



Agenda Item # 2d
Intersection Traffic Study – Crooks Avenue (STH 55) at Ann Street

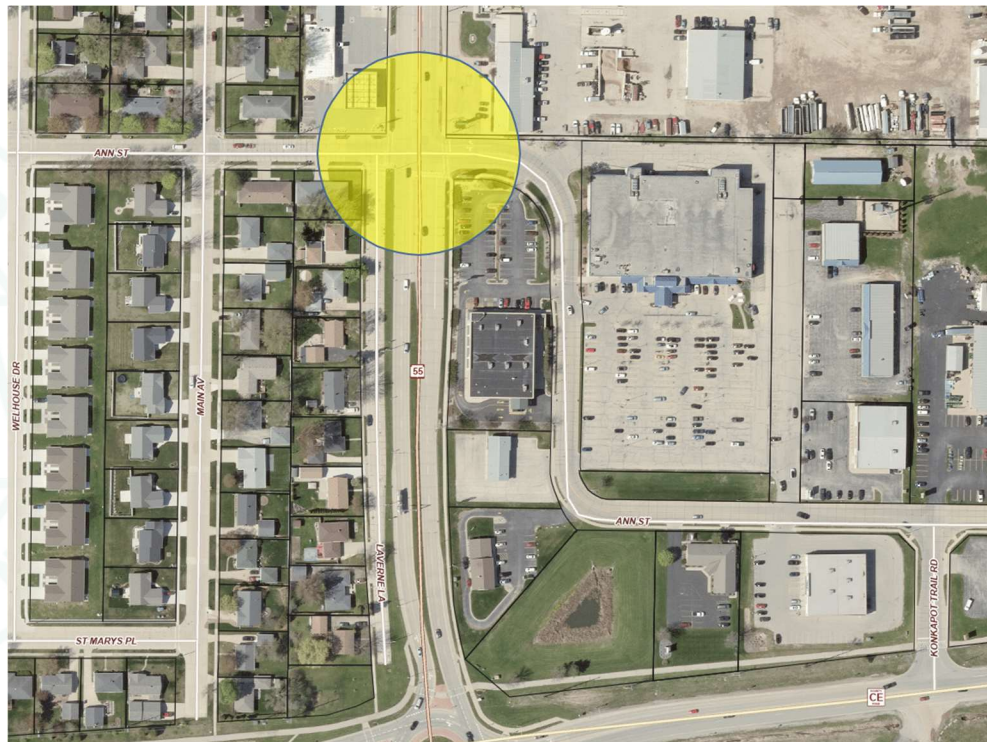
Background

The Engineering Department has completed an intersection traffic study for Crooks Avenue (STH 55) at Ann Street. A request was made for traffic signals at this location. The city worked with East Central Wisconsin Regional Plan Commission to perform a traffic count using video equipment. Vehicle counts, turning movements, and pedestrian/bicycle use were all documented. Accident history for the intersection is also looked at as part of the study. All information is entered into a Wisconsin Department of Transportation (WisDOT) Traffic Signal Warrant Summary Worksheet. The worksheet uses the data to determine if any of the nine traffic signal warrants are met.

After submitting the worksheet and data to WisDOT for review, it has been confirmed that none of signal warrants are met at this time. A copy of the worksheet and the signal warrants are attached.

Recommended Action

No action needed.



Wisconsin Department of Transportation Traffic Signal Warrant

Summary Worksheet

100%

The Worksheet(s) attached are provided as an attachment to the Engineering Investigation Study for:

Intersection: Crooks/Ann

County: Outagamie

City: Kaukauna

Major Street: Crooks Ave

Minor Street: Ann Street

Critical Approach Speed: 25 mph

Critical Approach Speed: 25 mph

Lanes: 2 or more lanes

Lanes: 1 lane

% Right Turns Included

From North (SB) 50%

From East (WB) 0%

From South (NB) 0%

From West (EB) 100%

In built-up area of isolated community of < 10,000 population? No

Total number of approaches at intersection? 4 or more

If it is a "T" intersection, inflate minor threshold to 150%? No

Manually set volume level? No

Analysis based on **EXISTING** volume data.

Date	Day of the Week	Time (HH:MM)			
		From	AM / PM	To	AM / PM
10/17/2023	Tuesday	6	AM	9	PM

Warrant Evaluation Summary	Warrant Met:
Warrant 1: Eight - Hour Vehicular Volume	No
Condition A: Minimum Vehicular Volume	No
Condition B: Interruption of Continuous Traffic	No
Condition C: Combination: 80% of A and B	No
Warrant 2: Four-Hour Volume	No
Warrant 3: Peak Hour Volume	No
Warrant 4: Pedestrian Volume	No
Criterion A: Four-Hour	No
Criterion B: Peak-Hour	No
Warrant 5: School Crossing	No
Warrant 6: Coordinated Signal System	N/A
Warrant 7: Crash Experience	No
Warrant 8: Roadway Network	N/A
Warrant 9: Intersection Near a Grade Crossing	N/A

Warrant Analysis Conducted By:

Name:

Agency:

Date:

Warrant 1: Eight - Hour Vehicular Volume

100%

Warrant Evaluated? Yes

Condition A : Min. Veh. Volume		
Volume Level	100%	80%
Major Rd. Req	600	480
Minor Rd. Req	150	120
Number of Hours	0	2

Satisfied? No

Condition B: Interruption of Continuous Traffic		
Volume Level	100%	80%
Major Rd. Req	900	720
Minor Rd. Req	75	60
Number of Hours	4	6

Satisfied? No

Condition C: Combination of A & B at 80%		
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Satisfied? No

Warrant Satisfied? No

Manually Set To:

6:00 AM		Enter Start Time (Military Time) (HH:MM)			Total
Time Period	From	To	Major Road: Both App. (VPH)	Minor Road: High App. (VPH)	
1	6:00	7:00	728	34	762
2	7:00	8:00	1537	149	1686
3	8:00	9:00	727	38	765
4	9:00	10:00	706	37	743
5	10:00	11:00	822	44	865.5
6	11:00	12:00	882	39	920.5
7	12:00	13:00	883	71	953.5
8	13:00	14:00	949	43	992
9	14:00	15:00	1036	36	1071.5
10	15:00	16:00	1461	146	1607
11	16:00	17:00	1654	82	1735.5
12	17:00	18:00	1409	60	1469
13	18:00	19:00	903	89	992
14	19:00	20:00	559	26	584.5
15	20:00	21:00	348	31	378.5
16	21:00	22:00	235	7	242

