

APPENDIX C: SIGNAL WARRANT WORKSHEETS



Warrant Summary

Warrant 1: 8-Hour Vehicular Volume **Met**

Warrant 1A: Minimum Vehicular Volume **Met**

OR

Warrant 1B: Interruption of Continuous Traffic **Met**

OR

Warrant 1C: 80% of Warrant 1A and 1B **Not Met**

Warrant 2: 4-Hour Vehicular Volume **Met**

Warrant 3: Peak Hour Vehicular Volume **Met**

Warrant 3A: Peak Hour Delay **Met**

OR

Warrant 3B: Peak Hour Volume **Met**

Warrant 4: Pedestrian Volume **N/A**

Warrant 4A: 4 Hours Pedestrian Volume **N/A**

OR

Warrant 4B: Peak Hour Pedestrian Volume **N/A**

AND

Warrant 4C: Gap Analysis **N/A**

Warrant 5: School Crossing **N/A**

Warrant 6: Coordinated Signal System **N/A**

Warrant 7: Crash Experience **N/A**

Warrant 7A: Five or more reported crashes **Not Met**

AND ONE OF

Warrant 7B: 80% of Warrant 1A Met? **Met**

OR

Warrant 7C: 80% of Warrant 1B Met? **Not Met**

OR

Warrant 7D: 80% of Warrant 4 Met? **Not Met**

Warrant 8: Roadway Network **Met**

Warrant 9: Intersection near a Grade Crossing **N/A**

Warrant 1A: Minimum Vehicular Volume

The warrant is satisfied when, for each of any 8 hours of an average day, the traffic volumes given in the table below exist on the major street and on the higher-volume minor street approach to the intersection.

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		
1	1	500	150
2 or more	1	600	150
2 or more	2 or more	600	200
1	2 or more	500	200

When the 85-percentile speed of major-street exceeds 40 mph in either an urban or rural area, or when the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the Minimum Vehicular Volume warrant is 70 percent of the requirements above.

Analysis

Major/Minor Info 2

Urban/Rural Info 2

	No of lanes
Major Street	1
Minor Street	1

Time	Major Street		Minor Street		Warrants MET/NOT
	Volume on major street (total of both approaches)	Threshold RURAL 350	Veh/hour on higher volume minor street (one direction only)	Threshold RURAL 105	
7:00 AM	704		299		MET
8:00 AM	536		229		MET
9:00 AM	634		188		MET
10:00 AM	642		191		MET
11:00 AM	575		170		MET
2:00 PM	578		171		MET
3:00 PM	603		136		MET
4:00 PM	604		121		MET

Use Turn Move instead of Tube?	Conflict	Adjusted
No	1	0
No	1	0
No	1	0
No	1	0
No	1	0
No	1	0
No	1	0
No	1	0

Number of hours for which warrant met	8
Percentage by which warrant met	100.0%

Warrant Met

80% Warrant

	No of lanes
Major Street	1
Minor Street	1

Time	Major Street		Minor Street		Warrants MET/NOT
	Volume on major street (total of both)	Threshold RURAL 400	Veh/hour on higher volume minor street	Threshold RURAL 120	
7:00 AM	704		299		MET
8:00 AM	536		229		MET
9:00 AM	634		188		MET
10:00 AM	642		191		MET
11:00 AM	575		170		MET
2:00 PM	578		171		MET
3:00 PM	603		136		MET
4:00 PM	604		121		MET

Number of hours for which warrant met	8
Percentage by which warrant met	100.0%

Warrant Met

Warrant 1B: Interruption of Continuous Traffic

The warrant is satisfied when, for each of any 8 hours of an average day, the traffic volumes given in the table below exist on the major street and on the higher-volume minor street approach to the intersection, and signal installation will not seriously disrupt progressive traffic flow.

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		
1	1	750	75
2 or more	1	900	75
2 or more	2 or more	900	100
1	2 or more	750	100

The major-street and minor -street volumes are for the same 8 hours. During those 8 hours, the direction of higher volume on the minor street may be on one approach during some hours and on the opposite approach during other hours.

When the 85-percentile speed of major-street exceeds 40 mph in either an urban or rural area, or when the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the Interruption of Continuous Traffic warrant is 70 percent of the requirements above.

