
**DUPUY AVENUE MODERNIZATION
TRAFFIC STUDY**

**CITY OF COLONIAL HEIGHTS
VIRGINIA**

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1. EXECUTIVE SUMMARY

This report presents the results of a traffic engineering study conducted as part of the Dupuy Avenue Modernization project. This study examines capacity and operational improvements needed along a 0.4-mile segment of Dupuy Avenue in the City of Colonial Heights, Virginia. Proposed improvements for this project include providing a center two-way left turn lane (TWLTL), along with landscaping and a storm drain system on Dupuy Avenue, between East River Road and Boulevard.

The expected project completion date is 2016, and the design year is 2036. Capacity analyses are conducted for the existing year (2012), build-out year (2016), and design year (2036). In addition, capacity analyses are conducted for 2016 and 2036 to determine whether Dupuy Avenue should be constructed as a two-lane roadway with a TWLTL or a four-lane roadway with a TWLTL.

Four intersections are examined in this study, and only one of them is currently signalized:

- Dupuy Avenue at Boulevard (signal)
- Dupuy Avenue at Battery Place (stop control on side street)
- Dupuy Avenue at Meridian Ave (stop control on side street)
- Dupuy Avenue/East River Road at Dupuy Road and Martin Luther King Drive (stop control on side street)

Summary of 2012 Existing Conditions

Intersection capacity analyses show that currently, in 2012, all four study intersections operate at acceptable overall levels of service (LOS) D or better. However, several movements operate at failing service levels of LOS E or F. Primarily, these poor service levels occur at the unsignalized side streets or left turns to/from Dupuy Avenue at Boulevard.

Summary of 2016 Build-Out Year Conditions

Whether improvements planned under Dupuy Avenue Modernization project are constructed or not, improvements planned for the Dupuy Avenue at Boulevard intersection will be constructed as a part of the Boulevard Modernization Project. In addition, construction and expansion at the Virginia Statue University is expected to be complete by 2016, and these activities change the lane configuration at the Dupuy Avenue intersections with Meridian Avenue and with Martin Luther King Drive. All analyses for 2016 and 2036 include these adjacent planned improvements and signal timings optimization.

In 2016 no build conditions where no improvements are constructed on Dupuy Avenue, more individual side street movements operate at LOS E or F, and side street delay at Battery Place reaches over 15 minutes on the southbound approach. Improvements at Dupuy Avenue and Boulevard are constructed by 2016, regardless of whether or not the Dupuy Avenue Modernization project is completed.

In 2016 build-out conditions, delays are reduced compared to the no-build scenario. All intersections again operate at overall LOS D or better, although there are still a few individual movements with LOS E. There is little difference between service levels if Dupuy Avenue is

constructed as a four-lane road instead of a two-lane road.

Summary of 2036 Design Year Conditions

In 2036 no-build conditions, the study intersections display many service failures, and the side street approaches at the unsignalized intersections operate with excessive delays of 7-18 minutes, depending on the approach.

In 2036 build-out conditions, the construction of the TWLTL dramatically improves operations at the unsignalized intersections. However, the intersection of Dupuy Avenue at Boulevard still operates at LOS F in the PM peak due to the large left turn volumes from Dupuy Avenue eastbound that are projected as 1,150 vehicles per hour. This is much larger than typically seen even for a quadruple-left turn. Because Boulevard is only a four-lane road, the Dupuy Avenue left turn is limited to two lanes. There is no way to improve the signal to handle this level of turns without significant redesign or rerouting a large percentage to another roadway.

Comparison of Two-Lane and Four-Lane Section

At the unsignalized intersections, there are some improvements to side street delay if Dupuy Avenue is constructed as a four-lane road instead of a two-lane road, but the overall intersection operations do not change.

Summary of Arterial Analysis Results

The ADT for Dupuy Avenue is 21,000 vpd in 2016 and 27,000 vpd in 2036. The daily traffic volumes on Dupuy Avenue for both 2016 and 2036 are **above** the HCM thresholds (15,400 to 18,899 vpd) for a two-lane urban street segment to operate at LOS D. However, the daily volumes are **below** the thresholds (31,400 to 37,899 vpd) defined for a four-lane roadway to operate at LOS D.

The corridor analyses indicates that during PM in existing condition, 2036 no build condition and 2036 build-out condition eastbound on Dupuy Avenue will experience LOS E or F due to signal related delay at Dupuy Avenue eastbound approach at Boulevard.

Based on these weekday results, widening Dupuy Avenue to four-lanes with a TWLTL yields slight benefit compared to a two-lane road with a TWLTL.

2. INTRODUCTION

This report presents results of a traffic engineering study conducted for a 0.4 mile segment of Dupuy Avenue between Boulevard (Route 1) and East River Road/Dupuy Road in the City of Colonial Heights, Virginia. This study is a part of the Boulevard Modernization project that is designed to provide capacity and operational improvements, including additional turn lanes, landscaping, and storm drain system improvements.

The advertisement year for the project is 2014, with a projected completion date of 2016. The future design year is the advertisement date plus 22 years, or 2036. Capacity and queuing analyses have been conducted for the existing year (2012), the build or opening year (2016), and the design year (2036). No-build conditions were also evaluated for 2016 and 2036 for base line comparison. The study has been conducted for the following intersections:

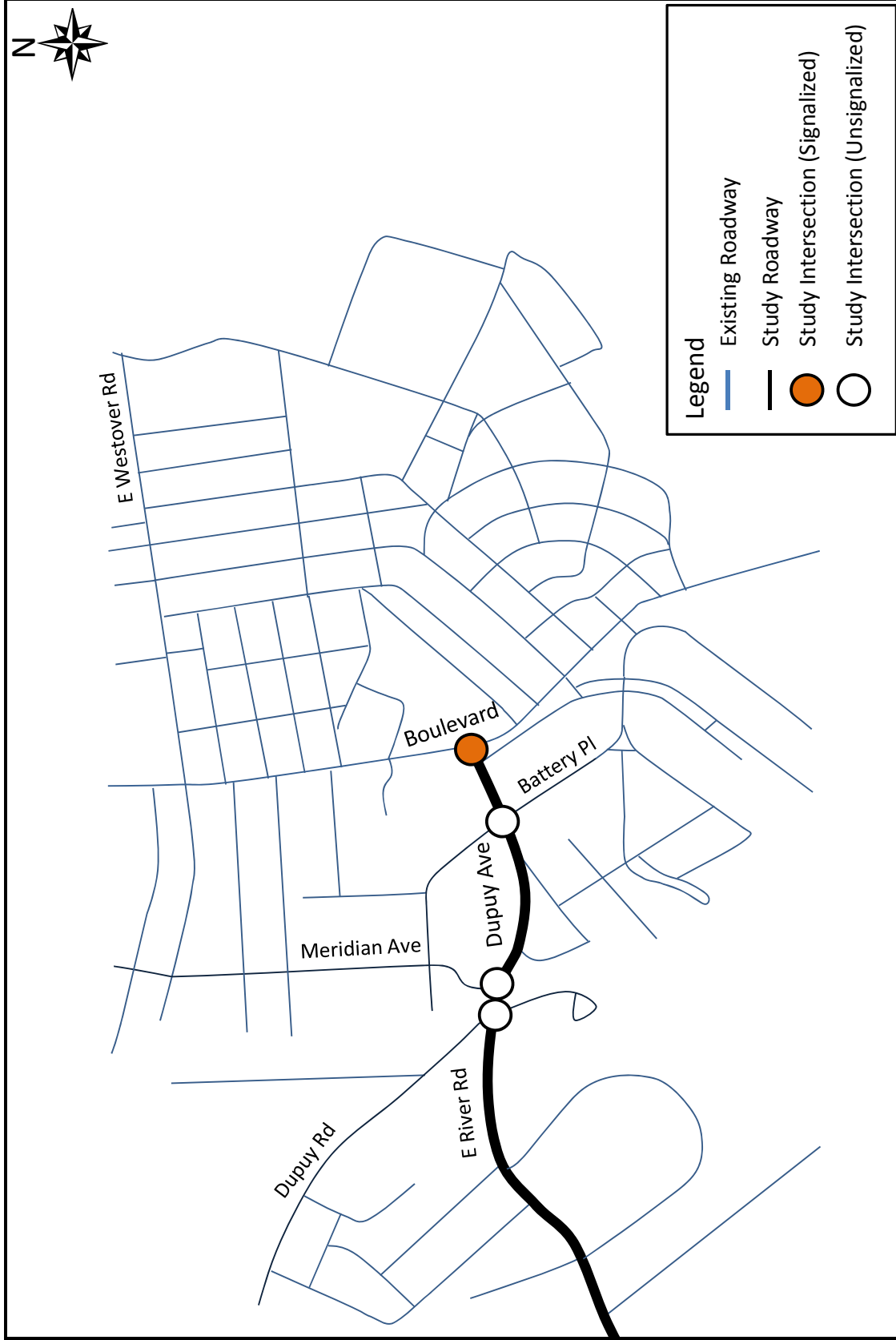
- Dupuy Avenue at Boulevard
- Dupuy Avenue at Battery Place
- Dupuy Avenue at Meridian Ave
- Dupuy Avenue/East River Road at Dupuy Road and Martin Luther King Drive

Figure 1 shows the site location and study intersections. The scope of this study includes the following tasks:

- Collect inventory of the existing roadway network, including storage and taper lengths for the turn lanes at each intersection
- Conduct two-way, 24-hour traffic classification counts at Dupuy Avenue, Dupuy Road, and East River Road
- Conduct turning movement counts at the study intersections for the AM and PM peak periods
- Review historical traffic volume data
- Review traffic volume data from the Richmond Regional Model
- Develop traffic growth rates for the opening and design years using historical traffic count data and information from the regional travel demand model
- Forecast design hourly volumes for the opening and design years using the appropriate traffic growth rate
- Review Virginia State University, Multipurpose Center Traffic Impact Study and consider traffic volume generated by the proposed development at the study intersections
- Capacity analysis of the study corridor for 2012 existing traffic conditions
- Capacity analysis of the study corridor for 2016 traffic conditions: build-out and no-build
- Capacity analysis of the study corridor for 2036 traffic conditions: build-out and no-build
- Corridor LOS analysis for 2016 and 2036 build-out conditions
- Analyze and recommend whether Dupuy Avenue should be constructed as a two-lane or a four-lane roadway with a TWLTL

This report provides a discussion of existing conditions, projected traffic growth, evaluation of the signalized intersections, future conditions, conclusions, and recommendations.

Figure 1: Study Site Location



3. 2012 EXISTING YEAR CONDITIONS

Roadway Inventory

Average Annual Daily Traffic (AADT) volumes listed in this section are as published in the 2010 VDOT Daily Traffic Volume estimates.

