MEMORANDUM

TO: Chris Fellows, Velocity Metropolitan District No. 1

FROM: Philip J. Dunham, PE

DATE: January 7th, 2020

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

The purpose of this memorandum is to summarize future traffic projections for the intersection of 64th Avenue & Powhaton 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 "blended" forecasts begin with the master Porteos Traffic Study information and then refines the numbers by adjusting to trip generation for known land uses as they compare to those presented in the master studies. These traffic studies include:

- Porteos Master Traffic Impact Study Update
- Porteos PA-7 Groot Distribution Center
- Porteos PA-5 JAG Logistics Center
- 64th Avenue ISP

NEATS results were not available at the time the master study was completed, so this approach produces very different projections than shown in the master Porteos Traffic Study. All subsequent 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 Powhaton Road. The more recent 64th Avenue ISP has informed a reduction in through traffic expected along 64th Avenue which reflects reduced development plans from properties to the west of Porteos. These volumes also consider that that 60th Avenue is no longer planned to continue east beyond Jackson Gap Street.

Figure 1 presents the final set of 2040 traffic volume projections for the intersection 64th Avenue & Powhaton 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 1**, 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 1 also displays peak hour traffic operations and geometry recommendations for the 64th Avenue & Powhaton Road; 64th Avenue will be a four-lane roadway west and east of Powhaton Road. Traffic analysis worksheets are attached to this memorandum.

Figure 1. Year 2040 Traffic Conditions
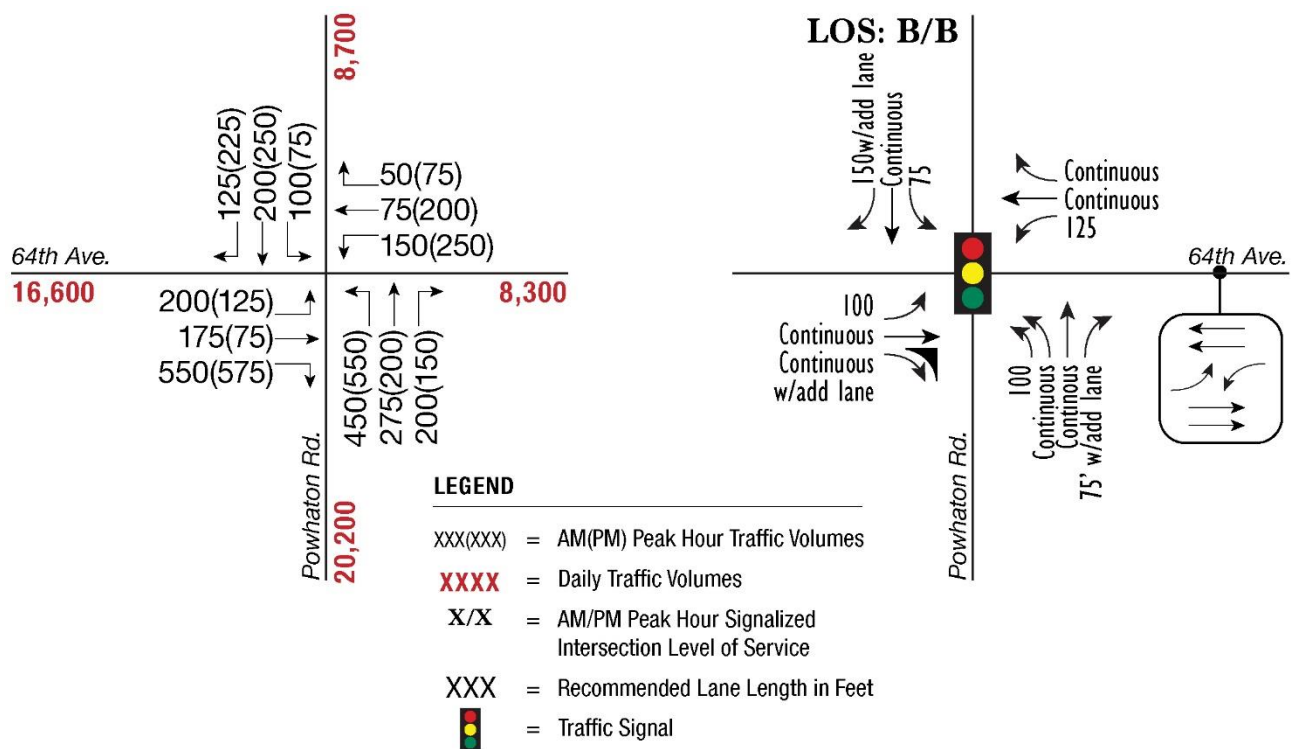
As shown, the intersection will operate at LOS B during both peak hours. Dedicated turn lanes should be provided for all turning movements on each approach. Dual left-turn lanes should be installed on the northbound approach. Each turn lane should have its own storage length with two exceptions; the 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 1** and the anticipated peak hour operations in Year 2040, 64th Avenue is planned to be constructed as a four-lane roadway both east and west of Powhaton Road. Powhaton Road is planned to 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. Volumes along both 64th Avenue and Powhaton Road presented in **Figure 1** are greater than values presented for a 2040 condition in the NEATS Refresh study, however language recommendations remain consistent and within LOS thresholds identified in the NEATS Refresh study. The eastbound and westbound through volumes do not support the need for two through lanes at the intersection and have been exchanged for continuous right turn lanes in both directions, and 64th Avenue would be a 4-lane arterial east of Powhaton Road. Only one lane in each direction is needed through the intersection based on the 2040 traffic projections. In the event that through traffic is more significant than forecast in this memo (equivalent to 12,000 vehicles per day based on city feedback), the intersection may need to be modified to accommodate additional east-west through lanes.

