Feasibility Analysis for US 29 Managed Lane

Technical Memorandum

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Introduction

Scope

The Montgomery County Department of Transportation requested an initial feasibility analysis to determine the traffic impacts of a managed lane, for Bus Rapid Transit (BRT), High Occupancy Vehicle (HOV), and right turning vehicles, be performed for the US 29 corridor to be implemented in the near term. The study limits of the project were from Fenton Street in Silver Spring to the Howard County line. It is assumed that north of MD 650 buses will run on the shoulder.

Methodology

Data was first compiled from State Highway Administration (SHA) files, of turning movement and Average Daily Traffic (ADT) counts to determine existing peak hour traffic demand and lane-by-lane utilization. The lane-by-lane utilization was then applied to traffic demand volumes to calculate the directional volumes for each lane during the AM and PM peak hours.

Based on available data, traffic volumes, lane configurations, and intersection spacing, the US 29 corridor was divided into three segments for the analysis from Fenton Street to MD 650.

The northern segment is from MD 650 to MD 193. The segment is a six-lane divided roadway with three lanes in each direction.

The middle segment is from MD 193 to just south of I-495. The middle segment is an eight-lane divided roadway with four lanes in each direction.

The southern segment is from Fenton Street to Sligo Creek Parkway. South of Sligo Creek Parkway, US 29 has six travel lanes with two reversible lanes in the center. The reversible lanes allow four lanes to service the southbound and northbound directions during the AM and PM peak hour, respectively.

Typical cross-sections under existing conditions are shown in Figure 1, Figure 2, and Figure .

Figure 1: Typical Cross-Section of Northern Segment

Figure 2: Typical Cross-Section of the Middle Segment

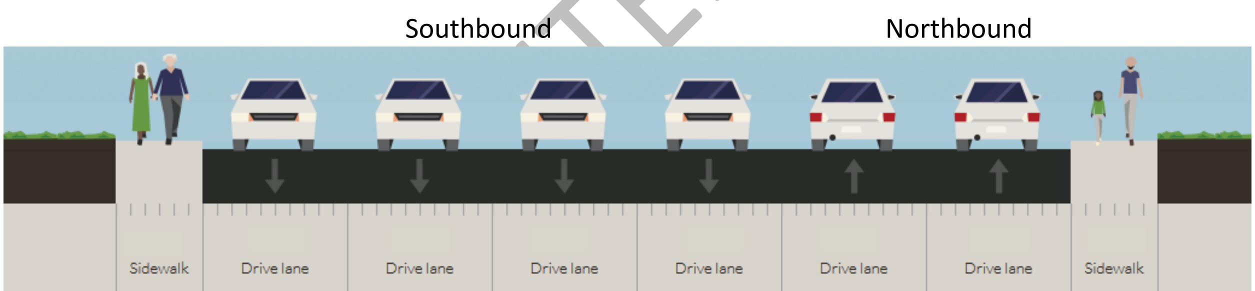

Figure 3A: Typical Cross-Section of the Southern Segment during the AM Peak Hour

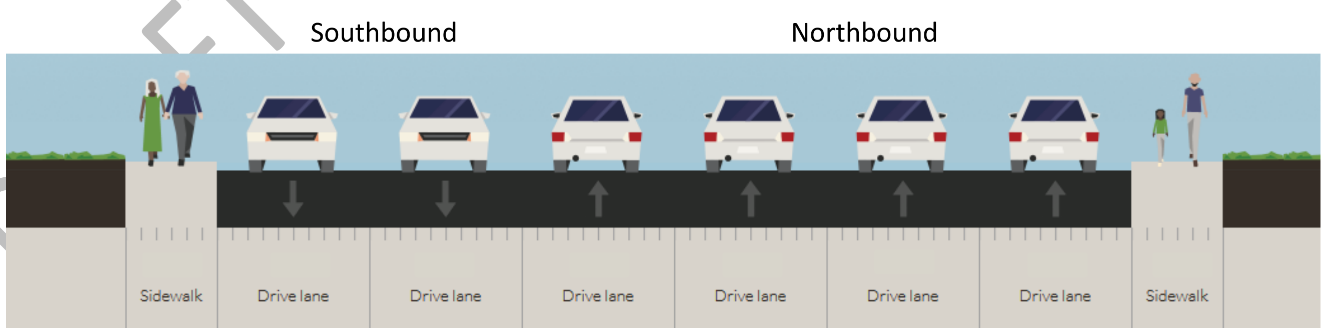

Figure 3B: Typical Cross-Section of the Southern Segment during the PM Peak Hour

For the purposes of this analysis, only the AM southbound and PM northbound directions were studied as they would be the limiting factors in determining the feasibility of the proposed alternative.