Dupuy Avenue is a two-lane undivided urban minor arterial that terminates at Boulevard to the east and Dupuy Road/East River Road to the west. Dupuy Avenue has a mix of residential and institutional land uses, including a church and the campus of Virginia State University (VSU). The posted speed limit on Dupuy Avenue is 25 mph, and the AADT is 13,000 vehicles per day (vpd).

Boulevard (Route 1/ Route 301) runs north-south within the City of Colonial Heights. South of the City, Route 1 extends as an urban other principal arterial and terminates at East Wythe Street. North of the City, Boulevard becomes Jefferson Davis Highway. Within the study limits, Boulevard is a four-lane undivided urban other principal arterial and has a posted speed limit of 30 mph. The AADT is 25,000 vpd.

Battery Place is a two-lane undivided local street that runs north-south through a residential area from Marvin Avenue to Wright Avenue. Battery Place intersects Dupuy Avenue about 600 feet west of Boulevard. The posted speed limit on Battery Place is 25 mph, and the AADT is not published for this road.

Dupuy Road is a two-lane undivided urban collector that runs northwest-southeast from the end of Dupuy Avenue at East River Road to Woodpecker Road. The posted speed limit on this roadway is 35 mph, and the AADT is 1,800 vpd.

East River Road is a two-lane undivided urban minor arterial that terminates at Granger Street to the west and extend east until Dupuy Road, where it is renamed Dupuy Avenue. East River Road provides direct access to Virginia State University (VSU). The posted speed limit is 35 mph, and the AADT is 17,000 vpd.

Martin Luther King Drive is a two-lane undivided local road that runs north-south from the intersection of Dupuy Avenue/East River Road at Dupuy Road and terminates as a cul-de-sac.

Meridian Avenue is a two-lane undivided local road that runs north-south from Maple Avenue to Dupuy Avenue. The speed limit is 25 mph, and the AADT is not published for this road.

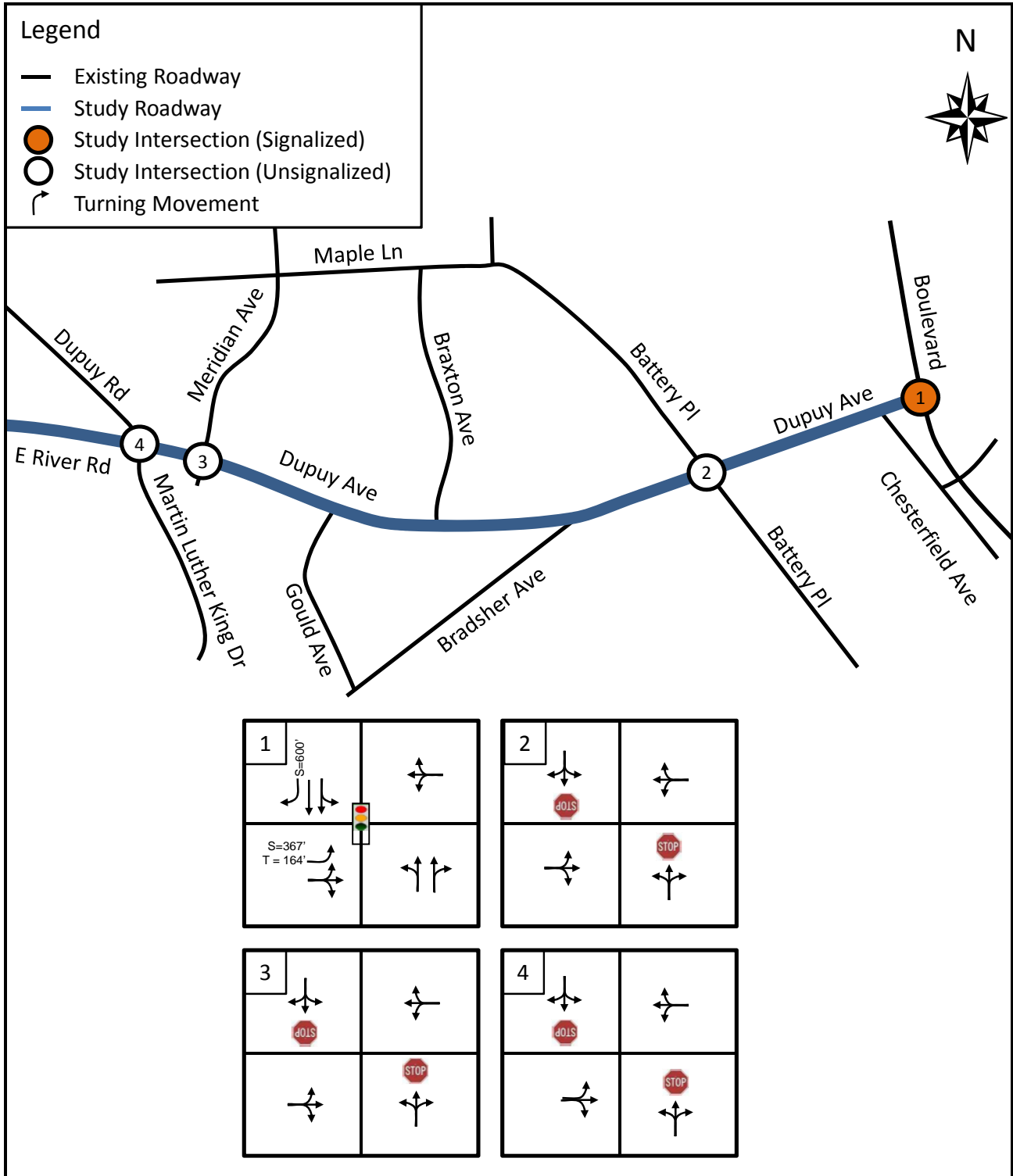
Study Intersections

1. **Boulevard at Dupuy Avenue** is a four-way signalized intersection. The westbound side street approach is a commercial entrance, and both side street approaches are operated with split phases. Because this intersection is so close to the intersection of Boulevard at Lee Avenue, they both operate together with a same controller. There are currently no pedestrian crosswalks at this intersection.
2. **Dupuy Avenue at Battery Place** is a four-way unsignalized intersection with stop control on the northbound and southbound Battery Place approaches. There are no dedicated turn lanes and no pedestrian crosswalks at this intersection.

3. **Dupuy Avenue at Meridian Avenue** is a three-way unsignalized intersection with stop control at the Meridian Avenue approach. The southbound approach is an entrance to a gravel parking lot. There are no dedicated turn lanes and pedestrian crosswalks at any approach to this intersection.
4. **Dupuy Avenue/East River Road at Dupuy Road/Martin Luther King Drive** is a four-way unsignalized intersection with stop control on the side street approaches. This intersection is located approximately 150 feet west of the unsignalized intersection of Dupuy Avenue at Meridian Avenue. There are no dedicated turn lanes and pedestrian crosswalks at any approach of this intersection.

Figure 2 shows the existing lane configurations at the study intersections, as well as storage and taper length dimensions for any turn bays.

Figure 2: 2012 Existing Intersection Geometry



2012 Existing Conditions

Peak period turning movement counts were collected during the week of February 27, 2012 from 7:30 AM – 10:00 AM and from 4:00 PM – 6:00 PM at the following intersections:

- Dupuy Avenue/East River Road at Dupuy Road/Martin Luther King Drive
- Dupuy Avenue at Meridian Avenue
- Dupuy Avenue at Battery Place

The peak hour turning movement counts at the Dupuy Avenue and Boulevard intersection were collected for the same time periods on March 21, 2012.

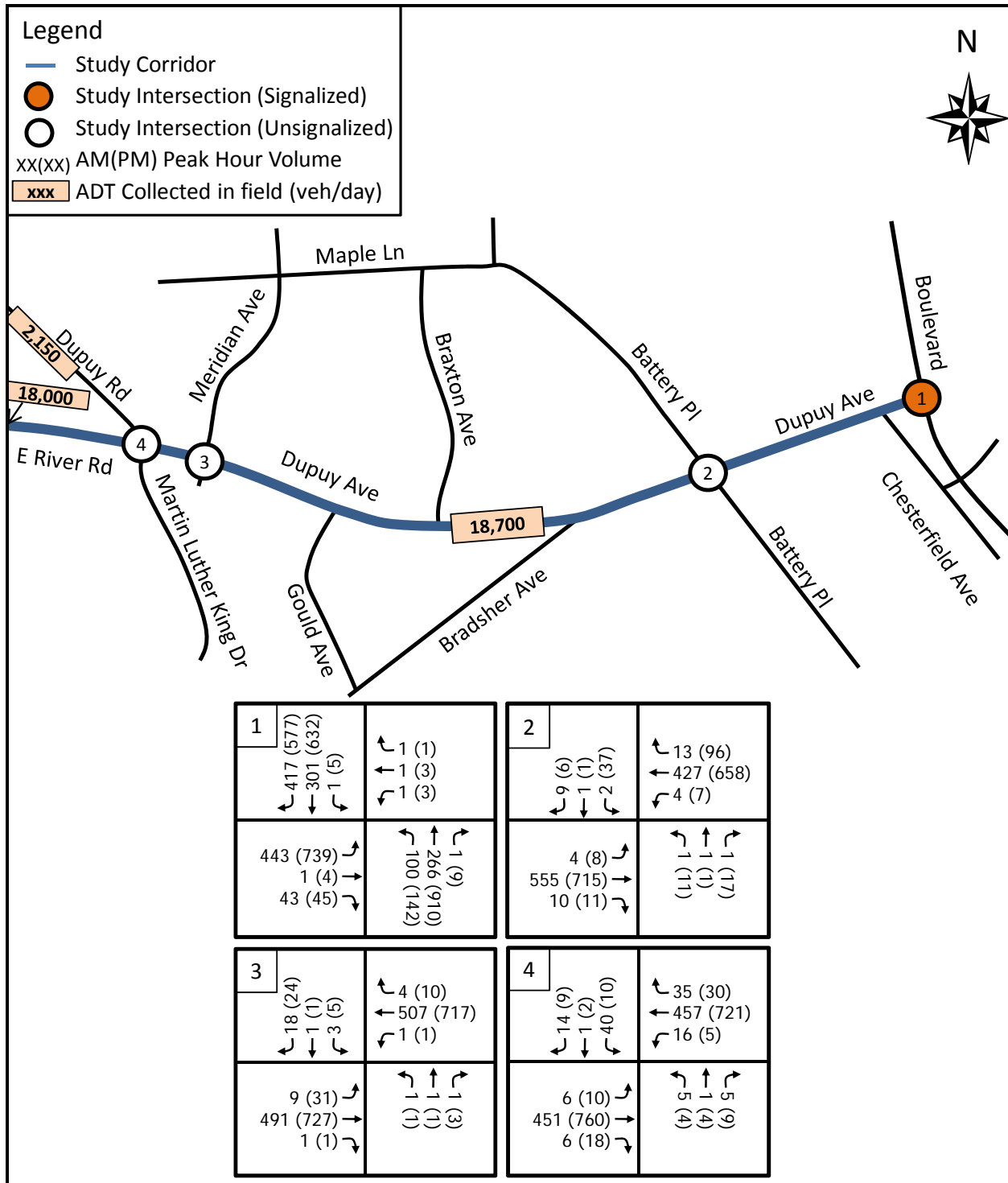
Twenty-four hour (24-hour) vehicle classification and speed data were collected in 15-minute intervals for each direction of travel on Dupuy Avenue, Dupuy Road, and East River Road from February 22, 2012 to February 24, 2012. Copies of the traffic data are included in Appendix A.

