Route 7/ Route 287 Interchange Study

Technical Memorandum

2014 Modified Build Scenario

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1 Setting and Study Objectives

The Virginia Department of Transportation (VDOT) has requested HNTB to conduct a transportation study to assess the existing and future traffic operating conditions at the congested interchange of VA Route 7 Bypass and VA Route 287 and the neighboring intersections. This study was performed as a supplement to the original "Route 7 Bypass and Route 287 Interchange Study" to analyze another build scenario, ***2014 Modified Build*** for the year 2014. This memo compares the traffic operations in the study area between ***Existing, 2014 Baseline, 2014 Improved, and 2014 Modified Build*** scenarios. A reader is recommended to refer to the report of the original Study for background information and results of all the options considered.

The interchange of VA Route 7 (Harry Byrd Highway) Bypass and VA Route 287 (Berlin Turnpike) is located at the northeast corner of the Town of Purcellville in Loudoun County, Virginia. Route 7 Bypass is a National Highway System (NHS) route which is classified as a rural principal arterial in the study area. This west-east route with a 55mph speed-limit is a major arterial with limited access points, and is heavily used by commuters during weekdays. Route 287 is a north-south 45mph roadway that originates in Purcellville and extends north into Maryland; it connects Route 9 and Route 7 Bypass. The Route 7 Bypass is connected to Route 287 via the diamond interchange that has two intersections on Route 287.

South of the Route 7 Bypass interchange, Route 287 has active land use on both sides with a number of access and egress points in the approach to its T-intersection with Route 7 Business/Main St. This has led to frequent turning and weaving traffic movements along Route 287. North of the interchange the land use consists of sparsely used residential areas and farmlands.

In addition, the extension of Route 287 beyond Route 7 (Sothern Collector Road), and developments such as the Purcellville Gateway in the north-west quadrant of Route7 Business and Route 287 intersection, and Catoctin Corner Development in the north-east quadrant of Route 7 Business and Route 287 intersection, would also potentially significantly increase traffic volumes in the study area.

The main objective of this study is to determine the amount of improvement in the 2014 study area operational conditions achievable with modifications to Route 287 alone, without any changes to the Route 7 Bypass ramps.

2 Summary of Findings Concerning the Modified Build Scenario

The following is a brief summary of the key finding from the analysis of the Modified Build Scenario. The details on the assumptions, methodology and outcomes of the MOE's for the alternatives are in the following sections of this report.

In the AM (morning) peak hour:

- Elimination of the proposed improvements on the Route 7 Bypass ramps result in minor or no increase in delays or queues in the study area when compared against the other 2014 scenarios.

In the PM (evening) peak hour:

- As shown in **Table 10 in this report,** Route 7 Bypass highway segments operating at LOS "F" in the existing conditions and in the ***2014 Baseline*** scenario will still operate at LOS "E" or worse. In the analysis the delay on these highway segments was reduced significantly by providing a majority of the green time (at the intersection of Route 287/WB Ramps Route 7 Bypass) to the WB approach.

- The intersection of Route 287/WB Route 7 Bypass continues to operate at LOS "E" in the ***2014 Modified Build*** scenario (see **Table 11**). Average and maximum queues (shown in **Tables 12 and 13** respectively) exceeding the storage length are observed on all the three approaches of the intersection in spite of improvements on Route 287. This is due in part to a majority of the signal green time being provided to the WB off-ramp to avoid back up on the Route 7 Bypass.

- The other intersections along Route 287 are observed to operate similarly to the ***2014 Improved*** scenario.

3 Scenario Analysis

The scenarios in this analysis included the following:

- ***Existing*** Scenario: Geometry and volumes replicate the existing conditions in the year 2011.

- ***2014 Baseline*** scenario: Includes traffic growth, traffic generated by newly built developments, and the roadway geometric improvements committed or programmed by 2014.

- ***2014 Improved*** scenario: Proposed roadway geometry improvements on Route 287 and ramps of Route 7 Bypass. These changes are made to the ***2014 Baseline*** scenario. Volumes are the same as ***2014 Baseline*** scenario.

- ***2014 Modified Build*** scenario: Proposed roadway geometry improvements on Route 287 alone. These changes are made to the ***2014 Baseline*** scenario. Volumes are same as ***2014 Baseline*** scenario.

3.1 Study Area and Roadway Network

The study area network is shown in **Figure 1.** The roadway segments analyzed in the study area include:

- Half a mile on Route 7 Bypass to the west from the center of the interchange;
- From the east side of Route 7 Bypass until the point where queue exists from the center of the interchange;
- The intersection of St Francis Court and Route 287 to the north; and
- The intersection of Route 7 Business (Main Street) and Route 287 to the south.

The intersections included within the study area described above, include:

1. Route 722 / St Francis Court and Route 287
2. Route 7 Bypass WB off-ramp and Route 287
3. Route 7 Bypass EB off-ramp and Route 287
4. Hirst Road and Route 287
5. Eastgate / Patrick Henry Circle and Route 287
6. Route 7 Business / Main Street and Route 287 (modified intersection)
7. Access to Purcellville Gateway development / Route 287 (new intersection)
8. Right-in Right-out access to Catoctin development / Route 287 (new intersection)

By the year 2014, intersection #6 is modified to a roundabout and new intersections #7 and #8 functioning along Route 287. Intersections #2, #4 and #7 will be controlled by traffic signals. Intersections #1, #3, #5 and #8 operate as two-way stop controlled intersections, with movement priority given to Route 287 NB and SB traffic. Intersection #6 (Main Street and Route 287) will be a two-lane roundabout with a new south-leg called Southern Collector Road. Southern Collector Road will join East A Street which might result in some traffic being diverted to and from Route 7 Business West onto Southern Collector Road.

