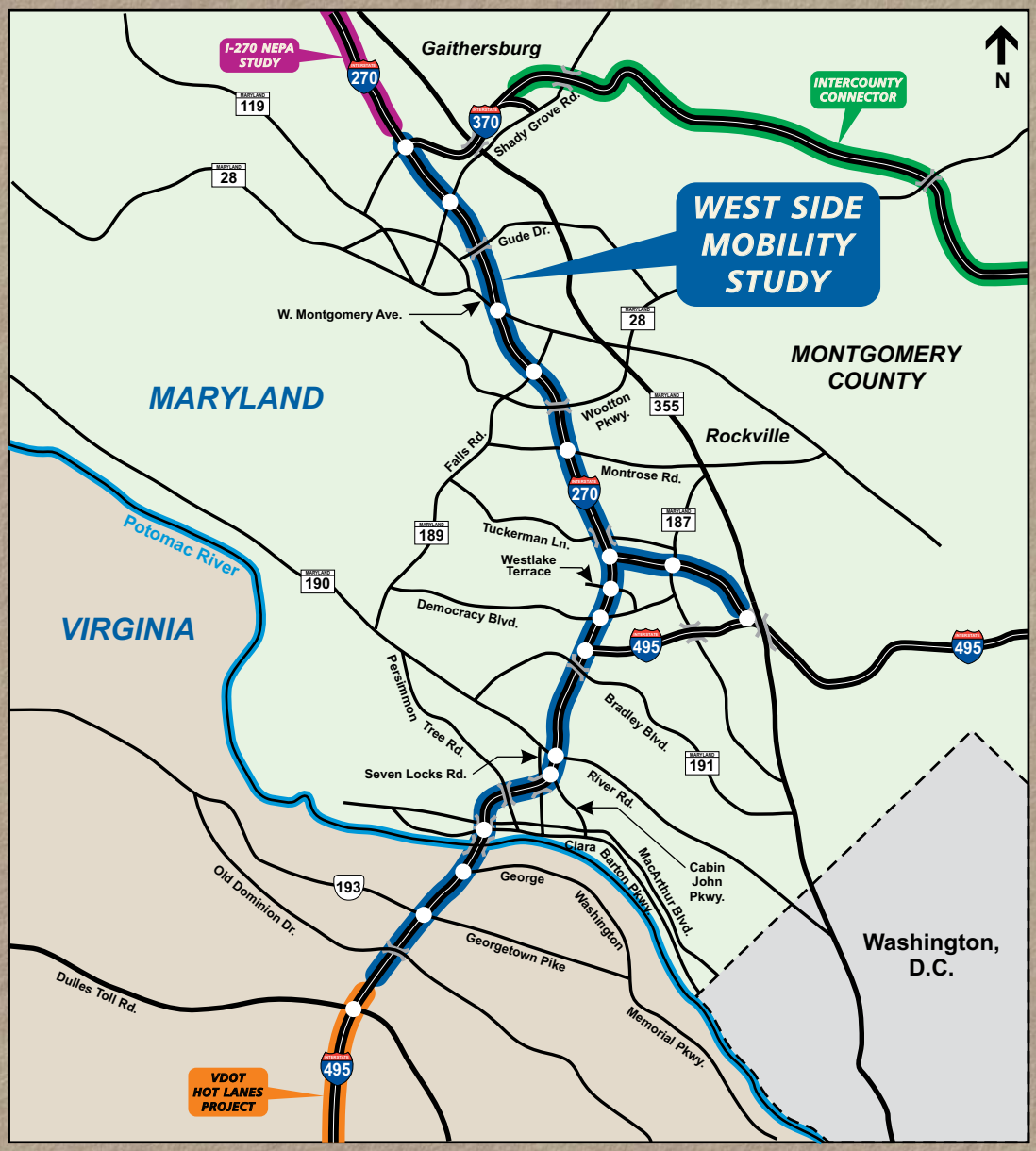
WEST SIDE MOBILITY STUDY



November 2009

Prepared for:

Maryland State Highway Administration

Maryland Transportation Authority

Virginia Department of Transportation

EXECUTIVE SUMMARY

The West Side Mobility Study is a joint study that was conducted by the Maryland State Highway Administration (SHA) and the Virginia Department of Transportation (VDOT) to evaluate potential improvements along the Capital Beltway, I-270 Spurs, and I-270 mainline between the VDOT High Occupancy Toll (HOT) Lanes Project and I-370 / Intercounty Connector (ICC). The study evaluated improvements that could increase capacity, improve traffic operations, and provide a managed lanes network to connect the adjacent facilities that are currently under construction. The existing conditions were analyzed and long-term, short-term, and mid-term improvements were developed.

The 14-mile long study corridor was divided into six distinct sections. Starting from the south, these sections include the following:

1. Capital Beltway in Virginia from the HOT Lanes Project to the American Legion Bridge
2. American Legion Bridge
3. Capital Beltway in Maryland from the American Legion Bridge to the I-270 West Spur
4. I-270 West Spur
5. I-270 mainline from the I-270 Spurs to the I-370 interchange
6. I-270 East Spur.

Traffic analyses for the existing and 2030 No-Build conditions indicated that significant portions of the study corridor will operate at level of service (LOS) E or F during the peak periods. In the southbound direction during the AM peak period, five out of 13 highway segments (portions of highway between the interchanges within the study limits) are operating at LOS E or F, including:

- I-495 from Clara Barton Parkway to MD 190 (2 segments).
- I-270 West Spur from I-495 split to Democracy Boulevard (1 segment).
- I-270 mainline from MD 189 to MD 28 (1 segment).
- I-270 mainline from Shady Grove Road to I-370 (1 segment).

In the northbound direction during the PM peak period, eight out of 13 highway segments are operating at LOS E or F, including:

- I-495 from Clara Barton Parkway to Cabin John Parkway (1 segment).
- Entire I-270 West Spur (3 segments).
- I-270 mainline from Y-Split to I-370 (4 segments).

The situation would deteriorate further by 2030 under the No-Build conditions. In the southbound direction during the AM peak period, seven out of 13 highway would be operating at LOS E or F, including:

- American Legion Bridge to I-270 West Spur (4 segments).
- I-270 West Spur between I-495 and Democracy Boulevard (1 segment).
- I-270 mainline between MD 189 and MD 28 (1 segment).
- I-270 mainline between Shady Grove Road and I-370 (1 segment).

In the northbound direction during the PM peak period, nine out of 13 highway segments would be operating at LOS E or F, including:

- I-495 between Clara Barton Parkway and Cabin John Parkway (2 segments).
- I-270 West Spur (3 segments).
- I-270 mainline between Y-Split interchange and MD 28 (4 segments).

Seven long-term alternatives were developed that would provide additional capacity throughout the study corridor. The new capacity would be created by widening the existing roadway and providing a managed lane system for the full length of the study corridor. The interchanges within the project limits would be modified to accommodate the widened and reconfigured mainline, and in some locations, provide access to the managed lanes (High Occupancy Vehicle - HOV, HOT, Express Toll Lane - ETL). The long-term alternatives would have significant costs ranging from $1.04 to $2.65 billion and extensive property impacts due to the mainline widening and interchange improvements.

Due to the extensive costs and impacts associated with the long-term alternatives, short-term and mid-term improvements were then considered. The short-term improvements focused on localized congestion points and modifications that could improve system-wide traffic operations with limited or no widening. These improvements were modeled in CORSIM to determine the effect on local and system-wide traffic operations. In general, some of the short-term improvements could provide some modest improvement to the overall system traffic operations.

Five mid-term improvements were considered that would provide increased capacity and a managed lane network throughout the study corridor with little or no widening. The mid-term improvements included restriping the existing highway to provide an additional lane in each direction; peak period shoulder use; use of reversible lanes to add capacity in the peak direction; and conversion of the existing HOV lanes on the I-270 Spurs and mainline to managed lanes. The restriping improvement appeared to provide the most benefits of all of the mid-term improvements, but there were a number of design and operational concerns with narrowing the lanes and shoulders to provide the additional capacity. These concerns would need to be studied in more detail before the restriping improvement could be implemented.

The West Side Mobility Study recommendations include completing more detailed studies of the following items:

Long-Term Improvements: Alternatives 1, 4, and 5/5A/5B.

Short-Term Improvements: Extending acceleration/deceleration lanes on ramp/slip ramp entrances; converting the HOV lanes on the I-270 West Spur to general purpose or managed lanes. It may also be possible to evaluate the short-term improvements as a separate study that could potentially be completed sooner.

Mid-Term Improvements: Restriping option.

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A. INTRODUCTION

The Maryland State Highway Administration (SHA) and Virginia Department of Transportation (VDOT) are currently studying and/or constructing improvements to the Capital Beltway, I-270, and I-370. In Virginia, VDOT in partnership with Fluor and Transurban, is constructing the Capital Beltway High Occupancy Toll (HOT) Lanes Project, which extends from I-95 / I-395 to the Dulles Toll Road. These improvements will provide two additional mainline lanes in each direction, which will be operated as HOT lanes. The project is anticipated to be completed in 2013. SHA is completing the I-270 Multi-Modal Corridor Study, which considers added capacity and Express Toll Lanes (ETL) on I-270 from north of I-370 to Frederick. A Public Hearing was held in June 2009 with selection of a locally preferred alternative to follow. SHA is also constructing the Intercounty Connector (ICC) between I-370 and I-95; the ICC will be a tolled roadway and the first section is scheduled to open by 2011.

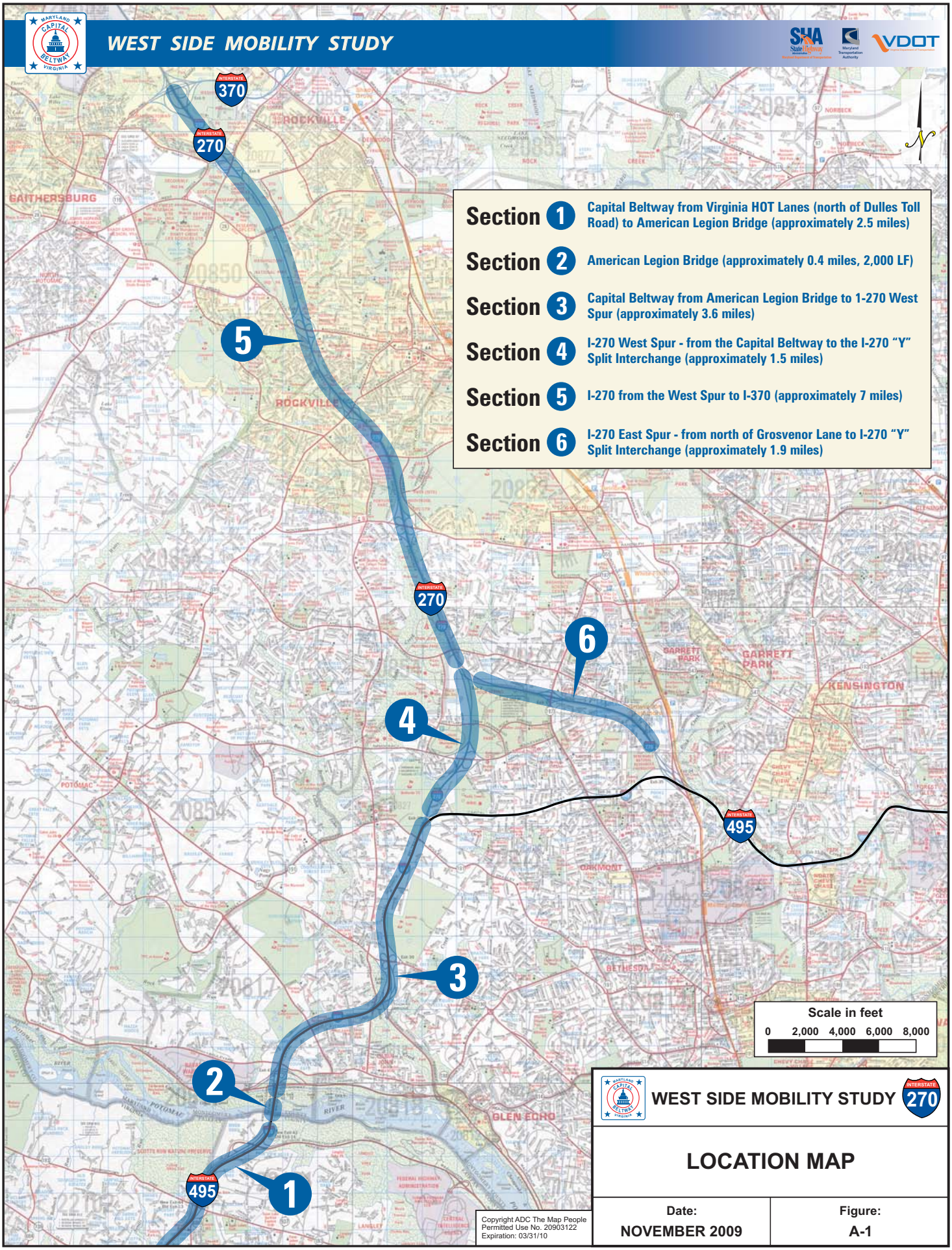
The combination of these three projects will leave a "gap" along the Capital Beltway, I-270 Spurs, and I-270 mainline where no capacity improvements or managed lanes are provided. As a result, SHA and VDOT initiated the West Side Mobility Study to evaluate potential improvements to provide additional capacity and a managed lane network along the Capital Beltway and I-270, including the I-270 West and East Spurs, between the VDOT HOT Lanes Project and I-370 / ICC, a total distance of 14 miles. The project location is shown in Figure A-1.

The study included an evaluation of short-term, mid-term, and long-term improvements focusing on traffic operations, impacts, and cost.

The long-term alternatives would include mainline widening, roadway modifications, and interchange improvements to provide additional capacity and a managed lanes network along the entire study corridor. Seven long-term improvements were evaluated for engineering feasibility, cost, impacts, and traffic operations.

The short-term improvements would include small-scale, low impact improvements to alleviate specific causes of recurring congestion, such as modifications to acceleration and deceleration lanes; changes to slip ramp operation on the I-270 mainline; conversion of the existing High Occupancy Vehicles (HOV) lanes on the I-270 West Spur to general purpose lanes; and modifications to the northbound split between the I-270 West Spur and I-495. These options were evaluated to determine the localized and overall system impact that would result from the improvements.

The mid-term improvements would include providing additional capacity without large-scale widening or capital investment, such as restriping the highway to provide an additional lane in each direction; peak period shoulder use; reversible lanes, and conversion of the existing HOV lanes on I-270 to HOT or other managed lanes. The evaluation of mid-term improvements considered engineering feasibility, traffic operational issues, cost, and potential revenue generation.



WEST SIDE MOBILITY STUDY

LOCATION MAP

Date:	Figure:
NOVEMBER 2009	A-1

B. EXISTING CONDITIONS

The West Side Mobility Study extends from just north of the Dulles Toll Road interchange along the Capital Beltway in Virginia to the I-370 interchange along I-270 in Maryland. These limits include six distinct highway sections:

1. Virginia portion of the Capital Beltway (Dulles Toll Road to American Legion Bridge)
2. American Legion Bridge
3. Maryland portion of the Capital Beltway (American Legion Bridge to I-270 West Spur)
4. I-270 West Spur
5. I-270 Mainline (I-270 Spurs to I-370)
6. I-270 East Spur

These sections are described below and shown in Figure A-1.

1. Virginia Capital Beltway – North of Dulles Toll Road to the American Legion Bridge

Section 1 includes the portion of the Capital Beltway in Virginia between the VDOT HOT Lanes Project and the American Legion Bridge, a distance of 2.7 miles. Upon completion of the VDOT HOT Lanes Project, this section will consist of six lanes per direction at the southern limits transitioning to four lanes in each direction near the SR 193 interchange. There is an auxiliary (fifth) lane in each direction between the George Washington Memorial Parkway interchange and the American Legion Bridge. In addition, there is a collector-distributor (CD) road along the outer loop (southbound) between the George Washington Memorial Parkway interchange and SR 193 interchange. This section includes the George Washington Memorial Parkway and SR 193 interchanges.

The existing typical section is shown in Figure B-1.

2. American Legion Bridge

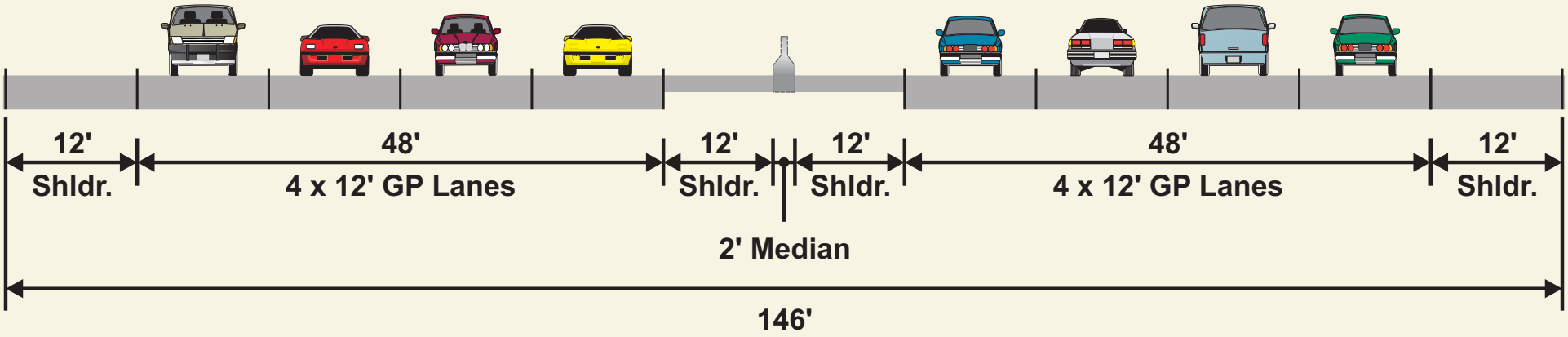
Section 2 includes the American Legion Bridge, which spans the Potomac River between Maryland and Virginia, a distance of 0.4 miles. The bridge consists of five lanes in each direction with three-foot offsets from the bridge parapets. The right-most lane in each direction is an auxiliary lane between the George Washington Memorial Parkway and Clara Barton Parkway interchanges.

The existing typical section is shown in Figure B-2.

3. Maryland Capital Beltway – American Legion Bridge to I-270 West Spur

Section 3 includes the portion of the Capital Beltway in Maryland between the American Legion Bridge and the I-270 West Spur, a distance of 3.6 miles. This section generally consists of four mainline lanes in each direction; however, there are auxiliary lanes at several locations in both directions (five lanes are provided in each direction between the American Legion Bridge and the Clara Barton Parkway interchange). Additional auxiliary lanes are also provided between the MD 190 and I-270 West Spur interchanges. This section includes the Clara Barton Parkway, MD 190 / Cabin John Parkway, and I-495 / I-270 West Spur interchanges.

The existing typical section is shown in Figure B-3.



NOTES

- There is a 3-lane CD Road along the outer loop between the George Washington Parkway and SR 193.

Not to scale

WEST SIDE MOBILITY STUDY

EXISTING TYPICAL SECTION - VIRGINIA CAPITAL BELTWAY

Date	Figure
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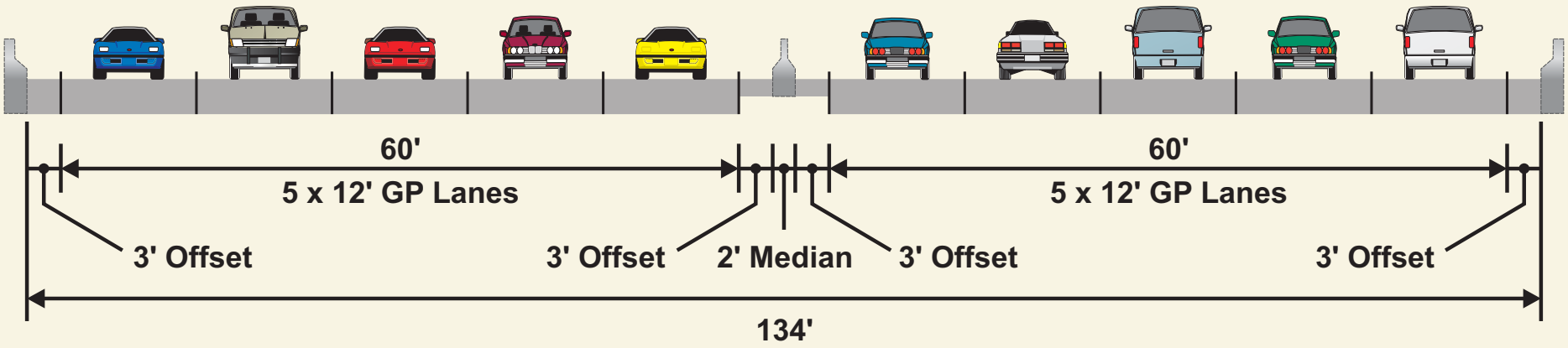

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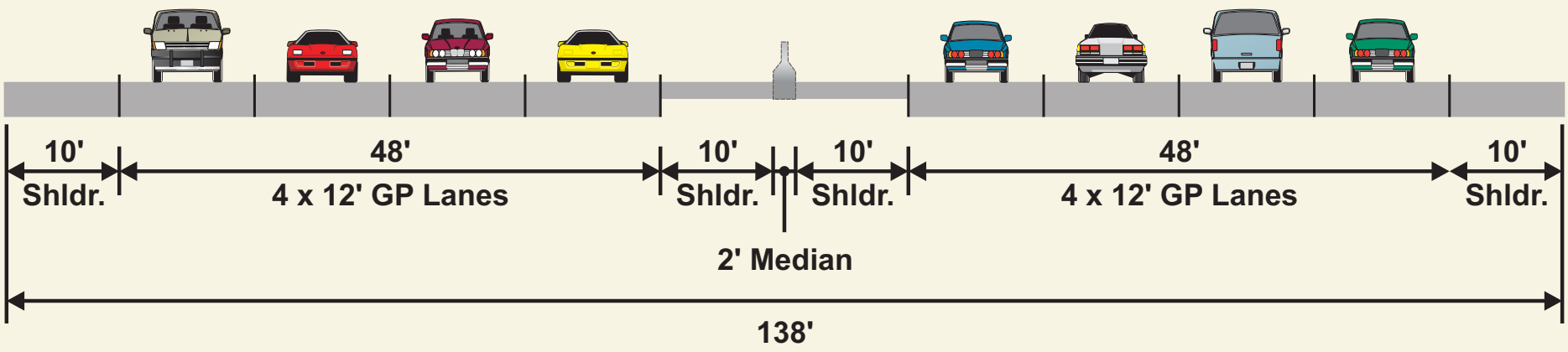
WEST SIDE MOBILITY STUDY

EXISTING TYPICAL SECTION - AMERICAN LEGION BRIDGE

Date	Figure
NOVEMBER 2009	B-2



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WEST SIDE MOBILITY STUDY

EXISTING TYPICAL SECTION - MARYLAND CAPITAL BELTWAY

Date	Figure
NOVEMBER 2009	B-3

4. I-270 West Spur

Section 4 includes the I-270 West Spur between the Capital Beltway and I-270 mainline, a total distance of 1.5 miles. The section generally consists of three lanes in each direction, but an auxiliary (fourth) lane is provided in the southbound direction between the Y-Split and Democracy Boulevard interchanges. The left lane is designated as a peak period HOV lane, southbound in the AM and northbound in the PM. This section includes the Democracy Boulevard and Westlake Terrace interchanges. The Westlake Terrace interchange only provides north-oriented direct access ramp to/from the HOV lanes.

The existing typical section is shown in Figure B-4.

5. I-270 Mainline

Section 5 includes the I-270 mainline between the I-270 Spurs and the I-370 interchange, a distance of 7 miles. The section can be subdivided between CD Road and non-CD Road portions. The non-CD Road portion extends from the Y-Split interchange to just south of the Montrose Road interchange and generally consists of six lanes in each direction. The CD Road portion extends from just south of the Montrose Road interchange through the I-370 interchange and generally consists of four mainline lanes and two CD Road lanes in each direction. The CD Road is separated from the mainline by a concrete traffic barrier. The left mainline lane in each direction is designated as a peak period HOV lane, southbound in the AM and northbound in the PM. This section includes the Y-Split, Montrose Road, MD 189, MD 28, Shady Grove Road, and I-370 interchanges.

The existing typical section is shown in Figure B-5.

6. I-270 – East Spur

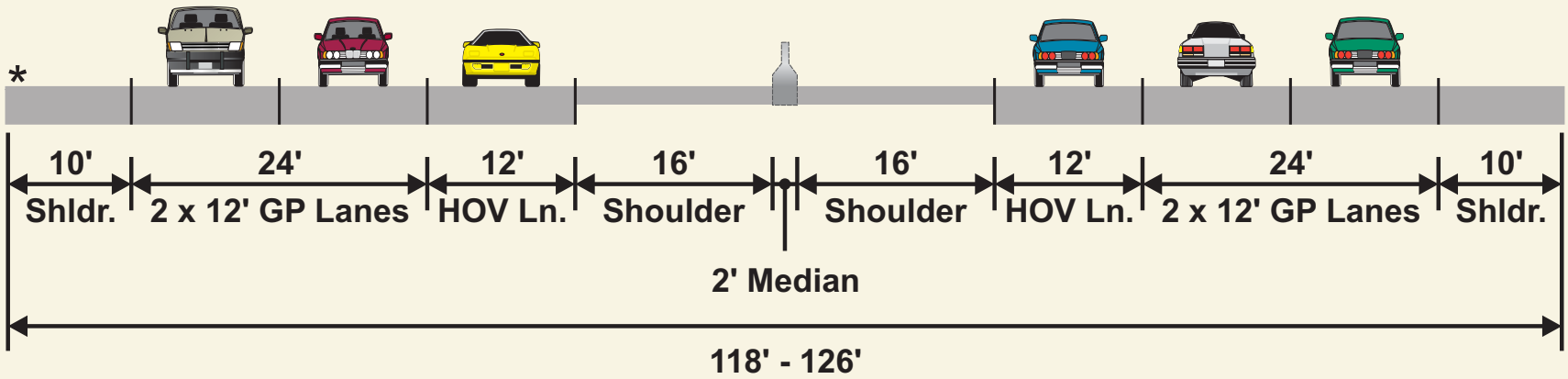
Section 6 includes the I-270 East Spur between the Capital Beltway and the I-270 mainline, a distance of 2.2 miles. The section generally consists of three lanes in each direction, but an auxiliary (fourth) lane is provided in both directions between the Y-Split and Rockledge Drive interchanges. The left lane is designated as a peak period HOV lane, southbound in the AM and northbound in the PM. This section includes the Rockledge Drive and MD 187 interchanges.

The existing typical section is shown in Figure B-6.

7. Traffic Conditions

A feasibility / planning level traffic analysis was performed for the existing (year 2006), 2030 No-Build, and 2030 Long-Term Build Alternatives to evaluate the current conditions and the proposed managed lane system to connect the Virginia HOT lanes to the ICC and to the I-270 Multi-Modal Corridor Study. The existing and No-Build analyses are discussed in this section and the 2030 Build analyses are discussed in Chapter C, Long-Term Improvements.

Traffic analyses were performed only for the mainline segments of I-495 between SR 193 in Virginia and the I-270 West Spur, then extending along the I-270 West Spur and along I-270 to the I-370 Interchange. Due to the preliminary nature of the study, ramp merges, diverges, and



* Narrow Paved Shoulder (2') from Democracy Blvd. to I-495 Merge

Not to scale

NOTES

- Additional SB lane from 'Y' split to Democracy Blvd.

WEST SIDE MOBILITY STUDY

EXISTING TYPICAL SECTION - I-270 WEST SPUR

Date	Figure
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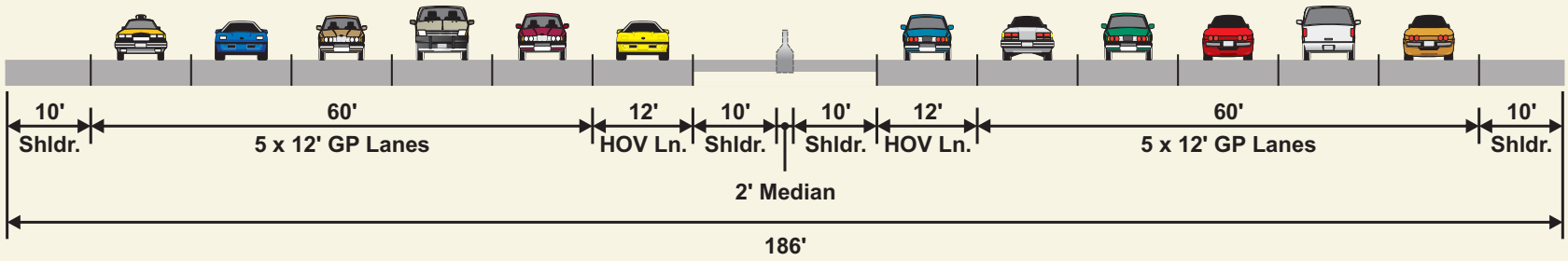
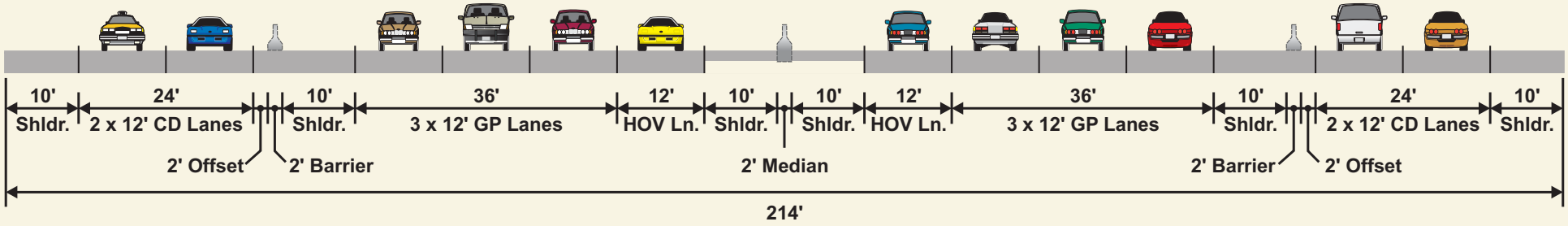


'Y' SPLIT TO MONTROSE ROAD



MONTROSE ROAD TO I-370

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WEST SIDE MOBILITY STUDY

EXISTING TYPICAL SECTION - I-270 MAINLINE

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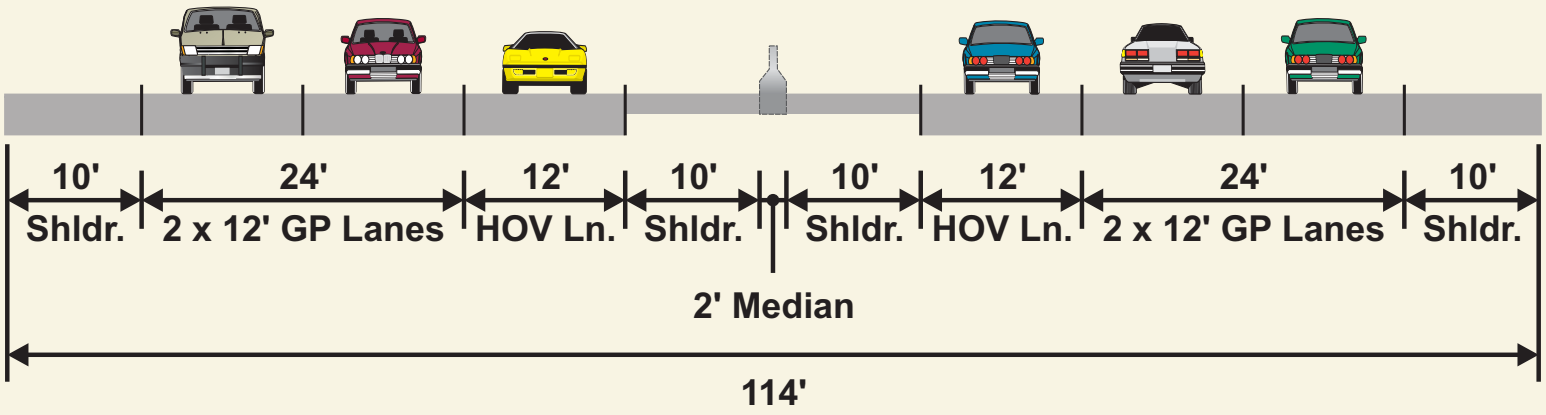

EXISTING CONDITIONS

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WEST SIDE MOBILITY STUDY

EXISTING TYPICAL SECTION - I-270 EAST SPUR

Date	Figure
NOVEMBER 2009	B-6

weave analyses were not performed. In addition, no traffic analyses were completed for the I-270 East Spur.

Traffic Analysis Methodology

Capacity analyses for all mainline freeway segments were conducted using the methodology presented in the 2000 Highway Capacity Manual (HCM). Specifically, the volume/capacity (v/c) ratio and corresponding Level of Service (LOS) were calculated for each mainline segment within the project area.

The assumptions used in calculating the capacity thresholds in Highway Capacity Software (HCS) are shown in Table B-1. The assumptions were applied for existing (2006), 2030 No-Build and all 2030 Build Alternatives.

Table B-1: HCS Assumptions

Parameter	Value used in HCS
Free-flow Speed	I-270 Mainline from I-495 (including I-270 East and West Spurs) to I-370: 70 mph
	I-270 CD lanes: 60 mph
	I-495 from VA 193 to I-270 West Spur: 70 mph
	Loop Ramps: 30 MPH; (25 MPH for I-495 interchanges) Directional Ramps: 50 MPH
Peak-Hour Factor (PHF)	0.95
Terrain Type	Level terrain for the entire project limits
Percent RVs	0% (Assuming RVs are included as part of % trucks/buses)
Driver Population Factor	1.00
Interchange Density	1.00 interchange/mile
Interstate Highway Designation	Urban freeway

The free-flow speeds were based on speed data that had been collected as part of SHA's Capital Beltway CORSIM Study. For that project, free flow speeds were obtained using GPS along the entire Maryland portion of the Beltway and also along the southern portion of I-270.

Based on concerns expressed by SHA's Office of Traffic and Safety and Travel Forecasting Division, the Peak Hour Factor (PHF) value of 0.95 was closely examined. Due to the lack of 15-minute data for the traffic volume collected along I-495 and I-270, a sensitivity analysis was performed to assess the validity of the assumed value. The analysis revealed that in general, the v/c ratio is linearly correlated to PHF. For more congested sections of I-495 and I-270, the change in v/c ratio for a change in PHF is 1 to 1 (i.e. a 10% increase in PHF decreases the v/c ratio by 10%). However, for less congested sections, a 10% increase in PHF decreases the v/c ratio in the range of 4 to 5%. The variation in v/c ratios for PHF values greater than or less than 0.95 is within 2 to 6% of the v/c ratios obtained by choosing the traditional PHF value of 0.95. Hence, choosing a PHF value of 0.95 was considered appropriate for both congested and non-congested sections of I-495 and I-270.

SHA's Travel Forecasting Division confirmed that the 0% RV assumption is reasonable for this analysis and is consistent with the assumptions for the I-270 Multi-Modal Corridor Study.

The percentage of trucks and buses along the mainline during the AM and PM peak periods are shown in Table B-2. These values were obtained based on 48-hour traffic counts conducted along I-270 within the project limits in March and August 2006. Since there are no truck restrictions in the managed lanes (build alternatives), the truck percentages within the managed lanes were assumed to be the same as the corresponding section of general purpose lanes.

The percentage of trucks and buses along the ramps were based on the corresponding mainline section. For example, for all interchanges along the I-495 inner loop, the percentage of trucks/buses assumed for all entry and exit ramps during AM Peak is 6%, the same truck percentages are shown in Table B-2 for the general purpose lanes of the inner loop.

Table B-2: Percentage of Trucks and Buses

	Existing (2006), 2030 No-Build, Build Alternates 1-5			
	AM Peak[1]		PM Peak[2]	
Location	GPL	ETL	GPL	ETL
I-495 Inner Loop	6%	6%	7%	7%
I-495 Outer Loop	7%	7%	5%	5%
I-270 NB	8%	8%	5%	5%
I-270 SB	6%	6%	5%	5%
I-270 West Spur NB	5%	5%	5%	5%
I-270 West Spur SB	5%	5%	5%	5%
I-270 East Spur NB	8%	8%	5%	5%
I-270 East Spur SB	6%	6%	5%	5%

GPL = General Purpose Lane
ETL = Express Toll Lane
[1] 6 to 9 AM
[2] 4 to 7 PM

Existing Traffic

Year 2006 is considered the existing condition for purposes of this study. The traffic volumes for the existing condition, which are based on traffic counts conducted along I-270.

Along I-270 from south of Montrose Road to north of I-370, there are general purpose (GP), High Occupancy Vehicle (HOV), and Collector-Distributor (CD) lanes. Based on Year 2005 traffic data collected along I-270 at various locations between Montrose Road and I-370, the percentage of the total volume between the GP, HOV and CD Road lanes was calculated. The I-270 HOV/GP/CD Road volume distributions are shown in Tables B-3A and B-3B.

Table B-3A: I-270 Northbound HOV/GP/CD Volume Distributions

	Existing (2006)				
	AM Peak[1]		PM Peak[2]		
	GP	CD	HOV	GP	CD
Montrose Rd. to MD 189	66%	34%	14%	52%	34%
MD 189 to MD 28	67%	33%	14%	56%	30%
MD 28 to Shady Grove Rd.	56%	44%	12%	53%	35%
Shady Grove Rd. to I-370	57%	43%	10%	44%	46%

[1] 6 to 9 AM
[2] 4 to 7 PM

Table B-3B: I-270 Southbound HOV/GP/CD Volume Distributions

	Existing (2006)				
	AM Peak[1]			PM Peak[2]	
	HOV	GP	CD	GP	CD
I-370 to Shady Grove Rd.	15%	63%	22%	59%	41%
Shady Grove Rd. to MD 28	13%	58%	29%	75%	25%
MD 28 to MD 189	12%	56%	32%	66%	34%
MD 189 to Montrose Rd.	12%	50%	38%	60%	40%

[1] 6 to 9 AM
[2] 4 to 7 PM

To calculate the volume/capacity ratios for the segments along I-270 and I-495 within the project limits, the adjusted capacity thresholds were calculated using HCS+. The capacity thresholds were calculated for GP and CD Road lanes for truck percentages ranging from 5 to 8 percent (in accordance with the truck percentage values identified in Table B-2). Since trucks over 5 tons gross vehicle weight are prohibited in the HOV lanes, the thresholds calculated for the HOV lanes are based on zero percent trucks.

For the HOV lane(s), thresholds were calculated for one and two lane scenarios. For CD Road lanes, thresholds were calculated for one to three-lane scenarios. For GP lanes, thresholds were calculated for two to six-lane scenarios. To calculate the threshold for a single lane (HOV or CD Road lane), a two-lane facility was assumed and speed reductions were applied based on two-lane highway methodology assuming 100 percent no-passing zones. Then the corresponding throughput was divided by two to determine a single lane throughput.

The LOS values associated with the capacity thresholds were also identified. The LOS boundaries are based on HCM Freeway methodology. The capacity thresholds and related LOS values for the existing condition are shown in Table B-4.

The total volume; the volume distribution between the HOV, general purpose, and CD Road lanes; the v/c ratios; and LOS values for various freeway segments along I-270 and I-495 within the limits of the project under the existing (2006) condition are shown in Table B-5. The existing typical sections for each highway segment are shown in Figures B-1 through B-6.

As shown in Table B-5, several segments of the mainline operate at LOS E or F during the peak period based on the existing highway capacity constraints. In the southbound direction, during the AM peak period, these segments include:

- I-495 from Cabin John Parkway to MD 190 (LOS F)
- I-270 West Spur from I-270 West Spur / I-495 split to Democracy Boulevard (LOS F)
- I-270 mainline from Shady Grove Road to I-370 (LOS E).

In the northbound direction, during the PM peak period, these segments include:

- Entire West Spur (LOS F)
- I-270 mainline from Montrose Road to MD 28 (LOS E or F).

2030 No-Build

Year 2030 was considered the future year in which the No-Build and Build (long-term) Alternatives would be analyzed. These volumes were based on the Land Use 7.0 forecast. As a point of comparison, the I-270 Multi-Modal Corridor Study was based on the Land Use 6.4a forecasts.

In addition, the traffic volumes for the No-Build and Build Alternatives are based on the assumption that the 2030 Build 2+1 condition for the I-270 Multi-Modal Corridor Study will be in place (i.e., two Express Toll Lanes (ETL) per direction along I-270 in Montgomery County from I-370 to the north and one ETL per direction along I-270 in Frederick County to I-70).

The capacity thresholds and related LOS values for the 2030 No-Build are shown in Table B-4. The total volume; the volume distribution between the HOV, general purpose, and CD Road lanes; the v/c ratios; and LOS values for various freeway segments along I-270 and I-495 within the limits of the project under the 2030 No-Build condition are shown in Table B-6.

In 2030, there would be congestion and bottlenecks in both directions during the peak periods. In the southbound direction, during the AM peak, there would be bottlenecks on the following segments:

- I-495 between Cabin John Parkway and MD 190
- I-270 West Spur between I-495 and Democracy Boulevard.

Six out of 13 highway segments between interchanges would be failing in the southbound direction.

In the northbound direction, during the PM peak, there would be bottlenecks on the following segments:

- I-495 between Clara Barton Parkway and Cabin John Parkway
- I-270 West Spur between I-495 and Democracy Boulevard
- I-270 mainline between MD 189 and MD 28

Nine of the 13 highway segments between interchanges would be failing in the northbound direction.