Warrant 2: Four-Hour Volume

100%

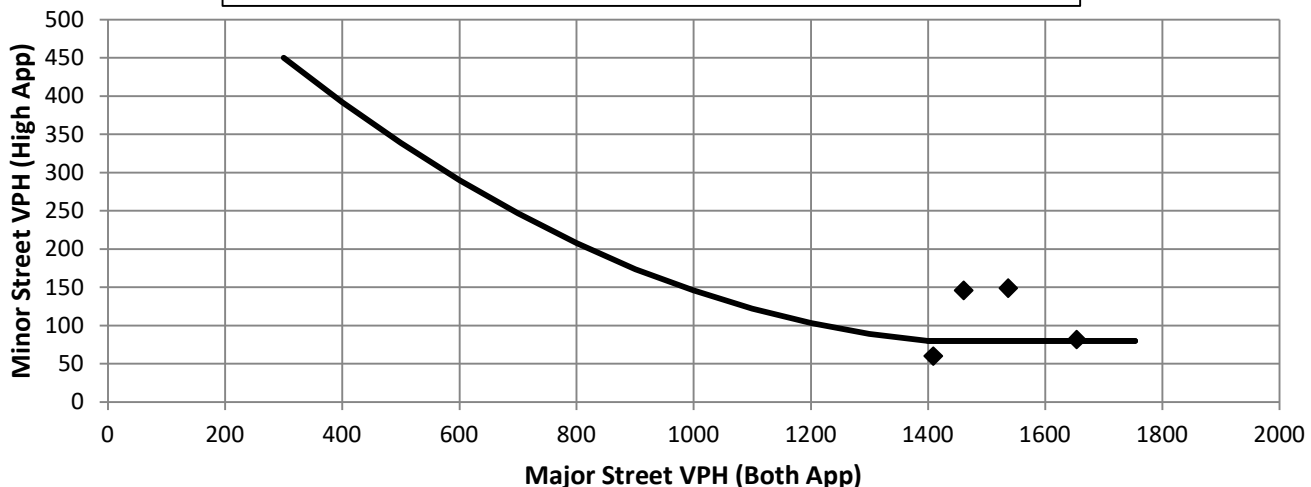
Warrant Evaluated? Yes

Warrant Satisfied? No

Manually Set To:

Hour Start	16:00	7:00	15:00	17:00
Major Road Vol.	1653.5	1537	1461	1409
Minor Road Vol.	82	149	146	60

Figure 4C-1 Warrant 2, Four-Hour Vehicular Volume



Warrant 3: Peak Hour Volume

100%

Warrant Evaluated? Yes

Warrant Satisfied? No

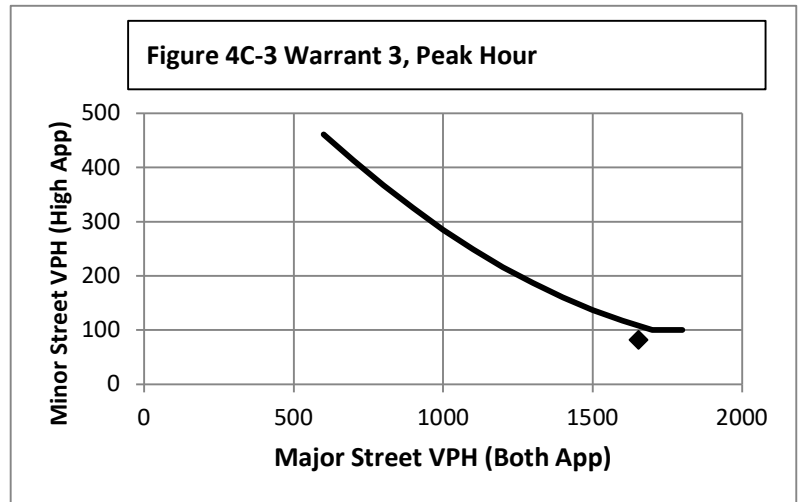
Manually Set To:

Condition justifying use of warrant:

Criteria		Met?
Delay on Minor Approach	4	Yes
Volume on Minor Approach	100	Yes
Total Entering Volume (veh/h)	800	

Manually Set Peak Hour? No

Peak Hour	Major Road Vol. (Both App.)	Minor Road Vol. (High App.)
16:00	1653.5	82



Warrant 4: Pedestrian Volume

100%

Warrant Evaluated? Yes

Warrant Satisfied? No

Manually Set To:

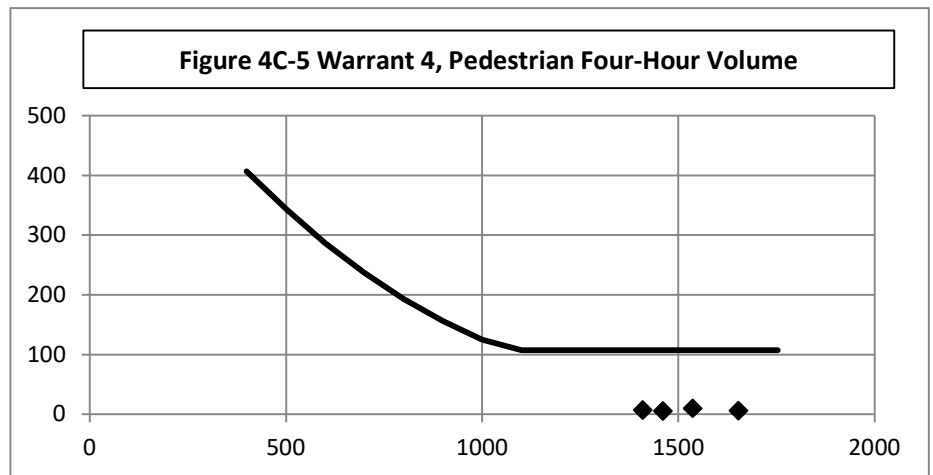
Criterion A: Four Hour

Hour (Start)	Pedestrian Volume	Major Road Vol.
16:00	6	1653.5
7:00	10	1537
15:00	5	1461
17:00	7	1409

Manually Set Major Rd Vol?

