MEMO - FINAL

To: Stephanie Fisher, City Administrator, City of Waverly

From: JEO Consulting Group

Date: May 1, 2023

Subject: 143rd Street & Bailie Street Traffic Study

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5/1/23
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Background

The City of Wavery requested a review of traffic operations at the intersections of 143rd Street & Bailie Street and 145th Street & Bailie Street to determine the need for revisions in traffic control, specifically the implementation of stop control on one or more approaches to the study intersections. The goal of this traffic study was to identify safety enhancements for implementation, if applicable. The location of study intersections within the City of Waverly is marked by a blue star on the Vicinity Map shown in Figure 1 and are shown in greater detail in Figure 2.

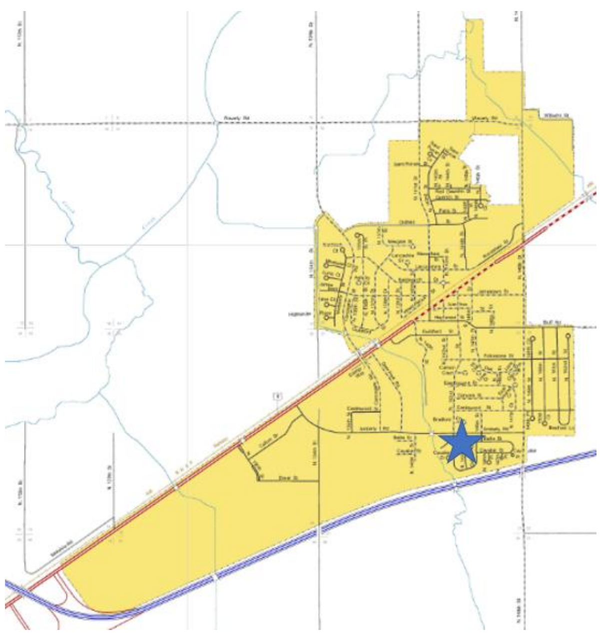

Figure 1: Vicinity Map

This report applies the guidance of the Manual on Uniform Traffic Control Devices, 2009 Edition (MUTCD). The MUTCD is a publication by the Federal Highway Administration (FHWA) that provides guidance on traffic control devices and their use on all types of public roadways.

Figure 2: Study Area

Roadway Characteristics

Baillie Street, N 143rd Street, and N 145th Street are all local streets, as classified by the Nebraska Department of Transportation's (NDOT) State Functional Classification Map. Bailie Street has an approximate back-of-curb to back-of-curb (BOC to BOC) width of 28 feet. N 143rd Street has an approximate BOC to BOC width of 38 feet north of Bailie Street and 28 feet south of Baillie Street. N 145th Street has an approximate width of 38 feet, BOC to BOC. Sidewalk and on-street, parallel parking are provided on both sides of all three study streets. Though not posted by traffic control signs, the statutory speed limit on all three streets is 25 mph.

The intersection of 143rd Street & Bailie Street is uncontrolled (i.e., no traffic control signs) with Bailie Street forming the eastbound and westbound approaches and N 143rd Street forming the northbound and southbound approaches. All approaches consist of a single shared left-, through, and right-turn lane. Pedestrian accommodations in the form of curb ramps and unmarked crosswalks are provided across all four approaches to the intersection.

The intersection of 145th Street & Bailie Street is an uncontrolled, three-leg intersection with Bailie Street forming the eastbound and westbound approaches and N 145th Street forming the southbound approach. All approaches consist of a single lane sharing the respective available movements for that approach. Pedestrian accommodations in the form of curb ramps and unmarked crosswalks are provided across the southbound and westbound approaches only. However, it should be noted that instead of a curb ramp at the south end of the unmarked crosswalk across the westbound approach, the crosswalk uses a local resident's private driveway.

Further details regarding existing roadway geometrics and traffic control are shown in Figure 3.