Figure 1: Rte 7/287 Interchange Study Area in 2014

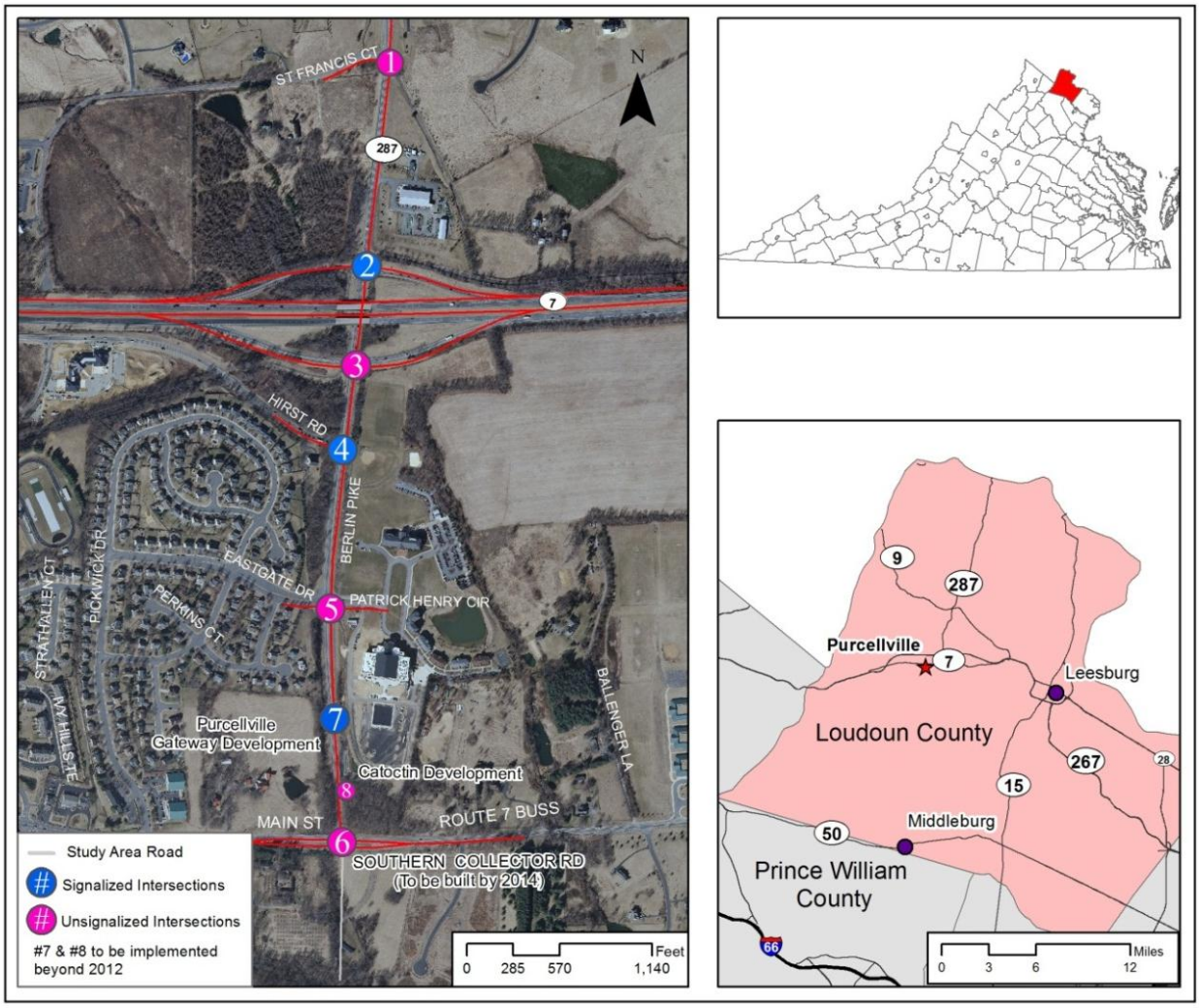


Figure 2 depicts the roadway geometry in the ***2014 Baseline*** conditions with committed or programmed improvements in place. **Figure 3** depicts the roadway geometry in the ***2014 Improved*** scenario with proposed changes (to the ***2014 Baseline*** network) shown in red.

Figure 2: Rte 7/287 Interchange Study 2014 Baseline Scenario Lane Configuration

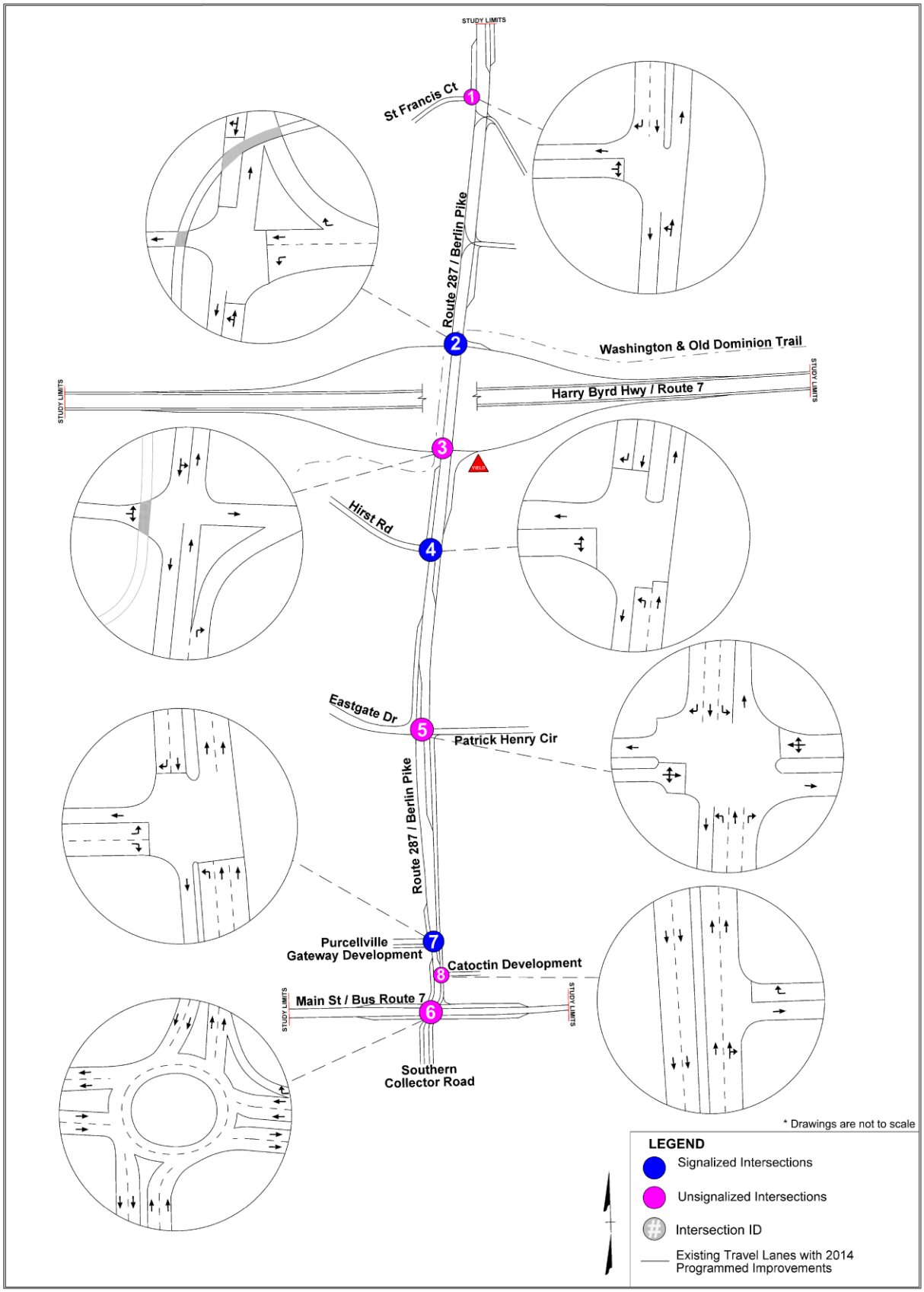
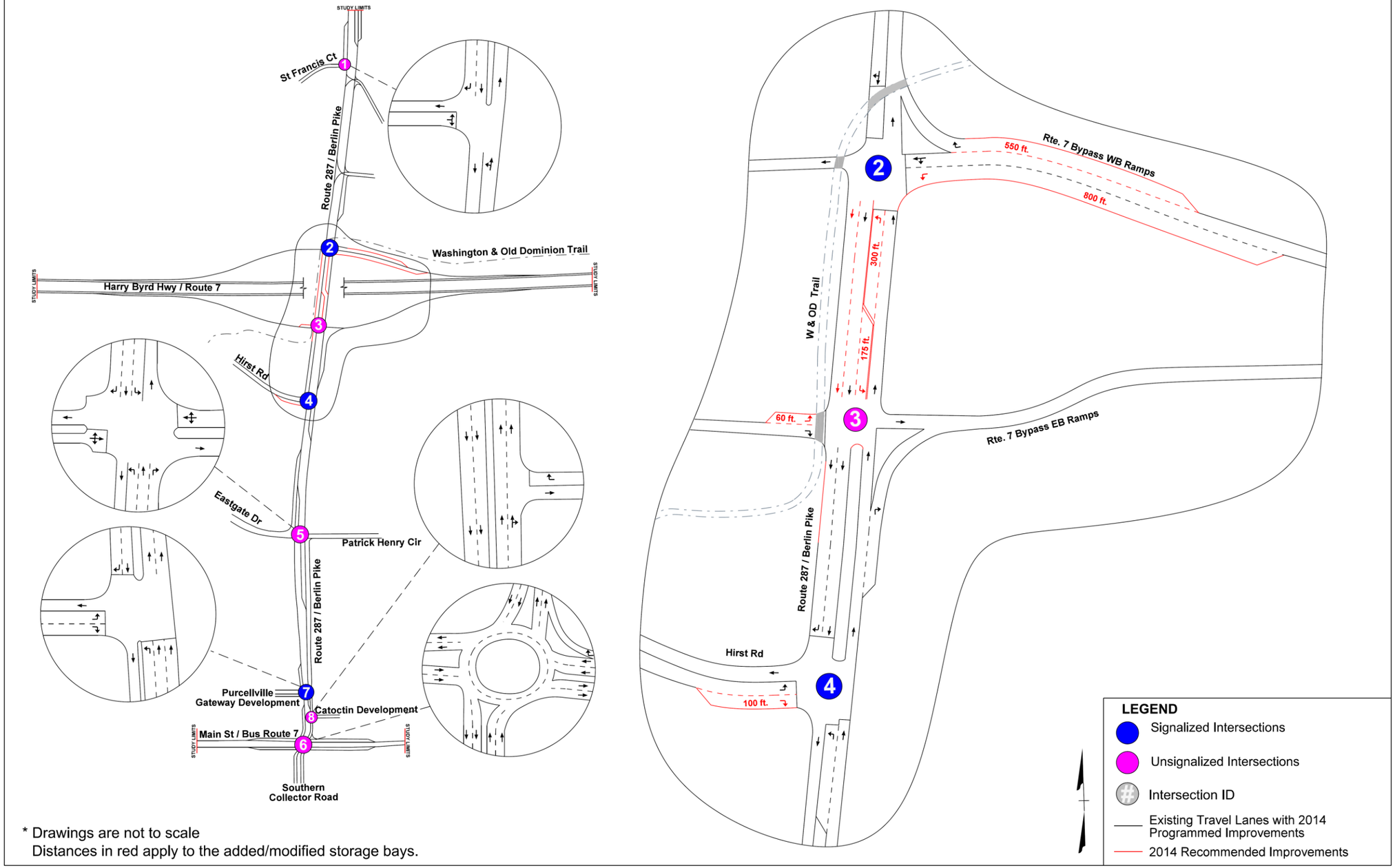


