LSC TRANSPORTATION CONSULTANTS, INC.
2504 East Pikes Peak Avenue, Suite 304
Colorado Springs, CO 80909
(719) 633-2868
FAX (719) 633-5430
E-mail: lsc@lsctrans.com
Website: http://www.lsctrans.com

MEMORANDUM

DATE: September 27, 2024

TO: Adam Lancaster – CDOT R2 Permits Manager

FROM: Jeffrey C. Hodsdon, P.E. - LSC Transportation Consultants, Inc.

SUBJECT: Monument Ridge East
RE: Traffic Impact Study
Response to CDOT Comments Memorandum
LSC #S234450
EPC PCD File Nos. P245, P246, SP241

Following are the LSC Transportation Consultants, Inc. responses to the September 10, 2024 Comment Letter from CDOT – Region 2 – Traffic & Safety – Permits regarding the Monument Ridge East project.

COUNTY LINE ROAD/I-25 RAMP INTERSECTIONS
LONG-TERM (2044) REVISED LOS ANALYSIS & QUEUING ANALYSIS

Per CDOT direction from the meeting on September 25, 2024, a separate, exclusive, northbound-right turn lane at the I-25 northbound off-ramp intersection with County Line Road has been added. The following presents updated level of service and vehicle queuing analysis at the northbound-ramp intersections with County Line Road. The analysis continues to show, as in the August 2024 TIS, the need for all-way stop control (AWSC) at the I-25 southbound ramp intersection to mitigate a projected LOS F for the southbound approach with TWSC.

Traffic Volumes

Volumes used in this analysis are shown in Figure 10 of the August 6, 2024 TIS report (copy attached for reference). The Long-Term "Total" (2044 Background plus Site-Generated) AM and PM peak-hour traffic volumes have been analyzed.

Level of Service Analysis

The following presents a summary of the results. For additional detail, please refer to the *HCM* TWSC and AWSC analysis reports, which have been attached for reference.

2044 Total AM

Assuming use of all-way stop control, all individual turning movements and single-lane approaches at the I-25 southbound ramp intersections are projected to operate at LOS D or better during the 2044 Total AM scenario.

With the addition of a northbound right turn lane at the I-25 northbound ramps, and assuming a stop sign on the northbound approach only (TWSC analysis procedure), all individual turning movements are projected to operate at LOS D or better during the 2044 Total AM scenario.

2044 Total PM

Assuming use of all-way stop control, all individual turning movements and single-lane approaches at the I-25 southbound ramp intersections are projected to operate at LOS D or better during the 2044 Total PM scenario.

With the addition of a northbound right-turn lane at the I-25 northbound ramps, and assuming a stop sign on the northbound approach only (TWSC analysis procedure), all individual turning movements are projected to operate at LOS D or better during the 2044 Total PM scenario.

Queuing Analysis

The following presents a summary of the results. For additional detail, please refer to the *HCM* TWSC and AWSC analysis reports.

No individual turn lanes or single-lane approaches at either I-25 ramp intersection are projected to experience any upstream or storage block time during the 2044 Total AM or PM scenarios. There are at least 300 feet for queuing between the ramp intersections. Projected queues would be accommodated on all approaches at both I-25 ramp intersections.

2044 Total AM

HCM AWSC queuing results for each individual turn lane or single-lane approach at the I-25 southbound ramp during the 2044 Total AM peak hour are summarized below:

Queue Lengths I-25/County Line Road **Southbound** Ramp Intersection AM Peak Hour – 2044 Total Traffic				
Queuing Metric	**EB**	**WBL**	**WBT**	**SB**
95th-Percentile Queue (vehicles)	1.7	6.8	1.3	1

HCM TWSC queuing analysis results for each individual turn lane for yielding movements at the I-25 northbound-ramp intersection during the 2044 Total AM peak hour are summarized below:

Queue Lengths I-25/County Line Road **Northbound** Ramp Intersection AM Peak Hour – 2044 Total Traffic - TWSC			
Queuing Metric	**EBL**	**NB LT**	**NBR**
95th-Percentile Queue (vehicles)	0.3	0.9	0.4

<u>2044 Total PM</u>

HCM AWSC queuing results for each individual turn lane or single-lane approach at the I-25 southbound ramp intersection during the 2044 Total PM peak hour are summarized below:

Queue Lengths I-25/County Line Road **Southbound** Ramp Intersection PM Peak Hour – 2044 Total Traffic - AWSC				
Queuing Metric	**EB**	**WBL**	**WBT**	**SB**
95th-Percentile Queue (vehicles)	6.3	1.6	1.9	5.1

HCM TWSC queuing analysis results for each individual turn lane for yielding movements at the I-25 northbound ramp intersection during the 2044 Total PM peak hour are summarized below:

Queue Lengths I-25/County Line Road **Northbound** Ramp Intersection PM Peak Hour – 2044 Total Traffic - TWSC			
Queuing Metric	**EBL**	**NB LT**	**NBR**
95th-Percentile Queue (vehicles)	0.2	1.5	2.7

ALL-WAY STOP CONTROL WARRANTS EVALUATION

The following is an excerpt from the *MUTCD* regarding "warrants" for all-way stop control (AWSC):

Section 2B.12 All-Way Stop Control

Support:

01 The provisions in the following sections describe warrants for the recommended engineering study to determine all-way stop control. Warrants are not a substitute for engineering judgment. The fact that a warrant for a particular traffic control device is met is not conclusive justification to install or not install all-way stop control. Because each intersection will have unique characteristics that affect its operational performance or safety, it is the engineering study for a given intersection that is ultimately the basis for a decision to install or not install all-way stop control.

02 All-way stop controls at intersections with substantially differing approach volumes can reduce the effectiveness of these devices for all roadway users.

Guidance:

03 *The decision to establish all-way stop control at an unsignalized intersection should be based on an engineering study. The engineering study for all-way stop control should include an analysis of factors related to the existing operation and safety at the intersection, the potential to improve these conditions, and the applicable factors contained in the following all-way stop control warrants:*

A. *All-Way Stop Control Warrant A: Crash Experience (see Section 2B.13)*
B. *All-Way Stop Control Warrant B: Sight Distance (see Section 2B.14)*
C. *All-Way Stop Control Warrant C: Transition to Signal Control or Transition to Yield Control at a Circular Intersection (see Section 2B.15)*
D. *All-Way Stop Control Warrant D: 8-Hour Volume (Vehicles, Pedestrians, Bicycles) (see Section 2B.16)*
E. *All-Way Stop Control Warrant E: Other Factors (see Section 2B.17)*

SOUTHBOUND I-25/COUNTY LINE ROAD INTERSECTION

The following presents evaluation of this intersection with respect to each AWSC warrant listed in the *MUTCD* section 2B.12

A. Crash Experience

For a four-leg intersection, there are five or more reported crashes in a 12-month period or six or more reported crashes in a 36-month period that were of a type susceptible to correction by the installation of all-way stop control

In the past 3 years, there has been one crash at the southbound-ramp intersection.

B. Sight Distance

The interchange has recently been improved and LSC presumes that sight distance meets CDOT standards.

C. Transition to Signal Control or Transition to Yield Control at a Circular Intersection

The implementation of AWSC in the future, once needed, to reduce delay and improve LOS for the southbound approach could be considered a "transitional" traffic control measure. The potential future need to signalize one or both of the ramp intersections in the future exists, but the timing would depend on both overall growth in traffic demand on County Line Road and the future land use (and associated trip generation) of the vacant parcels southwest of I-25 and County Line Road. If in the future signal warrants are met, a pair of roundabouts rather than traffic signals at the ramp terminals may be implemented.