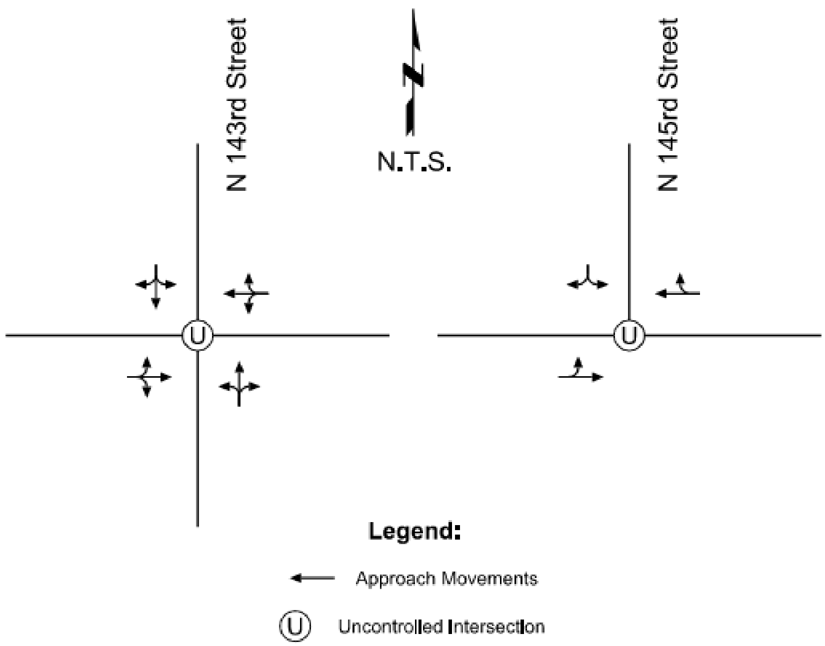

Figure 3: Existing Roadway Geometry and Traffic Control

Peak Hour Volumes

Traffic and pedestrian volumes for both study intersections were collected on Tuesday, March 28th using Miovision Scout Cameras. For both intersections, the observed AM peak hour was between 7:30 and 8:30 a.m. The observed PM peak hour differed between the two intersections with N 143rd Street & Bailie Street peaking during a typical commuter PM time period (4:45 and 5:45 p.m.) while N 145th Street & Bailie Street peaked during a typical school release time period (3:00 and 4:00 p.m.). AM and PM peak hour turning movement volumes as well as AM and PM peak hour pedestrian volumes are shown in Figure 4 below.