Figure 3: Rte 7/287 Interchange Study 2014 Improved Scenario Lane Configuration

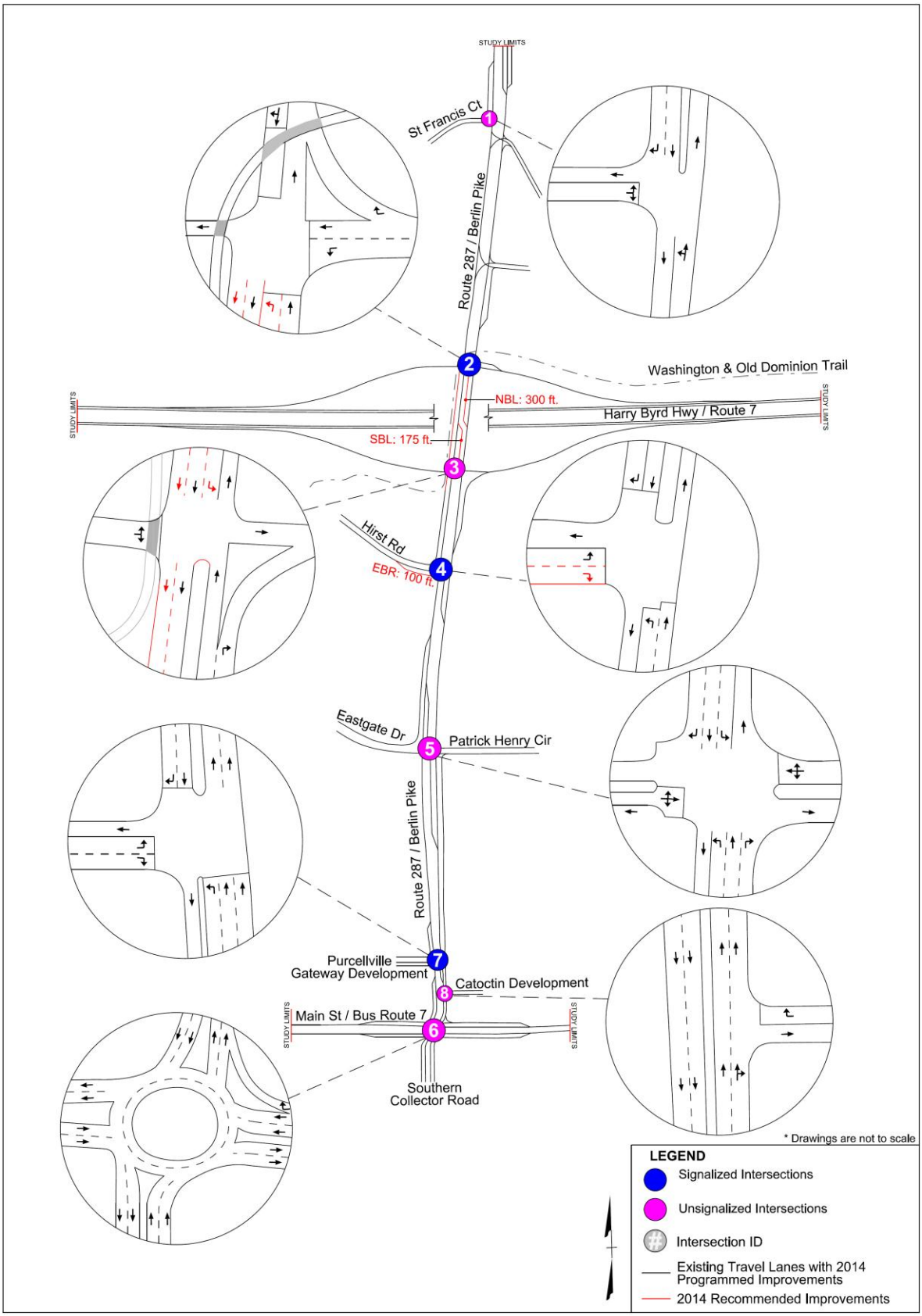


* Drawings are not to scale
Distances in red apply to the added/modified storage bays.

The 2014 Modified Build scenario, shown in **Figure 4,** has all the proposed improvements in the ***2014 Improved*** scenario except for the changes on the Route 7 Bypass Ramps. The improvements analyzed in this scenario include:

1. At Route 7 Bypass WB off-ramp and Route 287 (Intersection #2)
    a. Add a NBL turn bay with a storage of 300 feet
    b. Add a second receiving lane on the SB receiving approach
2. At Route 7 Bypass EB off-ramp and Route 287 (Intersection #3)
    a. Add a SBL turn bay with 175 feet of storage
3. At Hirst Road and Route 287 (Intersection #4)
    a. Add a EBR turn bay with 100 feet of storage
    b. Extend the SBR turn bay to a full lane to the intersection with Route 7 EB off ramp

Figure 4: Rte 7/287 Interchange Study 2014 Modified Build Lane Configuration



3.2 Peak Hour Traffic Volumes

To generate the 2014 volumes, the traffic counts collected in December 2011 by HNTB were compared to the 2008 counts done by Wells and Associates and no increase in the traffic was found in the three (3) year period. Based on this observation, a low growth rate of 1.8% per year, used in the Southern Collector Memo by VDOT in 2011, was assumed. This flat annual growth rate is applied to balanced existing (2011) traffic volume to obtain the base traffic for 2014. Reader should note that growth rates in other reference studies provided by VDOT where significantly higher (3% or more per year).

The background traffic includes the potential traffic generated by the new developments, Purcellville Gateway and Catoctin by 2014. The volumes generated due to these new developments were forecasted using the ITE trip generation manual and approved Traffic Impact Analyses (TIAs). Purcellville Gateway is expected to be completed by 2012. As a result, 100 percent of the trips generated by the Gateway development were added to the network. Only 35% of the Catoctin development is assumed for this analysis, as it is not expected to be completed by 2014. The extension of Patrick Henry College is not expected to be completed until 2017, so it is not included for the year 2014. The trips generated by 2014 from the new developments are shown in **Table 1**. The trips observed in the **Table 1** were assigned to the network using the same trip distribution used in the approved TIAs which is then added to the 2014 background traffic.