Table B-4: Capacity Th8resholds for HOV, GP, CD Lanes – Existing and 2030 No-Build

HCS Assumptions and Calculated Maximum Flow Rates By LOS Threshold - 5% Trucks

HOV			GP						CD			
PHF		0.95	PHF		0.95				PHF		0.95	
%Trucks		0	%Trucks		5				%Trucks		1	
Measured FF Speed		70	Measured FF Speed		70				Measured FF Speed		60	
Terrain		Level	Terrain		Level				Terrain		Level	
Unadjusted Capacity		2,400	Unadjusted Capacity		2,400				Unadjusted Capacity		2300	
HCS LOS Thresholds			**HCS LOS Thresholds**						**HCS LOS Thresholds**			
Adjusted Flow Rates			*Adjusted Flow Rates*						*Adjusted Flow Rates*			
1	**2**	**LOS**	**2**	**3**	**4**	**5**	**6**	**LOS**	**1**	**2**	**3**	**LOS**
0	0	**A**	0	0	0	0	0	**A**	0	0	0	**A**
715	1429	**B**	1429	2144	2858	3573	4288	**B**	625	1249	1872	**B**
1112	2337	**C**	2337	3506	4675	5844	7012	**C**	1022	2043	3063	**C**
1596	3283	**D**	3283	4924	6566	8207	9848	**D**	1476	2951	4425	**D**
1986	3987	**E**	3987	5981	7974	9968	11962	**E**	1909	3817	5723	**E**
2233	4451	**F**	4451	6676	8901	11127	13352	**F**	2175	4350	6522	**F**

HCS Assumptions and Calculated Maximum Flow Rates By LOS Threshold - 6% Trucks

HOV			GP						CD			
PHF		0.95	PHF		0.95				PHF		0.95	
%Trucks		0	%Trucks		6				%Trucks		1	
Measured FF Speed		70	Measured FF Speed		70				Measured FF Speed		60	
Terrain		Level	Terrain		Level				Terrain		Level	
Unadjusted Capacity		2,400	Unadjusted Capacity		2,400				Unadjusted Capacity		2300	
HCS LOS Thresholds			**HCS LOS Thresholds**						**HCS LOS Thresholds**			
Adjusted Flow Rates			*Adjusted Flow Rates*						*Adjusted Flow Rates*			
1	**2**	**LOS**	**2**	**3**	**4**	**5**	**6**	**LOS**	**1**	**2**	**3**	**LOS**
0	0	**A**	0	0	0	0	0	**A**	0	0	0	**A**
680	1422	**B**	1422	2133	2844	3556	4267	**B**	625	1249	1872	**B**
1112	2326	**C**	2326	3489	4652	5815	6978	**C**	1022	2043	3063	**C**
1596	3267	**D**	3267	4900	6534	8167	9801	**D**	1476	2951	4425	**D**
1986	3968	**E**	3968	5952	7936	9920	11904	**E**	1909	3817	5723	**E**
2233	4429	**F**	4429	6644	8858	11073	13287	**F**	2175	4350	6522	**F**

HCS Assumptions and Calculated Maximum Flow Rates By LOS Threshold - 7% Trucks

HOV			GP						CD			
PHF		0.95	PHF		0.95				PHF		0.95	
%Trucks		0	%Trucks		7				%Trucks		1	
Measured FF Speed		70	Measured FF Speed		70				Measured FF Speed		60	
Terrain		Level	Terrain		Level				Terrain		Level	
Unadjusted Capacity		2,400	Unadjusted Capacity		2,400				Unadjusted Capacity		2300	
HCS LOS Thresholds			**HCS LOS Thresholds**						**HCS LOS Thresholds**			
Adjusted Flow Rates			*Adjusted Flow Rates*						*Adjusted Flow Rates*			
1	**2**	**LOS**	**2**	**3**	**4**	**5**	**6**	**LOS**	**1**	**2**	**3**	**LOS**
0	0	**A**	0	0	0	0	0	**A**	0	0	0	**A**
680	1415	**B**	1415	2123	2831	3538	4246	**B**	625	1249	1872	**B**
1112	2315	**C**	2315	3472	4630	5787	6945	**C**	1022	2043	3063	**C**
1596	3251	**D**	3251	4877	6502	8128	9753	**D**	1476	2951	4425	**D**
1986	3949	**E**	3949	5923	7897	9872	11846	**E**	1909	3817	5723	**E**
2233	4408	**F**	4408	6611	8815	11019	13223	**F**	2175	4350	6522	**F**

HCS Assumptions and Calculated Maximum Flow Rates By LOS Threshold - 8% Trucks

HOV			GP						CD			
PHF		0.95	PHF		0.95				PHF		0.95	
%Trucks		0	%Trucks		8				%Trucks		1	
Measured FF Speed		70	Measured FF Speed		70				Measured FF Speed		60	
Terrain		Level	Terrain		Level				Terrain		Level	
Unadjusted Capacity		2,400	Unadjusted Capacity		2,400				Unadjusted Capacity		2300	
HCS LOS Thresholds			**HCS LOS Thresholds**						**HCS LOS Thresholds**			
Adjusted Flow Rates			*Adjusted Flow Rates*						*Adjusted Flow Rates*			
1	**2**	**LOS**	**2**	**3**	**4**	**5**	**6**	**LOS**	**1**	**2**	**3**	**LOS**
0	0	**A**	0	0	0	0	0	**A**	0	0	0	**A**
680	1409	**B**	1409	2113	2817	3521	4226	**B**	625	1249	1872	**B**
1112	2304	**C**	2304	3456	4608	5759	6911	**C**	1022	2043	3063	**C**
1596	3235	**D**	3235	4853	6471	8089	9706	**D**	1476	2951	4425	**D**
1986	3930	**E**	3930	5895	7859	9824	11789	**E**	1909	3817	5723	**E**
2233	4386	**F**	4386	6580	8773	10966	13159	**F**	2175	4350	6522	**F**

Table B-5: Capacity Calculations – Existing Conditions

AM Peak Period - Northbound (2006 Existing)

Interchange	Total Volume	HOV # Lanes	HOV % of Tot	HOV Resulting Vol.	HOV HCS Adj. Capacity	HOV v/c	HOV LOS	GP Lanes # Lanes	GP Lanes % of Tot (2006 Count)	GP Lanes Resulting Vol.	GP Lanes HCS Adj. Capacity	GP Lanes v/c	GP Lanes LOS	CD Lanes # Lanes	CD Lanes % of Tot (2006 count)	CD Lanes Resulting Vol.	CD Lanes HCS Adj. Capacity	CD Lanes v/c	CD Lanes LOS
VA 193																			
	9,150							5	100%	9,150	11,073	0.83	D						
GW Parkway																			
	8,975							5	100%	8,975	11,073	0.81	D						
Clara Barton Parkway																			
	8,225							4	100%	8,225	8,858	0.93	E						
Cabin John Parkway																			
	8,525							5	100%	8,525	11,073	0.77	D						
MD 190																			
	8,875							5	100%	8,875	11,073	0.80	D						
I-495/I-270 West Spur																			
	4,875							3	100%	4,875	6,676	0.73	C						
Democracy Boulevard																			
	3,750							3	100%	3,750	6,676	0.56	C						
West Lake Terrace																			
	4,425							3	100%	4,425	6,676	0.66	C						
I-270 Y-Split																			
	9,125							6	100%	9,125	13,159	0.69	C						
Montrose Road																			
	9,100							4	66%	6,006	8,773	0.68	C	2	34%	3,094	4,350	0.71	D
MD 189																			
	9,150							4	67%	6,131	8,773	0.70	C	2	33%	3,020	4,350	0.69	D
MD 28																			
Shady Grove Road	7,800							4	56%	4,368	8,773	0.50	B	2	44%	3,432	4,350	0.79	D
	5,750							4	57%	3,278	8,773	0.37	B	2	43%	2,473	4,350	0.57	C
I-370																			
I-495																			
								3	100%	-	6,580	0.00	A						
MD 187																			
								3	100%	-	6,580	0.00	A						
Rockledge Drive																			
								3	100%	-	6,580	0.00	A						
I-270 Y-Split																			

#'s in Red are from Field Counts, #'s in Black are assumed

AM Peak Period - Southbound (2006 Existing)

Interchange	Total Volume	HOV # Lanes	HOV % of Tot (2006 Count)	HOV Resulting Vol.	HOV HCS Adj. Capacity	HOV v/c	HOV LOS	GP Lanes # Lanes	GP Lanes % of Tot (2006 Count)	GP Lanes Resulting Vol.	GP Lanes HCS Adj. Capacity	GP Lanes v/c	GP Lanes LOS	CD Lanes # Lanes	CD Lanes % of Tot (2006 Count)	CD Lanes Resulting Vol.	CD Lanes HCS Adj. Capacity	CD Lanes v/c	CD Lanes LOS
I-370																			
Shady Grove Road	9,850	1	15%	1,478	2,233	0.66	C	3	63%	6,206	6,644	0.93	E	3	22%	2,167	6,522	0.33	B
	9,700	1	13%	1,261	2,233	0.56	C	3	58%	5,626	6,644	0.85	D	2	29%	2,813	4,350	0.65	C
MD 28																			
	10,775	1	12%	1,293	2,233	0.58	C	3	56%	6,034	6,644	0.91	E	2	32%	3,448	4,350	0.79	D
MD 189																			
Montrose Road	10,725	1	12%	1,287	2,233	0.58	C	3	50%	5,363	6,644	0.81	D	2	38%	4,076	4,350	0.94	E
	10,800	1	13%	1,404	2,233	0.63	C	5	87%	9,396	11,073	0.85	D						
I-270 Y-Split																			
West Lake Terrace	5,400	1	13%	702	2,233	0.31	B	3	87%	4,698	6,676	0.70	C						
Democracy Boulevard	4,725	1	13%	614	2,233	0.28	A	3	87%	4,111	6,676	0.62	C						
I-495/I-270 West Spur	5,400	1	13%	702	2,233	0.31	B	2	87%	4,698	4,451	1.06	F						
	9,650							5	100%	9,650	11,019	0.88	D						
MD 190																			
Cabin John Parkway	9,700							4	100%	9,700	8,815	1.10	F						
Clara Barton Parkway	8,050							4	100%	8,050	8,815	0.91	E						
George Washington	9,025							5	100%	9,025	11,019	0.82	D						
	8,100							4	76%	6,156	8,815	0.70	C	3	24%	1,944	6,522	0.30	B
VA 193																			
I-270 Y-Split																			
Rockledge Drive		1	12%	-	2,233	0.00	A	2	88%	-	4,429	0.00	A						
		1	12%	-	2,233	0.00	A	2	88%	-	4,429	0.00	A						
MD 187																			
		1	12%	-	2,233	0.00	A	2	88%	-	4,429	0.00	A						
I-495																			

#'s in Red are from Field Counts, #'s in Black are assumed

PM Peak Period - Northbound (2006 Existing)

Interchange	Total Volume	HOV # Lanes	HOV % of Tot (2006	HOV Vol.	HOV Capacity	HOV v/c	HOV LOS	GP Lanes # Lanes	GP Lanes % of Tot	GP Lanes Vol.	GP Lanes Capacity	GP Lanes v/c	GP Lanes LOS	CD Lanes # Lanes	CD Lanes % of Tot	CD Lanes Vol.	CD Lanes Capacity	CD Lanes v/c	CD Lanes LOS
VA 193																			
	7,450							5	100%	7,450	11,019	0.68	C						
GW Parkway																			
	8,550							5	100%	8,550	11,019	0.78	D						
Clara Barton Parkway																			
	7,900							4	100%	7,900	8,815	0.90	E						
Cabin John Parkway																			
	9,050							5	100%	9,050	11,019	0.82	D						
MD 190																			
	9,150							5	100%	9,150	11,019	0.83	D						
I-495/I-270 West Spur																			
	5,350	1	12%	642	2,233	0.29	A	2	88%	4,708	4,451	1.06	F						
Democracy Boulevard																			
	5,050	1	12%	606	2,233	0.27	A	2	88%	4,444	4,451	1.00	E						
West Lake Terrace																			
	5,750	1	12%	690	2,233	0.31	A	2	88%	5,060	4,451	1.14	F						
I-270 Y-Split																			
Montrose Road	11,600	1	12%	1,392	2,233	0.62	C	5	88%	10,208	11,127	0.92	E						
	12,650	1	14%	1,771	2,233	0.79	D	3	52%	6,578	6,676	0.99	E	2	34%	4,301	4,350	0.99	E
MD 189																			
	12,950	1	14%	1,813	2,233	0.81	D	3	56%	7,252	6,676	1.09	F	2	30%	3,885	4,350	0.89	E
MD 28																			
Shady Grove Road	11,350	1	12%	1,362	2,233	0.61	C	3	53%	6,016	6,676	0.90	E	2	35%	3,973	4,350	0.91	E
	11,000	1	10%	1,100	2,233	0.49	B	3	44%	4,840	6,676	0.72	C	2	46%	5,060	4,350	1.16	F
I-370																			
I-495																			
		1	12%	-	2,233	0.00	A	2	88%	-	4,451	0.00	A						
MD 187																			
		1	12%	-	2,233	0.00	A	2	88%	-	4,451	0.00	A						
Rockledge Drive																			
		1	12%	-	2,233	0.00	A	2	88%	-	4,451	0.00	A						
I-270 Y-Split																			

#'s in Red are from Field Counts, #'s in Black are assumed

PM Peak Period - Southbound (2006 Existing)

Interchange	Total Volume	HOV # Lanes	HOV % of Tot	HOV Vol.	HOV Capacity	HOV v/c	HOV LOS	GP Lanes # Lanes	GP Lanes % of Tot	GP Lanes Vol.	GP Lanes Capacity	GP Lanes v/c	GP Lanes LOS	CD Lanes # Lanes	CD Lanes % of Tot	CD Lanes Vol.	CD Lanes Capacity	CD Lanes v/c	CD Lanes LOS
I-370																			
Shady Grove Road	6,100							4	59%	3,599	8,901	0.40	B	3	41%	2,501	6,522	0.38	B
	7,100							4	75%	5,325	8,901	0.60	C	2	25%	1,775	4,350	0.41	B
MD 28																			
	8,100							4	66%	5,346	8,901	0.60	C	2	34%	2,754	4,350	0.63	C
MD 189																			
Montrose Road	8,100							4	60%	4,860	8,901	0.55	C	2	40%	3,240	4,350	0.74	D
	7,500							6	100%	7,500	13,352	0.56	C						
I-270 Y-Split																			
West Lake Terrace	3,900							4	100%	3,900	8,901	0.44	B						
Democracy Boulevard	3,250							4	100%	3,250	8,901	0.37	B						
I-495/I-270 West Spur	4,300							3	100%	4,300	6,676	0.64	C						
	8,200							5	100%	8,200	11,127	0.74	C						
MD 190																			
Cabin John Parkway	8,050							4	100%	8,050	8,901	0.90	E						
Clara Barton Parkway	7,550							4	100%	7,550	8,901	0.85	D						
George Washington	8,150							5	100%	8,150	11,127	0.73	C						
	8,700							4	65%	5,655	8,901	0.64	C	3	35%	3,045	6,522	0.47	B
VA 193																			
I-270 Y-Split																			
Rockledge Drive								3	100%	-	6,676	0.00	A						
								3	100%	-	6,676	0.00	A						
MD 187																			
								3	100%	-	6,676	0.00	A						
I-495																			

#'s in Red are from Field Counts, #'s in Black are assumed

Assumption for Truck Percentages:

	AM Peak	PM Peak
I-495	6%	7%
I-270 Spur	5%	5%
I-270	8%	5%

Assumption for Truck Percentages:

	AM Peak	PM Peak
I-495	7%	5%
I-270 Spur	5%	5%
I-270	6%	5%

Table B-6: Capacity Calculations – 2030 No-Build Condition

AM Peak Period - Northbound (2030 No Build)

Interchange	Total Volume	HOV # Lanes	HOV % of Tot (2006 Count)	HOV Resulting Vol.	HOV HCS Adj. Capacity	HOV v/c	HOV LOS	GP Lanes # Lanes	GP Lanes % of Tot (2006 Count)	GP Lanes Resulting Vol.	GP Lanes HCS Adj. Capacity	GP Lanes v/c	GP Lanes LOS	CD Lanes # Lanes	CD Lanes % of Tot (2006 count)	CD Lanes Resulting Vol.	CD Lanes HCS Adj. Capacity	CD Lanes v/c	CD Lanes LOS
VA 193																			
	11,475							5	100%	11,475	11,073	1.04	F						
GW Parkway																			
	10,300							5	100%	10,300	11,073	0.93	E						
Clara Barton Parkway																			
	8,525							4	100%	8,525	8,858	0.96	E						
Cabin John Parkway																			
	9,250							5	100%	9,250	11,073	0.84	D						
MD 190																			
	9,200							5	100%	9,200	11,073	0.83	D						
I-495/I-270 West Spur																			
	5,050							3	100%	5,050	6,676	0.76	D						
Democracy Boulevard																			
	4,200							3	100%	4,200	6,676	0.63	C						
West Lake Terrace																			
	4,950							3	100%	4,950	6,676	0.74	D						
I-270 Y-Split																			
	9,475							6	100%	9,475	13,159	0.72	C						
Montrose Road																			
	9,250							4	66%	6,105	8,773	0.70	C	2	34%	3,145	4,350	0.72	D
MD 189																			
	9,300							4	67%	6,231	8,773	0.71	C	2	33%	3,069	4,350	0.71	D
MD 28																			
	7,850							4	56%	4,396	8,773	0.50	B	2	44%	3,454	4,350	0.79	D
Shady Grove Road																			
	6,175							4	57%	3,520	8,773	0.40	B	2	43%	2,655	4,350	0.61	C
I-370																			
I-495																			
								3	100%	-	6,580	0.00	A						
MD 187																			
								3	100%	-	6,580	0.00	A						
Rockledge Drive																			
								3	100%	-	6,580	0.00	A						
I-270 Y-Split																			

#'s in Red are from Field Counts, #'s in Black are assumed

AM Peak Period - Southbound (2030 No Build)

Interchange	Total Volume	HOV # Lanes	HOV % of Tot (2006 Count)	HOV Resulting Vol.	HOV HCS Adj. Capacity	HOV v/c	HOV LOS	GP Lanes # Lanes	GP Lanes % of Tot (2006 Count)	GP Lanes Resulting Vol.	GP Lanes HCS Adj. Capacity	GP Lanes v/c	GP Lanes LOS	CD Lanes # Lanes	CD Lanes % of Tot (2006 Count)	CD Lanes Resulting Vol.	CD Lanes HCS Adj. Capacity	CD Lanes v/c	CD Lanes LOS
I-370																			
Shady Grove Road	10,750	1	15%	1,613	2,233	0.72	D	3	63%	6,773	6,644	1.02	F	3	22%	2,365	6,522	0.36	B
MD 28	9,750	1	13%	1,268	2,233	0.57	C	3	58%	5,655	6,644	0.85	D	2	29%	2,828	4,350	0.65	C
MD 189	10,825	1	12%	1,299	2,233	0.58	C	3	56%	6,062	6,644	0.91	E	2	32%	3,464	4,350	0.80	D
Montrose Road	11,000	1	12%	1,320	2,233	0.59	C	3	50%	5,500	6,644	0.83	D	2	38%	4,180	4,350	0.96	E
I-270 Y-Split	11,300	1	13%	1,469	2,233	0.66	C	5	87%	9,831	11,073	0.89	D						
West Lake Terrace	6,125	1	13%	796	2,233	0.36	B	3	87%	5,329	6,676	0.80	D						
Democracy Boulevard	5,350	1	13%	696	2,233	0.31	B	3	87%	4,655	6,676	0.70	C						
I-495/I-270 West Spur	5,600	1	13%	728	2,233	0.33	B	2	87%	4,872	4,451	1.09	F						
MD 190	10,050							5	100%	10,050	11,019	0.91	E						
Cabin John Parkway	10,550							4	100%	10,550	8,815	1.20	F						
Clara Barton Parkway	8,350							4	100%	8,350	8,815	0.95	E						
George Washington	10,350							5	100%	10,350	11,019	0.94	E						
VA 193	10,125							4	76%	7,695	8,815	0.87	D	3	24%	2,430	6,522	0.37	B
I-270 Y-Split																			
Rockledge Drive		1	12%	-	2,233	0.00	A	2	88%	-	4,429	0.00	A						
MD 187		1	12%	-	2,233	0.00	A	2	88%	-	4,429	0.00	A						
I-495		1	12%	-	2,233	0.00	A	2	88%	-	4,429	0.00	A						

#'s in Red are from Field Counts
#'s in Black are assumed

PM Peak Period - Northbound (2030 No Build)

Interchange	Total Volume	HOV # Lanes	HOV % of Tot (2006 Count)	HOV Resulting Vol.	HOV HCS Adj. Capacity	HOV v/c	HOV LOS	GP Lanes # Lanes	GP Lanes % of Tot (2006 Count)	GP Lanes Resulting Vol.	GP Lanes HCS Adj. Capacity	GP Lanes v/c	GP Lanes LOS	CD Lanes # Lanes	CD Lanes % of Tot (2006 Count)	CD Lanes Resulting Vol.	CD Lanes HCS Adj. Capacity	CD Lanes v/c	CD Lanes LOS
VA 193																			
	9,350							5	100%	9,350	11,019	0.85	D						
GW Parkway																			
	9,850							5	100%	9,850	11,019	0.89	D						
Clara Barton Parkway																			
	8,250							4	100%	8,250	8,815	0.94	E						
Cabin John Parkway																			
	9,875							5	100%	9,875	11,019	0.90	E						
MD 190																			
	9,550							5	100%	9,550	11,019	0.87	D						
I-495/I-270 West Spur																			
	5,550	1	12%	666	2,233	0.30	A	2	88%	4,884	4,451	1.10	F						
Democracy Boulevard																			
	5,725	1	12%	687	2,233	0.31	A	2	88%	5,038	4,451	1.13	F						
West Lake Terrace																			
	6,525	1	12%	783	2,233	0.35	B	2	88%	5,742	4,451	1.29	F						
I-270 Y-Split																			
Montrose Road	12,150	1	12%	1,458	2,233	0.65	C	5	88%	10,692	11,127	0.96	E						
	12,975	1	14%	1,817	2,233	0.81	D	3	52%	6,747	6,676	1.01	F	2	34%	4,412	4,350	1.01	F
MD 189																			
	13,275	1	14%	1,859	2,233	0.83	D	3	56%	7,434	6,676	1.11	F	2	30%	3,983	4,350	0.92	E
MD 28																			
Shady Grove Road	11,375	1	12%	1,365	2,233	0.61	C	3	53%	6,029	6,676	0.90	E	2	35%	3,981	4,350	0.92	E
	11,975	1	10%	1,198	2,233	0.54	C	3	44%	5,269	6,676	0.79	D	2	46%	5,509	4,350	1.27	F
I-370																			
I-495																			
		1	12%	-	2,233	0.00	A	2	88%	-	4,451	0.00	A						
MD 187																			
Rockledge Drive		1	12%	-	2,233	0.00	A	2	88%	-	4,451	0.00	A						
		1	12%	-	2,233	0.00	A	2	88%	-	4,451	0.00	A						
I-270 Y-Split																			

#'s in Red are from Field Counts, #'s in Black are assumed

PM Peak Period - Southbound (2030 No Build)

Interchange	Total Volume	HOV # Lanes	HOV % of Tot (2006 Count)	HOV Resulting Vol.	HOV HCS Adj. Capacity	HOV v/c	HOV LOS	GP Lanes # Lanes	GP Lanes % of Tot (2006 Count)	GP Lanes Resulting Vol.	GP Lanes HCS Adj. Capacity	GP Lanes v/c	GP Lanes LOS	CD Lanes # Lanes	CD Lanes % of Tot (2006 Count)	CD Lanes Resulting Vol.	CD Lanes HCS Adj. Capacity	CD Lanes v/c	CD Lanes LOS
I-370																			
Shady Grove Road	6,650							4	59%	3,924	8,901	0.44	B	3	41%	2,727	6,522	0.42	B
MD 28	7,100							4	75%	5,325	8,901	0.60	C	2	25%	1,775	4,350	0.41	B
MD 189	8,250							4	66%	5,445	8,901	0.61	C	2	34%	2,805	4,350	0.64	C
Montrose Road	8,250							4	60%	4,950	8,901	0.56	C	2	40%	3,300	4,350	0.76	D
I-270 Y-Split	7,800							6	100%	7,800	13,352	0.58	C						
West Lake Terrace	4,375							4	100%	4,375	8,901	0.49	B						
Democracy Boulevard	3,650							4	100%	3,650	8,901	0.41	B						
I-495/I-270 West Spur	4,425							3	100%	4,425	6,676	0.66	C						
MD 190	8,475							5	100%	8,475	11,127	0.76	D						
Cabin John Parkway	8,725							4	100%	8,725	8,901	0.98	E						
Clara Barton Parkway	7,825							4	100%	7,825	8,901	0.88	D						
George Washington	9,350							5	100%	9,350	11,127	0.84	D						
VA 193	10,875							4	65%	7,069	8,901	0.79	D	3	35%	3,806	6,522	0.58	C
I-270 Y-Split																			
Rockledge Drive								3	100%	-	6,676	0.00	A						
MD 187								3	100%	-	6,676	0.00	A						
I-495								3	100%	-	6,676	0.00	A						

#'s in Red are from Field Counts, #'s in Black are assumed

Assumptions for Truck Percentages:

	AM Peak	PM Peak
I-495	6%	7%
I-270 Spur	5%	5%
I-270	8%	5%

Assumptions for Truck Percentages:

	AM Peak	PM Peak
I-495	7%	5%
I-270 Spur	5%	5%
I-270	6%	5%

C. LONG-TERM IMPROVEMENTS

1. Introduction

The long-term alternatives would provide permanent additional capacity throughout the study corridor. It was anticipated that this new capacity would be provided by widening the existing roadway and it would be operated as a managed lane system. The interchanges within the project limits would be modified to accommodate the widened and reconfigured mainline, and in some locations, they would provide direct access to the managed lanes. The managed lane (HOV, HOT, ETL) system would consist of one or two managed lanes in each direction and would connect the VDOT HOT lanes with the Express Toll (ETL) lanes planned as part of the I-270 Multi-Modal Corridor Study and the Intercounty Connector, which is currently under construction.

2. Range of Alternatives

A wide array of options were considered for the long-term alternatives due to the variety of existing typical sections and constraints that exist within each section of the study area.

Along the Capital Beltway, there were two proposed typical sections for the long-term alternatives: a one-lane and a two-lane managed system. However, the physical footprint for all of the alternatives was the same and it included widening for two lanes per direction in Virginia and widening for one lane per direction on the American Legion Bridge and in Maryland. The widening in Maryland was constrained by the right-of-way, proximity to sensitive environmental features, and proximity to adjacent residences.

Along I-270 and the I-270 Spurs, all possible scenarios were briefly identified to determine the most feasible and viable typical sections to carry forward. Two matrices were developed to summarize these typical section scenarios and assist in justifying which options should be studied further. The matrices compare the number of managed lanes, the location of the barrier, and the conversion of existing lane operations to present all of the possible options. The matrices are presented in Table C-1 and Table C-2.

The matrices identify five alternatives that were selected for more detailed evaluation and provided justification for why particular options were not recommended to be studied further. After detailed development of the five selected alternatives, two additional alternatives, which were variations of Alternative 5, were also considered. All of these alternatives were evaluated based on lane configuration, traffic operations, impacts, and cost. The lane configurations by alternative and section are presented in Table C-3 and a detailed discussion of each alternative is summarized in the following sections.

Table C-1: Matrix of Alternatives for I-270 Mainline

	1-LANE MANAGED SYSTEM	2–LANE MANAGED SYSTEM	
	Convert Existing HOV Lane to Managed Lane	**Convert Existing HOV and 1 GP Lane to Managed Lanes**	**Convert Existing HOV to Managed Lane and ADD 1 Managed Lane**
REMOVE **Barrier Separated CD Road**	Scenario A • 6 lanes (1 Managed & 5 GP) • Unnecessary to remove existing CD Road barrier • Most likely require 2-lane Managed Lane system ↓ Eliminate from further study because there is no need to remove CD barrier if there are no changes to the typical section	Scenario B • 6 lanes (2 Managed & 4 GP) • Would include barrier between Managed and GP lanes (relocation of barrier between GP lanes and CD Road) ↓ 1 - With barrier between Managed and GP lanes Carry forward as build alternative **ALTERNATIVE #2** 2 - without barrier between Managed and GP lanes Eliminate from further consideration because it would be narrower section than existing	Scenario C • 7 lanes (2 Managed & 5 GP) • Could use either a barrier or a buffer between the Managed and GP lanes ↓ 1 - with barrier between Managed and GP lanes Carry forward as build alternative **ALTERNATIVE #3** 2 - without barrier between Managed and GP lanes Eliminate from further study because it there would be no separation for 7 lanes 3 - with barrier between Managed and GP lanes and Reduced CD road separation Carry forward as build alternative **ALTERNATIVE #4**
MAINTAIN **Barrier Separated CD Road**	Scenario D • 6 lanes (1 Managed & 3 GP & 2 CD) • Use buffer separation between Managed and GP • Conversion of HOV lane to Managed is only action required ↓ Carry forward as No-Build **ALTERNATIVE #1**	Scenario E • 6 lanes (2 Managed & 2 GP & 2 CD) • Would include either barrier or buffer separations between Managed and GP lanes • Poor use of existing pavement because of lane distribution ↓ Eliminate from further study because there would only be 2 GP lanes	Scenario F • 7 lanes (2 Managed & 3 GP & 2 CD) • Could use either a barrier or a buffer between the Managed and GP lanes ↓ 1 - with barrier between Managed and GP lanes Eliminate from further study because it would have 3 separated roadways 2 - without barrier between Managed and GP lanes Carry forward as build alternative **ALTERNATIVE #5**

Note: Between Montrose Road and the Y-Split Interchange, where there is no existing CD Road, the No-Build Alternative would be 5 GP & 1 Managed and only Build Alternatives, (2) and (3) would be considered.

Potential scenarios to carry forward:

Alternative #1: No-Build
Alternative #2: 2 Managed and 4 GP (move barrier separation from CD road to Managed Lanes)
Alternative #3: with option 1 – 2 Managed and 5 GP (move barrier separation from CD road to Managed Lanes)
Alternative #4: with option 3 – 2 Managed and 5 GP (move barrier separation from CD road to Managed Lanes) but provide reduced CD Road
Alternative #5: with option 2 – 2 Managed and 3 GP and 2 CD (maintain CD barrier separation and NO separation for Managed Lanes)

Table C-2: Matrix of Alternatives for I-270 Spurs

Convert Existing HOV Lane to Managed Lane	Convert Existing HOV and 1 GP Lane to Managed Lanes	Convert Existing HOV to Managed Lane and Add 1 Managed Lane
Scenario AA • 3 lanes (1 Managed & 2GP) • Use buffer separation between Managed and GP lanes • Conversion of HOV lane to Managed is only action required ↓ Carry forward as No-Build	Scenario BB • 3 lanes (2 Managed & 1 GP) • Reduces GP lanes to 1 per direction • Cannot have only 1 GP lane per direction ↓ Eliminated from further study because only one GP lane would be provided in each direction	Scenario CC • 4 lanes (2 Managed & 2 GP) • Could use either a barrier or a buffer between the Managed and GP lanes ↓ Carry forward as build alternative with options 1 - with barrier between Managed and GP lanes 2 - without barrier between Managed and GP lanes

Note: Along the SB I-270 West Spur, between the Y-Split Interchange and Democracy Boulevard, there are three GP lanes. In the No-Build Alternative, there would be three GP lanes and one Managed Lane. In the Build Alternative, there would be three GP lanes and two Managed Lanes.

Potential scenario to carry forward:

(AA) No-Build
(CC) Build Alternative with options 1 and 2

Table C-3: Lane Configurations by Section (per direction)

Concept	Description	Section 1 Capital Beltway Virginia (2.7 miles)	Section 2 American Legion Bridge (0.4 miles)	Section 3 Capital Beltway Maryland (3.6 miles)	Section 4 I-270 West Spur (1.5 miles)	Section 5 I-270 (from Y-Split to I-370) (7 miles)	
						Existing - No CD Y Split to Montrose	Existing - With CD Montrose to I-370
Existing / No Build	HOV and GP lanes	4 GP	5 GP	4 GP	1 HOV 2 or 3 GP	1 HOV 5 GP	1 HOV 3 GP Barrier Separation 2 CD
Alternative 1	1-ML with buffer between ML and GP in all Sections[1]	2 HOT or Transition Lanes 4 GP	Add 1 ML 5 GP	Add 1 ML 4 GP	Convert HOV to ML 2 or 3 GP	Convert HOV to ML 5 GP	Convert HOV to ML 3 GP Barrier Separation 2 CD
Alternative 2	2-ML with barrier between ML and GP in Sections 4-5	Same as above	Add 1 ML Convert 1GP to ML 4 GP	Add 1 ML Convert 1GP to ML 3 GP	Convert HOV to ML Barrier Separated 2 or 3 GP	Convert HOV to ML Convert 1 GP to ML Barrier Separation 4 GP	Convert HOV to ML Convert 1 GP to ML Barrier Separation 4 GP (remove existing separation between GP& CD)
Alternative 3	2-ML with barrier between ML and GP in Sections 4-5	Same as above	Same as above	Same as above	Convert HOV to ML Add 1 ML Barrier Separated 2 or 3 GP	Convert HOV to ML Add 1 ML Barrier Separation 5 GP	Convert HOV to ML Add 1 ML Barrier Separation 5 GP
Alternative 4	2-ML with barrier between ML and GP & buffer between GP and CD in Sections 4-5	Same as above	Same as above	Same as above	Same as above	Same as above	Convert HOV to ML Add 1 ML Barrier Separation 3 GP Buffer between GP & CD 2 CD
Alternative 5 Reduced A[2] Reduced B[3]	2-ML by restriping 4-lane road to 5 lanes. Maintain barrier between CD and GP in Section 5	Same as above	Same as above	Same as above	Same as above	Convert HOV to ML Add 1 ML 5 GP	Convert HOV to ML Add 1 ML by restriping the existing 4-lane road to 5 lanes 3 GP Barrier Separated 2 CD

Notes: [1] Locations where barrier-separation is not designated between Managed Lanes (ML) and GP, it is assumed there will be a 4-foot buffer separation.
[2] Alternative 5 Reduced A would not include direct access interchanges at Montrose Road or Gude Drive.
[3] Alternative 5 Reduced B would not include any direct access interchanges on I-270 and would provide the same improvements as Alternative 1 on the West Spur.

3. Alternative 1

Description

Alternative 1 would provide a one-lane managed lane system in each direction throughout the study corridor. The proposed improvements for each section are described below.

Capital Beltway

As described in Section 2, the improvements for the Capital Beltway would require the same amount of widening for each long-term alternative. These improvements are described in Alternative 1, but would apply for all long-term alternatives. However, the alternatives vary in number of managed and general purpose lanes on the American Legion Bridge and on the Capital Beltway in Maryland.

The section of the Capital Beltway located in Virginia would directly abut the Virginia HOT lane system, which will extend along I-495 from the Springfield (I-95 / I-395) interchange to just north of the Dulles Toll Road. The Virginia HOT lane system will consist of two HOT lanes and four general purpose lanes in each direction. The HOT lanes will be separated from the remainder of the highway by a four-foot painted buffer. Vehicles will not be allowed to cross the painted buffer, but access for the HOT lanes will be provided at interchanges via direct access ramps from the cross roads.

To match the Virginia HOT system, the Virginia portion of the Capital Beltway would need to be widened by two lanes per direction resulting in six-lane section per direction. To match the proposed widening for the American Legion Bridge, one lane would need to add (outer loop) and drop (inner loop) within the George Washington Memorial Parkway interchange. This section of the Capital Beltway could be utilized as a transition area between the VDOT HOT lanes and the Maryland managed lanes if the operational configurations are not consistent. The transition would allow drivers some distance to maneuver into the proper lanes between the two operating systems. For instance, if the Maryland managed lanes are operated as Express Toll Lanes (ETL) where all vehicles are required to pay a toll, this section of the Capital Beltway would allow HOV vehicles in the VDOT HOT lanes an area to merge out of the median lanes prior to the start of tolling in Maryland. Similarly, this section of the Capital Beltway could allow HOV users from Maryland to merge into the VDOT HOT lanes. If the operational approach is the same between the two systems, with both utilizing HOT lanes, then this section of the Capital Beltway could provide a continuous HOT system between Maryland and Virginia. This lane configuration in Virginia would be utilized with all build alternatives.

The American Legion Bridge would be widened to accommodate one extra lane per direction, resulting in a total of six lanes per direction plus full shoulders. This alternative would provide one managed lane, four general purpose lanes, and one auxiliary lane per direction across the bridge.

The section of the Capital Beltway located in Maryland between the American Legion Bridge and the I-270 West Spur would be widened by one lane in each direction resulting in a total of five lanes per direction. This alternative would provide one managed lane and four general purpose lanes per direction.

I-270 Mainline / I-270 West Spur / I-270 East Spur
There would be no widening on the I-270 Spurs or mainline, but the existing peak period HOV lanes would be converted to managed lanes. This would provide one managed lane and two to three general purpose lanes on the I-270 West Spur; one managed lane and two to three general purpose lanes on the I-270 East Spur; one managed lane and five general purpose lanes on the I-270 mainline south of Montrose Road; and one managed lane, three general purpose lanes, and two CD Road lanes on I-270 north of Montrose Road.

The proposed typical sections for Alternative 1 are shown in Figures C-1 through C-6.

Managed Lanes Access
Access to the managed lanes would be provided at specified at-grade locations and through direct access ramps at several interchanges. At-grade access would be provided at the southern end of the system, south of the American Legion Bridge in Virginia. An additional at-grade access would be located along the Capital Beltway in Maryland between the MD 190 and I-270 West Spur / I-495 interchanges.

Direct access ramps would be provided at the existing Westlake Terrace interchange. The existing HOV access ramps would be converted to managed lanes access ramps. As with the existing condition, only north oriented ramps would be provided.

Traffic Analysis
Under Alternative 1, one managed lane would be added to the Capital Beltway in Maryland. Along the I-270 West Spur and mainline the existing HOV lane would be converted to a managed lane. As a general policy, it was assumed that SHA would allow HOV vehicles to use the managed lanes at no cost and there would be no truck restrictions in the managed lanes. Hence, all of the existing HOV volumes would use the managed lanes in Alternative 1. It was also assumed that some of the traffic in the general purpose lanes would use the managed lanes in the future for potential time savings, including trucks. Therefore, the capacity thresholds and related LOS values for managed lanes are different from the existing HOV lanes. However, the capacity values would remain the same for general purpose lanes and CD Road lanes because the physical configuration of the highway would not change.

The capacity thresholds and related LOS values for Alternative 1, including the managed lanes are shown in Table C-4. The total volume; the volume distribution between the managed lanes, general purpose lanes, and CD Road lanes; v/c ratios; and LOS values for the freeway segments along I-270 and I-495 within the limits of the project for Alternative 1 are shown in Table C-5.

In the southbound direction, during the AM peak, 4 of 13 highway segments would fail and there would be bottlenecks on the following segments:
- I-495 between Cabin John Parkway and MD 190
- I-270 West Spur between I-495 and Democracy Boulevard

This would be two fewer failing highway segments than the No-Build and would eliminate the bottleneck on the I-270 mainline between MD 189 and MD 28.

In the northbound direction, during the PM peak, 6 of 13 highway segments would fail and there would be bottlenecks on the following segments:
- I-270 West Spur between I-495 and Democracy Boulevard
- I-270 mainline between MD 189 and MD 28

This would be three fewer failing highway segments than the No-Build and would eliminate the bottleneck on I-495 between Clara Barton Parkway and Cabin John Parkway.

Cost / Impacts

Preliminary property and environmental impacts were estimated based on an assumed right-of-way / limit-of-disturbance that was offset 25 feet from the proposed limit of grading or outside edge of retaining wall. It was assumed that property displacements would result when the edge of a building was ten feet or less from the proposed right-of-way line.

The proposed improvements would result in impacts to 70 properties along the Capital Beltway, including four residential displacements. The widening along the Capital Beltway could impact five wetlands / Waters of the U.S. and approximately 3.2 acres of park.

The cost is estimated at over $1.04 billion (2008 dollars), which is the lowest cost of the long-term alternatives analyzed. Note that over $800 million of the estimated cost is associated with the widening of the Capital Beltway and American Bridge alone, which would be included in all alternatives.

Status / Conclusion

Alternative 1 would provide a nominal operational improvement compared to the No-Build and would also result in the least impacts and lowest cost of all long-term alternatives. However, Alternative 1 would only provide a one-lane managed lane system through the study corridor, which may not operate as effectively as a two-lane system because motorists would not be able to pass a vehicle traveling at a slower speed or one that was stopped on the shoulder.

Due to the projected operational improvement and the lower cost and impacts compared to other long-term alternatives, it was determined that Alternative 1 should be evaluated in greater detail in a subsequent planning study.

Table C-4: Capacity Thresholds for ETL, GP, & CD Lanes – 2030 Build Alternatives 1, 2, 3 & 4

HCS Assumptions and Calculated Maximum Flow Rates By LOS Threshold - 5% Trucks

ETL			General Purpose						Collector-Distributor (CD)			
PHF		0.95	PHF		0.95				PHF		0.95	
%Trucks		5	%Trucks		5				%Trucks		1	
Measured FF Speed		65	Measured FF Speed		70				Measured FF Speed		60	
Terrain		Level	Terrain		Level				Terrain		Level	
Unadjusted Capacity		2,350	Unadjusted Capacity		2,400				Unadjusted Capacity		2,300	
HCS LOS Thresholds			**HCS LOS Thresholds**						**HCS LOS Thresholds**			
Adjusted Flow Rates			*Adjusted Flow Rates*						*Adjusted Flow Rates*			
1 Lane	**2 Lanes**	**LOS**	**2 Lanes**	**3 Lanes**	**4 Lanes**	**5 Lanes**	**6 Lanes**	**LOS**	**1 Lane**	**2 Lanes**	**3 Lanes**	**LOS**
0	0	**A**	0	0	0	0	0	**A**	0	0	0	**A**
659	1318	**B**	1429	2144	2858	3573	4288	**B**	625	1249	1872	**B**
1085	2171	**C**	2337	3506	4675	5844	7012	**C**	1022	2043	3063	**C**
1558	3116	**D**	3283	4924	6566	8207	9848	**D**	1476	2951	4425	**D**
1938	3876	**E**	3987	5981	7974	9968	11962	**E**	1909	3817	5723	**E**
2179	4358	**F**	4451	6676	8901	11127	13352	**F**	2175	4350	6522	**F**

HCS Assumptions and Calculated Maximum Flow Rates By LOS Threshold - 6% Trucks

ETL			General Purpose						Collector-Distributor (CD)			
PHF		0.95	PHF		0.95				PHF		0.95	
%Trucks		6	%Trucks		6				%Trucks		1	
Measured FF Speed		65	Measured FF Speed		70				Measured FF Speed		60	
Terrain		Level	Terrain		Level				Terrain		Level	
Unadjusted Capacity		2,350	Unadjusted Capacity		2,400				Unadjusted Capacity		2,300	
HCS LOS Thresholds			**HCS LOS Thresholds**						**HCS LOS Thresholds**			
Adjusted Flow Rates			*Adjusted Flow Rates*						*Adjusted Flow Rates*			
1 Lane	**2 Lanes**	**LOS**	**2 Lanes**	**3 Lanes**	**4 Lanes**	**5 Lanes**	**6 Lanes**	**LOS**	**1 Lane**	**2 Lanes**	**3 Lanes**	**LOS**
0	0	**A**	0	0	0	0	0	**A**	0	0	0	**A**
656	1312	**B**	1422	2133	2844	3556	4267	**B**	625	1249	1872	**B**
1080	2160	**C**	2326	3489	4652	5815	6978	**C**	1022	2043	3063	**C**
1550	3101	**D**	3267	4900	6534	8167	9801	**D**	1476	2951	4425	**D**
1929	3857	**E**	3968	5952	7936	9920	11904	**E**	1909	3817	5723	**E**
2168	4337	**F**	4429	6644	8858	11073	13287	**F**	2175	4350	6522	**F**

HCS Assumptions and Calculated Maximum Flow Rates By LOS Threshold - 7% Trucks

ETL			General Purpose						Collector-Distributor (CD)			
PHF		0.95	PHF		0.95				PHF		0.95	
%Trucks		7	%Trucks		7				%Trucks		1	
Measured FF Speed		65	Measured FF Speed		70				Measured FF Speed		60	
Terrain		Level	Terrain		Level				Terrain		Level	
Unadjusted Capacity		2,350	Unadjusted Capacity		2,400				Unadjusted Capacity		2,300	
HCS LOS Thresholds			**HCS LOS Thresholds**						**HCS LOS Thresholds**			
Adjusted Flow Rates			*Adjusted Flow Rates*						*Adjusted Flow Rates*			
1 Lane	**2 Lanes**	**LOS**	**2 Lanes**	**3 Lanes**	**4 Lanes**	**5 Lanes**	**6 Lanes**	**LOS**	**1 Lane**	**2 Lanes**	**3 Lanes**	**LOS**
0	0	**A**	0	0	0	0	0	**A**	0	0	0	**A**
653	1305	**B**	1415	2123	2831	3538	4246	**B**	625	1249	1872	**B**
1075	2150	**C**	2315	3472	4630	5787	6945	**C**	1022	2043	3063	**C**
1543	3086	**D**	3251	4877	6502	8128	9753	**D**	1476	2951	4425	**D**
1919	3839	**E**	3949	5923	7897	9872	11846	**E**	1909	3817	5723	**E**
2158	4316	**F**	4408	6611	8815	11019	13223	**F**	2175	4350	6522	**F**

HCS Assumptions and Calculated Maximum Flow Rates By LOS Threshold - 8% Trucks

ETL			General Purpose						Collector-Distributor (CD)			
PHF		0.95	PHF		0.95				PHF		0.95	
%Trucks		8	%Trucks		8				%Trucks		1	
Measured FF Speed		65	Measured FF Speed		70				Measured FF Speed		60	
Terrain		Level	Terrain		Level				Terrain		Level	
Unadjusted Capacity		2,350	Unadjusted Capacity		2,400				Unadjusted Capacity		2,300	
HCS LOS Thresholds			**HCS LOS Thresholds**						**HCS LOS Thresholds**			
Adjusted Flow Rates			*Adjusted Flow Rates*						*Adjusted Flow Rates*			
1 Lane	**2 Lanes**	**LOS**	**2 Lanes**	**3 Lanes**	**4 Lanes**	**5 Lanes**	**6 Lanes**	**LOS**	**1 Lane**	**2 Lanes**	**3 Lanes**	**LOS**
0	0	**A**	0	0	0	0	0	**A**	0	0	0	**A**
650	1301	**B**	1409	2113	2817	3521	4226	**B**	625	1249	1872	**B**
1070	2139	**C**	2304	3456	4608	5759	6911	**C**	1022	2043	3063	**C**
1536	3071	**D**	3235	4853	6471	8089	9706	**D**	1476	2951	4425	**D**
1910	3820	**E**	3930	5895	7859	9824	11789	**E**	1909	3817	5723	**E**
2148	4295	**F**	4386	6580	8773	10966	13159	**F**	2175	4350	6522	**F**

Table C-5: Capacity Calculations – 2030 Build Alternative 1

AM Peak Period - Northbound (2030 Alternative 1)

Interchange	Total Volume	ETL # Lanes	ETL Forecast Vol.	ETL HCS Adj. Capacity	ETL v/c	ETL LOS	GP Lanes # Lanes	GP Lanes % of GP+CD (2006 Count)	GP Lanes Resulting Vol.	GP Lanes HCS Adj. Capacity	GP Lanes v/c	GP Lanes LOS	CD Lanes # Lanes	CD Lanes % of GP+CD (2006 Count)	CD Lanes Resulting Vol.	CD Lanes HCS Adj. Capacity	CD Lanes v/c	CD Lanes LOS
VA 193																		
	12,200						6	100%	12,200	13,287	0.92	E						
GW Parkway	10,600	1	1,700	2,168	0.78	D	5	100%	8,900	11,073	0.80	D						
Clara Barton Parkway	9,450	1	1,400	2,168	0.65	C	4	100%	8,050	8,858	0.91	E						
Cabin John Parkway	10,000	1	1,400	2,168	0.65	C	5	100%	8,600	11,073	0.78	D						
MD 190	9,850	1	1,400	2,168	0.65	C	5	100%	8,450	11,073	0.76	D						
At-Grade Access	9,850	1	350	2,168	0.16	A	5	100%	9,500	11,073	0.86	D						
I-495/I-270 West Spur	5,200	1	350	2,148	0.16	A	2	100%	4,850	4,451	1.09	F						
Democracy Boulevard	4,525	1	350	2,148	0.16	A	2	100%	4,175	4,451	0.94	E						
West Lake Terrace	5,325	1	1,150	2,148	0.54	C	2	100%	4,175	4,451	0.94	E						
I-270 Y-Split	9,575	1	1,475	2,148	0.69	C	5	100%	8,100	10,966	0.74	D						
Montrose Road	9,400	1	1,325	2,148	0.62	C	3	66%	5,330	6,580	0.81	D	2	34%	2,746	4,350	0.63	C
MD 189	9,475	1	1,325	2,148	0.62	C	3	67%	5,461	6,580	0.83	D	2	33%	2,690	4,350	0.62	C
MD 28	7,925	1	1,325	2,148	0.62	C	3	56%	3,696	6,580	0.56	C	2	44%	2,904	4,350	0.67	C
Gude Drive	7,950	1	1,350	2,148	0.63	C	3	56%	3,696	6,580	0.56	C	2	44%	2,904	4,350	0.67	C
Shady Grove Road	6,275	1	1,350	2,148	0.63	C	3	57%	2,807	6,580	0.43	B	2	43%	2,118	4,350	0.49	C
I-370																		
I-495																		
		1		2,168	0.00	A	2	100%	-	4,386	0.00	A						
MD 187		1		2,168	0.00	A	2	100%	-	4,386	0.00	A						
Rockledge Drive		1		2,168	0.00	A	2	100%	-	4,386	0.00	A						
I-270 Y-Split																		

