Broadway Street Pedestrian Safety Study
Cass Street to 700 Feet North of Randall Avenue

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City of De Pere, Wisconsin

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1. Study Background

The City of De Pere has received complaints regarding pedestrian crossing safety and traffic speeds on Broadway Street between Cass Street and a point 700 feet north of Randall Avenue. These concerns include pedestrian crossing safety on Broadway Street, excessive traffic speeds along Broadway Street and the failure of drivers to obey traffic warning devices, including the flashing red flashing STOP signs on school buses picking up or dropping off students. The City has identified the following traffic management measures for evaluation as a part of this study:

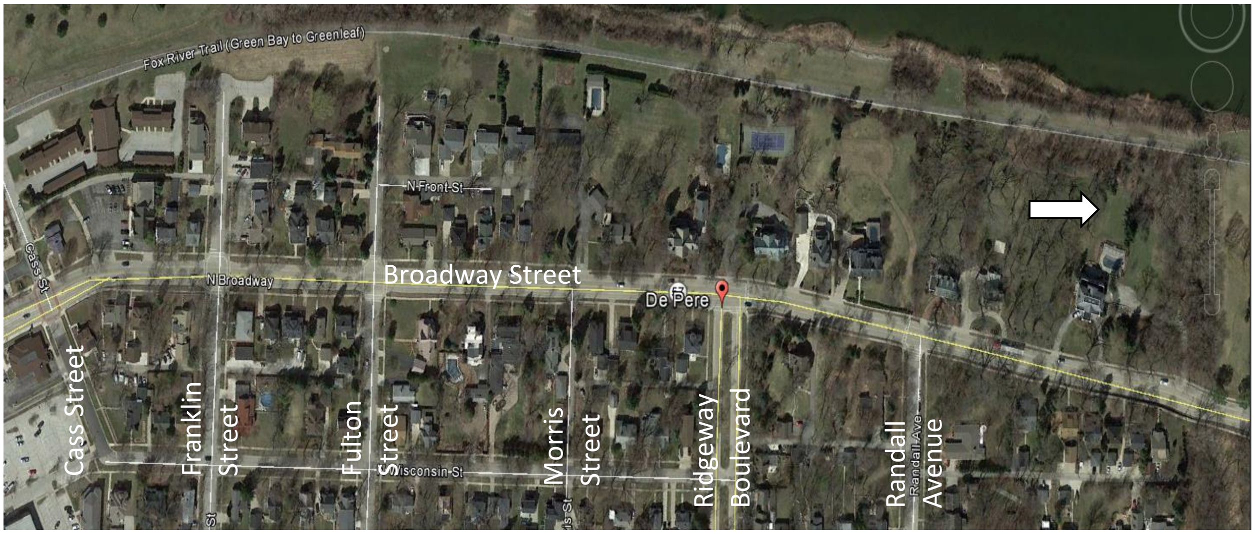
1. Traffic calming options for arterial streets
2. Use of rectangular rapid flashing beacons (RRFB)
3. Use of High-Intensity Activated Crosswalk (HAWK) beacons
4. Traffic signal installation at Broadway/Ridgeway intersection
5. Median pedestrian refuge crosswalk islands
6. Elimination of crosswalks to increase usage of other marked crosswalks
7. Modifications to crosswalk striping patterns

This report has been prepared to identify existing pedestrian and traffic conditions along the study segment of Broadway Street, provide analysis of the traffic management measures listed above, and to recommend pedestrian safety enhancements and traffic speed management controls on Broadway Street. Included in the Appendix of this report is a policy for a city-wide crosswalk location evaluation process.

2. Existing Conditions

For reference purposes, Figure 1 shows the study segment of Broadway Street.

Figure 1: Broadway Street Pedestrian Safety Study Corridor



a. Roadway Design/Traffic Controls

The study segment of Broadway Street is a 44-foot wide, 4-lane arterial street, with a posted 25 mph speed limit. The posted speed limit north of the study segment is 35 mph. On-street parking is not allowed along the study segment of Broadway Street. According to 2015 traffic counts taken by the Wisconsin Department of Transportation (WisDOT), Broadway Street carries 13,000 vpd south of James Street and 17,600 vpd north of Randall Avenue. Ridgeway Boulevard east of Broadway Street carries 3,800 vpd.

Intersection spacing along the Broadway Street study corridor is listed below on Table 1.

Table 1: Broadway Street Intersections

Intersection	Spacing	Crosswalk
Cass Street	--	Yes
Franklin Street	380 ft.	Yes
Fulton Street	350 ft.	Yes
Morris Street	440 ft.	No
Ridgeway Boulevard	350 ft.	Yes
Randall Avenue	430 ft.	Yes

Each of these intersections has marked crosswalks on Broadway Street except at Morris Street. The crosswalk marking patterns range from colored crosswalks at Cass Street to diagonal 'Zebra' style markings at Randall Avenue with the other crossings marked with two standard parallel white lines.

b. Pedestrian/Traffic Gap Data

The *Manual on Traffic Control Devices* (MUTCD) provides national standards for the use of all traffic control devices. The MUTCD requires specific analysis of traffic/pedestrian volumes and traffic gap availability in the study of pedestrian crossing safety enhancements. Accordingly, the City of De Pere requested that Ayres Associates collect traffic volume, pedestrian counts and traffic gap distribution data at the Broadway Street intersections with Randall Avenue and with Ridgeway Boulevard. Traffic gaps can be qualified as a 'combined' gap when simultaneous gaps occur in both directions of traffic or as 'individual' gaps when gaps are only available in one direction of traffic flow. Tables 2 and 3 summarize the pedestrian and traffic gap data.

