



MEMORANDUM

TO: Chris Fellows, Velocity Metropolitan District No. 1

FROM: Philip J. Dunham, PE

DATE: August 27, 2019

SUBJECT: **Porteos ISP Traffic Analysis (64th Avenue & Powhatan Road)**
(FHU No. 119296-01)

The purpose of this memorandum is to summarize future traffic projections for the intersection of 64th Avenue & Powhatan Road in the Porteos development of Aurora, Colorado, and to update lane geometry recommendations compared to the previous Porteos traffic studies. Information from new development plans and recent transportation studies were utilized to develop a “blended” forecast of traffic volumes and operations at this intersection. Intersection operations analyses were conducted using methodology outlined in the 6th Edition of the *Highway Capacity Manual* (HCM, 2017). Levels of Service (LOS) and 95th percentile queue lengths were referenced to provide lane geometry recommendations.

2040 Traffic Projections

Several studies were referenced in developing the forecasts shown in this memorandum. One of the foundation studies used in this analysis is the Aurora Northeast Area Transportation Study (NEATS) Refresh. This study presented results of travel demand modeling for the area. Traffic impact studies prepared to consider specific impacts of a maximum build out scenario were also used to develop “blended” traffic forecasts. These traffic studies include:

- Porteos Master Traffic Impact Study Update
- Porteos PA-7 Groot Distribution Center
- Porteos PA-5 JAG Logistics Center

All of the Porteos traffic studies utilized the NEATS Refresh study to aid in determining background traffic volumes. The Groot and JAG studies refined traffic forecasts for specific planning areas within the larger Porteos development area. These two studies were used primarily as the basis for determining traffic volumes on Powhatan Road.

New information from development plans indicate that 64th Avenue will not connect to the east of Porteos as previously assumed. As a result, background traffic volumes are expected to decrease significantly compared to the NEATS study.

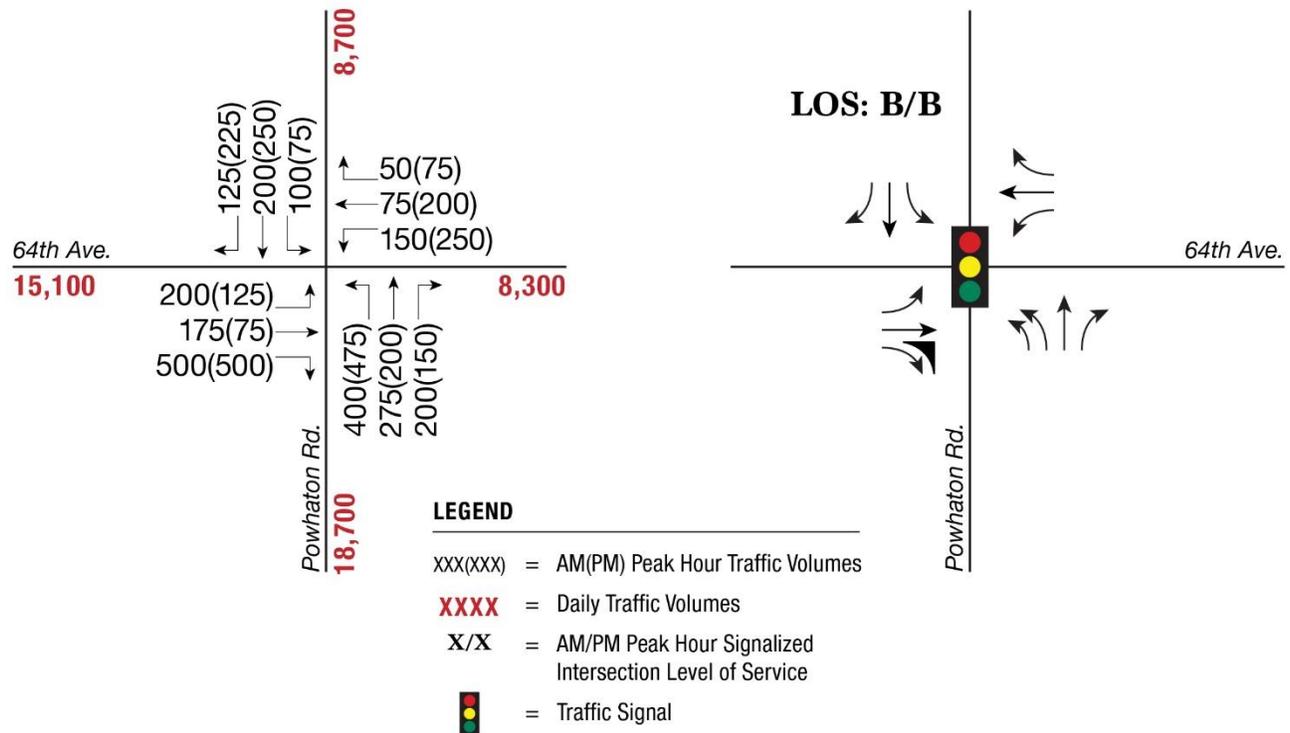
Figure 1 presents the final set of 2040 traffic volume projections for the intersection 64th Avenue & Powhatan Road intersection. Daily and peak hour traffic volumes on each approach leg are lower than the previous Porteos studies, but they are generally higher than 2040 volumes presented in the NEATS refresh study.