SWA conducted a manual peak hour field survey to determine vehicle occupancy in each of the three segments within the corridor for the peak hours and directions studied. Rates from the survey were then applied to the traffic demand volumes to determine total Single Occupancy Vehicle (SOV), HOV2, and HOV3+ volumes for each direction and peak hour studied.

The above data was then entered into a lane distribution spreadsheet to determine existing conditions and traffic impacts under the proposed alternative. Typical cross-sections under the proposed alternative for each of the three segments are shown below in Figure , Figure 4, and Figure .

Figure 4: Proposed Cross-Section of the Northern Segment

Figure 4: Proposed Cross-Section of the Middle Segment

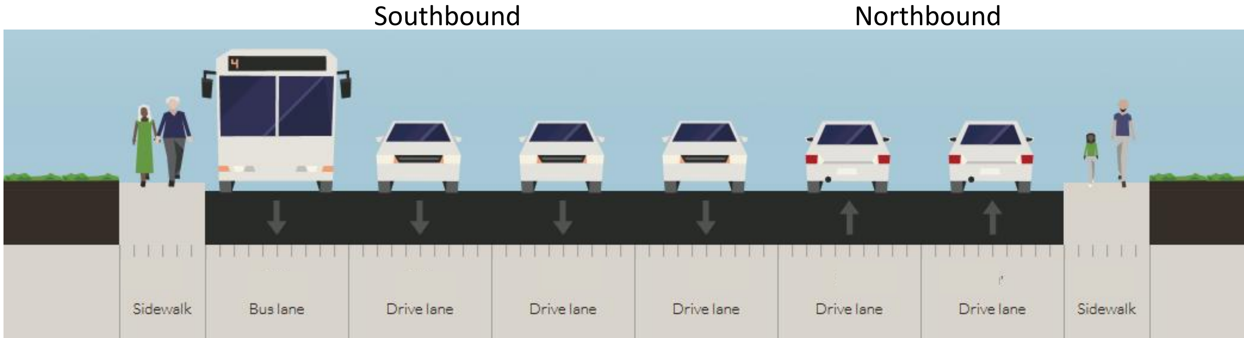

Figure 6A: Proposed Cross-Section of the Southern Segment during the AM Peak Hour

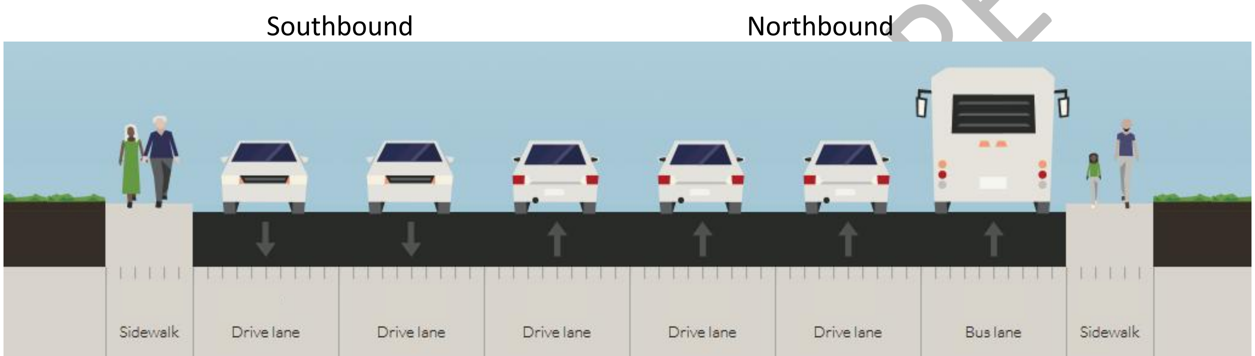

Figure 6B: Proposed Cross-Section of the Southern Segment during the PM Peak Hour

Data Compilation

Peak Hour Volumes

Peak hour turning movement counts were compiled from SHA files for all signalized intersections along US 29 between MD 97 and Prelude Drive. All turning movement data was collected within the past two years with the exceptions of US 29 at Franklin Ave and US 29 at Prelude Drive, which were collected in 2012 and balanced conservatively to match current year conditions. Intersection traffic counts are included in Appendix A.