D. Eight-Hour Volumes

Section 2B.16 All-Way Stop Control Warrant D: 8-Hour Volume (Vehicles, Pedestrians, Bicycles)

Option:

01 All-way stop control may be installed at an intersection where an engineering study indicates:

A. The combined motor vehicle, bicycle, and pedestrian volume entering the intersection from the major-street approaches is at least 300 units per hour for each of any 8 hours of a typical day; and

B. The combined motor vehicle, bicycle, and pedestrian volume entering the intersection from the minor-street approaches is at least 200 units per hour for each of any of the same 8 hours.

02 If the 85th-percentile approach speed of the major-street traffic exceeds 40 mph, the minimum vehicular volume warrants may be reduced to 70 percent of the values given in Items A and B in Paragraph 1 of this Section.

I-25 Northbound Ramp Intersection

Four hours of projected volumes were analyzed for this intersection. The volumes reflect motor-vehicle demand as pedestrian/bicycle demand is low. Three of the four hours analyzed would meet the *MUTCD*'s minimum-volume combination on major and minor streets to meet an AWSC warrant at the I-25 northbound ramp intersection (potentially, other hours of the day could meet both of these thresholds, but six additional hours would need to meet both minor and major street thresholds):

I-25 Southbound Ramp Intersection

Four hours of projected volumes were analyzed for this intersection. Two of the four hours analyzed would meet the *MUTCD*'s minimum volume combination on major and minor streets to meet AWSC Warrant Item D at the I-25 southbound ramp intersection (potentially other hours of the day could meet both of these thresholds, but six additional hours would need to meet both minor and major street thresholds to satisfy the Item D part of the warrant evaluation). Item D of the *MUTCD* AWSC warrant analysis at the I-25 southbound ramp intersection with County Line Road could be revisited at the future platting/access permitting stage of the development process for this development, which could include full evaluation of the off-peak hours as well (8-10 hours of the day).

Analysis Period			Minor Street			Major Street			Overall
Peak Period	Start	End	2044 Total Volume	MUTCD Minimum	Meets Threshold	2044 Total Volume	MUTCD Minimum	Meets Threshold	Meets Threshold
AM Hour 1	6:30	7:30	80	200	X	604	300	✓	No
AM Hour 2	7:30	8:30	121	200	X	727	300	✓	No
AM Overall	7:10	8:10	125	200	X	821	300	✓	No
PM Hour 1	**16:00**	**17:00**	**347**	**200**	✓	**673**	**300**	✓	Yes
PM Hour 2	**17:00**	**18:00**	**379**	**200**	✓	**598**	**300**	✓	Yes
PM Overall	16:35	17:35	358	200	✓	689	300	✓	Yes
09/26/2024		# of hours of the 4 analyzed which meet the Major and minor street thresholds:							**2 hours**

E. Other Factors

> 01 All-way stop control may be installed at an intersection where an engineering study indicates that all-way stop control is needed due to other factors not addressed in the other all-way stop control warrants. Such other factors may include, but are not limited to, the following:
>
> A. The need to control left-turn conflicts,
> B. An intersection of two residential neighborhood collector (through) streets of similar design and operating characteristics where all-way stop control would improve traffic operational characteristics of the intersection, or
> C. Where pedestrian and/or bicyclist movements support the installation of all-way stop control.

Part "A" may apply. There is a relatively heavy WBL volume at the southbound-ramp intersection during the morning peak hour. Additionally, there is a relatively heavy SBL volume during the afternoon peak hour.

Part "B" does not apply since neither I-25 ramp is in a residential neighborhood.

Part "C" may become more applicable in the future with growth in the area and any increase in non-motorized travel demand that may accompany such growth.

Additionally, with respect to future use of AWSC, as shown in the TIS, as mitigation at the southbound ramp intersection for the projected LOS below D:

- The projected 2044 total volumes in the TIS show relatively balanced volumes on all approaches for the PM peak hour.
- In the morning peak hour, the predominant volume movement is the westbound left turn and not either of the straight through movements on County Line Road.
- This intersection can be considered an "endpoint" or "breakpoint" intersection of the series of intersections along County Line Road to the east, which have heavier through volumes than County Line Road west of I-25. This is obviously subject to change if traffic demand changes west of the I-25 interchange in the future.