2040 Traffic Analysis

Using peak hour projections from **Figure I**, intersection LOS were calculated to help identify appropriate lane geometry and are attached for reference. Additionally, the Colorado State Highway Access Code (CDOT SHAC) was referenced to determine the need for left-turn and right-turn storage lanes. The 95th percentile queue lengths associated with peak hour operations were used to inform storage lane length recommendations.

Figure I also displays peak hour traffic operations and geometry recommendations for the 64th Avenue & Powhaton Road. Traffic analysis worksheets are attached to this memorandum.

Figure I. Year 2040 Traffic Conditions



As shown, the intersection will operate at LOS B during both peak hours. Dedicated turn lanes should be provided for all turning movements on each approach. Dual left-turn lanes should be installed on the northbound approach. Each turn lane should have its own storage length with two exceptions; the eastbound right-turn and outside northbound left-turn lanes should be continuous to allow transition between the 4-lane roads (64th Avenue west of Powhaton Road and Powhaton Road south of 64th Avenue) and the 2-lane roads (north and east legs). The eastbound right-turn lane should be channelized and given an acceleration lane onto southbound Powhaton Road to create a free operating condition.

Based on the daily traffic volumes shown on **Figure I** and the anticipated peak hour operations in Year 2040, 64th Avenue can be constructed as a two-lane road east of Powhaton Road and a four-lane road west of Powhaton Road. Similarly, Powhaton Road can be constructed as a two-lane road north of 64th Avenue (with a center turn lane where appropriate) and a four-lane road south of 64th Avenue.

Table I displays 2040 peak hour 95th percentile queue lengths and recommended storage lengths based on both the estimated queues and guidance contained in the CDOT SHAC using an NR-B classification. Heavy vehicle percentage is assumed at twenty-five percent for the purposes of determining queue length. These recommended storage lengths are chosen to contain the maximum anticipated peak hour queue length.

Table I. Year 2040 95th Percentile Queue Lengths

Approach	Movement	95 th Percentile Queue Length (ft) ¹		Recommended Storage Length based on 95 th Percentile	SCHAC Recommended Storage Length ²
		AM	PM		
Eastbound	Left-Turn	83	70	100	300
	Through	95	50	Continuous	Continuous
	Right-Turn	0	0	Continuous	Continuous
Westbound	Left-Turn	65	128	125	375
	Through	38	130	Continuous	Continuous
	Right-Turn	25	43	75	125
Northbound	Left-Turn	65	88	100 (L) / Continuous (R)	350 (L) / Continuous (R)
	Through	128	88	Continuous	Continuous
	Right-Turn	70	50	75	300
Southbound	Left-Turn	40	33	75	150
	Through	108	155	Continuous	Continuous
	Right-Turn	55	135	150	350

¹ Calculations based on HCM methodology using a heavy vehicle percentage of 15 percent.

² Number shown is based on volume adjustments of 3 PCE per heavy vehicle

Recommendation

City of Aurora *Traffic Impact Study Guidelines* indicate that the CDOT SHAC be used to determine storage and taper lengths. These values yield overly conservative results and provide storage well in excess 95th percentile queues (which already incorporates a heavy vehicle percentage), often by a factor of two to three. The SHAC procedures do not account for other conditions in the intersection such as a low opposing through movements if a left turn movement is in question. Rather, our recommendation is that the values in **Table I** corresponding to the 95th percentile lengths plus 144-foot tapers (to provide the required 12:1 taper for 12-foot lanes at 40 MPH for NR-B classification as identified in the CDOT SHAC) be incorporated in the design of the 64th Avenue & Powhaton Road intersection.