The AM and PM peak hour traffic volumes were balanced between each intersection for continuity and are shown in Figure 3.

Heavy Vehicle Percentage

The 24-hour vehicle classification data as well as the 2010 AADT data published by VDOT were evaluated to determine the heavy vehicle percentages on Dupuy Avenue and intersecting roadways. On all roadways, the percentage ranged between 1 to 2 percent, so a 2 percent heavy vehicle percentage was used at all intersections.

Figure 3: 2012 Existing Peak Hour Volumes



Analysis Methodology

Capacity analyses of the study intersections were completed using methodologies defined in the *Highway Capacity Manual (HCM 2000)*. This is the typical methodology for the analysis of traffic condition. Synchro 7.0 traffic modeling and simulation software was used to perform the analyses.

Operating conditions at the intersections are evaluated in terms of levels of service. Levels of Service (LOS) for signalized intersections are presented in terms of control delay (delay caused by the traffic signal). Individual turning movements at signalized intersections may experience poor LOS, particularly on the side streets, while the intersection as a whole has an acceptable LOS. Generally, this is because the major movements are given priority in assigning green time to promote progression and/or mainline mobility.

Traffic conditions at unsignalized intersections with stop sign control on the minor street are only evaluated for the minor street approaches and for the left turn from the major street. Major street through traffic is considered to have no delay since it has a free-flow operation (no stop sign), unless traffic must stop on a two-lane road behind a vehicle waiting to turn left.

LOS A through D are considered acceptable peak hour operations. LOS E and F are generally considered unacceptable peak hour condition, although low-volume side-street approaches at unsignalized intersections frequently experience low levels of service. The LOS criteria for signalized and unsignalized intersections are shown in Table 1.

Table 1: Intersection LOS Delay Criteria

Level of Service	Control Delay (seconds per vehicle)	
	Signalized Intersection	Unsignalized Intersection
A	≤ 10	≤ 10
B	>10 and ≤20	>10 and ≤15
C	>20 and ≤35	>15 and ≤25
D	>35 and ≤55	>25 and ≤35
E	>55 and ≤80	>35 and ≤50
F	> 80	> 50

Source: Highway Capacity Manual, Millennium Edition.

The corridor level of service measured on Dupuy Avenue Corridor between Dupuy Road and Boulevard is based on the percentage of travel time compared to the basic free flow speed that is assumed to be the same as the 25 mph posted speed limit. The travel time on segment includes the running timing and the delay time. The LOS criteria for arterial corridor are shown in Table 2.

Table 2: Automobile Urban Street LOS Delay Criteria for Corridors

Urban Street Class	IV	
Range of Free-Flow Speeds (FFS)	35 to 25 mph	
Typical FFS	30 mph	
Level of Service	Average Travel Speed (mi/h)	
A	>	25
B	>	19 - 25
C	>	13 - 19
D	>	9 - 13
E	>	7 - 9
F	<=	7

Source: Highway Capacity Manual, Millennium Edition.

Intersection Capacity Analysis: 2012 Existing Conditions

Table 3 presents capacity analysis results for the 2012 existing traffic conditions. The Synchro reports for 2012 are compiled and presented in Appendix B.

Table 3: 2012 Existing Year Levels of Service

Intersection	Control Type	Movement	Existing 2012			
			AM		PM	
			Delay	LOS	Delay	LOS
1. Dupuy Ave @ Boulevard	Signalized	EBL	46.0	D	120.4	F
		EBLTR	43.7	D	122.3	F
		EB Overall	44.9	D	121.3	F
		WBLTR	48.1	D	49.6	D
		WB Overall	48.1	D	49.6	D
		NBLT/NBTR	3.3	A	29.9	C
		NB Overall	3.3	A	29.9	C
		SBLT/SBT	8.8	A	14.1	B
		SBR	10.2	B	14.7	B
		SB Overall	9.6	A	14.4	B
Intersection Overall		19.3	B	49.7	D	
2. Dupuy Ave @ Battery Pl	Unsignalized	EBLTR	0.2	A	0.4	A
		WBLTR	0.3	A	0.4	A
		SBLTR	16.8	C	162.1	F
		NBLTR	21.9	C	47.0	E
		Intersection Overall	0.8	A	7.1	A
3. Dupuy Avenue @ Meridian Ave	Unsignalized	EBLTR	0.6	A	1.3	A
		WBLTR	0.1	A	0.0	A
		NBLTR	26.8	D	47.2	E
		SBLTR	16.7	C	32.3	D
		Intersection Overall	0.9	A	2.0	A
4. Dupuy Ave/East River Rd @ Dupuy Rd	Unsignalized	EBLTR	0.3	A	0.6	A
		WBLTR	0.5	A	0.3	A
		NBLTR	24.7	C	47.9	E
		SBLTR	32.2	D	68.3	F
		Intersection Overall	2.5	A	2.3	A

During the AM peak hour, all movements at the study intersections operate at an acceptable LOS of D or better.

During the PM peak hour, all intersections operate at acceptable LOS, but several individual movements operate at failing levels. Movements with LOS E or F include eastbound Dupuy Avenue at Boulevard, and most of the stop-controlled side street approaches at unsignalized intersections.

Corridor LOS Analysis: 2012 Existing Conditions

Table 4 shows the corridor LOS results.

Table 4: 2012 Existing Year Dupuy Avenue Corridor Levels of Service

From	To	Direction	Existing 2012 AM							
			BFFS (mph)	Distance (mile)	Running Time (sec)	Delays (sec)	Travel Time (sec)	Arterial Speed (mph)	Travel Speed as a Percentage of BFFS (%)	LOS
Dupuy Rd	Boulevard	EB	25	0.4	64.7	44.5	109.2	14.8	59%	C
Boulevard	Dupuy Rd	WB	25	0.4	64.7	0.9	65.6	24.7	99%	B
From	To	Direction	Existing 2012 PM							
			BFFS (mph)	Distance (mile)	Running Time (sec)	Delays (sec)	Travel Time (sec)	Arterial Speed (mph)	Travel Speed as a Percentage of BFFS (%)	LOS
Dupuy Rd	Boulevard	EB	25	0.4	64.7	124.0	188.7	8.6	34%	E
Boulevard	Dupuy Rd	WB	25	0.4	64.7	0.7	65.4	24.7	99%	A

Currently, Dupuy Avenue eastbound operates at LOS E in the PM peak period. This is due primarily to delays from the traffic signal at Boulevard.

4. 2016 BUILD-OUT YEAR CONDITIONS

Background Traffic Growth

The advertisement date for Dupuy Avenue Modernization is 2014, with a project completion date of 2016. Traffic volumes are expected to increase each year, whether or not any improvements are made to the roadway network. Future traffic volumes are projected by applying an annual growth rate to the existing traffic volumes and compounding it for the number of years required for each analysis period.

The annual traffic growth rates for Dupuy Avenue was determined by evaluating trends in the historical AADT traffic volume data published by VDOT, traffic growth projection provided by the Statewide Planning System (SPS), and AADT data from the Richmond Regional Model.

The historical AADT data published by VDOT indicates that the AADT volumes on Dupuy Avenue remain consistent as 13,000 vpd from 2007 to 2010. The SPS database indicates a 0.9 percent annual traffic growth rate on Dupuy Avenue between West City Line Colonial Heights to Boulevard.

Traffic growth rates calculated using the Richmond Tri-Cities Model between 2011 and 2031 indicate a 0.8 percent traffic growth rate on Dupuy Avenue between East River Road and Battery Place, as well as a 0.9 percent growth rate between Battery Place and Boulevard.

To remain consistent with the trends shown in VDOT historical AADT volumes, SPS database, and the Richmond Tri-Cities Model, a one (1) percent traffic annual growth rate was used on Dupuy Avenue for future traffic projections. A two (2) percent traffic annual growth rate was applied on Boulevard to be consistent with the *Virginia State University Multipurpose Center Traffic Impact Study*.

Traffic Due to VSU Expansion and Multipurpose Center

In addition to background regional growth, traffic in the immediate study area is expected to increase due to the planned expansion of Virginia State University (VSU). The *VSU Multipurpose Center Traffic Impact Study* conducted by Timmons Group in 2010 was reviewed to determine the additional trips generated based on increased future student enrollment and construction of a proposed Multipurpose Center. Analyses in the *VSU Multipurpose Center Traffic Impact Study* are based on the assumption that construction of the Multipurpose Center will be completed by 2012. As of June, 2012, the Center has not yet been constructed, but it is anticipated that it will be completed by the Dupuy Avenue project build-out year (2016).

Trip generation and distribution described in the *VSU Multipurpose Center Traffic Impact Study* were used in order to project future volumes at the study intersections for the Dupuy Avenue project.

The current (2012) student population at VSU is about 5,500 students. The 20/20 Vision or “VSU Campus Master Plan and Design Guidelines” from 2007 anticipates student growth to 10,000 by 2020. This means approximately an additional 570 students are expected to enroll per year. The proposed Multipurpose Center consists of 8,500-seat arena, along with conference and meeting rooms, a practice court, and a fitness center. In the *VSU Multipurpose Center Traffic Impact Study*, only a portion of the building is assumed to be used on a typical weekday. The full use of the building is assumed for a *Saturday* analysis that essentially details special event traffic for

maximum event capacity at the arena.

Since the Dupuy Avenue Modernization traffic study was conducted for an average weekday, trips generated by the Multipurpose Center on an average weekday were used instead of the weekend special event traffic conditions. The 20/20 VSU Master Plan anticipates providing on-campus housing to approximately 50 percent of the students. In the *VSU Multipurpose Center Traffic Impact Study*, a 25 percent internal capture reduction was applied to account for the on-campus student population. This reduction factor was approved by VDOT, Chesterfield County, and the City of Colonial Heights. The 25 percent internal capture reduction was applied to the trips generated by the student population and Multipurpose Center for 2016 build-out conditions.

