Technical Memo

Date: Friday, October 20, 2023

Project: On Call Traffic Services

To: City of Brookings

From: HDR

Subject: 5th Avenue & 5th Street Intersection Traffic Control Review

Introduction

The purpose of this memo is to review traffic control at the intersection of 5th Avenue & 5th Street in Brookings, SD based on guidance outlined in the *Manual on Uniform Traffic Control Devices (MUTCD)*. Volume-based warrants were analyzed with traffic counts collected by HDR. Crash history-based warrants were reviewed with crash data obtained from the South Dakota Department of Transportation (SDDOT). Measured intersection sight distances are based on American Association of State Highway and Transportation Officials (AASHTO) guidance.

The following intersection turning movements were utilized (provided in the **Appendix**):

- September 12, 2023
  - Total Duration: 10 hours
  - Time: 6:30 AM – 8:30 AM, 10:30 AM – 6:30 PM

Existing conditions for both intersecting roadways and the intersection are shown in **Figure 1** and detailed below:

- **5th Avenue**
  - Classification: Urban 3-Lane (with TWLTL) Collector Street
  - Roadway Width: 55 ft. (back of curb to back of curb)
  - Speed Limit: 25 mph (15 mph school zone near Children's Museum of South Dakota)
  - Additional Features: 9 ft. on-street parallel parking

- **5th Street**
  - Classification: Urban 2-Lane Local Street
  - Roadway Width:
    - East of 5th Avenue: 50 ft. (back of curb to back of curb)
    - West of 5th Avenue: 58 ft. (back of curb to back of curb)
  - Speed Limit: 25 mph (15 mph school zone near Children's Museum of South Dakota)
  - Additional Features:
    - East of 5th Avenue: On-street parallel parking
    - West of 5th Avenue: 12 ft. on-street angle parking

- **5th Avenue & 5th Street Intersection**
  - Intersection Control: Traffic Signal
  - Pavement Markings: Stop lines and pedestrian crosswalk markings at all approaches

Figure 1: 5th Avenue & 5th Street Intersection

Traffic Signal Warrant Review

A traffic signal warrant review at the 5th Avenue & 5th Street intersection was conducted based on September 12, 2023 traffic count data. This review analyzes the intersection under existing conditions with a single lane for moving traffic on all four approaches based on a review of intersection traffic patterns and incorporates all minor street traffic volumes. Signal warrant reports are summarized in **Table 1** and provided in full in the **Appendix**.

Overall, no signal warrant thresholds were met at this intersection. The volume-based warrants observed that both major and minor street traffic volumes are considerably low and would need to increase in order to meet warrant thresholds for the analyzed intersection configuration (i.e. one lane major street and minor street approaches). In addition, neither current pedestrian movements nor the previous 5 full year of crash history (2018-2022) met designated thresholds warranting a signal. A 50% thresholds review was also conducted for Warrants 1 and 2 that confirmed that traffic volumes did not warrant signalization under reduced thresholds. Based on these findings, it is recommended that consideration should be given to remove the traffic signal at this intersection.

When considering the removal of a traffic signal, MUTCD Section 4B.02 provides the following guidance:

- *Engineering judgement should be applied in the review of operating traffic control signals to determine whether the type of installation and the timing program meet the current requirements of all forms of traffic. If changes in traffic patterns eliminate the need for a traffic control signal, consideration should be given to removing it and replacing it with appropriate alternative traffic control devices, if any are needed.*
- *If the engineering study indicates that the traffic control signal is no longer justified, removal may be accomplished using the following steps:*
    A. *Determine the appropriate traffic control to be used after removal of the signal.*
    B. *Remove any sight-distance restrictions as necessary.*
    C. *Inform the public of the removal study, for example by installing an information sign (or signs) with the legend TRAFFIC SIGNAL UNDER STUDY FOR REMOVAL at the signalized location in a position where it is visible to all road users.*
    D. *Flash or cover the signal heads for a minimum of 90 days, and install the appropriate stop control or other traffic control devices.*
    E. *Remove the signal if the engineering data collected during the removal study period confirms that the signal is no longer needed. Instead of total removal of the traffic control signal, the poles and cables may remain in place after removal of the signal heads for continued analysis.*

Table 1: 5th Avenue & 5th Street Intersection Signal Warrants Review (based on September 12, 2023 traffic count data)

Signal Warrant	Warrant Criteria Status	Notes
Warrant 1 – Eight-Hour Vehicular Volume	**Not met**	• Condition A[1]: 0 of 8 unique hours met • Condition B[2]: 0 of 8 unique hours met
Warrant 2 – Four-Hour Vehicular Volume	**Not met**	• 0 of 4 unique hours met
Warrant 3 – Peak Hour	**Not met**	• 0 unique hours met
Warrant 4 – Pedestrian Volume	**Not met**	• Criterion A[3]: 0 of 4 unique hours met • Criterion B[4]: 0 of 1 unique hours met
Warrant 5 – School Crossing	**Not met**	Intersection does not meet Warrant 5 criteria for minimum pedestrian movements. In addition, no school crossings are currently identified near the intersection.
Warrant 6 – Coordinated Signal System	**Not applicable**	Intersection does not require signalization to maintain platooning of vehicles through the 5th Avenue corridor.
Warrant 7 – Crash Experience	**Not met**	• 0 reported crashes from 2018 to 2022.
Warrant 8 – Roadway Network	**Not applicable**	Intersection is not a common intersection of two major routes.
Warrant 9 – Intersection Near a Grade Crossing	**Not applicable**	Intersection is not near a grade crossing.
Warrants 1 & 2 – 50% Thresholds Review	*Not met*	*<u>Warrant 1 (50% Thresholds)</u>* • *Condition A[1]: 0 of 8 unique hours met* • *Condition B[2]: 2 of 8 unique hours met* *<u>Warrant 2 (50% Thresholds)</u>* • *0 of 4 unique hours met*

[1] Warrant 1 – Condition A: Minimum Vehicular Volume
[2] Warrant 1 – Condition B: Interruption of Continuous Traffic
[3] Warrant 4 – Criterion A: Pedestrian Four-Hour Volume
[4] Warrant 4 – Criterion B: Pedestrian Peak Hour

Multi-Way Stop-Control Application Warrant Review

If the traffic signal at the 5th Avenue & 5th Street intersection is removed, a type of stop-control (multi-way or two-way) should be installed. Multi-way stop-control application warrants for the 5th Avenue & 5th Street intersection were reviewed in accordance with *MUTCD* primary and optional criteria guidance. A summary of the warrant review results is shown in **Table 2.** Full descriptions of the reviewed criteria and summarized results are included in the **Appendix**.

Based on this review, multi-way stop-control is recommended due to the following considerations:

- Safety benefits of providing pedestrians a controlled crossing of 5th Avenue with crosswalks (optional Criterion B).
- Potential sight distance conflicts exist based on the presence of dense street trees, on-street parking, building signage, and other obstructions (optional Criterion C). See '*Intersection Sight Distance*' section for further details.
- Volume-based warrants are currently not met based on existing volumes, however:
    - Major approach volumes meet or exceed volume criteria for 5 of 8 unique hours in the Base Condition and 8 of 8 unique hours in the 80% Minimum Values condition
- Adjacent multi-way stop-control intersections:
    - 5th Avenue & 4th Street (425 ft. to the south) *[similar intersection configurations, functional classifications, and controlled pedestrian crossings]*
    - Main Avenue & 5th Street (450 ft. to the west) *[controlled pedestrian crossings]*
    - 6th Avenue & 5th Street (425 ft. to the east) *[controlled pedestrian crossings]*

Table 2: 5th Avenue & 5th Street Intersection Multi-Way Stop-Control Warrant Review Summary

Multi-Way Stop Control Warrant Criteria	Base Condition*		80% Minimum Values**	
Primary Guidance				
Criterion A Interim Multi-Way Stop prior to Traffic Signal Installation	**Not met**	Based on *MUTCD* signal warrants, traffic volumes do not meet warrant thresholds. See signal warrant report in the **Appendix**.	**Not applicable**	-
Criterion B Crash History	**Not met**	Crash history does not meet Criterion B of 5 or more correctable crashes in a 12-month period. Crash Data Summary • Total Crashes: 0 (2018-2022)	**Not met**	Crash history does not meet Criterion B of 4 or more correctable crashes in a 12-month period. Crash Data Summary • Total Crashes: 0 (2018-2022) *80% of B value in Base Condition*
Criterion C Minimum Volumes	**Not met**	Posted speed: 25 mph Overall (C.1 and C.2): Not met • Posted Speed: 0 of 8 unique hours met C.1 (Major Approach Volume): Not met • Posted Speed: 5 of 8 unique hours met C.2 (Minor Approach Volume): Not met • Posted Speed: 0 of 8 unique hours met • Westbound Approach Peak Hour Delay AM / (PM): ○ 2023 Existing Conditions: 12.6s / (13.2s)	**Not met**	Posted speed: 25 mph Overall (C.1 and C.2): Not met • Posted Speed: 0 of 8 unique hours met C.1 (Major Approach Volume): Met • Posted Speed: 8 of 8 unique hours met C.2 (Minor Approach Volume): Not met • Posted Speed: 0 of 8 unique hours met *80% of C.1 and C.2 values in Base Condition*
Criterion D 80% of Minimum Criteria B, C.1, and C.2 Values	**Not applicable**	-	**Not met**	D (80% of B, C.1, and C.2 Values): Not met
Optional Guidance				
Criterion A Control Left-Turn Conflicts	**Likely not applicable:** Traffic volumes and crash history do not indicate a need to control left-turn conflicts.			
Criterion B Control Vehicle / Pedestrian Conflicts	**Potentially applicable:** Criterion potentially applicable due to the safety benefits of providing a controlled crossing with crosswalks for pedestrians and bicyclists to cross 5th Avenue. Controlled crossings would provide safer connections for non-motorists to/from the downtown district, Children's Museum of South Dakota, 5th Street Gym, and other attractions east and west of this intersection.			
Criterion C Sight Distance Conflicts	**Potentially applicable:** Criterion potentially applicable due to potential sight distance issues with the presence of dense street trees, on-street parking, building signage, and other obstructions. See '*Intersection Sight Distance'* section for further details.			
Criterion D Two Intersecting Residential Collector Streets	**Not applicable:** 5th Avenue and 5th Street are functionally classified as a collector and local street, respectively, per the *Major Street Plan* included in the City of Brookings 2040 Comprehensive Plan.			

* *Base Condition scenario reflects 5h Avenue posted speed limit of 25 mph.*
** *80% Minimum Values scenario reflects the Base Condition (25 mph) at 80% minimum values*

Intersection Sight Distance

If two-way stop-control is desired at the 5th Avenue & 5th Street intersection, intersection sight distance should be considered prior to installation. Intersection Sight Distance (ISD) is the sufficient distance for all road users to anticipate and avoid potential conflicts with crossing and merging traffic streams, pedestrians, and cyclists. ISD dimensions are established at intersections with sight triangles that are based on the physical conditions of the intersection (i.e. three-leg or four-leg approaches), traffic control (i.e. signal, stop-control, or yield control), road user behavior, design speeds, and acceleration-deceleration distances. A preliminary review of sight triangles at the 5th Avenue & 5th Street intersection was conducted for Case B (Intersections with Minor Road Stop-Control) and Case F (Left Turns from the Major Road) criteria.