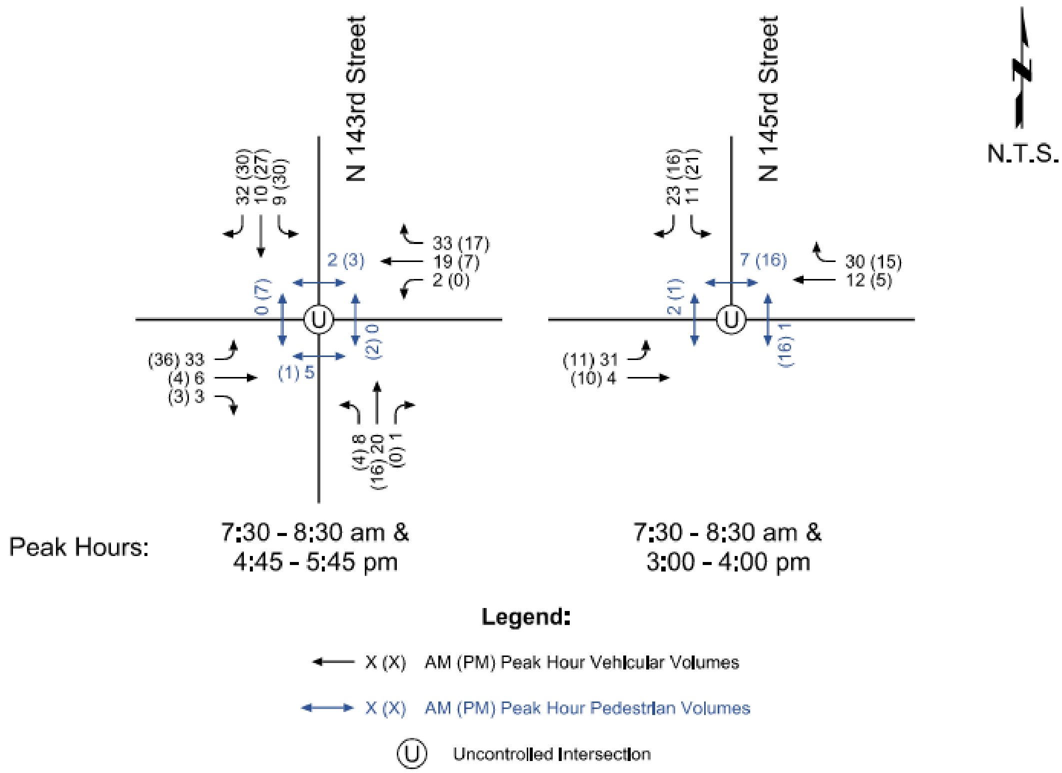

Figure 4: Peak Hour Volumes

Peak Hour Capacity Analysis

Traffic operations analyses incorporating the peak hour volumes for the study intersections were performed using the unsignalized intersection capacity analysis procedures outlined in the Highway Capacity Manual, 6th Edition (HCM). Per the HCM, Level of Service (LOS) is presented as a letter grade (A through F) based on the calculated average delay for an intersection or movement during a specific time period (such as AM and PM peak hours). LOS A represents free flow movement with very little to no delay, while LOS F represents congested flow at, or exceeding, the capacity of the roadway. As shown in Figure 5, all approaches to both study intersections at LOS A during both peak hours. This intersection was analyzed in Synchro and Synchro output sheets are available in Attachment A.