Trips generation due to the student enrollment at VSU and the construction of the proposed Multipurpose Center for the build-out year (2016) and design year (2036) are presented in Table 5.

Table 5: Trips Generated due to the Proposed Developments at VSU

Proposed Development	Land Use	ITE Code	Year	Amount	Units	ADT	AM Peak Hour			PM Peak Hour		
							In	Out	Total	In	Out	Total
Student Enrollment	University/ College	550	2016	2280	Students	4143	246	61	307	124	290	414
			2020	4546		7933	531	133	664	221	516	737
Multipurpose Center	Junior/ Community College	540	2016	104,000	SF	2144	173	61	233	115	83	198
Total Trips for 2016						6288	419	122	540	239	373	612
Total Trips for 2036						10077	704	194	897	336	599	935

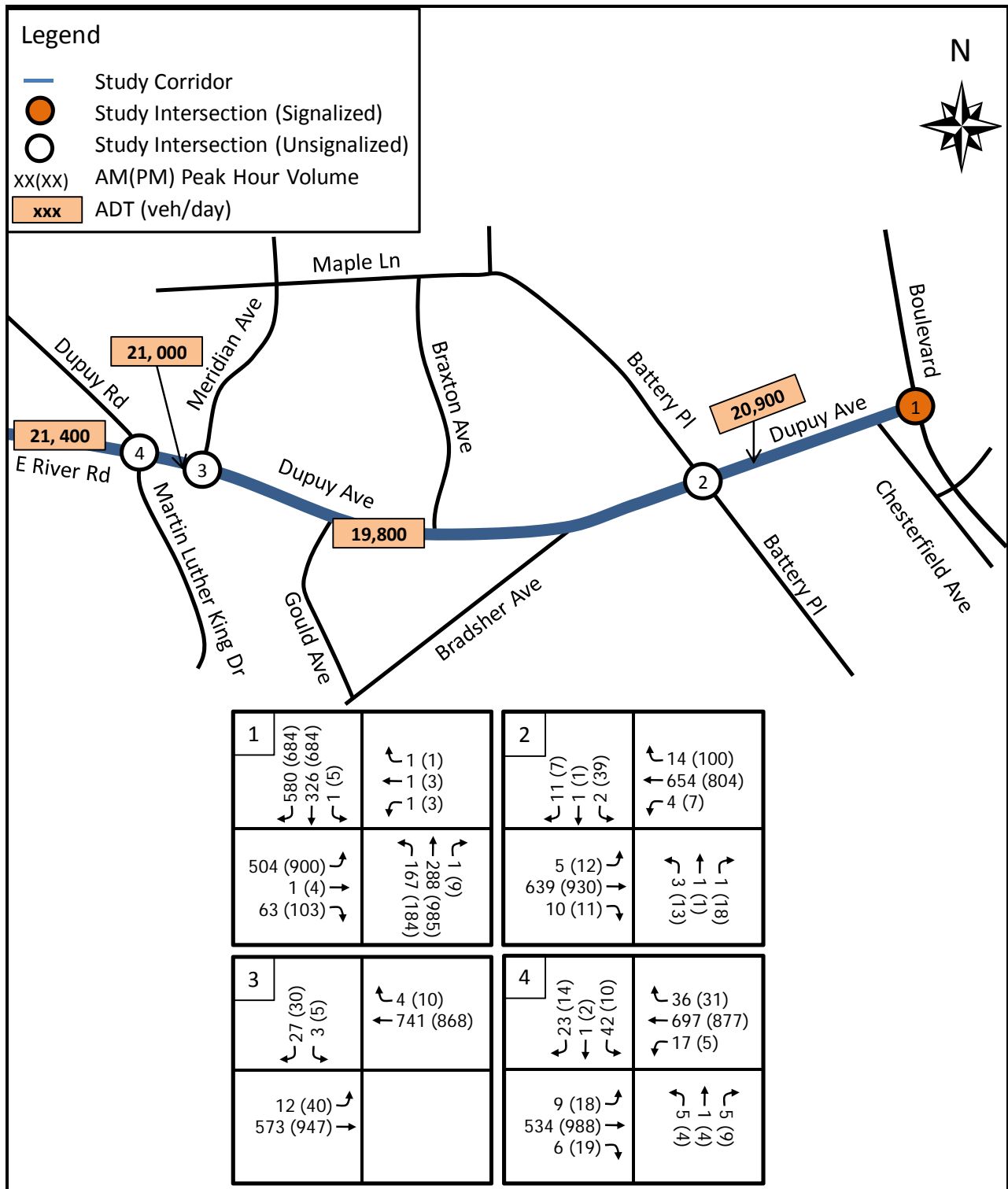
Note: Numbers of trips are shown after applying a 25% internal capture reduction factor

Build-out Year (2016) Peak Hour Volumes

Peak hour traffic volumes for 2016 were projected by applying the one percent annual growth rate factor to the 2012 existing traffic volumes over a four-year period and adding trips expected from the proposed construction and expansion at VSU. The resulting 2016 peak hour volumes are shown in Figure 4, along with projected AADT volumes. These volumes include lane configuration changes at the intersections of Dupuy Avenue with Meridian Avenue and with Martin Luther King Drive that are detailed on the following page.

The AADT volumes for the build-out and design year traffic conditions were computed by using a K-factor (percent of daily traffic that occurs in the peak hour) of 9 percent and applying it to the PM peak hour volumes. The K-factor was calculated from the 24-hour volumes collected on Dupuy Avenue.

Figure 4: Build-Out Year (2016) Peak Hour Volumes



Intersection Capacity Analysis - 2016 No-Build Conditions

Capacity analyses were conducted using 2016 future volumes for the existing geometry to represent future conditions if the project is not constructed. The no-build condition provides a base line to compare the intersection operation with and without the proposed improvements.

However, whether or not the Dupuy Avenue Modernization project is constructed, improvements at the Dupuy Avenue and Boulevard intersection will be constructed as part of an the adjacent Boulevard Modernization project. These improvements include the following:

- Dedicated left turn lanes for the northbound and southbound left turn movements from Boulevard.
- A dedicated right turn lane on eastbound Dupuy Avenue and converting left/through/right lane to left/through lane only. This would result in an exclusive left turn lane, a left/through lane and an exclusive right turn lane on eastbound Dupuy Avenue.

In addition, construction and expansion at the Virginia Statue University will eliminate the northbound approach from the parking lot directly opposite Meridian Avenue. Also, a separate northbound right turn bay will be constructed on Martin Luther King Drive, so by 2016, this approach will have one shared left/through lane and one right turn bay. These are considered background improvements for all scenarios analyzed.

Signal timing for the intersection was also optimized for these improvements and the projected traffic volumes. Table 6 presents the LOS results for 2016 no-build conditions. Synchro reports are compiled and presented in Appendix C.

Table 6: LOS Results - 2016 No-Build Conditions

			Dupuy Ave 2-Lane Section - No-Build			
Intersection	Control Type	Movement	2016			
			AM		PM	
			Delay	LOS	Delay	LOS
Dupuy Ave @ Boulevard	Signalized	EBL	50.3	D	70.5	E
		EBLT	50.5	D	67.2	E
		EBR	26.7	C	26.5	C
		EB Overall	47.0	D	64.4	E
		WBLTR	58.6	E	75.4	E
		WB Overall	58.6	E	75.4	E
		NBL	10.4	B	65.2	E
		NBTR	3.6	A	9.3	A
		NB Overall	6.3	A	19.7	B
		SBL	8.9	A	30.5	C
		SBT	13.4	B	34.1	C
		SBR	42.3	D	46.8	D
		SB Overall	31.7	C	40.2	D
		Intersection Overall	30.4	C	41.0	D
Dupuy Ave @ Battery Pl	Unsignalized	EBLTR	0.3	A	1.1	A
		WBLTR	0.3	A	0.7	A
		SBLTR	24.0	C	917.3	F
		NBLTR	44.9	E	228.0	F
		Intersection Overall	1.3	A	33.3	D
Dupuy Avenue @ Meridian Ave	Unsignalized	EBLT	1.0	A	2.5	A
		WBTR	0.0	A	0.0	A
		SBLR	22.0	C	42.4	E
		Intersection Overall	1.1	A	2.7	A
Dupuy Ave/East River Rd @ Dupuy Rd	Unsignalized	EBLTR	0.5	A	1.6	A
		WBLTR	0.6	A	0.5	A
		NBLT	49.6	E	108.9	F
		NBR	49.6	E	108.9	F
		SBLTR	97.5	F	208.3	F
		Intersection Overall	6.0	A	5.7	A

All overall intersection levels of service are at acceptable LOS D or better. However, several individual movements operate at LOS E or F. Detailed results of service failures by intersection are summarized as follows:

1. Dupuy Avenue at Boulevard

- During the PM peak hour, the eastbound Dupuy Avenue left turn operates at LOS E. The volume on this approach is quite high at about 900 vph, and this level is considered enough to justify at least a triple left turn. However, Boulevard is a four-lane road and does not have the three receiving lanes required for a triple (or greater) left.
- The westbound approach operates at LOS E in both the AM and PM peak hours but it is a low volume driveway that is given less priority.

- During the PM peak hour, the northbound left turn from Boulevard onto westbound Dupuy Avenue operates at LOS E.

2. Dupuy Avenue at Battery Place

- The northbound approach operates at LOS E during the AM peak hour. During the PM peak hour, both northbound and southbound side street approaches operate at LOS F, with significant delay for the southbound approach of over 15 minutes per vehicle.

3. Dupuy Avenue at Meridian Avenue

- During the PM peak hour, the southbound approach operates at LOS E.

4. Dupuy Avenue/East River Road at Dupuy Road

- The northbound and southbound side street approaches operate at LOS E or F during both AM and PM peak hours.

Corridor LOS Analysis - 2016 No-Build Conditions

Table 7 shows the corridor level of service results.

