



Multi-Way Stop for the Intersection of
E Front St and Indian Woods Dr (East Entrance)
City Engineering Department
July 2014

Criteria for Multi-Way Stop Installation

Based on MUTCD 2009 Edition Standards

Criterion 1: Crash Experience

This criterion is **not satisfied** because there have been no accidents at this intersection in the past 12 months that could have been prevented by a Multi-Way Stop.

Criterion 2: 8-hour Vehicular Volume

This criterion is **not satisfied** because the vehicles per hour entering the intersection of E Front St and Indian Woods Dr coming from E Front St is 61, which does not exceed the required minimum 300 vehicles per hour for any 8 hours of an average day. The vehicles per hour entering the intersection from Indian Woods Dr is 10 with an average delay to vehicular traffic is 1 second, which does not exceed the required minimum 200 vehicles per hour for the same 8 hours and the minimum average delay time of 30 seconds per vehicle during the peak hour.

Criterion 3: Major Road Approach Speed

This criterion is **not satisfied** because the 85th-percentile approach speed of traffic on E Front St is 31 mph, which does not exceed the required minimum of 40 mph.

Additional Notes

The level of service of the intersection was found to be a level A with an average control delay of 1 second per vehicle. During the observation period there was a long 7 minute gap in traffic within the first 10 minutes of observation. This gap was ended by a grouping of 3 vehicles on E Front St. Gapping like this occurred throughout the observed peak hour with times ranging from 1 to 5 minutes, each time ended by a grouping of 3 to 4 vehicles. These vehicles would be just over gap distance as well, leading to the high gap count of 49. It was also observed that around half of the vehicles travelling from East Bay Blvd westbound on E Front St would turn off onto either Wenonah or Huron St before reaching Indian Woods Dr. This leads to the conclusion that most vehicles travelling from the Peninsula use any one of these 3 roads as a thru route.

The number of bicycles traveling through the intersection was drastically higher than the number of pedestrians, with 8 bicyclists and only 1 pedestrian. A majority of the bicycles observed were cruisers in small groups, leading to the conclusion that this road is a casual exercise route. There were 3 more observed pedestrians that did not go through the intersection. These 3 were walking their dogs and appeared to be taking a short walk through the Indian Woods neighborhood.



Prepared By: *[Signature]*

Date: *7-7-14*

Reviewed By: *[Signature]*

Date: *7-28-14*

- Encl: 2009 MUTCD Section 2B.07 Multi-Way Stop Applications
- Stop Sign Criteria Data for E Front St and Indian Woods Dr
- Stop Time Delay Tabulation
- Stop Warrant Field Observations
- Detailed TraxPro E Front St Speed Report
- 2014 TraxPro E Front St Volume Report
- 2007 TraxPro Indian Woods Dr Volume Report



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.

**2014 Multi-Way Stop Sign Criteria -- E. Front St. and Indian Woods Dr.
Intersection Data**

KEY	
= Area of Concern	
**Estimates and Projected Data are found by using a 2% per year growth rate	

General Information

Major Road	Minor Road	Total Control Delay (sec)	Average Control Delay (sec/vehicle)	Level of Service	Total Pedestrians	School Children	Bicycles	Gaps	Major Road Speed Limit
E. Front	Indian Woods	12	1.00	A	1	0	8	49	25

Criterion 1: Crash Experience

Main Road	Minor Road	Correctable Crashes in Past 12 Months	Meets Conditions B
E. Front	Indian Woods	0	no

Criterion 2: 8-hour Vehicular Volume

Major Road	Minor Road	Vehicles per Hour on Major Road	Vehicles per Hour on Minor Road	Meets Condition C 1	Meets Condition C 2	Meets Condition B, C 1 and C 2 Combination to 80% of minimum	Major Street Volume Estimated** from:	Minor Street Volume Estimated** from:
E. Front	Indian Woods	61	10	no	no	no	Current (2014 Speed Study)	Past (2007)

Criterion 3: Major Road Approach Speed

Major Road	85th Percentile Approach Speed (mph)	Meets Condition C	Speed Data from:
E. Front	31	no	Current (2014)

Notes

Currently 1-way stop, sign is on Indian Woods

Indian Woods Dr. and E. Front St.