Analysis

	No of lanes
Major Street	1
Minor Street	1

Time	Major Street		Minor Street		Warrants MET/NOT
	Volume on major (total of both approaches)	Threshold	Veh/hour on higher volume minor (one direction only)	Threshold	
		RURAL		RURAL	
		525		52	
7:00 AM	704		299		MET
8:00 AM	536		229		MET
9:00 AM	634		188		MET
10:00 AM	642		191		MET
11:00 AM	575		170		MET
2:00 PM	578		171		MET
3:00 PM	603		136		MET
4:00 PM	604		121		MET

Use Turn Move instead of Tube?	Conflict	Adjusted
No	1	0
No	1	0
No	1	0
No	1	0
No	1	0
No	1	0
No	1	0
No	1	0
No	1	0

Number of hours for which warrant met	8
Percentage by which warrant met	100.0%

Warrant Met

80% Warrant

	No of lanes
Major Street	1
Minor Street	1

Time	Major Street		Minor Street		Warrants MET/NOT
	Volume on major (total of both approaches)	Threshold	Veh/hour on higher volume minor (one direction only)	Threshold	
		RURAL		RURAL	
		600		60	
7:00 AM	704		299		MET
8:00 AM	536		229		NOT MET
9:00 AM	634		188		MET
10:00 AM	642		191		MET
11:00 AM	575		170		NOT MET
2:00 PM	578		171		NOT MET
3:00 PM	603		136		MET
4:00 PM	604		121		MET

Number of hours for which warrant met	5
Percentage by which warrant met	62.5%

Warrant Not Met

Warrant 1C: Combination of Warrants

In exceptional cases, signals occasionally may be justified where no single warrant is satisfied but where Warrants 1A and 1B are satisfied to the extent of 80% or more of the stated values.

Analysis

80% of Warrant 1A Met	YES
80% of Warrant 1B Met	NO

Warrant	Not Met
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Warrant 2: Four-Hour Vehicular Volumes

The Four Hour Volume Warrant is satisfied when each of any four 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 curve in Figure 4-7 for the existing combination of approach lanes.

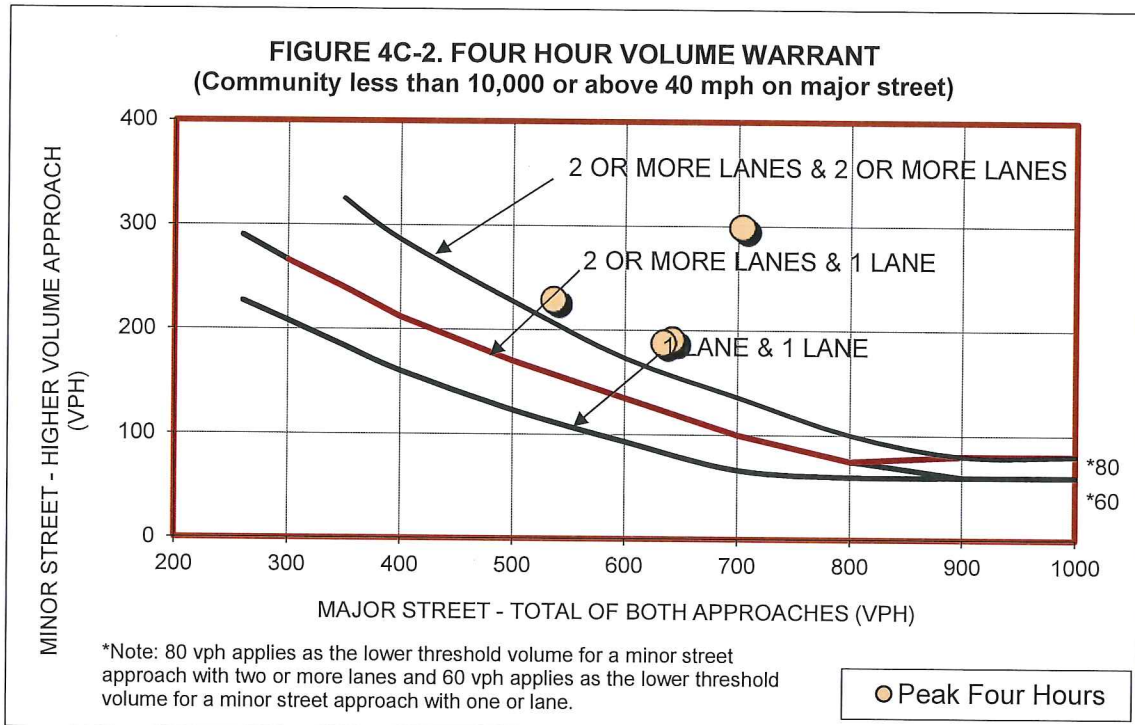
When the 85-percentile speed of the major-street exceeds 40 mile per hour or when the intersection lies within a built-up area of an isolated community having a population less than 10,000, the four hour volume requirement is satisfied when the plotted points referred to fall above the curve in Figure 4-8 for the existing combination of approach lanes.