Table 7: 2016 No-Build Dupuy Avenue Corridor Levels of Service

From	To	Direction	2016 No Build AM							
			BFFS (mph)	Distance (mile)	Running Time (sec)	Delays (sec)	Travel Time (sec)	Arterial Speed (mph)	Travel Speed as a Percentage of BFFS (%)	LOS
Dupuy Rd	Boulevard	EB	25	0.4	64.7	51.8	116.5	13.9	56%	C
Boulevard	Dupuy Rd	WB	25	0.4	64.7	0.9	65.6	24.7	99%	A
From	To	Direction	2016 No Build PM							
			BFFS (mph)	Distance (mile)	Running Time (sec)	Delays (sec)	Travel Time (sec)	Arterial Speed (mph)	Travel Speed as a Percentage of BFFS (%)	LOS
Dupuy Rd	Boulevard	EB	25	0.4	64.7	70.8	135.5	11.9	48%	D
Boulevard	Dupuy Rd	WB	25	0.4	64.7	1.2	65.9	24.5	98%	B

For both peak hour periods, Dupuy Avenue operates at acceptable levels of LOS D or above, due to the background improvements at the intersection of Dupuy Avenue at Boulevard.

2016 Build-Out Geometry

The build-out improvements to Dupuy Avenue include installation of a Two-Way-Left-Turn-Lane (TWLTL) along the center of Dupuy Avenue between East River Road and Battery Place. With a TWLTL, vehicles traveling in either direction on Dupuy Avenue use the center lane when turning left to side streets or driveways along Dupuy Avenue. This allows left turns to wait for gaps in the oncoming traffic stream without stopping through traffic, so it increases the safety and capacity.

Installation of a center lane along Dupuy Avenue also allows construction of exclusive left turn lanes along Dupuy Avenue instead of maintaining a TWLTL at intersections with significant left turn traffic. Because the final design for Dupuy Avenue is not complete, the analyses have been completed as if exclusive left turn lanes are constructed at each of the study intersections. This is the most conservative approach, since a TWLTL marginally improves side street delays by a second or two.

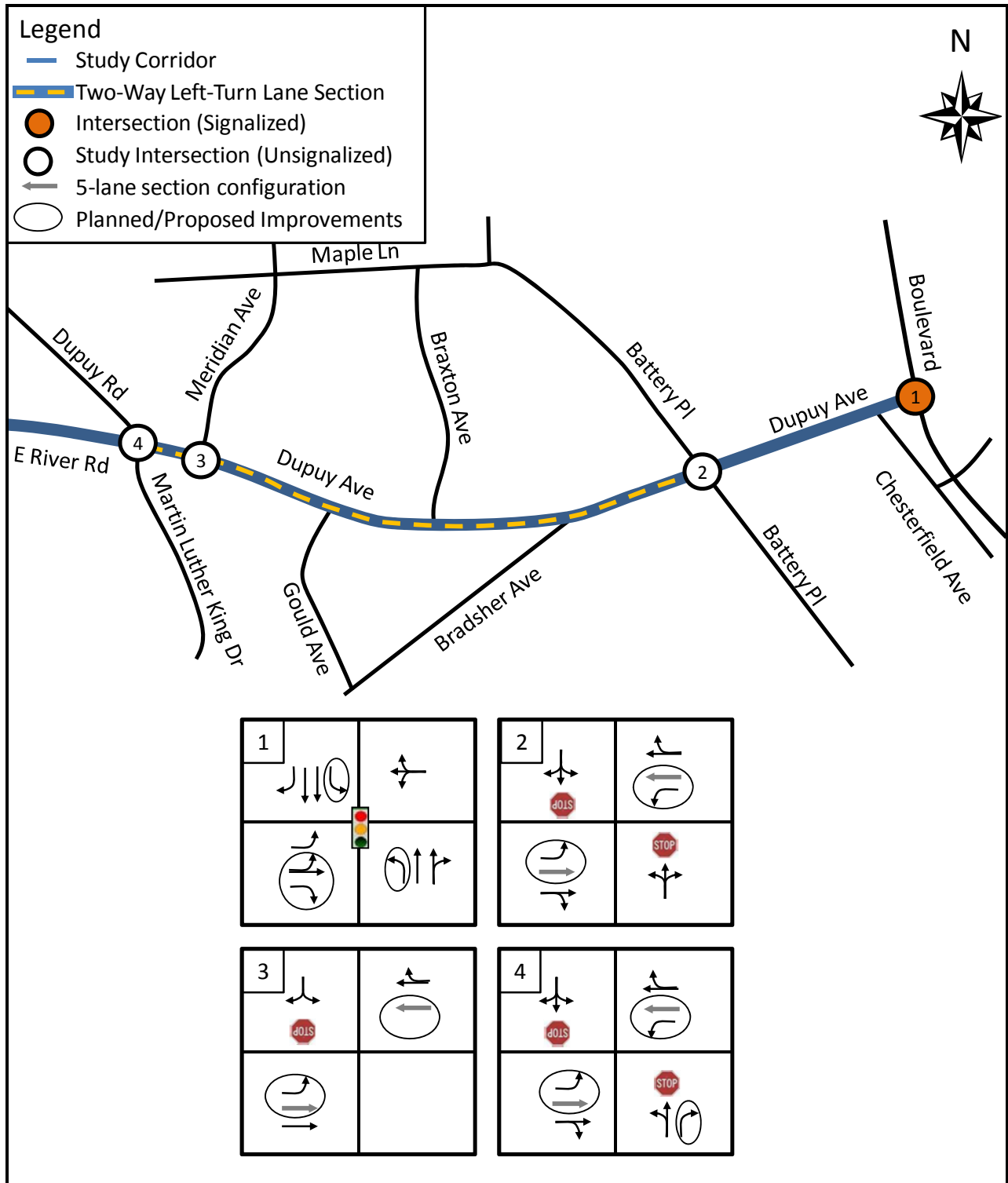
By 2016, the Boulevard Modernization project and the improvements on Martin Luther King Drive as well as the elimination of the VSU parking lot access directly opposite Meridian Avenue are expected to be completed, so those improvements are considered programmed improvements already completed, as detailed in the no-build scenario.

For build-out and design year conditions, capacity analyses of the study intersections were conducted for the following two alternatives:

- Dupuy Avenue as a two-lane section with a center TWLTL
- Dupuy Avenue as a four-lane section with a center TWLTL

Figure 5 illustrates the intersection geometry in 2016 when the Dupuy Avenue Modernization project will be completed. The option of two lanes or four lanes is also represented in this figure.

Figure 5: 2016 and 2036 Build-Out Intersection Geometry



Capacity Analysis: 2016 Build-Out Conditions

Table 8 presents capacity analysis results for 2016 build-out conditions with Dupuy Avenue as a two-lane versus four-lane section. The build-out scenario includes roadway improvements planned as part of the Dupuy Avenue Modernization project as well as signal timing optimization. Synchro reports are compiled and presented in Appendix D.

Table 8: LOS Results - 2016 Build-Out Conditions

Intersection	Control Type	Movement	Dupuy Ave 2-Lane Section - Build Out				Dupuy Ave 4-Lane Section - Build Out			
			2016				2016			
			AM		PM		AM		PM	
Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS			
Dupuy Ave @ Boulevard	Signalized	EBL	50.3	D	70.5	E	50.3	D	70.5	E
		EBLT	50.5	D	67.2	E	50.5	D	67.2	E
		EBR	26.7	C	26.5	C	26.7	C	26.5	C
		EB Overall	47.0	D	64.4	E	47.0	D	64.4	E
		WBLTR	58.6	E	75.4	E	58.6	E	75.4	E
		WB Overall	58.6	E	75.4	E	58.6	E	75.4	E
		NBL	10.4	B	65.2	E	4.9	A	61.9	E
		NBTR	3.6	A	9.3	A	4.2	A	10.0	A
		NB Overall	6.3	A	19.7	B	4.5	A	19.6	B
		SBL	8.9	A	30.5	C	8.9	A	30.5	C
		SBT	13.4	B	34.1	C	13.4	B	34.1	C
		SBR	42.3	D	46.8	D	42.3	D	45.6	D
		SB Overall	31.7	C	40.2	D	31.7	C	39.6	D
	Intersection Overall	30.4	C	41.0	D	30.0	C	40.7	D	
Dupuy Ave @ Battery Pl	Unsignalized	EBL	9.4	A	10.7	B	9.4	A	10.4	B
		EBTR	0.0	A	0.0	A	0.0	A	0.0	A
		WBL	9.0	A	11.1	B	9.1	A	11.2	B
		WBTR	0.0	A	0.0	A	0.0	A	0.0	A
		SBLTR	15.9	C	40.2	E	13.1	B	24.2	C
		NBLTR	17.9	C	28.2	D	15.6	C	20.5	C
		Intersection Overall	0.6	A	2.0	A	0.6	A	1.3	A
Dupuy Avenue @ Meridian Ave	Unsignalized	EBL	10.2	B	10.3	B	10.2	B	10.3	B
		EBT	0.0	A	0.0	A	0.0	A	0.0	A
		WBTR	0.0	A	0.0	A	0.0	A	0.0	A
		SBLR	18.9	C	20.5	C	13.0	B	14.0	B
		Intersection Overall	0.7	A	0.9	A	0.5	A	0.7	A
Dupuy Ave/East River Rd @ Dupuy Rd	Unsignalized	EBL	10.4	B	11.2	B	10.4	B	11.3	B
		EBTR	0.0	A	0.0	A	0.0	A	0.0	A
		WBL	8.7	A	10.4	B	8.7	A	10.5	B
		WBTR	0.0	A	0.0	A	0.0	A	0.0	A
		NBLT	19.3	C	23.9	C	14.3	B	19.0	C
		NBR	19.3	C	23.9	C	14.3	B	19.0	C
		SBLTR	25.4	D	27.5	D	21.3	C	21.0	C
		Intersection Overall	1.7	A	0.9	A	1.4	A	0.7	A

All overall intersection levels of service are at acceptable LOS D or better. However, several individual movements operate at LOS E or F. Detailed results by intersection are summarized as follows:

1. Dupuy Avenue at Boulevard

Since improvements at the Dupuy Avenue at Boulevard intersection are planned to be constructed under the Boulevard Modernization project, the capacity analysis results at this intersection remain the same for both no-build and build-out conditions. The following approaches operate at LOS E or F:

- Eastbound left/through movements on Dupuy Avenue operate at LOS E during the PM peak hour.
- Westbound approach operates at LOS E during the AM and PM peak hours.
- Northbound left turn from Boulevard onto westbound Dupuy Avenue operates at LOS E during the PM peak hour.

It should be noted that all Dupuy Avenue movements at Boulevard intersection operate with the same LOS whether Dupuy Avenue is constructed as a two-lane or a four-lane facility, since the lane configurations of each approach stay the same. The geometric change if Dupuy Avenue is widened to four lanes is that one of the additional lanes would become a turn lane at the intersection with Boulevard instead of requiring construction of a separate turn bay, but this is not an operational change.

2. Dupuy Avenue at Battery Place

- If Dupuy Avenue is widened to four lanes, the southbound approach improves from LOS E to C in the PM peak hour.