Lane Utilization

ADT counts with lane by lane directional volumes were obtained from SHA at one location within each of the three segments of the corridor. The locations of the counts were .20 miles south of MD650, .20 miles south of MD 193, and .15 miles south of I-495 for the northern, middle, and southern segments, respectively. ADT traffic counts are included in Appendix B.

Vehicle Occupancy

To determine vehicle occupancy at the three locations where the lane utilization and ADT counts were collected, SWA conducted manual field surveys. Data was collected in the southbound direction during the AM peak hour and northbound direction during the PM peak hour. Vehicle occupancy rates were calculated from the representative population studied during the field surveys and applied to the demand volumes to determine SOV, HOV2, and HOV 3+ volumes. Table 1, Table 2, and Table 3 show summaries of the vehicle occupancy volumes and rates for the representative populations sampled at the three locations (note totals do not equal observed traffic count volumes).

Table 1: Vehicle Occupancy Summary for Southern Segment

South of I-495								
Approach	Total (veh)				Percent (%)			
	Single	Two	Three +	Bus	Single	Two	Three +	Bus
SB AM	1769	267	56	32	84.6	12.8	2.7	1.5
NB PM	1959	315	69	21	83.6	13.4	2.9	0.8

Table 2: Vehicle Occupancy Summary for Middle Segment

South of MD 193								
Approach	Total (veh)				Percent (%)			
	Single	Two	Three +	Bus	Single	Two	Three +	Bus
SB AM	2030	295	74	36	84.6	12.3	3.1	1.4
NB PM	1995	300	53	20	85.0	12.8	2.3	0.8

Table 3: Vehicle Occupancy Summary for the Northern Segment

South of MD 650								
Approach	Total (veh)				Percent (%)			
	Single	Two	Three +	Bus	Single	Two	Three +	Bus
SB AM	2179	296	48	34	86.4	11.7	1.9	1.3
NB PM	2156	298	47	24	86.2	11.9	1.9	0.9

Transit Ridership

The MTA, WMATA, and Ride On currently utilize the 11.85 mile long US 29 corridor within Montgomery County. Table 4 shows information on the distance travelled within the corridor and average weekday ridership for all bus routes.

Table 4: Bus Routes along US 29 Corridor

Route Name	Length in Miles, Corridor-Wide	Length in Miles, MD 650 to MD 193	Length in Miles, MD 193 to MD 97	Avg. Weekday Ridership
MTA				
201	4.19			395
203	4.19			107
305	**11.85**	**2.03**	**1.93**	**667**
315	**11.85**	**2.03**	**1.93**	**550**
325	**11.85**	**2.03**	**1.93**	**289**
WMATA				
F4	0.26		0.12	7141
J4	0.14		0.14	1117
S2 / S4	**0.38**			**13241**
Z2	**4.16**	**2.03**	**1.93**	**1051**
Z6	**3.18**	**1.05**	**1.93**	**2769**
Z8	**3.18**	**1.05**	**1.93**	**3166**
Z11 / Z13	**7.83**	**2.03**	**1.93**	**835**
Z9 / Z29	**10.07**	**2.03**	**1.93**	**782**
Ride On				
8	**1.12**		**0.92**	**631**
9	**2.13**		**1.93**	**1411**
10	1.07			2759
12	0.37		0.23	1896
13	**1.06**		**0.92**	**357**
14	**1.18**		**1.04**	**821**
16	0.26		0.12	3716
17	0.26		0.12	1482
20	0.26		0.12	3566
21	**4.16**	**2.03**	**1.93**	**413**
22	**4.16**	**2.03**	**1.93**	**466**
Corridor	11.85	2.03	1.93	

Routes with bold fonts in the above table represent routes along the corridor that would be affected the most by a managed lane scenario as they utilize a larger portion of the corridor.

MTA operates three closed door express commuter routes running the entire length of the corridor with average peak hour headways of 20 minutes, as well as two other closed-door routes operating between the Intercounty Connector and the Howard County line.

WMATA operates four bus lines (F, J, S and Z series routes) along the corridor which consist of four all-day local routes, two peak period-only lines, and two express routes with average peak hour headways ranging from 10 to 20 minutes.