AASHTO Guidance

ISD dimensions were reviewed in accordance with AASHTO geometric design guidelines under the following cases:

- Case B (Intersections with Minor Road Stop-Control)
- Case D (Intersections with Traffic Signal Control)
- Case E (Intersections with All-Way Stop-Control)
- Case F (Left Turns from the Major Road)

ISD Case B (Intersections with Minor Road Stop-Control) Guidelines:

- Departure sight triangles for intersections with stop control and the minor road should be considered for three situations (shown in **Figure 2**):
  - Case B1 – Left turns from the minor road
  - Case B2 – Right turns from the minor road
  - Case B3 – Crossing the major road from a minor road approach

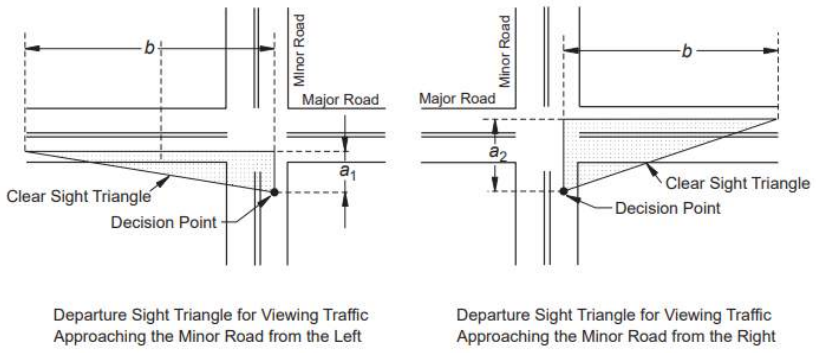


Figure 2: Departure Sight Triangles (Stop-Controlled)

Based on a major road design speed of 30 mph and passenger vehicle for the analysis design vehicle, ISDs required along 5th Avenue and 5th Street are the following for each Case B scenario:

- Case B1 (Left turns from the minor road):
  - 5th Avenue: b = 375 feet

- Case B2 (Right turns from the minor road)
    - 5th Avenue: b = 290 feet
- Case B3 (Crossing the major road from a minor-road approach)
    - 5th Avenue: b = 375 feet

ISD Case D (Intersections with Traffic Signal Control) Guidelines:

- The first vehicle stopped on one approach should be visible to the driver of the first vehicle stopped on each of the other approaches
- Left-turning vehicles should have sufficient sight distance to select gaps in oncoming traffic and complete left turns
- No other sight triangles are needed for signalized intersections
    - Exception: If the traffic signal is placed on two-way flashing operation under off-peak or nighttime conditions, then appropriate departure sight triangles for Case B (intersections with minor road stop control), both to the left and to the right, should be provided for the minor-road approaches

ISD Case E (Intersections with All-Way Stop-Control) Guidelines:

- The first vehicle stopped on one approach should be visible to the driver of the first vehicle stopped on each of the other approaches.
- No other sight triangles are needed for all-way stop-control intersections

ISD Case F (Left Turns from the Major Road) Guidelines:

- Sight distance design should be based on a left turn by a stopped vehicle since a vehicle that turns left without stopping would need less sight distance
- The sight distance along the major road to accommodate left turns is the distance traversed at the design speed of the major road in the travel time for the design vehicle

Based on a major road design speed of 30 mph and passenger vehicle for the analysis design vehicle, Case F ISD required along 5th Avenue and 5th Street is 265 feet.

The preliminary sight triangle review also involved a field visit that occurred on September 13, 2023. The field review consisted of a camera placed on each decision point (positioned on a tripod at an assumed driver height of 3.5 ft.) and traffic cones placed on the two other respective sight triangle corners. Site photos with sight triangle visualizations from the review are included in the **Appendix**.

Case B criteria ISD conflicts observed in the field review include:

- Dense trees (all eastbound and westbound views)
- Parallel on-street parking (all eastbound and westbound views)
- Right angle on-street parking (eastbound right view)
- Building signage (eastbound right and westbound left views)
- Fencing (westbound left view)
- Signal controller cabinet (westbound right view)

Conclusions

Based on the review of traffic signal warrants, multi-way stop-control warrants, and ISD, the following items are recommended for the 5th Avenue & 5th Street intersection:

- Signal warrant thresholds are not met under existing conditions and traffic signal removal at this intersection should be considered.

- Multi-way stop-control is recommended due to the following:
  - Safety benefits of providing pedestrians a controlled crossing of 5th Avenue with crosswalks (optional Criterion B).
  - Potential sight distance conflicts exist based on the presence of dense street trees, on-street parking, building signage, and other obstructions (optional Criterion C).
  - Volume-based warrants are currently not met based on existing volumes, however:
    - Major approach volumes meet or exceed volume criteria for 5 of 8 unique hours in the Base Condition and 8 of 8 unique hours in the 80% Minimum Values condition
  - Adjacent multi-way stop-control intersections with similar features:
    - 5th Avenue & 4th Street
    - Main Avenue & 5th Street
    - 6th Avenue & 5th Street

- If two-way stop-control on the minor road (5th Street) is desired, the following potential intersection sight triangle conflicts should be evaluated prior to installation:
  - Dense trees (all eastbound and westbound views)
  - Parallel on-street parking (all eastbound and westbound views)
  - Right angle on-street parking (eastbound right view)
  - Building signage (eastbound right and westbound left views)
  - Fencing (westbound left view)
  - Signal controller cabinet (westbound right view)

Appendix

Appendix A: Traffic Counts

5th Avenue & 5th Street Intersection (10-Hr) [September 12, 2023]

Appendix B: Signal Warrant Report

5th Avenue & 5th Street Intersection (10-Hr) [September 12, 2023]

- Warrant 1 – Eight-Hour Vehicular Volume
- Warrant 2 – Four-Hour Vehicular Volume
- Warrant 3 – Peak Hour
- Warrant 4 – Pedestrian Volume

Appendix C: MUTCD Multi-Way Stop-Control Application Warrant Criteria

Appendix D: MUTCD ASWC Primary Criteria Summary

5th Avenue & 5th Street Intersection (Base Condition)

Appendix E: Intersection Sight Distance Review

Case B – Intersections with Minor Road Stop-Control

- 5th Street: Eastbound (Left View)
- 5th Street: Eastbound (Right View)
- 5th Street: Westbound (Left View)
- 5th Street: Westbound (Right View)

Case F – Left Turns from the Major Road

- 5th Avenue: Northbound Left Turn
- 5th Avenue: Southbound Left Turn

Appendix A: Traffic Counts

5th Avenue & 5th Street Intersection (10-Hr) [September 12, 2023]

5th Avenue & 5th Street Intersection (10-HR) - TMC

Tue Sep 12, 2023
Full Length (6:30 AM-8:30 AM, 10:30 AM-6:30 PM)
All Classes (Motorcycles, Lights, Single-Unit Trucks, Articulated Trucks, Buses, Pedestrians, Bicycles on Road, Bicycles on Crosswalk)
All Movements
ID: 1105705, Location: 44.310303, -96.796906, Site Code: 20230912

Provided by: HDR : Sioux Falls (SD)
101 S. Phillips Avenue, Suite 401,
Sioux Falls, SD, 57104, US

Leg	South						North						West						East						
Direction	Northbound						Southbound						Eastbound						Westbound						
Time	L	T	R	U	App	Ped*	L	T	R	U	App	Ped*	L	T	R	U	App	Ped*	L	T	R	U	App	Ped*	Int
2023-09-12 6:30AM	0	11	0	0	**11**	0	0	7	1	0	**8**	0	2	1	0	0	**3**	0	0	1	0	0	**1**	0	**23**
6:45AM	3	11	0	0	**14**	0	0	12	5	0	**17**	0	0	1	1	0	**2**	0	0	1	1	0	**2**	0	**35**
Hourly Total	3	22	0	0	**25**	0	0	19	6	0	**25**	0	2	2	1	0	**5**	0	0	2	1	0	**3**	0	**58**
7:00AM	3	23	2	0	**28**	0	0	8	3	0	**11**	0	5	0	0	0	**5**	0	1	0	1	0	**2**	0	**46**
7:15AM	1	26	1	0	**28**	1	1	11	2	0	**14**	0	1	1	1	0	**3**	0	2	1	1	0	**4**	0	**49**
7:30AM	6	49	5	0	**60**	0	1	23	2	0	**26**	1	1	0	0	0	**1**	2	4	1	0	0	**5**	3	**92**
7:45AM	8	73	3	0	**84**	4	0	20	3	0	**23**	0	4	1	2	0	**7**	0	1	8	2	0	**11**	0	**125**
Hourly Total	18	171	11	0	**200**	5	2	62	10	0	**74**	1	11	2	3	0	**16**	2	8	10	4	0	**22**	3	**312**
8:00AM	11	48	9	0	**68**	4	0	20	7	0	**27**	0	0	3	2	0	**5**	0	3	7	2	0	**12**	0	**112**
8:15AM	2	42	5	0	**49**	1	2	22	5	0	**29**	3	3	2	1	0	**6**	2	3	4	0	0	**7**	1	**91**
Hourly Total	13	90	14	0	**117**	5	2	42	12	0	**56**	3	3	5	3	0	**11**	2	6	11	2	0	**19**	1	**203**
10:30AM	3	32	0	0	**35**	1	0	17	6	0	**23**	0	5	2	5	0	**12**	0	2	3	0	0	**5**	0	**75**
10:45AM	1	27	2	0	**30**	2	1	29	7	0	**37**	0	1	3	4	0	**8**	0	1	2	0	0	**3**	0	**78**
Hourly Total	4	59	2	0	**65**	3	1	46	13	0	**60**	0	6	5	9	0	**20**	0	3	5	0	0	**8**	0	**153**
11:00AM	4	32	1	0	**37**	0	1	24	3	0	**28**	0	3	3	6	0	**12**	1	1	5	0	0	**6**	1	**83**
11:15AM	2	32	3	0	**37**	0	0	23	4	0	**27**	1	5	2	2	0	**9**	1	1	4	0	0	**5**	0	**78**
11:30AM	8	27	4	0	**39**	0	0	10	7	0	**17**	0	9	5	9	0	**23**	0	4	4	4	0	**12**	1	**91**
11:45AM	7	37	4	0	**48**	0	1	37	4	0	**42**	0	6	3	3	0	**12**	0	7	4	0	0	**11**	1	**113**
Hourly Total	21	128	12	0	**161**	0	2	94	18	0	**114**	1	23	13	20	0	**56**	2	13	17	4	0	**34**	3	**365**
12:00PM	0	33	2	0	**35**	1	1	38	4	0	**43**	0	2	6	1	0	**9**	0	6	1	0	0	**7**	1	**94**
12:15PM	3	38	2	0	**43**	1	0	26	8	0	**34**	4	8	1	4	0	**13**	1	0	6	1	0	**7**	1	**97**
12:30PM	5	37	2	0	**44**	2	1	39	6	0	**46**	1	4	7	3	0	**14**	0	2	6	0	0	**8**	2	**112**
12:45PM	1	42	5	0	**48**	3	0	44	10	0	**54**	2	6	3	5	0	**14**	0	7	11	2	0	**20**	0	**136**
Hourly Total	9	150	11	0	**170**	7	2	147	28	0	**177**	7	20	17	13	0	**50**	1	15	24	3	0	**42**	4	**439**
1:00PM	5	47	2	0	**54**	1	0	32	4	0	**36**	0	5	2	4	0	**11**	0	5	1	1	0	**7**	4	**108**
1:15PM	5	39	6	0	**50**	0	1	19	5	0	**25**	0	5	4	8	0	**17**	0	6	5	1	0	**12**	0	**104**
1:30PM	3	38	2	0	**43**	0	1	23	5	0	**29**	0	4	2	5	0	**11**	0	1	4	2	0	**7**	1	**90**
1:45PM	7	39	3	0	**49**	0	1	28	3	0	**32**	2	6	1	6	0	**13**	1	2	3	0	0	**5**	0	**99**
Hourly Total	20	163	13	0	**196**	1	3	102	17	0	**122**	2	20	9	23	0	**52**	1	14	13	4	0	**31**	5	**401**
2:00PM	7	40	2	0	**49**	1	2	30	4	0	**36**	1	7	2	2	0	**11**	0	3	5	3	0	**11**	2	**107**
2:15PM	2	31	2	0	**35**	2	0	25	8	0	**33**	1	4	7	0	0	**11**	0	2	2	3	0	**7**	1	**86**
2:30PM	5	36	0	0	**41**	2	0	20	1	0	**21**	2	1	1	3	0	**5**	0	3	5	2	0	**10**	0	**77**
2:45PM	5	31	4	0	**40**	1	0	30	5	0	**35**	0	2	4	5	0	**11**	0	3	7	1	0	**11**	0	**97**
Hourly Total	19	138	8	0	**165**	6	2	105	18	0	**125**	4	14	14	10	0	**38**	0	11	19	9	0	**39**	3	**367**
3:00PM	1	37	0	0	**38**	0	0	26	1	0	**27**	0	10	2	5	0	**17**	1	5	4	3	0	**12**	0	**94**
3:15PM	8	33	8	0	**49**	0	1	24	5	0	**30**	0	5	0	5	0	**10**	0	13	8	4	0	**25**	0	**114**
3:30PM	10	53	5	0	**68**	0	1	37	4	0	**42**	1	8	3	5	0	**16**	0	4	7	1	0	**12**	1	**138**
3:45PM	8	44	5	0	**57**	2	0	28	11	0	**39**	1	10	1	3	0	**14**	1	2	5	1	0	**8**	1	**118**
Hourly Total	27	167	18	0	**212**	2	2	115	21	0	**138**	2	33	6	18	0	**57**	2	24	24	9	0	**57**	2	**464**
4:00PM	7	45	1	0	**53**	2	1	33	6	0	**40**	0	10	3	0	0	**13**	0	2	5	0	0	**7**	2	**113**
4:15PM	3	36	1	0	**40**	0	0	23	11	0	**34**	0	10	2	5	0	**17**	2	4	3	4	0	**11**	0	**102**
4:30PM	9	37	3	0	**49**	0	2	38	4	0	**44**	2	6	4	7	0	**17**	0	3	7	3	0	**13**	0	**123**
4:45PM	7	46	3	0	**56**	1	1	39	8	0	**48**	1	5	2	5	0	**12**	0	12	5	3	0	**20**	1	**136**
Hourly Total	26	164	8	0	**198**	3	4	133	29	0	**166**	3	31	11	17	0	**59**	2	21	20	10	0	**51**	3	**474**
5:00PM	4	42	5	0	**51**	0	1	55	4	0	**60**	0	7	3	17	0	**27**	0	1	4	2	0	**7**	0	**145**
5:15PM	6	46	10	0	**62**	0	0	36	2	0	**38**	0	4	2	7	0	**13**	1	7	8	1	0	**16**	4	**129**
5:30PM	0	40	4	0	**44**	2	2	34	3	0	**39**	0	6	5	4	0	**15**	0	9	1	0	0	**10**	1	**108**
5:45PM	2	23	3	0	**28**	0	0	43	4	0	**47**	0	6	2	6	0	**14**	1	3	3	0	0	**6**	0	**95**
Hourly Total	12	151	22	0	**185**	2	3	168	13	0	**184**	0	23	12	34	0	**69**	2	20	16	3	0	**39**	5	**477**
6:00PM	3	26	0	0	**29**	0	1	19	4	0	**24**	5	1	2	1	0	**4**	0	4	2	1	0	**7**	0	**64**
6:15PM	1	27	1	0	**29**	1	0	14	2	0	**16**	1	2	3	1	0	**6**	1	3	1	1	0	**5**	2	**56**
Hourly Total	4	53	1	0	**58**	1	1	33	6	0	**40**	6	3	5	2	0	**10**	1	7	3	2	0	**12**	2	**120**
Total	176	1456	120	0	**1752**	35	24	1066	191	0	**1281**	29	189	101	153	0	**443**	15	142	164	51	0	**357**	31	**3833**
% Approach	10.0%	83.1%	6.8%	0%	**-**	-	1.9%	83.2%	14.9%	0%	**-**	-	42.7%	22.8%	34.5%	0%	**-**	-	39.8%	45.9%	14.3%	0%	**-**	-	-
% Total	4.6%	38.0%	3.1%	0%	**45.7%**	-	0.6%	27.8%	5.0%	0%	**33.4%**	-	4.9%	2.6%	4.0%	0%	**11.6%**	-	3.7%	4.3%	1.3%	0%	**9.3%**	-	-
Motorcycles	3	11	1	0	**15**	-	0	5	0	0	**5**	-	1	2	1	0	**4**	-	1	1	0	0	**2**	-	26
% Motorcycles	1.7%	0.8%	0.8%	0%	**0.9%**	-	0%	0.5%	0%	0%	**0.4%**	-	0.5%	2.0%	0.7%	0%	**0.9%**	-	0.7%	0.6%	0%	0%	**0.6%**	-	0.7%
Lights	172	1426	110	0	**1708**	-	23	1050	186	0	**1259**	-	182	95	150	0	**427**	-	135	158	49	0	**342**	-	3736
% Lights	97.7%	97.9%	91.7%	0%	**97.5%**	-	95.8%	98.5%	97.4%	0%	**98.3%**	-	96.3%	94.1%	98.0%	0%	**96.4%**	-	95.1%	96.3%	96.1%	0%	**95.8%**	-	97.5%