Table 2: Pedestrian Two-Way North/South 'Combined' Traffic Gap Summary

*** Randall Avenue Intersection**

Time Period	Gaps Greater Than 14 Seconds Wed. 10/12/16	Gaps Greater Than 14 Seconds Thur. 10/13/16	Number of Pedestrians* Wed/Thur.		Hourly Volume Wed./Thur.
7:00 – 8:00 AM	11	9	1	1	1,340/1,420
7:30 – 8:30 AM	14	12	0	6	
8:00 – 9:00 AM	36	28	0	9	880/910
Total	45	39	1	16	
	Tues. 10/11/16	**Thur. 10/13/16**			
2:30 – 3:30 PM	21	19	0	0	
3:00 – 4:00 PM	13	20	0	0	1,300/1,240
3:30 – 4:30 PM	8	15	0	0	
4:00 – 5:00 PM	7	16	0	0	1,540/1,480
4:30 – 5:30 PM	7	21	1	0	
Total	36	55	1	0	

*** Ridgeway Boulevard Intersection**

Time Period	Gaps Greater Than 14 Seconds Wed. 10/12/16	Gaps Greater Than 14 Seconds Thur. 10/13/16	Number of Pedestrians* Wed/Thur.		Hourly Volume Wed./Thur.
7:00 – 8:00 AM	21	24	1	0	1,160/1,230
7:30 – 8:30 AM	19	21	0	0	
8:00 – 9:00 AM	39	39	0	0	830/830
Total	58	63	1	0	
	Tues. 10/11/16	**Thur. 10/13/16**			
2:30 – 3:30 PM	25	13	0	0	
3:00 – 4:00 PM	13	14	0	0	1,280/1,220
3:30 – 4:30 PM	11	18	0	0	
4:00 – 5:00 PM	7	13	0	0	1,490/1,450
4:30 – 5:30 PM	5	11	0	0	
Total	36	42	0	0	

Note: * Traffic gap data, pedestrian and traffic counts were all collected on the same days.
Weather Conditions: October 11th – partly cloudy/72 degrees
October 12th – cloudy/61 degrees
October 13th – cloudy/48 degrees

Based on the 44-foot curb-to-curb width of Broadway Street it is calculated that a pedestrian requires a 'combined' two-way gap in northbound and southbound traffic of 12.6 to 14.7 seconds at a walking speed of 3.5 to 3.0 feet per second, respectively, to safely cross Broadway Street in accordance with the MUTCD. The 14.7 second traffic gap time reflects the slower walking speeds of some elderly and physically disabled citizens.

Randall Avenue: As shown on Table 2, the minimum number of 'combined' traffic gaps exceeding 14 seconds at Randall Avenue was 9 during the morning 7:00 to 8:00 AM time period compared to 7 acceptable gaps during the 4:30 to 5:30 PM time period. As also shown on Table 2, the number of pedestrians crossing Broadway Street during a one-hour time period reaches a maximum of 9 pedestrians during the morning 8:00 to 9:00 AM time period with only 1 pedestrian crossing Broadway Street during the 3-hour evening 2:30 to 5:30 PM time period.

Ridgeway Boulevard: In comparison, at the Ridgeway Boulevard intersection the minimum number of 'combined' traffic gaps greater than 14 seconds was 19 during the 7:30 to 8:30 AM morning time period and 5 during the 4:30 to 5:30 PM evening time period. There was only 1 pedestrian observed crossing Broadway Street during the morning time period with no pedestrians observed during the 3-hour afternoon time period. The traffic gap and pedestrian count data was relatively consistent during both survey days.

The data summary from Table 2 assumes a pedestrian needs to completely cross Broadway Street in a single stage. If Broadway Street was constructed with pedestrian refuge median islands then a pedestrian would only be required to cross one direction of traffic at a time requiring a reduced 'individual' one-way traffic gap of 8 seconds or greater. Table 3 provides a summary of 'individual' traffic gaps in north and southbound traffic.

Table 3: Pedestrian North and South 'Individual' Traffic Gap Summary

*** Randall Avenue Intersection**

	Gaps Greater Than 8 Seconds	
	Wed. 10/12/16	**Thur. 10/13/16**
Time Period	**Northbound/Southbound**	**Northbound/Southbound**
7:00 – 8:00 AM	100/116	86/127
8:00 – 9:00 AM	143/146	129/153
	Tues. 10/11/16	**Thur. 10/13/16**
2:30 – 3:30 PM	121/139	147/138
3:30 – 4:30 PM	126/130	127/137
4:30 – 5:30 PM	126/100	114/116

Table 3: Pedestrian North and South 'Individual' Traffic Gap Study Summary (continued)

*** Ridgeway Boulevard Intersection**

	Gaps Greater Than 8 Seconds	
	Wed. 10/12/16	**Thur. 10/13/16**
Time Period	**Northbound/Southbound**	**Northbound/Southbound**
7:00 – 8:00 AM	133/133	116/134
8:00 – 9:00 AM	144/146	148/151
	Tues. 10/11/16	**Thur. 10/13/16**
2:30 – 3:30 PM	115/132	113/125
3:30 – 4:30 PM	130/126	140/119
4:30 – 5:30 PM	124/89	122/104

As shown on Table 3, the minimum number of acceptable gaps per hour exceeding 8 seconds for a pedestrian to safely cross northbound traffic at Randall Avenue was 86 gaps on Thursday, November 13th with 116 acceptable gaps in southbound traffic during the 7:00 AM to 9:00 AM morning time period on Wednesday, November 12th. During the evening 2:30 PM to 5:30 PM time period the minimum number of hourly gaps exceeding 8 seconds was 114 gaps in northbound traffic on Thursday, November 13th with 100 gaps in southbound traffic on Tuesday, November 11th.

In comparison, at the adjacent Ridgeway Boulevard intersection there were 116 northbound gaps on Thursday, November 13th with 133 acceptable gaps in southbound traffic on Wednesday, November 12th during the morning 7:00 AM to 9:00 AM time period. During the evening 2:30 PM to 5:30 PM time period the minimum number of hourly gaps exceeding 8 seconds was 113 gaps in northbound traffic on Thursday, November 13th with 89 gaps in southbound traffic on Tuesday, November 11th.

c. Ridgeway Boulevard Intersection Traffic Operation

A peak hour traffic analysis was conducted for the Broadway Street intersection with Ridgeway Boulevard. Intersection operation is defined by Level of Service (LOS) ratings of 'A' through 'F'. Level of Service 'A' is associated with no traffic delays or intersection queuing, whereas LOS 'F' represents gridlock conditions where the volume entering an intersection exceeds the intersection capacity. Urban intersections are typically designed to operate at LOS 'C' or LOS 'D' conditions. Table 4 summarizes the LOS operation for the Ridgeway Boulevard intersection during the morning and evening peak hour time periods.