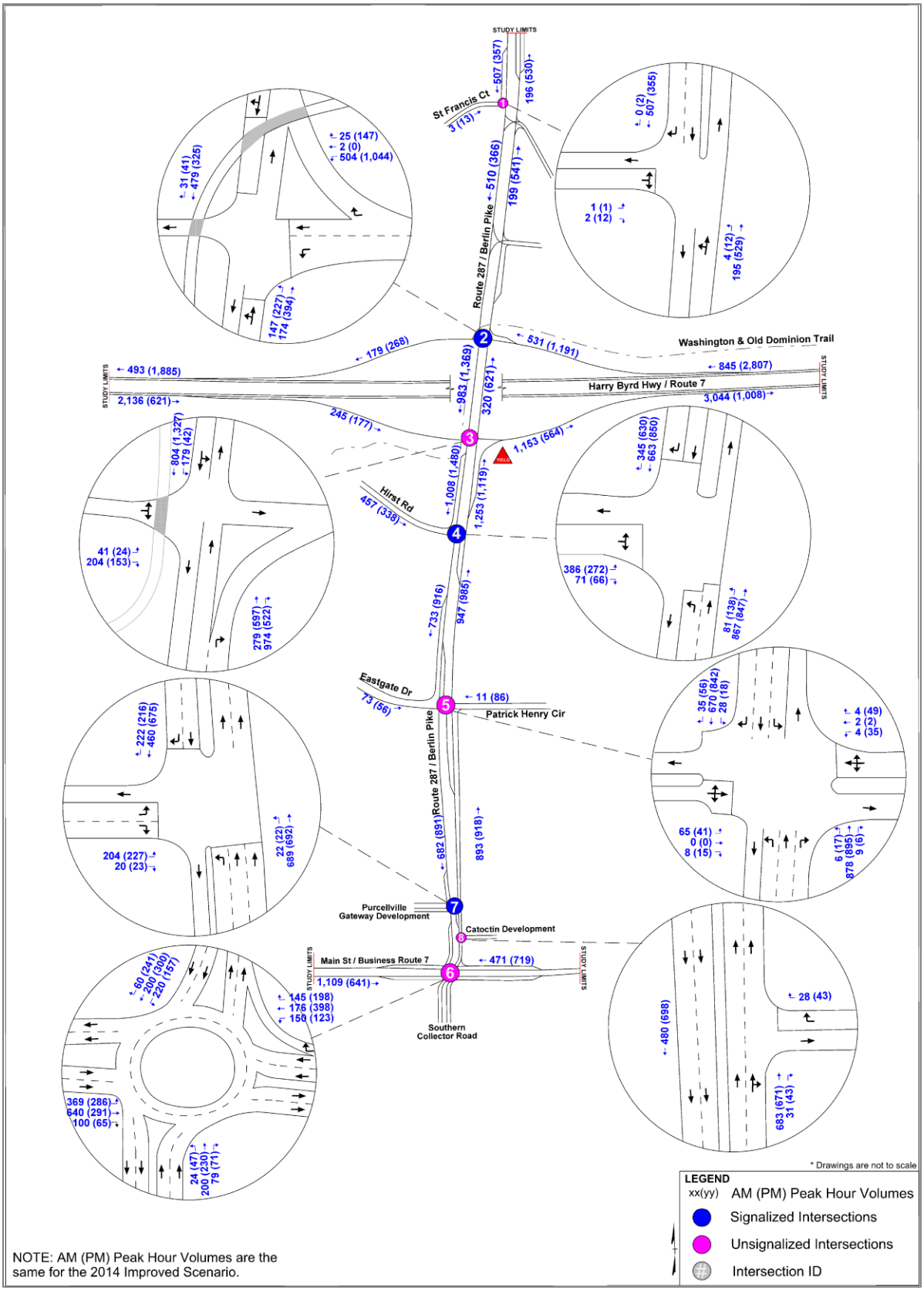
Table 1: Trips generated using ITE manual

	AM Peak Hour		PM Peak Hour	
Development	Entering Trips	Existing Trips	Entering Trips	Existing Trips
Gateway	444	407	432	453
Catoctin	87	70	122	107
Patrick Henry College	-	-	-	-

As stated in the previous section, a new fourth leg will be built at the intersection of Route 7 Business and Route 287. This will potentially result in diversion of traffic to and from Route 7 Business West, also considered in the traffic forecast. Volume splits for the traffic diversion were estimated based on the approved TIA for Catoctin development.

The study area volume remains the same in ***2014 Baseline***, ***2014 Improved*** and ***2014 Modified Build*** scenarios. **Figure 5** depicts the roadway and intersection turning movement volumes in 2014 for both AM and PM peak hour conditions.

Figure 5: 2014 AM and PM Peak Hour Traffic Volumes



Based on the turning movement counts, field observation and approved TIAs in the study area, an Origin-Destination (O-D) table was generated for 2014. **Figure 6** depicts the O-D zones used for the analysis along with the overall roadway network used for modeling.

Figure 6: Rte 7/287 Interchange Study Network and O-D Zone Map

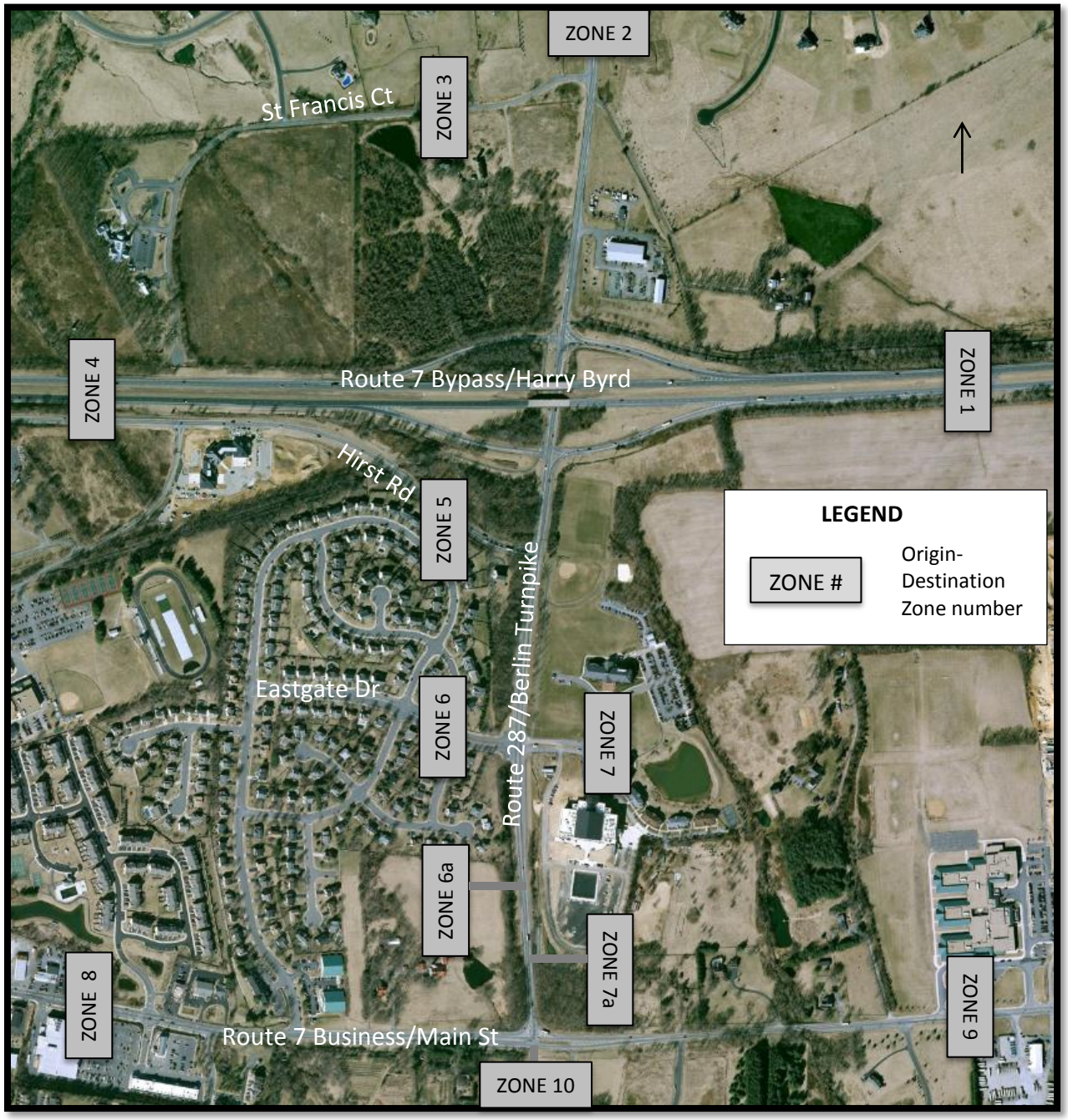


Table 2 and **Table 3** detail the volume travelling between any two O-D pairs for AM and PM peak hour conditions. O-D information was coded directly into the VISSIM models to replicate the observed travel patterns from each origin to all the destinations. Traffic travelling between each pair of origins and destinations is validated using the assumptions in approved TIAs in the study area.