Avg. walk speed less than 3.5 ft/s?

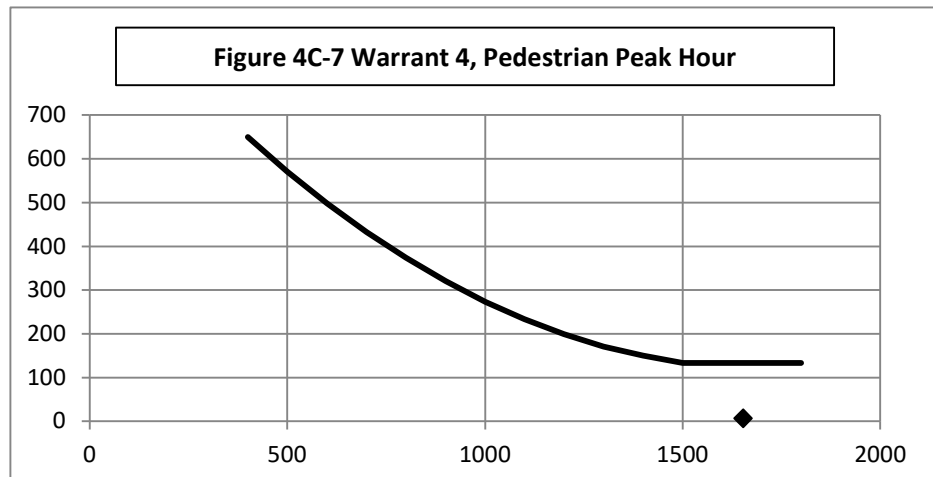
Criterion A Satisfied? No



Criterion B: Peak Hour

Peak Hour	Pedestrian Vol.	Major Road Vol.
16:00	6	1653.5

Criterion B Satisfied? No



Warrant 5: School Crossing

100%

Warrant Evaluated? Yes

Warrant Satisfied? No

Manually Set To:

Criteria		Fulfilled?
1	There are a MINIMUM of 20 school children during the highest crossing hour.	No
2	There are fewer adequate gaps in the major road traffic stream during the period when the school children are using the crossing than the number of minutes in the same period.	No
3	The nearest traffic signal along the major road is located more than 300 ft away. Or, the nearest traffic signal is within 300 ft but the proposed traffic signal will not restrict the progressive movement of traffic.	Yes

Warrant 6: Coordinated Signal System

100%

Warrant Evaluated? No

Warrant Satisfied? N/A

Manually Set To:

Criteria		Fulfilled?
1	Signal spacing > 1000 ft	
2	On a one-way road or a road that has traffic predominantly in one direction, the adjacent signals are so far apart that they do not provide the necessary degree of vehicle platooning.	
3	On a two-way road, adjacent signals do not provide the necessary degree of platooning and the proposed and the adjacent signals will collectively provide a progressive operation.	

Warrant 7: Crash Experience

100%

Warrant Evaluated? Yes

Warrant Satisfied? No

Manually Set To:

Criteria		Met?	Fulfilled?
1	Adequate trial of other remedial measures has failed to reduce crash frequency. Measures Tried: Turn Lanes Added		No
2	Five or more reported crashes, of types susceptible to correction by signal, have occurred within a 12 month period.	# of crashes per 12 months 7	Yes
3	Warrant 1, Condition A (80%)	No	No
	Warrant 1, Condition B (80%)	No	
	Warrant 4, Criterion A (80%)	No	
	Warrant 4, Criterion B (80%)	No	

Warrant 8: Roadway Network

100%

Warrant Evaluated? No

Warrant Satisfied? N/A

Manually Set To:

Criteria		Met?	Fulfilled?
1	Total entering volume of at least 1,000 veh/h during typical weekday peak hour	1735.5	Yes
	Five-year projected volumes that satisfy one or more of Warrants 1, 2, or 3.	3	Yes
2	Total entering vol. of at least 1,000 veh/h for each of any 5 hrs of non-normal business day (Sat. or Sun.)		
	Hour		
	Volume		

Characteristics of Major Routes - Select yes if all intersecting routes have characteristic		Fulfilled?
1	Part of the road or highway system that serves as the principal roadway network for through traffic flow	
2	Rural or suburban highway outside of, entering, or traversing a city	
3	Appears as a major route on an official plan	

Warrant 9: Intersection Near a Grade Crossing

100%

Warrant Evaluated? No

Warrant Satisfied? N/A

Manually Set To:

Adjustment Factors			Manually Set Peak Hour?				
Rail Traffic per Day	% High Occupancy Buses on Minor Road	% Tractor-Trailer Trucks on Minor Road	D	Peak Hour	Major Road Vol.	Minor Road Vol.	Adjusted Minor Vol.
1	0	0% to 2.5%	660	16:00	1653.5	82	27.47