Table 4: Existing Peak Hour Operation of the Broadway Street Intersection with Ridgeway Boulevard

	Southbound		Northbound		Westbound	
Time Period	Left Turn	Through	Right Turn	Through	Left Turn	Right Turn
Morning Peak Hour	A	A	A	A	D	B
Evening Peak Hour	A	A	A	A	F	B

As shown on Table 4, all morning peak hour intersection traffic movements are operating at Level of Service ‘D’ or better with LOS ‘A’ operation on Broadway Street. In comparison, during the evening peak hour the westbound left turn movement from Ridgeway Boulevard onto Broadway Street operates at LOS ‘F’.

d. Traffic Speeds

At the request of the City of De Pere, the WisDOT collected traffic speed information on Broadway Street at its intersection with Randall Avenue, which has a posted speed limit of 25 mph. This data, collected in August 2015, indicates that the existing average speed was 30.3 mph with an 85th percentile speed of 34.5 mph and a maximum measured speed of 39 mph. (It is noted that the 85th percentile speed value is frequently used as a criteria to determine posted speed limits.)

The WisDOT also collected Broadway Street speed data north of the North City Limit in November, 2015. According to the WisDOT data, the average traffic speed on Broadway Street was 38.4 mph, which the WisDOT considers to represent moderate compliance with the posted 35 mph speed limit. The WisDOT data also indicates that the 85th percentile speed was 42.1 mph with a maximum measured speed of 50 mph. The WisDOT concluded that reducing the speed limit to 25 mph north of the City Limit could be expected to increase driver non-compliance with the posted speed limit to 95%, expressing concern that lowering the speed limit would increase the variance in vehicle speeds resulting in an increased number of vehicle crashes on Broadway Street.

e. Traffic Safety

According to a WisDOT 7-year time period review of traffic crashes on Broadway Street between 2010 and 2016, the study segment crash rate was 79 crashes per 100 million vehicle miles. This is below the most recent statewide average rate of 87. A detailed review of the crash data during that 7-year time period conducted by Ayres Associates is summarized on Table 5.

Table 5: Broadway Street Intersection Crash Summary: 2010-2016

	Total	Property		Collision Type		
Intersection	Crashes	Damage	Injury	Rear End	Object	Other
Randall Avenue	9	8	1	4	1	4
Cass Street	6	6	0	2	2	2
Ridgeway Boulevard	1	0	1	0	0	1
Total	16	14	2	6	3	7

As shown on Table 5, the only intersections with reported crashes between 2010 and 2016 involved Randall Avenue with 9 crashes, Cass Street with 6 crashes and Ridgeway Boulevard with 1 crash. Only two crashes resulted in personal injuries with the other 14 crashes resulting in property damage only. The predominant collision type, 38 percent, involved rear-end collisions between vehicles.

f. Existing Condition Summary

It is concluded from the analysis of existing conditions along the study segment of Broadway Street that:

1. The number of pedestrians observed crossing Broadway Street at its intersections with Randall Avenue and Ridgeway Boulevard were very low reaching a high of 9 pedestrians at the Randall Avenue intersection during the 8:00 AM to 9:00 AM time period. Formal public access points to the Fox River Trail are provided at Cass Street and south of Rose Lawn Boulevard north of the City Limit.

2. According to the *Manual on Uniform Traffic Control Devices* guidelines, a minimum two-way ‘combined’ traffic gap of 14 seconds is required for a pedestrian to safely cross Broadway Street. Based on traffic gap data collected in October there are a minimum of 9 gaps exceeding 14 seconds during the morning 7:00 AM to 8:00 AM time period and a minimum of 7 gaps exceeding 14 seconds during the evening 4:30 PM to 5:30 PM peak traffic time period at the Randall Avenue intersection.

   At Ridgeway Boulevard the 14 second gap availability is fairly similar with a minimum of 19 gaps exceeding 14 seconds during the morning 7:30 AM to 8:30 AM time period with 5 gaps exceeding 14 seconds during the evening 4:30 PM to 5:30 PM time period.

   The maximum number of pedestrians observed crossing Broadway Street at Randall Avenue during the morning peak traffic time period was 9 during the 8:00 AM to 9:00 AM time period. During the 3-hour afternoon time period between 2:30 PM to 5:30 PM only one pedestrian was observed crossing Broadway Street at Randall Avenue.

   Even though the number of acceptable traffic gaps exceeds the number of pedestrians, this data indicates pedestrians desiring to cross Broadway Street can be required to wait for acceptable gaps to safely cross the street.

3. Analysis of peak hour traffic operating conditions indicates westbound left turns from Ridgeway Boulevard are experiencing delays and Level of Service ‘F’ operation during the evening peak traffic period. All other traffic movements are operating at acceptable levels.

4. Based on a year 2015 traffic speed study conducted by the WisDOT, current Broadway Street traffic speeds at Randall Avenue average 30 mph with 85 percent of drivers traveling at or below 34 mph. The maximum speed measured was 39 mph.

5. Over the 7-year time period between 2010 to 2016, a total of 16 crashes were reported on the study segment of Broadway Street with 9 crashes reported at Randall Avenue, 6 crashes reported at Cass Street and 1 crash reported at Ridgeway Boulevard. Only two crashes involved injuries with the predominant collision pattern involving rear-end collisions. No other traffic crashes were reported at the other study intersections.

3. Traffic Management Measures for Arterial Streets

Traffic calming is typically reserved for neighborhood streets with low traffic volumes and speeds. The purpose of neighborhood traffic calming is directed at reducing traffic speeds and discouraging cut-through traffic on neighborhood streets. Traffic calming tools for neighborhood streets typically include the use speed tables, intersection traffic circles, narrowed lanes and access restrictions such as construction of partial traffic diverters, mid-block center islands or curb extensions and cul-de-sacs.