Analysis

	No of lanes
Major Street	1
Minor Street	1

Peak Four Hours

Time	Vehicles Per Hour	
	Major Street (Sum of both approaches)	Minor street (High volume approach)
10:00 AM	642	191
7:00 AM	704	299
8:00 AM	536	229
9:00 AM	634	188



Warrant	Met
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Warrant 3A: Peak Hour Delay

The peak hour delay warrant is intended for application where traffic conditions are such that for one hour of the day minor street traffic suffers undue delay in entering or crossing the major street. The peak hour delay warrant is satisfied when the conditions given below exist for one hour (any four consecutive 15-minute periods) of an average weekday.

The peak hour delay warrant is met when:

1. The total delay experienced by the traffic on one minor street approach (one direction only) controlled by a STOP sign equals or exceeds four vehicle-hours for a one-lane approach and five vehicle-hours for a two-lane approach, and
2. The volume on the same minor street approach (one direction only) equals or exceeds 100 vph for one moving lane of traffic or 150 vph for two moving lanes, and
3. The total entering volume serviced during the hour equals or exceeds 800 vph for intersections with four (or more) approaches or 650 vph for intersections with three approaches.

Analysis

Minor Street Lanes	1
Total Approaches	4
Time	7:00 AM

	Peak Hour Delay on Minor Approach (vehicle-hours)	Peak Hour Volume on Minor Approach (vph)	Peak Hour Entering Volume Serviced for the Intersection (vph)
Existing	16.1	299	1,070
Limiting Value	4	100	800
Met/ Not Met	Met	Met	Met

Use Turn Move instead of tube?

Peak Hour Volume on Minor	Peak Hour Entering Volume
No	No

Yes
No

Warrant	Met
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Warrant 3B: Peak Hour Volume

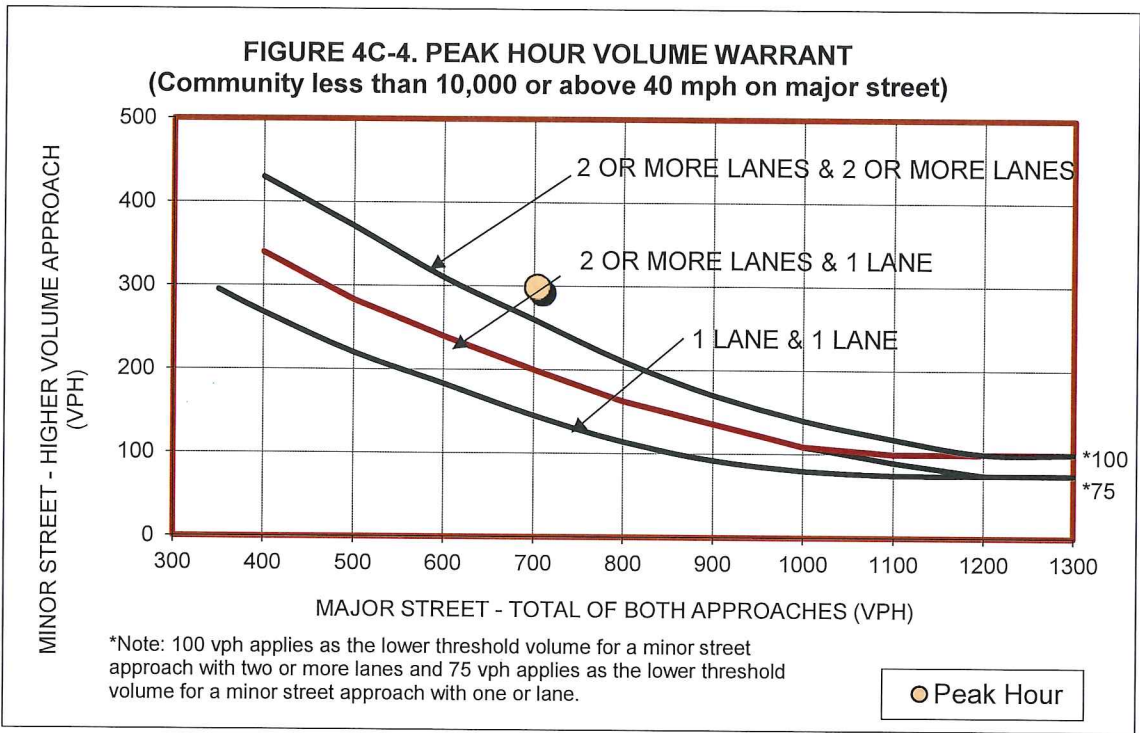
The peak hour volume warrant is satisfied when the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour of the higher volume minor street approach (one direction only) for one hour (any four consecutive 15-minute periods) of an average day falls above the curve in Figure 4-5 for the existing combination of approach lanes.