Table 2: 2014 AM Peak Hour O-D Matrix

		DESTINATION ZONE												
		1	2	3	4	5	6	6a	7	7a	8	9	10	Total
ORIGIN ZONE														
1	Rte 7/Harry Byrd Hwy East	0	21	4	313	233	35	67	27	0	25	29	91	845
2	Rte 287/Berlin Pike North	179	0	0	31	102	-	22	-	0	19	69	83	505
3	Rte 722/St Francis Ct	-	1	0	-	-	-	0	2	0	-	-	0	3
4	Rte 7/Harry Byrd Hwy West	1891	41	-	0	11	-	111	-	0	13	49	21	2136
5	Hirst Rd	348	39	-	-	0	-	22	-	0	2	44	3	457
6	Eastgate Dr West	59	7	-	-	-	0	0	0	0	-	8	-	73
6a	Gateway	61	20	0	102	20	0	0	0	0	-	20	-	224
7	Eastgate Dr East	4	-	-	-	-	2	0	0	0	2	-	3	11
7a	Catoctin RIRO	3	14	0	3	3	3	0	0	0	-	-	-	28
8	Main St/Rte 7 Business West	278	37	-	16	13	-	-	-	24	0	640	100	1109
9	Main St/Rte 7 Business East	46	5	-	22	40	3	22	9	-	176	0	150	473
10	Southern Collector Road	175	10	-	4	4	-	-	-	7	24	79	0	303
	Total	3044	196	4	491	426	44	244	38	31	260	938	450	

Table 3: 2014 PM Peak Hour O-D Matrix

		DESTINATION ZONE												
		1	2	3	4	5	6		7		8	9		Total
ORIGIN ZONE														
1	Rte 7/Harry Byrd Hwy East	0	135	12	1617	549	19	65	18	0	124	74	195	2807
2	Rte 287/Berlin Pike North	42	0	2	41	65	10	22	-	0	61	29	84	357
3	Rte 722/St Francis Ct	-	1	0	-	-	12	0	-	0	-	-	-	13
4	Rte 7/Harry Byrd Hwy West	444	24	-	0	16	15	108	-	0	4	6	4	621
5	Hirst Rd	184	88	-	-	0	-	22	-	0	17	10	17	338
6	Eastgate Dr West	37	4	-	-	-	0	0	0	0	-	15	0	56
6a	Gateway	68	23	0	113	23	0	0	0	0	-	23	0	249
7	Eastgate Dr East	9	39	-	-	0	2	0	0	0	35	-	0	85
7a	Catoctin RIRO	5	21	0	5	5	5	0	0	0	-	-	0	43
8	Main St/Rte 7 Business West	119	38	-	48	40	9	-	-	32	0	291	65	641
9	Main St/Rte 7 Business East	28	43	-	43	55	-	22	6	-	398	0	123	719
10	Southern Collector Road	72	113	-	17	14	3	-	0	11	47	71	0	348
	Total	1009	529	14	1885	768	75	238	24	43	686	519	488	

3.3 Operational Analysis Methodology

Micro-simulation software VISSIM (Version 5.30) was used for the analysis in order to provide a comprehensive understanding of the traffic operations at interchange and the neighboring intersections in ***2014 Baseline***, ***2014 Improved*** and ***2014 Modified Build*** conditions.

The following Measures of Effectiveness (MOEs) were collected from the AM and PM VISSIM models:

- Network wide travel times
- Along Route 7 Bypass:
    - Average speed
    - Average density
- At intersections along Route 287:
    - Approach and intersection delay
    - Maximum queue lengths by movement

LOS was obtained using the criteria established in the 2000 Highway Capacity Manual (HCM) based on traffic density (vehicles/mile/lane) for the Route 7 Bypass and based on delay (seconds/vehicle) for intersections.

3.4 Operational Analysis Findings

Table 4 and **Table 5** compare the VISSIM travel times between the ***Existing***, ***2014 Baseline***, ***2014 Improved*** and ***2014 Modified Build*** conditions for the AM and PM models respectively.

Table 4: Travel Times AM Peak Hour

		VISSIM TRAVEL TIME (minutes)			
SEGMENT	DIRECTION	2011 Existing	2014 Baseline	2014 Improved	2014 Mod. Build
From Route 7 Bypass WB (At Ivandale Rd/Route 709) to West of Main St/Route 7 Business	WB (towards Purcellville)	4.2	3.9	3.7	3.7
West of Main St/Route 7 Business to Route 7 Bypass EB (At Ivandale rd/Route 709)	EB (towards Leesburg)	3.3	3.5	3.6	3.7

Table 5: Travel Times PM Peak Hour

		VISSIM TRAVEL TIME (minutes)			
SEGMENT	DIRECTION	2011 Existing	2014 Baseline	2014 Improved	2014 Mod. Build
From Route 7 Bypass WB (At Ivandale Rd/Route 709) to West of Main St/Route 7 Business	WB (towards Purcellville)	6.7	11.1	4.1	6.0
West of Main St/Route 7 Business to Route 7 Bypass EB (At Ivandale rd/Route 709)	EB (towards Leesburg)	3.0	4.6	3.5	4.6

In the PM peak hour, travel time decreased by 4 minutes in the WB direction in the ***2014 Modified Build*** scenario when compared to a 6 minute decrease in the ***2014 Improved*** scenario compared to baseline scenario. The lower travel time in the WB direction could be achieved by providing majority of green time to WB off-ramp (at the intersection of Route 287/Route 7 Bypass WB Ramps) in the ***2014 Modified Build*** scenario. As a result, travel time in EB direction does not change in spite of improvements on Route 287.

Table 6 through **Table 13** detail the measures of effectiveness (MOEs) obtained from the VISSIM models and the corresponding HCM Level of Service (LOS).

Key observations in the AM peak hour:

- Elimination of the proposed improvements on the ramps of the Route 7 Bypass result in minor or no increase in delays or queues in the study area.

Table 6: AM Peak Hour LOS for Highway Segments Along Route 7 Bypass

				2011 Existing AM		2014 Baseline AM		2014 Improved AM		2014 Mod. Build AM	
ID	SEGMENT	DIRECTION	TYPE OF OPERATION	DENSITY	LOS	DENSITY	LOS	DENSITY	LOS	DENSITY	LOS
1	Rte. 7 Bypass/Harry Byrd Hwy WB upstream of off-ramp	WB	Basic	6.1	A	7.5	A	7.5	A	7.5	A
2	Rte. 7 Bypass/Harry Byrd Hwy WB off-ramp	WB	Diverge	4.0	A	5.0	A	5.0	A	4.9	A
3	Rte. 7 Bypass/Harry Byrd Hwy WB between on/off ramps	WB	Basic	2.6	A	2.7	A	2.7	A	2.7	A
4	Rte. 7 Bypass/Harry Byrd Hwy WB on-ramp	WB	Merge	2.1	A	2.9	A	2.8	A	2.8	A
5	Rte. 7 Bypass/Harry Byrd Hwy WB downstream of on-ramp	WB	Basic	3.3	A	4.4	A	4.3	A	4.3	A
6	Rte. 7 Bypass/Harry Byrd Hwy EB upstream of off-ramp	EB	Basic	17.4	B	19.5	C	19.5	C	19.5	C
7	Rte. 7 Bypass/Harry Byrd Hwy EB off-ramp	EB	Diverge	11.5	B	13.2	B	13.2	B	13.2	B
8	Rte. 7 Bypass/Harry Byrd Hwy EB between on/off ramps	EB	Basic	16.2	B	17.2	B	17.2	B	17.2	B
9	Rte. 7 Bypass/Harry Byrd Hwy EB on-ramp	EB	Merge	16.4	B	19.0	B	19.2	B	19.1	B
10	Rte. 7 Bypass/Harry Byrd Hwy EB downstream of on-ramp	EB	Basic	24.5	C	28.0	D	28.1	D	28.1	D