In comparison, arterial streets are typically designed to operate at higher speeds ranging between 25 to 35 mph and carry significantly higher traffic volumes accommodating both local and through traffic patterns. It has been recognized in national studies that motorists will travel at the speed they feel is safe and appropriate within the adjacent land use context and street design. In order to tame (calm) traffic operation on arterial streets to create a pedestrian friendly environment it is necessary to evaluate selected neighborhood traffic calming tools as well as additional management measures designed to calm traffic speeds. Selected arterial traffic 'taming' and pedestrian safety measures are described below:

a. Speed Feedback Signs

Speed feedback signs may be permanently located on arterial street segments with documented traffic speeding conditions. These signs are designed to measure oncoming traffic speeds and indicate to drivers when they exceed the speed limit by flashing their speed in red numbers. In many cases the use of speed feedback signs have been shown to reduce traffic speeds by approximately 5 mph. The typical cost of a single speed feedback sign with a solar powered display is $6,000. Figure 2 illustrates a typical radar speed feedback sign assembly.

Figure 2: Typical Radar Speed Feedback Sign

This traffic taming measure is considered an effective tool to manage traffic speeds on Broadway Street.

b. Lane Narrowing

Reducing the width of traffic lanes through the use of pavement markings has been shown to lower traffic speeds as drivers feel more restricted along a roadway. According to the ITE/CNU* *Designing Walkable Urban Thoroughfare* report, arterial street lane widths can be as narrow as 10-feet without impacting traffic capacity or safety. Before/after studies indicate that traffic speeds can be reduced by approximately 2 mph by narrowing existing 12-foot wide traffic lanes. Typical pavement marking costs are approximately $1 per foot.

This measure is not considered a viable tool to reduce traffic speeds on Broadway Street due to its existing narrower 11-foot wide traffic lanes and designation as a truck route.

*Institute of Transportation Engineers/Congress for the New Urbanism (ITE/CNU)

c. Corner Turn Radii

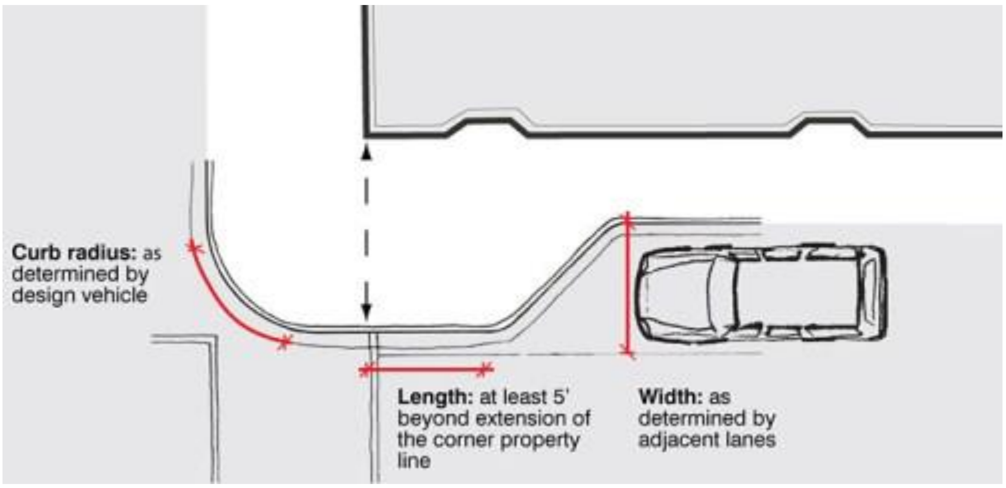
It has been shown that drivers will make slower speed right turns when corner curb radii are constructed with a small turning radius. Typical urban street corner radii should be designed with a 10 to 15-foot radius. The smaller radius also provides a benefit to pedestrians by reducing their walking distance to cross a street and is more accommodating for the design of standard Americans with Disabilities Act (ADA) curb ramp requirements. The cost of reconstructing existing curb radii and ADA ramps is estimated at approximately $15,000 per corner.

This traffic management measure is not considered a viable tool for Broadway Street as most intersection curb radii are constructed with an approximate 15 to 20-foot radius. It is noted that some existing corner curbs include a slight taper to reduce truck turning conflicts with oncoming traffic on Broadway Street.

d. Curb Extensions

Construction of corner curb extensions, as shown in Figure 3, can effectively narrow overall roadway widths at their approaches to intersections thereby shortening the distance for pedestrians to cross the street.

Figure 3: Typical Curb Extension



Corner curb extensions often are used to protect on-street parking areas and have the ability to provide opportunities for downtown streetscape enhancements. The cost of reconstructing existing curb radii for a corner curb extension is approximately $15,000 per corner.

This traffic management measure is not considered a viable tool on the study segment of Broadway Street due to the need to maintain 4 through traffic lanes.

e. Median Islands

Figure 4 shows a typical median pedestrian refuge island design. Median pedestrian refuge islands can be constructed with a minimum width of 4-feet to provide a protected area for pedestrians crossing a street. It is desirable to provide a 6-foot median width to maximize safety for groups of pedestrians and children crossing a street.

Figure 4: Typical Pedestrian Median Refuge Island

Construction of pedestrian median refuge islands serve two major purposes. The first purpose of a pedestrian median refuge island is its ability to allow a pedestrian to find a gap in one direction of traffic at a time as compared to requiring a ‘combined’ two-way gap to safely cross the street. The second purpose of a pedestrian median refuge island is to reduce traffic speeds by providing a physical indication of a narrow traffic lane on the driver’s side of a vehicle. The cost of reconstructing a pedestrian median refuge island on Broadway Street is estimated at $25,000 each as it requires a minimum 2-foot set-back of the existing curb approaches to the intersection.

This traffic management measure, based on existing traffic gap data, is considered an important tool for enhancing pedestrian safety on Broadway Street.

f. Gateway Treatments

Gateway treatments usually consist of enhanced ground mounted signs, landscaping treatments or physical columns located adjacent to a street edge or median to notify drivers that they are entering a higher pedestrian urban area context to reduce speeds. Figures 5 and 6 illustrate gateway treatment examples. The cost of gateway construction can range from $20,000 to $50,000 depending on the complexity of the design.