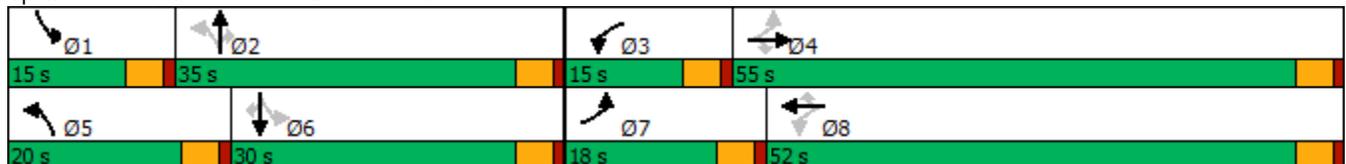
Timings
1: Powhatan Rd & 64th Ave

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	200	175	500	150	75	50	400	275	200	100	200	125
Future Volume (vph)	200	175	500	150	75	50	400	275	200	100	200	125
Turn Type	pm+pt	NA	Perm									
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8		8	2		2	6		6
Detector Phase	7	4	4	3	8	8	5	2	2	1	6	6
Switch Phase												
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	9.5	22.5	22.5	9.5	22.5	22.5	9.5	22.5	22.5	9.5	22.5	22.5
Total Split (s)	18.0	55.0	55.0	15.0	52.0	52.0	20.0	35.0	35.0	15.0	30.0	30.0
Total Split (%)	15.0%	45.8%	45.8%	12.5%	43.3%	43.3%	16.7%	29.2%	29.2%	12.5%	25.0%	25.0%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Lead/Lag	Lead	Lag	Lag									
Lead-Lag Optimize?	Yes											
Recall Mode	None	Min	Min	None	Min	Min	None	None	None	None	None	None
Act Effct Green (s)	29.7	17.2	17.2	24.1	14.4	14.4	35.5	25.0	25.0	25.3	16.6	16.6
Actuated g/C Ratio	0.39	0.23	0.23	0.32	0.19	0.19	0.46	0.33	0.33	0.33	0.22	0.22
v/c Ratio	0.50	0.56	0.76	0.45	0.29	0.15	0.51	0.60	0.38	0.31	0.66	0.35
Control Delay	20.8	34.0	10.7	20.6	30.8	0.9	16.2	30.8	5.8	16.5	39.2	8.2
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	20.8	34.0	10.7	20.6	30.8	0.9	16.2	30.8	5.8	16.5	39.2	8.2
LOS	C	C	B	C	C	A	B	C	A	B	D	A
Approach Delay		17.6			19.8			18.4			24.7	
Approach LOS		B			B			B			C	

Intersection Summary

Cycle Length: 120	
Actuated Cycle Length: 76.4	
Natural Cycle: 65	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.76	
Intersection Signal Delay: 19.4	Intersection LOS: B
Intersection Capacity Utilization 61.0%	ICU Level of Service B
Analysis Period (min) 15	