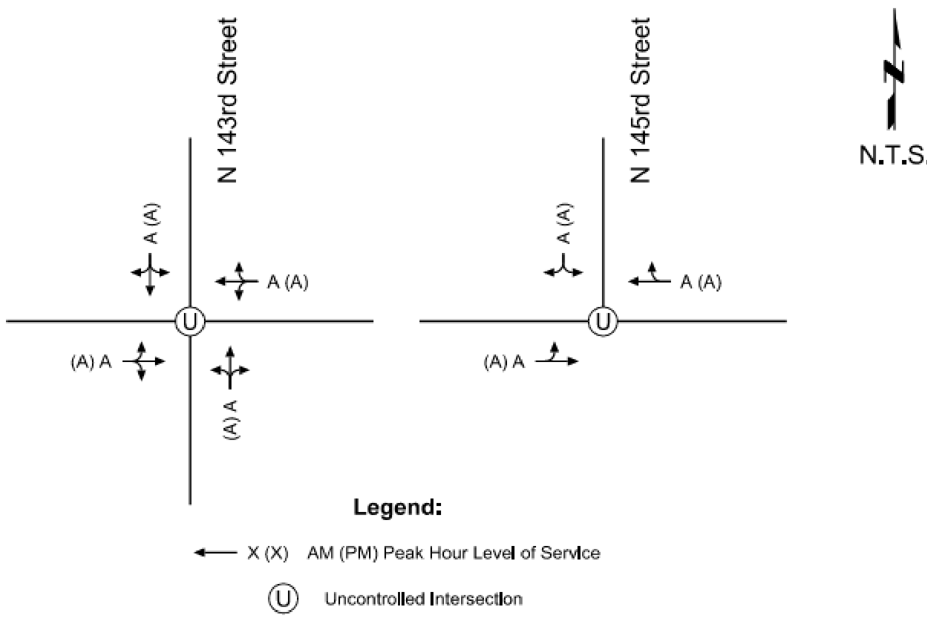

Figure 5: Peak Hour Level of Service

Speed Study

A speed study was conducted on Bailie Street between N 143rd St and N 145th St with a Houston Radar Armadillo radar unit placed approximately 140' west of the centerline of Oxford Avenue on the south side of Bailie Street. This radar unit collected vehicle speeds from midnight on the morning of March 28th until midnight on the evening of March 30th, resulting in three full days of collected data. This equated to a total sample size of 555 vehicle speeds. As shown in Table 1, vehicles on Bailie Street were observed to have very consistent speeds with 70-80% of vehicles within the same 10 mph window. This window, or pace, is a measure of driver speed consistency. The 85th percentile speed measures the maximum speed among 85% of drivers and is recommended by the MUTCD as the speed at which posted speed limits are established.

Table 1: Speed Study

Location	**Statutory Speed Limit**	**Direction**	**% in Pace**	**Pace (mph)**	**85th Percentile**	**Average Speed**
Bailie Street (140' West of Oxford Avenue)	25	WB	71 %	18.0 – 28.0	28.0	23.2
	25	EB	77 %	18.0 – 28.0	27.0	22.4

Site Observation

Conditions at study area intersections were observed from 3:00 to 4:00p.m. on Wednesday, April 12th and 7:30 to 8:15a.m. on Thursday, April 13th. During these times, no safety or operational issues were observed at either intersection. Motorists were also observed to be correctly yielding their right-of-way to other motorists or pedestrians, as required.

Safety Study

Crash history for the study area was gathered from NDOT's crash portal for the latest five-year period available (January 1, 2015 – December 31, 2020). According to this data, there were no reported crashes at either study intersection during this time period.

Stop Control Analysis

The MUTCD outlines criteria and provides guidance for the application of both all-way stop control (AWSC) and two-way stop control (TWSC) at an intersection. The following summary presents how the MUTCD guidance for the use of stop signs at intersections applies to both study intersections. Full text of the MUTCD guidance is provided in Attachment B.

ALL-WAY STOP CONTROL ANALYSIS

The MUTCD provides the following criteria when evaluating if all-way stop control could be used at an intersection:

Criteria A

This criterion allows for the use of stop-control as an interim measure when a traffic signal is being installed. Both study area intersections are currently uncontrolled and the existing conditions, namely traffic volumes, would not warrant a traffic signal. Criteria A is not satisfied at either study intersection.

Criteria B

This criterion allows for the use of stop-control if there have been five or more crashes at the study intersection. As NDOT has no reports of crashes at either intersection, Criteria B is not satisfied.

Criteria C

This criterion has three different sub-criteria based on minimum volumes. It should be noted that for Criteria C to be satisfied, both Criteria C.1 and C.2 must be satisfied.

Criteria C.1

This criterion allows for all-way stop-control if the major street approach vehicular volumes average higher than 300 vehicles per hour for at least eight hours of the day. This threshold is not satisfied for either study intersection.

Criteria C.2

This criterion allows for stop-control if the minor street approach total (vehicular, pedestrian, and bicycle) volumes average at least 200 per hour for the same eight hours in Criteria C.1. They also must experience a certain amount of delay during the highest peak hour. As volumes at the study intersections average lower than 200 per hour, this threshold is not satisfied for either study intersection.

Criteria C.3

This criterion allows for the reduction of thresholds in Criteria C.1 and C.2 if the 85th percentile speed exceeds 40 mph. However, as shown previously in Table 1, the 85th percentile speed for Bailie Street is 27-28 mph, so this criterion is not applicable.

As the threshold for both Criteria C.1 and C.2 are not satisfied and Criteria C.3 is not applicable, Criteria C is not satisfied.

Criteria D

This criterion is a special case where all-way stop control can be considered if Criteria B, C.1, and C.2 were all satisfied at 80% of their current thresholds. This would require an average of 240 vehicles on the major street and an average of 160 units on the side street. As the approach volumes of both study intersections are below 110 during all peak hours (and normally below 50), Criteria D is not satisfied.

Based on the above analysis, it can be concluded that conditions do not satisfy warrant criteria for all-way stop control at either study intersection.