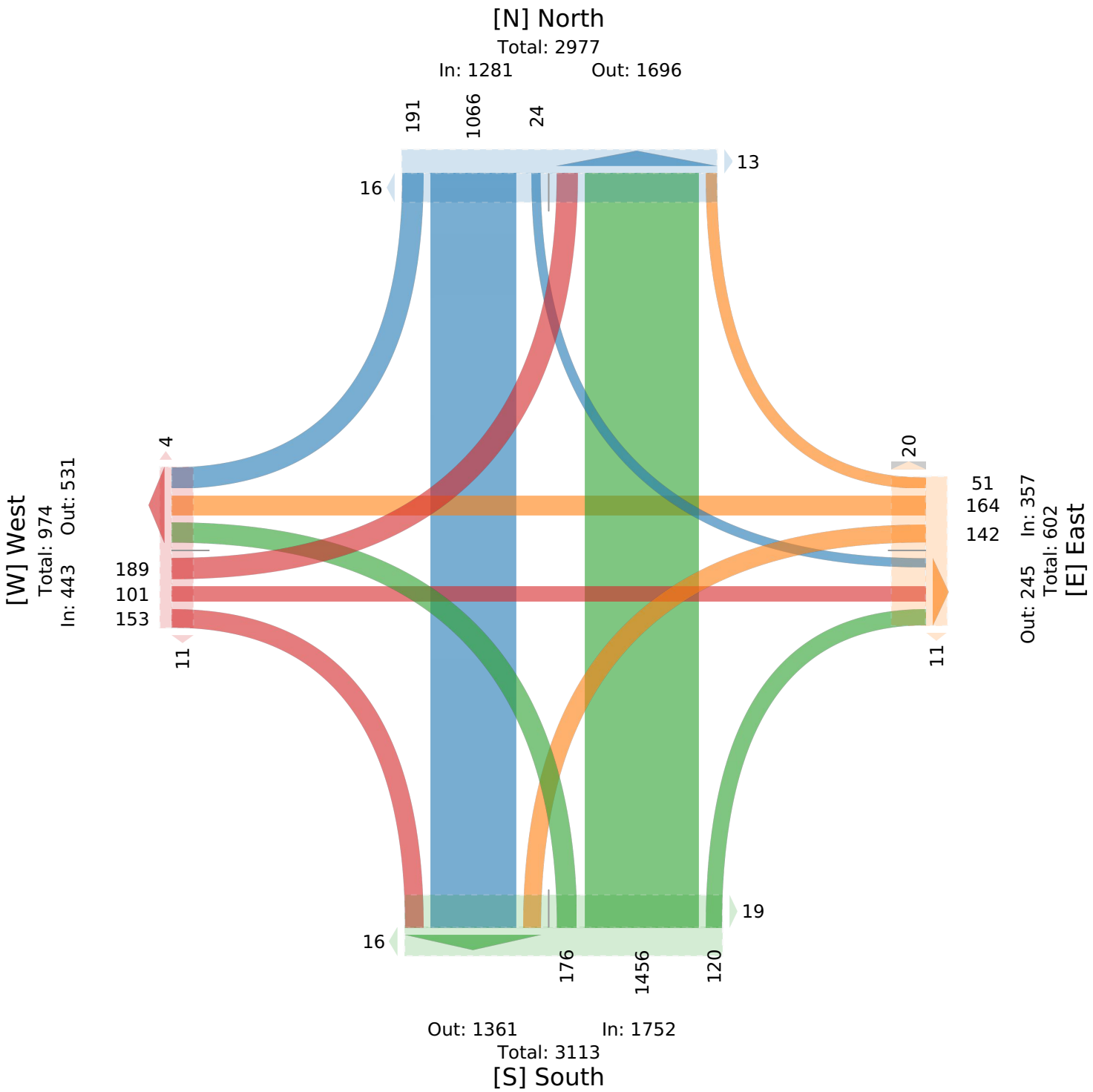
Leg Direction	South Northbound						North Southbound						West Eastbound						East Westbound						
Time	L	T	R	U	**App**	Ped*	L	T	R	U	**App**	Ped*	L	T	R	U	**App**	Ped*	L	T	R	U	**App**	Ped*	**Int**
Single-Unit Trucks	1	7	3	0	**11**	-	0	6	3	0	**9**	-	6	2	1	0	**9**	-	3	0	1	0	**4**	-	33
% Single-Unit Trucks	0.6%	0.5%	2.5%	0%	**0.6%**	-	0%	0.6%	1.6%	0%	**0.7%**	-	3.2%	2.0%	0.7%	0%	**2.0%**	-	2.1%	0%	2.0%	0%	**1.1%**	-	0.9%
Articulated Trucks	0	1	0	0	**1**	-	0	1	0	0	**1**	-	0	0	0	0	**0**	-	0	0	0	0	**0**	-	2
% Articulated Trucks	0%	0.1%	0%	0%	**0.1%**	-	0%	0.1%	0%	0%	**0.1%**	-	0%	0%	0%	0%	**0%**	-	0%	0%	0%	0%	**0%**	-	0.1%
Buses	0	5	5	0	**10**	-	0	3	0	0	**3**	-	0	1	0	0	**1**	-	1	2	0	0	**3**	-	17
% Buses	0%	0.3%	4.2%	0%	**0.6%**	-	0%	0.3%	0%	0%	**0.2%**	-	0%	1.0%	0%	0%	**0.2%**	-	0.7%	1.2%	0%	0%	**0.8%**	-	0.4%
Bicycles on Road	0	6	1	0	**7**	-	1	1	2	0	**4**	-	0	1	1	0	**2**	-	2	3	1	0	**6**	-	19
% Bicycles on Road	0%	0.4%	0.8%	0%	**0.4%**	-	4.2%	0.1%	1.0%	0%	**0.3%**	-	0%	1.0%	0.7%	0%	**0.5%**	-	1.4%	1.8%	2.0%	0%	**1.7%**	-	0.5%
Pedestrians	-	-	-	-	-	29	-	-	-	-	-	27	-	-	-	-	-	12	-	-	-	-	-	28	
% Pedestrians	-	-	-	-	-	- 82.9%	-	-	-	-	-	- 93.1%	-	-	-	-	-	- 80.0%	-	-	-	-	-	- 90.3%	-
Bicycles on Crosswalk	-	-	-	-	-	6	-	-	-	-	-	2	-	-	-	-	-	3	-	-	-	-	-	3	
% Bicycles on Crosswalk	-	-	-	-	-	- 17.1%	-	-	-	-	-	- 6.9%	-	-	-	-	-	- 20.0%	-	-	-	-	-	- 9.7%	-

*Pedestrians and Bicycles on Crosswalk. L: Left, R: Right, T: Thru, U: U-Turn

5th Avenue & 5th Street Intersection (10-HR) - TMC

Tue Sep 12, 2023
Full Length (6:30 AM-8:30 AM, 10:30 AM-6:30 PM)
All Classes (Motorcycles, Lights, Single-Unit Trucks, Articulated Trucks, Buses, Pedestrians, Bicycles on Road, Bicycles on Crosswalk)
All Movements
ID: 1105705, Location: 44.310303, -96.796906, Site Code: 20230912

Provided by: HDR : Sioux Falls (SD)
101 S. Phillips Avenue, Suite 401,
Sioux Falls, SD, 57104, US



5th Avenue & 5th Street Intersection (10-HR) - TMC

Tue Sep 12, 2023
AM Peak (7:30 AM - 8:30 AM)
All Classes (Motorcycles, Lights, Single-Unit Trucks, Articulated Trucks, Buses, Pedestrians, Bicycles on Road, Bicycles on Crosswalk)
All Movements
ID: 1105705, Location: 44.310303, -96.796906, Site Code: 20230912

Provided by: HDR : Sioux Falls (SD)
101 S. Phillips Avenue, Suite 401,
Sioux Falls, SD, 57104, US