Splits and Phases: 1: Powhatan Rd & 64th Ave



HCM 6th Signalized Intersection Summary
1: Powhatan Rd & 64th Ave

Porteos ISP 64th/Powhatan
08/27/2019



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	200	175	500	150	75	50	400	275	200	100	200	125
Future Volume (veh/h)	200	175	500	150	75	50	400	275	200	100	200	125
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1530	1530	1530	1530	1530	1530	1530	1530	1530	1530	1530	1530
Adj Flow Rate, veh/h	217	190	0	163	82	54	435	299	181	109	217	123
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	25	25	25	25	25	25	25	25	25	25	25	25
Cap, veh/h	459	264		370	207	175	842	427	362	331	296	251
Arrive On Green	0.16	0.17	0.00	0.12	0.14	0.14	0.16	0.28	0.28	0.08	0.19	0.19
Sat Flow, veh/h	1457	1530	1296	1457	1530	1296	2826	1530	1296	1457	1530	1296
Grp Volume(v), veh/h	217	190	0	163	82	54	435	299	181	109	217	123
Grp Sat Flow(s),veh/h/ln	1457	1530	1296	1457	1530	1296	1413	1530	1296	1457	1530	1296
Q Serve(g_s), s	6.4	6.1	0.0	4.8	2.5	1.9	5.7	9.1	6.0	3.0	6.9	4.4
Cycle Q Clear(g_c), s	6.4	6.1	0.0	4.8	2.5	1.9	5.7	9.1	6.0	3.0	6.9	4.4
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	459	264		370	207	175	842	427	362	331	296	251
V/C Ratio(X)	0.47	0.72		0.44	0.40	0.31	0.52	0.70	0.50	0.33	0.73	0.49
Avail Cap(c_a), veh/h	608	1493		489	1405	1190	1225	902	764	513	754	639
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	15.2	20.2	0.0	16.3	20.4	20.2	12.2	16.7	15.6	15.1	19.6	18.6
Incr Delay (d2), s/veh	0.8	3.7	0.0	0.8	1.2	1.0	0.5	2.1	1.1	0.6	3.5	1.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(95%),veh/ln	3.3	3.8	0.0	2.6	1.5	1.0	2.6	5.1	2.8	1.6	4.3	2.2
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	16.0	23.9	0.0	17.1	21.7	21.2	12.7	18.8	16.7	15.6	23.1	20.1
LnGrp LOS	B	C		B	C	C	B	B	B	B	C	C
Approach Vol, veh/h		407	A		299			915			449	
Approach Delay, s/veh		19.7			19.1			15.5			20.4	
Approach LOS		B			B			B			C	
Timer - Assigned Phs	1	2	3	4	5	6	7	8				
Phs Duration (G+Y+Rc), s	8.6	18.9	10.8	13.4	13.0	14.5	12.7	11.5				
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5				
Max Green Setting (Gmax), s	10.5	30.5	10.5	50.5	15.5	25.5	13.5	47.5				
Max Q Clear Time (g_c+I1), s	5.0	11.1	6.8	8.1	7.7	8.9	8.4	4.5				
Green Ext Time (p_c), s	0.1	1.7	0.1	0.9	0.8	1.1	0.2	0.5				

Intersection Summary

HCM 6th Ctrl Delay	17.9
HCM 6th LOS	B

Notes

Unsignalized Delay for [EBR] is excluded from calculations of the approach delay and intersection delay.

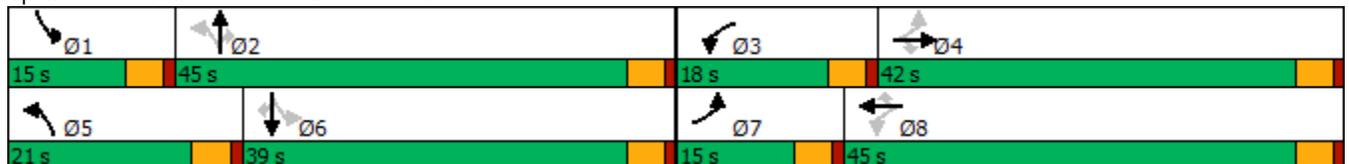
Timings
1: Powhatan Rd & 64th Ave

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	125	75	500	250	200	75	475	200	150	75	250	225
Future Volume (vph)	125	75	500	250	200	75	475	200	150	75	250	225
Turn Type	pm+pt	NA	Perm									
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8		8	2		2	6		6
Detector Phase	7	4	4	3	8	8	5	2	2	1	6	6
Switch Phase												
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	9.5	22.5	22.5	9.5	22.5	22.5	9.5	22.5	22.5	9.5	22.5	22.5
Total Split (s)	15.0	42.0	42.0	18.0	45.0	45.0	21.0	45.0	45.0	15.0	39.0	39.0
Total Split (%)	12.5%	35.0%	35.0%	15.0%	37.5%	37.5%	17.5%	37.5%	37.5%	12.5%	32.5%	32.5%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Lead/Lag	Lead	Lag	Lag									
Lead-Lag Optimize?	Yes											
Recall Mode	None	Min	Min	None	Min	Min						
Act Effct Green (s)	26.5	16.6	16.6	33.2	19.9	19.9	42.2	32.2	32.2	29.1	20.9	20.9
Actuated g/C Ratio	0.31	0.19	0.19	0.39	0.23	0.23	0.49	0.37	0.37	0.34	0.24	0.24
v/c Ratio	0.41	0.28	0.84	0.64	0.62	0.20	0.62	0.38	0.28	0.22	0.74	0.49
Control Delay	22.3	33.0	18.3	27.8	38.5	1.8	19.0	26.1	5.6	16.7	44.5	7.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	22.3	33.0	18.3	27.8	38.5	1.8	19.0	26.1	5.6	16.7	44.5	7.7
LOS	C	C	B	C	D	A	B	C	A	B	D	A
Approach Delay		20.6			28.2			18.3			25.6	
Approach LOS		C			C			B			C	