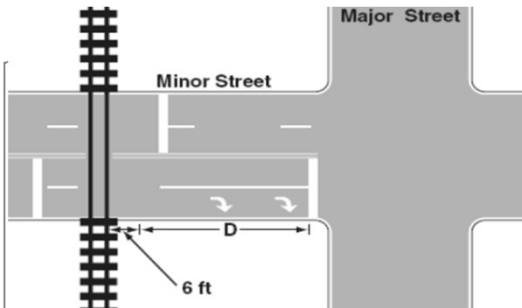
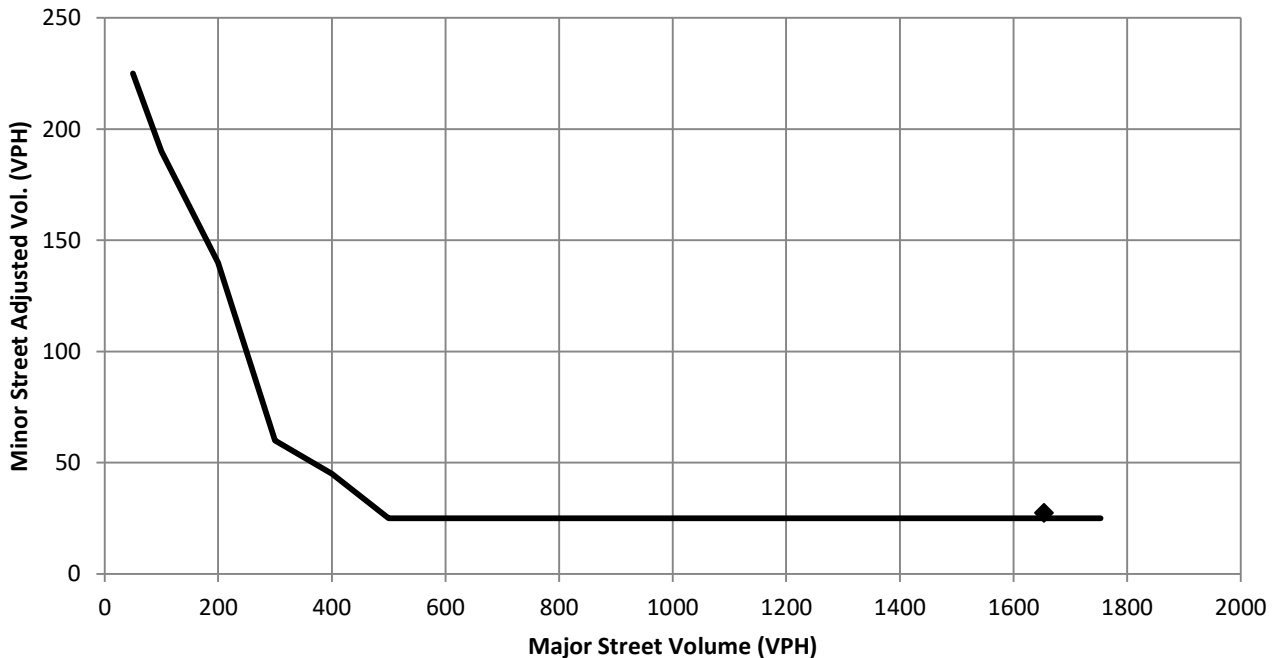


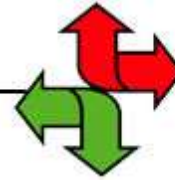
Figure 4C-9 Warrant9, Intersection Near a grade Crossing (One Approach Lane at the Track Crossing)



Conclusions/Comments:

Updated: 12/6/2017

Manual on Uniform Traffic Control Devices (MUTCD)



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Search 2009 Edition of MUTCD:

2009 Edition Chapter 4C. Traffic Control Signal Needs Studies

Section 4C.01 Studies and Factors for Justifying Traffic Control Signals

Standard:

- 01 **An engineering study of traffic conditions, pedestrian characteristics, and physical characteristics of the location shall be performed to determine whether installation of a traffic control signal is justified at a particular location.**
- 02 **The investigation of the need for a traffic control signal shall include an analysis of factors related to the existing operation and safety at the study location and the potential to improve these conditions, and the applicable factors contained in the following traffic signal warrants:**

- Warrant 1, Eight-Hour Vehicular Volume**
- Warrant 2, Four-Hour Vehicular Volume**
- Warrant 3, Peak Hour**
- Warrant 4, Pedestrian Volume**
- Warrant 5, School Crossing**
- Warrant 6, Coordinated Signal System**
- Warrant 7, Crash Experience**
- Warrant 8, Roadway Network**
- Warrant 9, Intersection Near a Grade Crossing**

- 03 **The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal.**

Support:

- 04 [Sections 8C.09](#) and [8C.10](#) contain information regarding the use of traffic control signals instead of gates and/or flashing-light signals at highway-rail grade crossings and highway-light rail transit grade crossings, respectively.

Guidance:

- 05 *A traffic control signal should not be installed unless one or more of the factors described in this Chapter are met.*
- 06 *A traffic control signal should not be installed unless an engineering study indicates that installing a traffic control signal will improve the overall safety and/or operation of the intersection.*
- 07 *A traffic control signal should not be installed if it will seriously disrupt progressive traffic flow.*
- 08 *The study should consider the effects of the right-turn vehicles from the minor-street approaches. Engineering judgment should be used to determine what, if any, portion of the right-turn traffic is subtracted from the minor-street traffic count when evaluating the count against the signal warrants listed in [Paragraph 2](#).*

09 *Engineering judgment should also be used in applying various traffic signal warrants to cases where approaches consist of one lane plus one left-turn or right-turn lane. The site-specific traffic characteristics should dictate whether an approach is considered as one lane or two lanes. For example, for an approach with one lane for through and right-turning traffic plus a left-turn lane, if engineering judgment indicates that it should be considered a one-lane approach because the traffic using the left-turn lane is minor, the total traffic volume approaching the intersection should be applied against the signal warrants as a one-lane approach. The approach should be considered two lanes if approximately half of the traffic on the approach turns left and the left-turn lane is of sufficient length to accommodate all left-turn vehicles.*

10 *Similar engineering judgment and rationale should be applied to a street approach with one through/left-turn lane plus a right-turn lane. In this case, the degree of conflict of minor-street right-turn traffic with traffic on the major street should be considered. Thus, right-turn traffic should not be included in the minor-street volume if the movement enters the major street with minimal conflict. The approach should be evaluated as a one-lane approach with only the traffic volume in the through/left-turn lane considered.*

11 *At a location that is under development or construction and where it is not possible to obtain a traffic count that would represent future traffic conditions, hourly volumes should be estimated as part of an engineering study for comparison with traffic signal warrants. Except for locations where the engineering study uses the satisfaction of Warrant 8 to justify a signal, a traffic control signal installed under projected conditions should have an engineering study done within 1 year of putting the signal into stop-and-go operation to determine if the signal is justified. If not justified, the signal should be taken out of stop-and-go operation or removed.*

12 *For signal warrant analysis, a location with a wide median, even if the median width is greater than 30 feet, should be considered as one intersection.*

Option:

13 At an intersection with a high volume of left-turn traffic from the major street, the signal warrant analysis may be performed in a manner that considers the higher of the major-street left-turn volumes as the "minor-street" volume and the corresponding single direction of opposing traffic on the major street as the "major-street" volume.