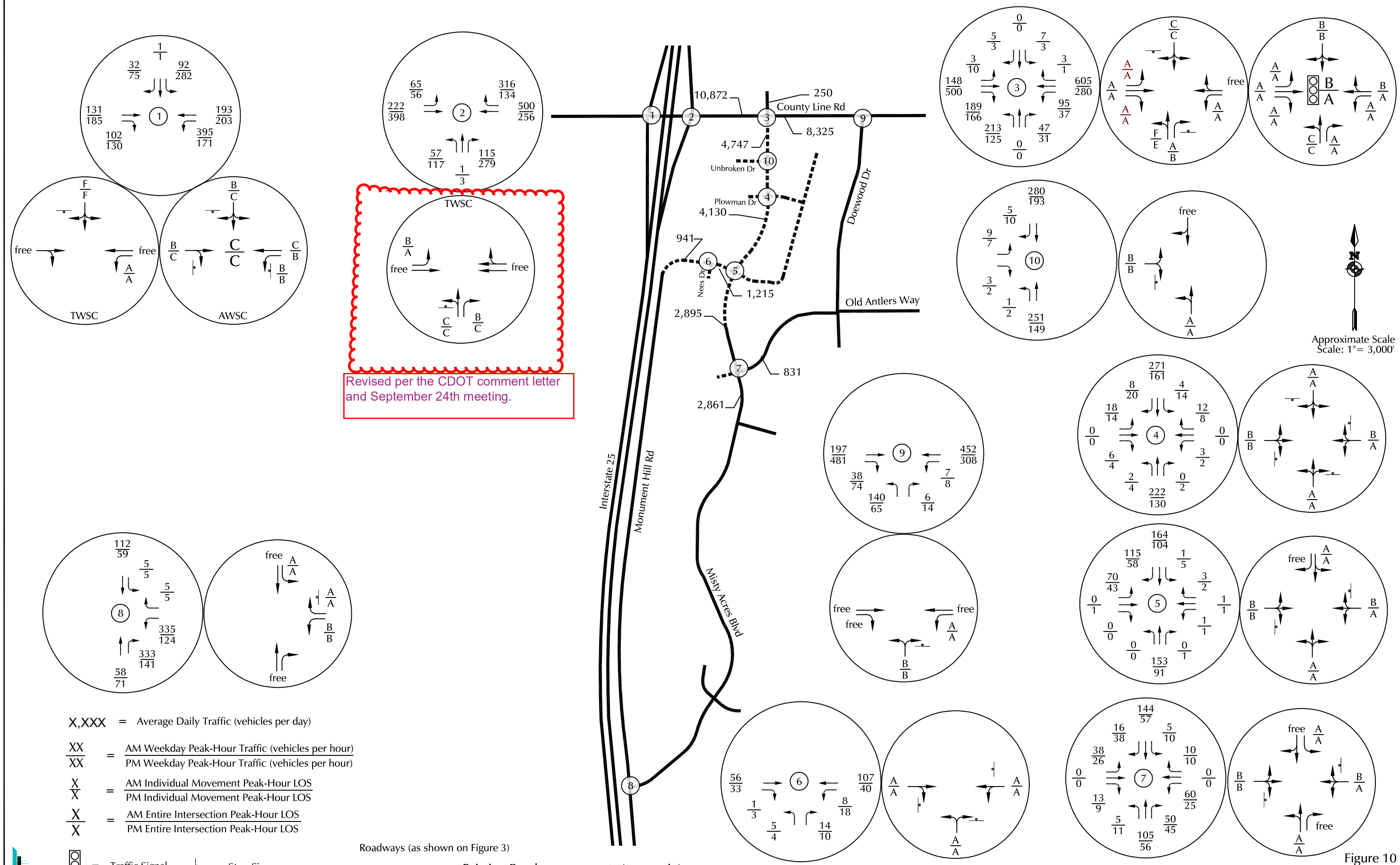

Figure 10

2044 Background + Site-Generated Traffic

Monument Ridge East (LSC# S234450)

w/separate NB RT

Intersection	
Int Delay, s/veh	2.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	65	222	0	0	500	316	57	1	115	0	0	0
Future Vol, veh/h	65	222	0	0	500	316	57	1	115	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	0	-	-	-	-	300	-	-	0	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	87	87	87	93	93	93	87	87	87	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	75	255	0	0	538	340	66	1	132	0	0	0