Table 7: AM Peak Hour LOS for Intersections Along Route 287

			2011 Existing AM				2014 Baseline AM				2014 Improved AM				2014 Modified Build AM			
			APPROACH		INTERSECTION		APPROACH		INTERSECTION		APPROACH		INTERSECTION		APPROACH		INTERSECTION	
ID	INTERSECTION	APPROACH	DELAY	LOS	DELAY	LOS	DELAY	LOS	DELAY	LOS	DELAY	LOS	DELAY	LOS	DELAY	LOS	DELAY	LOS
1	Rte. 287/Berlin Pike & St Francis Ct/Rte. 722 (Unsignalized)	EB	5.5	A	0.2	A	6.8	A	0.1	A	6.9	A	0.1	A	6.8	A	0.3	A
		NB	0.4	A			0.1	A			0.2	A			0.3	A		
		SB	0.0	A			0.0	A			0.0	A			0.2	A		
2	Rte. 287/Berlin Pike & Rte. 7 Bypass/Harry Byrd Hwy WB ramps (Signalized)	WB	35.5	D	20.9	C	36.2	D	30.1	C	28.6	C	19.3	B	33.6	C	24.3	C
		NB	10.6	B			43.0	D			16.2	B			21.6	C		
		SB	11.7	B			16.1	B			11.5	B			16.2	B		
3	Rte. 287/Berlin Pike & Rte. 7 Bypass/Harry Byrd Hwy EB ramps (Unsignalized)	EB	12.8	B	4.3	A	26.2	D	9.5	A	13.0	B	6.1	A	13.5	B	6.3	A
		NB	5.3	A			10.0	A			7.9	A			8.5	A		
		SB	1.7	A			4.6	A			2.1	A			1.7	A		
4	Rte. 287/Berlin Pike & Hirst Rd (Signalized)	EB	161.3	F	43.8	D	68.9	E	25.1	C	50.2	D	20.9	C	49.4	D	21.8	C
		NB	9.0	A			13.6	B			13.3	B			18.5	B		
		SB	10.7	B			16.1	B			14.8	B			12.2	B		
5	Rte. 287/Berlin Pike & Eastgate Dr (Unsignalized)	EB	10.9	B	1.2	A	20.0	C	2.0	A	17.5	C	1.9	A	18.4	C	1.9	A
		WB	6.9	A			11.4	B			14.9	B			12.8	B		
		NB	0.2	A			1.1	A			0.9	A			1.1	A		
		SB	0.8	A			1.1	A			1.3	A			1.0	A		
6	Rte. 287/Berlin Pike & Main St/Rte. 7 Business (Unsignalized)	EB	1.4	A	5.5	A	9.1	A	9.1	A	9.5	A	9.5	A	10.2	B	9.9	A
		WB	1.5	A			3.9	A			3.8	A			3.8	A		
		NB					18.4	C			18.8	C			18.3	C		
		SB	22.9	C			8.3	A			9.2	A			9.9	A		
7	Rte. 287/Berlin Pike & Gateway (Signalized)	EB					39.2	D	8.0	A	34.2	C	7.3	A	34.0	C	8.0	A
		NB					4.8	A			4.6	A			4.8	A		
		SB					1.3	A			1.3	A			2.9	A		
8	Rte. 287/Berlin Pike & Catoctin (Unsignalized)	WB					4.7	A	1.0	A	4.6	A	1.0	A	4.6	A	1.0	A
		NB					0.8	A			0.8	A			0.8	A		

Table 8: Average Queues by Movement at Intersections

			Existing AM		2014 Baseline AM		2014 Improved AM		2014 Modified Build AM	
ID	INTERSECTION	MOVEMENT	Available Storage Length (ft)	Avg. Queue Length (ft)	Available Storage Length (ft)	Avg. Queue Length (ft)	Available Storage Length (ft)	Avg. Queue Length (ft)	Available Storage Length (ft)	Avg. Queue Length (ft)
1	Rte. 287/Berlin Pike & St Francis Ct/Rte. 722 (Unsignalized)	EBL	1540	0	1540	0	1540	0	1540	0
		EBR	1540	0	1540	0	1540	0	1540	0
		NBL	695	0	695	0	695	0	695	0
		NBT	695	0	695	0	695	0	695	0
		SBT	510	0	510	0	510	0	510	0
		SBR	345	0	345	0	345	0	345	0
2	Rte. 287/Berlin Pike & Rte. 7 Bypass/Harry Byrd Hwy WB ramps (Signalized)	WBL	900	70	900	105	850	53	900	94
		WBR	200	27	200	56	550	0	200	0
		NBL	430	6	430	64	300	14	300	17
		NBT	430	6	430	64	430	14	430	17
		SBT	485	20	485	37	485	23	485	37
		SBR	485	20	485	37	485	23	485	37
3	Rte. 287/Berlin Pike & Rte. 7 Bypass/Harry Byrd Hwy EB ramps (Unsignalized)	EBL	920	0	920	22	60	3	920	4
		EBR	920	0	920	22	920	3	920	4
		NBT	450	2	450	0	450	0	450	0
		NBR	300	2	300	50	300	20	300	23
		SBL	475	0	475	3	175	1	175	0
		SBT	475	0	475	3	475	1	475	0
4	Rte. 287/Berlin Pike & Hirst Rd (Signalized)	EBL	1500	1279	1500	225	1500	131	1500	135
		EBR	1500	1235	1500	214	100	131	1500	135
		NBL	350	2	350	6	350	6	350	9
		NBT	870	21	870	56	870	60	870	99
		SBT	420	21	420	80	420	65	420	53
		SBR	410	9	410	12	420	17	420	10
5	Rte. 287/Berlin Pike & Eastgate Dr (Unsignalized)	EBL	240	0	240	0	240	0	240	0
		EBT	240	0	240	0	240	0	240	0
		EBR	240	0	240	0	240	0	240	0
		WBL	250	0	250	0	250	0	250	0
		WBT	250	0	250	0	250	0	250	0
		WBR	250	0	250	0	250	0	250	0
		NBL	285	0	285	0	285	0	285	0
		NBT	1305	0	660	0	660	0	660	0
		NBR	480	0	480	0	480	0	480	0
		SBL	320	0	320	0	320	0	320	0
		SBT	850	0	850	0	850	0	850	0
		SBR	565	0	565	0	565	0	565	0
6	Rte. 287/Berlin Pike & Main St/Rte. 7 Business (Unsignalized)	EBL	400	0	500	22	500	23	500	27
		EBT	1115	0	500	22	500	23	500	27
		EBR	-		500	22	500	23	500	27
		WBL	-		500	0	500	0	500	0
		WBT	1200	0	500	0	500	0	500	0
		WBR	425	0	500	0	500	0	500	0
		NBL	-		350	8	350	5	350	5
		NBT	-		350	8	350	5	350	5
		NBR	-	0	350	8	350	5	350	5
		SBL	1370	3	410	6	410	8	410	9
		SBT	-		550	6	550	8	550	9
		SBR	1370	3	410	6	410	8	410	9
7	Rte. 287/Berlin Pike & Gateway (Signalized)	EBL	-		300	39	300	36	300	36
		EBR	-		300	39	300	36	300	36
		NBL	-		245	5	245	6	245	6
		NBT	-		250	5	250	6	250	6
		SBT	-		660	2	660	2	660	3
		SBR	-		260	2	260	2	260	3
8	Rte. 287/Berlin Pike & Catoctin (Unsignalized)	WBR	-		120	0	120	0	120	0
		NBT	-		270	0	270	0	270	0
		NBR	-		270	0	270	0	270	0