14 For signal warrants requiring conditions to be present for a certain number of hours in order to be satisfied, any four sequential 15-minute periods may be considered as 1 hour if the separate 1-hour periods used in the warrant analysis do not overlap each other and both the major-street volume and the minor-street volume are for the same specific one-hour periods.

15 For signal warrant analysis, bicyclists may be counted as either vehicles or pedestrians.

Support:

16 When performing a signal warrant analysis, bicyclists riding in the street with other vehicular traffic are usually counted as vehicles and bicyclists who are clearly using pedestrian facilities are usually counted as pedestrians.

Option:

17 Engineering study data may include the following:

- A. The number of vehicles entering the intersection in each hour from each approach during 12 hours of an average day. It is desirable that the hours selected contain the greatest percentage of the 24-hour traffic volume.
- B. Vehicular volumes for each traffic movement from each approach, classified by vehicle type (heavy trucks, passenger cars and light trucks, public-transit vehicles, and, in some locations, bicycles), during each 15-minute period of the 2 hours in the morning and 2 hours in the afternoon during which total traffic entering the intersection is greatest.
- C. Pedestrian volume counts on each crosswalk during the same periods as the vehicular counts in Item B and during hours of highest pedestrian volume. Where young, elderly, and/or persons with physical or visual disabilities need special consideration, the pedestrians and their crossing times may be classified by general observation.
- D. Information about nearby facilities and activity centers that serve the young, elderly, and/or persons with disabilities, including requests from persons with disabilities for accessible crossing

improvements at the location under study. These persons might not be adequately reflected in the pedestrian volume count if the absence of a signal restrains their mobility.

- E. The posted or statutory speed limit or the 85th-percentile speed on the uncontrolled approaches to the location.
- F. A condition diagram showing details of the physical layout, including such features as intersection geometrics, channelization, grades, sight-distance restrictions, transit stops and routes, parking conditions, pavement markings, roadway lighting, driveways, nearby railroad crossings, distance to nearest traffic control signals, utility poles and fixtures, and adjacent land use.
- G. A collision diagram showing crash experience by type, location, direction of movement, severity, weather, time of day, date, and day of week for at least 1 year.

18 The following data, which are desirable for a more precise understanding of the operation of the intersection, may be obtained during the periods described in Item B of [Paragraph 17](#):

- A. Vehicle-hours of stopped time delay determined separately for each approach.
- B. The number and distribution of acceptable gaps in vehicular traffic on the major street for entrance from the minor street.
- C. The posted or statutory speed limit or the 85th-percentile speed on controlled approaches at a point near to the intersection but unaffected by the control.
- D. Pedestrian delay time for at least two 30-minute peak pedestrian delay periods of an average weekday or like periods of a Saturday or Sunday.
- E. Queue length on stop-controlled approaches.

Section 4C.02 Warrant 1, Eight-Hour Vehicular Volume

Support:

01 The Minimum Vehicular Volume, Condition A, is intended for application at locations where a large volume of intersecting traffic is the principal reason to consider installing a traffic control signal.

02 The Interruption of Continuous Traffic, Condition B, is intended for application at locations where Condition A is not satisfied and where the traffic volume on a major street is so heavy that traffic on a minor intersecting street suffers excessive delay or conflict in entering or crossing the major street.

03 It is intended that Warrant 1 be treated as a single warrant. If Condition A is satisfied, then Warrant 1 is satisfied and analyses of Condition B and the combination of Conditions A and B are not needed. Similarly, if Condition B is satisfied, then Warrant 1 is satisfied and an analysis of the combination of Conditions A and B is not needed.

Standard:

04 **The need for a traffic control signal shall be considered if an engineering study finds that one of the following conditions exist for each of any 8 hours of an average day:**

- A. The vehicles per hour given in both of the 100 percent columns of Condition A in [Table 4C-1](#) exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection; or**
- B. The vehicles per hour given in both of the 100 percent columns of Condition B in [Table 4C-1](#) exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.**

In applying each condition the major-street and minor-street volumes shall be for the same 8 hours. On the minor street, the higher volume shall not be required to be on the same approach during each of these 8 hours.

Table 4C-1. Warrant 1, Eight-Hour Vehicular Volume

Condition A—Minimum Vehicular Volume									
Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100% ^a	80% ^b	70% ^c	56% ^d	100% ^a	80% ^b	70% ^c	56% ^d

1	1	500	400	350	280	150	120	105	84
2 or more	1	600	480	420	336	150	120	105	84
2 or more	2 or more	600	480	420	336	200	160	140	112
1	2 or more	500	400	350	280	200	160	140	112
Condition B—Interruption of Continuous Traffic									
Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100% ^a	80% ^b	70% ^c	56% ^d	100% ^a	80% ^b	70% ^c	56% ^d
1	1	750	600	525	420	75	60	53	42
2 or more	1	900	720	630	504	75	60	53	42
2 or more	2 or more	900	720	630	504	100	80	70	56
1	2 or more	750	600	525	420	100	80	70	56

^a Basic minimum hourly volume

^b Used for combination of Conditions A and B after adequate trial of other remedial measures

^c May be used when the major-street speed exceeds 40 mph or in an isolated community with a population of less than 10,000

^d May be used for combination of Conditions A and B after adequate trial of other remedial measures when the major-street speed exceeds 40 mph or in an isolated community with a population of less than 10,000

Option:

05 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 70 percent columns in [Table 4C-1](#) may be used in place of the 100 percent columns.

Guidance:

06 *The combination of Conditions A and B is intended for application at locations where Condition A is not satisfied and Condition B is not satisfied and should be applied only after an adequate trial of other alternatives that could cause less delay and inconvenience to traffic has failed to solve the traffic problems.*

Standard:

07 **The need for a traffic control signal shall be considered if an engineering study finds that both of the following conditions exist for each of any 8 hours of an average day:**

- A. The vehicles per hour given in both of the 80 percent columns of Condition A in [Table 4C-1](#) exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection; and**
- B. The vehicles per hour given in both of the 80 percent columns of Condition B in [Table 4C-1](#) exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.**

These major-street and minor-street volumes shall be for the same 8 hours for each condition; however, the 8 hours satisfied in Condition A shall not be required to be the same 8 hours satisfied in Condition B. On the minor street, the higher volume shall not be required to be on the same approach during each of the 8 hours.