Figure 5: Gateway Column Example

Figure 6: Gateway Signage Example

The existing land use context along Broadway Street changes dramatically at the northern limit of this study. Broadway Street north of the City Limit reflects a suburban development pattern with large building setbacks, surface parking lots and a lack of street related landscaping. In comparison, the segment of Broadway Street from 700 feet north of Randall Avenue to Cass Street represents a rich historic City of De Pere development context with residential homes and mature curb side tree landscaping.

This traffic management measure is considered a viable tool to reinforcing driver awareness of the changing land use conditions at 700 feet north of Randall Avenue compatible with an appropriate lower traffic speed and higher pedestrian activity.

g. Landscaping

One of the most noticeable impacts to a drivers' perception of reasonable driving speeds involves the presence of landscaping along a street or in the median. Figure 7 illustrates an urban street landscaping design.

Figure 7: Urban Street Landscaping Example

Landscaping treatments affect a motorist's sense of comfort and appropriate speed as well as its ability to enhance the pedestrian friendliness atmosphere of a street. The majority of Broadway Street is lined with mature trees except for the segment north of the study limit. The cost of street landscaping can vary widely depending on the extent of tree plantings and other related treatments such as flower beds and hardscape treatments.

Based on the extent of current landscaping from Cass Street to 700 feet north of Randall Avenue, this is not considered to be an effective traffic management measure for the study segment of Broadway Street.

h. In-Street Pedestrian Crossing Signs

In-street pedestrian crossing signs, as shown on Figure 8, provide an effective tool to inform drivers of Wisconsin State Statute requirements to yield to pedestrians in a crosswalk.

Figure 8: In-Street Pedestrian Crossing Sign

In-street pedestrian crossing signs can provide an added benefit of taming traffic speeds by creating a narrow lane perception to drivers. The estimated cost per sign is $350.

An option to placing these signs in the roadway is to mount them on a curbside pole used to support a pedestrian crosswalk sign. The signs would need to be placed as double sided signs facing both directions of traffic on the east and west sides of Broadway Street due to the four-lane operation of Broadway Street.

An additional option to the ‘In-Street’ sign placement (MUTCD R1-6) is to mount the sign (in this case MUTCD R1-9) on an overhead mast arm as shown as shown on Figure 9. The overhead mounting eliminates the need to remove ‘Yield to Pedestrian’ signs under winter weather conditions. The overhead sign placement increases sign visibility, particularly on 4-lane streets. Placement of overhead mast arm signs may present a conflict with the nature of the historic district along Broadway Street. The estimated cost per sign, including the overhead sign pole, is $3,500.

Figure 9: Overhead 'Yield to Pedestrians in Crosswalk' Sign

The current use of in-street 'Yield to Pedestrians in Crosswalk' signs should be continued on Broadway Street, even during winter snow conditions with consideration given to installing the signs on overhead mounting poles to increase their effectiveness along the 4-lane segment of Broadway Street or to construct median pedestrian refuge islands on Broadway Street where the 'Yield to Pedestrians' signs can be located within the refuge island and the pedestrian crossing sign poles to eliminate the winter snow conflict issue.

i. Pedestrian Crosswalk Rectangular Rapid Flashing Beacons (RRFB)

RRFB's are a traffic control device that combines a pedestrian warning sign with pedestrian activated yellow flashing light diodes as shown on Figure 10. The flashing lights remain dark until activated by a pedestrian push button.

Figure 10: Pedestrian Crossing Rectangular Rapid Flashing Beacon (RRFB)

RRFB’s can enhance pedestrian safety by reducing crashes between vehicles and pedestrians at unsignalized intersections and mid-block pedestrian crossings. According Federal Highway Administration (FHWA) research, installing RRFB’s at a marked crosswalk can increase driver yielding to pedestrian patterns to between 80% and 100%.

RRFB signs and markings have been used to reduce the incidence of ‘multiple-threat’ crashes at crosswalks on multi-lane roads (i.e., crashes where a vehicle in one lane stops to allow a pedestrian to cross the street while a vehicle in the adjacent lane, traveling in the same direction, strikes the pedestrian because the pedestrian visibility was blocked by the stopped vehicle.). RRFB’s should be installed as double sided signs to face both directions of traffic providing a flashing indication to drivers traveling in both directions with signs along both the east and west sides on the street. The WisDOT *Traffic Guidelines Manual,* Section 4-5-2 indicates that RRFB’s may be considered based on the following criteria:

1. Location is an uncontrolled pedestrian crossing.
2. Minimum volume* thresholds should be met:
    a. 20 or more pedestrians during a single hour (any four consecutive 15-minute time periods) of an average day, or
    b. 18 or more pedestrians during each of any two hours of an average day, or
    c. 15 or more pedestrians during each of any three hours of an average day.

    *Young (<12), elderly (>85) and disabled pedestrians count 2X toward volume thresholds. Additionally, seasonal day volumes can be used in place of average day volumes if the crossing is a known tourist area.
3. A minimum vehicle volume of 1,500 vehicles per day.

4. Maximum of four lanes crossed, unless there is a raised median, in which case it can be five lanes.
5. There exists a minimum of 300 feet between the subject crossing and the nearest controlled pedestrian crossing or intersection traffic control device on the state trunk highway system. Consideration should be given to extending this distance beyond 300 feet if the proposed crosswalk location falls within an auxiliary turn lane for the nearby intersection or if the standing queue from the intersection extends over the proposed crosswalk location.
6. The approach speed is posted at 40 mph or less.
7. Adequate stopping sight distance exists based on FDM 11-10-5 or greater than 8 times the posted speed limit.

Based on existing pedestrian count data the criteria for installing a RRFB on Broadway Street are not satisfied.

RRFB cost is approximately $10,000 to $15,000 for purchase and installation of two units (one on either side of a street). This traffic management measure is considered an effective tool to increasing pedestrian safety on Broadway Street.

j. High-Intensity Activated Crosswalk (HAWK) Beacons

The High-Intensity Activated Crosswalk (HAWK) beacon is designed to assist pedestrians crossing high traffic volume streets. The HAWK beacon is a push-button pedestrian activated red signal that stops traffic, allowing pedestrians to cross and is shown on Figure 11.