(#'s in Red are from Field Counts, #'s in Black are assumed)

AM Peak Period - Southbound (2030 Alternative 1)

Interchange	Total Volume	ETL # Lanes	ETL Forecast Vol.	ETL HCS Adj. Capacity	ETL v/c	ETL LOS	GP Lanes # Lanes	GP Lanes % of GP+CD (2006 Count)	GP Lanes Resulting Vol.	GP Lanes HCS Adj. Capacity	GP Lanes v/c	GP Lanes LOS	CD Lanes # Lanes	CD Lanes % of GP+CD (2006 Count)	CD Lanes Resulting Vol.	CD Lanes HCS Adj. Capacity	CD Lanes v/c	CD Lanes LOS
I-370																		
Shady Grove Road	10,750	1	1,600	2,168	0.74	D	3	74%	6,771	6,644	1.02	F	3	26%	2,379	6,522	0.36	B
Gude Drive	9,900	1	1,600	2,168	0.74	D	3	67%	5,561	6,644	0.84	D	2	33%	2,739	4,350	0.63	C
MD 28	9,900	1	1,600	2,168	0.74	D	3	64%	5,312	6,644	0.80	D	2	36%	2,988	4,350	0.69	D
MD 189	11,000	1	1,600	2,168	0.74	D	3	57%	5,358	6,644	0.81	D	2	43%	4,042	4,350	0.93	E
Montrose Road	11,100	1	1,600	2,168	0.74	D	3	66%	6,270	6,644	0.94	E	2	34%	3,230	4,350	0.74	D
I-270 Y-Split	11,350	1	1,700	2,168	0.78	D	5	100%	9,650	11,073	0.87	D						
West Lake Terrace	6,525	1	1,475	2,168	0.68	C	3	100%	5,050	6,676	0.76	D						
Democracy Boulevard	5,700	1	650	2,168	0.30	A	3	100%	5,050	6,676	0.76	D						
I-495/I-270 West Spur	5,800	1	650	2,168	0.30	A	2	100%	5,150	4,451	1.16	F						
At-Grade Access	10,750	1	650	2,158	0.30	A	5	100%	10,100	11,019	0.92	E						
MD 190	10,750	1	1,600	2,158	0.74	D	5	100%	9,150	11,019	0.83	D						
Cabin John Parkway	11,425	1	1,600	2,158	0.74	D	4	100%	9,825	8,815	1.11	F						
Clara Barton Parkway	9,275	1	1,600	2,158	0.74	D	4	100%	7,675	8,815	0.87	D						
George Washington	10,675	1	1,775	2,158	0.82	D	5	100%	8,900	11,019	0.81	D						
VA 193	10,825						5	76%	8,227	11,019	0.75	D	3	24%	2,598	6,522	0.40	B
I-270 Y-Split																		
Rockledge Drive		1		2,158	0.00	A	2	100%	-	4,429	0.00	A						
MD 187		1		2,158	0.00	A	2	100%	-	4,429	0.00	A						
I-495		1		2,158	0.00	A	2	100%	-	4,429	0.00	A						

(#'s in Red are from Field Counts, #'s in Black are assumed)

PM Peak Period - Northbound (2030 Alternative 1)

Interchange	Total Volume	ETL # Lanes	ETL Vol.	ETL Capacity	ETL v/c	ETL LOS	GP Lanes # Lanes	GP Lanes (2006 Count)	GP Lanes Vol.	GP Lanes Capacity	GP Lanes v/c	GP Lanes LOS	CD Lanes # Lanes	CD Lanes (2006 Count)	CD Lanes Vol.	CD Lanes Capacity	CD Lanes v/c	CD Lanes LOS
VA 193																		
	9,950						6	100%	9,950	13,223	0.75	D						
GW Parkway	10,100	1	1,750	2,158	0.81	D	5	100%	8,350	11,019	0.76	D						
Clara Barton Parkway	9,075	1	1,600	2,158	0.74	D	4	100%	7,475	8,815	0.85	D						
Cabin John Parkway	10,625	1	1,600	2,158	0.74	D	5	100%	9,025	11,019	0.82	D						
MD 190	10,175	1	1,600	2,158	0.74	D	5	100%	8,575	11,019	0.78	D						
At-Grade Access	10,175	1	650	2,158	0.30	A	5	100%	9,525	11,019	0.86	D						
I-495/I-270 West Spur	5,725	1	650	2,179	0.30	A	2	100%	5,075	4,451	1.14	F						
Democracy Boulevard	6,075	1	650	2,179	0.30	A	2	100%	5,425	4,451	1.22	F						
West Lake Terrace	6,900	1	1,475	2,179	0.68	C	2	100%	5,425	4,451	1.22	F						
I-270 Y-Split	12,150	1	1,700	2,179	0.78	D	5	100%	10,450	11,127	0.94	E						
Montrose Road	13,025	1	1,625	2,179	0.75	D	3	61%	6,954	6,676	1.04	F	2	39%	4,446	4,350	1.02	F
MD 189	13,325	1	1,625	2,179	0.75	D	3	65%	7,605	6,676	1.14	F	2	35%	4,095	4,350	0.94	E
MD 28	11,500	1	1,625	2,179	0.75	D	3	60%	5,925	6,676	0.89	D	2	40%	3,950	4,350	0.91	E
Gude Drive	11,475	1	1,600	2,179	0.73	D	3	60%	5,925	6,676	0.89	D	2	40%	3,950	4,350	0.91	E
Shady Grove Road	12,075	1	1,600	2,179	0.73	D	3	49%	5,133	6,676	0.77	D	2	51%	5,342	4,350	1.23	F
I-370																		
I-495																		
		1		2,158	0.00	A	2	100%	-	4,451	0.00	A						
MD 187		1		2,158	0.00	A	2	100%	-	4,451	0.00	A						
Rockledge Drive		1		2,158	0.00	A	2	100%	-	4,451	0.00	A						
I-270 Y-Split																		

(#'s in Red are from Field Counts, #'s in Black are assumed)

PM Peak Period - Southbound (2030 Alternative 1)

Interchange	Total Volume	ETL # Lanes	ETL Vol.	ETL Capacity	ETL v/c	ETL LOS	GP Lanes # Lanes	GP Lanes (2006 Count)	GP Lanes Vol.	GP Lanes Capacity	GP Lanes v/c	GP Lanes LOS	CD Lanes # Lanes	CD Lanes (2006 Count)	CD Lanes Vol.	CD Lanes Capacity	CD Lanes v/c	CD Lanes LOS
I-370																		
Shady Grove Road	6,700	1	1,350	2,179	0.62	C	4	59%	3,157	8,901	0.35	B	3	41%	2,194	6,522	0.34	B
Gude Drive	7,200	1	1,350	2,179	0.62	C	4	75%	4,388	8,901	0.49	B	2	25%	1,463	4,350	0.34	B
MD 28	7,150	1	1,300	2,179	0.60	C	4	66%	3,861	8,901	0.43	B	2	34%	1,989	4,350	0.46	B
MD 189	8,325	1	1,300	2,179	0.60	C	4	60%	4,215	8,901	0.47	B	2	40%	2,810	4,350	0.65	C
Montrose Road	8,325	1	1,300	2,179	0.60	C	4	78%	5,480	8,901	0.62	C	2	22%	1,546	4,350	0.36	B
I-270 Y-Split	7,825	1	1,300	2,179	0.60	C	5	100%	6,525	11,127	0.59	C						
West Lake Terrace	4,650	1	1,150	2,179	0.53	C	3	100%	3,500	6,676	0.52	B						
Democracy Boulevard	3,875	1	375	2,179	0.17	A	3	100%	3,500	6,676	0.52	B						
I-495/I-270 West Spur	4,550	1	375	2,179	0.17	A	2	100%	4,175	4,451	0.94	E						
At-Grade Access	9,050	1	375	2,179	0.17	A	5	100%	8,675	11,127	0.78	D						
MD 190	9,050	1	1,425	2,179	0.65	C	5	100%	7,625	11,127	0.69	C						
Cabin John Parkway	9,425	1	1,425	2,179	0.65	C	5	100%	8,000	11,127	0.72	C						
Clara Barton Parkway	8,650	1	1,425	2,179	0.65	C	4	100%	7,225	8,901	0.81	D						
George Washington	9,600	1	1,725	2,179	0.79	D	5	100%	7,875	11,127	0.71	C						
VA 193	11,575						5	65%	7,524	11,127	0.68	C	3	35%	4,051	6,522	0.62	C
I-270 Y-Split																		
Rockledge Drive		1		2,179	0.00	A	2	100%	-	4,451	0.00	A						
MD 187		1		2,179	0.00	A	2	100%	-	4,451	0.00	A						
I-495		1		2,179	0.00	A	2	100%	-	4,451	0.00	A						

(#'s in Red are from Field Counts, #'s in Black are assumed)

Truck Percentages

	AM Peak	PM Peak
I-495	6%	7%
I-270 Spur	5%	5%
I-270	8%	5%

Truck Percentages

	AM Peak	PM Peak
I-495	7%	5%
I-270 Spur	5%	5%
I-270	6%	5%

4. Alternative 2

Description
Alternative 2 would provide a two-lane managed lane system in each direction throughout the study corridor. The proposed improvements for each section are described below.

Capital Beltway
The section of the Capital Beltway in Virginia would provide two HOT / transition lanes and four general purpose lanes per direction as described in Alternative 1.

The American Legion Bridge would be widened to accommodate one extra lane per direction, and this alternative would also include converting one general purpose lane to a managed lane to provide two managed lanes, three general purpose lanes, and one auxiliary lane per direction. This lane configuration would be utilized for Alternatives 2 through 5.

The section of the Capital Beltway located in Maryland between the American Legion Bridge and I-270 West Spur would be widened by one lane in each direction, and this alternative would also include converting one general purpose lane to a managed lane to provide two managed lanes and three general purpose lanes per direction. This lane configuration would be utilized for Alternatives 2 through 5.

I-270 West Spur
The I-270 West Spur would be widened slightly to accommodate a concrete traffic barrier between the median lane, which would be converted from a peak period HOV lane to a managed lane, and the general purpose lanes. Only minimal widening would be required to accommodate the barrier because the existing 16-foot wide median shoulder, which is comprised of full depth pavement, would be reduced to a four-foot shoulder. The total number of lanes on the I-270 West Spur would be maintained, with two general purpose lanes and one managed lane per direction, except in the southbound direction between the Y-Split and Democracy Boulevard interchanges where an auxiliary (fourth) lane is provided.

I-270 Mainline
The I-270 mainline between the Y-Split interchange and the start of the CD Road system south of Montrose Road would be widened to accommodate a concrete traffic barrier between the left two lanes and the right four lanes in each direction. The left two lanes in each direction would be converted from a peak period HOV lane and general purpose lane to managed lanes.

Within the CD Road section, from south of Montrose Road to I-370, the roadway would be reconfigured to remove the existing concrete traffic barrier between the general purpose lanes and CD Road and provide a concrete traffic barrier between the left two lanes and the remainder of the highway. The left two lanes in each direction would be converted from a peak period HOV lane and general purpose lane to two managed lanes. The CD Road would be completely removed.

I-270 East Spur
The I-270 East Spur would be widened to accommodate a concrete traffic barrier between the median lane, which would be converted from a peak period HOV lane to a managed lane, and the general purpose lanes. The total number of lanes on the I-270 East Spur would be the same as the existing condition.

The proposed typical sections for Alternative 2 are shown in Figures C-1, and C-7 through C-11.

Managed Lanes Access

Access to the managed lanes would be provided at specified at-grade locations and through direct access ramps at several interchanges. At-grade access would be provided at the southern end of the system, south of the American Legion Bridge in Virginia. An additional at-grade access would be located along the Capital Beltway in Maryland between the MD 190 and I-270 West Spur / I-495 interchanges.

Direct access ramps would be provided at the existing Westlake Terrace, Montrose Road, and I-370 interchanges, and at a new direct access only interchange with Gude Drive. The existing Westlake Terrace HOV access ramps would be converted to managed lanes access ramps; the Montrose Road and I-370 interchanges would be modified to include direct access ramps; and only new direct access ramps would be provided at Gude Drive (no general purpose ramps). The direct access ramps would provide a direct link between the managed lanes and cross roads.

Traffic Analysis

Under Alternative 2, one lane would be added and one general purpose lane would be converted to managed lanes along the Capital Beltway. On the I-270 West Spur, the HOV lane would be converted to a managed lane. On the I-270 mainline, the existing HOV lane and one general purpose lane would be converted to managed lanes. As a result, the existing HOV volumes would use the managed lanes and some of the existing general purpose volumes would use the managed lanes for potential time savings, especially with one less general purpose lane provided on the mainline.

The capacity thresholds and related LOS values for Alternative 2 are shown in Table C-4. The total volume; the volume distribution between the managed lanes and general purpose lanes; the v/c ratios; and LOS values for the freeway segments along I-270 and I-495 within the limits of the project for Alternative 2 are shown in Table C-6.

In the southbound direction, during the AM peak, 7 of 13 highway segments would fail and there would be bottlenecks on the following segments:

- I-495 between Cabin John Parkway and MD 190
- I-270 West Spur between I-495 and Democracy Boulevard
- I-270 mainline between MD 189 and MD 28

This would be one more failing highway segment than the No-Build and would not eliminate any bottlenecks.

In the northbound direction, during the PM peak, 9 of 13 highway segments would fail and there would be bottlenecks on the following segments:

- I-270 West Spur between I-495 and Democracy Boulevard
- I-270 mainline between MD 189 and MD 28

This would be the same number of failing highway segments as the No-Build and would eliminate the bottleneck on I-495 between Clara Barton Parkway and Cabin John Parkway.

Cost / Impacts

Preliminary property and environmental impacts were estimated based on an assumed right-of-way / limit-of-disturbance that was offset 25 feet from the proposed limit of grading or outside edge of retaining wall. It was assumed that property displacements would result when the edge of a building was ten feet or less from the proposed right-of-way line.

The proposed improvements would result in impacts to 193 properties, including 18 displacements (17 residential and one commercial). The widening along the Capital Beltway, I-270 Spurs, and the I-270 mainline could impact 79 wetlands / Waters of the U.S. and approximately 14.4 acres of park.

The cost is estimated at $2.17 billion (2008 dollars).

Status / Conclusion

Alternative 2 would not provide an operational improvement compared to the No-Build and it would result in more impacts and substantially higher cost than Alternative 1. However, Alternative 2 would provide a two-lane managed lane system through the study corridor, which may be more preferable than the one-lane system proposed in Alternative 1.

Due to the lack of improved traffic operations and the significant cost and impacts, it was determined that Alternative 2 would not be considered for further study at this time.

Table C-6: Capacity Calculations – 2030 Build Alternative 2

AM Peak Period - Northbound (2030 Alternative 2)

Interchange	Total Volume	ETL # Lanes	ETL Forecast Vol.	ETL HCS Adj. Capacity	ETL v/c	ETL LOS	GP Lanes # Lanes	GP Lanes % of GP+CD (2006 Count)	GP Lanes Resulting Vol.	GP Lanes HCS Adj. Capacity	GP Lanes v/c	GP Lanes LOS	CD Lanes # Lanes	CD Lanes % of GP+CD (2006 Count)	CD Lanes Resulting Vol.	CD Lanes HCS Adj. Capacity	CD Lanes v/c	CD Lanes LOS
VA 193																		
	12,200						6		12,200	13,287	0.92	E						
GW Parkway																		
	10,975	2	2,125	4,337	0.49	B	4		8,850	8,858	1.00	E						
Clara Barton Parkway																		
	9,300	2	1,925	4,337	0.44	B	3		7,375	6,644	1.11	F						
Cabin John Parkway																		
	9,775	2	1,925	4,337	0.44	B	4		7,850	8,858	0.89	D						
MD 190																		
	9,825	2	1,925	4,337	0.44	B	4		7,900	8,858	0.89	D						
At-Grade Access																		
	9,825	2	775	4,337	0.18	A	5		9,050	11,073	0.82	D						
I-495/I-270 West Spur																		
	5,175	1	775	2,148	0.36	B	2		4,400	4,451	0.99	E						
Democracy Boulevard																		
	4,850	1	775	2,148	0.36	B	2		4,075	4,451	0.92	E						
West Lake Terrace																		
	5,200	1	1,125	2,148	0.52	C	2		4,075	4,451	0.92	E						
I-270 Y-Split																		
	9,250	2	2,275	4,295	0.53	C	4		6,975	8,773	0.80	D						
Montrose Road																		
	8,675	2	2,750	4,295	0.64	C	4		5,925	8,773	0.68	C						
MD 189																		
	8,325	2	2,750	4,295	0.64	C	4		5,575	8,773	0.64	C						
MD 28																		
	8,100	2	2,750	4,295	0.64	C	4		5,350	8,773	0.61	C						
Gude Drive																		
	7,925	2	2,575	4,295	0.60	C	4		5,350	8,773	0.61	C						
Shady Grove Road																		
	6,075	2	2,575	4,295	0.60	C	4		3,500	8,773	0.40	B						
I-370																		

#'s in Red are from Field Counts, #'s in Black are assumed

I-495																		
		1		2,168	0.00	A	2		-	4,386	0.00	A						
MD 187																		
		1		2,168	0.00	A	2		-	4,386	0.00	A						
Rockledge Drive																		
		1		2,168	0.00	A	2		-	4,386	0.00	A						
I-270 Y-Split																		

AM Peak Period - Southbound (2030 Alternative 2)

Interchange	Total Volume	ETL # Lanes	ETL Forecast Vol.	ETL HCS Adj. Capacity	ETL v/c	ETL LOS	GP Lanes # Lanes	GP Lanes % of GP+CD (2006 Count)	GP Lanes Resulting Vol.	GP Lanes HCS Adj. Capacity	GP Lanes v/c	GP Lanes LOS	CD Lanes # Lanes	CD Lanes % of GP+CD (2006 Count)	CD Lanes Resulting Vol.	CD Lanes HCS Adj. Capacity	CD Lanes v/c	CD Lanes LOS
I-370																		
Shady Grove Road	11,700	2	3,275	4,337	0.76	D	4		8,425	8,858	0.95	E						
Gude Drive	11,175	2	3,275	4,337	0.76	D	4		7,900	8,858	0.89	D						
MD 28	11,125	2	3,225	4,337	0.74	D	4		7,900	8,858	0.89	D						
MD 189	11,200	2	3,225	4,337	0.74	D	4		7,975	8,858	0.90	E						
Montrose Road	12,000	2	3,225	4,337	0.74	D	4		8,775	8,858	0.99	E						
I-270 Y-Split	12,775	2	3,400	4,337	0.78	D	5		9,375	11,073	0.85	D						
West Lake Terrace	6,375	1	1,700	2,168	0.78	D	3		4,675	6,676	0.70	C						
Democracy Boulevard	6,050	1	1,375	2,168	0.63	C	3		4,675	6,676	0.70	C						
I-495/I-270 West Spur	5,750	1	1,375	2,168	0.63	C	2		4,375	4,451	0.98	E						
At-Grade Access	10,700	2	1,375	4,316	0.32	B	5		9,325	11,019	0.85	D						
MD 190	10,700	2	3,125	4,316	0.72	D	4		7,575	8,815	0.86	D						
Cabin John Parkway	11,175	2	3,125	4,316	0.72	D	4		8,050	8,815	0.91	E						
Clara Barton Parkway	9,150	2	3,125	4,316	0.72	D	3		6,025	6,611	0.91	E						
George Washington	11,075	2	3,125	4,316	0.72	D	4		7,950	8,815	0.90	E						
VA 193	10,850						5	76%	8,246	11,019	0.75	D	3		2,604	6,522	0.40	B

#'s in Red are from Field Counts, #'s in Black are assumed

I-270 Y-Split																		
Rockledge Drive		1		2,158	0.00	A	2		-	4,429	0.00	A						
MD 187		1		2,158	0.00	A	2		-	4,429	0.00	A						
I-495		1		2,158	0.00	A	2		-	4,429	0.00	A						

PM Peak Period - Northbound (2030 Alternative 2)

Interchange	Total Volume	ETL # Lanes	ETL Forecast Vol.	ETL HCS Adj. Capacity	ETL v/c	ETL LOS	GP Lanes # Lanes	GP Lanes % of GP+CD (2006 Count)	GP Lanes Resulting Vol.	GP Lanes HCS Adj. Capacity	GP Lanes v/c	GP Lanes LOS	CD Lanes # Lanes	CD Lanes % of GP+CD (2006 Count)	CD Lanes Resulting Vol.	CD Lanes HCS Adj. Capacity	CD Lanes v/c	CD Lanes LOS
VA 193																		
	9,925						6		9,925	13,223	0.75	D						
GW Parkway																		
	10,450	2	3,175	4,316	0.74	D	4		7,275	8,815	0.83	D						
Clara Barton Parkway																		
	8,925	2	3,100	4,316	0.72	D	3		5,825	6,611	0.88	D						
Cabin John Parkway																		
	10,375	2	3,100	4,316	0.72	D	4		7,275	8,815	0.83	D						
MD 190																		
	10,100	2	3,100	4,316	0.72	D	4		7,000	8,815	0.79	D						
At-Grade Access																		
	10,100	2	1,350	4,316	0.31	B	5		8,750	11,019	0.79	D						
I-495/I-270 West Spur																		
	5,650	1	1,350	2,179	0.62	C	2		4,300	4,451	0.97	E						
Democracy Boulevard																		
	6,400	1	1,350	2,179	0.62	C	2		5,050	4,451	1.13	F						
West Lake Terrace																		
	6,725	1	1,675	2,179	0.77	D	2		5,050	4,451	1.13	F						
I-270 Y-Split																		
	11,725	2	3,375	4,358	0.77	D	4		8,350	8,901	0.94	E						
Montrose Road																		
	12,050	2	3,250	4,358	0.75	D	4		8,800	8,901	0.99	E						
MD 189																		
	11,800	2	3,250	4,358	0.75	D	4		8,550	8,901	0.96	E						
MD 28																		
	11,525	2	3,275	4,358	0.75	D	4		8,250	8,901	0.93	E						
Gude Drive																		
Shady Grove Road	11,550	2	3,275	4,358	0.75	D	4		8,275	8,901	0.93	E						
	11,675	2	3,275	4,358	0.75	D	4		8,400	8,901	0.94	E						
I-370																		

#'s in Red are from Field Counts, #'s in Black are assumed

I-495																		
		1		2,158	0.00	A	2		-	4,451	0.00	A						
MD 187																		
		1		2,158	0.00	A	2		-	4,451	0.00	A						
Rockledge Drive																		
		1		2,158	0.00	A	2		-	4,451	0.00	A						
I-270 Y-Split																		

Assumptions for Truck Percentages:

	AM Peak	PM Peak
I-495	6%	7%
I-270 Spur	5%	5%
I-270	8%	5%

PM Peak Period - Southbound (2030 Alternative 2)

Interchange	Total Volume	ETL # Lanes	ETL Forecast Vol.	ETL HCS Adj. Capacity	ETL v/c	ETL LOS	GP Lanes # Lanes	GP Lanes % of GP+CD (2006 Count)	GP Lanes Resulting Vol.	GP Lanes HCS Adj. Capacity	GP Lanes v/c	GP Lanes LOS	CD Lanes # Lanes	CD Lanes % of GP+CD (2006 Count)	CD Lanes Resulting Vol.	CD Lanes HCS Adj. Capacity	CD Lanes v/c	CD Lanes LOS
I-370																		
Shady Grove Road	6,525	2	2,575	4,358	0.59	C	4		3,950	8,901	0.44	B						
Gude Drive	7,275	2	2,575	4,358	0.59	C	4		4,700	8,901	0.53	C						
MD 28	7,425	2	2,725	4,358	0.63	C	4		4,700	8,901	0.53	C						
MD 189	7,425	2	2,725	4,358	0.63	C	4		4,700	8,901	0.53	C						
Montrose Road	7,750	2	2,725	4,358	0.63	C	4		5,025	8,901	0.56	C						
I-270 Y-Split	7,625	2	2,250	4,358	0.52	C	5		5,375	11,127	0.48	B						
West Lake Terrace	4,600	1	1,100	2,179	0.50	C	3		3,500	6,676	0.52	B						
Democracy Boulevard	4,250	1	750	2,179	0.34	B	3		3,500	6,676	0.52	B						
I-495/I-270 West Spur	4,575	1	750	2,179	0.34	B	2		3,825	4,451	0.86	D						
At-Grade Access	9,075	2	750	4,358	0.17	A	5		8,325	11,127	0.75	D						
MD 190	9,075	2	1,900	4,358	0.44	B	4		7,175	8,901	0.81	D						
Cabin John Parkway	9,225	2	1,900	4,358	0.44	B	4		7,325	8,901	0.82	D						
Clara Barton Parkway	8,525	2	1,900	4,358	0.44	B	3		6,625	6,676	0.99	E						
George Washington	9,925	2	2,100	4,358	0.48	B	4		7,825	8,901	0.88	D						
VA 193	11,550						6	65%	7,508	13,352	0.56	C	3		4,043	6,522	0.62	C

#'s in Red are from Field Counts, #'s in Black are assumed

I-270 Y-Split																		
Rockledge Drive		1	-	2,179	0.00	A	2		-	4,451	0.00	A						
MD 187		1	-	2,179	0.00	A	2		-	4,451	0.00	A						
I-495		1	-	2,179	0.00	A	2		-	4,451	0.00	A						

Assumptions for Truck Percentages:

	AM Peak	PM Peak
I-495	7%	5%
I-270 Spur	5%	5%
I-270	6%	5%

5. Alternative 3

Description
Alternative 3 would provide a two-lane managed lane system in each direction throughout the study corridor. The proposed improvements for each section are described below.

Capital Beltway
The section of the Capital Beltway in Virginia would provide two HOT / transition lanes and four general purpose lanes per direction as described in Alternative 1.

The American Legion Bridge would be widened similar to Alternative 2 to accommodate one extra lane per direction, and this alternative would also include converting one general purpose lane to a managed lane to provide two managed lanes, three general purpose lanes, and one auxiliary lane per direction.

The section of the Capital Beltway located in Maryland between the American Legion Bridge and I-270 West Spur would be widened by one lane in each direction, and this alternative would also include converting one general purpose lane to a managed lane to provide two managed lanes and three general purpose lanes per direction, similar to Alternative 2.

I-270 West Spur
The I-270 West Spur would be widened to accommodate one additional lane and a concrete traffic barrier between the median two lanes, which would be operated as managed lanes, and the general purpose lanes. The HOV lane would be converted to a managed lane.

I-270 Mainline
The I-270 mainline between the Y-Split interchange and the start of the CD Road system south of Montrose Road would be widened to provide an additional lane and a concrete traffic barrier between the left two lanes and the right five lanes in each direction. The left two lanes in each direction would be managed lanes. One general purpose lane in each direction would be converted to a managed lane.

Within the CD Road section, from south of Montrose Road to I-370, the roadway would be reconfigured and widened to remove the existing concrete traffic barrier between the general purpose lanes and CD Road and provide an additional lane and a concrete traffic barrier between the left two lanes and the remainder of the highway. The left two lanes in each direction would be managed lanes. One general purpose lane in each direction would be converted to a managed lane. The CD Road would be completely removed.

I-270 East Spur
The I-270 East Spur would be widened to accommodate a concrete traffic barrier between the median lane, which would be converted from a peak period HOV lane to a managed lane, and the general purpose lanes. The total number of lanes on the I-270 East Spur would be the same as the existing condition, similar to Alternative 2.

The proposed typical sections for Alternative 3 are shown in Figures C-1, C-7, C-8, and C-12 through C-14.

Managed Lanes Access

Access to the managed lanes would be provided at specified at-grade locations and through direct access ramps at several interchanges. At-grade access would be provided at the southern end of the system, south of the American Legion Bridge in Virginia. An additional at-grade access would be located along the Capital Beltway in Maryland between the MD 190 and I-270 West Spur / I-495 interchanges.

Direct access ramps would be provided at the existing Westlake Terrace, Montrose Road, and I-370 interchanges and at a new direct access only interchange with Gude Drive. The existing Westlake Terrace HOV access ramps would be converted to managed lanes access ramps; the Montrose Road and I-370 interchanges would be modified to provide direct access ramps; and only new direct access ramps would be provided at Gude Drive (no general purpose ramps). The direct access ramps would provide a direct link between the managed lanes and cross roads.

Traffic Analysis

Traffic analyses were not completed for Alternative 3 because the lane configuration was very similar to Alternative 4 and therefore it can be expected to operate the same as Alternative 4.

The Alternative 4 traffic analysis indicated that in the southbound direction, during the AM peak, 6 of 13 highway segments would be failing and there would be bottlenecks on the following segments:

- I-495 between Cabin John Parkway and MD 190
- I-270 West Spur between I-495 and Democracy Boulevard

This would be the same number of failing highway segments as the No-Build and would eliminate the bottleneck on the I-270 mainline between MD 189 and MD 28.

In the northbound direction, during the PM peak, 4 of 13 highway segments would be failing and there would be a bottleneck on the I-270 West Spur between I-495 and Democracy Boulevard. This would be five fewer failing highway segments than the No-Build and would eliminate the bottlenecks on I-495 between Clara Barton Parkway and Cabin John Parkway and on the I-270 mainline between MD 189 and MD 28. A new bottleneck would be created north of the I-270 Spurs due to the additional capacity provided on the I-270 West Spur that would feed additional traffic to the I-270 mainline.

Cost / Impacts

Preliminary property and environmental impacts were estimated based on an assumed right-of-way / limit-of-disturbance that was offset 25 feet from the proposed limit of grading or outside edge of retaining wall. It was assumed that property displacements would result when the edge of a building was ten feet or less from the proposed right-of-way line.

The proposed improvements would result in impacts to 266 properties, including 18 displacements (17 residential and one commercial). The widening along the Capital Beltway, I-270 Spurs, and the I-270 mainline could impact 114 wetlands / Waters of the U.S. and approximately 14.4 acres of park.

The cost is estimated at $2.27 billion (in 2008 dollars).

Status / Conclusion
Alternative 3 would provide similar operational improvements as Alternative 4 and would result in the same impacts and cost. However, Alternative 3 would not provide any separation between the general purpose and CD Road lanes, effectively eliminating the CD Road. A buffer separation would be provided with Alternative 4.

Since Alternative 3 would have similar improvements and impacts to Alternative 4, but it would lack the separation between the general purpose and CD Road lanes, it was determined that Alternative 3 would not be considered for further study at this time.

6. Alternative 4

Alternative 4 would provide a two-lane managed lane system in each direction throughout the study corridor. Detailed engineering for the mainline and interchanges was completed for Alternative 4 because it would provide the widest typical section and therefore result in the highest impacts and cost. A more thorough description of the alternative is provided below, which includes the typical section for the mainline sections as well as details of proposed interchange improvements and managed lane access locations.

In addition, display sheets showing the proposed Alternative 4 improvements are provided in Appendix A.

Description
Capital Beltway
The section of the Capital Beltway in Virginia would provide two HOT / transition lanes and four general purpose lanes per direction as described in Alternative 1.

The American Legion Bridge would be widened to accommodate one extra lane per direction, and this alternative would also include converting one general purpose lane to a managed lane to provide two managed lanes, three general purpose lanes, and one auxiliary lane per direction, similar to Alternatives 2 and 3.

The section of the Capital Beltway located in Maryland between the American Legion Bridge and I-270 West Spur would be widened by one lane in each direction, and this alternative would include converting one general purpose lane to a managed lane to provide two managed lanes and three general purpose lanes per direction, similar to Alternatives 2 and 3.

I-270 West Spur
The I-270 West Spur would be widened to accommodate one additional lane and a concrete traffic barrier between the median two lanes, which would be operated as managed lanes, and the general purpose lanes. The HOV lane would be converted to a managed lane.

I-270 Mainline
The I-270 mainline between the Y-Split interchange and the start of the CD Road system south of Montrose Road would be widened to provide an additional lane. The left two lanes in each direction would be operated as managed lanes and separated from the right five lanes by a four-foot buffer. The HOV lane would be converted to a managed lane.

Within the CD Road section, from south of Montrose Road to I-370, the mainline would be reconfigured and widened to provide an additional lane. The left two lanes in each direction would be operated as managed lanes and separated from the general purpose lanes by a concrete traffic barrier. The HOV lane would be converted to a managed lane. The concrete barrier between the mainline and CD Road would be removed and the general purpose and CD Road lanes would be separated by a four-foot buffer. The reconfiguration of the mainline would require many of the overpasses with piers located between the general purpose lanes and CD Road lanes to be reconstructed. These overpasses are specifically noted in the interchange improvements described below.

I-270 East Spur

The I-270 East Spur would be widened to accommodate a concrete traffic barrier between the median lane, which would be converted from a peak period HOV lane to a managed lane, and the general purpose lanes. The total number of lanes on the I-270 East Spur would be the same as the existing condition, similar to Alternatives 2 and 3.

The proposed typical sections for Alternative 4 are shown in Figures C-1, C-7, C-8, C-12, C-13, and C-15.

Managed Lanes Access

Access to the managed lanes would be provided at specified at-grade locations and through direct access ramps at several interchanges. At-grade access would be provided at the southern end of the system, south of the American Legion Bridge in Virginia. An additional at-grade access would be located along the Capital Beltway in Maryland between the MD 190 and I-270 West Spur / I-495 interchanges.

Direct access ramps would be provided at the existing Westlake Terrace, Montrose Road, and I-370 interchanges and at a new direct access only interchange with Gude Drive. The direct access ramps would provide a direct link between the managed lanes and cross roads. These interchange configurations are described in more detail below.

Interchanges

The existing 15 interchanges located in the study limits would be modified to accommodate the widened mainline typical sections and reconfigured as needed to provide direct access to the managed lanes or other ramp enhancements. In addition, Alternative 4 would include one new direct access interchange with Gude Drive. The interchange improvements are described in detail below.

The typical section for new and reconfigured interchange ramps would be consistent throughout the project, regardless of the type: loop, directional, flyover, or direct access. On one-lane ramps the section would include a 4-foot left shoulder, a 15-foot lane, and a 10-foot right shoulder. On multi-lane ramps the shoulders would be maintained at 4 feet and 10 feet and the lane widths would be reduced to 12 feet per lane. More detailed study could determine if the ramp typical sections need to be modified to address sight distance limitations. The design speed for all loop ramps would range from 25 to 30 mph. The design speed on all directional, flyover, and direct access ramps would generally range from 35 to 50 mph.

SR 193 / Georgetown Pike Interchange
The SR 193 interchange ramps would be adjusted to accommodate the widened mainline. The SR 193 Bridge over the Capital Beltway would be reconstructed to accommodate the widened mainline. No direct access ramps would be provided for the managed lanes.

George Washington Memorial Parkway Interchange
The George Washington Memorial Parkway interchange ramps would be adjusted to accommodate the widened mainline. The George Washington Memorial Parkway Bridges over the Capital Beltway would be reconstructed to accommodate the widened mainline. No direct access ramps would be provided for the managed lanes.

Clara Barton Parkway Interchange
The Clara Barton Parkway interchange ramps would be adjusted to accommodate the widened mainline. No direct access ramps would be provided for the managed lanes.

MD 190 / Cabin John Parkway Interchange
The MD 190 and Cabin John Parkway interchange ramps would be adjusted to accommodate the widened mainline. The MD 190 Bridge over the Capital Beltway would be reconstructed to accommodate the widened mainline. No direct access ramps would be provided for the managed lanes.

I-270 West Spur / I-495 Interchange
The I-270 West Spur / I-495 Interchange would be designed to accommodate future managed lane direct ramps along the Capital Beltway. The outer loop overpass bridge would be reconstructed to accommodate the widened I-270 West Spur typical section. The inner loop within the interchange would be shifted toward the outside to accommodate a future managed lane structure in the median (Capital Beltway median over the northbound direction of the I-270 West Spur) and also to avoid widening toward the outer loop because Thomas Branch runs directly parallel to the Beltway within the interchange. The widening along the inner loop would result in displacements to four residential properties.

Democracy Boulevard
The existing interchange ramps would be adjusted to accommodate the widened mainline typical section. No direct access ramps would be provided for the managed lanes.

Westlake Terrace
The Westlake Terrace interchange would provide the same configuration as the existing condition where by the HOV direct access ramps would be converted to direct access ramps to the managed lanes. No additional ramp movements would be added to the interchange and it would only provide access to / from the north.

MD 187 / Rockledge Boulevard
The existing MD 187 and Rockledge Drive interchanges are constructed as one combined interchange with complimentary ramp movements to/from I-270. The existing interchange ramps would be adjusted to accommodate the widened mainline typical section. The MD 187 and Rockledge Drive bridges over the I-270 East Spur would be reconstructed to accommodated the widened mainline. No direct access ramps would be provided for the managed lanes.

Y-Split
The Y-split interchange would retain a similar layout to the existing interchange, with HOV ramps converted to managed lane ramps. However, the widened mainline, and proposed design for two-lane ramps, require the reconstruction of the ramp structures to replace all existing structures in the center of the interchange.

Montrose Road
The Montrose Road interchange would be modified to provide four new direct access ramps for the managed lanes. To accommodate the direct access, left turn lanes, as well as a signalized intersection, would be added to Montrose Road. The left turn lanes would require widening the Montrose Road overpass. The addition of the direct access intersection would cause conflicting maneuvers with the existing weaving areas between the loop ramps on Montrose Road. To eliminate this conflict, the existing northwest and southeast loop ramps would be removed and replaced with left turn spurs that would tie to the existing outer directional ramps. The remaining existing loop ramps in the northeast and southwest quadrants, and all existing directional ramps, would be modified to accommodate the widened mainline typical section. The Montrose Road Bridge over I-270 would have to be reconstructed to accommodate the reconfigured interchange and widened and reconfigured mainline.

MD 189 / Great Falls Road
The existing interchange ramps would be adjusted to accommodate the widened mainline typical section. The existing MD 189 Bridge over I-270 would be reconstructed to accommodate the widened and reconfigured mainline. No direct access ramps would be provided for the managed lanes.

MD 28 / West Montgomery Avenue
The existing interchange ramps would be adjusted to accommodate the widened mainline typical section. The existing MD 28 Bridge over I-270 would be reconstructed to accommodate the widened and reconfigured mainline. No direct access ramps would be provided for the managed lanes.

Gude Drive
A new interchange would be provided with Gude Drive. The interchange would only provide direct access for the managed lanes; no interchange ramps would be provided for general purpose lanes. The four direct access ramps would be located in the median of I-270 and would tie to the Gude Drive Bridge over I-270, which would have to be reconstructed to accommodate the widened and reconfigured mainline. The segment of I-270 north and south of Gude Drive is surrounded by commercial and residential properties. For this reason, the mainline approaches to Gude Drive would be enclosed with retaining walls in both the northbound and southbound directions to minimize impacts to these properties.

Shady Grove Road
The existing interchange ramps would be adjusted to accommodate the widened mainline typical section. The existing Shady Grove Road Bridge over I-270 would be reconstructed to accommodate the widened and reconfigured mainline. No direct access ramps would be provided for the managed lanes.

I-370 Interchange
The I-270 / I-370 interchange, located at the northern end of the project, is a four-leg directional interchange.

Five different options were developed for proposed modifications to this interchange, which involved different ramp configurations and alignments. Multiple options were evaluated to determine what configurations would best balance the geometric and operational requirements of the system-to-system (I-270 / I-370 / ICC) connection and the environmental and property impacts that would result from widening the highways and increasing the footprint of the interchange. The figures included in the Appendix show two of the potential interchange configurations that were studied in more detail.

Both of the interchange configurations shown in Appendix A would provide the same general improvements (though the specific engineering details for each interchange would vary). Direct access ramps would be provided for both directions of I-270 to allow managed lane movements to and from the east side of I-370, heading to and from the ICC. The existing ramps providing access for the general purpose lanes would be modified to accommodate the widened mainline and direct access ramps. Due to the complex design of flyover ramps at I-370, the proposed design would require the reconstruction of three existing bridges, as well as the addition of five new ramp bridges. The existing I-270 bridge over I-370 would need to be widened to accommodate the widened mainline typical section. The north side of the I-370 interchange would be enclosed by retaining walls on both the I-270 northbound and southbound roadways to minimize impacts to existing communities.

In addition, the interchange options were all developed to integrate with the interchange and mainline improvements being considered as part of the I-270 Multi-Modal Corridor Study, which included direct access ramps between I-370/ICC and the managed lanes being considered as part of the I-270 Multi-Modal Corridor Study, north of this interchange.

Bridge Overpasses
In addition to the interchange structures, several overpasses would have to be reconstructed to accommodate the widened and reconfigured mainline. These would include Old Dominion Drive and Live Oak Drive over the Capital Beltway in Virginia; Persimmon Tree Road and Bradley Boulevard over the Capital Beltway in Maryland; and Wooten Parkway over the I-270 mainline.

Traffic Analysis
Under Alternative 4, one lane would be added and one general purpose lane would be converted to a managed lane to create two managed lanes in each direction along the Capital Beltway. The existing HOV lane along the I-270 West Spur and I-270 mainline would be converted to a managed lane and one additional barrier-separated managed lane would be constructed. The managed lanes and general purpose lanes would be separated by a concrete traffic barrier. In the CD Road section of the I-270 mainline, the general purpose and CD Road lanes would be separated by a buffer.

The capacity thresholds and related LOS values for the Alternate 4 are shown in Table C-4. The total volume; the volume distribution between the managed lanes, general purpose lanes, and CD Road lanes; the v/c ratios; and LOS values for various freeway segments along I-270 and I-495 within the limits of the project are shown in Table C-7.

In the southbound direction, during the AM peak, 6 of 13 highway segments would be failing and there would be bottlenecks on the following segments:

- I-495 between Cabin John Parkway and MD 190
- I-270 West Spur between I-495 and Democracy Boulevard

This would be the same number of failing highway segments as the No-Build and would eliminate the bottleneck on the I-270 mainline between MD 189 and MD 28.

In the northbound direction, during the PM peak, 4 of 13 highway segments would be failing and there would be a bottleneck on the I-270 West Spur between I-495 and Democracy Boulevard. This would be five fewer failing highway segments than the No-Build and would eliminate the bottlenecks on I-495 between Clara Barton Parkway and Cabin John Parkway and on the I-270 mainline between MD 189 and MD 28. A new bottleneck would be created north of the I-270 Spurs due to the additional capacity provided on the I-270 West Spur that would allow additional traffic to the I-270 mainline.

Cost / Impacts

Preliminary Impacts

Preliminary property and environmental impacts were estimated based on an assumed right-of-way / limit-of-disturbance that was offset 25 feet from the proposed limit of grading or outside edge of retaining wall. It was assumed that property displacements would result when the edge of a building was ten feet or less from the proposed right-of-way line.

The proposed improvements would result in impacts to 266 properties, including 18 displacements (17 residential and one commercial). The widening along the Capital Beltway, I-270 Spurs, and the I-270 mainline could impact 114 wetlands / Waters of the U.S. and approximately 14.4 acres of park.

Impact Minimization Analysis

Additional investigation was conducted to identify potential modifications to the Alternative 4 typical section that could minimize the number and size of property displacements. There were four general locations with extensive impacts where these modifications were considered: along the Capital Beltway inner loop just south and within the I-495 / I-270 West Spur interchange; the southwest quadrant of the MD 28 / West Montgomery Avenue interchange; along southbound I-270 south of Gude Drive; and along southbound I-270 north of I-370.

Four residential displacements would result from the proposed improvements in the vicinity of the I-495 / I-270 West Spur interchange. After reviewing the proposed alignment and interchange configurations, it was determined that the impacts associated with these improvements could not be reduced without shifting the entire alignment of the Capital Beltway toward the outer loop, which, as noted in the interchange descriptions above, would directly impact Thomas Branch. SHA had previously determined that the Thomas Branch should not be further impacted by widening of the Beltway due to the floodplain elevations and the adjacent residences.

Several residential buildings would be impacted by the I-270 widening and interchange improvements in the southwest quadrant of the MD 28 interchange. There were three options that could eliminate these displacements: elimination of the assumed 10-foot buffer from the proposed right-of-way line; a reduction of the southbound median general purpose shoulder

from ten feet to four feet; or a reduction of the southbound right general purpose shoulder from twelve feet to six feet. Due to the preliminary nature of this study, a decision was not made on the optimal minimization effort.

Several buildings along the southbound roadway would be impacted by the I-270 widening and new interchange at Gude Drive. These impacts could be reduced but not eliminated by reducing all of the shoulders in the southbound direction to 4 feet. This would likely eliminate direct displacements, but would still result in impacts to the parking areas of adjacent buildings.

Several buildings north of the I-370 interchange would be displaced by the proposed widening and interchange improvements. The number of displacements could be reduced to match the displacements from similar improvements proposed as part of the I-270 Multi-Modal Corridor Study assuming the 10-foot offset from the proposed right-of-way line were eliminated. The 10-foot offset was not included in the I-270 Multi-Modal Corridor Study.

Preliminary Cost

The cost is estimated at $2.65 billion (2009 dollars) or $2.27 billion in 2008 dollars, which is the highest cost of all long-term alternatives.

Status / Conclusion

Alternative 4 would provide some operational improvements compared to the No-Build; however, it would require the most significant widening and interchange modifications and would result in the largest impacts and highest cost of all long-term alternatives being considered.

Due to the operational improvements provided by this alternative and the two-lane managed lane system and associated interchange improvements, it was determined that Alternative 4 should be evaluated in greater detail in a subsequent planning study.