Ride On operates eleven local routes that use a portion of US 29 with average peak hour headways of 25-30 minutes

For the purposes of this preliminary analysis, the transit ridership for each segmented is estimated based upon the known ridership for each bus line, with adjustment factors applied to estimate ridership within the segments and by time of day. Table 5 shows the estimated transit ridership in the peak periods (peak direction) for the two highlighted segments, as well as for the entire corridor.[1]

Table 5: Transit Ridership

Segment	Estimated Transit Ridership (all services)		
	AM Peak Hour SB	PM Peak Hour NB	All Day (both directions)
MD 650-MD 193	560	590	1,800
MD 193-MD 97	830	850	4,400
Entire Corridor	2,800	2,900	12,000

The County's proposed Rapid Transit System includes a Bus Rapid Transit route along US 29 from the Howard County Line to downtown Silver Spring. The route is proposed to run frequent (less than 10 minute headway) service with stations at Burtonsville, Briggs Chaney, Fairland, Tech Road, White Oak, Burnt Mills Shopping Center, Four Corners, Sligo Creek Parkway, Fenton Street and the Silver Spring Metro Station. The US 29 BRT is expected to carry 1,475 passengers per peak hour per direction by the year 2040 according to the County's *Service Planning Integration Study*.

Person Throughput

The total person throughput of the roadway was studied to determine how productive each segment of the corridor is at carrying people versus vehicles under different conditions.

For the purposes of this analysis, person throughput under **existing** conditions for each lane was calculated by assuming an even distribution of SOV, HOV2 and HOV3+ vehicles while all buses were assumed to operate in the right lane. Based on the vehicle percentages and average

[1] Current year 2015 transit ridership for the US 29 corridor was obtained from staff of WMATA, Montgomery County Ride On, and the Maryland Transit Administration.

occupancy (e.g. HOV2 or bus ridership) the total number of people in each lane was calculated then summed to determine overall person throughput.

Person throughput under the **proposed** managed lane alternative was calculated using the same methodology as existing conditions however all HOV2, HOV3+, buses and right turning vehicles were reassigned to the managed lane.

Lastly, a third scenario was performed to assess the sensitivity under a 10% mode shift from SOV to HOV2 for a managed lane option.

Table 6 shows the person throughput for each time, direction, and scenario analyzed. It is important to note that the overall person throughput does not change for any scenario (e.g. without the addition of BRT ridership).

The middle segment moves the most number of total persons (5,450) in the southbound AM. The north segment moves the least number of total persons (4,166) in the northbound PM. It should be noted that with the shift of 10% of SOV to HOV2, the managed lane will carry more persons than the general purpose lanes in all segments and directions.

Table 6: Person Throughput

Segment	Lane(s)	Southbound (AM)		Northbound (PM)	
		Volumes	Person Throughput	Volumes	Person Throughput
Northern		Existing			
	Left	1225	1401	1120	1288
	Center	1225	1401	1056	1214
	Right	1050	1563	1024	1664
	Total	**3500**	**4366**	**3200**	**4166**
		Proposed Alternative			
	Left	1505	1505	1376	1376
	Center	1470	1470	1312	1312
	Right*	524	1391	506	1474
	Total	**3500**	**4366**	**3200**	**4166**
		Alternative with 10% Conversion SOV to HOV			
	Left	1204	1204	1101	1101
	Center	1176	1176	1050	1050
	Right*	821	1987	778	2016
	Total	**3200**	**4366**	**2930**	**4166**
Middle		Existing			
	Left	1160	1362	756	881
	Center	1320	1550	1656	1931
	Right	1520	2539	1188	2014
	Total	**4000**	**5451**	**3600**	**4827**
		Proposed			
	Left	1040	1040	648	648
	Center	1040	1040	1404	1404
	Right*	1920	3371	1545	2773
	Total	**4000**	**5451**	**3600**	**4827**
		Alternative with 10% Conversion SOV to HOV			
	Left	832	832	518	518
	Center	832	832	1123	1123
	Right*	2001	3788	1653	3186
	Total	**3665**	**5451**	**3295**	**4827**
Southern		Existing			
	Left	525	615	396	469
	Center	2065	2418	2079	2464
	Right	910	1833	825	1572
	Total	**3500**	**4866**	**3300**	**4503**
		Proposed			
	Left	560	560	462	462
	Center	2170	2170	2244	2244
	Right*	767	2132	590	1792
	Total	**3500**	**4866**	**3300**	**4503**
		Alternative with 10% Conversion SOV to HOV			
	Left	448	448	370	370
	Center	1736	1736	1795	1795
	Right*	1023	2681	860	2337
	Total	**3207**	**4866**	**3025**	**4503**

* Managed lane with HOV, HOV2, buses, and right turning vehicles

Lane Utilization Analysis

Inputs

Volumes inputted into the lane distribution spreadsheet for analysis were determined by conservatively balancing actual volumes from SHA ADT and Turning Movement counts to account for upstream traffic demand.