Table 1 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 1.   Year 2040 95th Percentile Queue Lengths

Approach	Movement	95th Percentile Queue Length (ft) [1]		Recommended Storage Length based on 95th Percentile	SCHAC Recommended Storage Length[2]
		AM	PM		
Eastbound	Left-Turn	85	68	100	300
	Through	100	50	Continuous	Continuous
	Right-Turn	0	0	Continuous	Continuous[3]
Westbound	Left-Turn	68	123	125	375
	Through	40	128	Continuous	Continuous
	Right-Turn	25	43	75	Continuous
Northbound	Left-Turn	75	80	100 (L) / Continuous (R)	350 (L) / Continuous (R)
	Through	130	88	Continuous	Continuous
	Right-Turn	73	50	75	300
Southbound	Left-Turn	43	33	75	150
	Through	113	153	Continuous	Continuous
	Right-Turn	58	133	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

[3] A sensitivity analysis, testing a scenario in which four east-west through lanes would be provided through the intersection, produces a 95th percentile queue of 485 feet for the eastbound right turn lane. However, the intersection lane recommendation entails the eastbound right turn lane to be free-flowing as an eastbound lane-drop into a southbound lane-add.

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 1** 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.

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑	↱	↰	↑	↱	↰↰	↑	↱	↰	↑	↱
Traffic Volume (vph)	200	175	550	150	75	50	450	275	200	100	200	125
Future Volume (vph)	200	175	550	150	75	50	450	275	200	100	200	125
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	pm+pt	NA	Perm	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	Lag	Lead	Lag	Lag	Lead	Lag	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	Min	Min	None	Min	Min	None	None	None	None	None	None
Act Effct Green (s)	32.0	19.3	19.3	26.5	16.6	16.6	36.7	26.2	26.2	25.6	16.8	16.8
Actuated g/C Ratio	0.40	0.24	0.24	0.33	0.21	0.21	0.46	0.33	0.33	0.32	0.21	0.21
v/c Ratio	0.48	0.52	0.82	0.43	0.26	0.14	0.58	0.60	0.38	0.32	0.68	0.36
Control Delay	19.9	31.8	14.5	19.7	29.1	0.8	19.3	33.1	6.3	18.8	43.1	8.9
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	19.9	31.8	14.5	19.7	29.1	0.8	19.3	33.1	6.3	18.8	43.1	8.9
LOS	B	C	B	B	C	A	B	C	A	B	D	A
Approach Delay		19.0			18.8			20.6			27.3	
Approach LOS		B			B			C			C	