Table C-7: Capacity Calculations – 2030 Build Alternative 4

AM Peak Period - Northbound (2030 Alternative 4)

Interchange	Total Volume	ETL # Lanes	ETL Forecast Vol.	ETL HCS Adj. Capacity	ETL v/c	ETL LOS	GP Lanes # Lanes	GP Lanes % of GP+CD (2006 Count)	GP Lanes Resulting Vol.	GP Lanes HCS Adj. Capacity	GP Lanes v/c	GP Lanes LOS	CD Lanes # Lanes	CD Lanes % of GP+CD (2006 Count)	CD Lanes Resulting Vol.	CD Lanes HCS Adj. Capacity	CD Lanes v/c	CD Lanes LOS
VA 193																		
	12,250						6	100%	12,250	13,287	0.92	E						
GW Parkway	11,025	2	2,125	4,337	0.49	B	4	100%	8,900	8,858	1.00	F						
Clara Barton Parkway	9,250	2	2,125	4,337	0.49	B	3	100%	7,125	6,644	1.07	F						
Cabin John Parkway	9,825	2	2,125	4,337	0.49	B	4	100%	7,700	8,858	0.87	D						
MD 190	9,900	2	2,125	4,337	0.49	B	4	100%	7,775	8,858	0.88	D						
At-Grade Access	9,900	2	875	4,337	0.20	A	5	100%	9,025	11,073	0.82	D						
I-495/I-270 West Spur	5,450	2	875	4,295	0.20	A	2	100%	4,575	4,451	1.03	F						
Democracy Boulevard	4,500	2	875	4,295	0.20	A	2	100%	3,625	4,451	0.81	D						
West Lake Terrace	5,625	2	2,000	4,295	0.47	B	2	100%	3,625	4,451	0.81	D						
I-270 Y-Split	9,775	2	2,050	4,295	0.48	B	5	100%	7,725	10,966	0.70	C						
Montrose Road	9,075	2	1,300	4,295	0.30	A	3	66%	5,132	6,580	0.78	D	2	34%	2,644	4,350	0.61	C
MD 189	8,700	2	1,300	4,295	0.30	A	3	67%	4,958	6,580	0.75	D	2	33%	2,442	4,350	0.56	C
MD 28	8,050	2	1,300	4,295	0.30	A	3	56%	3,780	6,580	0.57	C	2	44%	2,970	4,350	0.68	D
Gude Drive	8,350	2	1,600	4,295	0.37	B	3	56%	3,780	6,580	0.57	C	2	44%	2,970	4,350	0.68	D
Shady Grove Road	6,500	2	1,600	4,295	0.37	B	3	57%	2,793	6,580	0.42	B	2	43%	2,107	4,350	0.48	C
I-370																		

#'s in Red are from Field Counts, #'s in Black are assumed

I-495																		
		1		2,168	0.00	A	2	100%	-	4,386	0.00	A						
MD 187		1		2,168	0.00	A	2	100%	-	4,386	0.00	A						
Rockledge Drive		1		2,168	0.00	A	3	100%	-	6,580	0.00	A						
I-270 Y-Split																		

AM Peak Period - Southbound (2030 Alternative 4)

Interchange	Total Volume	ETL # Lanes	ETL Forecast Vol.	ETL HCS Adj. Capacity	ETL v/c	ETL LOS	GP Lanes # Lanes	GP Lanes % of GP+CD (2006 Count)	GP Lanes Resulting Vol.	GP Lanes HCS Adj. Capacity	GP Lanes v/c	GP Lanes LOS	CD Lanes # Lanes	CD Lanes % of GP+CD (2006 Count)	CD Lanes Resulting Vol.	CD Lanes HCS Adj. Capacity	CD Lanes v/c	CD Lanes LOS
I-370																		
Shady Grove Road	12,200	2	3,300	4,337	0.76	D	3	74%	6,586	6,644	0.99	E	3	26%	2,314	6,522	0.35	B
Gude Drive	11,575	2	3,300	4,337	0.76	D	3	67%	5,544	6,644	0.83	D	2	33%	2,731	4,350	0.63	C
MD 28	11,600	2	3,325	4,337	0.77	D	3	64%	5,296	6,644	0.80	D	2	36%	2,979	4,350	0.68	D
MD 189	11,550	2	3,325	4,337	0.77	D	3	57%	4,688	6,644	0.71	C	2	43%	3,537	4,350	0.81	D
Montrose Road	12,450	2	3,325	4,337	0.77	D	3	66%	6,023	6,644	0.91	E	2	34%	3,103	4,350	0.71	D
I-270 Y-Split	13,425	2	3,225	4,337	0.74	D	5	100%	10,200	11,073	0.92	E						
West Lake Terrace	6,850	2	3,000	4,337	0.69	C	3	100%	3,850	6,676	0.58	C						
Democracy Boulevard	5,450	2	1,600	4,337	0.37	B	3	100%	3,850	6,676	0.58	C						
I-495/I-270 West Spur	6,025	2	1,600	4,337	0.37	B	2	100%	4,425	4,451	0.99	E						
At-Grade Access	10,750	2	1,600	4,316	0.37	B	5	100%	9,150	11,019	0.83	D						
MD 190	10,750	2	3,200	4,316	0.74	D	4	100%	7,550	8,815	0.86	D						
Cabin John Parkway	11,175	2	3,200	4,316	0.74	D	4	100%	7,975	8,815	0.90	E						
Clara Barton Parkway	9,050	2	3,200	4,316	0.74	D	3	100%	5,850	6,611	0.88	D						
George Washington	11,075	2	3,075	4,316	0.71	C	4	100%	8,000	8,815	0.91	E						
VA 193	10,825						5	76%	8,227	11,019	0.75	D	3	24%	2,598	6,522	0.40	B

#'s in Red are from Field Counts, #'s in Black are assumed

I-270 Y-Split																		
Rockledge Drive		1		2,158	0.00	A	3	100%	-	6,611	0.00	A						
MD 187		1		2,158	0.00	A	2	100%	-	4,408	0.00	A						
I-495		1		2,158	0.00	A	2	100%	-	4,408	0.00	A						

PM Peak Period - Northbound (2030 Alternative 4)

Interchange	Total Volume	ETL # Lanes	ETL Forecast Vol.	ETL HCS Adj. Capacity	ETL v/c	ETL LOS	GP Lanes # Lanes	GP Lanes % of GP+CD (2006 Count)	GP Lanes Resulting Vol.	GP Lanes HCS Adj. Capacity	GP Lanes v/c	GP Lanes LOS	CD Lanes # Lanes	CD Lanes % of GP+CD (2006 Count)	CD Lanes Resulting Vol.	CD Lanes HCS Adj. Capacity	CD Lanes v/c	CD Lanes LOS
VA 193																		
	9,950						6	100%	9,950	13,223	0.75	D						
GW Parkway	10,475	2	3,200	4,316	0.74	D	4	100%	7,275	8,815	0.83	D						
Clara Barton Parkway	8,850	2	3,200	4,316	0.74	D	3	100%	5,650	6,611	0.85	D						
Cabin John Parkway	10,375	2	3,200	4,316	0.74	D	4	100%	7,175	8,815	0.81	D						
MD 190	10,150	2	3,200	4,316	0.74	D	4	100%	6,950	8,815	0.79	D						
At-Grade Access	10,150	2	1,625	4,316	0.38	B	5	100%	8,525	11,019	0.77	D						
I-495/I-270 West Spur	5,925	2	1,625	4,358	0.37	B	2	100%	4,300	4,451	0.97	E						
Democracy Boulevard	5,925	2	1,625	4,358	0.37	B	2	100%	4,300	4,451	0.97	E						
West Lake Terrace	7,300	2	3,000	4,358	0.69	C	2	100%	4,300	4,451	0.97	E						
I-270 Y-Split	12,400	2	3,225	4,358	0.74	D	5	100%	9,175	11,127	0.82	D						
Montrose Road	12,575	2	3,325	4,358	0.76	D	3	61%	5,643	6,676	0.85	D	2	39%	3,608	4,350	0.83	D
MD 189	12,275	2	3,325	4,358	0.76	D	3	65%	5,818	6,676	0.87	D	2	35%	3,133	4,350	0.72	D
MD 28	12,125	2	3,325	4,358	0.76	D	3	60%	5,280	6,676	0.79	D	2	40%	3,520	4,350	0.81	D
Gude Drive	12,100	2	3,300	4,358	0.76	D	3	60%	5,280	6,676	0.79	D	2	40%	3,520	4,350	0.81	D
Shady Grove Road	12,300	2	3,300	4,358	0.76	D	3	49%	4,410	6,676	0.66	C	2	51%	4,590	4,350	1.06	F
I-370																		

#'s in Red are from Field Counts, #'s in Black are assumed

I-495																		
		1		2,158	0.00	A	2	100%	-	4,451	0.00	A						
MD 187		1		2,158	0.00	A	2	100%	-	4,451	0.00	A						
Rockledge Drive		1		2,158	0.00	A	3	100%	-	6,676	0.00	A						
I-270 Y-Split																		

PM Peak Period - Southbound (2030 Alternative 4)

Interchange	Total Volume	ETL # Lanes	ETL Forecast Vol.	ETL HCS Adj. Capacity	ETL v/c	ETL LOS	GP Lanes # Lanes	GP Lanes % of GP+CD (2006 Count)	GP Lanes Resulting Vol.	GP Lanes HCS Adj. Capacity	GP Lanes v/c	GP Lanes LOS	CD Lanes # Lanes	CD Lanes % of GP+CD (2006 Count)	CD Lanes Resulting Vol.	CD Lanes HCS Adj. Capacity	CD Lanes v/c	CD Lanes LOS
I-370																		
Shady Grove Road	6,800	2	1,600	4,358	0.37	B	3	59%	3,068	6,676	0.46	B	3	41%	2,132	5,100	0.42	B
Gude Drive	7,550	2	1,600	4,358	0.37	B	3	75%	4,463	6,676	0.67	C	2	25%	1,488	3,400	0.44	B
MD 28	7,275	2	1,325	4,358	0.30	B	3	66%	3,927	6,676	0.59	C	2	34%	2,023	3,400	0.60	B
MD 189	7,700	2	1,325	4,358	0.30	B	3	60%	3,825	6,676	0.57	C	2	40%	2,550	3,400	0.75	C
Montrose Road	8,075	2	1,325	4,358	0.30	B	3	78%	5,265	6,676	0.79	D	2	22%	1,485	3,400	0.44	B
I-270 Y-Split	8,050	2	2,050	4,358	0.47	B	5	100%	6,000	11,127	0.54	C						
West Lake Terrace	4,975	2	2,000	4,358	0.46	B	3	100%	2,975	6,676	0.45	B						
Democracy Boulevard	3,850	2	875	4,358	0.20	A	3	100%	2,975	6,676	0.45	B						
I-495/I-270 West Spur	4,800	2	875	4,358	0.20	A	2	100%	3,925	4,451	0.88	D						
At-Grade Access	9,125	2	875	4,358	0.20	A	5	100%	8,250	11,127	0.74	D						
MD 190	9,125	2	2,125	4,358	0.49	B	4	100%	7,000	8,901	0.79	D						
Cabin John Parkway	9,250	2	2,125	4,358	0.49	B	4	100%	7,125	8,901	0.80	D						
Clara Barton Parkway	8,475	2	2,125	4,358	0.49	B	3	100%	6,350	6,676	0.95	E						
George Washington	10,000	2	2,125	4,358	0.49	B	4	100%	7,875	8,901	0.88	D						
VA 193	11,625						5	65%	7,556	11,127	0.68	C	3	35%	4,069	5,100	0.80	C

#'s in Red are from Field Counts, #'s in Black are assumed

I-270 Y-Split																		
Rockledge Drive		1	-	2,179	0.00	A	3	100%	-	6,676	0.00	A						
MD 187		1	-	2,179	0.00	A	2	100%	-	4,451	0.00	A						
I-495		1	-	2,179	0.00	A	2	100%	-	4,451	0.00	A						

Assumptions for Truck Percentages:

	AM Peak	PM Peak
I-495	6%	7%
I-270 Spur	5%	5%
I-270	8%	5%

Assumptions for Truck Percentages:

	AM Peak	PM Peak
I-495	7%	5%
I-270 Spur	5%	5%
I-270	6%	5%

7. Alternative 5

Description

This alternative would have the same interchange improvements and direct access locations as described in Alternative 4. Alternative 5 would provide a two-lane managed lane system in both directions throughout the study corridor; however, the additional capacity in the I-270 mainline corridor would be provided by restriping the section in each direction between the median barrier and outside barrier separating the CD Road from the general purpose lanes. The improvements are described below.

Capital Beltway

The section of the Capital Beltway in Virginia would provide two HOT / transition lanes and four general purpose lanes per direction as described in Alternative 1.

The American Legion Bridge would be widened to accommodate one extra lane per direction, and this alternative would also include converting one general purpose lane to a managed lane to provide two managed lanes, three general purpose lanes, and one auxiliary lane per direction, similar to Alternatives 2, 3, and 4.

The section of the Capital Beltway located in Maryland between the American Legion Bridge and I-270 West Spur would be widened by one lane in each direction, and this alternative would include converting one general purpose lane to a managed lane to provide two managed lanes and three general purpose lanes per direction, similar to Alternatives 2, 3, and 4.

I-270 West Spur

The I-270 West Spur would be widened to accommodate one additional lane and a concrete traffic barrier between the median two lanes, which would be operated as managed lanes, and the general purpose lanes. The HOV lane would be converted to a managed lane.

I-270 Mainline

The I-270 mainline between the Y-Split interchange and the start of the CD Road system south of Montrose Road would be widened to provide an additional lane. The left two lanes in each direction would be operated as managed lanes and separated from the right five lanes by a four-foot buffer. The HOV lanes would be converted to managed lanes.

Within the CD Road section, from south of Montrose Road to I-370, the mainline would be restriped to provide an additional lane and a two-foot buffer between the left two lanes, which would be operated as managed lanes, and the remainder of the highway. In order to accommodate the additional lane and two-foot buffer on the mainline, the median shoulder would be reduced to a two-foot offset and the right shoulder would be reduced to nine feet. The HOV lanes would be converted to managed lanes.

I-270 East Spur

The I-270 East Spur would be widened to accommodate a concrete traffic barrier between the median lane, which would be converted from a peak period HOV lane to a managed lane, and the general purpose lanes. The total number of lanes on the I-270 East Spur would be the same as the existing condition, similar to Alternatives 2 and 3.

The proposed typical sections for Alternative 5 are shown in Figures C-1, C-7, C-8, C-12, C-16, and C-17.

Managed Lanes Access

Access to the managed lanes would be provided at specified at-grade locations and through direct access ramps at several interchanges. At-grade access would be provided at the southern end of the system, south of the American Legion Bridge in Virginia. An additional at-grade access would be located along the Capital Beltway in Maryland between the MD 190 and I-270 West Spur / I-495 interchanges.

Direct access ramps would be provided at the existing Westlake Terrace, Montrose Road, and I-370 interchanges, and at a new direct access only interchange with Gude Drive. The existing Westlake Terrace HOV access ramps would be converted to managed lanes access ramps; the Montrose Road and I-370 interchanges would be modified to provide direct access ramps; and only direct access ramps would be provided at Gude Drive (no general purpose ramps). The direct access ramps would provide a direct link between the managed lanes and cross roads.

Traffic Analysis

Under Alternative 5, one lane would be added and one general purpose lane would be converted to a managed lane to create two managed lanes in each direction along the Capital Beltway. The existing HOV lane along the I-270 West Spur and I-270 mainline would be converted to a managed lane and one additional managed lane would be constructed. The managed lanes and general purpose lanes would be separated by a painted buffer along the I-270 mainline.

The volumes would be the same between Alternatives 4 and 5. However, for Alternative 5, the capacities would be reduced due to the reduction in shoulder widths. Alternative 5 would provide two-foot left offset, a none-foot right shoulder, and a two-foot buffer between the managed and general purpose lanes.

The capacity thresholds and related LOS values for Alternative 5 are shown in Table C-8. The total volume; the volume distribution between the managed lanes, general purpose lanes, and CD Road lanes; the v/c ratios; and LOS values for various freeway segments along I-270 and I-495 within the limits of the project under the 2030 Build Alternative 5 are shown in Table C-9.

In the southbound direction, during the AM peak, 7 of 13 highway segments (between interchanges) would be failing and there would be bottlenecks on the following segments:

- I-495 between Cabin John Parkway and MD 190
- I-270 West Spur between I-495 and Democracy Boulevard

This would be one more failing highway segment than the No-Build. The bottleneck on the I-270 mainline between MD 189 and MD 28 would be eliminated.

In the northbound direction, during the PM peak, 5 of 13 highway segments (between interchanges) would be failing and there would be bottlenecks on the following segments:

- I-495 between Clara Barton Parkway and Cabin John Parkway
- I-270 West Spur between I-495 and Democracy Boulevard

This would be four fewer failing highway segments than the No-Build and would eliminate the bottleneck on the I-270 mainline between MD 189 and MD 28. A new bottleneck would be

created north of the I-270 Spurs due to the additional capacity provided on the I-270 West Spur that would feed additional traffic to the I-270 mainline.

Cost / Impacts

Preliminary property and environmental impacts were estimated based on an assumed right-of-way / limit-of-disturbance that was offset 25 feet from the proposed limit of grading or outside edge of retaining wall. It was assumed that property displacements would result when the edge of a building was ten feet or less from the proposed right-of-way line.

The proposed improvements would result in impacts to 193 properties, including 18 displacements (17 residential and one commercial). The widening along the Capital Beltway, I-270 Spurs, and mainline could impact 79 wetlands / Waters of the U.S. and approximately 14.4 acres of park. These impacts are the same as Alternative 2.

The cost is estimated at $2.09 billion (in 2008 dollars).

Status / Conclusion

Alternative 5 would provide some operational improvements compared to the No-Build, but less than Alternative 4 due to the narrow shoulders. Alternative 5 would result in significant impacts and high cost.

Due to the operational improvements provided by this alternative and the two-lane managed lane system and associated interchange improvements, as well as the reduced impacts along I-270 compared with Alternative 4, it was determined that Alternative 5 should be evaluated in greater detail in a subsequent planning study.

Table C-8: Capacity Thresholds for HOV, GP, and CD Lanes – 2030 Build Alternative 5

HCS Assumptions and Calculated Maximum Flow Rates By LOS Threshold - 5% Trucks

ETL		General Purpose		Collector Distributor (CD)	
PHF	0.95	PHF	0.95	PHF	0.95
%Trucks	5	%Trucks	5	%Trucks	1
Measured FF Speed	65	Measured FF Speed	65	Measured FF Speed	60
Terrain	Level	Terrain	Level	Terrain	Level
Unadjusted Capacity	2,350	Unadjusted Capacity	2,400	Unadjusted Capacity	2,300

HCS LOS Thresholds *Adjusted Flow Rates*

1 Lane	2 Lanes	LOS	2 Lanes	3 Lanes	4 Lanes	5 Lanes	6 Lanes	LOS	1 Lane	2 Lanes	3 Lanes	LOS
0	0	A	0	0	0	0	0	A	0	0	0	A
659	1318	B	1429	2144	2858	3573	4288	B	625	1249	1872	B
1085	2171	C	2337	3506	4675	5844	7012	C	1022	2043	3063	C
1558	3116	D	3283	4924	6566	8207	9848	D	1476	2951	4425	D
1938	3876	E	3987	5981	7974	9968	11962	E	1909	3817	5723	E
2179	4358	F	4451	6676	8901	11127	13352	F	2175	4350	6522	F

HCS Assumptions and Calculated Maximum Flow Rates By LOS Threshold - 6% Trucks

ETL		General Purpose		Collector Distributor (CD)	
PHF	0.95	PHF	0.95	PHF	0.95
%Trucks	6	%Trucks	6	%Trucks	1
Measured FF Speed	65	Measured FF Speed	70	Measured FF Speed	60
Terrain	Level	Terrain	Level	Terrain	Level
Unadjusted Capacity	2,350	Unadjusted Capacity	2,400	Unadjusted Capacity	2,300

HCS LOS Thresholds *Adjusted Flow Rates*

1 Lane	2 Lanes	LOS	2 Lanes	3 Lanes	4 Lanes	5 Lanes	6 Lanes	LOS	1 Lane	2 Lanes	3 Lanes	LOS
0	0	A	0	0	0	0	0	A	0	0	0	A
656	1312	B	1422	2133	2844	3556	4267	B	625	1249	1872	B
1080	2160	C	2326	3489	4652	5815	6978	C	1022	2043	3063	C
1550	3101	D	3267	4900	6534	8167	9801	D	1476	2951	4425	D
1929	3857	E	3968	5952	7936	9920	11904	E	1909	3817	5723	E
2168	4337	F	4429	6644	8858	11073	13287	F	2175	4350	6522	F

HCS Assumptions and Calculated Maximum Flow Rates By LOS Threshold - 7% Trucks

ETL		General Purpose		Collector Distributor (CD)	
PHF	0.95	PHF	0.95	PHF	0.95
%Trucks	7	%Trucks	7	%Trucks	1
Measured FF Speed	65	Measured FF Speed	70	Measured FF Speed	60
Terrain	Level	Terrain	Level	Terrain	Level
Unadjusted Capacity	2,350	Unadjusted Capacity	2,400	Unadjusted Capacity	2,300

HCS LOS Thresholds *Adjusted Flow Rates*

1 Lane	2 Lanes	LOS	2 Lanes	3 Lanes	4 Lanes	5 Lanes	6 Lanes	LOS	1 Lane	2 Lanes	3 Lanes	LOS
0	0	A	0	0	0	0	0	A	0	0	0	A
653	1305	B	1415	2123	2831	3538	4246	B	625	1249	1872	B
1075	2150	C	2315	3472	4630	5787	6945	C	1022	2043	3063	C
1543	3086	D	3251	4877	6502	8128	9753	D	1476	2951	4425	D
1919	3839	E	3949	5923	7897	9872	11846	E	1909	3817	5723	E
2158	4316	F	4408	6611	8815	11019	13223	F	2175	4350	6522	F

HCS Assumptions and Calculated Maximum Flow Rates By LOS Threshold - 8% Trucks

ETL		General Purpose		Collector Distributor (CD)	
PHF	0.95	PHF	0.95	PHF	0.95
%Trucks	8	%Trucks	8	%Trucks	1
Measured FF Speed	65	Measured FF Speed	70	Measured FF Speed	60
Terrain	Level	Terrain	Level	Terrain	Level
Unadjusted Capacity	2,350	Unadjusted Capacity	2,400	Unadjusted Capacity	2,300

HCS LOS Thresholds *Adjusted Flow Rates*

1 Lane	2 Lanes	LOS	2 Lanes	3 Lanes	4 Lanes	5 Lanes	6 Lanes	LOS	1 Lane	2 Lanes	3 Lanes	LOS
0	0	A	0	0	0	0	0	A	0	0	0	A
650	1301	B	1409	2113	2817	3521	4226	B	625	1249	1872	B
1070	2139	C	2304	3456	4608	5759	6911	C	1022	2043	3063	C
1536	3071	D	3235	4853	6471	8089	9706	D	1476	2951	4425	D
1910	3820	E	3930	5895	7859	9824	11789	E	1909	3817	5723	E
2148	4295	F	4386	6580	8773	10966	13159	F	2175	4350	6522	F

Table C-9: Capacity Calculations – 2030 Build Alternative 5

AM Peak Period - Northbound (2030 Alternative 5)

Interchange	Total Volume	ETL # Lanes	ETL Forecast Vol.	ETL HCS Adj. Capacity	ETL v/c	ETL LOS	GP Lanes # Lanes	GP Lanes % of GP+CD (2006 Count)	GP Lanes Resulting Vol.	GP Lanes HCS Adj. Capacity	GP Lanes v/c	GP Lanes LOS	CD Lanes # Lanes	CD Lanes % of GP+CD (2006 Count)	CD Lanes Resulting Vol.	CD Lanes HCS Adj. Capacity	CD Lanes v/c	CD Lanes LOS
VA 193																		
	12,250						6	100%	12,250	13,287	0.92	E						
GW Parkway	11,025	2	2,125	4,337	0.49	B	4	100%	8,900	8,858	1.00	F						
Clara Barton Parkway	9,250	2	2,125	4,337	0.49	B	3	100%	7,125	6,644	1.07	F						
Cabin John Parkway	9,825	2	2,125	4,337	0.49	B	4	100%	7,700	8,858	0.87	D						
MD 190	9,900	2	2,125	4,337	0.49	B	4	100%	7,775	8,858	0.88	D						
At-Grade Access	9,900	2	875	4,337	0.20	A	5	100%	9,025	11,073	0.82	D						
I-495/I-270 West Spur	5,450	2	875	4,295	0.20	A	2	100%	4,575	4,451	1.03	F						
Democracy Boulevard	4,500	2	875	4,295	0.20	A	2	100%	3,625	4,451	0.81	D						
West Lake Terrace	5,625	2	2,000	4,295	0.47	B	2	100%	3,625	4,451	0.81	D						
I-270 Y-Split	9,775	2	2,050	4,295	0.48	B	5	100%	7,725	10,966	0.70	C						
Montrose Road	9,075	2	1,300	4,295	0.30	A	3	66%	5,132	6,580	0.78	D	2	34%	2,644	4,350	0.61	C
MD 189	8,700	2	1,300	4,295	0.30	A	3	67%	4,958	6,580	0.75	D	2	33%	2,442	4,350	0.56	C
MD 28	8,050	2	1,300	4,295	0.30	A	3	56%	3,780	6,580	0.57	C	2	44%	2,970	4,350	0.68	D
Gude Drive	8,350	2	1,600	4,295	0.37	B	3	56%	3,780	6,580	0.57	C	2	44%	2,970	4,350	0.68	D
Shady Grove Road	6,500	2	1,600	4,295	0.37	B	3	57%	2,793	6,580	0.42	B	2	43%	2,107	4,350	0.48	C
I-370																		
I-495																		
		1		2,168	0.00	A	2	100%	-	4,386	0.00	A						
MD 187		1		2,168	0.00	A	2	100%	-	4,386	0.00	A						
Rockledge Drive		1		2,168	0.00	A	3	100%	-	6,580	0.00	A						
I-270 Y-Split																		

#'s in Red are from Field Counts, #'s in Black are assumed

AM Peak Period - Southbound (2030 Alternative 5)

Interchange	Total Volume	ETL # Lanes	ETL Forecast Vol.	ETL HCS Adj. Capacity	ETL v/c	ETL LOS	GP Lanes # Lanes	GP Lanes % of GP+CD (2006 Count)	GP Lanes Resulting Vol.	GP Lanes HCS Adj. Capacity	GP Lanes v/c	GP Lanes LOS	CD Lanes # Lanes	CD Lanes % of GP+CD (2006 Count)	CD Lanes Resulting Vol.	CD Lanes HCS Adj. Capacity	CD Lanes v/c	CD Lanes LOS
I-370																		
Shady Grove Road	12,200	2	3,300	4,337	0.76	D	3	74%	6,586	6,644	0.99	E	3	26%	2,314	6,522	0.35	B
Gude Drive	11,575	2	3,300	4,337	0.76	D	3	67%	5,544	6,644	0.83	D	2	33%	2,731	4,350	0.63	C
MD 28	11,600	2	3,325	4,337	0.77	D	3	64%	5,296	6,644	0.80	D	2	36%	2,979	4,350	0.68	D
MD 189	11,550	2	3,325	4,337	0.77	D	3	57%	4,688	6,644	0.71	C	2	43%	3,537	4,350	0.81	D
Montrose Road	12,450	2	3,325	4,337	0.77	D	3	66%	6,023	6,644	0.91	E	2	34%	3,103	4,350	0.71	D
I-270 Y-Split	13,425	2	3,225	4,337	0.74	D	5	100%	10,200	11,073	0.92	E						
West Lake Terrace	6,850	2	3,000	4,337	0.69	C	3	100%	3,850	6,676	0.58	C						
Democracy Boulevard	5,450	2	1,600	4,337	0.37	B	3	100%	3,850	6,676	0.58	C						
I-495/I-270 West Spur	6,025	2	1,600	4,337	0.37	B	2	100%	4,425	4,451	0.99	E						
At-Grade Access	10,750	2	1,600	4,316	0.37	B	5	100%	9,150	11,019	0.83	D						
MD 190	10,750	2	3,200	4,316	0.74	D	4	100%	7,550	8,815	0.86	D						
Cabin John Parkway	11,175	2	3,200	4,316	0.74	D	4	100%	7,975	8,815	0.90	E						
Clara Barton Parkway	9,050	2	3,200	4,316	0.74	D	3	100%	5,850	6,611	0.88	D						
George Washington	11,075	2	3,075	4,316	0.71	C	4	100%	8,000	8,815	0.91	E						
VA 193	10,825						5	76%	8,227	11,019	0.75	D	3	24%	2,598	6,522	0.40	B
I-270 Y-Split																		
Rockledge Drive		1		2,158	0.00	A	3	100%	-	6,611	0.00	A						
MD 187		1		2,158	0.00	A	2	100%	-	4,408	0.00	A						
I-495		1		2,158	0.00	A	2	100%	-	4,408	0.00	A						

#'s in Red are from Field Counts, #'s in Black are assumed

PM Peak Period - Northbound (2030 Alternative 5)

Interchange	Total Volume	ETL # Lanes	ETL Vol.	ETL Capacity	ETL v/c	ETL LOS	GP Lanes # Lanes	GP Lanes (2006 Count)	GP Lanes Vol.	GP Lanes Capacity	GP Lanes v/c	GP Lanes LOS	CD Lanes # Lanes	CD Lanes (2006 Count)	CD Lanes Vol.	CD Lanes Capacity	CD Lanes v/c	CD Lanes LOS
VA 193																		
	9,950						6	100%	9,950	13,223	0.75	D						
GW Parkway	10,475	2	3,200	4,316	0.74	D	4	100%	7,275	8,815	0.83	D						
Clara Barton Parkway	8,850	2	3,200	4,316	0.74	D	3	100%	5,650	6,611	0.85	D						
Cabin John Parkway	10,375	2	3,200	4,316	0.74	D	4	100%	7,175	8,815	0.81	D						
MD 190	10,150	2	3,200	4,316	0.74	D	4	100%	6,950	8,815	0.79	D						
At-Grade Access	10,150	2	1,625	4,316	0.38	B	5	100%	8,525	11,019	0.77	D						
I-495/I-270 West Spur	5,925	2	1,625	4,358	0.37	B	2	100%	4,300	4,451	0.97	E						
Democracy Boulevard	5,925	2	1,625	4,358	0.37	B	2	100%	4,300	4,451	0.97	E						
West Lake Terrace	7,300	2	3,000	4,358	0.69	C	2	100%	4,300	4,451	0.97	E						
I-270 Y-Split	12,400	2	3,225	4,358	0.74	D	5	100%	9,175	11,127	0.82	D						
Montrose Road	12,575	2	3,325	4,358	0.76	D	3	61%	5,643	6,676	0.85	D	2	39%	3,608	4,350	0.83	D
MD 189	12,275	2	3,325	4,358	0.76	D	3	65%	5,818	6,676	0.87	D	2	35%	3,133	4,350	0.72	D
MD 28	12,125	2	3,325	4,358	0.76	D	3	60%	5,280	6,676	0.79	D	2	40%	3,520	4,350	0.81	D
Gude Drive	12,100	2	3,300	4,358	0.76	D	3	60%	5,280	6,676	0.79	D	2	40%	3,520	4,350	0.81	D
Shady Grove Road	12,300	2	3,300	4,358	0.76	D	3	49%	4,410	6,676	0.66	C	2	51%	4,590	4,350	1.06	F
I-370																		
I-495																		
		1		2,158	0.00	A	2	100%	-	4,451	0.00	A						
MD 187		1		2,158	0.00	A	2	100%	-	4,451	0.00	A						
Rockledge Drive		1		2,158	0.00	A	3	100%	-	6,676	0.00	A						
I-270 Y-Split																		

#'s in Red are from Field Counts, #'s in Black are assumed

PM Peak Period - Southbound (2030 Alternative 5)

Interchange	Total Volume	ETL # Lanes	ETL Vol.	ETL Capacity	ETL v/c	ETL LOS	GP Lanes # Lanes	GP Lanes (2006 Count)	GP Lanes Vol.	GP Lanes Capacity	GP Lanes v/c	GP Lanes LOS	CD Lanes # Lanes	CD Lanes (2006 Count)	CD Lanes Vol.	CD Lanes Capacity	CD Lanes v/c	CD Lanes LOS
I-370																		
Shady Grove Road	6,800	2	1,600	4,358	0.37	B	3	59%	3,068	6,676	0.46	B	3	41%	2,132	5,100	0.42	B
Gude Drive	7,550	2	1,600	4,358	0.37	B	3	75%	4,463	6,676	0.67	C	2	25%	1,488	3,400	0.44	B
MD 28	7,275	2	1,325	4,358	0.30	B	3	66%	3,927	6,676	0.59	C	2	34%	2,023	3,400	0.60	B
MD 189	7,700	2	1,325	4,358	0.30	B	3	60%	3,825	6,676	0.57	C	2	40%	2,550	3,400	0.75	C
Montrose Road	8,075	2	1,325	4,358	0.30	B	3	78%	5,265	6,676	0.79	D	2	22%	1,485	3,400	0.44	B
I-270 Y-Split	8,050	2	2,050	4,358	0.47	B	5	100%	6,000	11,127	0.54	C						
West Lake Terrace	4,975	2	2,000	4,358	0.46	B	3	100%	2,975	6,676	0.45	B						
Democracy Boulevard	3,850	2	875	4,358	0.20	A	3	100%	2,975	6,676	0.45	B						
I-495/I-270 West Spur	4,800	2	875	4,358	0.20	A	2	100%	3,925	4,451	0.88	D						
At-Grade Access	9,125	2	875	4,358	0.20	A	5	100%	8,250	11,127	0.74	D						
MD 190	9,125	2	2,125	4,358	0.49	B	4	100%	7,000	8,901	0.79	D						
Cabin John Parkway	9,250	2	2,125	4,358	0.49	B	4	100%	7,125	8,901	0.80	D						
Clara Barton Parkway	8,475	2	2,125	4,358	0.49	B	3	100%	6,350	6,676	0.95	E						
George Washington	10,000	2	2,125	4,358	0.49	B	4	100%	7,875	8,901	0.88	D						
VA 193	11,625						5	65%	7,556	11,127	0.68	C	3	35%	4,069	5,100	0.80	C
I-270 Y-Split																		
Rockledge Drive		1	-	2,179	0.00	A	3	100%	-	6,676	0.00	A						
MD 187		1	-	2,179	0.00	A	2	100%	-	4,451	0.00	A						
I-495		1	-	2,179	0.00	A	2	100%	-	4,451	0.00	A						

#'s in Red are from Field Counts, #'s in Black are assumed

Assumptions fo Truck Percentages:

	AM Peak	PM Peak
I-495	6%	7%
I-270 Spur	5%	5%
I-270	8%	5%

Assumptions fo Truck Percentages:

	AM Peak	PM Peak
I-495	7%	5%
I-270 Spur	5%	5%
I-270	6%	5%

8. Alternatives 5A / 5B

Description
In an attempt to reduce costs, two variations of Alternative 5 were considered. The first, Alternative 5A, would eliminate the direct access interchanges at Montrose Road and Gude Drive. The second, Alternative 5B, would eliminate all direct access interchanges along I-270 and would scale back the I-270 West Spur improvements to those described in Alternative 1.

Traffic Analysis
No additional traffic analyses were completed for Alternatives 5A and 5B. It is assumed that the mainline would operate similar to Alternative 5.

Cost / Impacts
The proposed Alternative 5A improvements would result in impacts to 115 properties, including 15 displacements (14 residential and one commercial). The widening along the Capital Beltway, I-270 Spurs, and the I-270 mainline could impact 49 wetlands / Waters of the U.S. and approximately 14.4 acres of park.

The cost for Alternative 5A is estimated at $1.66 billion (in 2008 dollars).

The proposed Alternative 5B improvements would result in impacts to 70 properties, including 4 residential displacements. The widening along the Capital Beltway could impact 5 wetlands / Waters of the U.S. and approximately 3.2 acres of park. These are the same impacts as Alternative 1.

The cost for Alternative 5B is estimated at $1.1 billion (in 2008 dollars).

Status / Conclusion
Alternatives 5A and 5B would provide the same traffic operational improvements and result in fewer impacts than Alternative 5, but would still include significant cost. In addition, Alternatives 5A and 5B would provide fewer direct access locations for the managed lanes, which may reduce the operational effectiveness of the managed lane system.

Due to the operational improvements provided by these alternatives and the two-lane managed lane system, as well as the reduced impacts along the I-270 West Spur and the I-270 mainline compared with Alternative 5, it was determined that Alternatives 5A and 5B should be evaluated in greater detail in a subsequent planning study.

9. Summary

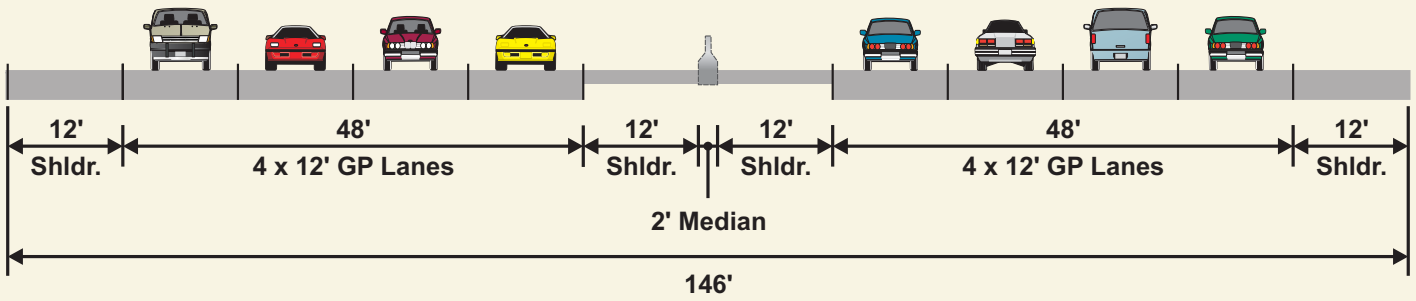
The long-term alternatives would provide additional capacity and a managed lanes system along the Capital Beltway and I-270 between the Virginia HOT Lanes and I-370, which were SHA's primary goals for evaluating improvements within the study corridor.

However, the long-term alternatives would require widening along some or all segments of highway within the study limits. The widening would result in property impacts, displacements, and environmental impacts. In addition, the roadway and interchange improvements would be costly to implement, with a cost range between $1.04 billion (2008 dollars) for Alternative 1 and $2.27 billion (2008 dollars) for Alternative 4.

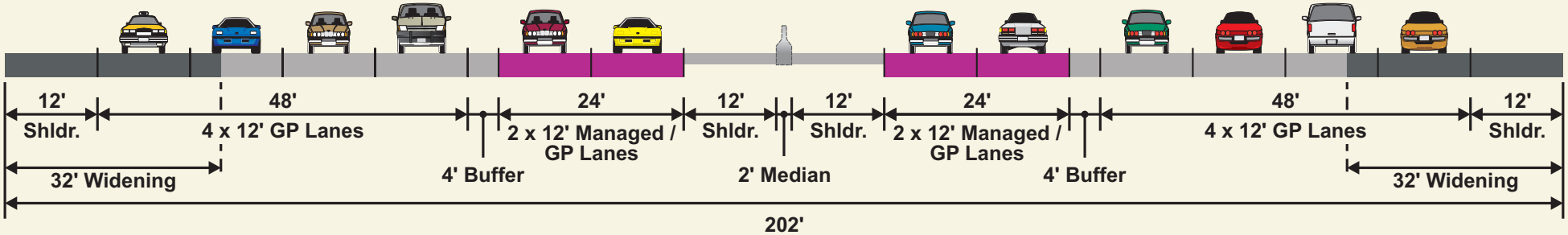
The long-term alternatives would have significant cost and impacts to implement the improvements along the Capital Beltway, I-270 Spurs, and I-270 mainline, but several of the long-term alternatives would also result in improved traffic operations compared with a future No-Build scenario. Therefore, it was determined that several of the alternatives should be evaluated further as part of a subsequent planning study. Alternative 1, Alternative 4, Alternative 5, Alternative 5A, and Alternative 5B will all be considered further.

Alternatives 2 and 3 would not offer the operational improvements as the other alternatives, especially when considering associated cost and impacts. These alternatives will not be evaluated further.

Given the cost and impacts associated with all of the long-term alternatives, it was also determined that smaller, less costly, and less impactive improvements should be evaluated. These short-term and mid-term improvements are presented in Chapters D and E.



EXISTING CONDITIONS



ALTERNATIVES 1, 2, 3, 4, and 5

- Add 2 Managed / GP lanes in each direction

Not to scale

LEGEND

- Existing Pavement
- Managed Lanes (HOV, HOT or ETL)
- New Pavement
- Converted General Purpose to Managed Lane

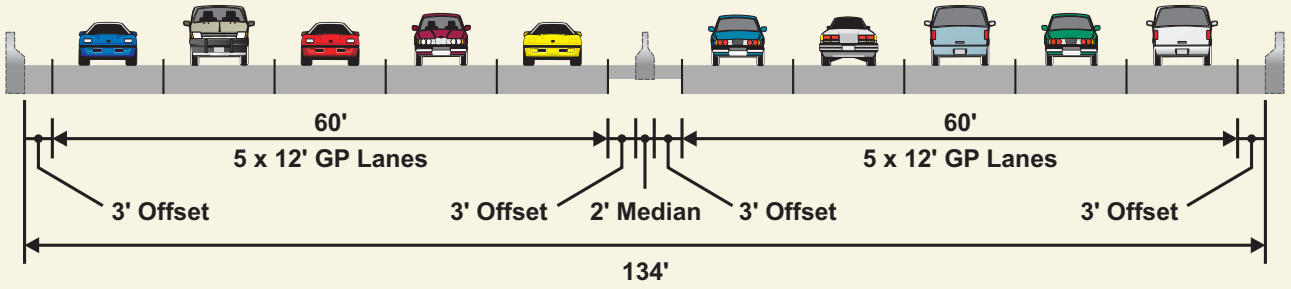
NOTES

- There is a 3-lane CD Road along the outer loop between the George Washington Parkway and SR 193.