Figure 11: Pedestrian Crossing Hybrid HAWK Beacon

The HAWK beacon is comprised of a yellow beacon centered below two red beacons that remain dark until activated by a pedestrian push button. Once activated by a pedestrian, the beacon flashes yellow for a few seconds, followed by a solid yellow indication with the yellow indication followed by a solid red indication during the WALK phase. At the end of the WALK phase the HAWK beacon will display an alternating flashing red indication allowing motorists to proceed after stopping and yielding to pedestrians. Once the pedestrian clearance interval is completed the beacon returns to a dark mode. The HAWK beacon only controls traffic on one side of an intersection. Side street traffic is controlled by STOP signs.

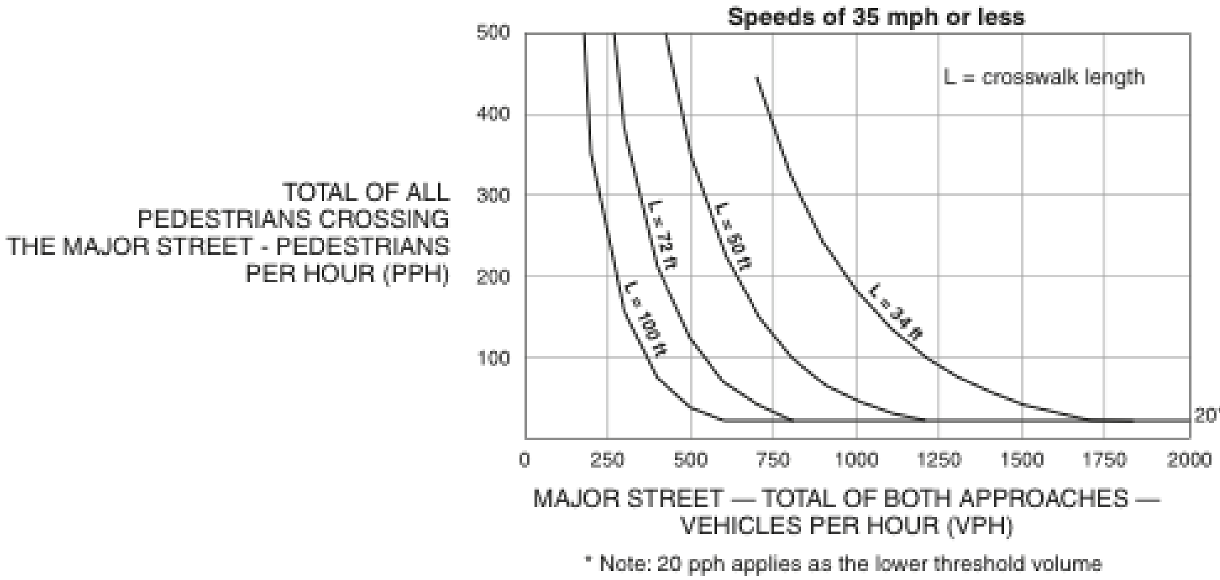
HAWK beacons can be evaluated for marked crosswalk locations with significant pedestrian demand that satisfy the *Manual on Uniform Traffic Control Devices* (*MUTCD)* traffic speed and volume warrants. In general, they should be used if:

1. There are an insufficient number of gaps in traffic to permit pedestrians to cross;
2. Vehicle speeds on the major street are too high to permit pedestrians to cross safely; or
3. Pedestrian delay is excessive.

Bus stop and school crossings are frequently good locations to consider HAWK beacons.

Figure 12 from the *MUTCD* identifies threshold criteria for the installation of HAWK beacons, shown with curves, for various crosswalk lengths based on the number of pedestrians and traffic volume for streets with traffic speeds of 35 mph or less. If pedestrian and traffic volumes exceed the threshold curve criteria, a HAWK beacon may be considered.

Figure 12: MUTCD Recommended Traffic Thresholds for HAWK Beacon Consideration



Installation of HAWK beacons has been shown to provide the following safety benefits:

- Up to a 69 percent reduction in pedestrian crashes; and
- Up to a 29 percent reduction in total roadway crashes

Based on an evaluation of Broadway Street traffic volume data at its intersections with Randall Avenue and with Ridgeway Boulevard the highest two-way hourly volume on Broadway Street is 1,540 vph as previously shown on Table 2. According to the *MUTCD* graph shown in Figure 12, a 44-foot wide roadway with a volume of 1,540 vph should have a minimum hourly volume of 20 pedestrians to consider installation of a HAWK beacon. This requirement is not satisfied along Broadway Street.

The estimated cost of a HAWK beacon is approximately $80,000 including installation.

k. Traffic Signal Installation at Broadway/Ridgeway Intersection

National warrants have been developed by the Federal Highway Administration (FHWA) to evaluate where traffic signals are an appropriate intersection traffic control measure. Unwarranted signals have been shown to increase crashes, traffic delays and lead to disregard for other warranted traffic control devices. These National warrants have been adopted by the WisDOT and are described in detail in the *MUTCD.* The evaluation of these warrants requires a Traffic Engineering Study to determine if a traffic signal is appropriate.

The following defines the traffic signal evaluation criteria requirements of a Traffic Engineering Study:

1. Collect 12-hour counts of traffic movements entering an intersection
2. Identify pedestrian volumes on each crosswalk
3. Identify nearby uses that may serve young, elderly or persons with disabilities
4. Identify posted speed limits
5. Prepare a ‘condition diagram’ of existing intersection geometrics, bus stops, parking, pavement markings, railroad crossings and distance to nearest traffic signals
6. Prepare a crash collision diagram
7. Identify vehicle hours of stopped delay, major street traffic gaps, pedestrian delay and queue length on stop controlled approaches

Fundamentally, there are nine basic traffic signal warrants that are related to hourly traffic volume levels, crash patterns, pedestrian levels, school and railroad crossings, progressive traffic flow, and signal systems.