TWO-WAY STOP CONTROL ANALYSIS

At locations where all-way stop control is not appropriate, the usage of two-way stop control could be appropriate. The MUTCD provides the following criteria when considering the usage of two-way stop control:

Criteria A

This criterion requires 6,000 vehicles per day on the major street. As traffic volumes on all study area streets are less than 1,000 vehicles per day, Criteria A is not satisfied.

Criteria B

This criterion is used when there is reduced sight distance at an intersection that would require the full stoppage of vehicles to see conflicting vehicles. Based on both observations made at study intersections and desktop review, full stoppage of vehicles is not required to see conflicting vehicles. Therefore, Criteria B is not satisfied.

Criteria C

This criterion indicates that two-way stop control could be used when there are five or more crashes at a study intersection in the past two years that would be susceptible to correction by the placement of a stop sign. As NDOT has no report of crashes at either study intersection, Criteria C is not satisfied.

Based on the above analysis, conditions do not satisfy MUTCD criteria for the installation of two-way stop control at either intersection. Furthermore, if two-way stop control were implemented at either intersection, it would be expected that vehicle speeds on the non-controlled approaches would increase.

Speed Zone Analysis

According to guidance provided by the MUTCD, speed limits should be set within 5 mph of the 85th percentile speed. As the 85th percentile speed of Bailie Street is between 27 and 28 mph, a speed limit of 25 mph is appropriate.

Considerations and Conclusions

Based on the results of the analysis, the study considerations and conclusions include the following:

- Both study intersections operate acceptably with LOS A during both AM and PM peak hours.
- No change to the speed limit is advised as the 85th percentile speed of vehicles is within 5 mph of the current regulatory speed limit.
- The current traffic control at both study intersections (uncontrolled) is appropriate based upon the analysis conducted for AWSC and TWSC. In addition, the observed motorists at study intersections correctly yielded their right-of-way during times of field observation, as is required at uncontrolled intersections.
- The application of unwarranted two-way stop control (TWSC) can often contribute to increased vehicle speeds on the uncontrolled approaches.

HCM 6th AWSC
3: Bailie St & N 145th St

04/13/2023

Intersection	
Intersection Delay, s/veh	7
Intersection LOS	A

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	31	4	12	30	11	23
Future Vol, veh/h	31	4	12	30	11	23
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	34	4	13	33	12	25
Number of Lanes	0	1	1	0	1	0

Approach	EB	WB	SB
Opposing Approach	WB	EB	
Opposing Lanes	1	1	0
Conflicting Approach Left	SB		WB
Conflicting Lanes Left	1	0	1
Conflicting Approach Right		SB	EB
Conflicting Lanes Right	0	1	1
HCM Control Delay	7.4	6.8	6.9
HCM LOS	A	A	A

Lane	EBLn1	WBLn1	SBLn1
Vol Left, %	89%	0%	32%
Vol Thru, %	11%	29%	0%
Vol Right, %	0%	71%	68%
Sign Control	Stop	Stop	Stop
Traffic Vol by Lane	35	42	34
LT Vol	31	0	11
Through Vol	4	12	0
RT Vol	0	30	23
Lane Flow Rate	38	46	37
Geometry Grp	1	1	1
Degree of Util (X)	0.045	0.046	0.038
Departure Headway (Hd)	4.211	3.599	3.738
Convergence, Y/N	Yes	Yes	Yes
Cap	853	996	956
Service Time	2.225	1.618	1.769
HCM Lane V/C Ratio	0.045	0.046	0.039
HCM Control Delay	7.4	6.8	6.9
HCM Lane LOS	A	A	A
HCM 95th-tile Q	0.1	0.1	0.1

Intersection	
Intersection Delay, s/veh	7.2
Intersection LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	33	6	3	2	19	33	8	20	1	9	10	32
Future Vol, veh/h	33	6	3	2	19	33	8	20	1	9	10	32
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	36	7	3	2	21	36	9	22	1	10	11	35
Number of Lanes	0	1	0	0	1	0	0	1	0	0	1	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	1	1	1	1
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	1	1	1	1
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	1	1	1	1
HCM Control Delay	7.5	7.1	7.4	7.1
HCM LOS	A	A	A	A