Major/Minor	Major1			Major2			Minor1		
Conflicting Flow All	878	0	-	-	-	0	674	1283	255
Stage 1	-	-	-	-	-	-	405	405	-
Stage 2	-	-	-	-	-	-	269	878	-
Critical Hdwy	4.13	-	-	-	-	-	6.63	6.53	6.23
Critical Hdwy Stg 1	-	-	-	-	-	-	5.43	5.53	-
Critical Hdwy Stg 2	-	-	-	-	-	-	5.83	5.53	-
Follow-up Hdwy	2.219	-	-	-	-	-	3.519	4.019	3.319
Pot Cap-1 Maneuver	767	-	0	0	-	-	404	164	783
Stage 1	-	-	0	0	-	-	673	598	-
Stage 2	-	-	0	0	-	-	753	365	-
Platoon blocked, %		-			-	-			
Mov Cap-1 Maneuver	767	-	-	-	-	-	364	0	783
Mov Cap-2 Maneuver	-	-	-	-	-	-	364	0	-
Stage 1	-	-	-	-	-	-	607	0	-
Stage 2	-	-	-	-	-	-	753	0	-

Approach	EB	WB	NB
HCM Control Delay, s	2.3	0	13
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBL	EBT	WBT	WBR
Capacity (veh/h)	464	783	767	-	-	-
HCM Lane V/C Ratio	0.239	0.113	0.097	-	-	-
HCM Control Delay (s)	15.2	10.2	10.2	-	-	-
HCM Lane LOS	C	B	B	-	-	-
HCM 95th %tile Q(veh)	0.9	0.4	0.3	-	-	-

w/separate NB RT

Intersection	
Int Delay, s/veh	5.9

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	56	398	0	0	256	134	117	3	279	0	0	0
Future Vol, veh/h	56	398	0	0	256	134	117	3	279	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	0	-	-	-	-	300	-	-	0	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	61	433	0	0	278	146	127	3	303	0	0	0

Major/Minor	Major1			Major2			Minor1		
Conflicting Flow All	424	0	-	-	-	0	694	979	433
Stage 1	-	-	-	-	-	-	555	555	-
Stage 2	-	-	-	-	-	-	139	424	-
Critical Hdwy	4.13	-	-	-	-	-	6.63	6.53	6.23
Critical Hdwy Stg 1	-	-	-	-	-	-	5.43	5.53	-
Critical Hdwy Stg 2	-	-	-	-	-	-	5.83	5.53	-
Follow-up Hdwy	2.219	-	-	-	-	-	3.519	4.019	3.319
Pot Cap-1 Maneuver	1133	-	0	0	-	-	392	249	622
Stage 1	-	-	0	0	-	-	574	512	-
Stage 2	-	-	0	0	-	-	874	586	-
Platoon blocked, %		-			-	-			
Mov Cap-1 Maneuver	1133	-	-	-	-	-	371	0	622
Mov Cap-2 Maneuver	-	-	-	-	-	-	371	0	-
Stage 1	-	-	-	-	-	-	543	0	-
Stage 2	-	-	-	-	-	-	874	0	-

Approach	EB	WB	NB
HCM Control Delay, s	1	0	17.3
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBL	EBT	WBT	WBR
Capacity (veh/h)	371	622	1133	-	-	-
HCM Lane V/C Ratio	0.352	0.488	0.054	-	-	-
HCM Control Delay (s)	19.9	16.2	8.4	-	-	-
HCM Lane LOS	C	C	A	-	-	-
HCM 95th %tile Q(veh)	1.5	2.7	0.2	-	-	-