Intersection Summary

Cycle Length: 120	
Actuated Cycle Length: 86.2	
Natural Cycle: 70	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.84	
Intersection Signal Delay: 22.5	Intersection LOS: C
Intersection Capacity Utilization 69.2%	ICU Level of Service C
Analysis Period (min) 15	

Splits and Phases: 1: Powhatan Rd & 64th Ave



HCM 6th Signalized Intersection Summary
1: Powhatan Rd & 64th Ave

Porteos ISP 64th/Powhatan
08/27/2019

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	125	75	500	250	200	75	475	200	150	75	250	225
Future Volume (veh/h)	125	75	500	250	200	75	475	200	150	75	250	225
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1530	1530	1530	1530	1530	1530	1530	1530	1530	1530	1530	1530
Adj Flow Rate, veh/h	136	82	0	272	217	82	516	217	127	82	272	232
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	25	25	25	25	25	25	25	25	25	25	25	25
Cap, veh/h	320	158		452	287	243	828	526	445	408	354	300
Arrive On Green	0.10	0.10	0.00	0.19	0.19	0.19	0.17	0.34	0.34	0.06	0.23	0.23
Sat Flow, veh/h	1457	1530	1296	1457	1530	1296	2826	1530	1296	1457	1530	1296
Grp Volume(v), veh/h	136	82	0	272	217	82	516	217	127	82	272	232
Grp Sat Flow(s),veh/h/ln	1457	1530	1296	1457	1530	1296	1413	1530	1296	1457	1530	1296
Q Serve(g_s), s	4.9	3.0	0.0	9.2	8.0	3.3	7.5	6.5	4.2	2.5	9.9	10.0
Cycle Q Clear(g_c), s	4.9	3.0	0.0	9.2	8.0	3.3	7.5	6.5	4.2	2.5	9.9	10.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	320	158		452	287	243	828	526	445	408	354	300
V/C Ratio(X)	0.43	0.52		0.60	0.76	0.34	0.62	0.41	0.29	0.20	0.77	0.77
Avail Cap(c_a), veh/h	425	963		507	1040	881	1117	1040	881	574	886	751
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	20.7	25.3	0.0	16.9	22.9	21.0	13.2	15.0	14.2	15.7	21.4	21.4
Incr Delay (d2), s/veh	0.9	2.6	0.0	1.6	4.1	0.8	0.8	0.5	0.3	0.2	3.5	4.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(95%),veh/ln	2.8	2.0	0.0	5.1	5.2	1.7	3.5	3.5	2.0	1.3	6.2	5.4
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	21.6	28.0	0.0	18.6	27.0	21.8	14.0	15.5	14.6	16.0	24.9	25.7
LnGrp LOS	C	C		B	C	C	B	B	B	B	C	C
Approach Vol, veh/h		218	A		571			860			586	
Approach Delay, s/veh		24.0			22.2			14.4			24.0	
Approach LOS		C			C			B			C	
Timer - Assigned Phs	1	2	3	4	5	6	7	8				
Phs Duration (G+Y+Rc), s	8.2	25.0	15.7	10.6	14.9	18.3	10.7	15.7				
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5				
Max Green Setting (Gmax), s	10.5	40.5	13.5	37.5	16.5	34.5	10.5	40.5				
Max Q Clear Time (g_c+I1), s	4.5	8.5	11.2	5.0	9.5	12.0	6.9	10.0				
Green Ext Time (p_c), s	0.1	1.3	0.1	0.3	0.9	1.8	0.1	1.2				

Intersection Summary

HCM 6th Ctrl Delay	19.9
HCM 6th LOS	B

Notes

Unsignalized Delay for [EBR] is excluded from calculations of the approach delay and intersection delay.