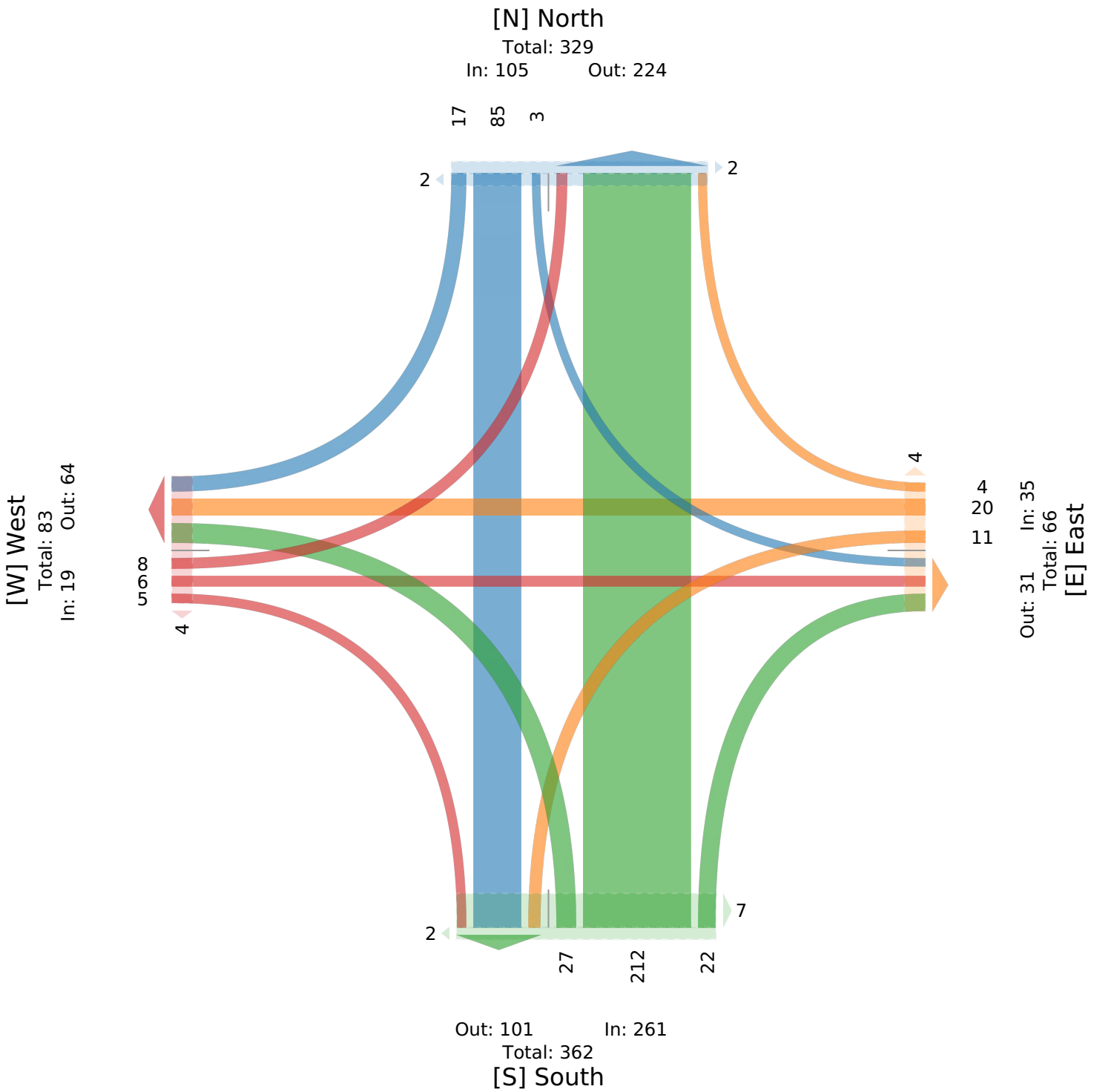
Leg / Direction	South Northbound						North Southbound						West Eastbound						East Westbound						
Time	L	T	R	U	App	Ped*	L	T	R	U	App	Ped*	L	T	R	U	App	Ped*	L	T	R	U	App	Ped*	Int
2023-09-12 7:30AM	6	49	5	0	**60**	0	1	23	2	0	**26**	1	1	0	0	0	**1**	2	4	1	0	0	**5**	3	**92**
7:45AM	8	73	3	0	**84**	4	0	20	3	0	**23**	0	4	1	2	0	**7**	0	1	8	2	0	**11**	0	**125**
8:00AM	11	48	9	0	**68**	4	0	20	7	0	**27**	0	0	3	2	0	**5**	0	3	7	2	0	**12**	0	**112**
8:15AM	2	42	5	0	**49**	1	2	22	5	0	**29**	3	3	2	1	0	**6**	2	3	4	0	0	**7**	1	**91**
Total	27	212	22	0	**261**	9	3	85	17	0	**105**	4	8	6	5	0	**19**	4	11	20	4	0	**35**	4	**420**
% Approach	10.3%	81.2%	8.4%	0%	**-**	-	2.9%	81.0%	16.2%	0%	**-**	-	42.1%	31.6%	26.3%	0%	**-**	-	31.4%	57.1%	11.4%	0%	**-**	-	**-**
% Total	6.4%	50.5%	5.2%	0%	**62.1%**	-	0.7%	20.2%	4.0%	0%	**25.0%**	-	1.9%	1.4%	1.2%	0%	**4.5%**	-	2.6%	4.8%	1.0%	0%	**8.3%**	-	**-**
PHF	0.614	0.726	0.583	-	**0.783**	-	0.375	0.924	0.607	-	**0.905**	-	0.500	0.500	0.500	-	**0.750**	-	0.625	0.625	0.500	-	**0.708**	-	0.848
Motorcycles	1	1	0	0	**2**	-	0	0	0	0	**0**	-	0	0	0	0	**0**	-	0	0	0	0	**0**	-	2
% Motorcycles	3.7%	0.5%	0%	0%	**0.8%**	-	0%	0%	0%	0%	**0%**	-	0%	0%	0%	0%	**0%**	-	0%	0%	0%	0%	**0%**	-	0.5%
Lights	26	208	20	0	**254**	-	3	84	17	0	**104**	-	7	6	4	0	**17**	-	10	20	4	0	**34**	-	409
% Lights	96.3%	98.1%	90.9%	0%	**97.3%**	-	100%	98.8%	100%	0%	**99.0%**	-	87.5%	100%	80.0%	0%	**89.5%**	-	90.9%	100%	100%	0%	**97.1%**	-	97.4%
Single-Unit Trucks	0	2	1	0	**3**	-	0	0	0	0	**0**	-	1	0	0	0	**1**	-	0	0	0	0	**0**	-	4
% Single-Unit Trucks	0%	0.9%	4.5%	0%	**1.1%**	-	0%	0%	0%	0%	**0%**	-	12.5%	0%	0%	0%	**5.3%**	-	0%	0%	0%	0%	**0%**	-	1.0%
Articulated Trucks	0	0	0	0	**0**	-	0	0	0	0	**0**	-	0	0	0	0	**0**	-	0	0	0	0	**0**	-	0
% Articulated Trucks	0%	0%	0%	0%	**0%**	-	0%	0%	0%	0%	**0%**	-	0%	0%	0%	0%	**0%**	-	0%	0%	0%	0%	**0%**	-	0%
Buses	0	1	0	0	**1**	-	0	1	0	0	**1**	-	0	0	0	0	**0**	-	0	0	0	0	**0**	-	2
% Buses	0%	0.5%	0%	0%	**0.4%**	-	0%	1.2%	0%	0%	**1.0%**	-	0%	0%	0%	0%	**0%**	-	0%	0%	0%	0%	**0%**	-	0.5%
Bicycles on Road	0	0	1	0	**1**	-	0	0	0	0	**0**	-	0	0	1	0	**1**	-	1	0	0	0	**1**	-	3
% Bicycles on Road	0%	0%	4.5%	0%	**0.4%**	-	0%	0%	0%	0%	**0%**	-	0%	0%	20.0%	0%	**5.3%**	-	9.1%	0%	0%	0%	**2.9%**	-	0.7%
Pedestrians	-	-	-	-	-	7	-	-	-	-	-	4	-	-	-	-	-	4	-	-	-	-	-	2	
% Pedestrians	-	-	-	-	-	77.8%	-	-	-	-	-	100%	-	-	-	-	-	100%	-	-	-	-	-	50.0%	-
Bicycles on Crosswalk	-	-	-	-	-	2	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	2	
% Bicycles on Crosswalk	-	-	-	-	-	22.2%	-	-	-	-	-	0%	-	-	-	-	-	0%	-	-	-	-	-	50.0%	-

*Pedestrians and Bicycles on Crosswalk. L: Left, R: Right, T: Thru, U: U-Turn

5th Avenue & 5th Street Intersection (10-HR) - TMC

Tue Sep 12, 2023
AM Peak (7:30 AM - 8:30 AM)
All Classes (Motorcycles, Lights, Single-Unit Trucks, Articulated Trucks, Buses, Pedestrians, Bicycles on Road, Bicycles on Crosswalk)
All Movements
ID: 1105705, Location: 44.310303, -96.796906, Site Code: 20230912

Provided by: HDR : Sioux Falls (SD)
101 S. Phillips Avenue, Suite 401,
Sioux Falls, SD, 57104, US



5th Avenue & 5th Street Intersection (10-HR) - TMC

Tue Sep 12, 2023
Midday Peak (12:30 PM - 1:30 PM)
All Classes (Motorcycles, Lights, Single-Unit Trucks, Articulated Trucks, Buses, Pedestrians, Bicycles on Road, Bicycles on Crosswalk)
All Movements
ID: 1105705, Location: 44.310303, -96.796906, Site Code: 20230912

Provided by: HDR : Sioux Falls (SD)
101 S. Phillips Avenue, Suite 401,
Sioux Falls, SD, 57104, US

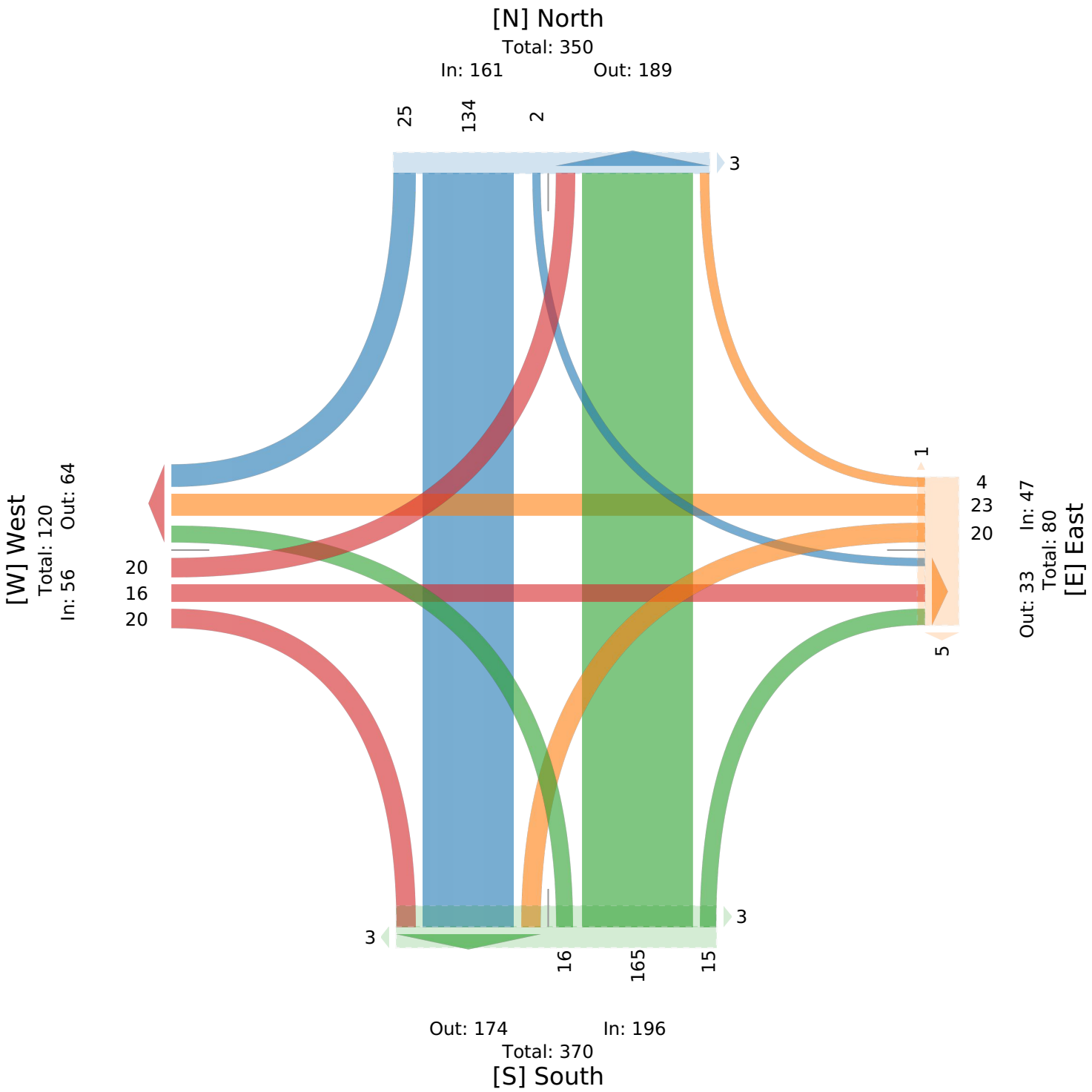
Leg / Direction	South Northbound						North Southbound						West Eastbound						East Westbound						
Time	L	T	R	U	App	Ped*	L	T	R	U	App	Ped*	L	T	R	U	App	Ped*	L	T	R	U	App	Ped*	Int
2023-09-12 12:30PM	5	37	2	0	**44**	2	1	39	6	0	**46**	1	4	7	3	0	**14**	0	2	6	0	0	**8**	2	**112**
12:45PM	1	42	5	0	**48**	3	0	44	10	0	**54**	2	6	3	5	0	**14**	0	7	11	2	0	**20**	0	**136**
1:00PM	5	47	2	0	**54**	1	0	32	4	0	**36**	0	5	2	4	0	**11**	0	5	1	1	0	**7**	4	**108**
1:15PM	5	39	6	0	**50**	0	1	19	5	0	**25**	0	5	4	8	0	**17**	0	6	5	1	0	**12**	0	**104**
Total	16	165	15	0	**196**	6	2	134	25	0	**161**	3	20	16	20	0	**56**	0	20	23	4	0	**47**	6	**460**
% Approach	8.2%	84.2%	7.7%	0%	**-**	-	1.2%	83.2%	15.5%	0%	**-**	-	35.7%	28.6%	35.7%	0%	**-**	-	42.6%	48.9%	8.5%	0%	**-**	-	**-**
% Total	3.5%	35.9%	3.3%	0%	**42.6%**	-	0.4%	29.1%	5.4%	0%	**35.0%**	-	4.3%	3.5%	4.3%	0%	**12.2%**	-	4.3%	5.0%	0.9%	0%	**10.2%**	-	**-**
PHF	0.800	0.891	0.625	-	**0.920**	-	0.500	0.761	0.625	-	**0.745**	-	0.833	0.571	0.625	-	**0.824**	-	0.792	0.523	0.500	-	**0.605**	-	0.848
Motorcycles	0	1	0	0	**1**	-	0	1	0	0	**1**	-	0	0	0	0	**0**	-	0	0	0	0	**0**	-	2
% Motorcycles	0%	0.6%	0%	0%	**0.5%**	-	0%	0.7%	0%	0%	**0.6%**	-	0%	0%	0%	0%	**0%**	-	0%	0%	0%	0%	**0%**	-	0.4%
Lights	16	162	14	0	**192**	-	2	131	25	0	**158**	-	20	16	19	0	**55**	-	19	22	4	0	**45**	-	450
% Lights	100%	98.2%	93.3%	0%	**98.0%**	-	100%	97.8%	100%	0%	**98.1%**	-	100%	100%	95.0%	0%	**98.2%**	-	95.0%	95.7%	100%	0%	**95.7%**	-	97.8%
Single-Unit Trucks	0	1	1	0	**2**	-	0	2	0	0	**2**	-	0	0	1	0	**1**	-	0	0	0	0	**0**	-	5
% Single-Unit Trucks	0%	0.6%	6.7%	0%	**1.0%**	-	0%	1.5%	0%	0%	**1.2%**	-	0%	0%	5.0%	0%	**1.8%**	-	0%	0%	0%	0%	**0%**	-	1.1%
Articulated Trucks	0	0	0	0	**0**	-	0	0	0	0	**0**	-	0	0	0	0	**0**	-	0	0	0	0	**0**	-	0
% Articulated Trucks	0%	0%	0%	0%	**0%**	-	0%	0%	0%	0%	**0%**	-	0%	0%	0%	0%	**0%**	-	0%	0%	0%	0%	**0%**	-	0%
Buses	0	0	0	0	**0**	-	0	0	0	0	**0**	-	0	0	0	0	**0**	-	0	1	0	0	**1**	-	1
% Buses	0%	0%	0%	0%	**0%**	-	0%	0%	0%	0%	**0%**	-	0%	0%	0%	0%	**0%**	-	0%	4.3%	0%	0%	**2.1%**	-	0.2%
Bicycles on Road	0	1	0	0	**1**	-	0	0	0	0	**0**	-	0	0	0	0	**0**	-	1	0	0	0	**1**	-	2
% Bicycles on Road	0%	0.6%	0%	0%	**0.5%**	-	0%	0%	0%	0%	**0%**	-	0%	0%	0%	0%	**0%**	-	5.0%	0%	0%	0%	**2.1%**	-	0.4%
Pedestrians	-	-	-	-	-	6	-	-	-	-	-	3	-	-	-	-	-	0	-	-	-	-	-	6	
% Pedestrians	-	-	-	-	-	100%	-	-	-	-	-	100%	-	-	-	-	-	-	-	-	-	-	-	100%	-
Bicycles on Crosswalk	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	
% Bicycles on Crosswalk	-	-	-	-	-	0%	-	-	-	-	-	0%	-	-	-	-	-	-	-	-	-	-	-	0%	-