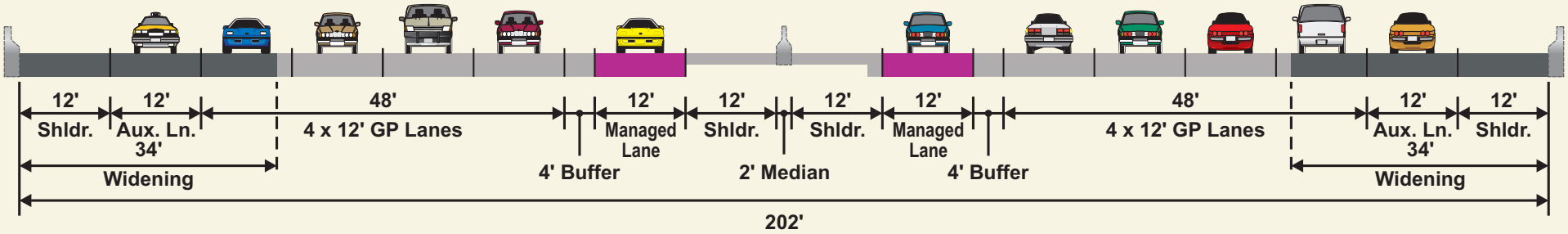
WEST SIDE MOBILITY STUDY

LONG-TERM ALTERNATIVES - VIRGINIA CAPITAL BELTWAY

Date	Figure
NOVEMBER 2009	C-1



EXISTING CONDITIONS



ALTERNATIVE 1

• Add 1 Managed lane in each direction plus full shoulders

Not to scale

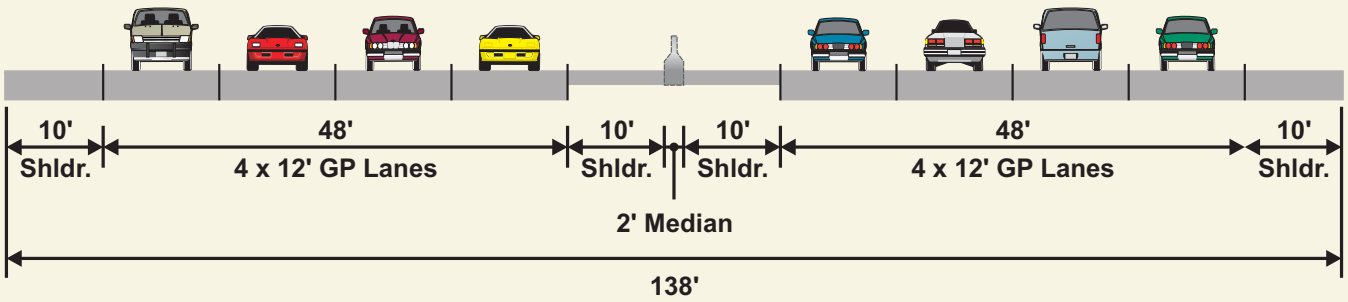
LEGEND

- Existing Pavement
- Managed Lanes (HOV, HOT or ETL)
- New Pavement
- Converted General Purpose to Managed Lane

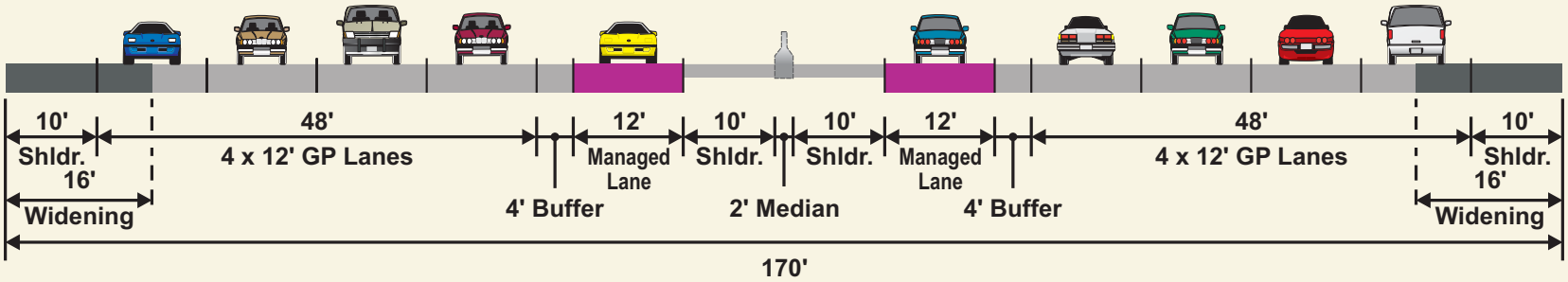
WEST SIDE MOBILITY STUDY

LONG-TERM ALTERNATIVES - AMERICAN LEGION BRIDGE

Date	Figure
NOVEMBER 2009	C-2



EXISTING CONDITIONS



ALTERNATIVE 1

- Add 1 Managed lane in each direction
- Buffer between Managed lane and GP

Not to scale

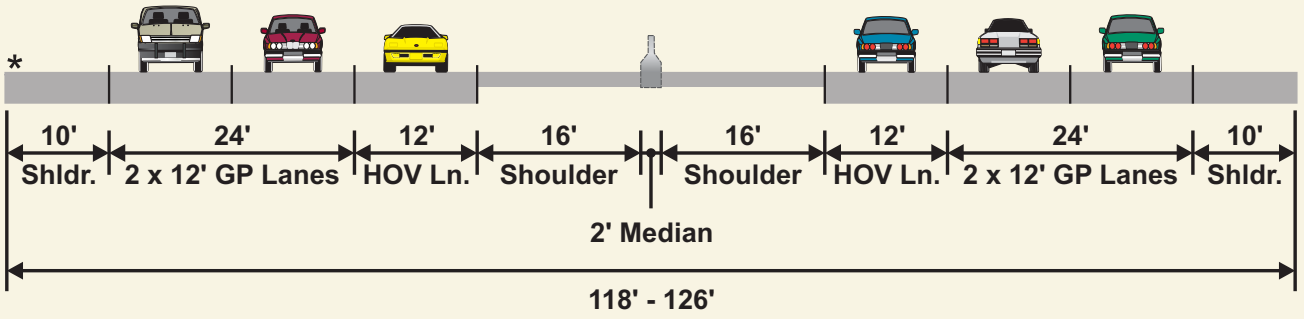
LEGEND

- Existing Pavement
- Managed Lanes (HOV, HOT or ETL)
- New Pavement
- Converted General Purpose to Managed Lane

WEST SIDE MOBILITY STUDY

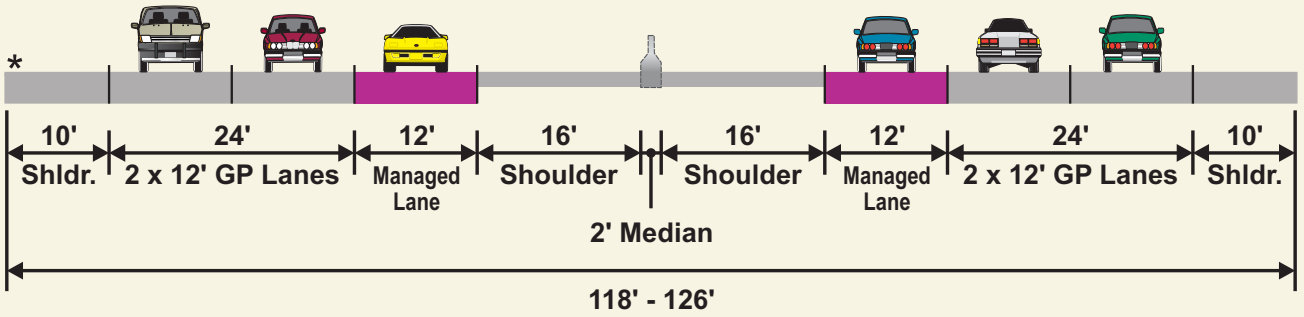
LONG-TERM ALTERNATIVES - MARYLAND CAPITAL BELTWAY

Date	Figure
NOVEMBER 2009	C-3



* Narrow Paved Shoulder (2') from Democracy Blvd. to I-495 Merge

EXISTING CONDITIONS



* Narrow Paved Shoulder (2') from Democracy Blvd. to I-495 Merge

ALTERNATIVE 1

- Convert existing HOV to Managed lane

Not to scale

LEGEND

- Existing Pavement
- Managed Lanes (HOV, HOT or ETL)
- New Pavement
- Converted General Purpose to Managed Lane

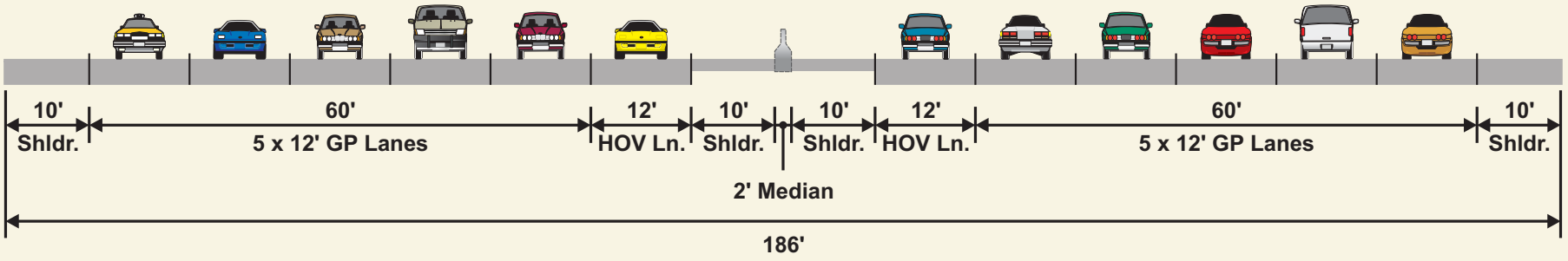
NOTES

- Additional SB lane from 'Y' split to Democracy Blvd.

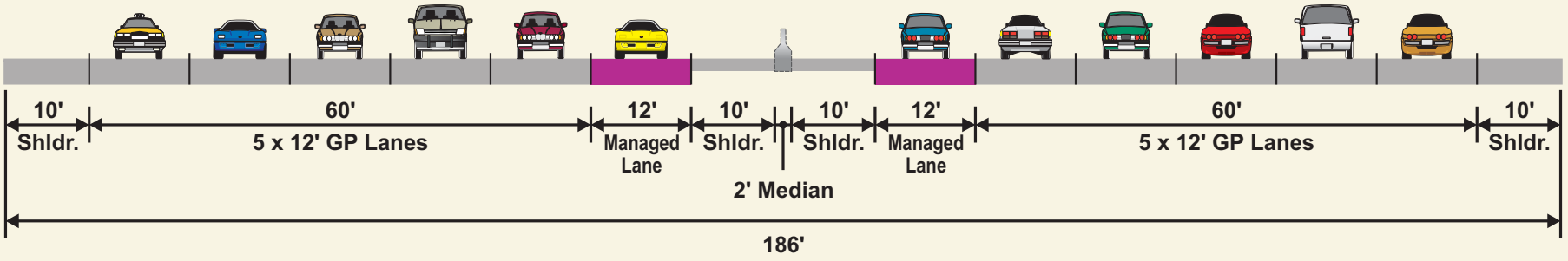
WEST SIDE MOBILITY STUDY

LONG-TERM ALTERNATIVES - I-270 WEST SPUR

Date	Figure
NOVEMBER 2009	C-4



EXISTING CONDITIONS



ALTERNATIVE 1

- Convert existing HOV to Managed lane

Not to scale

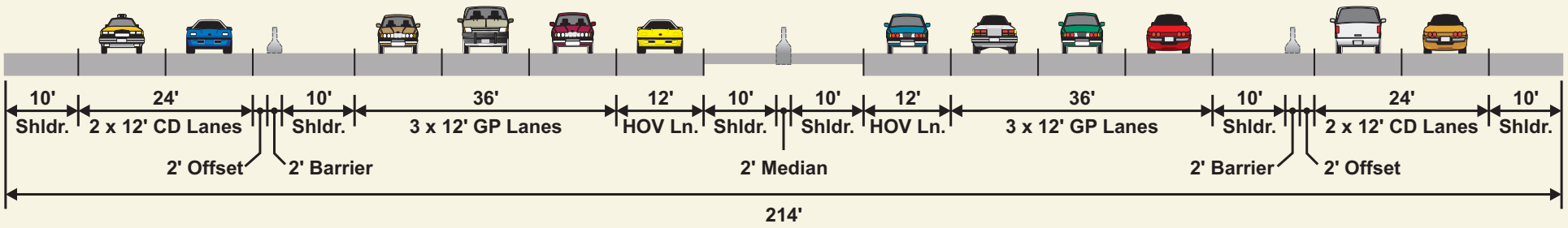
LEGEND

- Existing Pavement
- Managed Lanes (HOV, HOT or ETL)
- New Pavement
- Converted General Purpose to Managed Lane

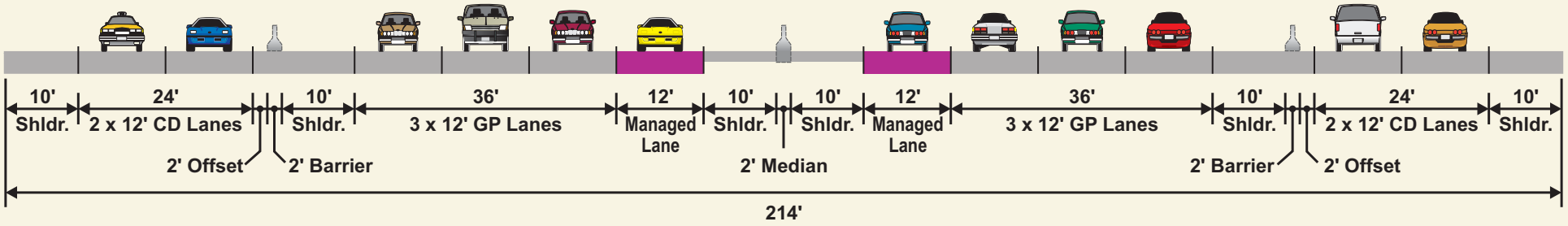
WEST SIDE MOBILITY STUDY INTERSTATE 270

LONG-TERM ALTERNATIVES - I-270 MAINLINE - 'Y' SPLIT TO MONTROSE ROAD

Date	Figure
NOVEMBER 2009	C-5



EXISTING CONDITIONS



ALTERNATIVE 1

- Convert existing HOV to Managed lane

Not to scale

LEGEND

- Existing Pavement
- Managed Lanes (HOV, HOT or ETL)
- New Pavement
- Converted General Purpose to Managed Lane

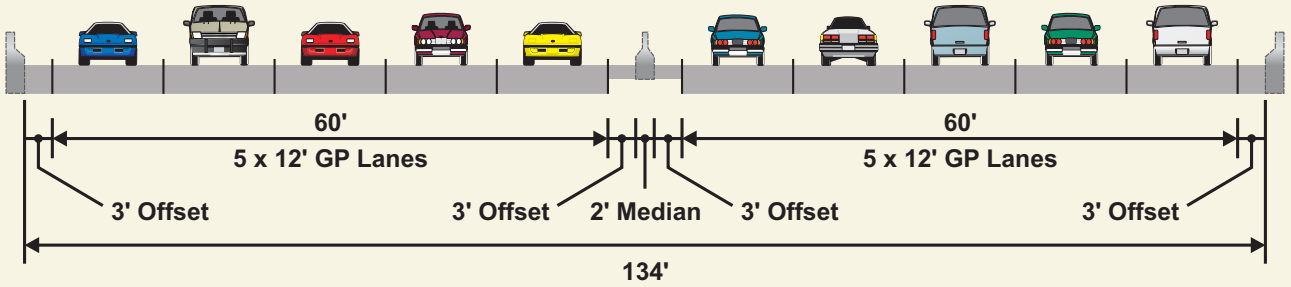
NOTES

- There is an additional SB CD Lane from I-370 to Shady Grove.

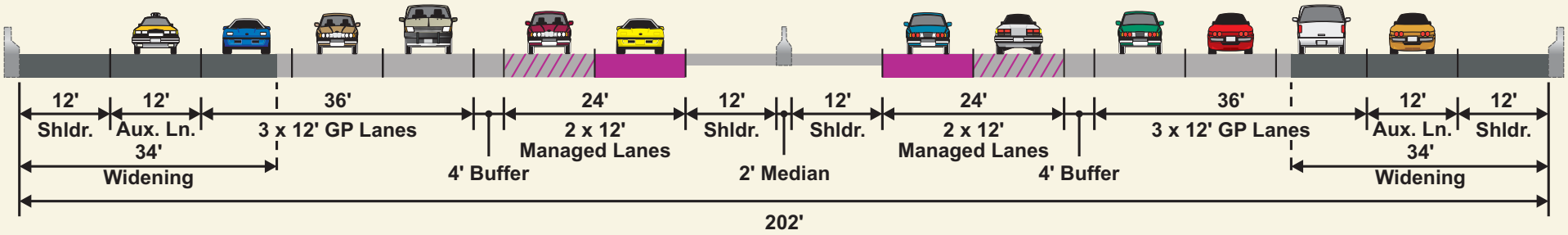
WEST SIDE MOBILITY STUDY

LONG-TERM ALTERNATIVES - I-270 MAINLINE - MONTROSE ROAD TO I-370

Date	Figure
NOVEMBER 2009	C-6



EXISTING CONDITIONS



* Inside Shoulders Vary From 6' to 10'

ALTERNATIVES 2, 3, 4, and 5

- Add 1 Managed lane
- Convert 1 GP to Managed lane

Not to scale

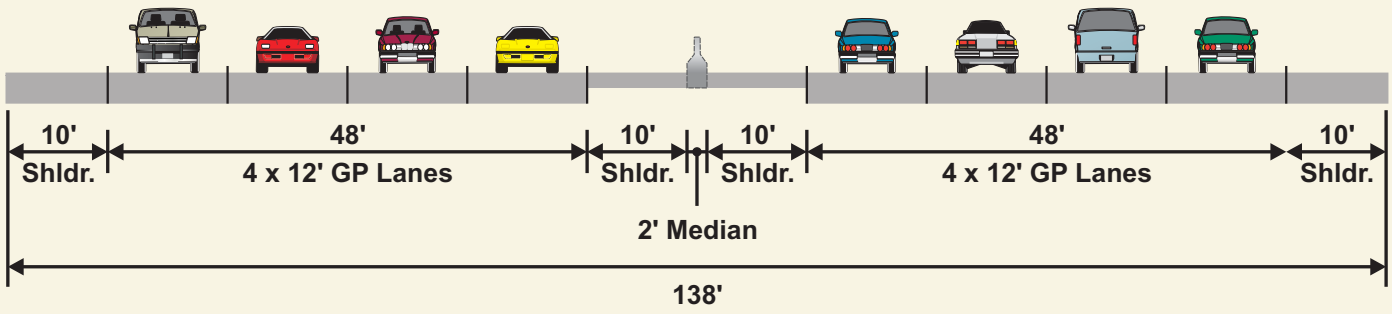
LEGEND

- Existing Pavement
- Managed Lanes (HOV, HOT or ETL)
- New Pavement
- Converted General Purpose to Managed Lane

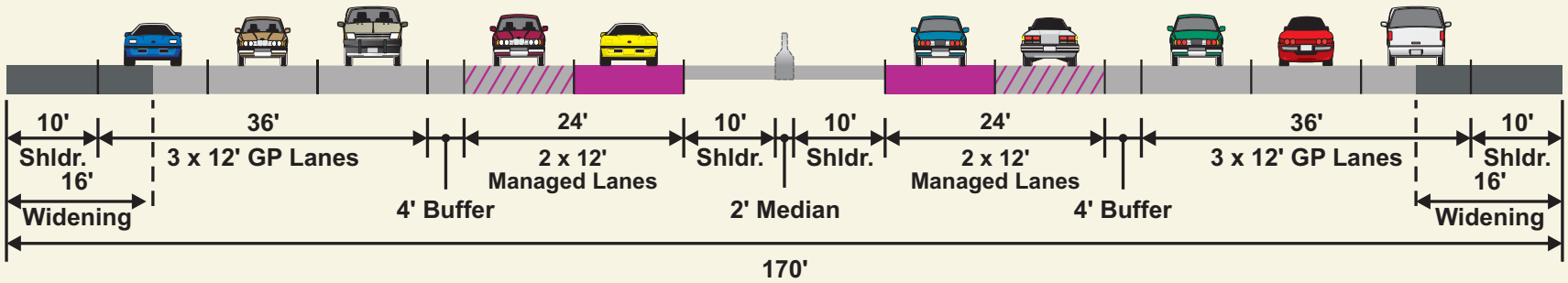
WEST SIDE MOBILITY STUDY

LONG-TERM ALTERNATIVES - AMERICAN LEGION BRIDGE

Date	Figure
NOVEMBER 2009	C-7



EXISTING CONDITIONS



ALTERNATIVES 2, 3, 4, and 5

- Add 1 Managed lane
- Convert 1 GP to Managed lane
- Buffer between Managed lane and GP

Not to scale

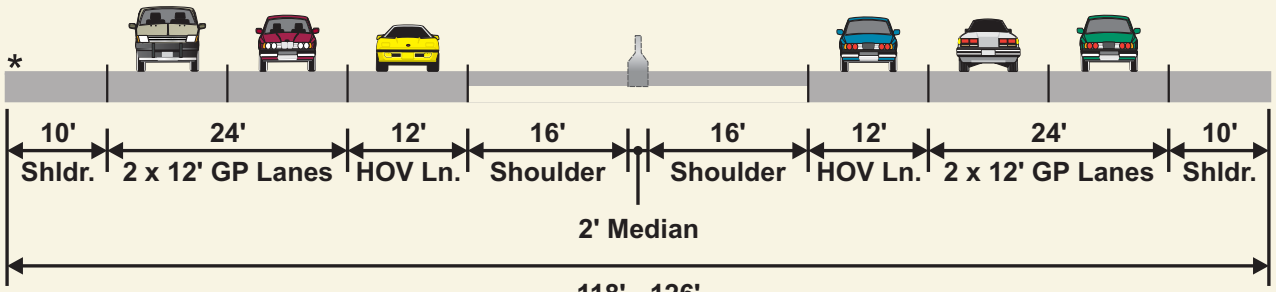
LEGEND

- Existing Pavement
- Managed Lanes (HOV, HOT or ETL)
- New Pavement
- Converted General Purpose to Managed Lane

WEST SIDE MOBILITY STUDY

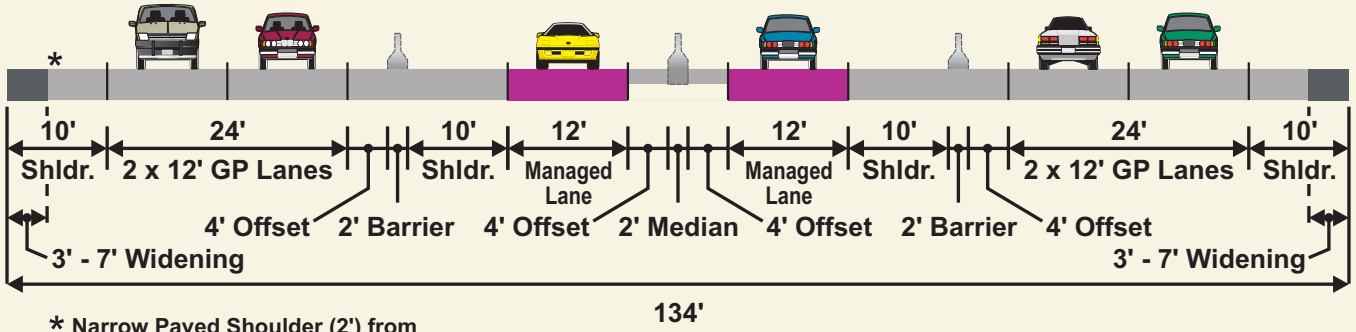
LONG-TERM ALTERNATIVES - MARYLAND CAPITAL BELTWAY

Date	Figure
NOVEMBER 2009	C-8



* Narrow Paved Shoulder (2') from Democracy Blvd. to I-495 Merge

EXISTING CONDITIONS



* Narrow Paved Shoulder (2') from Democracy Blvd. to I-495 Merge

ALTERNATIVE 2

- Convert existing HOV to Managed lane
- Barrier between Managed lane and GP

Not to scale

LEGEND

- Existing Pavement
- Managed Lanes (HOV, HOT or ETL)
- New Pavement
- Converted General Purpose to Managed Lane

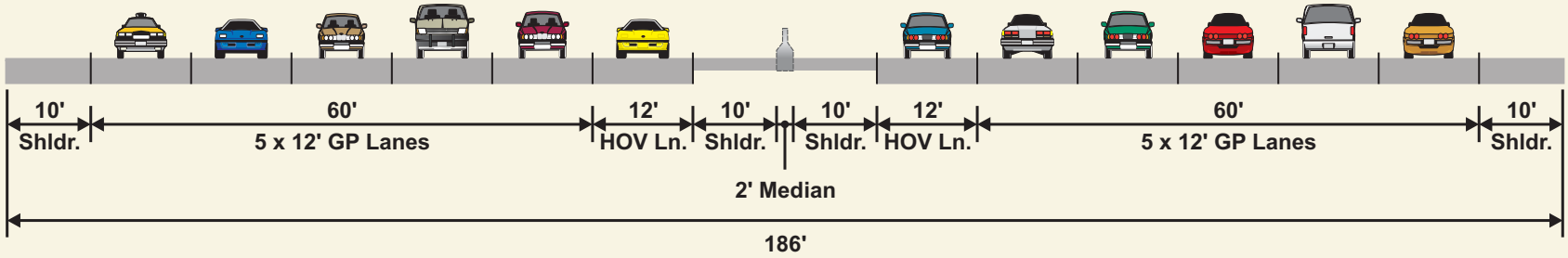
NOTES

- Additional SB lane from 'Y' split to Democracy Blvd.

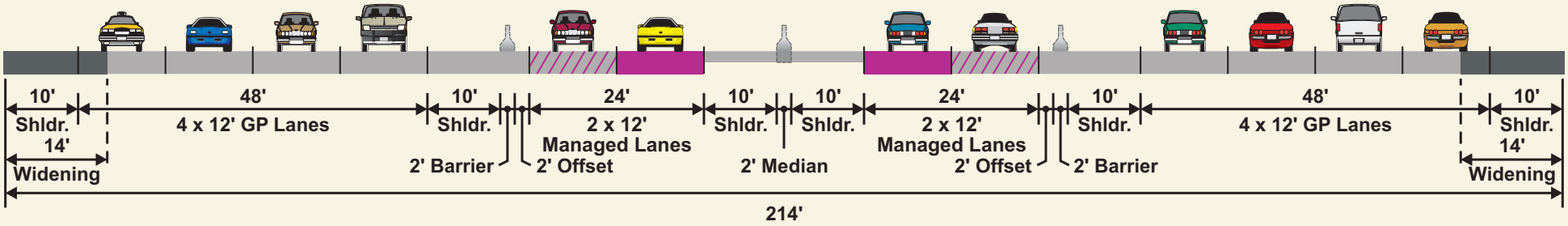
WEST SIDE MOBILITY STUDY

LONG-TERM ALTERNATIVES - I-270 WEST SPUR

Date	Figure
NOVEMBER 2009	C-9



EXISTING CONDITIONS



ALTERNATIVE 2

- Convert HOV to Managed lane
- Convert 1 GP to Managed lane
- Barrier between Managed lane and GP

Not to scale

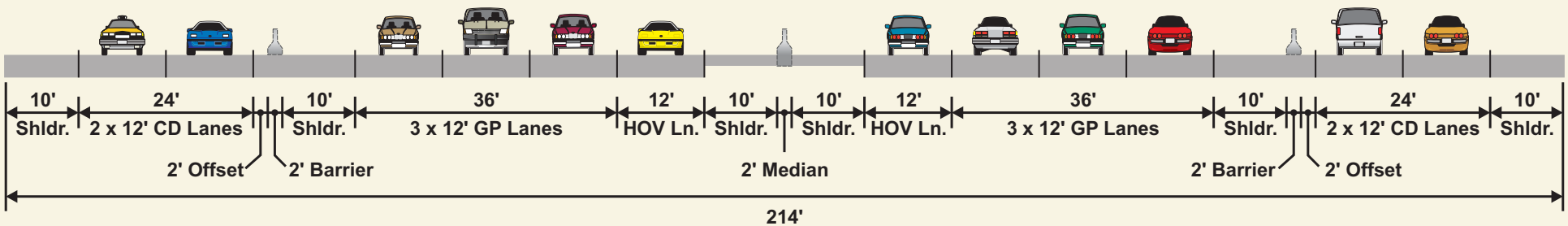
LEGEND

- Existing Pavement
- Managed Lanes (HOV, HOT or ETL)
- New Pavement
- Converted General Purpose to Managed Lane

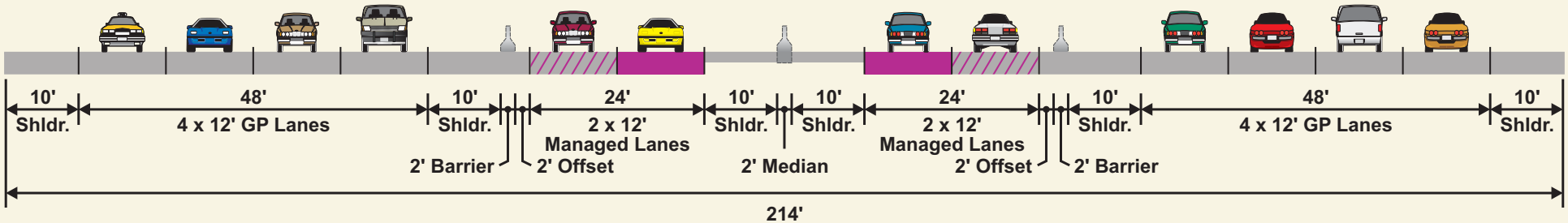
WEST SIDE MOBILITY STUDY

LONG-TERM ALTERNATIVES - I-270 MAINLINE - 'Y' SPLIT TO MONTROSE ROAD

Date	Figure
NOVEMBER 2009	C-10



EXISTING CONDITIONS



ALTERNATIVE 2

- Convert HOV to Managed lane
- Convert 1 GP to Managed lane
- Barrier between Managed lane and GP

Not to scale

LEGEND

- Existing Pavement
- Managed Lanes (HOV, HOT or ETL)
- New Pavement
- Converted General Purpose to Managed Lane

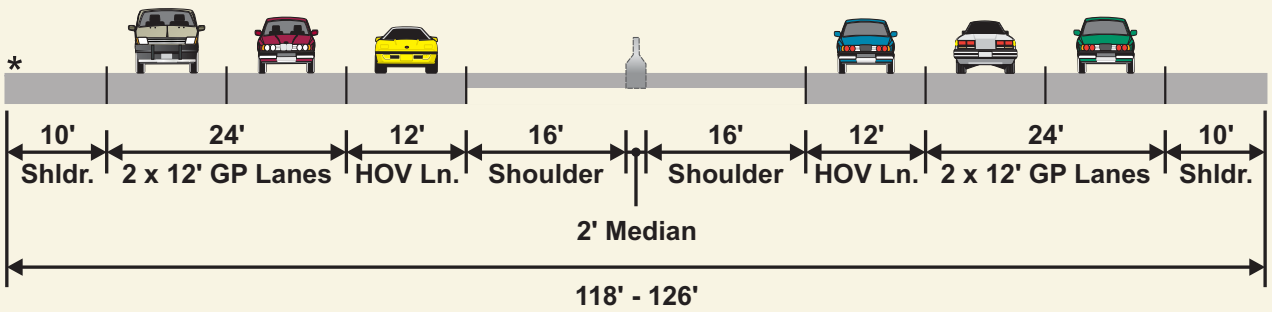
NOTES

- There is an additional SB CD Lane from I-370 to Shady Grove.

WEST SIDE MOBILITY STUDY

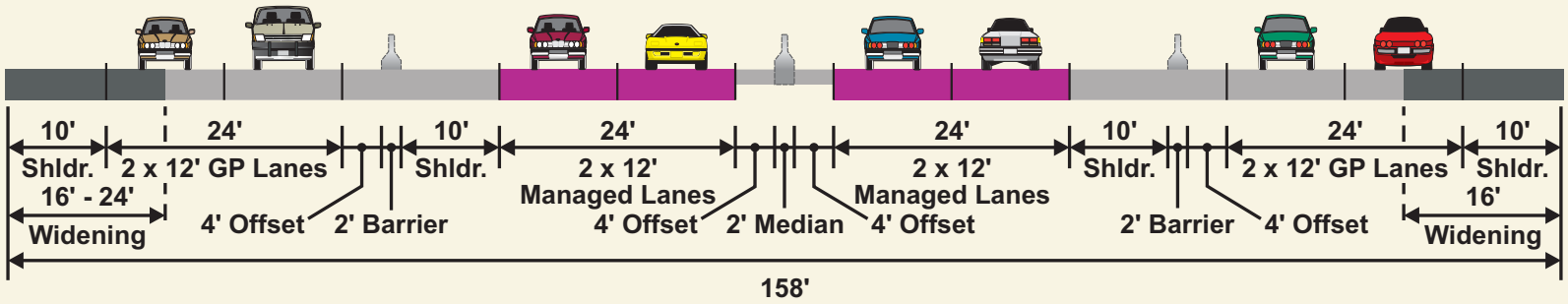
LONG-TERM ALTERNATIVES - I-270 MAINLINE - MONTROSE ROAD TO I-370

Date	Figure
NOVEMBER 2009	C-11



* Narrow Paved Shoulder (2') from Democracy Blvd. to I-495 Merge

EXISTING CONDITIONS



ALTERNATIVES 3, 4, and 5

- Convert HOV to Managed lane
- Add 1 Managed lane
- Barrier between Managed lane and GP

Not to scale

LEGEND

- Existing Pavement
- Managed Lanes (HOV, HOT or ETL)
- New Pavement
- Converted General Purpose to Managed Lane

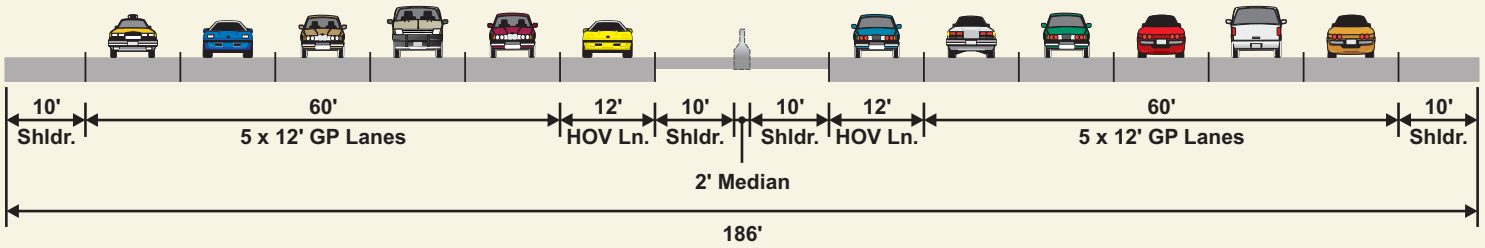
NOTES

- Additional SB lane from 'Y' split to Democracy Blvd.
- Widening ranges are due to variances in existing shoulder widths along Spur.

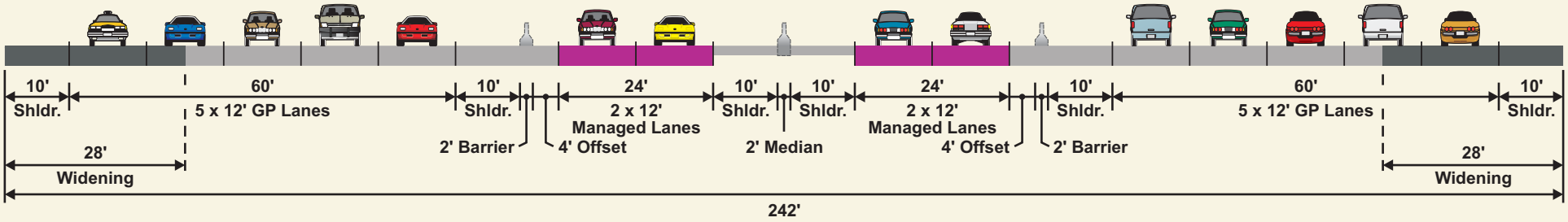
WEST SIDE MOBILITY STUDY

LONG-TERM ALTERNATIVES - I-270 WEST SPUR

Date	Figure
NOVEMBER 2009	C-12



EXISTING CONDITIONS



ALTERNATIVES 3 and 4

- Convert HOV to Managed lane
- Add 1 Managed lane
- Barrier between Managed lane and GP
- Buffer between GP and CD

Not to scale

LEGEND

- Existing Pavement
- Managed Lanes (HOV, HOT or ETL)
- New Pavement
- Converted General Purpose to Managed Lane

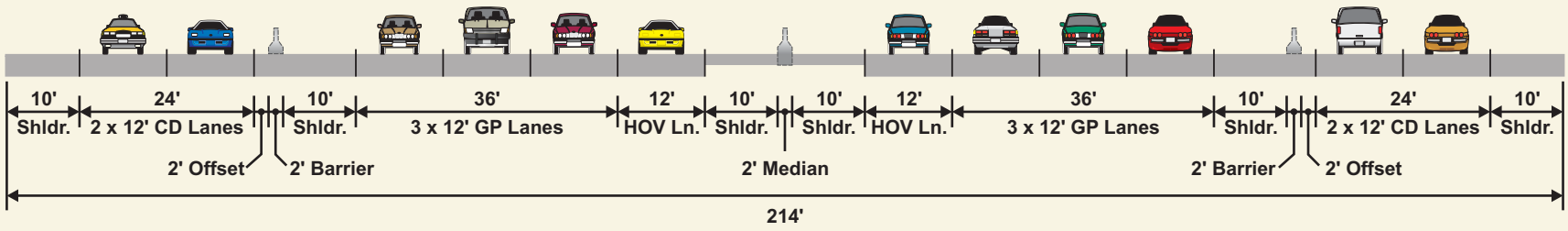
NOTE

- If desired, all shoulders, excluding those adjacent to the median, could be widened to 12'. This alteration would increase Alternative 4 to a 274' section.

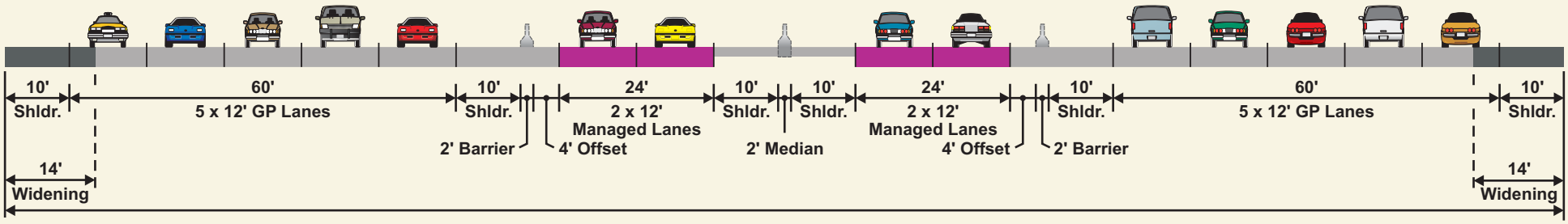
WEST SIDE MOBILITY STUDY

LONG-TERM ALTERNATIVES - I-270 MAINLINE - 'Y' SPLIT TO MONTROSE ROAD

Date	Figure
NOVEMBER 2009	C-13



EXISTING CONDITIONS



ALTERNATIVE 3

- Convert HOV to Managed lane
- Add 1 Managed lane
- Barrier between Managed lane and GP

Not to scale

LEGEND

- Existing Pavement
- Managed Lanes (HOV, HOT or ETL)
- New Pavement
- Converted General Purpose to Managed Lane

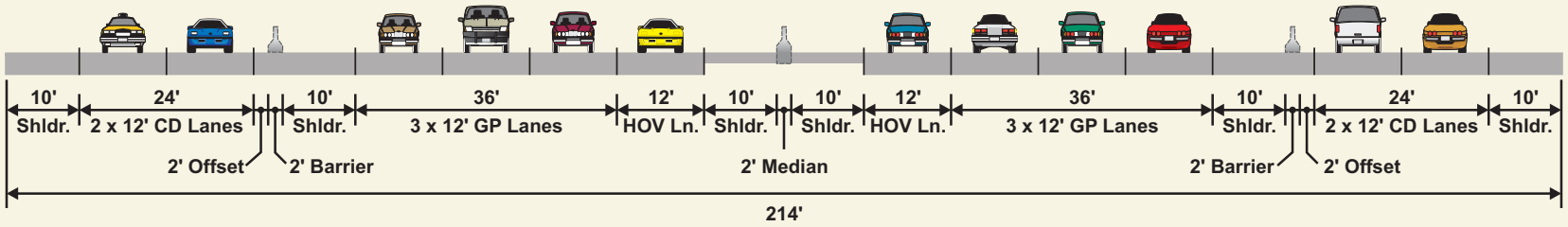
NOTES

- There is an additional SB CD Lane from I-370 to Shady Grove
- If desired, all shoulders, excluding those adjacent to the median, could be widened to 12'. This alteration would increase Alternative 4 to a 274' section.

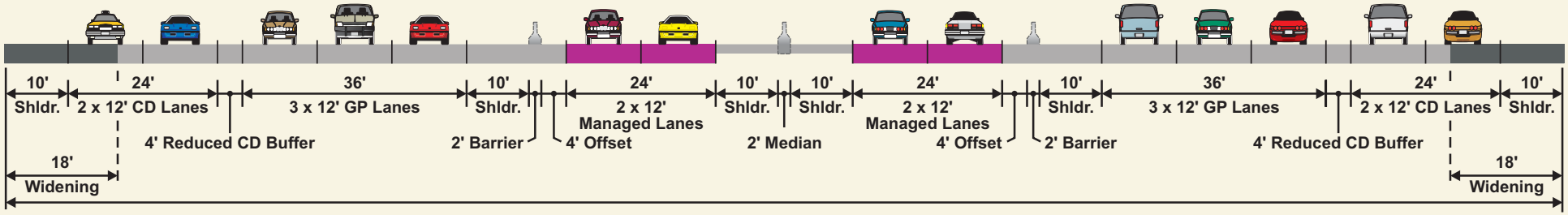
WEST SIDE MOBILITY STUDY

LONG-TERM ALTERNATIVES - I-270 MAINLINE - MONTROSE ROAD TO I-370

Date	Figure
NOVEMBER 2009	C-14



EXISTING CONDITIONS



ALTERNATIVE 4

- Convert HOV to Managed lane
- Add 1 Managed lane
- Barrier between Managed lane and GP
- Buffer between GP and CD

Not to scale

LEGEND

- Existing Pavement
- Managed Lanes (HOV, HOT or ETL)
- New Pavement
- Converted General Purpose to Managed Lane

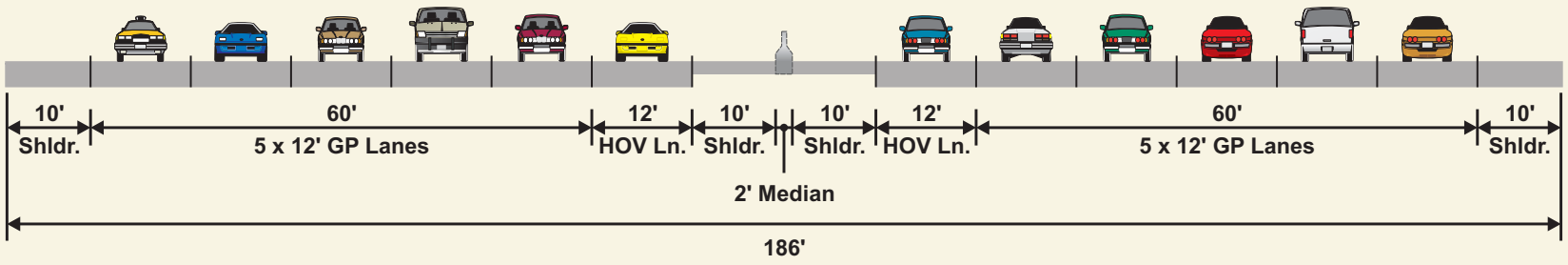
NOTES

- There is an additional SB CD Lane from I-370 to Shady Grove
- If desired, all shoulders, excluding those adjacent to the median, could be widened to 12'. This alteration would increase Alternative 4 to a 274' section.

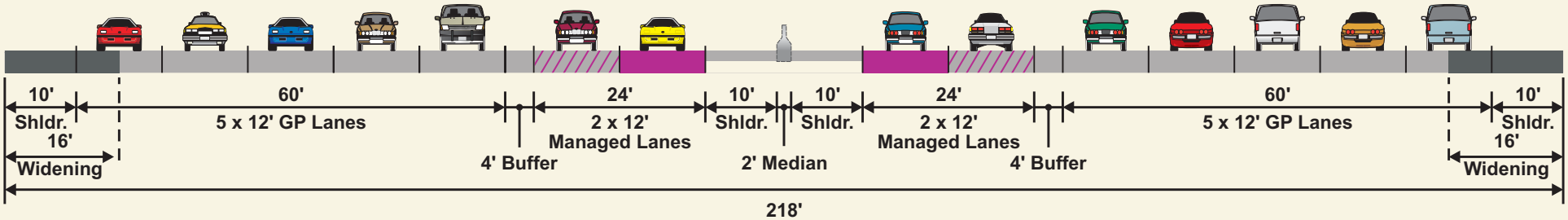
WEST SIDE MOBILITY STUDY

LONG-TERM ALTERNATIVES - I-270 MAINLINE - MONTROSE ROAD TO I-370

Date	Figure
NOVEMBER 2009	C-15



EXISTING CONDITIONS



ALTERNATIVE 5

- Convert HOV to Managed lane
- Add 1 Managed lane
- Buffer between Managed lane and GP

Not to scale

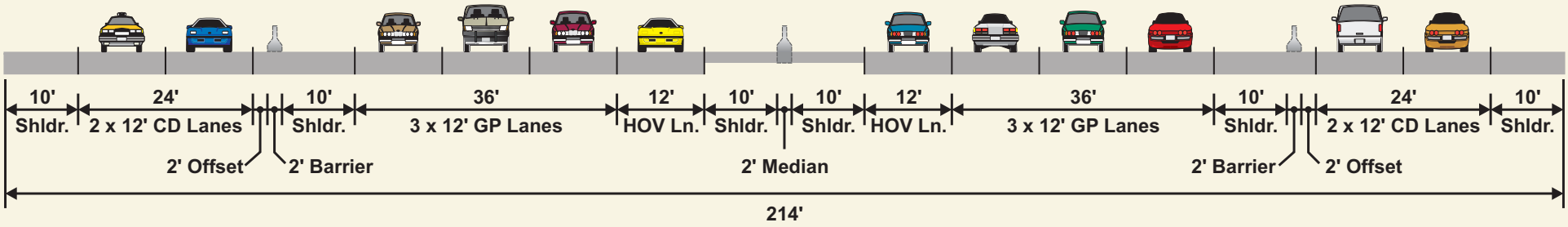
LEGEND

- Existing Pavement
- Managed Lanes (HOV, HOT or ETL)
- New Pavement
- Converted General Purpose to Managed Lane

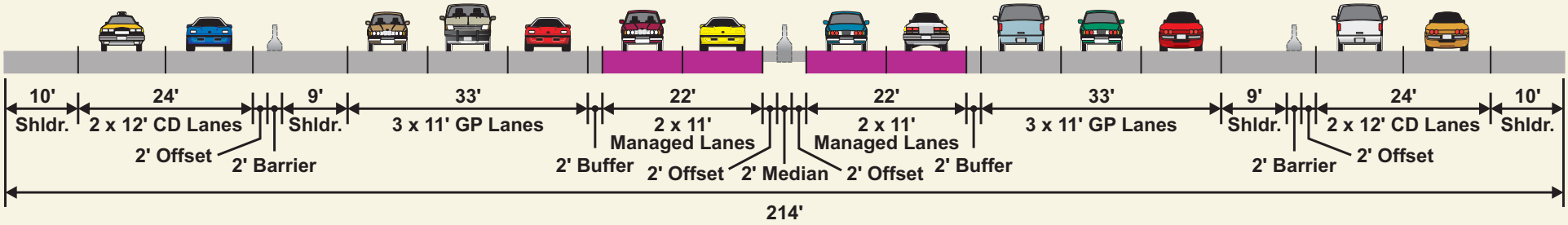
WEST SIDE MOBILITY STUDY

LONG-TERM ALTERNATIVES - I-270 MAINLINE - 'Y' SPLIT TO MONTROSE ROAD

Date	Figure
NOVEMBER 2009	C-16



EXISTING CONDITIONS



ALTERNATIVE 5

- Convert HOV to Managed lane
- Add 1 Managed lane by restriping
- Buffer between Managed lane and GP

Not to scale

LEGEND

- Existing Pavement
- Managed Lanes (HOV, HOT or ETL)
- New Pavement
- Converted General Purpose to Managed Lane

NOTES

- There is an additional SB CD Lane from I-370 to Shady Grove

WEST SIDE MOBILITY STUDY

LONG-TERM ALTERNATIVES - I-270 MAINLINE - MONTROSE ROAD TO I-370

Date	Figure
NOVEMBER 2009	C-17

D. SHORT-TERM IMPROVEMENTS

1. Introduction

The long-term improvements would have a high cost, result in right-of-way and environmental impacts, and require several years to be implemented. Because of these factors, improvements were investigated that could be implemented relatively quickly, within one to two years, and at a lower cost. These improvements would focus on localized congestion points and identify modifications that could improve system-wide traffic operations but would require limited or no widening.