3. Dupuy Avenue at Meridian Avenue

- Whether Dupuy Avenue is constructed as a two-lane or a four-lane facility, each approach operates at LOS D or better during the AM and PM peak hours.
- Whether Dupuy Avenue is constructed as a two-lane or a four-lane facility, the overall intersection operates at LOS A during both AM and PM peak hours.

4. Dupuy Avenue/East River Road at Dupuy Road

- Whether Dupuy Avenue is constructed as a two-lane or a four-lane facility, each approach operates at LOS D or better during the AM and PM peak hours.
- Whether Dupuy Avenue is constructed as a two-lane or a four-lane facility, the overall intersection operates at LOS A during both AM and PM peak hours.

Corridor LOS Analysis - 2016 Build-Out Conditions

Table 9 shows the corridor LOS results.

Table 9: 2016 Build-Out Dupuy Avenue Corridor Levels of Service

From	To	Direction	2016 Build Out AM (2-Lane and 4-lane)							
			BFFS (mph)	Distance (mile)	Running Time (sec)	Delays (sec)	Travel Time (sec)	Arterial Speed (mph)	Travel Speed as a Percentage of BFFS (%)	LOS
Dupuy Rd	Boulevard	EB	25	0.4	64.7	50.5	115.2	14.0	56%	C
Boulevard	Dupuy Rd	WB	25	0.4	64.7	0.0	64.7	25.0	100%	A
From	To	Direction	2016 Build Out PM (2-Lane and 4-lane)							
			BFFS (mph)	Distance (mile)	Running Time (sec)	Delays (sec)	Travel Time (sec)	Arterial Speed (mph)	Travel Speed as a Percentage of BFFS (%)	LOS
Dupuy Rd	Boulevard	EB	25	0.4	64.7	67.2	131.9	12.3	49%	D
Boulevard	Dupuy Rd	WB	25	0.4	64.7	0.0	64.7	25.0	100%	A

For both peak hour periods, Dupuy Avenue operates at LOS D or above.

Storage Length Requirement: 2016 Build-Out Conditions

Left and right turn lanes were analyzed to determine the storage requirements. Each turn lane has three components: storage, deceleration, and taper. The taper lengths are based on VDOT Road Design Manual (Rev 1/11) Appendix F, Figure 3-1 that states that for an urban highway with a design speed of 45 mph or under, the minimum taper length required is 100 ft. for a single lane and 200 ft. for dual lanes.

The deceleration length is based on the standards defined in AASHTO Green Book (6th Edition), Table 9-22. According to the AASTO requirements for a 30 mph design speed on Dupuy Avenue, the required deceleration length is 160 ft. and for a 35 mph design speed on Boulevard, the required deceleration length is 220 ft. (interpolated). AASHTO also considers the full deceleration length to include the taper length.

The storage length component is determined by operational analyses. For signalized intersections, the 95th percentile queue length is a measure of the **maximum** distance vehicles will stack behind the stop bar during a traffic signal cycle. The 50th percentile queue length is defined as the **average** queue length for a typical traffic signal cycle. Typically, the 95th percentile queue is longer than the 50th percentile queue. However, if the upstream intersection is at or near capacity, the 50th percentile queue length is considered maximum, because there is not enough physical roadway capacity to allow vehicles to reach the 95th percentile queue length. For unsignalized intersections, the 95th percentile queue length is a measure of the maximum distance vehicles will stack behind the stop bar while waiting for acceptable gaps in the oncoming traffic stream.

Left and right turn lane lengths requirements for the 2016 traffic conditions are presented in Table 10.

Table 10: Storage Length Requirement – 2016 Build-out Conditions

#		Left Turn Lanes																				Taper Length (ft)	
		95th Percentile (ft) (Highest of AM or PM Queue Length is reported)				Deceleration Length (ft)				Total Storage Length (95th %tile + Deceleration) (ft)				Storage Length (ft)				Taper (ft)					
		NB	SB	EB	WB	NB	SB	EB	WB	NB	SB	EB	WB	NB	SB	EB	WB	NB	SB	EB	WB		
1	Dupuy Ave @ Boulevard	157	9	701	/	220	220	160	160	377	229	861	/	70	100	400	/	70	100	50	100		
2	Dupuy Ave @ Battery Pl	/	/	2	2	/	/	160	160	/	/	162	162	/	/	/	/	/	/	/	/	/	
3	Dupuy Avenue @ Meridian Ave	/	/	6	/	/	/	160	160	/	/	166	166	/	/	/	/	/	/	/	/	/	
4	Dupuy Avenue @ Dupuy Rd	/	/	4	1	/	/	160	160	/	/	164	164	/	/	/	/	/	/	/	/	/	

#		Right Turn Lanes																				Taper Length (ft)	
		95th Percentile (ft) (Highest of AM or PM Queue Length is reported)				Deceleration Length (ft)				Total Storage Length (95th %tile + Deceleration) (ft)				Storage Length (ft)				Taper (ft)					
		NB	SB	EB	WB	NB	SB	EB	WB	NB	SB	EB	WB	NB	SB	EB	WB	NB	SB	EB	WB		
1	Dupuy Ave @ Boulevard	/	/	372	48	/	/	220	160	/	/	592	208	/	/	200	/	550	200	/	/	100	
2	Dupuy Ave @ Battery Pl	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
3	Dupuy Avenue @ Meridian Ave	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
4	Dupuy Avenue @ Dupuy Rd	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	

Results of the queue length analyses for 2016 traffic conditions are as follows:

- The 95th percentile queue length for the northbound Boulevard left turn onto westbound Dupuy Avenue is 157 ft., which is longer than the planned effective storage length (storage plus half taper length) of 95 ft.
- The planned storage length of 100 ft. for the southbound Boulevard left turn onto Dupuy Avenue is adequate for the 95th percentile queue length of 9 ft.
- The proposed effective storage length of 450 ft. (400 ft. storage plus 50 ft. taper) for the eastbound Dupuy Avenue left turn onto Boulevard is shorter than the 95th percentile queue length of 700 ft.
- The 95th percentile queue length of 372 ft. for the southbound Boulevard right turn can be accommodated within the proposed storage length of 550 ft.
- The 95th percentile queue length of 48 ft. for the eastbound Dupuy Avenue right turn at Boulevard can be accommodated within the proposed storage length of 200 ft.
- The proposed taper length of 50 ft. for the northbound Boulevard left turn lane onto Dupuy Avenue is less than the required taper length of 100 ft.

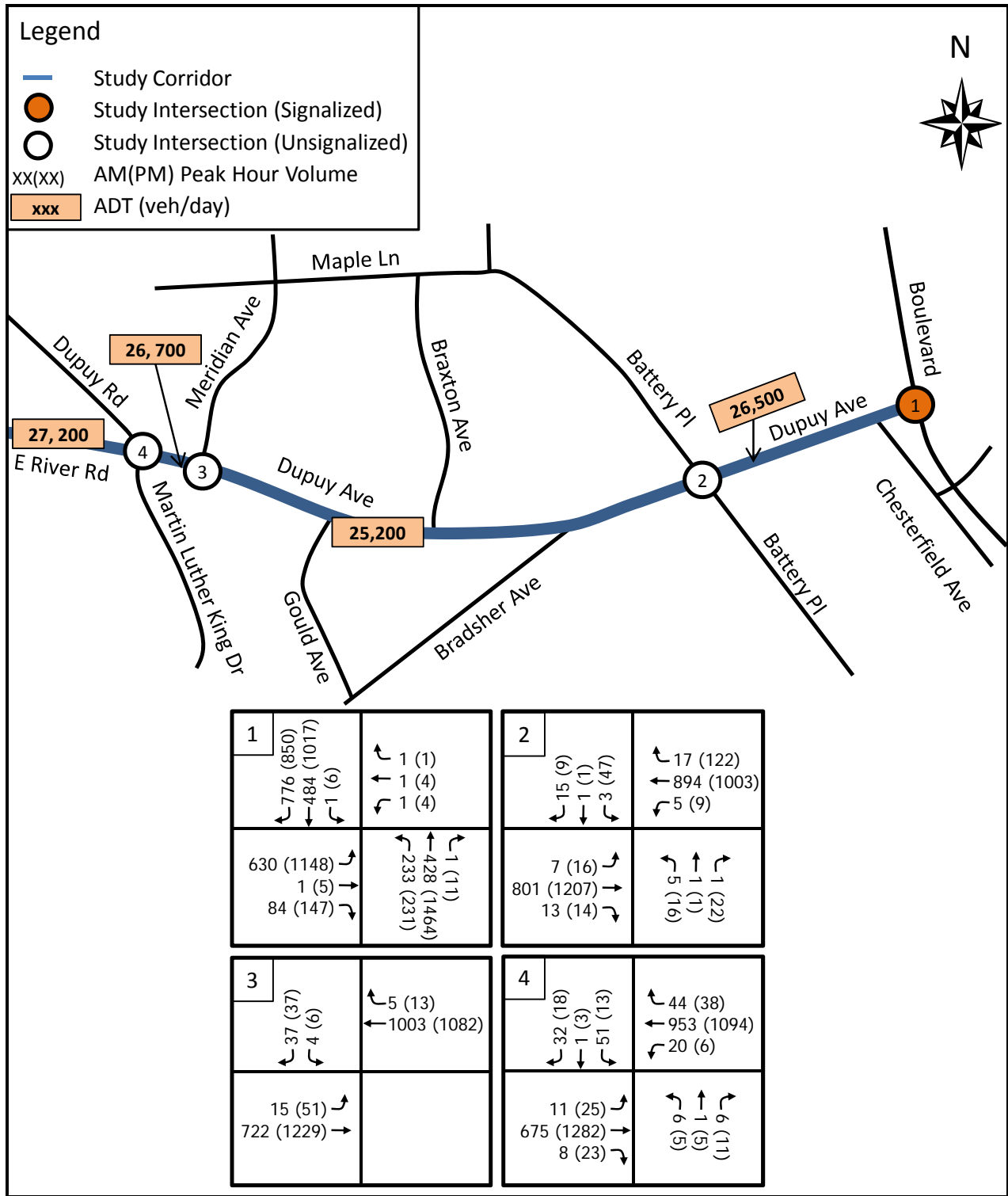
5. 2036 DESIGN YEAR CONDITIONS

Design Year (2036) Peak Hour Volumes

Peak hour traffic volumes for 2036 were projected by applying the one percent annual growth rate factor to the 2012 existing traffic volumes over a 24-year period and adding trips expected from the proposed developments at VSU for the year 2020. The resulting 2036 peak hour volumes are shown in Figure 6, along with projected AADT volumes.