*Pedestrians and Bicycles on Crosswalk. L: Left, R: Right, T: Thru, U: U-Turn

5th Avenue & 5th Street Intersection (10-HR) - TMC

Tue Sep 12, 2023
Midday Peak (12:30 PM - 1:30 PM)
All Classes (Motorcycles, Lights, Single-Unit Trucks, Articulated Trucks, Buses, Pedestrians, Bicycles on Road, Bicycles on Crosswalk)
All Movements
ID: 1105705, Location: 44.310303, -96.796906, Site Code: 20230912

Provided by: HDR : Sioux Falls (SD)
101 S. Phillips Avenue, Suite 401,
Sioux Falls, SD, 57104, US



5th Avenue & 5th Street Intersection (10-HR) - TMC

Tue Sep 12, 2023
PM Peak (4:30 PM - 5:30 PM) - Overall Peak Hour
All Classes (Motorcycles, Lights, Single-Unit Trucks, Articulated Trucks, Buses, Pedestrians, Bicycles on Road, Bicycles on Crosswalk)
All Movements
ID: 1105705, Location: 44.310303, -96.796906, Site Code: 20230912

Provided by: HDR : Sioux Falls (SD)
101 S. Phillips Avenue, Suite 401,
Sioux Falls, SD, 57104, US

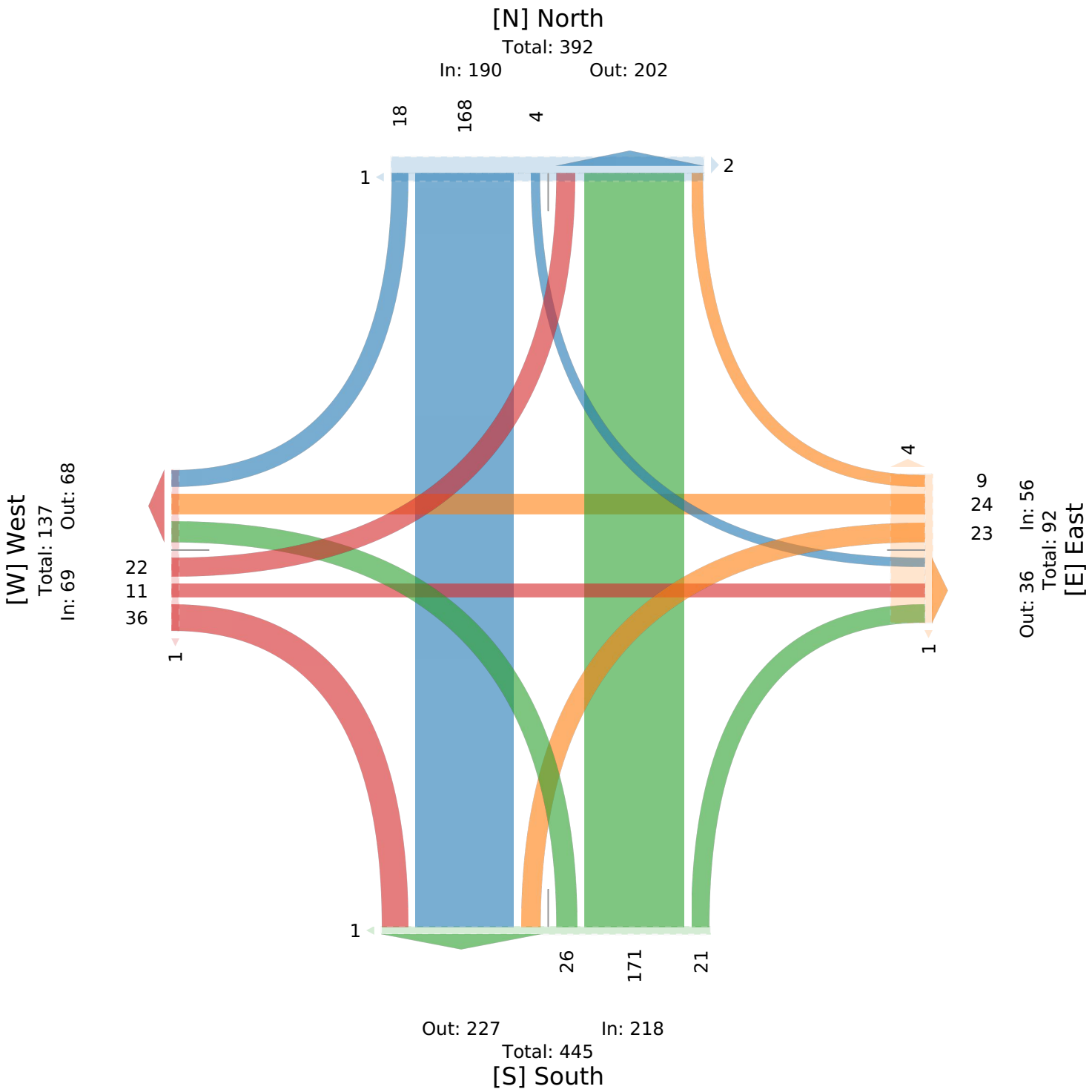
Leg / Direction	South Northbound						North Southbound						West Eastbound						East Westbound						
Time	L	T	R	U	App	Ped*	L	T	R	U	App	Ped*	L	T	R	U	App	Ped*	L	T	R	U	App	Ped*	Int
2023-09-12 4:30PM	9	37	3	0	**49**	0	2	38	4	0	**44**	2	6	4	7	0	**17**	0	3	7	3	0	**13**	0	**123**
4:45PM	7	46	3	0	**56**	1	1	39	8	0	**48**	1	5	2	5	0	**12**	0	12	5	3	0	**20**	1	**136**
5:00PM	4	42	5	0	**51**	0	1	55	4	0	**60**	0	7	3	17	0	**27**	0	1	4	2	0	**7**	0	**145**
5:15PM	6	46	10	0	**62**	0	0	36	2	0	**38**	0	4	2	7	0	**13**	1	7	8	1	0	**16**	4	**129**
Total	26	171	21	0	**218**	1	4	168	18	0	**190**	3	22	11	36	0	**69**	1	23	24	9	0	**56**	5	**533**
% Approach	11.9%	78.4%	9.6%	0%	**-**	-	2.1%	88.4%	9.5%	0%	**-**	-	31.9%	15.9%	52.2%	0%	**-**	-	41.1%	42.9%	16.1%	0%	**-**	-	-
% Total	4.9%	32.1%	3.9%	0%	**40.9%**	-	0.8%	31.5%	3.4%	0%	**35.6%**	-	4.1%	2.1%	6.8%	0%	**12.9%**	-	4.3%	4.5%	1.7%	0%	**10.5%**	-	-
PHF	0.722	0.929	0.525	-	**0.879**	-	0.500	0.764	0.563	-	**0.792**	-	0.786	0.688	0.529	-	**0.639**	-	0.479	0.719	0.667	-	**0.675**	-	0.916
Motorcycles	2	1	0	0	**3**	-	0	2	0	0	**2**	-	0	0	0	0	**0**	-	0	1	0	0	**1**	-	6
% Motorcycles	7.7%	0.6%	0%	0%	**1.4%**	-	0%	1.2%	0%	0%	**1.1%**	-	0%	0%	0%	0%	**0%**	-	0%	4.2%	0%	0%	**1.8%**	-	1.1%
Lights	24	170	21	0	**215**	-	4	166	17	0	**187**	-	22	10	36	0	**68**	-	23	22	8	0	**53**	-	523
% Lights	92.3%	99.4%	100%	0%	**98.6%**	-	100%	98.8%	94.4%	0%	**98.4%**	-	100%	90.9%	100%	0%	**98.6%**	-	100%	91.7%	88.9%	0%	**94.6%**	-	98.1%
Single-Unit Trucks	0	0	0	0	**0**	-	0	0	1	0	**1**	-	0	1	0	0	**1**	-	0	0	0	0	**0**	-	2
% Single-Unit Trucks	0%	0%	0%	0%	**0%**	-	0%	0%	5.6%	0%	**0.5%**	-	0%	9.1%	0%	0%	**1.4%**	-	0%	0%	0%	0%	**0%**	-	0.4%
Articulated Trucks	0	0	0	0	**0**	-	0	0	0	0	**0**	-	0	0	0	0	**0**	-	0	0	0	0	**0**	-	0
% Articulated Trucks	0%	0%	0%	0%	**0%**	-	0%	0%	0%	0%	**0%**	-	0%	0%	0%	0%	**0%**	-	0%	0%	0%	0%	**0%**	-	0%
Buses	0	0	0	0	**0**	-	0	0	0	0	**0**	-	0	0	0	0	**0**	-	0	0	0	0	**0**	-	0
% Buses	0%	0%	0%	0%	**0%**	-	0%	0%	0%	0%	**0%**	-	0%	0%	0%	0%	**0%**	-	0%	0%	0%	0%	**0%**	-	0%
Bicycles on Road	0	0	0	0	**0**	-	0	0	0	0	**0**	-	0	0	0	0	**0**	-	0	1	1	0	**2**	-	2
% Bicycles on Road	0%	0%	0%	0%	**0%**	-	0%	0%	0%	0%	**0%**	-	0%	0%	0%	0%	**0%**	-	0%	4.2%	11.1%	0%	**3.6%**	-	0.4%
Pedestrians	-	-	-	-	-	0	-	-	-	-	-	3	-	-	-	-	-	1	-	-	-	-	-	5	
% Pedestrians	-	-	-	-	-	0%	-	-	-	-	-	100%	-	-	-	-	-	100%	-	-	-	-	-	100%	-
Bicycles on Crosswalk	-	-	-	-	-	1	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	
% Bicycles on Crosswalk	-	-	-	-	-	100%	-	-	-	-	-	0%	-	-	-	-	-	0%	-	-	-	-	-	0%	-