Eight and Four-Hour Traffic Volume Warrants: These two principle signal warrants consider the number of intersection traffic lanes and the minimum hourly intersection approach volume thresholds that should be exceeded during eight or four hours of a day (the hours do not have to be consecutive hours). Table 6 and Figure 13 summarize the intersection requirements to satisfy the Eight and Four-Hour Traffic Volume Warrants.

Table 6: *MUTCD* Eight- Hour Vehicular Volume Warrant

Condition A—Minimum Vehicular Volume

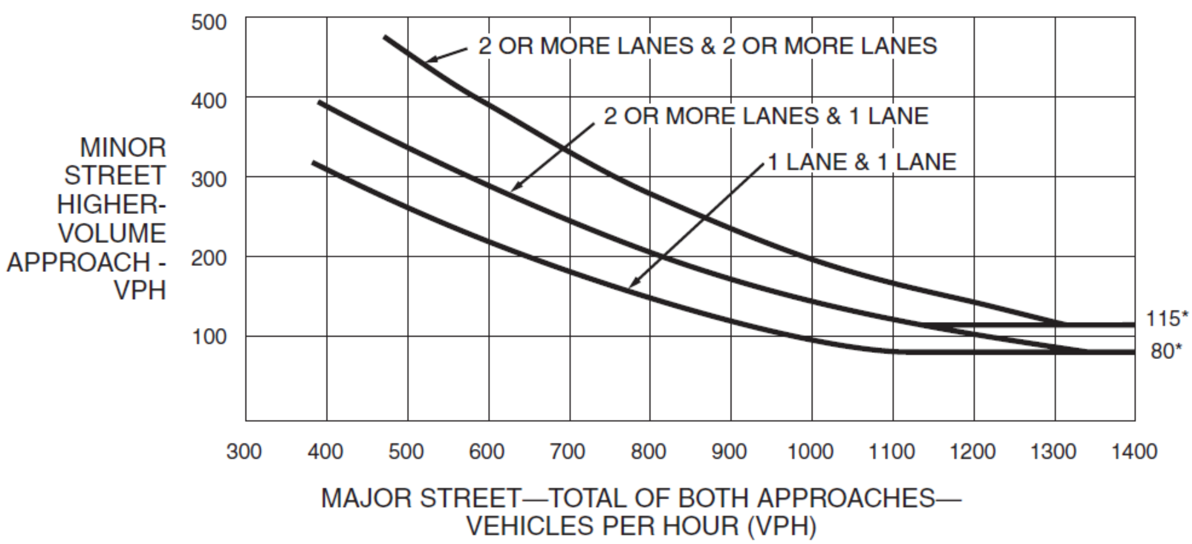
Number of lines for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100%[a]	80%[b]	70%[c]	56%[d]	100%[a]	80%[b]	70%[c]	56%[d]
1	1	500	400	350	280	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 lines 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

Figure 13: *MUTCD* Four-Hour Vehicular Volume Warrant



*Note: 115 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 80 vph applies as the lower threshold volume for a minor-street approach with one lane.

The City of De Pere collected 24-hour traffic counts on the approaches to the Broadway Street intersection with Ridgeway Boulevard. Based on a review of the traffic volume data collected at the intersection, it was determined that traffic levels do not satisfy intersection Warrant 1 (Eight-Hour Volume) and Warrant 2 (Four Hour Volume). It is noted that Warrant 3 (Peak Hour Volume) does not apply to this intersection. From a technical standpoint, the warrants were analyzed with a 50% reduction of right-turn volumes from Ridgeway Boulevard in conformance with WisDOT traffic analysis procedures.

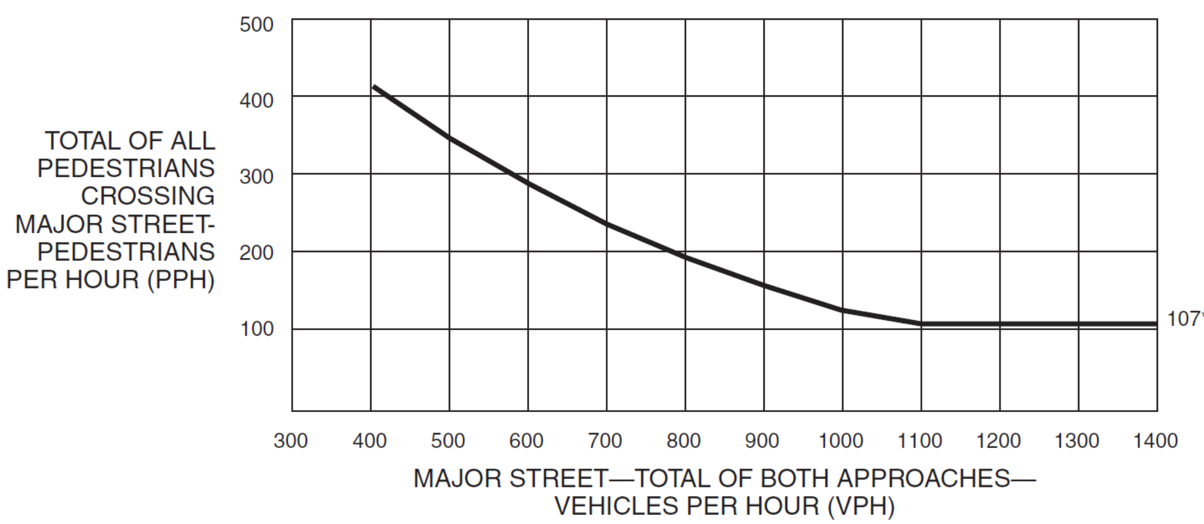
The other warrants analyzed were the Pedestrian Volume Warrant (Warrant 4) and the Crash Experience Warrant (Warrant 7).

<u>Pedestrian Volume Warrant</u>: The Pedestrian Volume Warrant is intended for streets where traffic volume on a major street is so heavy that pedestrians experience excessive delay in crossing the major street. In order to consider a traffic signal under this warrant the following criteria must be 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 both approaches) and the corresponding pedestrians per hour crossing the major street must 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 both approaches) and the corresponding pedestrians per hour crossing the major street falls above the curve on Figure 4C-7.