Table 9: Maximum Queues by Movement at Intersections

			Existing AM		2014 Baseline AM		2014 Improved AM		2014 Modified Build AM	
ID	INTERSECTION	MOVEMENT	Available Storage Length (ft)	Max. Queue Length (ft)	Available Storage Length (ft)	Max. Queue Length (ft)	Available Storage Length (ft)	Max. Queue Length (ft)	Available Storage Length (ft)	Max. Queue Length (ft)
1	Rte. 287/Berlin Pike & St Francis Ct/Rte. 722 (Unsignalized)	EBL	1540	0	1540	0	1540	0	1540	0
		EBR	1540	0	1540	0	1540	0	1540	0
		NBL	695	0	695	0	695	0	695	0
		NBT	695	0	695	0	695	0	695	0
		SBT	510	0	510	0	510	0	510	0
		SBR	345	0	345	0	345	0	345	0
2	Rte. 287/Berlin Pike & Rte. 7 Bypass/Harry Byrd Hwy WB ramps (Signalized)	WBL	900	382	900	461	850	287	900	387
		WBR	200	315	200	394	550	0	200	0
		NBL	430	83	430	396	300	146	300	148
		NBT	430	83	430	396	430	146	430	148
		SBT	485	240	485	326	485	247	485	331
		SBR	485	240	485	326	485	247	485	331
3	Rte. 287/Berlin Pike & Rte. 7 Bypass/Harry Byrd Hwy EB ramps (Unsignalized)	EBL	920	7	920	183	60	97	920	93
		EBR	920	7	920	183	920	97	920	93
		NBT	450	104	450	0	450	8	450	0
		NBR	300	104	300	529	300	318	300	328
		SBL	475	9	475	217	175	98	175	54
		SBT	475	9	475	217	475	98	475	54
4	Rte. 287/Berlin Pike & Hirst Rd (Signalized)	EBL	1500	1914	1500	693	1500	481	1500	523
		EBR	1500	1870	1500	682	100	481	1500	523
		NBL	350	47	350	85	350	88	350	175
		NBT	870	262	870	365	870	450	870	614
		SBT	420	239	420	515	420	481	420	445
		SBR	410	232	410	178	420	201	420	136
5	Rte. 287/Berlin Pike & Eastgate Dr (Unsignalized)	EBL	240	6	240	16	240	0	240	8
		EBT	240	6	240	16	240	0	240	8
		EBR	240	6	240	16	240	0	240	8
		WBL	250	0	250	0	250	0	250	0
		WBT	250	0	250	0	250	0	250	0
		WBR	250	0	250	0	250	0	250	0
		NBL	285	0	285	75	285	26	285	62
		NBT	1305	0	660	75	660	26	660	62
		NBR	480	0	480	75	480	26	480	62
		SBL	320	0	320	8	320	9	320	0
		SBT	850	0	850	0	850	0	850	0
		SBR	565	0	565	0	565	0	565	0
6	Rte. 287/Berlin Pike & Main St/Rte. 7 Business (Unsignalized)	EBL	400	0	500	249	500	384	500	322
		EBT	1115	0	500	249	500	384	500	322
		EBR	-		500	249	500	384	500	322
		WBL	-		500	48	500	64	500	44
		WBT	1200	0	500	48	500	64	500	44
		WBR	425	0	500	27	500	33	500	17
		NBL	-		350	103	350	95	350	85
		NBT	-		350	103	350	95	350	85
		NBR	-	0	350	103	350	95	350	85
		SBL	1370	144	410	142	410	167	410	155
		SBT	-		550	142	550	167	550	155
		SBR	1370	144	410	142	410	167	410	155
7	Rte. 287/Berlin Pike & Gateway (Signalized)	EBL	-		300	191	300	185	300	182
		EBR	-		300	191	300	185	300	182
		NBL	-		245	116	245	106	245	124
		NBT	-		250	116	250	106	250	124
		SBT	-		660	80	660	133	660	265
		SBR	-		260	80	260	133	260	265
8	Rte. 287/Berlin Pike & Catoctin (Unsignalized)	WBR	-		120	0	120	0	120	0
		NBT	-		270	0	270	0	270	0
		NBR	-		270	0	270	0	270	0

Findings in the PM peak hour concerning the Modified Build Scenario:

- As shown in **Table 10,** highway segments along Route 7 Bypass operating at LOS "F" in the existing conditions and ***2014 Baseline*** scenario will still operate at LOS "E" or worse. In the analysis the delay on these highway segments was reduced significantly by providing majority of the green time (at the intersection of Route 287/WB Ramps Route 7 Bypass) to the WB approach.
- The intersection of Route 287/WB Route 7 Bypass continues to operate at LOS "E" in the ***2014 Modified Build*** scenario (see **Table 11**). Average and maximum queues (shown in **Tables 12 and 13** respectively) exceeding the storage length are observed on all the three approaches of the intersection in spite of improvements on Route 287 as majority of the green time is provided to the WB off-ramp to avoid back up on to Route 7 Bypass.
- Other intersections along Route 287 are observed to operate similar to the ***2014 Improved*** scenario.

Table 10: PM Peak Hour LOS for Highway Segments Along Route 7 Bypass

				2011 Existing PM		2014 Baseline PM		2014 Improved PM		2014 Mod. Build PM	
ID	SEGMENT	DIRECTION	TYPE OF OPERATION	DENSITY	LOS	DENSITY	LOS	DENSITY	LOS	DENSITY	LOS
1	Rte. 7 Bypass/Harry Byrd Hwy WB upstream of off-ramp	WB	Basic	64.6	F	153.2	F	25.8	C	35.1	E
2	Rte. 7 Bypass/Harry Byrd Hwy WB off-ramp	WB	Diverge	106.3	F	139.7	F	21.1	C	96.1	F
3	Rte. 7 Bypass/Harry Byrd Hwy WB between on/off ramps	WB	Basic	15.9	B	11.8	B	14.9	B	14.5	B
4	Rte. 7 Bypass/Harry Byrd Hwy WB on-ramp	WB	Merge	11.1	B	8.9	A	11.3	B	11.0	B
5	Rte. 7 Bypass/Harry Byrd Hwy WB downstream of on-ramp	WB	Basic	16.8	B	13.6	B	17.2	B	16.8	B
6	Rte. 7 Bypass/Harry Byrd Hwy EB upstream of off-ramp	EB	Basic	4.7	A	5.6	A	5.6	A	5.6	A
7	Rte. 7 Bypass/Harry Byrd Hwy EB off-ramp	EB	Diverge	3.1	A	15.1	B	3.7	A	3.7	A
8	Rte. 7 Bypass/Harry Byrd Hwy EB between on/off ramps	EB	Basic	4.1	A	4.2	A	4.2	A	4.2	A
9	Rte. 7 Bypass/Harry Byrd Hwy EB on-ramp	EB	Merge	5.4	A	6.4	A	6.4	A	6.4	A
10	Rte. 7 Bypass/Harry Byrd Hwy EB downstream of on-ramp	EB	Basic	8.1	A	9.2	A	9.3	A	9.3	A

Table 11: PM Peak Hour LOS for Intersections Along Route 287

			2011 Existing PM				2014 Baseline PM				2014 Improved PM				2014 Modified Build PM			
			APPROACH		INTERSECTION		APPROACH		INTERSECTION		APPROACH		INTERSECTION		APPROACH		INTERSECTION	
ID	INTERSECTION	APPROACH	DELAY	LOS	DELAY	LOS	DELAY	LOS	DELAY	LOS	DELAY	LOS	DELAY	LOS	DELAY	LOS	DELAY	LOS
1	Rte. 287/Berlin Pike & St Francis Ct/Rte. 722 (Unsignalized)	EB	4.8	A	0.3	A	5.0	A	1.1	A	4.8	A	0.2	A	11.6	B	14.1	B
		NB	0.1	A			0.3	A			0.2	A			0.5	A		
		SB	0.3	A			2.1	A			0.1	A			33.8	D		
2	Rte. 287/Berlin Pike & Rte. 7 Bypass/Harry Byrd Hwy WB ramps (Signalized)	WB	44.6	D	45.3	D	43.6	D	69.9	E	39.1	D	31.3	C	32.1	C	76.4	E
		NB	54.7	D			75.3	E			21.6	C			119.6	F		
		SB	36.5	D			126.1	F			22.2	C			151.1	F		
3	Rte. 287/Berlin Pike & Rte. 7 Bypass/Harry Byrd Hwy EB ramps (Unsignalized)	EB	25.8	D	2.2	A	353.7	F	36.5	E	25.2	D	4.8	A	16.7	C	16.9	C
		NB	1.7	A			25.3	D			0.9	A			33.3	D		
		SB	1.2	A			9.4	A			5.5	A			3.1	A		
4	Rte. 287/Berlin Pike & Hirst Rd (Signalized)	EB	76.5	E	21.4	C	82.1	F	30.3	C	61.3	E	22.7	C	67.4	E	26.6	C
		NB	9.2	A			28.8	C			16.4	B			34.6	C		
		SB	11.7	B			16.4	B			17.9	B			11.4	B		
5	Rte. 287/Berlin Pike & Eastgate Dr (Unsignalized)	EB	11.2	B	1.4	A	46.9	E	16.6	C	21.4	C	2.7	A	38.4	E	8.8	A
		WB	9.7	A			25.7	D			18.3	C			22.5	C		
		NB	0.3	A			27.2	D			1.9	A			13.3	B		
		SB	0.4	A			1.0	A			0.9	A			0.9	A		
6	Rte. 287/Berlin Pike & Main St/Rte. 7 Business (Unsignalized)	EB	2.1	A	3.2	A	5.2	A	7.3	A	6.2	A	8.6	A	5.9	A	6.5	A
		WB	1.6	A			4.2	A			3.9	A			1.8	A		
		NB					8.1	A			8.5	A			8.3	A		
		SB	6.4	A			12.7	B			15.4	C			11.1	B		
7	Rte. 287/Berlin Pike & Gateway (Signalized)	EB					73.5	E	23.3	C	55.5	E	17.1	B	56.1	E	11.2	B
		NB					24.5	C			7.2	A			7.0	A		
		SB					5.9	A			14.1	B			1.7	A		
8	Rte. 287/Berlin Pike & Catoctin (Unsignalized)	WB					23.8	C	6.7	A	4.8	A	1.2	A	4.8	A	1.2	A
		NB					5.8	A			1.0	A			1.0	A		