Option:

08 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 56 percent columns in [Table 4C-1](#) may be used in place of the 80 percent columns.

Section 4C.03 Warrant 2, Four-Hour Vehicular Volume

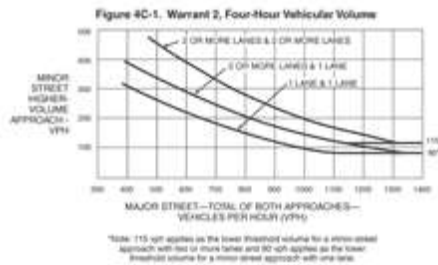
Support:

01 The Four-Hour Vehicular Volume signal warrant conditions are intended to be applied where the volume of intersecting traffic is the principal reason to consider installing a traffic control signal.

Standard:

02 **The need for a traffic control signal shall be considered if an engineering study finds that, for each of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) all fall above the applicable curve in [Figure 4C-1](#) for the existing combination of approach lanes. On the minor street, the higher volume shall not be required to be on the same approach during each of these 4 hours.**

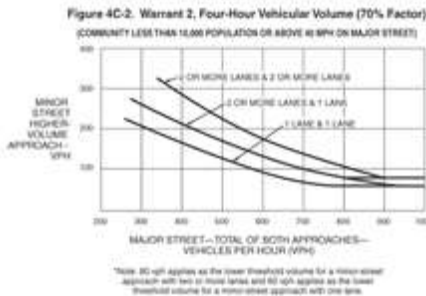
[Figure 4C-1](#) Warrant 2, Four-Hour Vehicular Volume



Option:

03 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, [Figure 4C-2](#) may be used in place of [Figure 4C-1](#).

[Figure 4C-2](#) Warrant 2, Four-Hour Vehicular Volume (70% Factor)



Section 4C.04 Warrant 3, Peak Hour

Support:

01 The Peak Hour signal warrant is intended for use at a location where traffic conditions are such that for a minimum of 1 hour of an average day, the minor-street traffic suffers undue delay when entering or crossing the major street.

Standard:

02 **This signal warrant shall be applied only in unusual cases, such as office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time.**

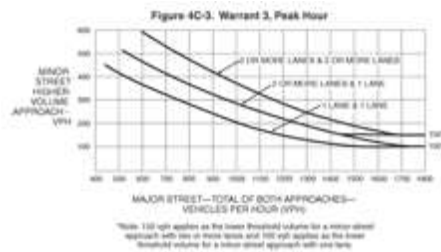
03 **The need for a traffic control signal shall be considered if an engineering study finds that the criteria in either of the following two categories are met:**

A. If all three of the following conditions exist for the same 1 hour (any four consecutive 15-minute periods) of an average day:

1. The total stopped time delay experienced by the traffic on one minor-street approach (one direction only) controlled by a STOP sign equals or exceeds: 4

- vehicle-hours for a one-lane approach or 5 vehicle-hours for a two-lane approach; and
2. The volume on the same minor-street approach (one direction only) equals or exceeds 100 vehicles per hour for one moving lane of traffic or 150 vehicles per hour for two moving lanes; and
 3. The total entering volume serviced during the hour equals or exceeds 650 vehicles per hour for intersections with three approaches or 800 vehicles per hour for intersections with four or more approaches.
- B. The plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in [Figure 4C-3](#) for the existing combination of approach lanes.

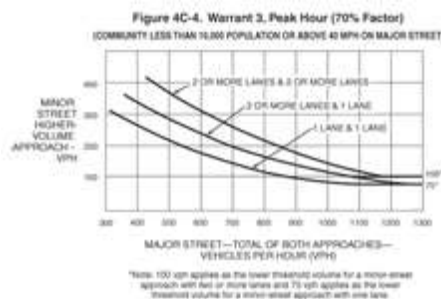
Figure 4C-3 Warrant 3, Peak Hour



Option:

04 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, [Figure 4C-4](#) may be used in place of [Figure 4C-3](#) to evaluate the criteria in the second category of the Standard.

Figure 4C-4 Warrant 3, Peak Hour (70% Factor)



05 If this warrant is the only warrant met and a traffic control signal is justified by an engineering study, the traffic control signal may be operated in the flashing mode during the hours that the volume criteria of this warrant are not met.

Guidance:

06 If this warrant is the only warrant met and a traffic control signal is justified by an engineering study, the traffic control signal should be traffic-actuated.

Section 4C.05 Warrant 4, Pedestrian Volume

Support:

01 The Pedestrian Volume signal warrant is intended for application where the traffic volume on a major street is so heavy that pedestrians experience excessive delay in crossing the major street.

Standard:

02 The need for a traffic control signal at an intersection or midblock crossing shall be considered if an engineering study finds that one of the following criteria is met:

- A. For each of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding pedestrians per hour crossing the major street (total of all crossings) all fall above the curve in [Figure 4C-5](#); or
- B. For 1 hour (any four consecutive 15-minute periods) of an average day, the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding pedestrians per hour crossing the major street (total of all crossings) falls above the curve in [Figure 4C-7](#).

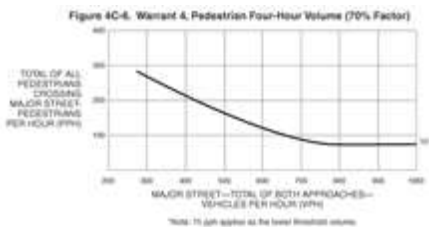
[Figure 4C-5](#) Warrant 4, Pedestrian Four-Hour Volume



Option:

03 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 35 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, [Figure 4C-6](#) may be used in place of [Figure 4C-5](#) to evaluate Criterion A in [Paragraph 2](#), and [Figure 4C-8](#) may be used in place of [Figure 4C-7](#) to evaluate Criterion B in [Paragraph 2](#).

[Figure 4C-6](#) Warrant 4, Pedestrian Four-Hour Volume (70% Factor)



[Figure 4C-7](#) Warrant 4, Pedestrian Peak Hour



[Figure 4C-8](#) Warrant 4, Pedestrian Peak Hour (70% Factor)



Standard:

04 **The Pedestrian Volume signal warrant shall not be applied at locations where the distance to the nearest traffic control signal or STOP sign controlling the street that pedestrians desire to cross is less than 300 feet, unless the proposed traffic control signal will not restrict the progressive movement of traffic.**

05 If this warrant is met and a traffic control signal is justified by an engineering study, the traffic control signal shall be equipped with pedestrian signal heads complying with the provisions set forth in [Chapter 4E](#).