The AADT volumes for the design year traffic conditions were computed by using a K-factor of 9 percent to the PM peak hour volumes. The K-factor was calculated from the 24-hour volumes collected on Dupuy Avenue.

Figure 6: Design Year (2036) Peak Hour Volumes



Capacity Analysis: 2036 No-Build Conditions

Capacity analyses were conducted using 2036 future volumes for the existing geometry to represent future conditions if roadway improvements were not constructed. The no-build condition provides a base line to compare the intersection operation with and without the proposed improvements for the Dupuy Avenue Modernization project. Table 11 presents the LOS results for 2036 no-build conditions. These results do include the improvements to be constructed with the Boulevard Modernization project. Synchro reports are included in Appendix E.

Table 11: LOS Results - 2036 No-Build Conditions

			Dupuy Ave 2-Lane Section - No-Build			
Intersection	Control Type	Movement	2036			
			AM		PM	
			Delay	LOS	Delay	LOS
Dupuy Ave @ Boulevard	Signalized	EBL	53.9	D	171.4	F
		EBT	53.9	D	163.6	F
		EBR	33.6	C	41.3	D
		EB Overall	50.8	D	152.6	F
		WBLTR	64.2	E	108.1	F
		WB Overall	64.2	E	108.1	F
		NBL	26.4	C	380.9	F
		NBTR	4.0	A	21.7	C
		NB Overall	12.7	B	79.7	E
		SBL	19.6	B	41.2	D
		SBT	21.0	C	39.4	D
		SBR	33.9	C	19.0	B
		SB Overall	28.9	C	30.5	C
		Intersection Overall	30.9	C	83.2	F
Dupuy Ave @ Battery Pl	Unsignalized	EBLTR	0.7	A	5.4	A
		WBLTR	0.6	A	2.0	A
		SBLTR	55.1	F	*	F
		NBLTR	216.3	F	*	F
		Intersection Overall	4.6	A	497.9	F
Dupuy Avenue @ Meridian Ave	Unsignalized	EBLT	2.1	A	9.9	A
		WBTR	0.0	A	0.0	A
		SBLR	47.2	E	199.6	F
		Intersection Overall	2.3	A	11.3	B
Dupuy Ave/East River Rd @ Dupuy Rd	Unsignalized	EBLTR	0.9	A	5.7	A
		WBLTR	1.6	A	1.5	A
		NBLT	212.9	F	829.9	F
		NBR	212.9	F	829.9	F
		SBLTR	689.4	F	*	F
		Intersection Overall	37.2	E	187.1	F

All of the intersections show service failures in the PM peak, and only two intersections operate at overall acceptable LOS D or better in the AM peak. Detailed results by intersection are summarized as follows:

1. Dupuy Avenue at Boulevard

- The Dupuy Avenue eastbound left turn operates at LOS F in the PM peak hour. By 2036, with the regional traffic growth, full expansion of VSU, and construction of VSU Multipurpose Center, eastbound Dupuy Avenue is projected to operate with a heavy left turn movement of 1,150 vph that typically would require an interchange to accommodate.
- The westbound approach operates at LOS E during the AM peak hour and at LOS F during the PM peak hour. This is a low volume driveway and is given less priority.
- The northbound Boulevard left turn onto Dupuy Avenue operates at LOS F in the PM peak hour.
- The overall intersection operates at LOS F during the PM peak hour.

2. Dupuy Avenue at Battery Place

- The northbound and southbound approaches operate at LOS F during the AM and PM peak hours.
- The overall intersection operates at LOS F during the PM peak hour.

3. Dupuy Avenue at Meridian Avenue

- The southbound approach operates at LOS E during the AM peak hour and at LOS F during the PM peak hour.

4. Dupuy Avenue/East River Road at Dupuy Road

- The northbound and southbound side-street approaches operate at LOS F during the AM and PM peak hours.
- The overall intersection operates at LOS E during the AM peak hour and LOS F during the PM peak hour.

Corridor LOS Analysis - 2036 No-Build Conditions

Table 12 shows the corridor LOS results.

Table 12: 2036 No-Build Dupuy Avenue Corridor Levels of Service

From	To	Direction	2036 No Build AM							
			BFFS (mph)	Distance (mile)	Running Time (sec)	Delays (sec)	Travel Time (sec)	Arterial Speed (mph)	Travel Speed as a Percentage of BFFS (%)	LOS
Dupuy Rd	Boulevard	EB	25	0.4	64.7	56.7	121.4	13.3	53%	C
Boulevard	Dupuy Rd	WB	25	0.4	64.7	2.2	66.9	24.2	97%	A
From	To	Direction	2036 No Build PM							
			BFFS (mph)	Distance (mile)	Running Time (sec)	Delays (sec)	Travel Time (sec)	Arterial Speed (mph)	Travel Speed as a Percentage of BFFS (%)	LOS
Dupuy Rd	Boulevard	EB	25	0.4	64.7	178.9	243.6	6.6	27%	F
Boulevard	Dupuy Rd	WB	25	0.4	64.7	3.5	68.2	23.7	95%	A

For 2036 No-Build conditions in the PM peak, eastbound Dupuy Avenue operates at LOS F, due to signal-related delay at the Boulevard intersection.

Capacity Analysis: 2036 Build-Out Conditions

Table 13 presents capacity analysis results for the 2036 design year conditions with Dupuy Avenue constructed as a two-lane versus four-lane section. The design year conditions include roadway improvements planned as part of the Dupuy Avenue Modernization project, as well as signal timing optimization.

Most of the intersections show service failures for individual side street movements in one or both peak periods. Detailed results by intersection are summarized as follows:

1. Dupuy Avenue at Boulevard

The turning movements at Dupuy Avenue at Boulevard intersection operate at the same LOS in the build-out conditions as in the no-build conditions whether Dupuy Avenue is analyzed as a two-lane or a four-lane road, since the lane configuration at each approach is the same.

2. Dupuy Avenue at Battery Place

- Whether Dupuy Avenue is constructed with two-lane or a four-lane facility, the overall intersection operates at LOS A.
- If Dupuy Avenue is widened to four lanes, the northbound approach improves from LOS F to D in the PM peak hour. The southbound approach operates at LOS E during the PM peak hour, but the delay for this approach is reduced by 120 sec/veh if Dupuy Avenue constructed as a four-lane road.

3. Dupuy Avenue at Meridian Avenue

- Whether Dupuy Avenue is constructed as a two-lane or a four-lane facility, all approaches and the overall intersection operate at LOS A during the AM and PM peak hours.

4. Dupuy Avenue/East River Road at Dupuy Road

- Whether Dupuy Avenue is constructed as a two-lane or a four-lane facility, the overall intersection operates at LOS A during the AM and PM peak hours.
- If Dupuy Avenue is widened to four lanes, the southbound approach improves from LOS F to D in the PM peak hour. The southbound approach improves from LOS F to E in the AM peak hour.
- If Dupuy Avenue is widened to four lanes, the northbound approach during PM peak hour improves from LOS E to D.

Overall, the results show some slight improvements for some individual side street movements for a four-lane Dupuy Avenue compared to a two-lane section.

Table 13: LOS Results – 2036 Build-Out Conditions

			Dupuy Ave 2-Lane Section - Build Out				Dupuy Ave 4-Lane Section - Build Out			
Intersection	Control Type	Movement	2036				2036			
			AM		PM		AM		PM	
			Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Dupuy Ave @ Boulevard	Signalized	EBL	58.1	E	171.4	F	58.1	E	171.4	F
		EBLT	58.1	E	163.6	F	58.1	E	163.6	F
		EBR	34.4	C	41.3	D	34.4	C	41.3	D
		EB Overall	54.5	D	152.6	F	54.5	D	152.6	F
		WBLTR	64.2	E	108.1	F	64.2	E	108.1	F
		WB Overall	64.2	E	108.1	F	64.2	E	108.1	F
		NBL	24.4	C	381.0	F	24.4	C	381.0	F
		NBTR	3.8	A	21.8	C	3.8	A	21.8	C
		NB Overall	11.8	B	79.7	E	11.8	B	79.7	E
		SBL	17.3	B	41.3	D	17.3	B	41.3	D
		SBT	20.3	C	37.6	D	20.3	C	37.6	D
		SBR	34.4	C	13.9	B	34.4	C	12.4	B
		SB Overall	28.9	C	27.3	C	28.9	C	26.6	C
		Intersection Overall	31.8	C	82.1	F	31.8	C	81.8	F
Dupuy Ave @ Battery Pl	Unsignalized	EBL	11.0	B	12.5	B	10.7	B	11.9	B
		EBTR	0.0	A	0.0	A	0.0	A	0.0	A
		WBL	9.7	A	13.4	B	9.8	A	13.5	B
		WBTR	0.0	A	0.0	A	0.0	A	0.0	A
		SBLTR	22.6	C	163.0	F	16.2	C	41.6	E
		NBLTR	27.6	D	58.0	F	20.3	C	33.8	D
				Intersection Overall	0.9	A	6.1	A	0.7	A
Dupuy Avenue @ Meridian Ave	Unsignalized	EBL	12.2	B	11.7	B	12.2	B	11.8	B
		EBT	0.0	A	0.0	A	0.0	A	0.0	A
		WBTR	0.0	A	0.0	A	0.0	A	0.0	A
		SBLR	32.8	D	32.0	D	16.5	C	17.2	C
				Intersection Overall	1.2	A	1.2	A	0.7	A
Dupuy Ave/East River Rd @ Dupuy Rd	Unsignalized	EBL	12.5	B	13.3	B	12.6	B	13.4	B
		EBTR	0.0	A	0.0	A	0.0	A	0.0	A
		WBL	9.3	A	12.2	B	9.3	A	12.2	B
		WBTR	0.0	A	0.0	A	0.0	A	0.0	A
		NBLT	35.0	D	39.2	E	18.0	C	27.9	D
		NBR	35.0	D	39.2	E	18.0	C	27.9	D
		SBLTR	64.7	F	51.3	F	43.9	E	32.3	D
				Intersection Overall	3.7	A	1.5	A	2.5	A

Corridor LOS Analysis - 2036 Build-Out Conditions

Table 14 shows the corridor LOS results.