Table 12: Average Queues by Movement at Intersections

			Existing PM		2014 Baseline PM		2014 Improved PM		2014 Modified Build PM	
ID	INTERSECTION	MOVEMENT	Available Storage Length (ft)	Avg. Queue Length (ft)	Available Storage Length (ft)	Avg. Queue Length (ft)	Available Storage Length (ft)	Avg. Queue Length (ft)	Available Storage Length (ft)	Avg. Queue Length (ft)
1	Rte. 287/Berlin Pike & St Francis Ct/Rte. 722 (Unsignalized)	EBL	1540	0	1540	0	1540	0	1540	0
		EBR	1540	0	1540	0	1540	0	1540	0
		NBL	695	0	695	0	695	0	695	0
		NBT	695	0	695	0	695	0	695	0
		SBT	510	0	510	3	510	0	510	66
		SBR	345	0	345	0	345	0	345	0
2	Rte. 287/Berlin Pike & Rte. 7 Bypass/Harry Byrd Hwy WB ramps (Signalized)	WBL	900	2208	900	8378	850	162	900	1594
		WBR	200	2145	200	8312	550	0	200	1546
		NBL	430	0	430	391	300	41	300	379
		NBT	430	96	430	391	430	41	430	379
		SBT	485	52	485	503	485	40	485	785
		SBR	485	52	485	503	485	40	485	785
3	Rte. 287/Berlin Pike & Rte. 7 Bypass/Harry Byrd Hwy EB ramps (Unsignalized)	EBL	920	0	920	440	60	4	920	1
		EBR	920	0	920	440	920	4	920	1
		NBT	450	0	450	149	450	0	450	206
		NBR	300	0	300	104	300	0	300	144
		SBL	475	0	475	38	175	10	175	2
		SBT	475	0	475	38	475	10	475	2
4	Rte. 287/Berlin Pike & Hirst Rd (Signalized)	EBL	1500	134	1500	174	1500	117	1500	129
		EBR	1500	100	1500	174	100	117	1500	129
		NBL	350	4	350	18	350	19	350	30
		NBT	870	16	870	343	870	82	870	335
		SBT	420	37	420	115	420	84	420	54
		SBR	410	27	410	41	420	120	420	32
5	Rte. 287/Berlin Pike & Eastgate Dr (Unsignalized)	EBL	240	0	240	2	240	0	240	0
		EBT	240	0	240	2	240	0	240	0
		EBR	240	0	240	2	240	0	240	0
		WBL	250	0	250	0	250	1	250	0
		WBT	250	0	250	0	250	1	250	0
		WBR	250	0	250	0	250	1	250	0
		NBL	285	0	285	139	285	1	285	37
		NBT	1305	0	660	139	660	1	660	37
		NBR	480	0	480	139	480	1	480	37
		SBL	320	0	320	0	320	0	320	0
		SBT	850	0	850	0	850	0	850	0
		SBR	565	0	565	0	565	0	565	0
6	Rte. 287/Berlin Pike & Main St/Rte. 7 Business (Unsignalized)	EBL	400	0	500	3	500	5	500	4
		EBT	1115	0	500	3	500	5	500	4
		EBR	-		500	3	500	5	500	4
		WBL	-		500	0	500	0	500	0
		WBT	1200	0	500	0	500	0	500	0
		WBR	425	0	500	0	500	0	500	0
		NBL	-		350	1	350	1	350	1
		NBT	-		350	1	350	1	350	1
		NBR	-	0	350	1	350	1	350	1
		SBL	1370	1	410	18	410	29	410	15
		SBT	-		550	18	550	29	550	15
		SBR	1370	1	410	18	410	29	410	15
7	Rte. 287/Berlin Pike & Gateway (Signalized)	EBL	-		300	81	300	71	300	71
		EBR	-		300	81	300	71	300	71
		NBL	-		245	38	245	10	245	9
		NBT	-		250	38	250	10	250	9
		SBT	-		660	19	660	68	660	2
		SBR	-		260	19	260	68	260	2
8	Rte. 287/Berlin Pike & Catoctin (Unsignalized)	WBR	-		120	0	120	0	120	0
		NBT	-		270	2	270	0	270	0
		NBR	-		270	2	270	0	270	0

Table 13: Maximum Queues by Movement at Intersections

			Existing PM		2014 Baseline PM		2014 Improved PM		2014 Modified Build PM	
ID	INTERSECTION	MOVEMENT	Available Storage Length (ft)	Max. Queue Length (ft)	Available Storage Length (ft)	Max. Queue Length (ft)	Available Storage Length (ft)	Max. Queue Length (ft)	Available Storage Length (ft)	Max. Queue Length (ft)
1	Rte. 287/Berlin Pike & St Francis Ct/Rte. 722 (Unsignalized)	EBL	1540	0	1540	8	1540	8	1540	8
		EBR	1540	0	1540	8	1540	8	1540	8
		NBL	695	0	695	0	695	0	695	49
		NBT	695	0	695	0	695	0	695	49
		SBT	510	0	510	81	510	0	510	349
		SBR	345	0	345	0	345	0	345	0
2	Rte. 287/Berlin Pike & Rte. 7 Bypass/Harry Byrd Hwy WB ramps (Signalized)	WBL	900	4172	900	9696	850	633	900	3297
		WBR	200	4105	200	9640	550	0	200	3244
		NBL	430	329	430	557	300	224	300	548
		NBT	430	329	430	557	430	224	430	548
		SBT	485	269	485	974	485	326	485	1298
		SBR	485	269	485	974	485	326	485	1298
3	Rte. 287/Berlin Pike & Rte. 7 Bypass/Harry Byrd Hwy EB ramps (Unsignalized)	EBL	920	0	920	888	60	125	920	81
		EBR	920	0	920	888	920	125	920	81
		NBT	450	27	450	524	450	0	450	540
		NBR	300	27	300	429	300	34	300	444
		SBL	475	0	475	584	175	311	175	202
		SBT	475	0	475	584	475	311	475	202
4	Rte. 287/Berlin Pike & Hirst Rd (Signalized)	EBL	1500	475	1500	601	1500	474	1500	530
		EBR	1500	432	1500	601	100	474	1500	530
		NBL	350	90	350	237	350	300	350	626
		NBT	870	256	870	772	870	701	870	1066
		SBT	420	289	420	532	420	525	420	499
		SBR	410	287	410	429	420	526	420	286
5	Rte. 287/Berlin Pike & Eastgate Dr (Unsignalized)	EBL	240	0	240	26	240	6	240	21
		EBT	240	0	240	26	240	6	240	21
		EBR	240	0	240	26	240	6	240	21
		WBL	250	24	250	30	250	39	250	45
		WBT	250	24	250	30	250	39	250	45
		WBR	250	24	250	30	250	39	250	45
		NBL	285	0	285	337	285	120	285	427
		NBT	1305	0	660	337	660	120	660	427
		NBR	480	0	480	337	480	120	480	427
		SBL	320	0	320	0	320	0	320	0
		SBT	850	0	850	0	850	0	850	0
		SBR	565	0	565	0	565	0	565	0
6	Rte. 287/Berlin Pike & Main St/Rte. 7 Business (Unsignalized)	EBL	400	0	500	120	500	166	500	136
		EBT	1115	0	500	120	500	166	500	136
		EBR	-		500	120	500	166	500	136
		WBL	-		500	51	500	49	500	45
		WBT	1200	0	500	51	500	49	500	50
		WBR	425	0	500	42	500	58	500	50
		NBL	-		350	55	350	62	350	60
		NBT	-		350	55	350	62	350	60
		NBR	-	0	350	55	350	62	350	60
		SBL	1370	95	410	216	410	218	410	169
		SBT	-		550	216	550	218	550	169
		SBR	1370	95	410	216	410	218	410	169
7	Rte. 287/Berlin Pike & Gateway (Signalized)	EBL	-		300	236	300	259	300	257
		EBR	-		300	236	300	259	300	257
		NBL	-		245	223	245	181	245	174
		NBT	-		250	223	250	181	250	174
		SBT	-		660	534	660	577	660	154
		SBR	-		260	534	260	577	260	154
8	Rte. 287/Berlin Pike & Catoctin (Unsignalized)	WBR	-		120	11	120	0	120	0
		NBT	-		270	60	270	0	270	0
		NBR	-		270	60	270	0	270	0