Lane	NBLn1	EBLn1	WBLn1	SBLn1
Vol Left, %	28%	79%	4%	18%
Vol Thru, %	69%	14%	35%	20%
Vol Right, %	3%	7%	61%	63%
Sign Control	Stop	Stop	Stop	Stop
Traffic Vol by Lane	29	42	54	51
LT Vol	8	33	2	9
Through Vol	20	6	19	10
RT Vol	1	3	33	32
Lane Flow Rate	32	46	59	55
Geometry Grp	1	1	1	1
Degree of Util (X)	0.037	0.054	0.061	0.058
Departure Headway (Hd)	4.192	4.244	3.76	3.798
Convergence, Y/N	Yes	Yes	Yes	Yes
Cap	849	840	947	936
Service Time	2.243	2.287	1.806	1.848
HCM Lane V/C Ratio	0.038	0.055	0.062	0.059
HCM Control Delay	7.4	7.5	7.1	7.1
HCM Lane LOS	A	A	A	A
HCM 95th-tile Q	0.1	0.2	0.2	0.2

HCM 6th AWSC
3: Bailie St & N 145th St

04/13/2023

Intersection	
Intersection Delay, s/veh	7.1
Intersection LOS	A

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	11	10	5	15	21	16
Future Vol, veh/h	11	10	5	15	21	16
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	12	11	5	16	23	17
Number of Lanes	0	1	1	0	1	0

Approach	EB	WB	SB
Opposing Approach	WB	EB	
Opposing Lanes	1	1	0
Conflicting Approach Left	SB		WB
Conflicting Lanes Left	1	0	1
Conflicting Approach Right		SB	EB
Conflicting Lanes Right	0	1	1
HCM Control Delay	7.3	6.7	7.1
HCM LOS	A	A	A

Lane	EBLn1	WBLn1	SBLn1
Vol Left, %	52%	0%	57%
Vol Thru, %	48%	25%	0%
Vol Right, %	0%	75%	43%
Sign Control	Stop	Stop	Stop
Traffic Vol by Lane	21	20	37
LT Vol	11	0	21
Through Vol	10	5	0
RT Vol	0	15	16
Lane Flow Rate	23	22	40
Geometry Grp	1	1	1
Degree of Util (X)	0.026	0.022	0.043
Departure Headway (Hd)	4.126	3.572	3.864
Convergence, Y/N	Yes	Yes	Yes
Cap	869	1003	928
Service Time	2.142	1.59	1.881
HCM Lane V/C Ratio	0.026	0.022	0.043
HCM Control Delay	7.3	6.7	7.1
HCM Lane LOS	A	A	A
HCM 95th-tile Q	0.1	0.1	0.1

HCM 6th AWSC
5: N 143rd St & Bailie St

Intersection	
Intersection Delay, s/veh	7.4
Intersection LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✣			✣			✣			✣	
Traffic Vol, veh/h	36	4	3	0	7	17	4	16	0	30	27	30
Future Vol, veh/h	36	4	3	0	7	17	4	16	0	30	27	30
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	39	4	3	0	8	18	4	17	0	33	29	33
Number of Lanes	0	1	0	0	1	0	0	1	0	0	1	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	1	1	1	1
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	1	1	1	1
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	1	1	1	1
HCM Control Delay	7.6	6.9	7.3	7.4
HCM LOS	A	A	A	A