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 80.1
Natural Cycle: 70
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.82

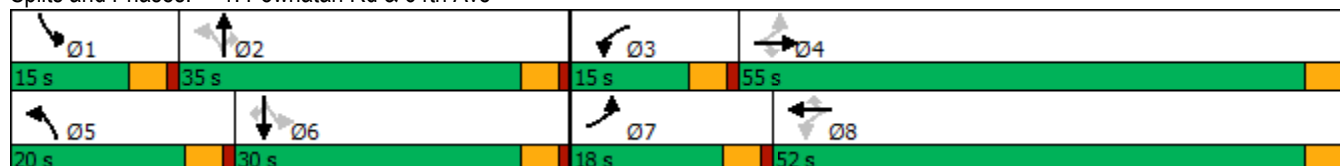|	
Intersection Signal Delay: 20.9	Intersection LOS: C
Intersection Capacity Utilization 64.1%	ICU Level of Service C

Analysis Period (min) 15

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

Ø1	Ø2		Ø3	Ø4
15 s	35 s		15 s	55 s

Ø5	Ø6		Ø7	Ø8
20 s	30 s		18 s	52 s

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↱	↑	↱	↱	↑	↱	↟↟	↑	↱	↱	↑	↱
Traffic Volume (veh/h)	200	175	550	150	75	50	450	275	200	100	200	125
Future Volume (veh/h)	200	175	550	150	75	50	450	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	489	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	453	262		364	205	174	869	446	378	338	294	249
Arrive On Green	0.16	0.17	0.00	0.12	0.13	0.13	0.18	0.29	0.29	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	489	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	6.6	6.3	0.0	5.0	2.6	2.0	6.6	9.2	6.1	3.1	7.1	4.5
Cycle Q Clear(g_c), s	6.6	6.3	0.0	5.0	2.6	2.0	6.6	9.2	6.1	3.1	7.1	4.5
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	453	262		364	205	174	869	446	378	338	294	249
V/C Ratio(X)	0.48	0.73		0.45	0.40	0.31	0.56	0.67	0.48	0.32	0.74	0.49
Avail Cap(c_a), veh/h	591	1449		474	1363	1155	1188	875	741	511	731	620
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	15.8	20.9	0.0	16.8	21.1	20.9	12.4	16.6	15.6	15.5	20.3	19.2
Incr Delay (d2), s/veh	0.8	3.8	0.0	0.9	1.3	1.0	0.6	1.8	0.9	0.5	3.6	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	3.4	4.0	0.0	2.7	1.6	1.0	3.0	5.2	2.9	1.7	4.5	2.3
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	16.5	24.7	0.0	17.7	22.4	21.9	13.0	18.4	16.5	16.0	23.9	20.7
LnGrp LOS	B	C		B	C	C	B	B	B	B	C	C
Approach Vol, veh/h		407	A		299			969			449	
Approach Delay, s/veh		20.4			19.7			15.3			21.1	
Approach LOS		C			B			B			C	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	8.7	20.0	11.0	13.6	14.0	14.7	12.9	11.7
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	30.5	10.5	50.5	15.5	25.5	13.5	47.5
Max Q Clear Time (g_c+I1), s	5.1	11.2	7.0	8.3	8.6	9.1	8.6	4.6
Green Ext Time (p_c), s	0.1	1.7	0.1	0.9	0.9	1.1	0.2	0.5