Guidance:

06 If this warrant is met and a traffic control signal is justified by an engineering study, then:

- A. If it is installed at an intersection or major driveway location, the traffic control signal should also control the minor-street or driveway traffic, should be traffic-actuated, and should include pedestrian detection.*
- B. If it is installed at a non-intersection crossing, the traffic control signal should be installed at least 100 feet from side streets or driveways that are controlled by STOP or YIELD signs, and should be pedestrian-actuated. If the traffic control signal is installed at a non-intersection crossing, at least one of the signal faces should be over the traveled way for each approach, parking and other sight obstructions should be prohibited for at least 100 feet in advance of and at least 20 feet beyond the crosswalk or site accommodations should be made through curb extensions or other techniques to provide adequate sight distance, and the installation should include suitable standard signs and pavement markings.*
- C. Furthermore, if it is installed within a signal system, the traffic control signal should be coordinated.*

Option:

07 The criterion for the pedestrian volume crossing the major street may be reduced as much as 50 percent if the 15th-percentile crossing speed of pedestrians is less than 3.5 feet per second.

08 A traffic control signal may not be needed at the study location if adjacent coordinated traffic control signals consistently provide gaps of adequate length for pedestrians to cross the street.

Section 4C.06 Warrant 5, School Crossing

Support:

01 The School Crossing signal warrant is intended for application where the fact that schoolchildren cross the major street is the principal reason to consider installing a traffic control signal. For the purposes of this warrant, the word "schoolchildren" includes elementary through high school students.

Standard:

02 The need for a traffic control signal shall be considered when an engineering study of the frequency and adequacy of gaps in the vehicular traffic stream as related to the number and size of groups of schoolchildren at an established school crossing across the major street shows that the number of adequate gaps in the traffic stream during the period when the schoolchildren are using the crossing is less than the number of minutes in the same period (see [Section 7A.03](#)) and there are a minimum of 20 schoolchildren during the highest crossing hour.

03 Before a decision is made to install a traffic control signal, consideration shall be given to the implementation of other remedial measures, such as warning signs and flashers, school speed zones, school crossing guards, or a grade-separated crossing.

04 The School Crossing signal warrant shall not be applied at locations where the distance to the nearest traffic control signal along the major street is less than 300 feet, unless the proposed traffic control signal will not restrict the progressive movement of traffic.

Guidance:

05 If this warrant is met and a traffic control signal is justified by an engineering study, then:

- A. If it is installed at an intersection or major driveway location, the traffic control signal should also control the minor-street or driveway traffic, should be traffic-actuated, and should include pedestrian detection.*
- B. If it is installed at a non-intersection crossing, the traffic control signal should be installed at least 100 feet from side streets or driveways that are controlled by STOP or YIELD signs, and should be pedestrian-actuated. If the traffic control signal is installed at a non-intersection crossing, at least one of the signal faces should be over the traveled way for each approach,*

parking and other sight obstructions should be prohibited for at least 100 feet in advance of and at least 20 feet beyond the crosswalk or site accommodations should be made through curb extensions or other techniques to provide adequate sight distance, and the installation should include suitable standard signs and pavement markings.

C. Furthermore, if it is installed within a signal system, the traffic control signal should be coordinated.

Section 4C.07 Warrant 6, Coordinated Signal System

Support:

01 Progressive movement in a coordinated signal system sometimes necessitates installing traffic control signals at intersections where they would not otherwise be needed in order to maintain proper platooning of vehicles.

Standard:

02 **The need for a traffic control signal shall be considered if an engineering study finds that one of the following criteria is met:**

- A. On a one-way street or a street that has traffic predominantly in one direction, the adjacent traffic control signals are so far apart that they do not provide the necessary degree of vehicular platooning.**
- B. On a two-way street, adjacent traffic control signals do not provide the necessary degree of platooning and the proposed and adjacent traffic control signals will collectively provide a progressive operation.**

Guidance:

03 *The Coordinated Signal System signal warrant should not be applied where the resultant spacing of traffic control signals would be less than 1,000 feet.*

Section 4C.08 Warrant 7, Crash Experience

Support:

01 The Crash Experience signal warrant conditions are intended for application where the severity and frequency of crashes are the principal reasons to consider installing a traffic control signal.

Standard:

02 **The need for a traffic control signal shall be considered if an engineering study finds that all of the following criteria are met:**

- A. Adequate trial of alternatives with satisfactory observance and enforcement has failed to reduce the crash frequency; and**
- B. Five or more reported crashes, of types susceptible to correction by a traffic control signal, have occurred within a 12-month period, each crash involving personal injury or property damage apparently exceeding the applicable requirements for a reportable crash; and**
- C. For each of any 8 hours of an average day, the vehicles per hour (vph) given in both of the 80 percent columns of Condition A in [Table 4C-1](#) (see [Section 4C.02](#)), or the vph in both of the 80 percent columns of Condition B in [Table 4C-1](#) exists on the major-street and the higher-volume minor-street approach, respectively, to the intersection, or the volume of pedestrian traffic is not less than 80 percent of the requirements specified in the Pedestrian Volume warrant. These major-street and minor-street volumes shall be for the same 8 hours. On the minor street, the higher volume shall not be required to be on the same approach during each of the 8 hours.**

Option:

03 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 56 percent columns in [Table 4C-1](#) may be used in place of the 80 percent columns.

Section 4C.09 Warrant 8, Roadway Network

Support:

01 Installing a traffic control signal at some intersections might be justified to encourage concentration and organization of traffic flow on a roadway network.