Monday, 6-30-14

Partly Cloudy, 82°

4:10 pm - 5:10 pm (peak hour)

Stop Time Delay (s)			
1	1	1	1
1	1	1	1
1	1	1	1
TOTAL:	12 sec 12 vehicles		
Average:	1.0 sec/vehicle		



Job E. Front St. + Indian Woods Dr.

Project No. _____ File _____

Description Multi-way Stop Warrant
Additional Field Observations

Computed by John Zarabonick Date _____

Checked by _____ Date _____

Reference

of Cars turning off Indian Woods:
III IIII

Stop Time Delay for Cars turning off Indian Woods:

1 sec.	1 sec.	1 sec.	1 sec.
1 sec.	1 sec.	1 sec.	1 sec.
1 sec.	1 sec.	1 sec.	1 sec.

- Long 7 minute gap in the 1st 10 minutes, ended by 3 cars back to back to back

- Gaps counted for cars turning off Indian Woods:
III IIII

- Mid to Long Gaps \approx between groups of cars, then
(1 min) (5 min.)
3-4 cars in a row, just over gap distance between

- Appeared that half the cars going west on E Front turned onto Denonah or Huron before getting to Indian Woods

- Pedestrians near intersection (3) would go around the block instead of going through the intersection, dog walking

E. Front St.
 (1700 Block, between Indian Woods Dr. and Wenonah)
 Speed

WB, EB	0	16	21	26	31	36	41	46	51	56	61	66	71	76	Total
Start Time	15	20	25	30	35	40	45	50	55	60	65	70	75	9999	
06/11/14	0	0	1	2	0	0	0	0	0	0	0	0	0	0	3
01:00	0	1	3	2	1	0	0	0	0	0	0	0	0	0	7
02:00	0	0	1	3	0	0	0	0	0	0	0	0	0	0	4
03:00	1	1	0	1	0	0	0	0	0	0	0	0	0	0	3
04:00	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2
05:00	0	0	4	2	1	0	0	0	0	0	0	0	0	0	7
06:00	0	2	3	5	1	0	0	0	0	0	0	0	0	0	11
07:00	2	7	8	24	10	1	0	0	0	0	0	0	0	0	52
08:00	1	10	22	25	2	1	0	0	0	0	0	0	0	0	61
09:00	2	7	8	21	6	1	0	0	0	0	0	0	0	0	45
10:00	1	4	8	22	5	3	0	0	0	0	0	0	0	0	43
11:00	3	7	16	23	18	3	0	0	0	0	0	0	0	0	70
12 PM	8	4	14	35	9	4	0	0	0	0	0	0	0	0	74
13:00	2	8	11	23	3	4	0	0	0	0	0	0	0	0	51
14:00	0	5	11	24	12	1	0	0	0	0	0	0	0	0	53
15:00	4	6	12	23	5	1	0	0	0	0	0	0	0	0	51
16:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
17:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
18:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
19:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
20:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
21:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
22:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
23:00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Day Total	24	62	122	237	73	19	0	0	0	0	0	0	0	0	537
Grand Total	37	106	204	461	144	33	1	0	0	0	0	0	0	0	986

Statistics

- Mean Speed(Average) : 25 MPH
- 10 MPH Pace Speed : 23-32 MPH
- Number in Pace : 591
- Percent in Pace : 59.9%
- Number of Vehicles > 25 MPH : 639
- Percent of Vehicles > 25 MPH : 64.8%

15th Percentile : 16 MPH
 50th Percentile : 26 MPH
 85th Percentile : 31 MPH
 95th Percentile : 34 MPH