*Pedestrians and Bicycles on Crosswalk. L: Left, R: Right, T: Thru, U: U-Turn

5th Avenue & 5th Street Intersection (10-HR) - TMC

Tue Sep 12, 2023
PM Peak (4:30 PM - 5:30 PM) - Overall Peak Hour
All Classes (Motorcycles, Lights, Single-Unit Trucks, Articulated Trucks, Buses, Pedestrians, Bicycles on Road, Bicycles on Crosswalk)
All Movements
ID: 1105705, Location: 44.310303, -96.796906, Site Code: 20230912

Provided by: HDR : Sioux Falls (SD)
101 S. Phillips Avenue, Suite 401,
Sioux Falls, SD, 57104, US



Appendix B: Signal Warrant Report

5th Avenue & 5th Street Intersection (10-Hr) [September 12, 2023]

- Warrant 1 – Eight-Hour Vehicular Volume
- Warrant 2 – Four-Hour Vehicular Volume
- Warrant 3 – Peak Hour
- Warrant 4 – Pedestrian Volume

Traffic Signal Warrant Analysis Workbook

STUDY AND ANALYSIS INFORMATION

Municipality:	City of Brookings	**Analysis Date:**	9/18/2023
County:		**Conducted By:**	HDR
PennDOT Engineering District:		**Agency/Company Name:**	HDR

Analysis Information

Data Collection Date:	9/12/2023
Day of the Week:	Tuesday

Is the intersection in a built-up area of an isolated community of <10,000 population? No

Major Street Information

Major Street Name and Route Number:	5th Avenue
Major Street Approach #1 Direction:	N-Bound
Major Street Approach #2 Direction:	S-Bound

Number of Lanes for Moving Traffic on Each Major Street Approach:	1	**LANE(S)**
Speed Limit or 85th Percentile Speed on the Major Street:	25	**MPH**

Minor Street Information

Minor Street Name and Route Number:	5th Street
Minor Street Approach #1 Direction:	E-Bound
Minor Street Approach #2 Direction:	W-Bound

Number of Lanes for Moving Traffic on Each Minor Street Approach:	1	**LANE(S)**

TRAFFIC SIGNAL WARRANT ANALYSIS FINDINGS

	Applicable?	Warrant Met?
Warrant 1, Eight-Hour Vehicular Volume	**Yes**	**No**
Warrant 2, Four-Hour Vehicular Volume	**Yes**	**No**
Warrant 3, Peak Hour	**Yes**	**No**
Warrant 4, Pedestrian Volume	**Yes**	**No**
Warrant 5, School Crossing	**Yes**	**No**
Warrant 6, Coordinated Signal System	**Yes**	**No**
Warrant 7, Crash Experience	**Yes**	**No**
Warrant 8, Roadway Network	**No**	**N/A**
Warrant 9, Intersection Near a Grade Crossing	**No**	**N/A**
Warrant PA-1, ADT Volume Warrant	**No**	**N/A**
Warrant PA-2, Midblock and Trail Crossings	**No**	**N/A**

ENTER VOLUME DATA PER 15 MINUTE INTERVAL, PER APPROACH

Time Interval		Major Street Approach #1 (N-Bound)	Major Street Approach #2 (S-Bound)	Major Street Combined	Minor Street Approach #1 (E-Bound)	Minor Street Approach #2 (W-Bound)
Begin At	End Of	Volume	Volume	Total Volume	Volume	Volume
12:00 AM	12:14 AM			0		
12:15 AM	12:29 AM			0		
12:30 AM	12:44 AM			0		
12:45 AM	12:59 AM			0		
1:00 AM	1:14 AM			0		
1:15 AM	1:29 AM			0		
1:30 AM	1:44 AM			0		
1:45 AM	1:59 AM			0		
2:00 AM	2:14 AM			0		
2:15 AM	2:29 AM			0		
2:30 AM	2:44 AM			0		
2:45 AM	2:59 AM			0		
3:00 AM	3:14 AM			0		
3:15 AM	3:29 AM			0		
3:30 AM	3:44 AM			0		
3:45 AM	3:59 AM			0		
4:00 AM	4:14 AM			0		
4:15 AM	4:29 AM			0		
4:30 AM	4:44 AM			0		
4:45 AM	4:59 AM			0		
5:00 AM	5:14 AM			0		
5:15 AM	5:29 AM			0		
5:30 AM	5:44 AM			0		
5:45 AM	5:59 AM			0		
6:00 AM	6:14 AM			0		
6:15 AM	6:29 AM			0		
6:30 AM	6:44 AM	11	8	19	3	1
6:45 AM	6:59 AM	14	17	31	2	2
7:00 AM	7:14 AM	28	11	39	5	2
7:15 AM	7:29 AM	28	14	42	3	4
7:30 AM	7:44 AM	60	26	86	1	5
7:45 AM	7:59 AM	84	23	107	7	11
8:00 AM	8:14 AM	68	27	95	5	12
8:15 AM	8:29 AM	49	29	78	6	7
8:30 AM	8:44 AM			0		
8:45 AM	8:59 AM			0		
9:00 AM	9:14 AM			0		
9:15 AM	9:29 AM			0		
9:30 AM	9:44 AM			0		
9:45 AM	9:59 AM			0		
10:00 AM	10:14 AM			0		
10:15 AM	10:29 AM			0		
10:30 AM	10:44 AM	35	23	58	12	5
10:45 AM	10:59 AM	30	37	67	8	3
11:00 AM	11:14 AM	37	28	65	12	6
11:15 AM	11:29 AM	37	27	64	9	5
11:30 AM	11:44 AM	39	17	56	23	12
11:45 AM	11:59 AM	48	42	90	12	11

MUTCD WARRANT 1, EIGHT-HOUR VEHICULAR VOLUME

Number of Lanes for Moving Traffic on Each Approach	
Major Street:	1 Lane
Minor Street:	1 Lane

Built-up Isolated Community With Less Than 10,000 Population or Above 40 MPH on Major Street?	No

Combination of Conditions A and B Necessary?*: No

**Only applicable for Warrant 1 if after an adequate trial of other alternatives that could cause less delay and inconvenience to traffic has failed to solve the traffic problems. See Section 4C.02 of the 2009 MUTCD for application.*

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%	80%	70%	56%	100%	80%	70%	56%
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%	80%	70%	56%	100%	80%	70%	56%
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

Condition A Evaluation

Number of Unique Hours Met: 0 **Condition A Satisfied?** No

Condition B Evaluation

Number of Unique Hours Met: 0 **Condition B Satisfied?** No

Combination of Condition A and Condition B Evaluation

Number of Unique Hours Met for Condition A: N/A

Number of Unique Hours Met for Condition B: N/A

Combination of Condition A and Condition B Satisfied? N/A

MUTCD WARRANT 2, FOUR-HOUR VEHICULAR VOLUME

Number of Lanes for Moving Traffic on Each Approach	
Major Street:	1 Lane
Minor Street:	1 Lane

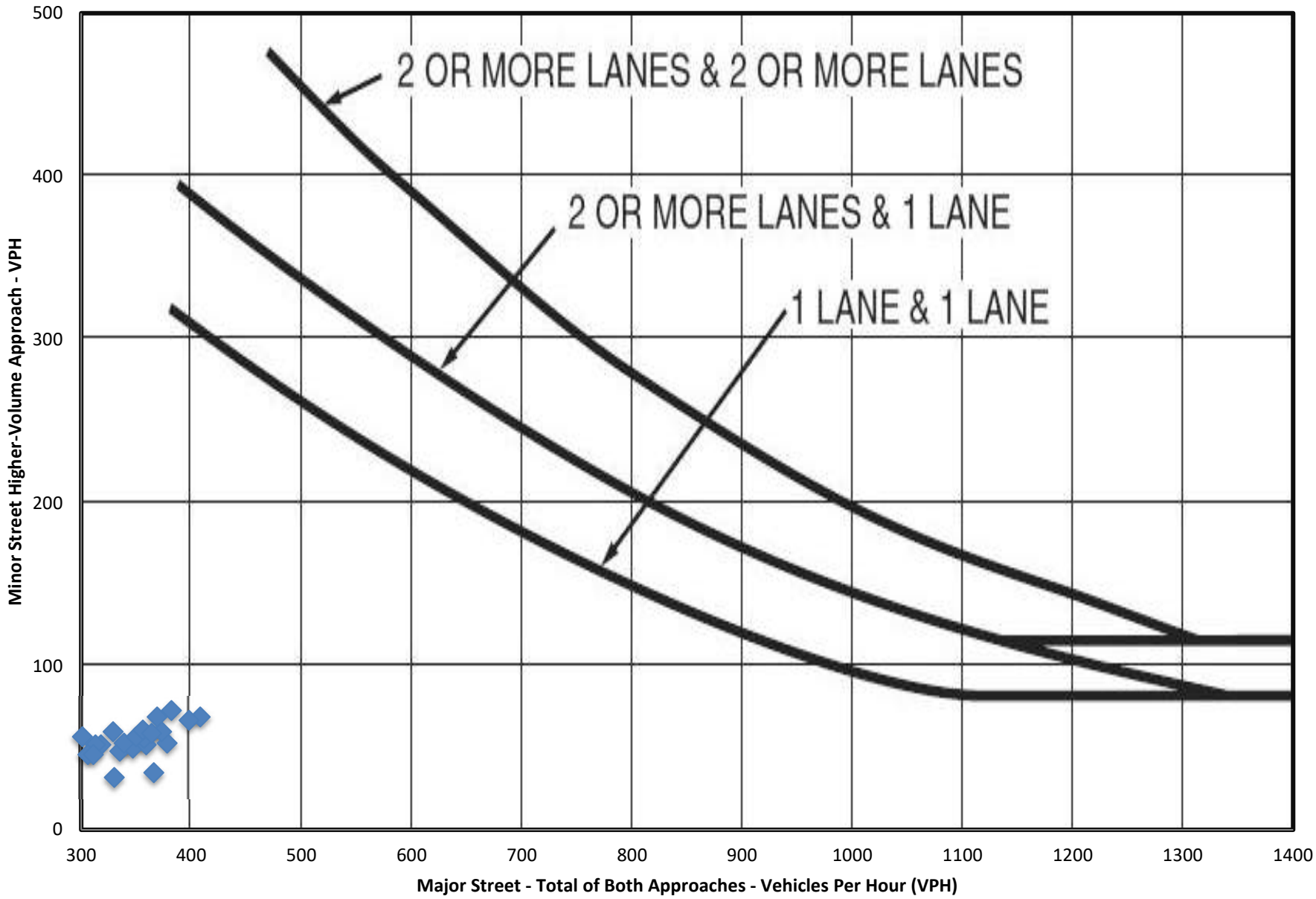
Total Number of Unique Hours Met On Figure 4C-1
0

Built-up Isolated Community With Less Than 10,000 Population or Above 40 MPH on Major Street?	No

Hourly Vehicular Volume			
Hour Interval Beginning At	Major Street Combined Vehicles Per Hour (VPH)	Highest Minor Street Approach Vehicles Per Hour (VPH)	Hour Met?
12:00 AM	0	0	
12:15 AM	0	0	
12:30 AM	0	0	
12:45 AM	0	0	
1:00 AM	0	0	
1:15 AM	0	0	
1:30 AM	0	0	
1:45 AM	0	0	
2:00 AM	0	0	
2:15 AM	0	0	
2:30 AM	0	0	
2:45 AM	0	0	
3:00 AM	0	0	
3:15 AM	0	0	
3:30 AM	0	0	
3:45 AM	0	0	
4:00 AM	0	0	
4:15 AM	0	0	
4:30 AM	0	0	
4:45 AM	0	0	
5:00 AM	0	0	
5:15 AM	0	0	
5:30 AM	0	0	
5:45 AM	19	3	
6:00 AM	50	5	
6:15 AM	89	10	
6:30 AM	131	13	
6:45 AM	198	13	
7:00 AM	274	22	
7:15 AM	330	32	
7:30 AM	366	35	
7:45 AM	280	30	
8:00 AM	173	19	
8:15 AM	78	7	
8:30 AM	0	0	
8:45 AM	0	0	
9:00 AM	0	0	
9:15 AM	0	0	
9:30 AM	0	0	
9:45 AM	58	12	
10:00 AM	125	20	
10:15 AM	190	32	
10:30 AM	254	41	
10:45 AM	252	52	
11:00 AM	275	56	
11:15 AM	288	53	
11:30 AM	301	57	
11:45 AM	335	48	

