	0			0	3	0					
Storage Bay Dist (ft)					275			190	510			
Storage Blk Time (%)					2	4	4					
Queuing Penalty (veh)					14	8	2					

Intersection: 1: Warrenton Rd (Rte.17) & Cardinal Forest Drive

Movement	EB	EB	WB	WB	NB	NB	NB	NB	SB	SB	SB	SB
Directions Served	LT	R	LT	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	113	78	92	30	340	382	318	47	72	197	209	30
Average Queue (ft)	86	37	30	6	207	185	91	3	21	73	80	5
95th Queue (ft)	125	66	71	23	319	348	225	31	54	155	168	20
Link Distance (ft)	98	98	791	791		413	413			950	950	950
Upstream Blk Time (%)	18	0				0	0					
Queuing Penalty (veh)	24	0				3	0					
Storage Bay Dist (ft)					275			190	510			
Storage Blk Time (%)					5	2	1					
Queuing Penalty (veh)					28	6	0					

Intersection: 1: Warrenton Rd (Rte.17) & Cardinal Forest Drive

Movement	EB	EB	WB	WB	NB	NB	NB	NB	SB	SB	SB	SB
Directions Served	LT	R	LT	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	108	55	91	26	242	301	232	10	17	89	86	21
Average Queue (ft)	54	25	33	6	116	140	52	1	1	15	13	2
95th Queue (ft)	103	51	75	21	205	284	150	6	7	55	52	11
Link Distance (ft)	98	98	791	791		413	413			950	950	950
Upstream Blk Time (%)	4	0										
Queuing Penalty (veh)	2	0										
Storage Bay Dist (ft)					275			190	510			
Storage Blk Time (%)					0	1	0					
Queuing Penalty (veh)					0	1	0					

Intersection: 1: Warrenton Rd (Rte.17) & Cardinal Forest Drive

Movement	EB	EB	WB	WB	NB	NB	NB	NB	SB	SB	SB	SB
Directions Served	LT	R	LT	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	114	65	88	26	346	415	388	191	97	210	200	30
Average Queue (ft)	90	32	30	6	199	247	185	12	34	87	94	4
95th Queue (ft)	130	58	70	21	320	397	356	89	80	164	169	18
Link Distance (ft)	98	98	791	791		414	414			950	950	950
Upstream Blk Time (%)	23	0				1	0					
Queuing Penalty (veh)	25	0				7	1					
Storage Bay Dist (ft)					275			190	510			
Storage Blk Time (%)					5	5	5					
Queuing Penalty (veh)					40	11	3					

Intersection: 1: Warrenton Rd (Rte.17) & Cardinal Forest Drive

Movement	B35
Directions Served	T
Maximum Queue (ft)	56
Average Queue (ft)	2
95th Queue (ft)	58
Link Distance (ft)	509
Upstream Blk Time (%)	0
Queuing Penalty (veh)	0
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 1: Warrenton Rd (Rte.17) & Cardinal Forest Drive

Movement	EB	EB	WB	WB	NB	NB	NB	NB	SB	SB	SB	SB
Directions Served	LT	R	LT	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	115	90	99	26	408	456	408	24	78	217	222	54
Average Queue (ft)	102	38	32	7	320	327	120	2	24	99	109	14
95th Queue (ft)	125	72	76	23	460	535	321	10	61	189	200	40
Link Distance (ft)	98	98	791	791		414	414			950	950	950
Upstream Blk Time (%)	44	0			6	18	0					
Queuing Penalty (veh)	72	0			0	124	2					
Storage Bay Dist (ft)					275			190	510			
Storage Blk Time (%)					39	8	1					
Queuing Penalty (veh)					198	25	0					

APPENDIX G

Background Development Trip Assignments