Intersection Summary

HCM 6th Ctrl Delay	18.1
HCM 6th LOS	B

Notes

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

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	125	75	575	250	200	75	450	200	150	75	250	225
Future Volume (vph)	125	75	575	250	200	75	450	200	150	75	250	225
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	pm+pt	NA	Perm	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	Lag	Lead	Lag	Lag	Lead	Lag	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	None	None	None	None	None	None	Min	Min	None	Min	Min
Act Effct Green (s)	32.3	22.4	22.4	39.1	25.8	25.8	43.4	33.2	33.2	30.8	22.2	22.2
Actuated g/C Ratio	0.35	0.24	0.24	0.42	0.28	0.28	0.46	0.36	0.36	0.33	0.24	0.24
v/c Ratio	0.37	0.23	0.92	0.59	0.52	0.18	0.63	0.40	0.29	0.23	0.75	0.50
Control Delay	21.0	30.6	27.7	25.5	33.7	1.6	22.1	29.9	6.0	19.5	49.0	8.0
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	21.0	30.6	27.7	25.5	33.7	1.6	22.1	29.9	6.0	19.5	49.0	8.0
LOS	C	C	C	C	C	A	C	C	A	B	D	A
Approach Delay		26.9			25.2			21.0			28.2	
Approach LOS		C			C			C			C	

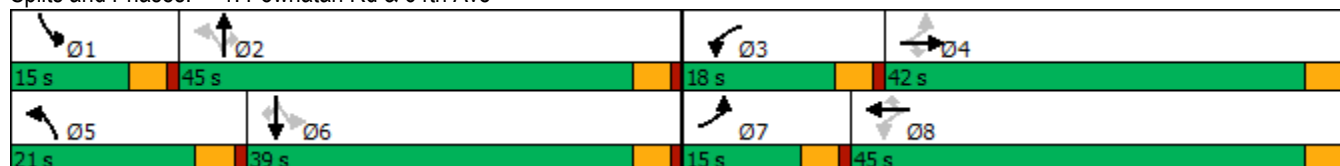| Intersection Summary	
Cycle Length: 120	
Actuated Cycle Length: 93.5	
Natural Cycle: 70	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.92	
Intersection Signal Delay: 25.1	Intersection LOS: C
Intersection Capacity Utilization 73.9%	ICU Level of Service D
Analysis Period (min) 15	

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

Ø1	Ø2	Ø3	Ø4
15 s	45 s	18 s	42 s

Ø5	Ø6	Ø7	Ø8
21 s	39 s	15 s	45 s

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↱	↑	↱	↱	↑	↱	↱↱	↑	↱	↱	↑	↱
Traffic Volume (veh/h)	125	75	575	250	200	75	450	200	150	75	250	225
Future Volume (veh/h)	125	75	575	250	200	75	450	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	489	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	323	158		455	288	244	815	516	437	408	355	301
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	489	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	4.8	3.0	0.0	9.1	7.9	3.2	6.9	6.4	4.2	2.5	9.7	9.8
Cycle Q Clear(g_c), s	4.8	3.0	0.0	9.1	7.9	3.2	6.9	6.4	4.2	2.5	9.7	9.8
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	323	158		455	288	244	815	516	437	408	355	301
V/C Ratio(X)	0.42	0.52		0.60	0.75	0.34	0.60	0.42	0.29	0.20	0.77	0.77
Avail Cap(c_a), veh/h	432	978		515	1057	896	1135	1057	896	577	900	763
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	20.4	24.9	0.0	16.6	22.5	20.6	13.0	15.0	14.3	15.4	21.0	21.0
Incr Delay (d2), s/veh	0.9	2.6	0.0	1.5	4.0	0.8	0.7	0.5	0.4	0.2	3.5	4.2
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	2.7	2.0	0.0	4.9	5.1	1.7	3.2	3.5	2.0	1.3	6.1	5.3
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	21.2	27.5	0.0	18.1	26.5	21.4	13.8	15.5	14.6	15.7	24.5	25.2
LnGrp LOS	C	C		B	C	C	B	B	B	B	C	C
Approach Vol, veh/h		218	A		571			833			586	
Approach Delay, s/veh		23.6			21.8			14.4			23.5	
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	24.3	15.6	10.6	14.4	18.1	10.6	15.5
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	40.5	13.5	37.5	16.5	34.5	10.5	40.5
Max Q Clear Time (g_c+I1), s	4.5	8.4	11.1	5.0	8.9	11.8	6.8	9.9
Green Ext Time (p_c), s	0.1	1.3	0.2	0.3	0.9	1.8	0.1	1.2

Intersection Summary

HCM 6th Ctrl Delay	19.6
HCM 6th LOS	B

Notes

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