2. Potential Improvements

SHA conducted peak period observations along the study corridor to determine the locations and causes of recurring traffic congestion. The observations were conducted during four weekdays, two days in the southbound direction during the AM peak period (January 15 and 16, 2008) and two days in the northbound direction during the PM peak period (February 5 and 7, 2008). The field observations generally indicated the following locations of recurring congestion:

Southbound (AM Peak Period)

1. Capital Beltway in Maryland prior to the exit to MD 190.
2. I-270 West Spur prior to the merge from Democracy Boulevard.
3. I-270 West Spur general purpose lanes.
4. I-270 mainline approaching the Y-Split interchange.
5. I-270 mainline at the slip ramps entering the mainline from the CD Road.
6. I-270 CD Road at the entrance ramp from eastbound MD 28.

Northbound (PM Peak Period)

7. Capital Beltway in Maryland at the I-270 West Spur / I-495 split.
8. I-270 West Spur at the merge from Democracy Boulevard.
9. I-270 West Spur general purpose lanes.
10. I-270 mainline just beyond the mainline / CD Road split.
11. I-270 CD Road north of MD 189.
12. I-270 CD Road between Shady Grove Road and I-370.

After identifying the locations of recurring congestion, the causes of the congestion were considered along with modifications that could potentially alleviate the congestion and improve overall traffic operations. These potential causes and possible improvements are shown on Table D-1.

3. Traffic Analysis

All potential short-term improvements presented in Table D-1 were considered and the following solutions were determined to be feasible and should be analyzed using the existing CORSIM network for the study corridor:

1. **Southbound Improvement 1** – Extend deceleration lane on shoulder of I-495 (improvement ***a*** in Table D-1).
2. **Southbound Improvement 2** – Operate the HOV lane on the I-270 West Spur as a peak period HOT or general purpose lane (improvement ***c*** in Table D-1).

Table D-1: Potential Causes and Possible Improvements to Alleviate Congestion

Location of Congestion	Potential Cause of Congestion	Possible Modifications to Alleviate Congestion
Southbound (AM Peak Period)		
1. Capital Beltway in Maryland prior to the exit to MD 190	Congestion on the exit ramp to MD 190 backs onto the mainline	a) Extend deceleration lane on shoulder of I-495 b) Modify the ramp terminal intersections
2. I-270 West Spur general purpose lanes	HOV lane is underutilized while general purpose lanes are congested	c) Operate the HOV lane as a peak period HOT or general purpose lane
3. I-270 West Spur prior to the merge from EB Democracy Boulevard	Heavy volume of merging traffic from the Democracy Boulevard eastbound entrance ramp	d) Extend acceleration lane on shoulder of the I-270 West Spur to the I-495 / I-270 West Spur interchange
4. I-270 mainline approaching the Y-Split interchange	Congestion backs from congestion on I-270 West Spur (2 and 3 above)	e) See modifications to 2 and 3 above
5. I-270 mainline at the slip ramps entering the mainline from the CD Road	Merging traffic from the CD Road onto mainline.	f) Extend the slip ramp acceleration lanes on the outside shoulder g) Eliminate the slip ramp entrance north of MD 28 h) Convert the slip ramp south of Gude Drive to a two-lane entrance and eliminate the slip ramp entrance north of MD 28
6. I-270 CD Road at the entrance ramp from eastbound MD 28	Heavy entering volume from MD 28	i) Extend acceleration lane for the CD Road entrance ramp on the right shoulder of the I-270 mainline
Northbound (PM Peak Period)		
7. Capital Beltway in Maryland south of the I-495 / I-270 West Spur interchange	The two general purpose lanes to the I-270 West Spur are congested and cause congestion to queue back into Virginia	j) Modify the split to provide four lanes to the I-270 West Spur and three lanes to I-495. The leftmost lane to I-495 would act as a shared lane that would provide access to both I-270 West Spur and I-495 k) Operate the HOV lane as a peak period HOT or general purpose lane l) Extend the addition of the left (HOV) lane further south in the median shoulder
8. I-270 West Spur prior to the merge from Democracy Boulevard	Heavy volume of merging traffic from Democracy Boulevard westbound entrance ramp	m) Operate the HOV lane as a peak period HOT or general purpose lane n) Add general purpose lane in the median shoulder o) Make the entrance from westbound Democracy Boulevard a lane addition
9. I-270 West Spur general purpose lanes	HOV lane is underutilized while general purpose lanes are congested	p) Operate the HOV lane as a peak period HOT or general purpose lane
10. I-270 mainline just north of the mainline / CD Road split	There is no clear cause for this congestion	q) None
11. I-270 CD Road north of MD 189	Weaving section between CD Road slip ramps	r) Close one of the slip ramps from the mainline to the CD Road
12. I-270 CD Road between Shady Grove Road and I-370	Weaving section between CD Road slip ramps	s) Close one of the slip ramps from the CD Road to the mainline

3. **Southbound Improvement 3** – Extend acceleration lane to the I-270 West Spur / I-495 interchange (improvement ***d*** in Table D-1).
4. **Southbound Improvement 4** – Extend the slip ramp acceleration lanes on the right shoulder of the I-270 mainline by 1,000 feet (improvement ***f*** in Table D-1).
5. **Southbound Improvement 5** – Close the northern of two consecutive slip ramp entrances between MD 28 and Gude Drive (improvement ***g*** in Table D-1).
6. **Southbound Improvement 6** – Extend acceleration lane for MD 28 ramp on right shoulder of CD Road by 1,000 feet (improvement ***i*** in Table D-1).
7. **Northbound Improvement 1** – Modify the I-270 West Spur / I-495 split to provide four lanes to the I-270 West Spur and three lanes to I-495. The leftmost lane to I-495 would act as a shared lane that would provide access to both I-270 West Spur and I-495 (improvement ***j*** in Table D-1).
8. **Northbound Improvement 2** – Convert HOV lane on the I-270 West Spur to a general purpose lane (improvement ***m*** in Table D-1).
9. **Northbound Improvement 3** – Extend the left HOV lane further south on the median shoulder of I-495 and convert HOV to a general purpose lane (improvement ***l*** in Table D-1).
10. **Northbound Improvement 4** – Extend the left HOV lane further south on the median shoulder of I-495.

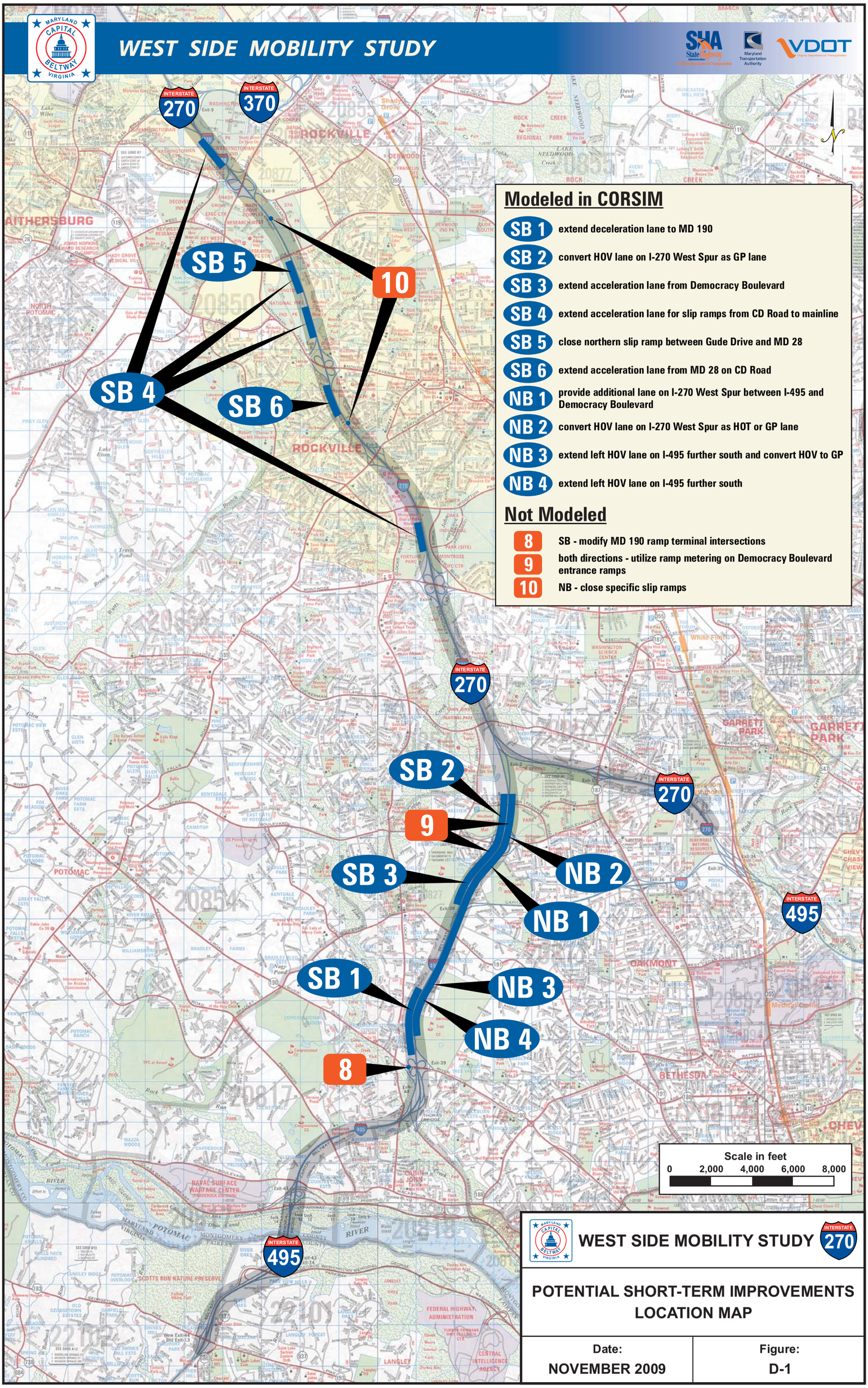
The locations of these improvements are shown on Figure D-1. The ten improvements were analyzed in CORSIM to determine the affect on average delay per vehicle and total delay for all vehicles in both the localized area (i.e. in the vicinity of the congestion point) and for the total system (i.e. the full study corridor). The results of these analyses are presented in Table D-2 and Table D-3. Note that positive (+) percentages indicate longer delays and negative (-) percentages indicate shorter delays.

The traffic analyses indicated that several of the potential short-term improvements would improve traffic operations in the localized area and/or the total system. However, the system-wide improvements would be relatively modest regardless of what improvements or combination of improvements would be implemented.

The largest reduction in delay in the southbound direction would result from implementing improvements 1, 2, 4, and 6, which involve extending acceleration/deceleration lanes and converting the HOV lane on the I-270 West Spur to a general purpose lane. The delay per vehicle and total delay for all vehicles would decrease by 12 and 14 percent, respectively, for the total system.

The largest reduction in delay in the northbound direction would result from implementing improvement 3, which would involve converting the HOV lane on the I-270 West Spur to a general purpose lane and extending the addition of the lane further south on I-495. The delay per vehicle and total delay for all vehicles would decrease by 7 percent.

WEST SIDE MOBILITY STUDY



Modeled in CORSIM

- **SB 1** extend deceleration lane to MD 190
- **SB 2** convert HOV lane on I-270 West Spur as GP lane
- **SB 3** extend acceleration lane from Democracy Boulevard
- **SB 4** extend acceleration lane for slip ramps from CD Road to mainline
- **SB 5** close northern slip ramp between Gude Drive and MD 28
- **SB 6** extend acceleration lane from MD 28 on CD Road
- **NB 1** provide additional lane on I-270 West Spur between I-495 and Democracy Boulevard
- **NB 2** convert HOV lane on I-270 West Spur as HOT or GP lane
- **NB 3** extend left HOV lane on I-495 further south and convert HOV to GP
- **NB 4** extend left HOV lane on I-495 further south

Not Modeled

- **8** SB - modify MD 190 ramp terminal intersections
- **9** both directions - utilize ramp metering on Democracy Boulevard entrance ramps
- **10** NB - close specific slip ramps

WEST SIDE MOBILITY STUDY

POTENTIAL SHORT-TERM IMPROVEMENTS LOCATION MAP

Date:	Figure:
NOVEMBER 2009	D-1

Table D-2: Traffic Affects of Potential Southbound Short-Term Improvements

Improvement	Localized		Total System (Mainline GP Lanes)		Comments
	Avg. Delay (min/veh-mile)	Total Delay (veh-hour)	Avg. Delay (min/veh-mile)	Total Delay (veh-hour)	
Existing	-	-	0.56	4,742	
Southbound Improvement 1	0% (GP)	0% (GP)	0.54 (-4%)	4,637 (-2%)	• May require additional model runs to ensure consistency and correct results. • May require additional field observations to determine cause of congestion. • Would eliminate right shoulder pull-off area for 500'.
Southbound Improvement 2	-5% (GP) -36% (CD)	-16% (GP) -29% (CD)	0.51 (-9%)	4,394 (-7%)	• Both I-270 Mainline and CD Road are improved more than 10% in travel time and speed.
Southbound Improvement 3	+29% (GP)	+28% (GP)	0.57 (+2%)	4,842 (+2%)	• The ramp merging point would be too close to I-495 merging downstream, which would deteriorate traffic.
Southbound Improvement 4	-3% (GP) -30% (CD)	-2% (GP) -23% (CD)	0.52 (-7%)	4,451 (-6%)	• Nominal improvements on I-270 mainline. • CD Road improved about 20% in travel time and speed. • Would eliminate right shoulder pull off areas for 1,000'
Southbound Improvement 5	+2% (GP) +125% (CD)	+2% (GP) +106% (CD)	0.62 (+11%)	5,231 (+10%)	• The heavy merge after combining two slip ramps would deteriorate traffic operations.
Southbound Improvement 6	-19% (CD)	-15% (CD)	0.54 (-4%)	4,661 (-2%)	• Slight improvement on I-270 CD Road. But it would not solve the congestion on MD 28 EB Ramp. • Would eliminate right shoulder for 1,000'
Southbound All Improvements combined	-	-	0.52 (-7%)	4,513 (-5%)	
SB Improvements 1, 2, 4, and 6 only	-	-	0.48 (-14%)	4,171 (-12%)	

Table D-3: Traffic Affects of Potential Northbound Short-Term Improvements

Improvement	Localized		Total System (Mainline GP Lanes)		Comments
	Avg. Delay (min/veh-mile)	Total Delay (veh-hour)	Avg. Delay (min/veh-mile)	Total Delay (veh-hour)	
Existing	-	-	1.39	11,819	
Northbound Improvement 1	+82% (I-270) -14% (I-495)	+85% (I-270) -5% (I-495)	1.38 (-1%)	11,658 (-1%)	• The overall system has very slight improvement. • Traffic in the additional lane would need to merge into the mainline before the exit to EB Democracy Blvd., merely relocating the bottleneck further north from I-270/I-495 split.
Northbound Improvement 2	-33% (I-270) -36% (I-495)	-30% (I-270) -32% (I-495)	1.37 (-1%)	11,494 (-3%)	• The additional capacity would improve both the I-270 West Spur and I-495 inner loop south of the I-270 West Spur / I-495 split. • However, the overall system has slight improvement due to the limited downstream capacity.
Northbound Improvement 3	+8% (I-270) -43% (I-495)	+17% (I-270) -37% (I-495)	1.29 (-7%)	11,018 (-7%)	• I-495 inner loop south of I-270 split is improved with this extension. • The extended left lane carries more traffic to I-270 West Spur and causes more delay on I-270 West Spur.
Northbound Improvement 4	-7% (I-270) -30% (I-495)	-7% (I-270) -30% (I-495)	• Total system operations (speeds) would improve slightly during the peak hour, but the LOS would not be improved.		
NB All Improvements 1, 2, and 3 combined	This scenario was not run because Improvement 1 and Improvement 2 are not likely to be implemented together.				
NB Improvements 2 and 3 only	No need to run this scenario because Improvement 2 is embedded within Improvement 3.				

4. Summary

Following an evaluation of the existing congestion throughout the study corridor and the short-term improvements that could be implemented to alleviate the congestion, SHA analyzed the affect that the feasible short-term improvements could have on traffic operations. The evaluation of these potential short-term improvements indicated that some improvements, or combination of improvements, would result in modest improvements in system-wide traffic operations.

It would be desirable to improve traffic operations for the entire study corridor and provide a comprehensive system-wide improvement, which would not result from implementation of one or more short-term improvements. However, because several of the short-term improvements, and/or combination of short-term improvements would provide some benefit to local and system-wide traffic operations, it was determined that these improvements should be considered further.

Due to the preliminary nature of the study, it has not been determined if the short-term improvements would be evaluated along with the long-term alternative and mid-term improvements as part of a subsequent planning study or if they would be investigated as part of an independent study. In addition, the short-term improvements could potentially be funded through a variety federal programs, and if any of the improvements are chosen to be implemented, such funding sources could be considered.

E. MID-TERM IMPROVEMENTS

1. Introduction

Due to the high cost and impacts associated with the long-term alternatives, it was determined that an intermediate approach should be investigated. Therefore, a series of mid-term improvements were considered that would provide increased capacity and a managed lanes network throughout the study corridor, but would require little or no widening. The mid-term improvements would be more extensive than the short-term improvements and would therefore take longer to implement, but would be less costly and impactive than the long-term improvements.

Several methods were considered to provide additional capacity within the existing highway typical section. The operational characteristics of the potential mid-term alternatives were considered and then the preferred approach was evaluated in greater detail as discussed below.

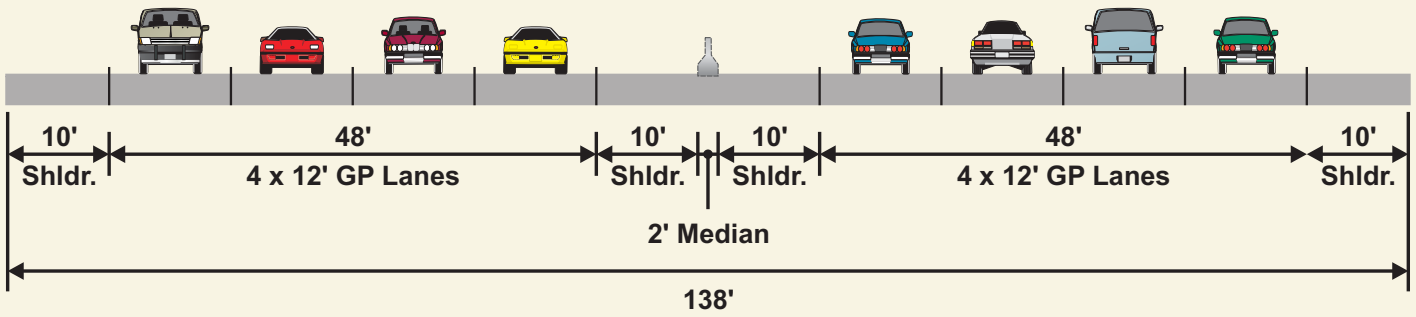
2. Potential Improvements

SHA considered five mid-term improvements that would provide increased capacity and a managed lane system throughout the study corridor.

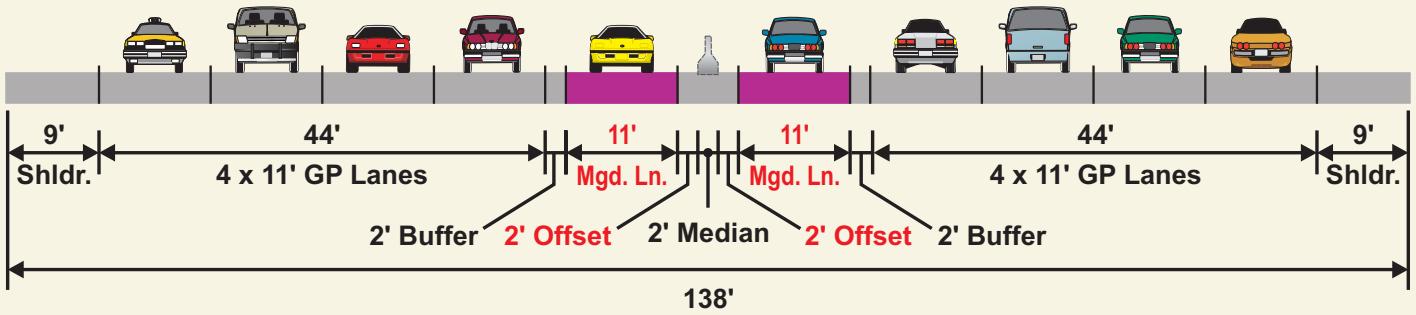
Restriping
The existing highway, with the exception of the I-270 East Spur, would be restriped to provide one additional lane in each direction. The additional lane would be created by narrowing the width of the existing lanes and shoulders. In general, restriping would result in 11-foot lanes, a 2-foot median offset, a 9-foot outside shoulder, and a 2-foot buffer between the managed lanes and general purpose lanes. The existing HOV lanes on the I-270 West Spur and I-270 mainline would be converted to managed lanes. The resulting typical section would provide a one-lane managed system on the Capital Beltway and I-270 West Spur and a two-lane managed system on the I-270 mainline.

The proposed typical sections for restriping are shown in Figures E-1 through E-3.

Peak Period Left Shoulder Use
Along the Capital Beltway, I-270 West Spur, and I-270 mainline, the existing left shoulder would be used as a travel lane during the peak periods only. This lane would provide additional capacity when required, but maintain the left shoulder for breakdowns, enforcement, and incident management during non-peak periods. The existing highway would be modified to permanently reduce the left two lanes in each direction from 12-feet wide to 11-feet wide, which would provide room for a 11-foot peak period lane with a 1-foot offset from the median concrete traffic barrier. The right shoulder would not be narrowed. The existing HOV lanes on the I-270 West Spur would be converted to general purpose lanes and the peak period shoulder lane could be operated as a managed lane. The existing HOV lanes on the I-270 mainline could be converted to general purpose lanes or maintained as managed lanes. Throughout the corridor the peak period shoulder lane could be operated as a managed lane, providing a one-lane managed system on the Capital Beltway and the I-270 West Spur and a one or two-lane managed system on the I-270 mainline.



EXISTING CONDITIONS



RESTRIPING - 11' Lanes With Reduced Right Shoulder and Managed Lanes Buffer

Not to scale

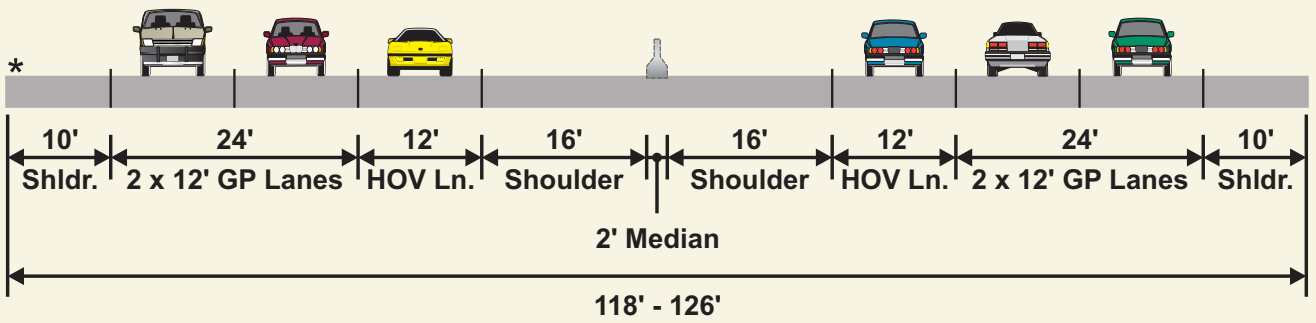
LEGEND

- Existing Pavement
- Managed Lanes (HOV, HOT or ETL)
- New Pavement

WEST SIDE MOBILITY STUDY

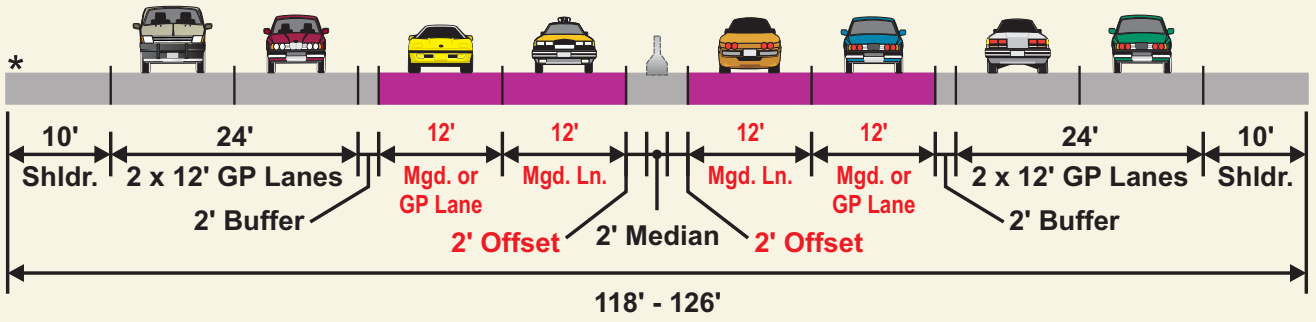
MID-TERM IMPROVEMENTS
RESTRIPING - CAPITAL BELTWAY

Date	Figure
NOVEMBER 2009	E-1



* Narrow Paved Shoulder (2') from Democracy Blvd. to I-495 Merge

EXISTING CONDITIONS



RESTRIPING OR LEFT SHOULDER USE OR RIGHT SHOULDER USE

Not to scale

LEGEND

- Existing Pavement
- Managed Lanes (HOV, HOT or ETL)
- New Pavement

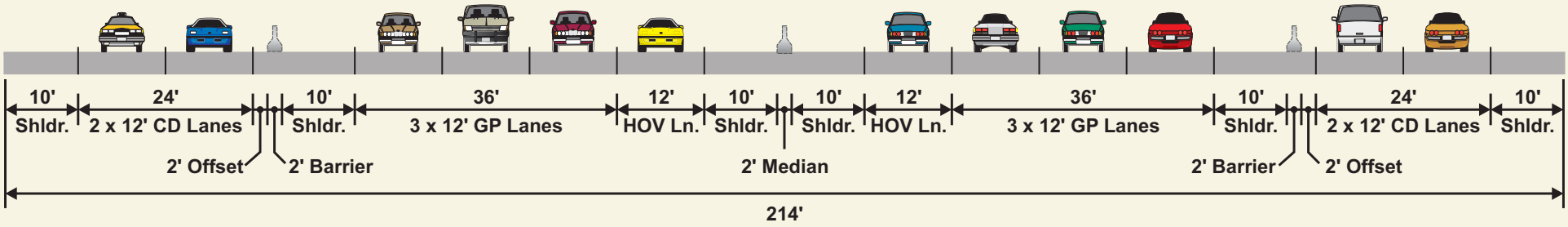
NOTES

- Additional SB lane from 'Y' split to Democracy Blvd.

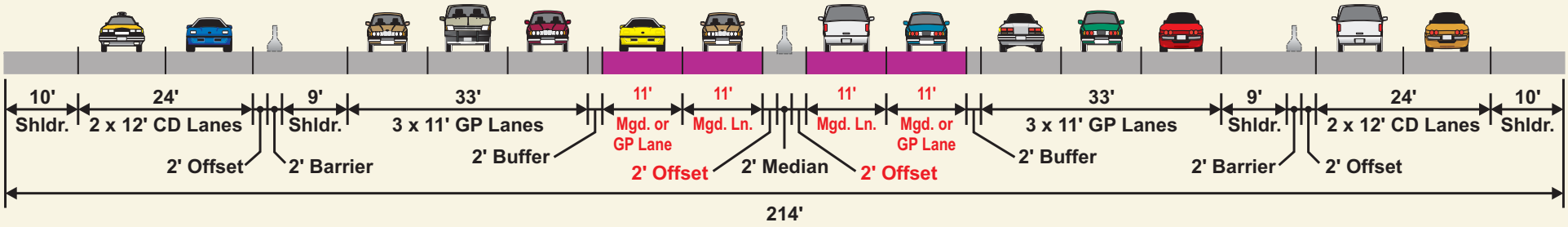
WEST SIDE MOBILITY STUDY

MID-TERM IMPROVEMENTS
RESTRIPING - I-270 WEST SPUR

Date	Figure
NOVEMBER 2009	E-2



EXISTING CONDITIONS



LEFT SHOULDER USE

Not to scale

LEGEND

- Existing Pavement
- Managed Lanes (HOV, HOT or ETL)
- New Pavement

NOTES

- There is an additional SB CD Lane from I-370 to Shady Grove.

WEST SIDE MOBILITY STUDY 270

MID-TERM IMPROVEMENTS
RESTRIPING - I-270 MAINLINE

Date	Figure
NOVEMBER 2009	E-3

The shoulder lane would be designated as opened or closed through the use of static signs and lane-use control signals mounted over the lane. Similar lane-use signals are used on I-66 in Northern Virginia and other highways that employ peak period shoulder use.

The proposed typical section for peak period left shoulder use on the Capital Beltway is shown in Figure E-4. Similar lane and shoulder width adjustments would occur on the I-270 West Spur and I-270 mainline.

Peak Period Right Shoulder Use

Along the Capital Beltway, I-270 West Spur, and I-270 mainline, the existing right shoulder would be used as a travel lane during the peak periods only. This would provide additional capacity when it is required but maintain the right shoulder for breakdowns, enforcement, and incident management during non-peak periods. The existing highway would be modified to reduce the right lane in each direction from 12-feet wide to 11-feet wide, which would provide room for an 11-foot peak period lane and zero right shoulder. The remaining lanes and left shoulder would not be narrowed.

Further investigation would be required to determine if the existing HOV lanes on the I-270 West Spur and I-270 mainline would be converted to managed lanes when the peak period shoulder lane is in operation. Similarly, operating the left lane on the Capital Beltway as a managed lane when the peak period shoulder lane is in operation would also have to be considered. Additional investigation would also be needed to determine how the peak period shoulder lane would operate within the CD Road section of the I-270 mainline where slip ramp entrances and exits currently utilize portions of the right shoulder.

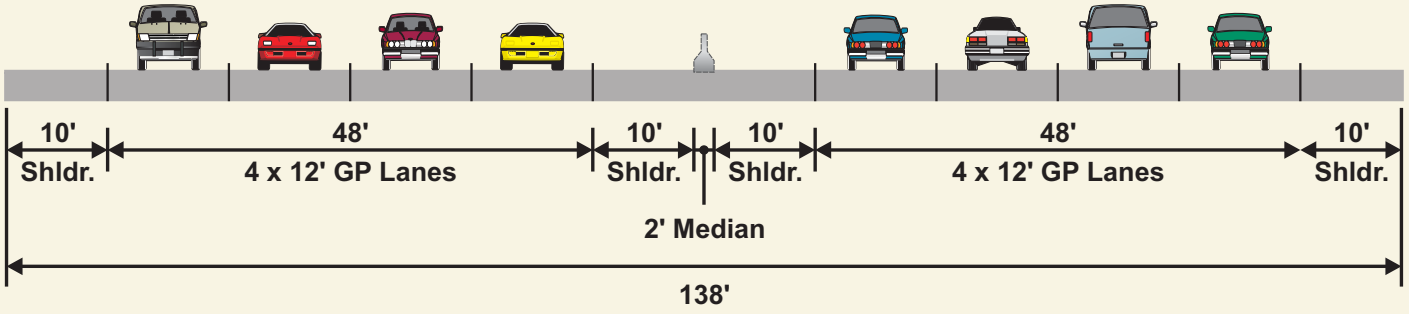
The shoulder lane would be designated as opened or closed through the use of static signs and lane-use control signals mounted over the lane. Similar lane-use signals are used on I-66 in Northern Virginia and other highways that employ peak period shoulder use.

The proposed typical section for peak period right shoulder use on the Capital Beltway is shown in Figure E-5. Similar lane and shoulder width adjustments would occur on the I-270 West Spur and I-270 mainline.

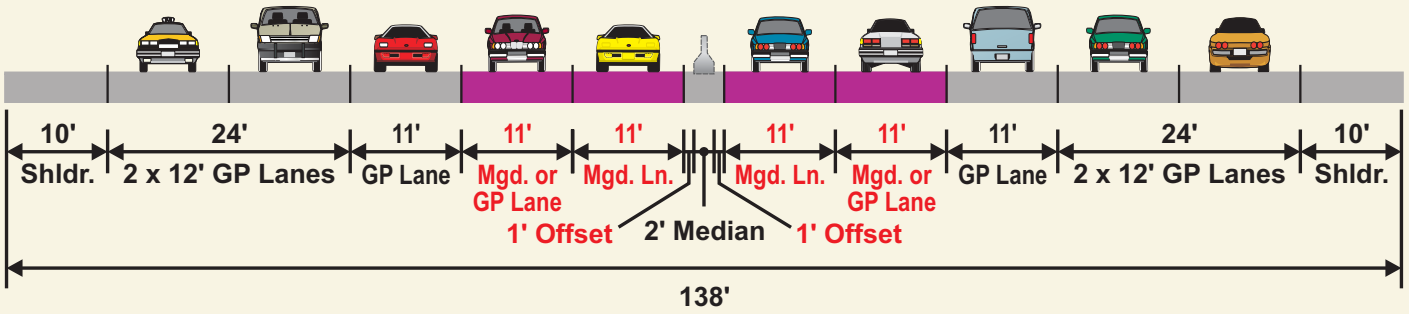
Reversible Lanes

The use of reversible lanes along the I-270 mainline and I-270 Spurs was previously investigated by SHA. The reversible lane system would extend from south of Father Hurley Boulevard along the I-270 mainline to just north of the Capital Beltway on both I-270 Spurs. During the peak period, one lane in the non-peak direction would be operated as a contra-flow lane for peak direction traffic. The contra-flow lane would be separated from the non-peak direction traffic by a movable barrier and from the peak direction by the median. The movable barrier would by placed along the lane line between the left and second to left lanes when deployed and against the median barrier when not deployed. The widths of the contra-flow lane, adjacent non-peak direction lanes, and median shoulder would all have to be reduced slightly to accommodate the movable barrier. When the movable barrier is deployed, the contra-flow lane would not have a right shoulder and the non-peak traffic would not have a left shoulder.

The movable barrier would be positioned through the use of one or more barrier moving machines. During non-peak periods, the existing highway configuration would be provided (i.e. no contra-flow lanes).



EXISTING CONDITIONS



LEFT SHOULDER USE

Not to scale

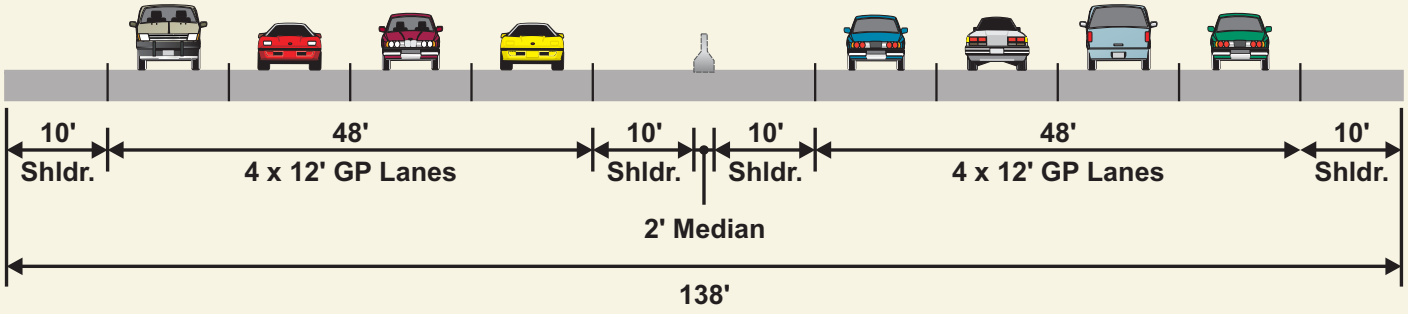
LEGEND

- Existing Pavement
- Managed Lanes (HOV, HOT or ETL)
- New Pavement

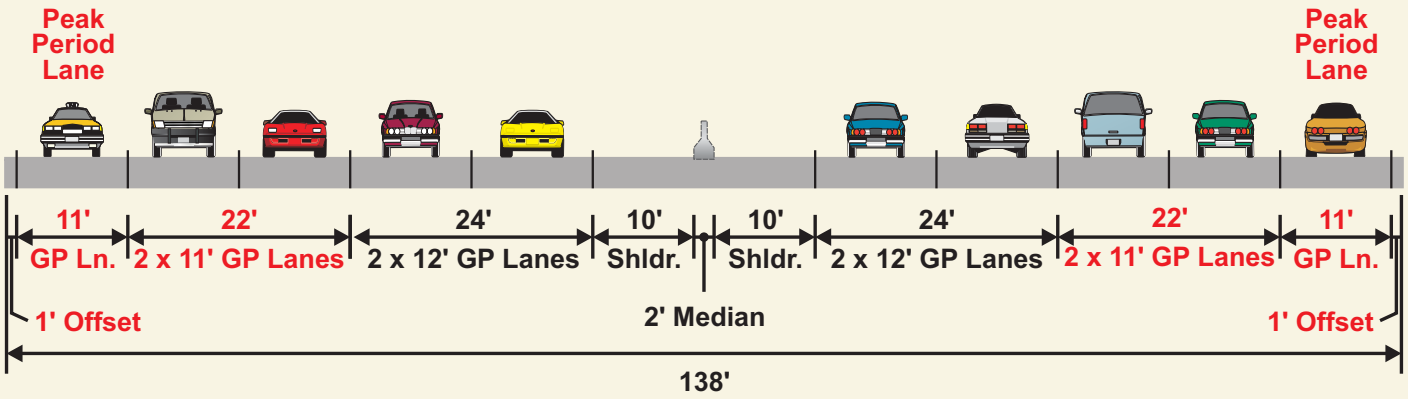
WEST SIDE MOBILITY STUDY

MID-TERM IMPROVEMENTS - PEAK PERIOD LEFT SHOULDER USE

Date	Figure
NOVEMBER 2009	E-4



EXISTING CONDITIONS



RIGHT SHOULDER USE

Not to scale

LEGEND

- Existing Pavement
- Managed Lanes (HOV, HOT or ETL)
- New Pavement

NOTES

- There is a 3-lane CD Road along the outer loop between the George Washington Parkway and SR 193.

WEST SIDE MOBILITY STUDY

MID-TERM IMPROVEMENTS - PEAK PERIOD RIGHT SHOULDER USE

Date	Figure
NOVEMBER 2009	E-5

The proposed typical sections for the reversible lanes are shown in Figure E-6.

The full study is detailed in the I-270 Movable Barrier Feasibility Technical Memorandum prepared by SHA in 2007.

Convert HOV Lanes to Managed Lanes
This improvement would convert the existing HOV lanes on the I-270 Spurs and I-270 mainline to managed lanes. All existing lane and shoulder widths would be maintained. There would be no improvements to the Capital Beltway. The managed lanes would likely be operated full time, as opposed to the peak period and peak direction operation of the existing HOV lanes. The resulting system would provide a one-lane managed lane system on the I-270 Spurs and I-270 mainline but no managed lanes on the Capital Beltway. In addition, this improvement would provide no capacity increase on any section of the study corridor.

Preliminary Evaluation of Mid-Term Improvements
SHA considered these five potential mid-term improvements and determined that both reversible lanes and conversion of the existing HOV lanes to managed lanes would not be considered further.

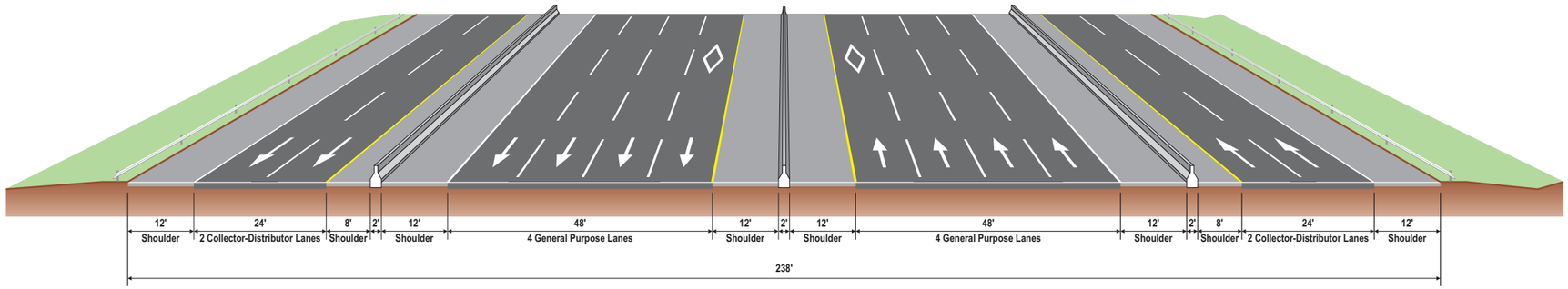
The use of reversible lanes was not preferred because it required the use of a movable barrier system, which included many operational concerns such as time to deploy the barrier; operation at the Y-Split interchange; storage and maintenance of the movable barrier machines, etc. In addition, the movable barrier would require median crossovers and other physical and signing modifications. In addition, it would provide improvements along the I-270 mainline and I-270 Spurs, but would not provide any improvement along the Capital Beltway.

Conversion of the HOV lanes on the I-270 Spurs and I-270 mainline was not considered further because it would not provide an improvement along the Capital Beltway and would only provide managed lanes along the I-270 Spurs and I-270 mainline.

Restriping and peak period shoulder use were considered further. Figure E-7 provides a flow chart that was used to determine the alternative that would appear to provide the most benefits and the general form that the preferred alternative should take. Following the bold red line shown in Figure E-7, the following decisions were made:

1. New capacity should be operated full time and not just during the peak periods. Full time capacity would accommodate additional traffic outside of the traditional AM and PM peak periods, which is especially important on the Capital Beltway where heavy traffic volumes can occur during any period of the day or week. Full time operation would also be less confusing to users, especially non-frequent users of the corridor.

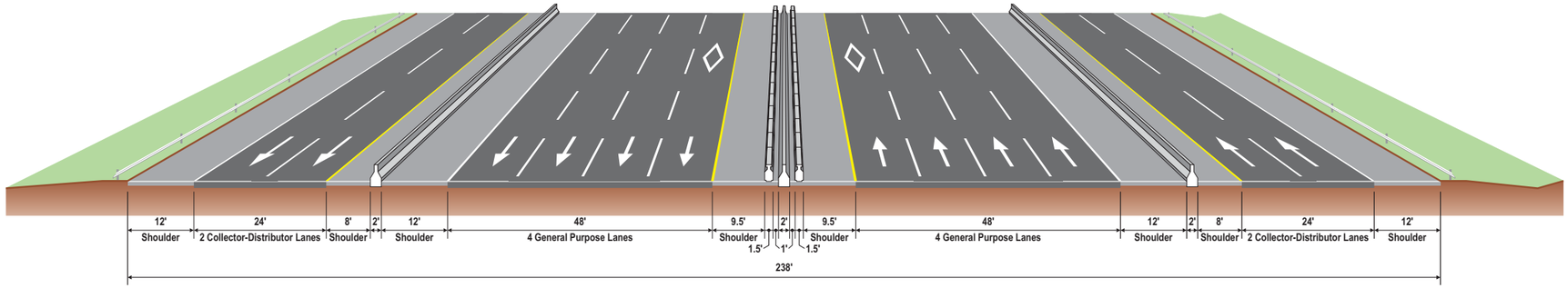
2. New capacity should be operated as managed lanes. This decision would allow at least some of the highway lanes to be managed during the peak periods, which would generally maintain free flow or congestion-free travel in these lanes. If the new lanes were not managed, projected traffic demand indicated that they would become congested during the peak periods soon after opening.



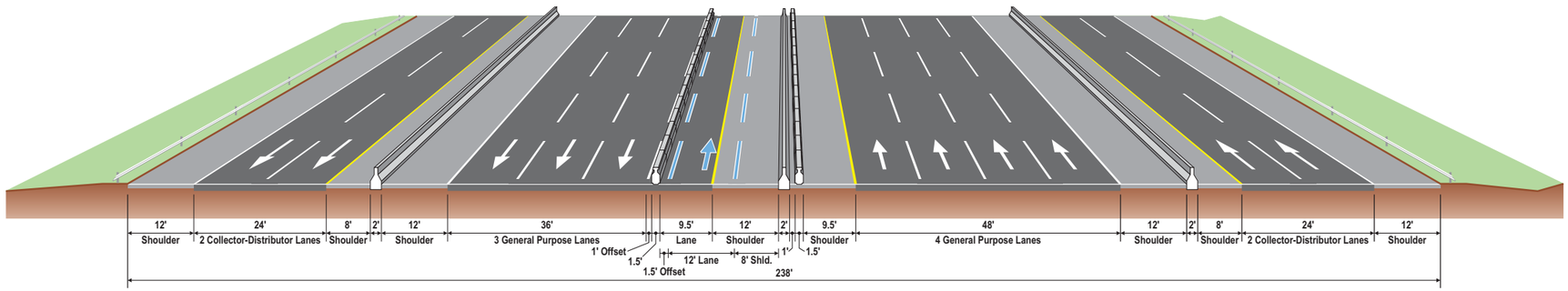
EXISTING OPERATION

8 GENERAL PURPOSE LANES WITH FULL SHOULDERS

- 12-foot travel lanes
- 12-foot shoulders



NEUTRAL OPERATION WITH MOVABLE BARRIER



OPTION 1

PLACE MOVABLE BARRIER ONE-FOOT OFFSET FROM LEFTMOST LANE LINE. CONTRA-FLOW LANE TO USE LEFTMOST LANE AND MEDIAN SHOULDER

- 5 lanes peak direction
- 3 lanes non-peak direction

NOTES: Blue striping and direction arrow for contra-flow lane shown to indicate potential contra-flow path and not actual pavement markings.

Median shoulders are 10' - 12' wide on the East Spur and 16' wide on the West Spur. Dimensions for the median shoulder with the reversible options would vary accordingly from those shown on this sheet for I-270 mainline.

Northbound Collector-Distributor lanes from south of Montrose Road to MD 124. Southbound Collector-Distributor lanes from I-370 to south of Montrose Road.