Table 14: 2036 Build-Out Dupuy Avenue Corridor Levels of Service

From	To	Direction	2036 Build Out AM (2-Lane and 4-lane)							
			BFFS (mph)	Distance (mile)	Running Time (sec)	Delays (sec)	Travel Time (sec)	Arterial Speed (mph)	Travel Speed as a Percentage of BFFS (%)	LOS
Dupuy Rd	Boulevard	EB	25	0.4	64.7	58.1	122.8	13.2	53%	C
Boulevard	Dupuy Rd	WB	25	0.4	64.7	0.0	64.7	25.0	100%	B
From	To	Direction	2036 Build Out PM (2-Lane and 4-lane)							
			BFFS (mph)	Distance (mile)	Running Time (sec)	Delays (sec)	Travel Time (sec)	Arterial Speed (mph)	Travel Speed as a Percentage of BFFS (%)	LOS
Dupuy Rd	Boulevard	EB	25	0.4	64.7	163.6	228.3	7.1	28%	F
Boulevard	Dupuy Rd	WB	25	0.4	64.7	0.0	64.7	25.0	100%	B

For 2036 Build-OUT conditions in the PM peak, eastbound Dupuy Avenue operates at LOS E, due to signal-related delay at the Boulevard intersection.

Storage Length Requirement: 2036 Build-Out Conditions

Queuing analyses for 2036 traffic conditions were conducted to determine the left and right turn lane storage requirements. The results are shown in Table 15.

- The 95th percentile queue length for the northbound Boulevard left turn onto westbound Dupuy Avenue is 290 ft. which extends beyond the proposed effective storage length (storage plus half taper) of 95 ft.
- The planned storage length of 100 ft. for the southbound Boulevard left turn movement is adequate for the 95th percentile queue length of 7 ft.
- The eastbound Dupuy Avenue left turn onto Boulevard has an excessively long 95th percentile queue length of 1,200 ft. that extends beyond the proposed effective storage length of 450 ft. (400 ft. storage plus 50 ft. taper).
- The 95th percentile queue length of 278 ft. for the southbound Boulevard right turn can be accommodated within the proposed storage length of 550 ft.
- The 95th percentile queue length of 137 ft. for the eastbound Dupuy Avenue right turn at the Boulevard can be accommodated within the proposed storage length of 200 ft.

Table 15: Storage Length Requirement – 2036 Design Year Conditions

Left Turn Lanes																																							
#	Intersection	95th Percentile (ft) (Highest of AM or PM Queue Length is						Deceleration Length (ft)						Total Storage Length (95th %tile + Deceleration)						Taper Length (ft)	Storage (ft)						Taper (ft)												
		NB	SB	EB	WB	WB	NB	NB	SB	EB	WB	WB	NB	NB	SB	EB	WB	WB	NB		NB	SB	EB	WB	WB	NB	NB	SB	EB	WB	WB	NB							
1	Dupy Ave @ Boulevard	290	7	1208				220	220	160	160					510	227	1368						100	100	400						50	100						
2	Dupuy Ave @ Battery Pl			4	3					160	160							164	163																				
3	Dupuy Avenue @ Meridian Ave			9						160								169																					
4	Dupuy Avenue @ Dupuy Rd			7	1					160	160							167	161																				

Right Turn Lanes																																							
#	Intersection	95th Percentile (ft) (Highest of AM or PM Queue Length is						Deceleration Length (ft)						Total Storage Length (95th %tile + Deceleration)						Taper Length (ft)	Storage (ft)						Taper (ft)												
		NB	SB	EB	WB	WB	NB	NB	SB	EB	WB	WB	NB	NB	SB	EB	WB	WB	NB		NB	SB	EB	WB	WB	NB	NB	SB	EB	WB	WB	NB							
1	Dupy Ave @ Boulevard			278	137					220	160							498	297					100	550	200													
2	Dupuy Ave @ Battery Pl																																						
3	Dupuy Avenue @ Meridian Ave																																						
4	Dupuy Avenue @ Dupuy Rd																																						

6. ARTERIAL CAPACITY ANALYSIS

Dupuy Avenue within the project limits is classified as an urban roadway. The performance level of an urban roadway for different geometric and traffic conditions can be evaluated using arterial level of service (LOS) analysis. The methodology defined in Chapter 16 of Highway Capacity Manual (HCM, 2010) *Urban Street Facilities*, defines an urban street to have segments that are approximately 2 miles long and bounded by signalized intersections. The Dupuy Avenue project does not fit this criteria, because it has only one signalized intersection, and the project length is just 0.4 miles long.

While an actual arterial level of service cannot be calculated, HCM provides planning tools. The generalized daily service volume thresholds defined for an urban street segment in Highway Capacity Manual can be used for evaluating whether a two-lane or a four-lane facility will have sufficient capacity to handle the future design year volumes. Chapter 16 of the HCM, provides thresholds for daily service volumes to assess the level of service provided by urban streets for a given posted speed limit, an hourly volume factor (K-factor), and a directional distribution factor (D-factor). Daily service volume thresholds as defined in HCM Chapter 16 are presented in Table 16.

Table 16: Generalized Daily Service Volumes for Urban Street Facilities
(1,000 vehicles/day)

K-Factor	D-Factor	Two-Lane Streets				Four-Lane Streets				Six-Lane Streets			
		LOS B	LOS C	LOS D	LOS E	LOS B	LOS C	LOS D	LOS E	LOS B	LOS C	LOS D	LOS E
Posted Speed = 30 mi/h													
0.09	0.55	NA	5.9	15.4	19.9	NA	11.3	31.4	37.9	NA	16.3	46.4	54.3
	0.60	NA	5.4	14.1	18.3	NA	10.3	28.8	34.8	NA	15.0	42.5	49.8
0.10	0.55	NA	5.3	13.8	17.9	NA	10.1	28.2	34.1	NA	14.7	41.8	48.9
	0.60	NA	4.8	12.7	16.4	NA	9.3	25.9	31.3	NA	13.5	38.3	44.8
0.11	0.55	NA	4.8	12.6	16.3	NA	9.2	25.7	31.0	NA	13.4	38.0	44.5
	0.60	NA	4.4	11.5	14.9	NA	8.4	23.5	28.4	NA	12.2	34.8	40.8
Posted Speed = 45 mi/h													
0.09	0.55	NA	10.3	18.6	19.9	NA	21.4	37.2	37.9	NA	31.9	54.0	54.3
	0.60	NA	9.4	17.1	18.3	NA	19.6	34.1	34.8	NA	29.2	49.5	49.8
0.10	0.55	NA	9.3	16.8	17.9	NA	19.3	33.5	34.1	NA	28.7	48.6	48.9
	0.60	NA	8.5	15.4	16.4	NA	17.7	30.7	31.3	NA	26.3	44.5	44.8
0.11	0.55	NA	8.4	15.3	16.3	NA	17.5	30.5	31.0	NA	26.1	44.2	44.4
	0.60	NA	7.7	14.0	14.9	NA	16.1	27.9	28.4	NA	23.9	40.5	40.7

The posted speed limit along Dupuy Avenue is 25 mph between Boulevard and East River Road. The K-factor on Dupuy Avenue is approximately 9 percent and D-factor is approximately 50 percent as determined from the 24-hour volumes collected on Dupuy Avenue.

Based on HCM values for a two-lane urban street, with a 30 mph posted speed, a 9 percent K-factor and 55 percent D-factor, the daily service volume range is between 15,400 and 19,899 vehicles per day at LOS D. For a four-lane urban street, the daily service volume range is between 31,400 and 37,899 vehicles per day at LOS D.

The 2016 Average Daily Traffic (ADT) volumes on Dupuy Avenue is 21,000 vehicles per day, and the 2036 ADT is 27,000 vehicles per day. The ADT volumes on Dupuy Avenue for both the

build-out year (2016) and the design year (2036) are **above** the threshold defined for a two-lane urban street segment operating at LOS D, but **below** the range of daily service volumes defined for a four-lane section operating at LOS D.

However, the capacity analyses do not indicate a significant difference in intersection LOS for the movements along Dupuy Avenue whether it is constructed as a two-lane or a four-lane roadway. This means that although the generalized daily service volume thresholds indicate that for Dupuy Avenue should be constructed as a four-lane section to meet future daily weekday traffic volumes, the capacity analyses show very little gains for the four-lane section. It should be noted that a four-lane section may improve weekend/special event conditions, as detailed in the *VSU Multipurpose Center Traffic Impact Study* completed by others.

7. CONCLUSIONS

Intersection Capacity Results

Intersection capacity analyses show that currently, in 2012, all four study intersections operate at overall LOS D or better. However, several movements operate at failing service levels of LOS E or F. Primarily, these poor LOS occur at the unsignalized side streets or left turns to/from Dupuy Avenue at Boulevard.

In 2016 no build conditions where no improvements are constructed on Dupuy Avenue, more individual side street movements operate at LOS E or F, and side street delay at Battery Place reaches over 15 minutes on the southbound approach. Improvements at Dupuy Avenue and Boulevard are constructed by 2016, regardless of whether or not the Dupuy Avenue Modernization project is completed.

In 2016 build-out conditions, delays are reduced compared to the no-build scenario. All intersections again operate at overall LOS D or better, although there are still a few individual movements with LOS E. There is little difference between service levels if Dupuy Avenue is constructed as a four-lane road instead of a two-lane road.

In 2036 no-build conditions, the study intersections display many service failures, and the side street approaches at the unsignalized intersections operate with excessive delays of 7-18 minutes, depending on the approach.

In 2036 build-out conditions, the construction of the TWLTL dramatically improves operations at the unsignalized intersections. However, the intersection of Dupuy Avenue at Boulevard still operates at LOS F in the PM peak hour due to the large left turn volumes from Dupuy Avenue eastbound that are projected as 1,150 vehicles per hour. This is much larger than typically seen even for a quadruple-left turn. Because Boulevard is only a four-lane road, the Dupuy Avenue left turn is limited to two lanes. There is no way to improve the signal to handle this level of turns without significant redesign or rerouting a large percentage to another roadway.

At the unsignalized intersections, there are some improvements in side street delay if Dupuy Avenue is constructed as a four-lane road instead of a two-lane road, but the overall intersection operations do not change.

Arterial LOS Analysis Results

The ADT for Dupuy Avenue is 21,000 vpd in 2016 and 27,000 vpd in 2036. The daily traffic volumes on Dupuy Avenue for both 2016 and 2036 are **above** the HCM thresholds (15,400 to 18,899 vpd) for a two-lane urban street segment to operate at LOS D. However, the daily volumes are **below** the thresholds (31,400 to 37,899 vpd) defined for a four-lane roadway to operate at LOS D.

The corridor analyses indicates that during PM in existing condition, 2036 no build condition and 2036 build-out condition eastbound on Dupuy Avenue will experience LOS E or F due to signal related delay at Dupuy Avenue eastbound approach at Boulevard.

Based on these weekday results, widening Dupuy Avenue to four-lanes with a TWLTL yields slight benefit compared to a two-lane road with a TWLTL.