Intersection	
Intersection Delay, s/veh	16.5
Intersection LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	131	102	395	193	0	0	0	0	92	1	32
Future Vol, veh/h	0	131	102	395	193	0	0	0	0	92	1	32
Peak Hour Factor	0.87	0.87	0.87	0.83	0.93	0.93	0.92	0.92	0.92	0.83	0.83	0.83
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	0	151	117	476	208	0	0	0	0	111	1	39
Number of Lanes	0	1	0	1	1	0	0	0	0	0	1	0

Approach	EB	WB	SB
Opposing Approach	WB	EB	
Opposing Lanes	2	1	0
Conflicting Approach Left	SB		WB
Conflicting Lanes Left	1	0	2
Conflicting Approach Right		SB	EB
Conflicting Lanes Right	0	1	1
HCM Control Delay	10.9	19.9	11
HCM LOS	B	C	B

Lane	EBLn1	WBLn1	WBLn2	SBLn1
Vol Left, %	0%	100%	0%	74%
Vol Thru, %	56%	0%	100%	1%
Vol Right, %	44%	0%	0%	26%
Sign Control	Stop	Stop	Stop	Stop
Traffic Vol by Lane	233	395	193	125
LT Vol	0	395	0	92
Through Vol	131	0	193	1
RT Vol	102	0	0	32
Lane Flow Rate	268	476	208	151
Geometry Grp	4a	5	5	2
Degree of Util (X)	0.368	0.755	0.3	0.249
Departure Headway (Hd)	4.948	5.715	5.211	5.948
Convergence, Y/N	Yes	Yes	Yes	Yes
Cap	718	628	683	598
Service Time	3.035	3.497	2.993	4.043
HCM Lane V/C Ratio	0.373	0.758	0.305	0.253
HCM Control Delay	10.9	24.1	10.2	11
HCM Lane LOS	B	C	B	B
HCM 95th-tile Q	1.7	6.8	1.3	1

Intersection	
Intersection Delay, s/veh	19.7
Intersection LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	185	130	95	171	203	0	0	0	0	282	1	75
Future Vol, veh/h	185	130	95	171	203	0	0	0	0	282	1	75
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
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	201	141	103	186	221	0	0	0	0	307	1	82
Number of Lanes	0	1	0	1	1	0	0	0	0	0	1	0

Approach	EB	WB	SB
Opposing Approach	WB	EB	
Opposing Lanes	2	1	0
Conflicting Approach Left	SB		WB
Conflicting Lanes Left	1	0	2
Conflicting Approach Right		SB	EB
Conflicting Lanes Right	0	1	1
HCM Control Delay	23.8	13.8	21.2
HCM LOS	C	B	C

Lane	EBLn1	WBLn1	WBLn2	SBLn1
Vol Left, %	45%	100%	0%	79%
Vol Thru, %	32%	0%	100%	0%
Vol Right, %	23%	0%	0%	21%
Sign Control	Stop	Stop	Stop	Stop
Traffic Vol by Lane	410	171	203	358
LT Vol	185	171	0	282
Through Vol	130	0	203	1
RT Vol	95	0	0	75
Lane Flow Rate	446	186	221	389
Geometry Grp	4a	5	5	2
Degree of Util (X)	0.735	0.364	0.4	0.672
Departure Headway (Hd)	5.938	7.044	6.533	6.216
Convergence, Y/N	Yes	Yes	Yes	Yes
Cap	606	507	547	580
Service Time	4.014	4.834	4.323	4.29
HCM Lane V/C Ratio	0.736	0.367	0.404	0.671
HCM Control Delay	23.8	13.9	13.7	21.2
HCM Lane LOS	C	B	B	C
HCM 95th-tile Q	6.3	1.6	1.9	5.1