WEST SIDE MOBILITY STUDY

REVERSIBLE LANE / MOVABLE BARRIER TYPICAL SECTION

Date	Figure
NOVEMBER 2009	E-6

Key Decisions:

1. Should the new lanes be operated full-time or only during peak periods?
2. Should the new lanes be operated as general-purpose lanes or as managed lanes (HOV/HOT/ETL)?
3. Should the reconfigured mainline maintain full (12') lane widths or one full (10') shoulder?
4. If the new lanes are operated as managed lanes, does a left shoulder have to be maintained for enforcement or should a full right shoulder pull-off area be provided?

1 New lanes operated full-time or during peak period only?

- Full-Time
- Peak Period Only

2 New lanes operated as General Purpose or Managed Lanes?

- Managed Lanes
- General Purpose Lanes

3 Maintain full lane widths or 1 full shoulder?

- Full Lane Widths
- Full Shoulder

4 Provide managed lane enforcement or full right shoulder?

- Enforcement
- Full Right Shoulder

Full-Time → Managed Lanes → Full Lane Widths

- Restripe highway to add one lane in each direction.
- Operate one lane in each direction as a full-time managed lane.
- Provides four-foot wide shoulders only.

Full-Time → Managed Lanes → Full Shoulder → Enforcement

- Add one new lane in each direction on right shoulder.
- Operate one lane in each direction as a full-time managed lane.
- Does not provide right shoulder

Full-Time → Managed Lanes → Full Shoulder → Full Right Shoulder

- Add one new lane in each direction on left shoulder.
- Operate one lane in each direction as a full-time managed lane.
- Does not provide left shoulder

Full-Time → General Purpose Lanes → Full Lane Widths

- Restripe highway to add one lane in each direction.
- Operate one lane in each direction as a full-time general-purpose lane.
- Provides four-foot wide shoulders only.

Full-Time → General Purpose Lanes → Full Shoulder

- Add one new lane in each direction on left shoulder.
- Operate the new lane as full-time general-purpose lane.
- Does not provide left shoulder

Peak Period Only → Managed Lanes → Full Lane Widths

- Restripe highway to add one lane in each direction.
- Operate one lane in each direction as a peak period managed lane.
- Provides four-foot wide shoulders only.

Peak Period Only → Managed Lanes → Full Shoulder → Enforcement

- Add one lane in each direction on right shoulder.
- Operate one lane in each direction as a peak period managed lane.
- Does not provide right shoulder

Peak Period Only → Managed Lanes → Full Shoulder → Full Right Shoulder

- Add one lane in each direction on left shoulder.
- Operate one lane in each direction as a peak period managed lane.
- Does not provide left shoulder

Peak Period Only → General Purpose Lanes → Full Lane Widths

- Restripe highway to add one lane in each direction.
- Operate one lane in each direction as a peak period general-purpose lane.
- Provides four-foot wide shoulders only.

Peak Period Only → General Purpose Lanes → Full Shoulder

- Add new lane in each direction on the left shoulder.
- Operate the new lane as a peak period general-purpose lane.
- Does not provide left shoulder.

Full-Time → General Purpose Lanes → Full Lane Widths

- Restripe highway to add one lane in each direction.
- Operate one lane in each direction as a full-time general-purpose lane.
- Provides four-foot wide shoulders only.

WEST SIDE MOBILITY STUDY

MID-TERM IMPROVEMENTS DECISION FLOW CHART

Date	Figure
NOVEMBER 2009	E-7

3. It is preferable to maintain at least one full shoulder as opposed to maintaining all lanes widths and reducing the shoulder widths. A full shoulder would provide an area for vehicles to pull off the mainline lanes during breakdowns or incidents and would allow space for police enforcement.

4. It is preferable to maintain a full right shoulder as opposed to a full left shoulder because right shoulders are a more commonly used area for vehicle breakdowns, incident management, and police enforcement.

As a result of these decisions, SHA determined that restriping would be the preferred mid-term improvement. The general characteristics of the restriping improvement, which would include narrowed lanes and left shoulders, are shown in Figures E-1 through E-3.

Note that in addition to the physical modifications required for implementation of the restriping improvement, or any of the other mid-term improvements considered, Active Traffic Management (ATM) techniques would also have to be employed. ATM consists of an array of strategies used to address the operation of highways. Elements of ATM could include variable speed limits; increased road monitoring through CCTV cameras, traffic loops, and roadside speed detectors; increased incident management; emergency pull-off areas; and increased roadway lighting. The use of ATM may help to alleviate the operational concerns associated with narrowing lanes and narrowing or eliminating shoulders. ATM has been successfully employed throughout Europe and is being extensively applied to motorways in the United Kingdom, especially where peak period shoulder use has been implemented.

3. Preferred Mid-Term Improvement – Restriping

The restriping improvement was identified as the preferred approach for a mid-term improvement. However, when adding capacity to freeways, a number of design and operational issues must be considered before restriping could be implemented. In addition, it is important to understand the potential cost of restriping and associated improvements as well as the revenue that could be generated by the managed lanes, assuming an HOT or ETL operation.

Description

As described in the previous section, restriping would provide one additional lane in each direction throughout the study corridor by narrowing the existing lanes, median shoulder, and the right shoulder. The typical sections for the restriping improvement are shown in Figures E-1 through E-3.

Active Traffic Management (ATM) would also be employed, but the extent and methods of an ATM system would be considered further in a more detailed study.

Design and Operational Concerns

Implementing the restriping improvement would raise a number of design and operational concerns, including the following:

1. Typical section on the American Legion Bridge.
2. Typical sections under bridge overpasses, particularly when bridge piers are located adjacent to the shoulder.
3. Horizontal sight distance resulting from narrowing the left shoulder.
4. The use of narrow (less than 12-feet wide) lanes on interstates/freeways.
5. Potential operational strategies for the managed lanes.

Typical Section on the American Legion Bridge

The American Legion Bridge currently provides five lanes in each direction with 3-foot offsets from the outside and median bridge parapets. The right lane in each direction is an auxiliary lane between the Clara Barton Parkway and George Washington Memorial Parkway interchanges. The existing typical section is shown in Figure B-2 and it does not provide sufficient width to obtain an addition lane as shown in the restriping typical section, Figure E-1.

There are three solutions for this concern and two would provide one additional through lane per direction. The first solution would be to narrow the auxiliary (right) lanes and two median lanes in each direction to 10-feet wide and reduce the offsets from the bridge parapets to 1-foot. The right two mainline lanes, commonly used by large trucks, would remain 12 feet wide. The reduction of lane and offset widths would allow for a new 10-foot wide lane to be added in the median. This option is shown in Figure E-8. The use of 10-foot wide lanes on interstates is not common and could result in operational concerns such as lower free flow speeds and increased collisions, including sideswipe and barrier impact collisions associated with vehicles leaving the travel lane.

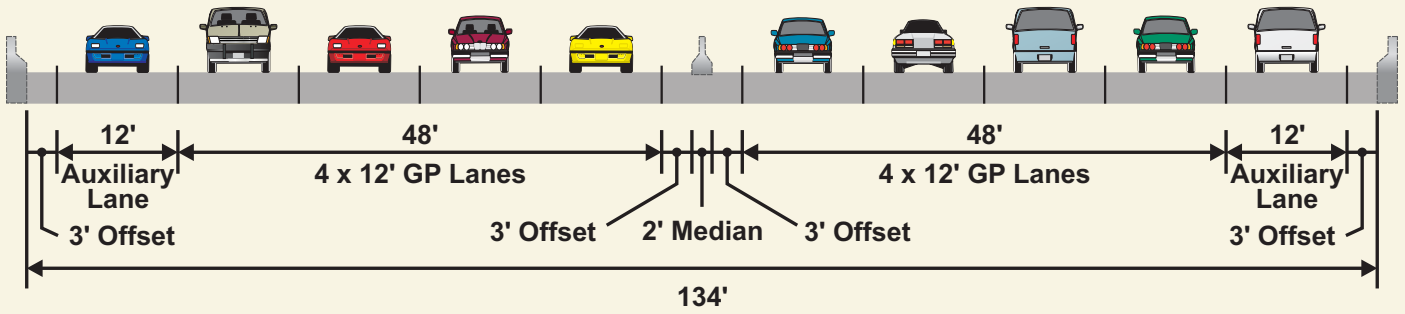
The second solution would be to convert the existing auxiliary (right) lanes to through lanes. This would not require any reduction to the existing typical section on the structure, but it would require widening upstream and downstream of the American Legion Bridge to provide acceleration and deceleration lanes to/from the Clara Barton Parkway and George Washington Memorial Parkway interchanges. This widening would occur within or adjacent to parkland owned by the National Park Service. This type of modification would also raise operational concerns because the heavy volumes on the mainline of the Capital Beltway could make merging from the acceleration lanes difficult, which in turn could congest traffic on the Clara Barton Parkway and George Washington Parkway approaching the Beltway.

The third solution would be to maintain the existing typical section on the bridge as four through lanes and one auxiliary lane per direction. When the adjacent Beltway sections are restriped to provide five through lanes, the bridge would operate as a bottleneck. The fifth lane on both sides of the bridge would be dropped at the adjacent interchanges; this configuration could result in a discontinuous managed lane system.

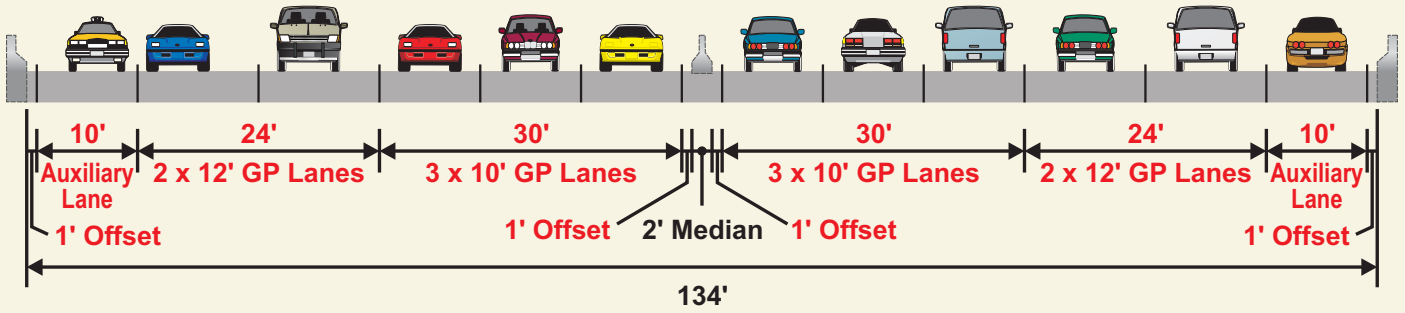
Typical Sections under Bridge Overpasses

There are 21 overpasses within the study limits. Most of these bridges have median bridge piers that are wider than the median traffic barrier and, therefore, result in slightly narrower median shoulders on the mainline under the overpasses. The proposed restriping improvement would provide a two-foot left offset. Under 14 of the 16 overpasses located in Maryland, the left offset would be reduced to one foot and the right shoulder would be reduced to eight feet. The highway would be shifted toward the outside approaching and following an overpass to provide the proposed typical section, which is shown in Figure E-9. If additional offset is required from the median barrier, the right shoulder would have to be further reduced under the overpasses.

Additional information would be needed from VDOT to evaluate the overpasses located in Virginia, but it is likely that the same condition would exist on the Capital Beltway in Virginia and the same adjustments would have to be made.



EXISTING CONDITIONS



RESTRIPING OPTION A

Not to scale

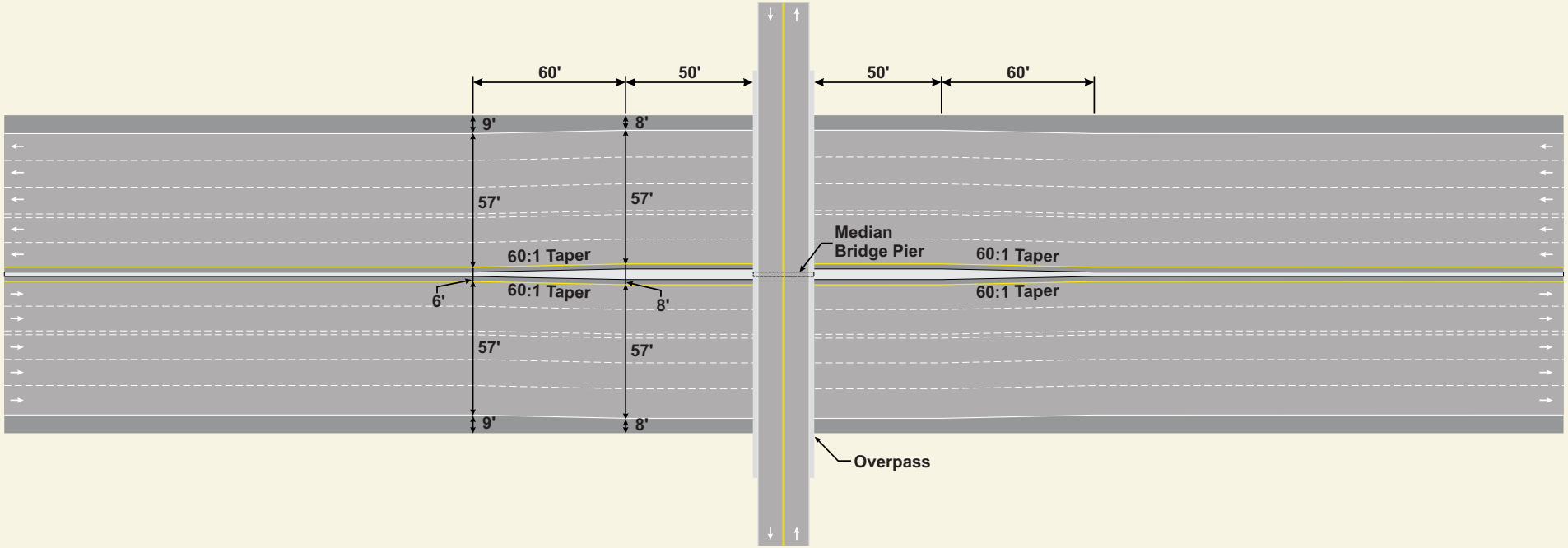
LEGEND

- Existing Pavement
- Managed Lanes (HOV, HOT or ETL)
- New Pavement

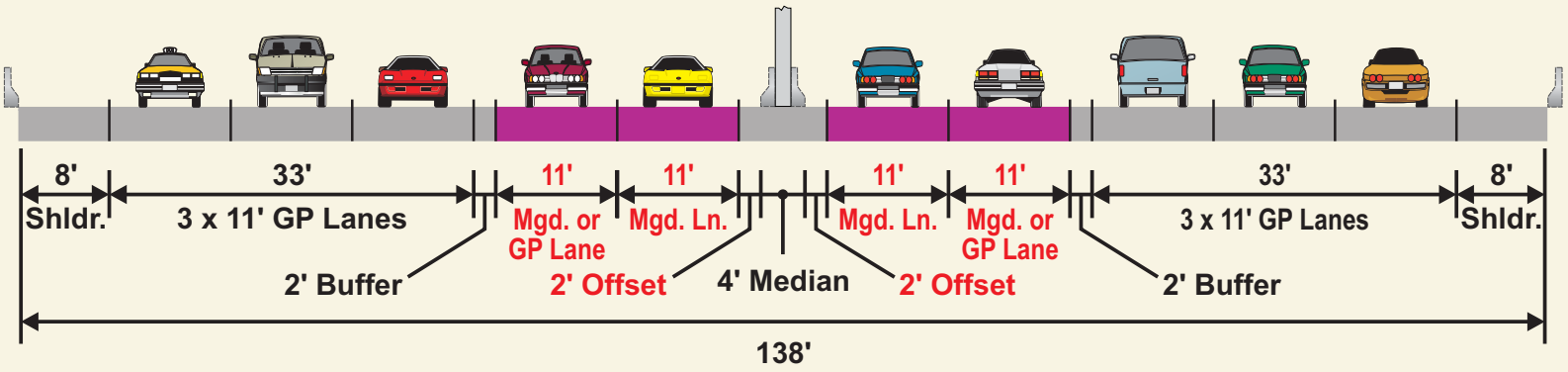
WEST SIDE MOBILITY STUDY

MID-TERM IMPROVEMENTS
AMERICAN LEGION BRIDGE
RESTRIPING OPTIONS

Date	Figure
NOVEMBER 2009	E-8



Lane Transition at Median Bridge Pier



Reduced Typical Section at Median Bridge Piers

Not to scale

LEGEND

- Existing Pavement
- Managed Lanes (HOV, HOT or ETL)
- New Pavement

WEST SIDE MOBILITY STUDY

MID-TERM IMPROVEMENTS
REDUCED RESTRIPING TYPICAL SECTION
UNDER OVERPASSES

Date	Figure
NOVEMBER 2009	E-9

Horizontal Sight Distance Resulting from Narrowing the Left Shoulder

The proposed restriping typical section would reduce the left shoulder to a 2-foot offset, which would reduce the horizontal sight distance for the left lane through the winding sections of the study corridor. In the existing condition, there are four curves with a horizontal stopping sight distance less than that required to meet a 60-mph design speed. With the proposed restriping improvements, there would be nine curves with a horizontal sight distance less than that required to meet a 60-mph design speed, including five curves less than 50 mph. These curves are shown in Figure E-10.

Horizontal curves with reduced sight distance could affect the operations of the highway by resulting in lower free-flow speeds; additional sideswipe and rear end collisions; and other erratic traffic maneuvering resulting from drivers avoiding objects or other vehicles in the left lane or median offset.

To avoid the potential operational affects of reduced horizontal sight distance, the feasibility of localized widening was evaluated to provide sufficient offsets from the median barrier to meet a 60-mph design speed. The details of these horizontal curves, the amount of widening required to meet a 60-mph design speed, and the impacts or issues associated with the localized widening are presented in Table E-1. As shown in the table, the horizontal curves along the Capital Beltway between SR 193 and MD 190 would have the shortest horizontal sight distance, but would also require the most widening and largest impact to meet a 60-mph design speed.

Use of Narrow Lanes on Interstates/Freeways

Lane widths of less than 12 feet wide are not commonly provided on interstates and freeways generally for permanent applications. Nor are a combination of narrowed lanes and shoulders used. As a result, there is not a thorough understanding of the potential operational effects that narrowed lane and shoulder widths could have on freeway operations. Therefore, data gathering and a literature search were conducted on the use of narrow lanes and shoulders on interstates and freeways around the country. The research included a review of applicable design guidelines; relevant technical reports and studies on similar applications; a survey of AASHTO members; and a scan of international design practice.

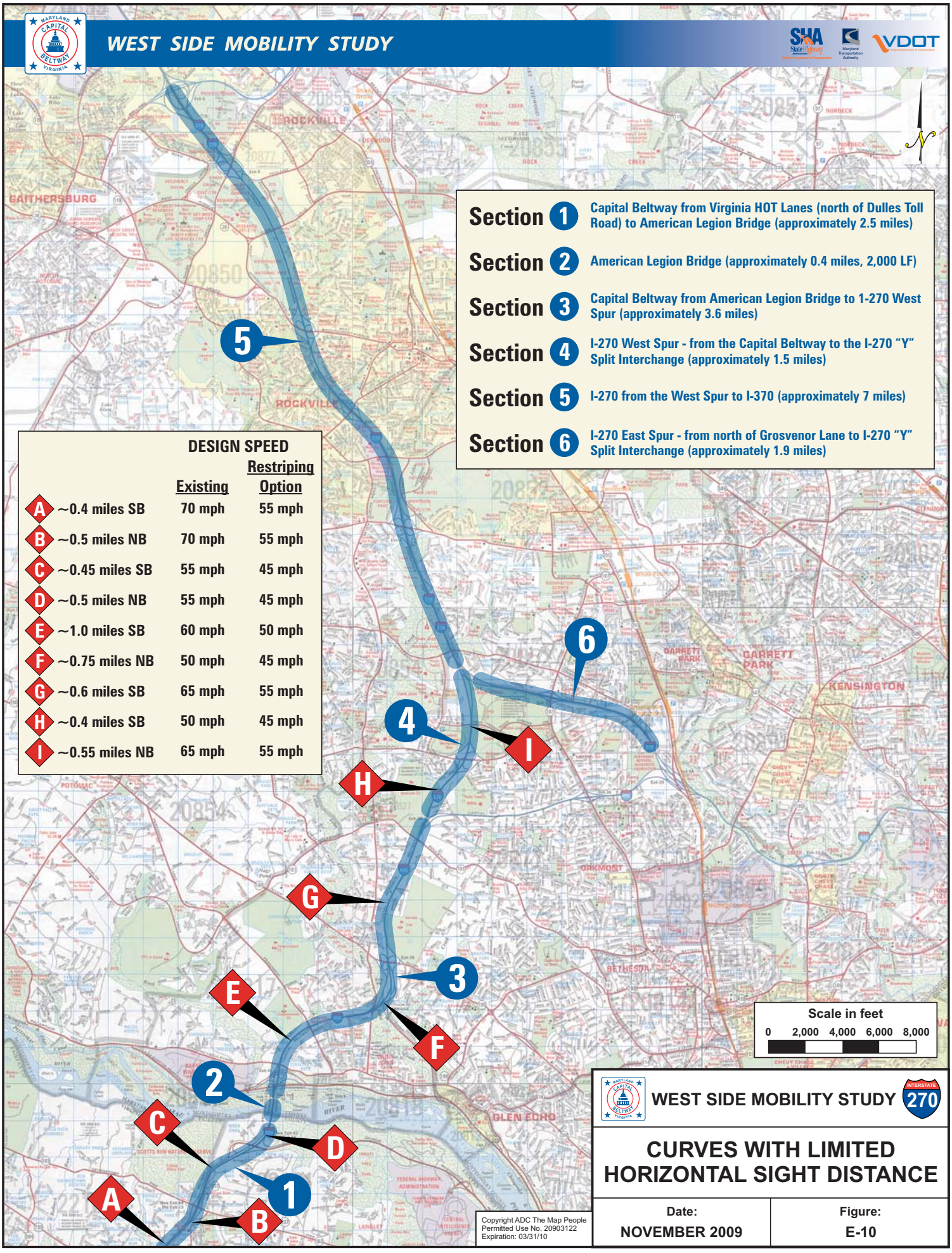
Applicable Design Guidelines

AASHTO guidance provided in *A Policy on Geometric Design of Highways and Streets* (2004) requires 12-foot lanes on freeway. There are no exceptions provided for reduced lanes widths. The Federal Highway Administration's *Mitigation Strategies for Design Exceptions* (2007) states that design exceptions are required for any lane widths on freeways less than 12 feet.

Technical Studies on the Use of Narrow Lanes and Shoulder on Freeway

Six technical reports were identified through the Transportation Research Information Search (TRIS) that were related to the use of narrow lanes and/or shoulders on freeways. These reports are summarized in Table E-2.

The research in the reports indicated that traffic operations and safety were improved, worsened, or unchanged depending on the specific roadway; therefore, the reports did not provide definitive evidence of the effect of narrow lanes and shoulders on freeway operations or safety.


WEST SIDE MOBILITY STUDY
SHA
VDOT
Section 1 Capital Beltway from Virginia HOT Lanes (north of Dulles Toll Road) to American Legion Bridge (approximately 2.5 miles)
Section 2 American Legion Bridge (approximately 0.4 miles, 2,000 LF)
Section 3 Capital Beltway from American Legion Bridge to I-270 West Spur (approximately 3.6 miles)
Section 4 I-270 West Spur - from the Capital Beltway to the I-270 "Y" Split Interchange (approximately 1.5 miles)
Section 5 I-270 from the West Spur to I-370 (approximately 7 miles)
Section 6 I-270 East Spur - from north of Grosvenor Lane to I-270 "Y" Split Interchange (approximately 1.9 miles)
DESIGN SPEED
Existing
Restriping Option
A ~0.4 miles SB 70 mph 55 mph
B ~0.5 miles NB 70 mph 55 mph
C ~0.45 miles SB 55 mph 45 mph
D ~0.5 miles NB 55 mph 45 mph
E ~1.0 miles SB 60 mph 50 mph
F ~0.75 miles NB 50 mph 45 mph
G ~0.6 miles SB 65 mph 55 mph
H ~0.4 miles SB 50 mph 45 mph
I ~0.55 miles NB 65 mph 55 mph
Scale in feet
0 2,000 4,000 6,000 8,000
WEST SIDE MOBILITY STUDY
INTERSTATE 270
CURVES WITH LIMITED HORIZONTAL SIGHT DISTANCE
Date: NOVEMBER 2009
Figure: E-10
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Expiration: 03/31/10

Table E-1: Feasibility of Localized Widening to Provide Adequate Horizontal Sight Distance through Curves

Curve	Location	Length	Horizontal Sight Distance	Potential Impacts/Issues Associated with Localized Widening
A	VA – I-495 SB between Old Dominion Drive and SR 193	2,075’	▪ With 2’ median offset – 535’ (55 mph D.S.) ▪ 3’ median offset would meet 60 mph D.S.	▪ No widening needed; outside shoulder may have to be narrowed to 9±’ wide
B	VA – I-495 NB just south of SR 193	2,675’	▪ With 2’ median offset – 535’ (55 mph D.S.) ▪ 3’ median offset would meet 60 mph D.S.	▪ No widening needed; outside shoulder may have to be narrowed to 9±’ wide
C	VA – I-495 SB between SR 193 and George Washington Pkwy.	2,300’	▪ With 2’ median offset – 340’ (40 mph D.S.) ▪ With 10’ median offset – 490’ (50 mph D.S.)	▪ Would require significant reduction or elimination of outside shoulder ▪ Outside shoulder widening would impact CD Road and barrier
D	VA – I-495 NB between George Washington Pkwy. and ALB	2,600’	▪ With 2’ median offset – 343’ (40 mph D.S.) ▪ With 10’ median offset – 493’ (50 mph D.S.)	▪ Would require significant reduction or elimination of outside shoulder ▪ Outside shoulder widening would require reconstruction of GW Pkwy bridge over the Beltway
E	MD – I-495 SB between Clara Barton Pkwy. and Cabin John Pkwy.	5,425’	▪ With 2’ median offset – 391’ (45 mph D.S.) ▪ With 10’ median offset – 562’ (55 mph D.S.)	▪ Would require widening of bridge over Clara Barton Pkwy
F	MD – I-495 NB within Cabin John Pkwy. interchange	3,850’	▪ With 2’ median offset – 337’ (40 mph D.S.) ▪ With 10’ median offset – 485’ (50 mph D.S. – same as today)	▪ Would require significant reduction or elimination of outside shoulder ▪ Outside shoulder widening would require widening of I-495 bridges
G	MD – I-495 SB between MD 190 and I-270 West Spur	3,125’	▪ With 2’ median offset – 458’ (50 mph D.S.) ▪ 6’ median offset would meet 60 mph D.S.	▪ No widening needed; outside shoulder may have to 6±’ wide
H	I-270 West Spur SB between I-495 and Democracy Blvd.	2,225’	▪ With 2’ median offset – 334’ (40 mph D.S.) ▪ With 10’ median offset – 480’ (50 mph D.S. – same as today)	▪ No widening needed; outside shoulder could be widened without major impacts
I	I-270 West Spur NB between Democracy Blvd. and Y-Split interchange	2,900’	▪ With 2’ median offset – 441’ (50 mph D.S.) ▪ 7’ median offset would meet 60 mph D.S.	▪ Would require minor adjustment of Democracy Blvd. ramps to accommodate widening for shoulder

D.S. – design speed

Table E-2: Studies Evaluating the Use of Narrow Lanes and Shoulders on Freeways

Study / Report	Summary / Description
Safety Impacts of Design Element Trade-Offs – NCHRP 15-27. Anticipated completion Fall 2008. By Nikiforos Stamatiadis.	Study objectives: (1) quantify safety and operational impacts of design elements trade-offs and their associated risks and (2) develop guidelines to assist designers in making reasonable choices among possible design element trade-offs.
Use of Shoulders and Narrow Lanes to Increase Freeway Capacity – NCHRP Report 369 (1995) by J.E. Curren.	Research proved that shoulder use increases capacity. Of the 5 corridors that implemented shoulder use and narrow lanes, 3 had significant increases in accident rates; 2 had decreases in accident rates. Report recommends that shoulder use and narrow lanes be used for widening in areas typically not longer than 1 mile, to provide lane continuity and balance. Although 1-mile segment is recommended, report acknowledges that if traffic flow can be maintained with the alteration, accident levels should not show significant increase. Accident increases appeared to be caused by speed variances between lanes as well as between lanes and ramps. Report suggests that width reduction should be (1) convert lanes to 11 feet, (2) reduce / use inside shoulder, (3) reduce / use outside shoulder.
Mitigation Strategies for Design Exceptions – July 2007 by FHWA.	FHWA-compiled mitigation strategies for implementing design exceptions and minimizing their effects. Generally, drivers shy away from the barrier when there are narrow shoulders and away from cars in adjacent lanes; they have a lessened sense of comfort in narrow lanes. Drivers tend to drive 1.9 mph slower in 11' lanes and 6.6 mph slower in 10' lanes. Speeds also drop slightly if lanes are adjacent to a narrow shoulder. Report recommends certain features be added to freeways with narrow lane/shoulders to increase driver comfort: Road-Narrows signs, wide pavement markings, delineators, improved lighting, and emergency pull off area.
Safety Effects of Narrow Lanes and Shoulder-Use to Increase Capacity of Urban Freeways – TRR #1897 (2004) by K M Bauer, D W Harwood, and K R Richard, and W E Hughes.	Before and after evaluation of accident frequency on California freeways that added a lane by decreasing lane widths or reducing insider shoulder width. Results showed overall accidents increased significantly on segments converted from 4 to 5 lanes, while accidents barely increased on segments converted from 5 to 6 lanes. Results specify that any increase in accidents could not be directly attributed to narrow lane widths and shoulder use, because increase in accidents may have been caused by the simultaneous introduction of HOV lanes, which typically traveled at higher speeds than the adjacent lanes.
Effect of Narrow Lanes on the Capacity of Motorways: A Trial in the Paris Region-Proceedings of the 3rd International Symposium on Highway Capacity: Copenhagen, Denmark, June 1998 by S Cohen.	Study narrowed lanes to reduce the space needed to provide same number of lanes. Implemented in 1996 for a 2.5 km segment. Study found that capacity was almost maintained and congestion levels were equivalent.
California Experience with Inside Shoulder Removal – TRR # 1122 (1987) by T Urbanik and C R Bonilla.	Details safety impacts experienced when California added HOV capacity by reducing inside shoulder and narrowing lanes. Summary documented that the changes either did not change or decreased the overall accident rates. Segments with decreased accident rates thought to be caused by reduction in congestion.

AASHTO Survey
An email survey was distributed to AASHTO members to determine where narrow lanes and/or shoulders had been used on interstates/freeways within the United States. Fifteen states responded to the survey. Eight of the responding states do not have reduced lane widths on interstates, while seven states do have reduced lanes widths. A summary of the responses to the AASHTO survey are provided in Table E-3.

In addition to the fifteen states that responded to the AASHTO survey, both Florida and California have interstates with narrowed lanes and shoulders. The Florida Department of Transportation (FDOT) recently opened the 95Express project in Miami-Dade County with future expansion planned for Broward County. The project provided additional capacity and managed lanes on I-95 without widening. The additional lane was provided by narrowing the several of the existing lane to 11-feet wide and reducing the width of the median shoulder.

In the Los Angeles region, the California Department of Transportation (CALTRANS) operates many HOV facilities that include hundreds of miles where the width of lanes and median shoulder have been reduced to provide needed capacity within the existing highway footprint.

Washington State (WsDOT) was one of the respondents to the AASHTO survey. WsDOT recently opened the SR 167 HOT lanes near Seattle. This project converted the one existing HOV lane in each direction to a HOT lane and reduced lane widths to provide a painted buffer separation between the HOT and general purpose lanes.

International Design Practice
The International Symposium on Highway Geometric Design Practices provided an overview of lane widths on freeways for 21 nations. The range for standard lane width ranged from 11'-6" to 12'-4". These widths are presented in Table E-4.

Potential Operational Strategies for the Managed Lanes
The mid-term restriping improvement would provide one managed lane in each direction on the Capital Beltway and I-270 Spurs and two managed lanes per direction on the I-270 mainline. The potential lane configuration is shown in Figure E-11. It was not determined what type of managed lane or operational strategy would be used for the managed lanes; however, several options were identified. The tie-in with the VDOT HOT Lane project would have to be considered with any operational scenarios, including an effective transition if a non-HOT approach is chosen. These strategies include the following:

- **HOV:** Operate the managed lanes as HOV lanes. The occupancy requirement could be two persons similar to the existing requirement, three persons similar to the proposed VDOT HOT lanes, or some higher number such as seven persons, which would apply to registered vanpools.

- **HOT:** Operate the managed lanes as HOT lanes. HOV users would be permitted in the lane without charge, but single occupancy vehicles (SOV) could pay a toll to use the lane. The occupancy requirement for HOV would have to be determined (2+, 3+, 7+, etc.).

- **ETL:** Operate the managed lanes as Express Toll Lanes (ETL). All users would have to pay a toll to use the lane.

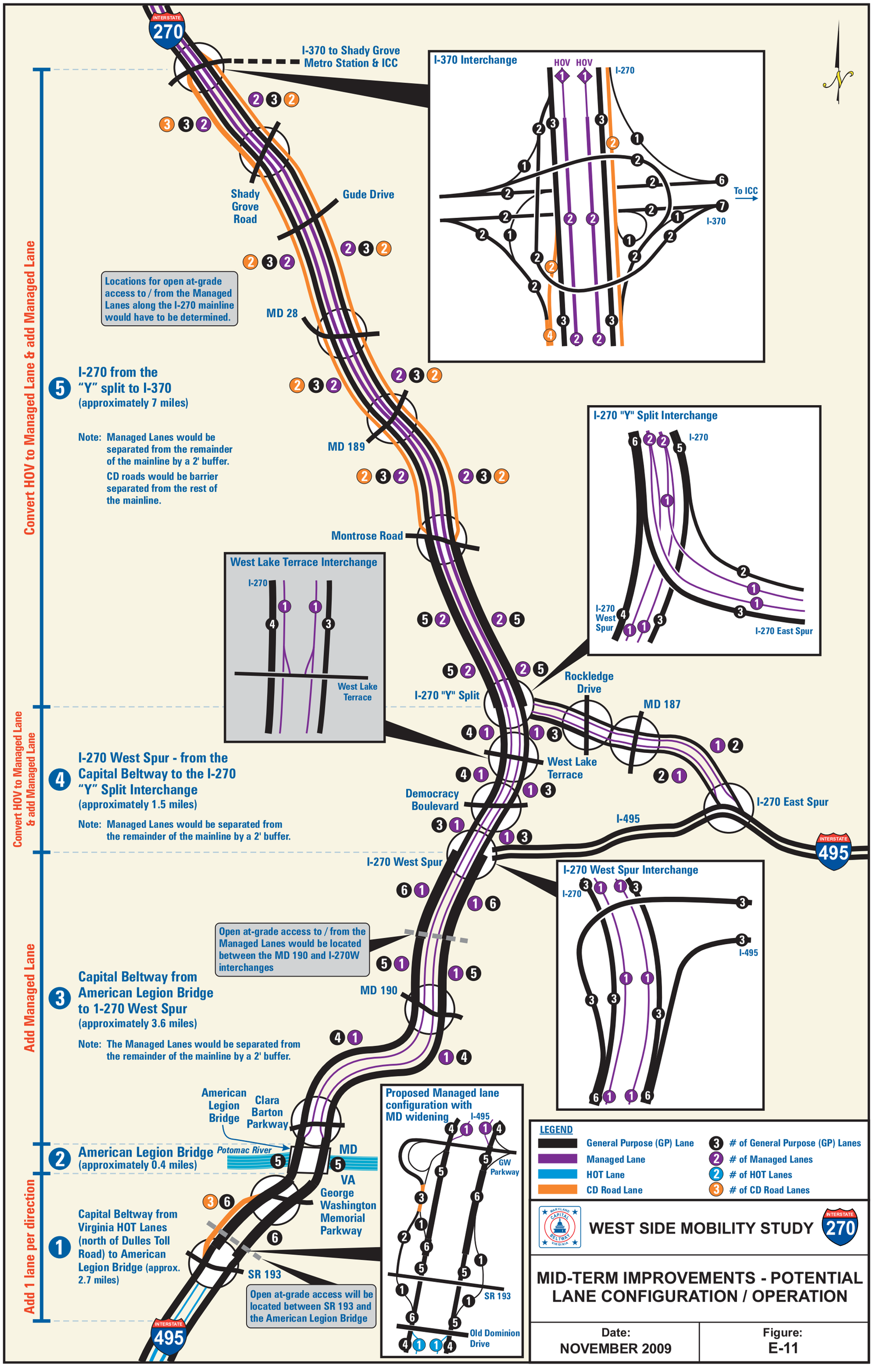

INTERSTATE 270
I-370 to Shady Grove Metro Station & ICC
I-370 Interchange
HOV HOV
I-270
To ICC
I-370
Shady Grove Road
Gude Drive
MD 28
MD 189
Montrose Road
Locations for open at-grade access to / from the Managed Lanes along the I-270 mainline would have to be determined.
Convert HOV to Managed Lane & add Managed Lane
5 I-270 from the "Y" split to I-370 (approximately 7 miles)
Note: Managed Lanes would be separated from the remainder of the mainline by a 2' buffer.
CD roads would be barrier separated from the rest of the mainline.
I-270 "Y" Split Interchange
I-270 West Spur
I-270 East Spur
West Lake Terrace Interchange
West Lake Terrace
I-270 "Y" Split
Rockledge Drive
MD 187
Convert HOV to Managed Lane & add Managed Lane
4 I-270 West Spur - from the Capital Beltway to the I-270 "Y" Split Interchange (approximately 1.5 miles)
Note: Managed Lanes would be separated from the remainder of the mainline by a 2' buffer.
Democracy Boulevard
I-495
INTERSTATE 495
I-270 West Spur Interchange
Add Managed Lane
3 Capital Beltway from American Legion Bridge to 1-270 West Spur (approximately 3.6 miles)
Note: The Managed Lanes would be separated from the remainder of the mainline by a 2' buffer.
Open at-grade access to / from the Managed Lanes would be located between the MD 190 and I-270W interchanges
MD 190
American Legion Bridge
Clara Barton Parkway
2 American Legion Bridge (approximately 0.4 miles)
Potomac River
MD
VA
George Washington Memorial Parkway
Add 1 lane per direction
1 Capital Beltway from Virginia HOT Lanes (north of Dulles Toll Road) to American Legion Bridge (approx. 2.7 miles)
SR 193
Open at-grade access will be located between SR 193 and the American Legion Bridge
INTERSTATE 495
Proposed Managed lane configuration with MD widening
I-495
GW Parkway
SR 193
Old Dominion Drive
LEGEND
General Purpose (GP) Lane
Managed Lane
HOT Lane
CD Road Lane
3 # of General Purpose (GP) Lanes
2 # of Managed Lanes
2 # of HOT Lanes
3 # of CD Road Lanes
WEST SIDE MOBILITY STUDY
INTERSTATE 270
MID-TERM IMPROVEMENTS - POTENTIAL LANE CONFIGURATION / OPERATION
Date: NOVEMBER 2009
Figure: E-11

Table E-3: Responses to AASHTO Survey

State	Response
Arizona	• 11' wide lanes are used in a few locations where space is at a premium, especially on structures • No freeways with reduced shoulder widths exist today, however, some are being considered for future projects
Illinois	• Reduced lane widths on short portions of I-55, I-64, and I-70 near St. Louis • Reduced lane widths on a ¼ mile segment of I-90/I-94 near downtown Chicago • Trucks are permitted in the narrowed lanes • Reduced shoulder widths are used in some locations • Design exceptions were required for the narrowed shoulders
Kentucky	• Reduced lanes and shoulder widths are used on a couple Ohio River bridge crossings (lane and shoulder width reduced to add additional lane of capacity) • Design exceptions were required to narrow the lanes/shoulders • Trucks are permitted in the narrowed lanes
Louisiana	• No freeway lanes with reduced widths • Reduced or eliminated shoulders on some freeways (no shoulders on the I-10 bridge at Whiskey Bay)
Michigan	• No freeway lanes with reduced widths • Reduced shoulders widths are used in some short sections
Mississippi	• No freeway lanes with reduced widths • Reduced shoulder widths or no shoulders are used in isolated sections • Trucks are permitted in all lanes
Montana	• No freeway lanes with reduced widths • 6' wide outside shoulders in some locations due to constraints of adjacent terrain
Oregon	• No freeway lanes with reduced widths • Reduced median shoulder widths in some locations, but full outside shoulders provided • Design exceptions are required for reduced shoulder widths
South Dakota	• No freeways with reduced lane or shoulder widths
Texas	• 11' wide lanes are present in some urban areas • Design exceptions were required for the narrower lanes • Trucks are permitted in the narrowed lanes • No freeway shoulders with reduced widths
Utah	• Reduced lane widths used on 7 miles if I-215 (Salt Lake City) • 2' wide median shoulders used on portions of I-15 (full outside shoulders provided)
Vermont	• No freeways with reduced lane or shoulder widths
Washington	• 11' wide lanes are used on I-90, I-405, and SR 167 • SR 167 has 11' wide lanes with 2' wide inside and 8' wide outside shoulders. Design exception from FHWA required implementation of safety measures • Additional information provided on ATM and the ROD for I-90
West Virginia	• No freeways with reduced lane or shoulder widths
Wisconsin	• 11' wide lanes are present on 3.5 miles of I-94 near Madison • Reduced shoulder widths (< 10' wide for right shoulders; < 6' wide for median shoulders on 4 lane freeways; < 10' wide median shoulders on 6 lane freeways) for over 100 miles including some locations where both shoulders are reduced • Design exceptions are required and Wisconsin has an established procedure

Table E-4: Typical Lane Width Design Values

Country	Freeway Lane Width
Brazil	12’ -4”
China	11’-6” to 12’-4”
Czech Republic	11’-6” to 12’-4”
Denmark	11’-6”
France	11’-6”
Germany	11’-6” to 12’-4”
Greece	11’-6” to 12’-4”
Hungary	12’ -4”
Indonesia	11’-6” to 12’-4”
Israel	12’ -4”
Japan	11’-6” to 12’-4”
Netherlands	11’-6”
Portugal	12’ -4”
South Africa	12’-0”
Spain	11’-6” to 12’-4”
Switzerland	3.75 to 4.0 m
United Kingdom	11’-10”
Venezuela	11’-8”
Yugoslavia (current nations)	11’-6” to 12’-4”

- **HOV Plus HOT:** Operate the new lanes as HOT lanes, but maintain the existing HOV lanes. This particular scenario would only apply on the I-270 mainline and Spurs where there are existing HOV lanes and a proposed two-lane managed facility. On the Capital Beltway, the one managed lane per direction would be operated as an HOT lane. The occupancy requirements for HOV vehicles would have to be determined (2+, 3+, 7+, etc.).

- **HOV Plus ETL:** Operate the new lanes as ETL, but maintain the existing HOV lanes. This particular scenario would only apply on the I-270 mainline and Spurs where there are existing HOV lanes and a proposed two-lane managed facility. On the Capital Beltway, the one managed lane would be operated as an ETL. The occupancy requirements for HOV vehicles would have to be determined (2+, 3+, 7+, etc.).

The operational scenarios will be studied in greater detail as the study moves forward.

Cost

A preliminary cost estimate was developed for the restriping improvement. Costs were developed that did and did not include localized widening to improve horizontal sight distance. These costs are summarized in Table E-5.

Table E-5: Preliminary Cost Estimates for Restriping Improvement (in 2008 dollars)

	Without Localized Widening ($ M)	With Localized Widening ($ M)
Category 1 (MOT)	$21.2	$25.2
Category 2 (Earthwork)	$1.9	$2.1
Category 3 (Drainage / SWM)	$21.4	$25.5
Category 4 (Structures)	$0.0	$8.8
Category 5 (Pavement)	$37.1	$38.4
Category 6 (Shoulders)	$13.9	$13.9
Category 7 (Landscaping)	$0.5	$0.6
Category 8 (Traffic)	$7.9	$7.9
Category 8 (Utilities)	$5.2	$7.1
Localized Widening (CPM)	$0.0	$27.3
Subtotal	**$109.1**	**$156.7**
Contingency (40%)	$43.7	$62.7
Neat Construction	**$152.8**	**$219.4**
Admin / Overhead (15%)	$22.9	$32.9
Preliminary Engineering (15%)	$27.1	$38.9
Total	**$202.8**	**$291.2**

4. Summary

Mid-term improvements would provide additional capacity and a managed lane system throughout the study corridor, but would not incur the expense or impacts associated with the long-term improvements.

The mid-term improvement that appears to offer the most benefits would include restriping the highway to provide one extra lane in each direction. The existing lane and shoulder widths would be reduced to accommodate the additional lane within the existing highway typical section. This restriping improvement should be investigated further.

There are numerous design and operational concerns associated with reducing the lane and shoulder widths within the study corridor. These issues were considered in this initial evaluation, but they would have to be more thoroughly investigated and addressed as the restriping improvement is carried forward in planning and design. Continued investigation of similar projects in other states and countries should be conducted to understand the lessons learned and best approaches to apply these types of modifications. Coordination with FHWA would be essential to ensure that the proposed physical typical section adjustments could pass a design exception.

In addition, the implementation of managed lanes within the study corridor will have to be further considered. More detailed study will be needed to evaluate the type of managed lane system (HOV, HOT, ETL) that should be utilized on these facilities, as well as the connection to the proposed systems on either end of the project limits. Technical considerations such as tolling systems (HOT or ETL), enforcement, and access will also need to be addressed in detail.

Finally, detailed traffic analysis would have to be completed to understand the affect that the restriping alternative would have on highway operations, especially compared to a No-Build condition.