Standard:

02 **The need for a traffic control signal shall be considered if an engineering study finds that the common intersection of two or more major routes meets one or both of the following criteria:**

- A. The intersection has a total existing, or immediately projected, entering volume of at least 1,000 vehicles per hour during the peak hour of a typical weekday and has 5-year projected traffic volumes, based on an engineering study, that meet one or more of Warrants 1, 2, and 3 during an average weekday; or**
- B. The intersection has a total existing or immediately projected entering volume of at least 1,000 vehicles per hour for each of any 5 hours of a non-normal business day (Saturday or Sunday).**

03 **A major route as used in this signal warrant shall have at least one of the following characteristics:**

- A. It is part of the street or highway system that serves as the principal roadway network for through traffic flow.**
- B. It includes rural or suburban highways outside, entering, or traversing a city.**
- C. It appears as a major route on an official plan, such as a major street plan in an urban area traffic and transportation study.**

Section 4C.10 Warrant 9, Intersection Near a Grade Crossing

Support:

01 The Intersection Near a Grade Crossing signal warrant is intended for use at a location where none of the conditions described in the other eight traffic signal warrants are met, but the proximity to the intersection of a grade crossing on an intersection approach controlled by a STOP or YIELD sign is the principal reason to consider installing a traffic control signal.

Guidance:

02 *This signal warrant should be applied only after adequate consideration has been given to other alternatives or after a trial of an alternative has failed to alleviate the safety concerns associated with the grade crossing. Among the alternatives that should be considered or tried are:*

- A. Providing additional pavement that would enable vehicles to clear the track or that would provide space for an evasive maneuver, or*
- B. Reassigning the stop controls at the intersection to make the approach across the track a non-stopping approach.*

Standard:

03 **The need for a traffic control signal shall be considered if an engineering study finds that both of the following criteria are met:**

- A. A grade crossing exists on an approach controlled by a STOP or YIELD sign and the center of the track nearest to the intersection is within 140 feet of the stop line or yield line on the approach; and**
- B. During the highest traffic volume hour during which rail traffic uses the crossing, the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the minor-street approach that crosses the track (one direction only, approaching the intersection) falls above the applicable curve in [Figure 4C-9](#) or [4C-10](#) for the existing combination of approach lanes over the track and the distance D, which is the clear storage distance as defined in [Section 1A.13](#).**

[Figure 4C-9](#) Warrant 9, Intersection Near a Grade Crossing (One Approach Lane at the Track Crossing)

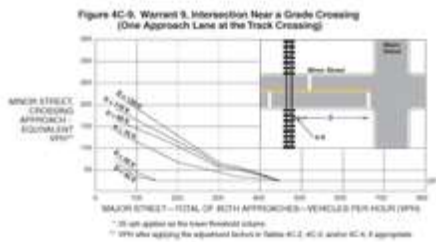
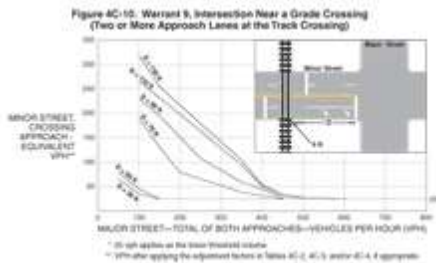


Figure 4C-10 Warrant 9, Intersection Near a Grade Crossing (Two or More Approach Lanes at the Track Crossing)



Guidance:

04 The following considerations apply when plotting the traffic volume data on [Figure 4C-9](#) or [4C-10](#):

- Figure [4C-9](#) should be used if there is only one lane approaching the intersection at the track crossing location and [Figure 4C-10](#) should be used if there are two or more lanes approaching the intersection at the track crossing location.
- After determining the actual distance D , the curve for the distance D that is nearest to the actual distance D should be used. For example, if the actual distance D is 95 feet, the plotted point should be compared to the curve for $D = 90$ feet.
- If the rail traffic arrival times are unknown, the highest traffic volume hour of the day should be used.

Option:

05 The minor-street approach volume may be multiplied by up to three adjustment factors as provided in [Paragraphs 6](#) through [8](#).

06 Because the curves are based on an average of four occurrences of rail traffic per day, the vehicles per hour on the minor-street approach may be multiplied by the adjustment factor shown in [Table 4C-2](#) for the appropriate number of occurrences of rail traffic per day.

Table 4C-2. Warrant 9, Adjustment Factor for Daily Frequency of Rail Traffic

Rail Traffic per Day	Adjustment Factor
1	0.67
2	0.91
3 to 5	1.00
6 to 8	1.18
9 to 11	1.25
12 or more	1.33

07 Because the curves are based on typical vehicle occupancy, if at least 2% of the vehicles crossing the track are buses carrying at least 20 people, the vehicles per hour on the minor-street approach may be multiplied by the adjustment factor shown in [Table 4C-3](#) for the appropriate percentage of high-occupancy buses.

Table 4C-3. Warrant 9, Adjustment Factor for Percentage of High-Occupancy Buses

% of High-Occupancy Buses* on Minor-Street Approach	Adjustment Factor
0%	1.00
2%	1.09

4%	1.19
6% or more	1.32

* A high-occupancy bus is defined as a bus occupied by at least 20 people.

08 Because the curves are based on tractor-trailer trucks comprising 10% of the vehicles crossing the track, the vehicles per hour on the minor-street approach may be multiplied by the adjustment factor shown in [Table 4C-4](#) for the appropriate distance and percentage of tractor-trailer trucks.

Table 4C-4. Warrant 9, Adjustment Factor for Percentage of Tractor-Trailer Trucks

% of Tractor-Trailer Trucks on Minor-Street Approach	Adjustment Factor	
	D less than 70 feet	D of 70 feet or more
0% to 2.5%	0.50	0.50
2.6% to 7.5%	0.75	0.75
7.6% to 12.5%	1.00	1.00
12.6% to 17.5%	2.30	1.15
17.6% to 22.5%	2.70	1.35
22.6% to 27.5%	3.28	1.64
More than 27.5%	4.18	2.09

Standard:

09 **If this warrant is met and a traffic control signal at the intersection is justified by an engineering study, then:**

- A. The traffic control signal shall have actuation on the minor street;**
- B. Preemption control shall be provided in accordance with [Sections 4D.27](#), [8C.09](#), and [8C.10](#); and**
- C. The grade crossing shall have flashing-light signals (see [Chapter 8C](#)).**

Guidance:

10 *If this warrant is met and a traffic control signal at the intersection is justified by an engineering study, the grade crossing should have automatic gates (see [Chapter 8C](#)).*

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