Hourly Vehicular Volume			
Hour Interval Beginning At	Major Street Combined Vehicles Per Hour (VPH)	Highest Minor Street Approach Vehicles Per Hour (VPH)	Hour Met?
12:00 PM	347	50	
12:15 PM	359	52	
12:30 PM	357	56	
12:45 PM	339	53	
1:00 PM	318	52	
1:15 PM	313	52	
1:30 PM	306	46	
1:45 PM	296	40	
2:00 PM	290	39	
2:15 PM	270	44	
2:30 PM	281	58	
2:45 PM	329	60	
3:00 PM	350	57	
3:15 PM	378	53	
3:30 PM	373	60	
3:45 PM	356	61	
4:00 PM	364	59	
4:15 PM	382	73	
4:30 PM	408	69	
4:45 PM	398	67	
5:00 PM	369	69	
5:15 PM	311	46	
5:30 PM	256	39	
5:45 PM	173	24	
6:00 PM	98	12	
6:15 PM	45	6	
6:30 PM	0	0	
6:45 PM	0	0	
7:00 PM	0	0	
7:15 PM	0	0	
7:30 PM	0	0	
7:45 PM	0	0	
8:00 PM	0	0	
8:15 PM	0	0	
8:30 PM	0	0	
8:45 PM	0	0	
9:00 PM	0	0	
9:15 PM	0	0	
9:30 PM	0	0	
9:45 PM	0	0	
10:00 PM	0	0	
10:15 PM	0	0	
10:30 PM	0	0	
10:45 PM	0	0	
11:00 PM	0	0	

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



MUTCD WARRANT 3, PEAK HOUR

Number of Lanes for Moving Traffic on Each Approach	
Major Street:	1 Lane
Minor Street:	1 Lane

Built-up Isolated Community With Less Than 10,000 Population or Above 40 MPH on Major Street?	No
Is this signal warrant being applied for an unusual case, 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?	Yes

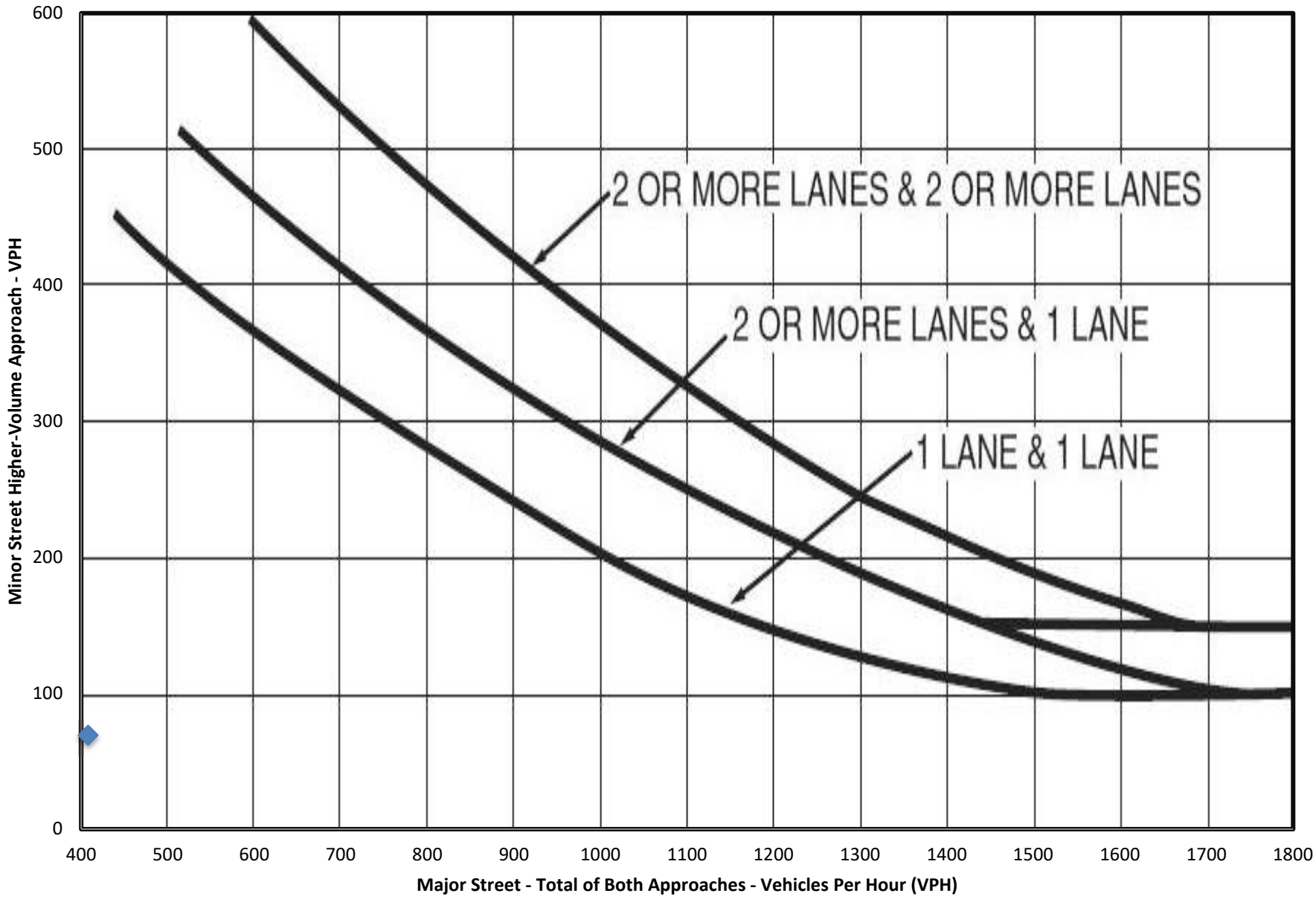
Indicate whether all three of the following conditions for the same 1 hour (any four consecutive 15-minute periods) of an average day are present*	
Does the total stopped time delay experienced by the traffic on one minor-street approach (one direction only) controlled by a STOP sign equal or exceed 4 vehicle-hours for a one-lane approach or 5 vehicle-hours for a two-lane approach?	No
Does the volume on the same minor-street approach (one direction only) equal or exceed 100 vehicles per hour for one moving lane of traffic or 150 vehicles per hour for two moving lanes?	No
Does the total entering volume serviced during the hour equal or exceed 650 vehicles per hour for intersection with three approaches or 800 vehicles per hour for intersections with four or more approaches?	No
**If applicable, attach all supporting calculations and documentation.*	

Total Number of Unique Hours Met On Figure 4C-3
0

Hourly Vehicular Volume			
Hour Interval Beginning At	Major Street Combined Vehicles Per Hour (VPH)	Highest Minor Street Approach Vehicles Per Hour (VPH)	Hour Met?
12:00 AM	0	0	
12:15 AM	0	0	
12:30 AM	0	0	
12:45 AM	0	0	
1:00 AM	0	0	
1:15 AM	0	0	
1:30 AM	0	0	
1:45 AM	0	0	
2:00 AM	0	0	
2:15 AM	0	0	
2:30 AM	0	0	
2:45 AM	0	0	
3:00 AM	0	0	
3:15 AM	0	0	
3:30 AM	0	0	
3:45 AM	0	0	
4:00 AM	0	0	
4:15 AM	0	0	
4:30 AM	0	0	
4:45 AM	0	0	
5:00 AM	0	0	
5:15 AM	0	0	
5:30 AM	0	0	
5:45 AM	19	3	
6:00 AM	50	5	
6:15 AM	89	10	
6:30 AM	131	13	
6:45 AM	198	13	
7:00 AM	274	22	
7:15 AM	330	32	
7:30 AM	366	35	
7:45 AM	280	30	
8:00 AM	173	19	
8:15 AM	78	7	

Hourly Vehicular Volume			
Hour Interval Beginning At	Major Street Combined Vehicles Per Hour (VPH)	Highest Minor Street Approach Vehicles Per Hour (VPH)	Hour Met?
8:30 AM	0	0	
8:45 AM	0	0	
9:00 AM	0	0	
9:15 AM	0	0	
9:30 AM	0	0	
9:45 AM	58	12	
10:00 AM	125	20	
10:15 AM	190	32	
10:30 AM	254	41	
10:45 AM	252	52	
11:00 AM	275	56	
11:15 AM	288	53	
11:30 AM	301	57	
11:45 AM	335	48	
12:00 PM	347	50	
12:15 PM	359	52	
12:30 PM	357	56	
12:45 PM	339	53	
1:00 PM	318	52	
1:15 PM	313	52	
1:30 PM	306	46	
1:45 PM	296	40	
2:00 PM	290	39	
2:15 PM	270	44	
2:30 PM	281	58	
2:45 PM	329	60	
3:00 PM	350	57	
3:15 PM	378	53	
3:30 PM	373	60	
3:45 PM	356	61	
4:00 PM	364	59	
4:15 PM	382	73	
4:30 PM	408	69	
4:45 PM	398	67	
5:00 PM	369	69	
5:15 PM	311	46	
5:30 PM	256	39	
5:45 PM	173	24	
6:00 PM	98	12	
6:15 PM	45	6	
6:30 PM	0	0	
6:45 PM	0	0	
7:00 PM	0	0	
7:15 PM	0	0	
7:30 PM	0	0	
7:45 PM	0	0	
8:00 PM	0	0	
8:15 PM	0	0	
8:30 PM	0	0	
8:45 PM	0	0	
9:00 PM	0	0	
9:15 PM	0	0	
9:30 PM	0	0	
9:45 PM	0	0	
10:00 PM	0	0	
10:15 PM	0	0	
10:30 PM	0	0	
10:45 PM	0	0	
11:00 PM	0	0	

MUTCD Figure 4C-3. Warrant 3, Peak Hour



MUTCD WARRANT 4, PEDESTRIAN VOLUME

Built-up Isolated Community With Less Than 10,000 Population or Above 35 MPH on Major Street?	No
15th Percentile Pedestrian Crossing Speed Less than 3.5 f/s?*	No
Is the distance to the nearest traffic control signal or STOP sign controlling the major street that pedestrians desire to cross less than 300 feet?	No
If the distance to the nearest traffic control signal or STOP sign controlling the major street that pedestrians desire to cross is less than 300 feet, will the proposed traffic control signal restrict the progressive movement of traffic?*	N/A
Total Number of Unique Hours Met for Criterion A:	**0**
Total Number of Unique Hours Met for Criterion B:	**0**