F. CONCLUSIONS

The West Side Mobility Study examined a full range of alternatives that could be implemented to increase capacity and provide a managed lane network on the Capital Beltway and I-270 between the VDOT HOT Lanes Project and the I-270 / I-370 interchange. These improvements include long-term alternatives that would provide additional capacity through widening of the mainline, modifications to existing interchanges, and construction of new direct access interchanges; short-term improvements that would focus on localized solutions to relieve specific congestion points; and mid-term improvements that would provide increased capacity and a managed lanes network within the existing highway typical section.

Seven long-term alternatives were evaluated in this study and all of them would require widening along some or all segments of highway within the study limits. Due to the preliminary nature of the study, detailed engineering was completed for the alternative that would include the largest footprint and impacts (Alternative 4). Traffic analyses were completed for four alternatives (1, 2, 4, and 5) and the results were applied to the other three alternatives. The widening would result in property impacts, displacements, and environmental impacts. Preliminary environmental impacts were quantified for wetlands / Waters of the U.S. and parks adjacent to the highway; however, additional environmental impacts could be expected.

General costs were prepared for all seven of the alternatives ranging between $1.04 billion (in 2008 dollars) for Alternative 1 and $2.65 billion for Alternative 4 (in 2009 dollars; $2.27 billion in 2008 dollars). Generally, the long-term alternatives would improve future traffic operations compared to a No-Build scenario, but congestion would persist in multiple locations along the mainline. Of the seven long-term alternatives evaluated, it was determined that Alternative 1, 4, 5, 5A, and 5B would provide additional capacity and a managed lane network along with improvements to the traffic operations and should be studied further. Alternatives 2 and 3 would not offer as great a benefit and will not be studied further.

A series of short-term improvements were considered that could be implemented to alleviate some of the existing congestion. These improvements were analyzed to determine the effect that they could have on traffic operations. The evaluation of potential short-term improvements indicated that some improvements, or combination of improvements, would result in modest benefits to the system-wide traffic operations. The short-term improvements could be evaluated further as part of a subsequent planning study or broken out as a separate study that could potentially be implemented sooner.

Five mid-term improvements were considered and the restriping option offers the most benefits by providing one full-time, extra lane per direction. However, the existing lane and shoulder widths would be reduced to accommodate an additional lane in each direction within the existing highway typical section. There are a number of design and operational concerns associated with reducing the lane and shoulder widths considered in this initial study, but they would require more thorough investigation as the restriping improvement is carried forward in planning and design.

Finally, the implementation of a managed lane strategy within the study corridor would have to be considered further, along with detailed traffic analyses and revenue analyses for all of these strategies.

APPENDIX A –
LONG-TERM ALTERNATIVE 4 DISPLAY SHEETS

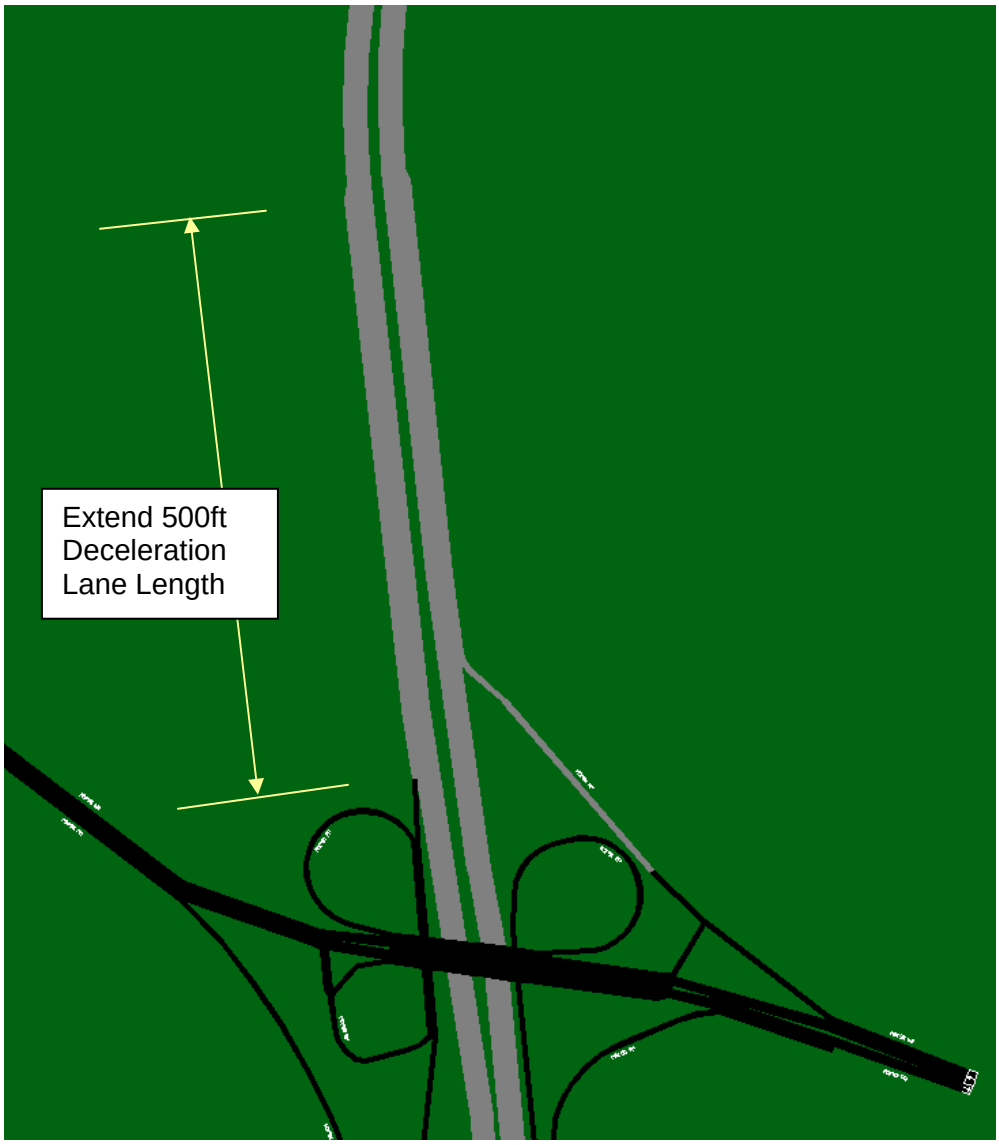
APPENDIX B –
CORSIM RESULTS FOR SHORT-TERM IMPROVEMENTS

Potential Short-term Improvement Comparisons
Southbound AM Peak Hour

	Localized		Total System (Mainline GP)		Comments
	Avg. Delay (min/veh-mile)	Total Delay (veh-hour)	Avg. Delay (min/veh-mile)	Total Delay (veh-hour)	
Existing	-	-	0.56	4742	
SB Improvement 1: Capital Beltway in Maryland SB ➔ *extend deceleration lane on the shoulder from the MD 190 exit by 500'*	0% (GP)	0% (GP)	0.54 (-4%)	4637 (-2%)	• Recommend additional model runs to ensure consistency and correct results. • Consider more field observations to determine cause of congestion. • Would eliminate right shoulder pull-off area for 500'
SB Improvement 2: I-270 West Spur ➔ convert *the HOV lane as a general purpose lane*	-5% (GP) -36% (CD)	-16% (GP) -29% (CD)	0.51 (-9%)	4394 (-7%)	• Both I-270 Mainline and CD Road are improved more than 10% in travel time and speed.
SB Improvement 3: I-270 West Spur ➔ *extend acceleration lane from the Democracy Blvd ramp to the I-270 West Spur / I-495 Interchange*	+29% (GP)	+28% (GP)	0.57 (+2%)	4842 (+2%)	• The ramp merging point would be too close to I-495 merging downstream, which would deteriorate traffic.
SB Improvement 4: I-270 Mainline SB (multiple locations) ➔ *extend slip ramp acceleration lanes on the right shoulder of mainline by 1000'*	-3% (GP) -30% (CD)	-2% (GP) -23% (CD)	0.52 (-7%)	4451 (-6%)	• Nominal improvements on I-270 Mainline. • CD Road improved about 20% in travel time and speed. • Would eliminate right shoulder pull off areas for 1000'
SB Improvement 5: I-270 Mainline SB ➔ *Close the northern of two consecutive slip ramp entrances between MD 28 and Gude Drive*	+2% (GP) +125% (CD)	+2% (GP) +106% (CD)	0.62 (+11%)	5231 (+10%)	• The heavy merge after combining two slip ramps would deteriorate traffic operations.
SB Improvement 6: I-270 CD Road SB ➔ *extend acceleration lane for MD 28 ramp on right shoulder by 1000'*	-19% (CD)	-15% (CD)	0.54 (-4%)	4661 (-2%)	• Slight improvement on I-270 CD Road. But it would not solve the congestion on MD 28 EB Ramp. • Would eliminate right shoulder pull-off area for 1000'
SB All Improvements Combined	-	-	0.52 (-7%)	4513 (-5%)	
SB Improvements 1, 2, 4, and 6 only			0.48 (-14%)	4171 (-12%)	

Pink – worse than existing
Green – better than existing

SB Improvement 1: Capital Beltway in Maryland SB – extend deceleration lane in the shoulder from the MD 190 exit.

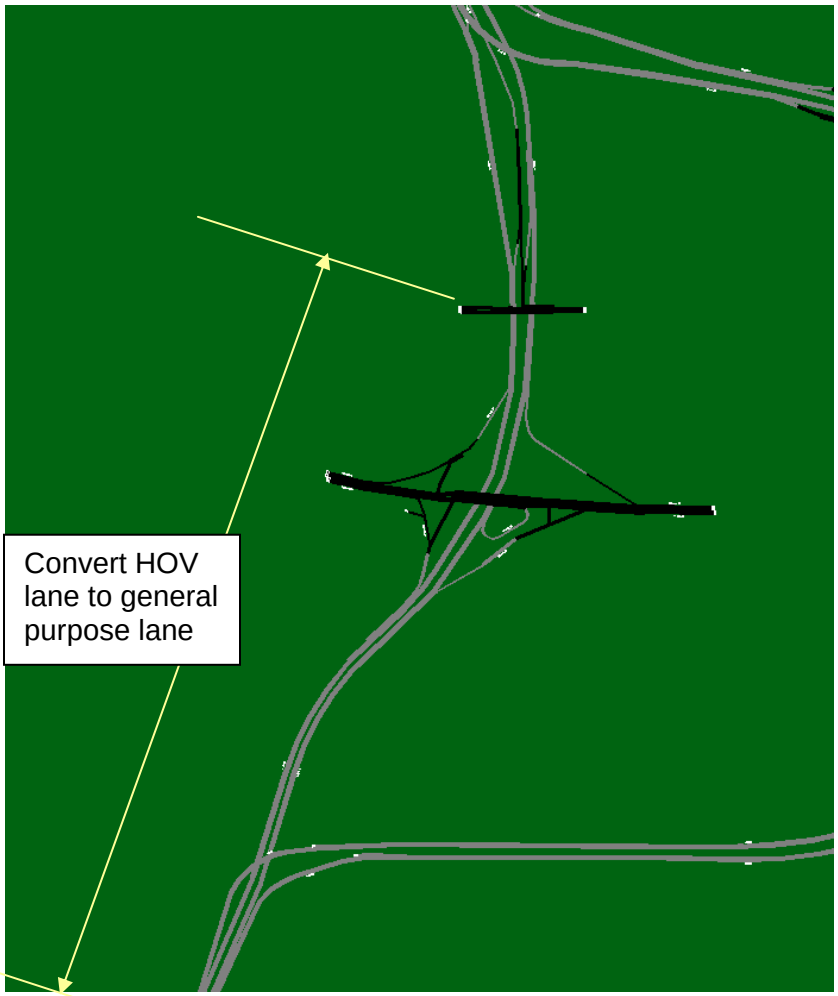


MOE	Existing	SB Improvement 1
Impact Area 1 (Mainline):	**I-495 OL from I-270 to Clara Barton Pkwy (3.2 miles)**	
Travel time (mainline)	3.3 min	3.3 min
Speed (mainline)	30 mph	30 mph
Density (mainline)	58 vpmpl	58 vpmpl
LOS (mainline)	F	F
Impact Area 2 (Exit Ramp):		
Speed (exit-ramp)	22 mph	33 mph
Density (exit -ramp)	46.7 vpmpl	32.7 vpmpl
LOS (exit -ramp)	F	C
Impact Area 1 Avg. Delay	0.19 Min/Veh-Mile	0.19 Min/Veh-Mile
Impact Area 1 Total Delay	70 Veh-Hour	70 Veh-Hour
Total System Avg. Delay	0.56 Min/Veh-Mile	0.54 Min/Veh-Mile
Total System Total Delay	4742 Veh-Hour	4637 Veh-Hour

Comments:

- Recommend additional model runs to ensure consistency and correct results.
- Consider more field observations to determine cause of congestion.

SB Improvement 2: I-270 West Spur – designate the HOV lane on the I-270 West spur (both directions) as a general purpose lane.



MOE	Existing	SB Improvement 2
Impact Area 1 (Mainline):	**I-270 Mainline SB from MD 28 to Beltway (6.0 miles)**	
Travel time	13.8 min	13.4 min
Speed	26 mph	27 mph
Density	75 vpmpl	73 vpmpl
LOS	F	F
Impact Area 1 Avg. Delay	1.45 Min/Veh-Mile	1.38 Min/Veh-Mile
Impact Area 1 Total Delay	1508 Veh-Hour	1484 Veh-Hour
Impact Area 2 (CD):	**I-270 CD Road SB (5.5 miles)**	
Travel time	16.3 min	12.6 min
Speed	20 mph	26 mph
Density	65 vpmpl	55 vpmpl
LOS	F	F
Impact Area 2 Avg. Delay	2.0 Min/Veh-Mile	1.28 Min/Veh-Mile
Impact Area 2 Total Delay	883 Veh-Hour	626 Veh-Hour
Total System Avg. Delay	0.56 Min/Veh-Mile	0.51 Min/Veh-Mile
Total System Total Delay	4742 Veh-Hour	4394 Veh-Hour

Comments:

- Both I-270 Mainline and CD Road are improved more than 10% in travel time and speed.

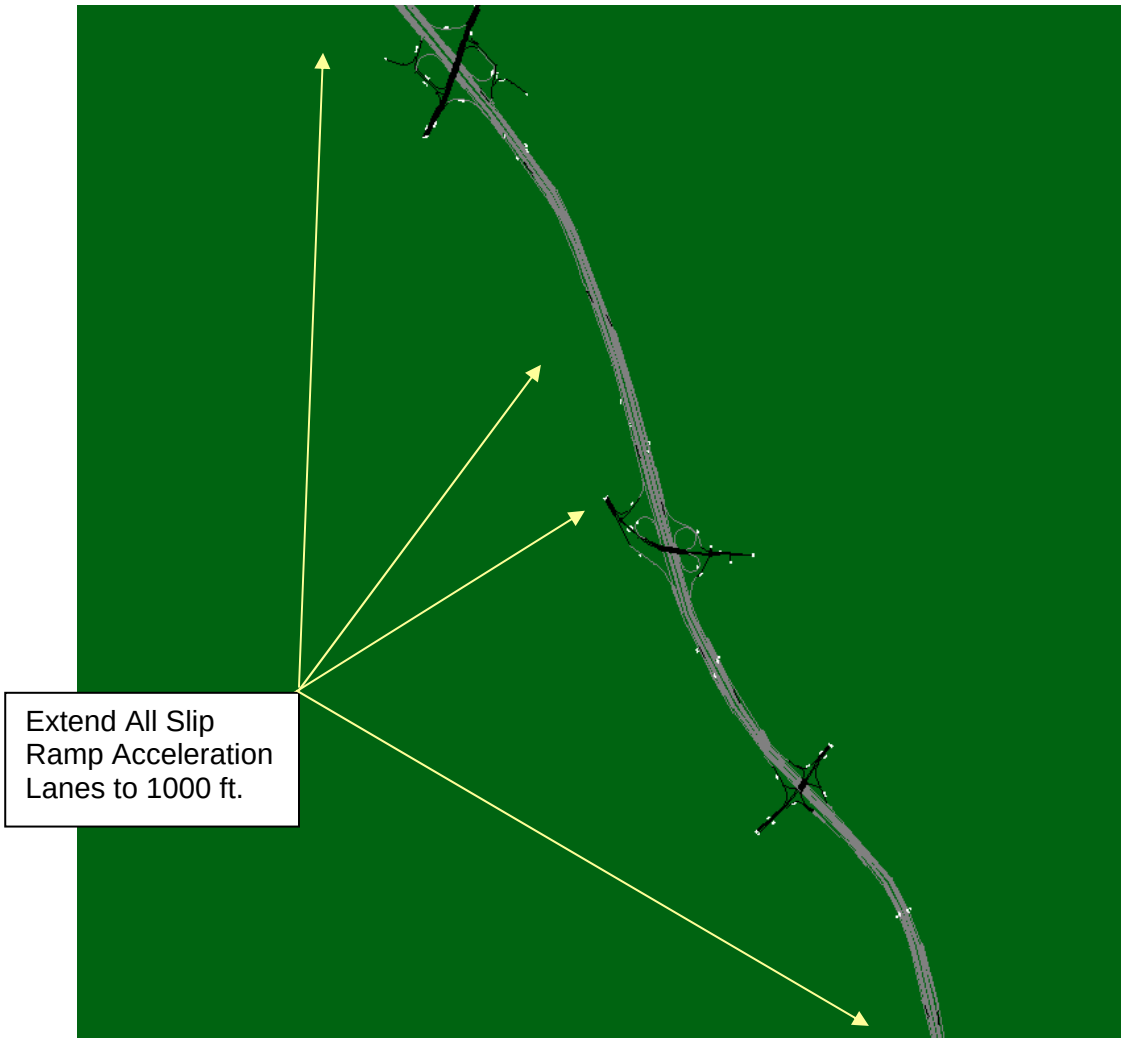
SB Improvement 3: I-270 West Spur – extend acceleration lane from the Democracy Blvd ramp to the I-270 West Spur / I-495 Interchange

MOE	Existing	SB Improvement 3
Impact Area (Mainline):	**I-270 Mainline SB from East Spur to Beltway (1.9 miles)**	
Travel time	4.1 min	4.7 min
Speed	28 mph	24 mph
Density	71 vpmpl	73 vpmpl
LOS	F	F
Impact Area Avg. Delay	1.26 Min/Veh-Mile	1.63 Min/Veh-Mile
Impact Area Total Delay	341 Veh-Hour	435 Veh-Hour
Total System Avg. Delay	0.56 Min/Veh-Mile	0.57 Min/Veh-Mile
Total System Total Delay	4742 Veh-Hour	4842 Veh-Hour

Comments:

- The ramp merging point would be too close to the I-495 merge downstream.
- Improvement would deteriorate traffic operations.

SB Improvement 4: I-270 Mainline SB (multiple locations) – extend slip ramp acceleration lanes in the right shoulder of mainline

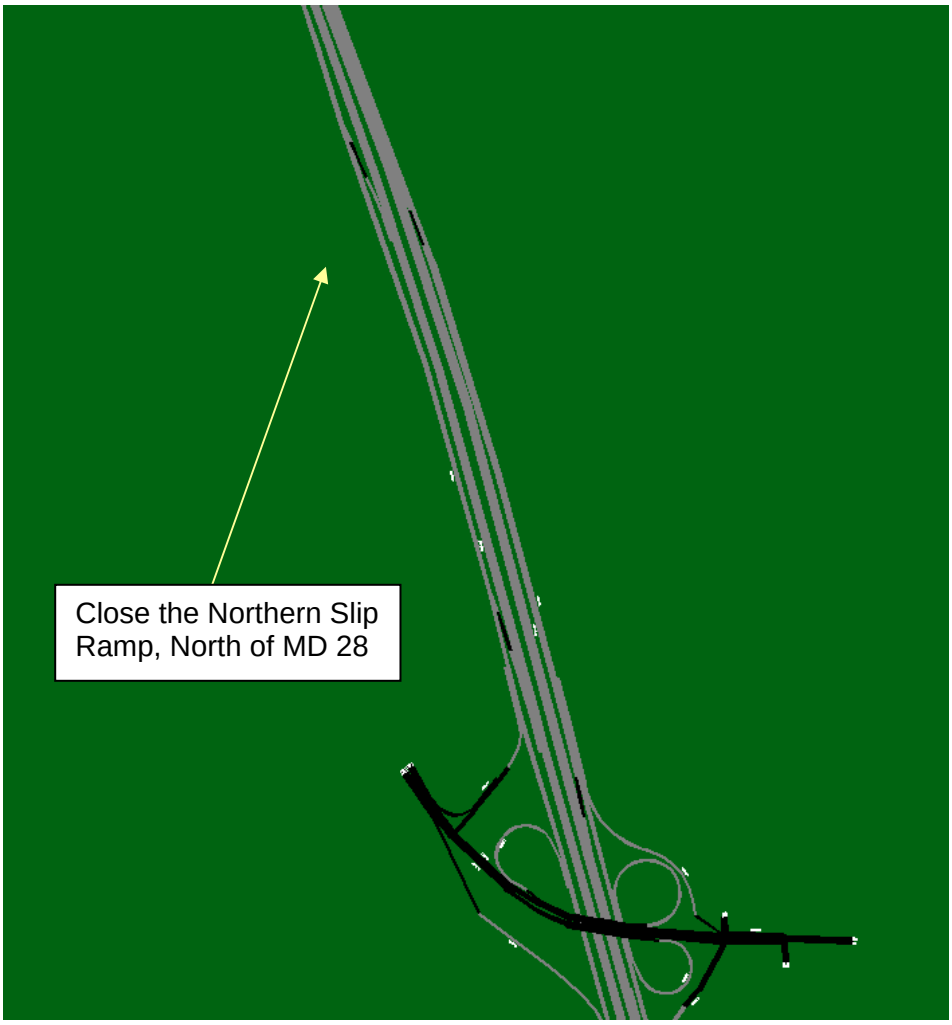


MOE	Existing	SB Improvement 4
Impact Area 1 (Mainline):	**I-270 Mainline SB parallel with CD Road (5.6 miles)**	
Travel time	12.1 min	11.9 min
Speed	28 mph	28 mph
Density	68 vpmpl	65 vpmpl
LOS	F	F
Impact Area 1 Avg. Delay	1.29 Min/Veh-Mile	1.25 Min/Veh-Mile
Impact Area 1 Total Delay	1445 Veh-Hour	1415 Veh-Hour
Impact Area 2 (CD):	**I-270 CD Road SB (5.5 miles)**	
Travel time	16.3 min	13.1 min
Speed	20 mph	25 mph
Density	65 vpmpl	56 vpmpl
LOS	F	F
Impact Area 2 Avg. Delay	2.0 Min/Veh-Mile	1.4 Min/Veh-Mile
Impact Area 2 Total Delay	883 Veh-Hour	663 Veh-Hour
Total System Avg. Delay	0.56 Min/Veh-Mile	0.52 Min/Veh-Mile
Total System Total Delay	4742 Veh-Hour	4451 Veh-Hour

Comments:

- Nominal improvements on I-270 Mainline.
- CD Road improved about 20% in travel time and speed.

SB Improvement 5: I-270 Mainline SB – Close the northern of two consecutive slip ramp entrances between MD 28 and Gude Drive.

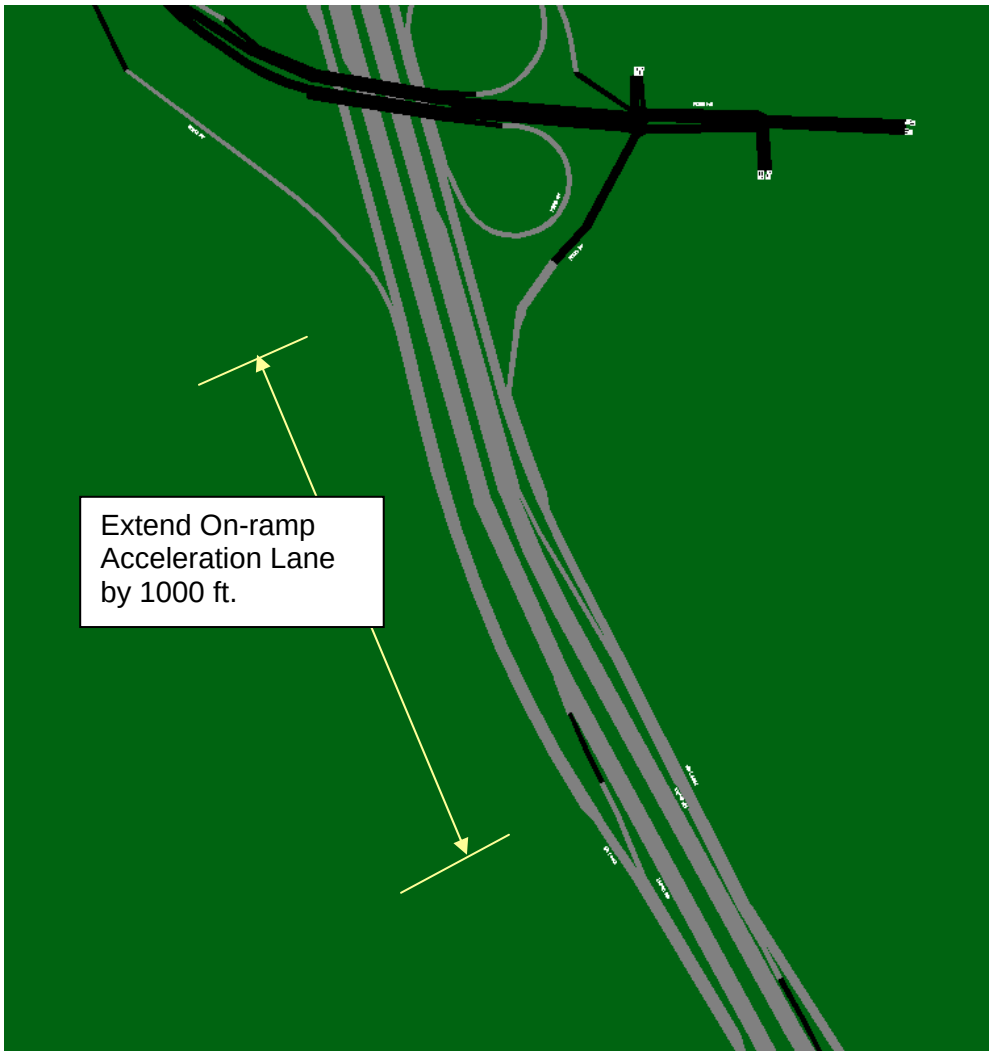


MOE	Existing	SB Improvement 5
Impact Area 1 (Mainline):	**I-270 Mainline SB from MD 117 to MD 28 (4.9 miles)**	
Travel time	8.5 min	8.6 min
Speed	35 mph	34 mph
Density	54 vpmpl	56 vpmpl
LOS	F	F
Impact Area 1 Avg. Delay	0.86 Min/Veh-Mile	0.88 Min/Veh-Mile
Impact Area 1 Total Delay	915 Veh-Hour	934 Veh-Hour
Impact Area 2 (CD):	**I-270 CD Road SB from Begin to MD 28 (2.4 miles)**	
Travel time	7.4 min	13.7 min
Speed	20 mph	11 mph
Density	58 vpmpl	99 vpmpl
LOS	F	F
Impact Area 2 Avg. Delay	2.0 Min/Veh-Mile	4.5 Min/Veh-Mile
Impact Area 2 Total Delay	364 Veh-Hour	751 Veh-Hour
Total System Avg. Delay	0.56 Min/Veh-Mile	0.62 Min/Veh-Mile
Total System Total Delay	4742 Veh-Hour	5231 Veh-Hour

Comments:

- Volumes from two slip ramps would be combined onto one slip ramp.
- Heavy merge would deteriorate traffic operations.

SB Improvement 6: I-270 CD Road SB – extend acceleration lane for MD 28 ramp into right shoulder.



MOE	Existing	SB Improvement 6
Impact Area 1 (CD):	**I-270 CD Road SB from SGR to MD 189 (2.5 miles)**	
Travel time (CD Road)	6.7 min	5.8 min
Speed (CD Road)	22 mph	25 mph
Density (CD Road)	72 vpmpl	62 vpmpl
LOS (CD Road)	F	F
Impact Area 1 Avg. Delay	1.72 Min/Veh-Mile	1.4 Min/Veh-Mile
Impact Area 1 Total Delay	378 Veh-Hour	321 Veh-Hour
Impact Area 2 (On-Ramp):		
Speed (on-ramp)	8 mph	10 mph
Density (on-ramp)	173 vpmpl	160 vpmpl
LOS (on-ramp)	F	F
Total System Avg. Delay	0.56 Min/Veh-Mile	0.54 Min/Veh-Mile
Total System Total Delay	4742 Veh-Hour	4661 Veh-Hour

Comments:

- Slight improvement on I-270 CD Road.
- Does not solve the congestion on MD 28 EB Ramp.

Potential Short-term Improvement Comparisons
Northbound – PM Peak Hour

	Localized		Total System (Mainline GP)		Comments
	Avg. Delay (min/veh-mile)	Total Delay (veh-hour)	Avg. Delay (min/veh-mile)	Total Delay (veh-hour)	
Existing	-	-	1.39	11,819	
NB Improvement 1: West Spur / I-495 Split ➔ I-270 *provide 4 lanes to I-270 west spur and 3 lanes to I-495*	+82% (I-270) -14% (I-495)	+85% (I-270) -5% (I-495)	1.38 (-1%)	11,658 (-1%)	• The overall system has very slight improvement. • Traffic in the additional lane would need to merge into mainline before the exit to Democracy EB, merely relocating the bottleneck further north from I-270/I-495 diverge.
NB Improvement 2: I-270 West Spur ➔ convert *HOV lane on the I-270 West spur as a general purpose lane*	-33% (I-270) -36% (I-495)	-30% (I-270) -32% (I-495)	1.37 (-1%)	11,494 (-3%)	• The additional capacity would improve both I-270 west spur and I-495 inner loop south of I-270 split. • However, the overall system has slight improvement due to the limited downstream capacity.
NB Improvement 3: Capital Beltway ➔ *Extend the left HOV lane further south on the left shoulder and convert HOV to general purpose lane*	+8% (I-270) -43% (I-495)	+17% (I-270) -37% (I-495)	1.29 (-7%)	11,018 (-7%)	• I-495 inner loop south of I-270 split is improved with this extension. • The extended left lane carries more traffic to west spur and causes more delay on I-270 west spur.
NB Improvement 4: Capital Beltway ➔ *Extend the left HOV lane further south on the left shoulder*	-8% (I-270) -36% (I-495)	7% (I-270) -31% (I-495)	1.29 (-7%)	11,022 (-7%)	• I-495 inner loop south of I-270 split is improved (less than Improvement 3) with this extension. • This option also slightly improves I-270 west spur.
NB All Improvements Combined	This scenario would not be run because Improvement 1 and Improvement 2 are not likely to be implemented together.				
NB Improvements 2 and 3 only	No need to run this scenario because Improvement 2 is embedded within Improvement 3.				

pink – worse than existing
green – better than existing

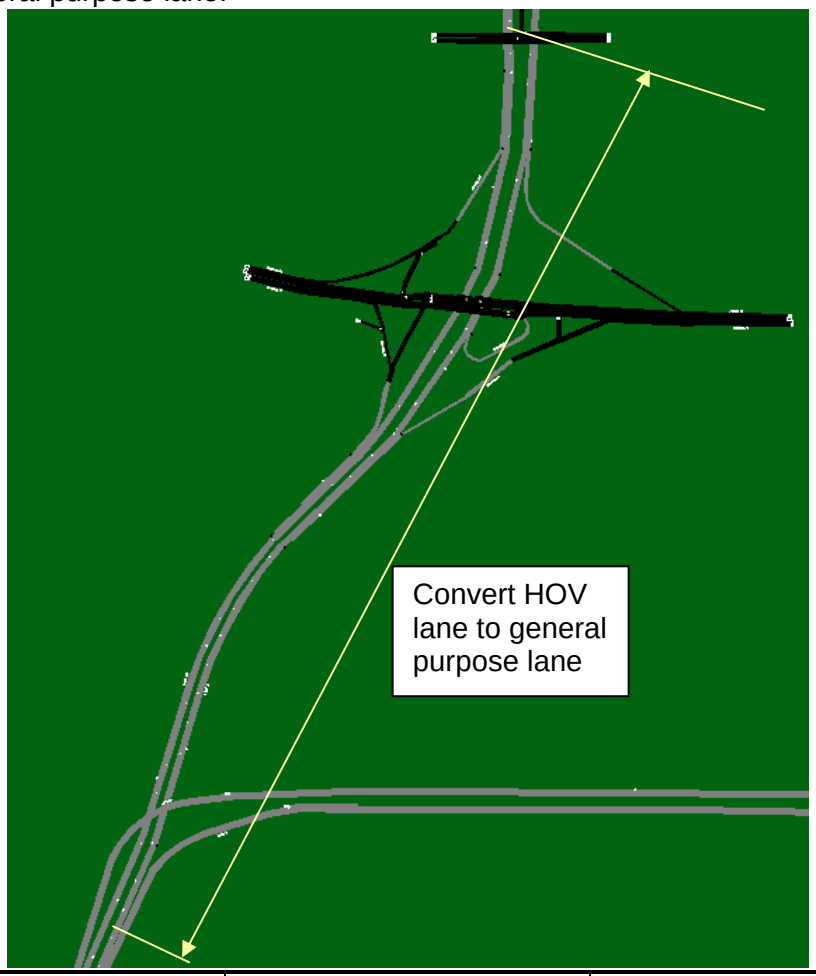
NB Improvement 1: Modify the I-270 west spur / I-495 split, provide 4 lanes to I-270 west spur and 3 lanes to I-495.

MOE	Existing	NB Improvement 1
Impact Area 1 (I-270):	**I-270 NB from I-495 to Democracy EB Ramp (0.8 mile)**	
Travel time (mainline)	1.6 min	2.3 min
Speed (mainline)	30 mph	21 mph
Density (mainline)	54 vpmpl	61 vpmpl
LOS (mainline)	F	F
Impact Area 1 Avg. Delay	1.1 Min/Veh-Mile	2.0 Min/Veh-Mile
Impact Area 1 Total Delay	118 Veh-Hour	218 Veh-Hour
Impact Area 2 (I-495):	**I-495 Inner Loop from VA 193 to I-270 Split (5.4 miles)**	
Travel time (mainline)	11.9 min	11.5 min
Speed (mainline)	27.1 mph	28.0 mph
Density (mainline)	62 vpmpl	61 vpmpl
LOS (mainline)	F	F
Impact Area 2 Avg. Delay	1.4 Min/Veh-Mile	1.2 Min/Veh-Mile
Impact Area 2 Total Delay	1591 Veh-Hour	1512 Veh-Hour
Total System Avg. Delay	1.39 Min/Veh-Mile	1.38 Min/Veh-Mile
Total System Total Delay	11,819 Veh-Hour	11,658 Veh-Hour

Comments:

- The overall system has very slight improvement.
- Traffic in the additional lane would need to merge into mainline before the exit to Democracy EB, merely relocating the bottleneck further north from I-270/I-495 diverge. .

NB Improvement 2: I-270 West Spur – designate the HOV lane on the I-270 West spur as a general purpose lane.

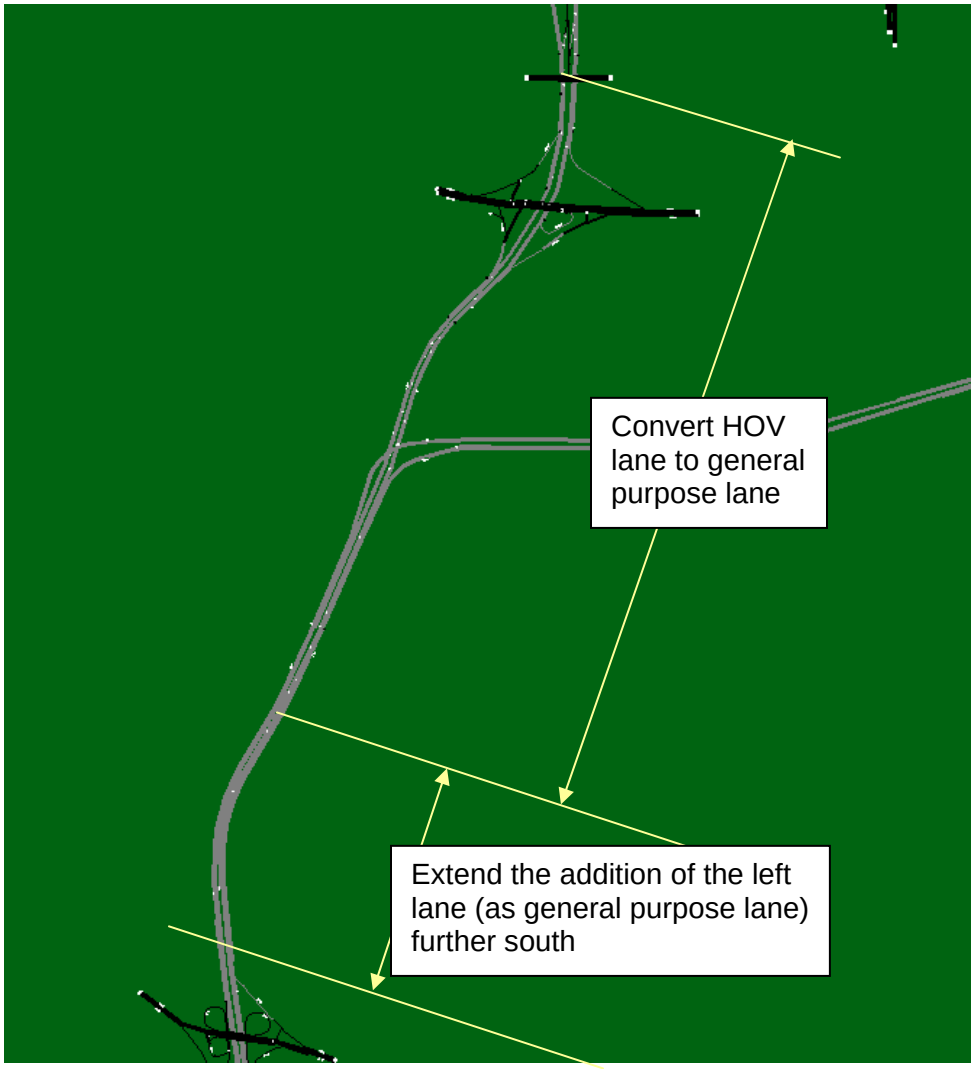


MOE	Existing	NB Improvement 2
Impact Area 1 (I-270):	**I-270 NB from I-495 to Westlake Terrace (1.5 miles)**	
Travel time (mainline)	3.1 min	2.5 min
Speed (mainline)	29 mph	36 mph
Density (mainline)	58 vpmpl	53 vpmpl
LOS (mainline)	F	F
Impact Area 1 Avg. Delay	1.2 Min/Veh-Mile	0.8 Min/Veh-Mile
Impact Area 1 Total Delay	239 Veh-Hour	168 Veh-Hour
Impact Area 2 (I-495):	**I-495 Inner Loop from VA 193 to I-270 Split (5.4 miles)**	
Travel time (mainline)	11.9 min	9.6 min
Speed (mainline)	27.1 mph	33.6 mph
Density (mainline)	62 vpmpl	51 vpmpl
LOS (mainline)	F	F
Impact Area 2 Avg. Delay	1.4 Min/Veh-Mile	0.9 Min/Veh-Mile
Impact Area 2 Total Delay	1591 Veh-Hour	1084 Veh-Hour
Total System Avg. Delay	1.39 Min/Veh-Mile	1.37 Min/Veh-Mile
Total System Total Delay	11,819 Veh-Hour	11,494 Veh-Hour

Comments:

- The additional capacity would improve both I-270 west spur and I-495 inner loop south of I-270 split.
- However, the overall system has slight improvement due to the limited downstream capacity.

NB Improvement 3: Extend the addition of the left lane further south and designate the lane as general purpose lane

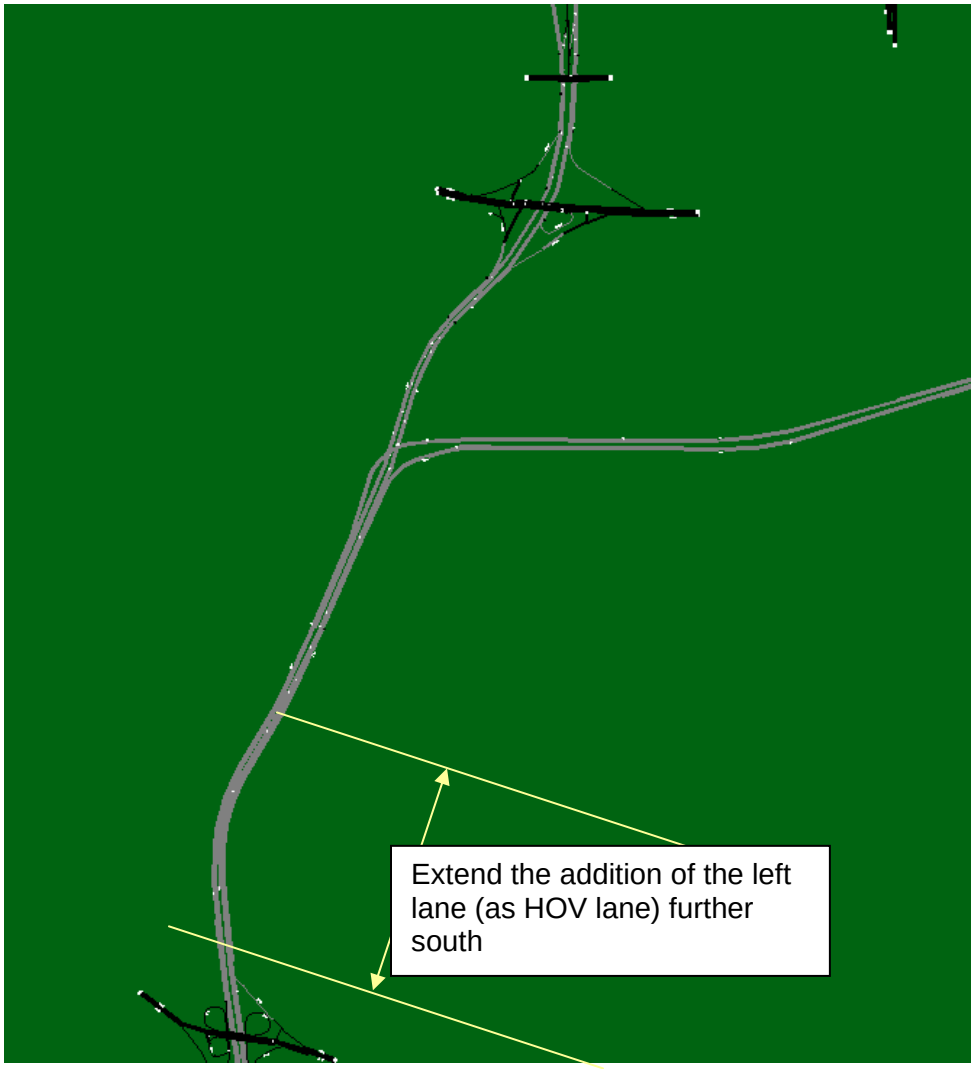


MOE	Existing	NB Improvement 3
Impact Area 1 (I-270):	**I-270 NB from I-495 to Westlake Terrace (1.5 miles)**	
Travel time (mainline)	3.1 min	3.3 min
Speed (mainline)	29 mph	27 mph
Density (mainline)	58 vpmpl	73 vpmpl
LOS (mainline)	F	F
Impact Area 1 Avg. Delay	1.2 Min/Veh-Mile	1.3 Min/Veh-Mile
Impact Area 1 Total Delay	239 Veh-Hour	280 Veh-Hour
Impact Area 2 (I-495):	**I-495 Inner Loop from VA 193 to I-270 Split (5.4 miles)**	
Travel time (mainline)	11.9 min	9.3 min
Speed (mainline)	27.1 mph	34.9 mph
Density (mainline)	62 vpmpl	48 vpmpl
LOS (mainline)	F	F
Impact Area 2 Avg. Delay	1.4 Min/Veh-Mile	0.8 Min/Veh-Mile
Impact Area 2 Total Delay	1591 Veh-Hour	999 Veh-Hour
Total System Avg. Delay	1.39 Min/Veh-Mile	1.29 Min/Veh-Mile
Total System Total Delay	11,819 Veh-Hour	11,018 Veh-Hour

Comments:

- I-495 inner loop south of I-270 split is improved with this extension.
- The extended left lane carries more traffic to west spur and causes more delay.

NB Improvement 4: Extend the addition of the left lane further south and designate the lane as HOV lane



MOE	Existing	NB Improvement 3
Impact Area 1 (I-270):	**I-270 NB from I-495 to Westlake Terrace (1.5 miles)**	
Travel time (mainline)	3.1 min	2.9 min
Speed (mainline)	29 mph	31 mph
Density (mainline)	58 vpmpl	58 vpmpl
LOS (mainline)	F	F
Impact Area 1 Avg. Delay	1.2 Min/Veh-Mile	1.1 Min/Veh-Mile
Impact Area 1 Total Delay	239 Veh-Hour	223 Veh-Hour
Impact Area 2 (I-495):	**I-495 Inner Loop from VA 193 to I-270 Split (5.4 miles)**	
Travel time (mainline)	11.9 min	9.9 min
Speed (mainline)	27.1 mph	32.5 mph
Density (mainline)	62 vpmpl	52 vpmpl
LOS (mainline)	F	F
Impact Area 2 Avg. Delay	1.4 Min/Veh-Mile	0.9 Min/Veh-Mile
Impact Area 2 Total Delay	1,591 Veh-Hour	1,097 Veh-Hour
Total System Avg. Delay	1.39 Min/Veh-Mile	1.29 Min/Veh-Mile
Total System Total Delay	11,819 Veh-Hour	11,022 Veh-Hour

Comments:

- I-495 inner loop south of I-270 split is improved (less than Improvement 3).
- This option also slightly improves the I-270 west spur.