When the 85-percentile speed of the major street traffic exceeds 40 mile per hour or when the intersection lies within a built-up area of an isolated community having a population less than 10,000, the peak hour volume requirement is satisfied when the plotted point referred to above falls above the curve in Figure 4-6 for the existing combination of approach lanes.

Analysis

	No of lanes
Major Street	1
Minor Street	1

Peak Hour		
Time	Vehicles Per Hour	
	Major Street (Sum of both approaches)	Minor street (High volume approach)
7:00 AM	704	299



Warrant	Met
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Warrant 4: Pedestrian Volumes

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

A. The pedestrian volume crossing the major street at an intersection or midblock location during an average day is 100 or more for each of any 4 hours or 190 or more during any 1 hour; and

B. There are fewer than 60 gaps per hour in the traffic stream of adequate length to allow pedestrians to cross during the same period when the pedestrian volume criterion is satisfied. Where there is a divided street having a median of sufficient width for pedestrians to wait, the requirement applies separately to each direction of vehicular traffic.

Analysis

Warrant 4A - 4 Hours Pedestrian Volume

	Pedestrian Volume	Greater than 100?
6:00 AM	0	No
8:15 AM	0	No
2:00 PM	0	No
3:00 PM	0	No

Sub-Warrant	N/A
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Warrant 4B - Peak Hour Pedestrian Volume

Hour	Pedestrian Volume	Greater than 190?
7:15 AM	40	No

Sub-Warrant	N/A
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Warrant 4C - Gap Analysis

Hour	Gaps per Hour	Less than 60?
6:00 AM	N/A	N/A
8:15 AM	N/A	N/A
2:00 PM	N/A	N/A
3:00 PM	N/A	N/A

Sub-Warrant	N/A
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Warrant	N/A
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Warrant 5: School Crossing

The School Crossing signal warrant is intended for applicaiton 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: 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 and there are a minimum of 20 schoolchildren during the highest crossing hour.

Analysis

Warrant 5A - School present?

<u>Yes</u>	<u>No</u>
X	

Sub-Warrant

Met

Warrant 5B - Pedestrians across major street

Hour	Pedestrian Volume	Greater than 20?
7:15 AM	40	Yes

Sub-Warrant

Met

Warrant

N/A

Warrant 5: Coordinated Signal System

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: 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.

Warrant	N/A
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Warrant 7: Crash Experience

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

Standard:

A. 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

B. Warrant 1A or Warrant 1B or 80% of the pedestrian volume warrant is met

Warrant 7A - Five or more reported crashes

	Number	5 or more?
Number of crashes within a 12-month period, of types susceptible to correction by a traffic signal, each involving personal injury or property damage (reportable)	1	N

Plus at least one of the following:	Yes	No
Warrant 7B - 80% Warrant 1A		
Warrant 1A: 80% threshold met?	X	
Warrant 7C - 80% Warrant 1B		
Warrant 1B: 80% threshold met?		X
Warrant 7D - 80% Warrant 4		
Warrant 4: 80% threshold met (152 or more peds for any hour, and 80 or more peds for any 4 hours)?		X

Warrant	N/A
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Warrant 8: Roadway Network

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

Standard: 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 projects, entering volume of at least 1,000 vehicles per hour during the peak hour of a typical weekday and has 5-year projected 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)

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

Warrant	Met
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Total AM Vol	Total PM Vol
1106 > 1000	850

Warrant 9: Intersection near a Grade Crossing

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.

Standard: 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 of 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 of 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

Warrant	N/A
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