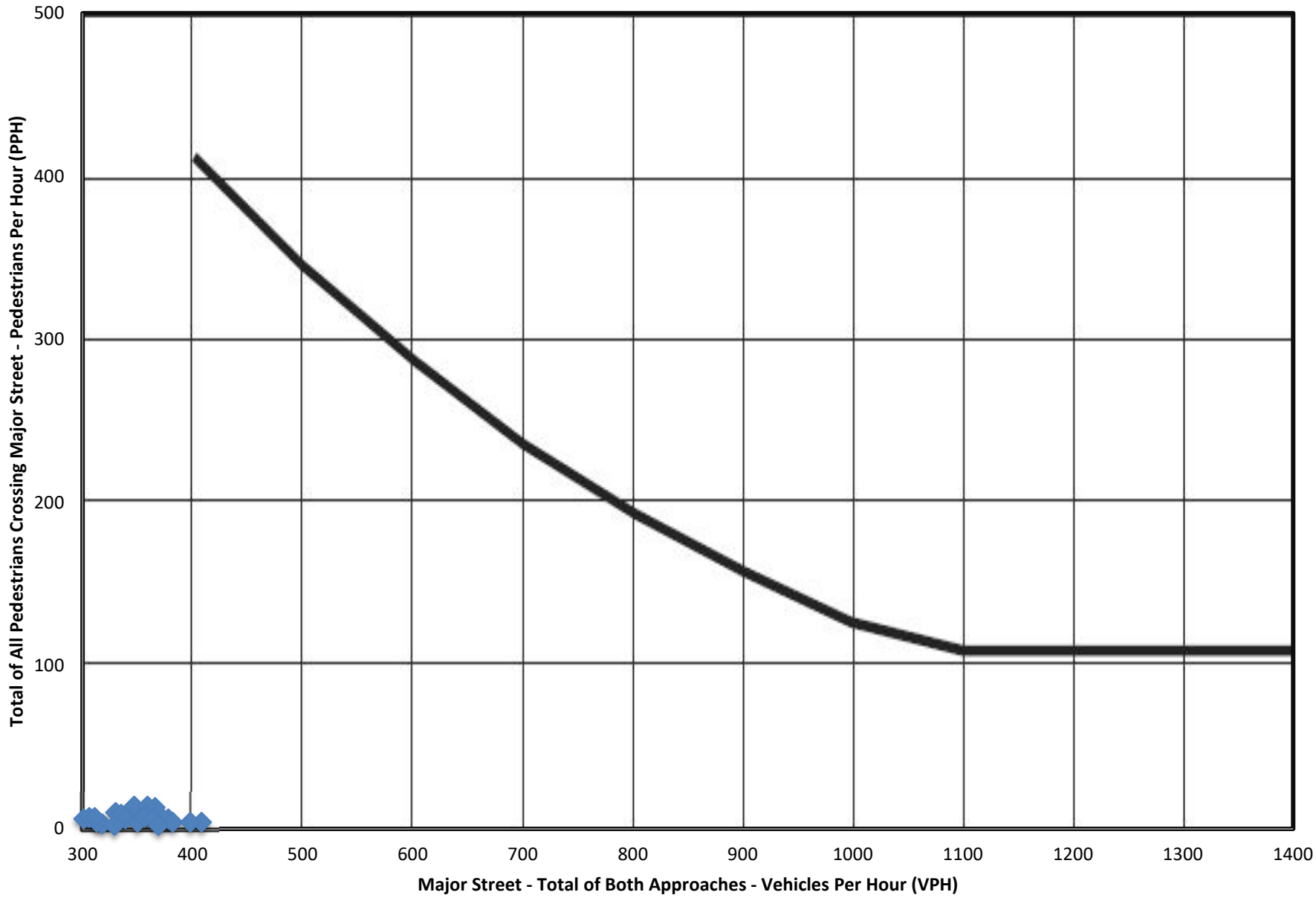
*If applicable, attach all supporting calculations, documentation, and findings.

*If applicable, attach supporting justification.

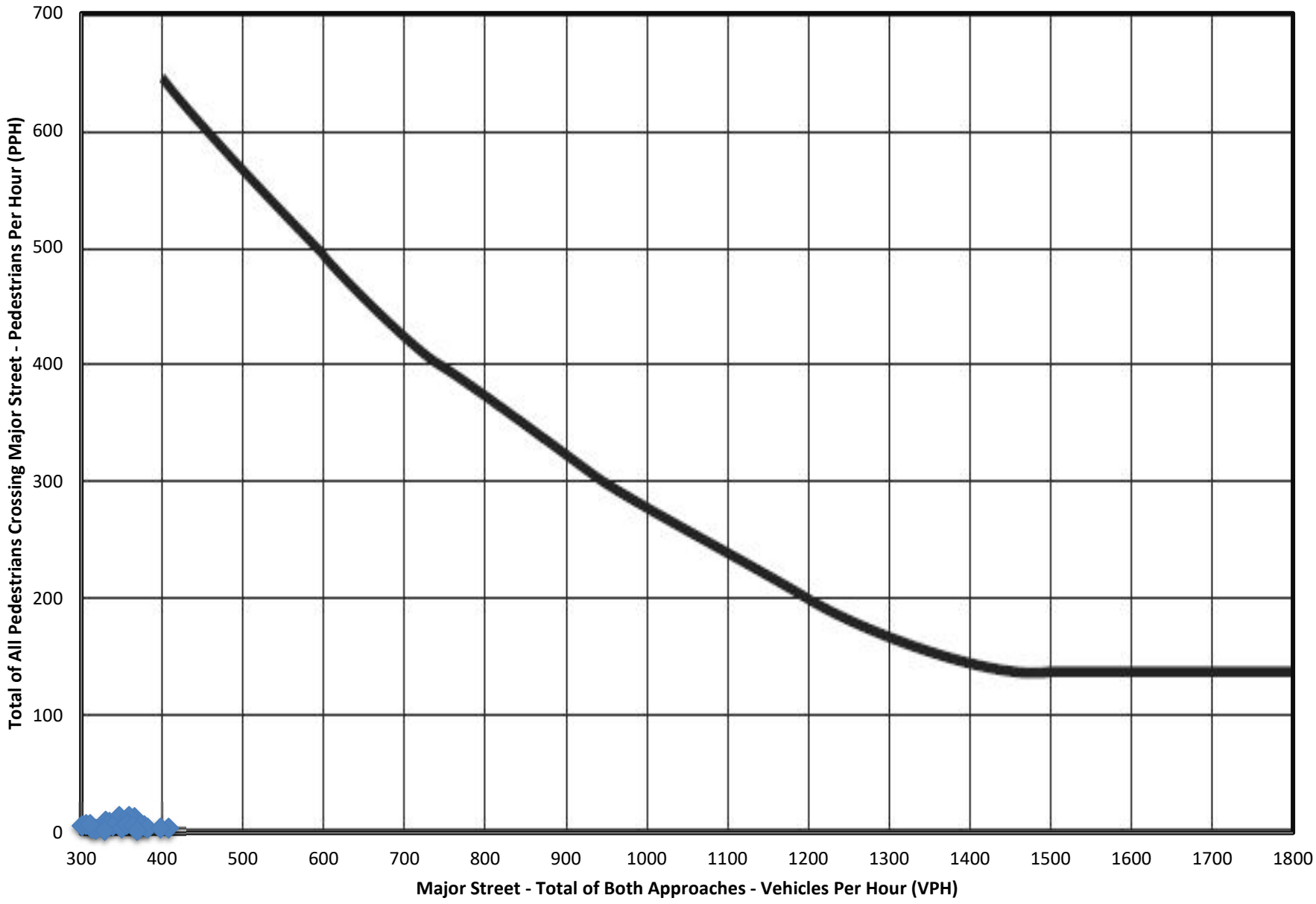
Hourly Vehicular & Pedestrian Volume				
Hour Interval Beginning At	**Major Street Combined Vehicles Per Hour (VPH)**	**Total of All Pedestrians Crossing Major Street Pedestrians Per Hour (PPH)**	**Criterion A: 4-Hour Hour Met on Figure 4C-5?**	**Criterion B: 1-Hour Hour Met on Figure 4C-7?**
12:00 AM	0			
12:15 AM	0			
12:30 AM	0			
12:45 AM	0			
1:00 AM	0			
1:15 AM	0			
1:30 AM	0			
1:45 AM	0			
2:00 AM	0			
2:15 AM	0			
2:30 AM	0			
2:45 AM	0			
3:00 AM	0			
3:15 AM	0			
3:30 AM	0			
3:45 AM	0			
4:00 AM	0			
4:15 AM	0			
4:30 AM	0			
4:45 AM	0			
5:00 AM	0			
5:15 AM	0			
5:30 AM	0			
5:45 AM	19	0		
6:00 AM	50	0		
6:15 AM	89	0		
6:30 AM	131	1		
6:45 AM	198	2		
7:00 AM	274	6		
7:15 AM	330	10		
7:30 AM	366	13		
7:45 AM	280	12		
8:00 AM	173	8		
8:15 AM	78	4		
8:30 AM	0			
8:45 AM	0			
9:00 AM	0			
9:15 AM	0			
9:30 AM	0			
9:45 AM	58	1		

Hourly Vehicular & Pedestrian Volume				
Hour Interval Beginning At	Major Street Combined Vehicles Per Hour (VPH)	Total of All Pedestrians Crossing Major Street Pedestrians Per Hour (PPH)	Criterion A: 4-Hour Hour Met on Figure 4C-5?	Criterion B: 1-Hour Hour Met on Figure 4C-7?
10:00 AM	125	3		
10:15 AM	190	3		
10:30 AM	254	4		
10:45 AM	252	3		
11:00 AM	275	1		
11:15 AM	288	2		
11:30 AM	301	6		
11:45 AM	335	9		
12:00 PM	347	14		
12:15 PM	359	14		
12:30 PM	357	9		
12:45 PM	339	6		
1:00 PM	318	3		
1:15 PM	313	4		
1:30 PM	306	7		
1:45 PM	296	11		
2:00 PM	290	10		
2:15 PM	270	8		
2:30 PM	281	5		
2:45 PM	329	2		
3:00 PM	350	4		
3:15 PM	378	6		
3:30 PM	373	6		
3:45 PM	356	7		
4:00 PM	364	6		
4:15 PM	382	4		
4:30 PM	408	4		
4:45 PM	398	4		
5:00 PM	369	2		
5:15 PM	311	7		
5:30 PM	256	9		
5:45 PM	173	7		
6:00 PM	98	7		
6:15 PM	45	2		
6:30 PM	0			
6:45 PM	0			
7:00 PM	0			
7:15 PM	0			
7:30 PM	0			
7:45 PM	0			
8:00 PM	0			
8:15 PM	0			
8:30 PM	0			
8:45 PM	0			
9:00 PM	0			
9:15 PM	0			
9:30 PM	0			
9:45 PM	0			
10:00 PM	0			
10:15 PM	0			
10:30 PM	0			
10:45 PM	0			
11:00 PM	0			

MUTCD Figure 4C-5. Warrant 4, Pedestrian Four-Hour Volume



MUTCD Figure 4C-7. Warrant 4, Pedestrian Peak Hour



Appendix C: MUTCD Multi-Way Stop-Control Application Warrant Criteria

Multi-Way Stop-Control Application Warrants

Multi-way stop-control application warrants are reviewed in accordance with guidance from the Manual on Uniform Traffic Control Devices (MUTCD) and considers both primary and optional guidance criteria.

Primary Guidance Criteria

Primary guidance on the application of multi-way stop-control applications is detailed in Section 2B.07 of the MUTCD. The primary criteria that should be considered in the engineering study for a multi-way stop sign installation include:

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.*

Optional Criteria

Optional criteria that may be considered in a multi-way stop sign installation 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 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.*

Appendix D: MUTCD ASWC Criteria Summary

5th Avenue & 5th Street Intersection (Base Condition)

ASWC Warrant Criteria

MUTCD No

MUTCD

Met?	Criteria
No	A. Is a signal justified? No
No	B. # of crashes in a 12 month period that can be corrected by multi-way stop control: 0
No	C. Minimum Volumes

1. Major road approach volume (total of both) at least 300 vph for min 8 hours?
2. Combined ped, bike, and veh volume on minor approach (total of both) at least 200 units per hour for the same 8 hours as criteria C-1?
3. If the 85th percentile speed on the major road exceeds 40 mph, may use 70% of the values in C-1 and C-2

Major Street 85th percentile mph: 25

Time Period	From	To	Major Road: Both App.	Minor Road: Both App. (VPH)	C-1	C-2	Both Met?	D (80%)		Both Met?
1	6:00	7:00								
2	7:00	8:00	274	44	No	No	No	Yes	No	No
3	8:00	9:00								
4	9:00	10:00								
5	10:00	11:00								
6	11:00	12:00	275	91	No	No	No	Yes	No	No
7	12:00	13:00	347	106	Yes	No	No	Yes	No	No
8	13:00	14:00	318	86	Yes	No	No	Yes	No	No
9	14:00	15:00	290	87	No	No	No	Yes	No	No
10	15:00	16:00	350	118	Yes	No	No	Yes	No	No
11	16:00	17:00	364	116	Yes	No	No	Yes	No	No
12	17:00	18:00	369	110	Yes	No	No	Yes	No	No
13	18:00	19:00								
14	19:00	20:00								
15	20:00	21:00								
16	21:00	22:00								

No D. Use when previous criteria have not been met:

If 80% minimum values of Criteria B, C-1, and C-2 (C-3 excluded) are satisfied, warrant is met.

Appendix E: Intersection Sight Distance Review

Case B – Intersections with Minor Road Stop-Control

- 5th Street: Eastbound (Left View)
- 5th Street: Eastbound (Right View)
- 5th Street: Westbound (Left View)
- 5th Street: Westbound (Right View)

Case F – Left Turns from the Major Road

- 5th Avenue: Northbound Left Turn
- 5th Avenue: Southbound Left Turn

Case B – Intersections Minor Road Stop-Control

Figure A: 5th Street - Eastbound (Left View)

Figure B: 5th Street - Eastbound (Right View)

Note: Right view sight triangle reflects larger Case B3 sight triangle

Figure C: 5th Street - Westbound (Left View)

Figure D: 5th Street - Westbound (Right View)
Note: Right view sight triangle reflects larger Case B3 sight triangle

Case F – Left Turns from the Major Road

Figure E: 5th Avenue - Northbound Left Turn

Figure F: 5th Avenue - Southbound Left Turn