E. Front St.
 (1700 Block, between Indian Woods Dr. and Wenonah)
 Count #53

Start Time	09-Jun-14 Mon	10-Jun-14 Tue	11-Jun-14 Wed	12-Jun-14 Thu	13-Jun-14 Fri	Weekday Average	14-Jun-14 Sat	15-Jun-14 Sun
12:00 AM	*	*	3	13	*	8	*	*
01:00	*	*	7	6	*	6	*	*
02:00	*	*	4	3	*	4	*	*
03:00	*	*	3	2	*	2	*	*
04:00	*	*	2	6	*	4	*	*
05:00	*	*	7	4	*	6	*	*
06:00	*	*	11	13	*	12	*	*
07:00	*	*	52	39	*	46	*	*
08:00	*	*	61	45	*	53	*	*
09:00	*	*	45	32	*	38	*	*
10:00	*	*	43	*	*	43	*	*
11:00	*	*	70	*	*	70	*	*
12:00 PM	*	*	74	*	*	74	*	*
01:00	*	*	51	*	*	51	*	*
02:00	*	44	53	*	*	48	*	*
03:00	*	78	51	*	*	64	*	*
04:00	*	70	65	*	*	68	*	*
05:00	*	68	72	*	*	70	*	*
06:00	*	45	46	*	*	46	*	*
07:00	*	42	46	*	*	44	*	*
08:00	*	45	29	*	*	37	*	*
09:00	*	33	29	*	*	31	*	*
10:00	*	16	21	*	*	18	*	*
11:00	*	8	13	*	*	10	*	*
Total	0	449	858	163	0		0	0
Percentage	0.0%	52.6%	100.6%	19.1%	0.0%		0.0%	0.0%
AM Peak	-	-	11:00	08:00	-	-	-	-
Vol.	-	-	70	45	-	-	-	-
PM Peak	-	15:00	12:00	-	-	-	-	-
Vol.	-	78	74	-	-	-	-	-
Total		449	858					

Start Time	Mon 21-May-07	Tue 22-May-07	Wed 23-May-07	Thu 24-May-07	Fri 25-May-07	Sat 26-May-07	Sun 27-May-07	Week Average
12:00 AM	0	0	0	0	0	0	0	0
01:00	0	0	0	0	0	0	0	0
02:00	0	0	0	0	0	0	0	0
03:00	0	0	0	0	0	0	0	0
04:00	0	1	1	1	1	1	1	1
05:00	0	2	2	2	2	2	2	2
06:00	0	2	2	2	2	2	2	2
07:00	0	2	2	2	2	2	2	2
08:00	0	5	5	5	5	5	5	5
09:00	0	10	10	10	10	10	10	10
10:00	0	13	13	13	13	13	13	13
11:00	0	8	8	8	8	8	8	8
12:00 PM	0	5	5	5	5	5	5	5
01:00	0	7	7	7	7	7	7	7
02:00	0	7	7	7	7	7	7	7
03:00	0	9	9	9	9	9	9	9
04:00	0	11	11	11	11	11	11	11
05:00	0	4	4	4	4	4	4	4
06:00	0	11	11	11	11	11	11	11
07:00	0	9	9	9	9	9	9	9
08:00	0	8	8	8	8	8	8	8
09:00	0	3	3	3	3	3	3	3
10:00	0	2	2	2	2	2	2	2
11:00	0	0	0	0	0	0	0	0
Day Total	0	84	35	0	0	0	0	119
% Avg. WKDay	0.0%	70.6%	29.4%	0.0%	0.0%	0.0%	0.0%	100.0%
% Avg. Week	0.0%	70.6%	29.4%	0.0%	0.0%	0.0%	0.0%	100.0%
AM Peak Volume		11:00 8	10:00 13					10:00 13
PM Peak Volume		16:00 11						16:00 11
Grand Total	0	84	35	0	0	0	0	119

ADT Not Calculated