Lane	NBLn1	EBLn1	WBLn1	SBLn1
Vol Left, %	20%	84%	0%	34%
Vol Thru, %	80%	9%	29%	31%
Vol Right, %	0%	7%	71%	34%
Sign Control	Stop	Stop	Stop	Stop
Traffic Vol by Lane	20	43	24	87
LT Vol	4	36	0	30
Through Vol	16	4	7	27
RT Vol	0	3	17	30
Lane Flow Rate	22	47	26	95
Geometry Grp	1	1	1	1
Degree of Util (X)	0.025	0.056	0.027	0.103
Departure Headway (Hd)	4.173	4.281	3.746	3.939
Convergence, Y/N	Yes	Yes	Yes	Yes
Cap	852	831	946	906
Service Time	2.225	2.333	1.807	1.979
HCM Lane V/C Ratio	0.026	0.057	0.027	0.105
HCM Control Delay	7.3	7.6	6.9	7.4
HCM Lane LOS	A	A	A	A
HCM 95th-tile Q	0.1	0.2	0.1	0.3

Section 2B.06 STOP Sign Applications

Guidance:

01 *At intersections where a full stop is not necessary at all times, consideration should first be given to using less restrictive measures such as YIELD signs (see Sections 2B.08 and 2B.09).*

02 *The use of STOP signs on the minor-street approaches should be considered if engineering judgment indicates that a stop is always required because of one or more of the following conditions:*

A. *The vehicular traffic volumes on the through street or highway exceed 6,000 vehicles per day;*
B. *A restricted view exists that requires road users to stop in order to adequately observe conflicting traffic on the through street or highway; and/or*
C. *Crash records indicate that three or more crashes that are susceptible to correction by the installation of a STOP sign have been reported within a 12-month period, or that five or more such crashes have been reported within a 2-year period. Such crashes include right-angle collisions involving road users on the minor-street approach failing to yield the right-of-way to traffic on the through street or highway.*

Support:

03 The use of STOP signs at grade crossings is described in Sections 8B.04 and 8B.05.

Section 2B.07 Multi-Way Stop Applications

Support:

01 Multi-way stop control can be useful as a safety measure at intersections if certain traffic conditions exist. Safety concerns associated with multi-way stops include pedestrians, bicyclists, and all road users expecting other road users to stop. Multi-way stop control is used where the volume of traffic on the intersecting roads is approximately equal.

02 The restrictions on the use of STOP signs described in Section 2B.04 also apply to multi-way stop applications.

Guidance:

03 *The decision to install multi-way stop control should be based on an engineering study.*

04 *The following criteria should be considered in the engineering study for a multi-way STOP sign installation:*

A. *Where traffic control signals are justified, the multi-way stop is an interim measure that can be installed quickly to control traffic while arrangements are being made for the installation of the traffic control signal.*
B. *Five or more reported crashes in a 12-month period that are susceptible to correction by a multi-way stop installation. Such crashes include right-turn and left-turn collisions as well as right-angle collisions.*
C. *Minimum volumes:*
   1. *The vehicular volume entering the intersection from the major street approaches (total of both approaches) averages at least 300 vehicles per hour for any 8 hours of an average day; and*
   2. *The combined vehicular, pedestrian, and bicycle volume entering the intersection from the minor street approaches (total of both approaches) averages at least 200 units per hour for the same 8 hours, with an average delay to minor-street vehicular traffic of at least 30 seconds per vehicle during the highest hour; but*
   3. *If the 85th-percentile approach speed of the major-street traffic exceeds 40 mph, the minimum vehicular volume warrants are 70 percent of the values provided in Items 1 and 2.*
D. *Where no single criterion is satisfied, but where Criteria B, C.1, and C.2 are all satisfied to 80 percent of the minimum values. Criterion C.3 is excluded from this condition.*

Option:

05 Other criteria that may be considered in an engineering study include:

A. The need to control left-turn conflicts;
B. The need to control vehicle/pedestrian conflicts near locations that generate high pedestrian volumes;
C. Locations where a road user, after stopping, cannot see conflicting traffic and is not able to negotiate the intersection unless conflicting cross traffic is also required to stop; and
D. An intersection of two residential neighborhood collector (through) streets of similar design and operating characteristics where multi-way stop control would improve traffic operational characteristics of the intersection.