The ideal flow rate used in the analysis was 1900 vehicles per lane per hour. The saturated flow rate used in the analysis was 1700 vehicles per lane per hour, which represents the estimated capacity per lane for free flowing traffic within the corridor.

The green time to cycle length (g/c) ratio differs from signal to signal throughout the corridor. However, all signals within each segment have similar g/c ratios. The g/c ratios for each segment of the corridor were estimated conservatively, based on g/c ratios for each signal within the segment. Signal timing plans were extracted from the latest Synchro model for the corridor. Table 7 shows the green to capacity ratio for the northern, middle, and southern segments during the study periods. Table 8 shows the resulting vehicle per lane per hour green capacity for each segment.

Table 7: Green to Capacity Ratio for Each Segment

Segment	Mainline g/C Ratio	
	SB (AM)	NB (PM)
Northern	0.80	0.80
Middle	0.70	0.65
Southern	0.65	0.65

Table 8: Lane Capacity for Each Segment

Segment	Lane Capacity	
	SB (AM)	NB (PM)
Northern	1,360	1,360
Middle	1,190	1,105
Southern	1,105	1,105

Managed lane volumes include the sum of buses, right turns, and HOV vehicles in each segment. HOV volumes were calculated by summing the HOV2 and HOV3+ rates found in the vehicle occupancy study and multiplying them by the total demand volumes in each segment.

Outputs

The lane distribution spreadsheet outputs volume to capacity (v/c) ratios for each lane and direction studied, under both existing and proposed alternative conditions. **The governing Critical Lane Volume for each segment (Silver Spring and White Oak) of 1,600 vehicles (equivalent to a volume-to-capacity ratio of 1.0) is the used as threshold for this analysis.** The lane distribution analysis spreadsheet can be found in Appendix C.

Existing Condition

The traffic demand volumes are multiplied by the lane utilization factors to obtain lane by lane directional volumes. The capacity flow in vehicles per lane per hour green is calculated by multiplying the segments g/c ratio by the saturated flow rate. The capacity flow represents the maximum capacity for each lane per hour. The lane by lane directional volumes are then divided by the capacity flow to calculate the v/c ratio for each lane and direction studied. The process is then repeated for each of the three segments of the corridor.

Proposed Alternative – Initial Managed Lane Test

Lane volumes under the proposed alternatives were determined by placing all HOV2, HOV3+, right turn, and bus volumes in the curb lane, then distributing the remaining volumes into the other travel lanes for each segment and scenario analyzed. Right turn volumes were calculated by averaging right turn volumes at each signalized intersection within each segment. As in the existing conditions, the v/c ratio for each lane was calculated by dividing the lane by lane directional volumes by the capacity flow for each segment.

Sensitivity Analysis

A sensitivity analysis was performed to determine the effects of a 10% mode shift from SOV to HOV2 under the proposed managed lane alternative. The sensitivity analysis results are shown in Appendix C.

The mode shift reduced the volume to capacity ratios within the northern and southern segments of the corridor. All of the lanes in the northern and southern segments have a v/c below 1 under the proposed alternative, with the exception of the northern segment in the southbound direction during the AM peak hour, which has a volume to capacity ratio of exactly 1.

The result of the sensitivity analysis on the middle segment of the corridor was that the mode shift exacerbated capacity issues due to the effects of assigning more vehicles to the right lane, which already exceeds capacity under existing and proposed conditions. The volume to capacity ratios for the right lane increased by about 10% in the northbound PM and southbound AM directions.

Findings

- Existing uneven lane utilization causes some lanes within each segment to perform at or above capacity.
- Volume to capacity ratios greater than 1.0 under existing conditions:
  - Northern Segment: None
  - Middle Segment: Only the right lanes operate 28% and 8% above capacity for the southbound and northbound directions, respectively. This is due to the high volumes of right turns from US 29 to I-495.
  - Southern Segment: None
- Volume to capacity ratios greater than 1.0 under the proposed alternative:
  - Northern Segment: The left and center lanes operate about 10% above capacity due to the displacement of SOV vehicles from the right lane during AM period in the southbound direction. The left lane in the northbound direction during the PM peak hour operates 1% above capacity.
  - Middle Segment: Conditions under the proposed alternatives for the right lanes in the southbound and northbound directions are expected to worsen with 50% increases in the already failing volume to capacity ratios.
  - Southern Segment: Only the middle lanes in the northbound direction during the PM peak hour slightly exceed capacity by 2%.
- Recommendations:
  - Based on the results from the feasibility analysis, a managed lane is only recommended in the southern and northern segments of the corridor.