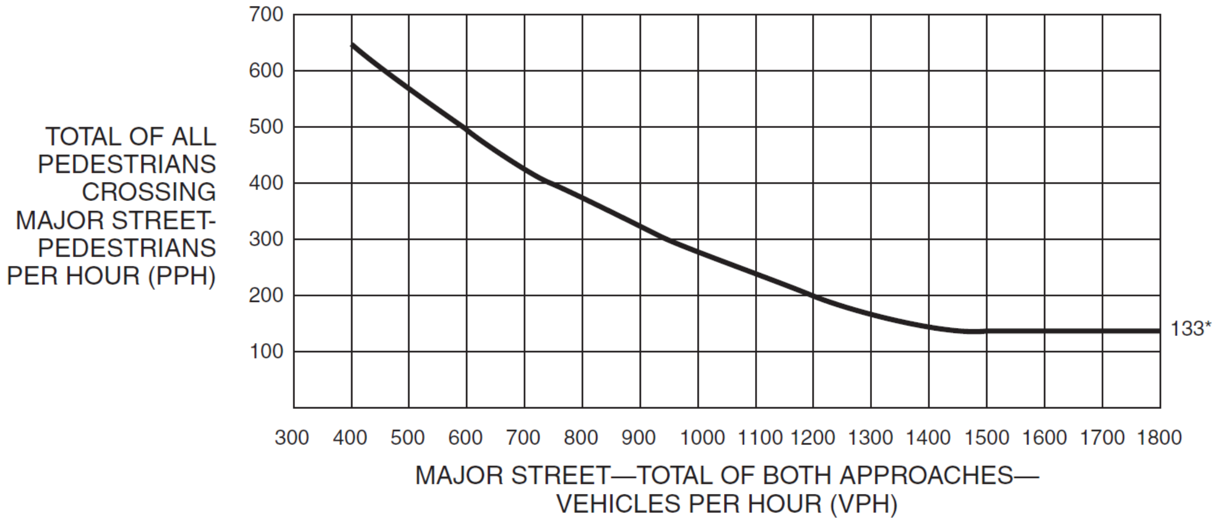
Figure 14: *MUTCD* Figures 4C-5 and 4C-7 Pedestrian Volume Warrants

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



*Note: 107 pph applies as the lower threshold volume.

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



*Note: 133 pph applies as the lower threshold volume.

Based on the October 2016 peak hour pedestrian and traffic intersection counts collected by Ayres Associates, the Ridgeway Boulevard intersection does not experience sufficient pedestrian crossings to satisfy the minimum 107 hourly pedestrian volume threshold to satisfy the Pedestrian Volume Warrant.

<u>Crash Experience Warrant</u>: The Crash Experience Warrant contains the following three requirements:

1. That five or more crashes susceptible to correction by a signal have occurred within a 12-month period;
2. That the eight-hour warrants be met at 80% of the minimum volume thresholds; and
3. Other remedial countermeasures have been implemented to reduce the crash frequency before safety is used as justification for installing a traffic signal.

The crash data for the Ridgeway Boulevard intersection does not experience a sufficient number of right angle crashes to meet the Crash Experience Warrant.

The remaining warrants, which focus on school zones, coordinated signal systems, roadway network, and railroad crossings, are not considered applicable to the Broadway Street intersection with Ridgeway Boulevard.

I. **Crosswalk Location Principles**

Pedestrians in high density urban areas should be able to cross streets at regular intervals. Pedestrians should not be expected to go more than 400 feet out of their way to cross a street to reach their destination.

Pedestrian crosswalk markings are a useful traffic control device, but it is very important to realize the positive as well as the negative consequences of marking crosswalks. From a mobility point of view, marked crosswalks may seem to increase pedestrian mobility, however they can also create a false sense of pedestrian safety.

The widely used national guideline regarding crosswalk markings is documented in the *MUTCD* Section 3B-17 and 3B-18 (6). It states that crosswalks should be marked at all intersections where there is a substantial conflict between vehicle and pedestrian movements. As previously noted, Wisconsin State Statues 346.24 (c) states that 'motorists are to yield to a pedestrian at an intersection with pedestrian facilities, whether the crosswalk is marked or not'.

Marked crosswalks indicate optimal or preferred locations for pedestrians to cross a street and help designate right-of-way for motorists to yield to pedestrians. Pedestrians are sensitive to out-of-the-way travel and reasonable accommodation should be made to make crossings both convenient and safe.

Marked crosswalks are intended to provide pedestrians with a feeling of confidence that it is safe to cross a street at a marked location and to give drivers adequate warning to expect that pedestrians will be in the roadway.

Marked crosswalks should be installed where:

1. There is a substantial conflict between vehicle and pedestrian movements
2. Significant pedestrian concentrations occur
3. Pedestrians would not otherwise recognize the proper place to cross
4. Traffic movements are controlled

Crosswalks should not be installed at locations where sidewalks do not exist unless adequate roadway shoulders are provided for pedestrian use.

Marked crosswalks on 2-lane roadways with ADT's greater than 9,000 vpd or 4-lane roadways with ADT's greater than 12,000 vpd require special crossing enhancement treatments such as median refuge islands, curb extensions, overhead lighting, pedestrian activated signals or warning lights along with a Traffic Engineering Study that concludes pedestrian safety will be improved by the special treatments.

National pedestrian safety research studies documented in the Federal Highway Administration Report HRT-04-100, '*Safety Effects of Marked versus Unmarked Crosswalks at Uncontrolled Locations'*, September, 2005 concluded that there is no significant effect of marked versus unmarked crosswalks on pedestrian safety crashes under the following conditions:

- Two-lane streets
- Multilane streets without raised medians with ADT's below 12,000 vpd
- Multilane streets with raised medians and ADT's below 15,000 vpd

For multilane streets with ADT's above these volumes, research has shown that there is a significant increase in pedestrian crashes on streets with marked crosswalks, compared to streets with unmarked crosswalks.

Marked crosswalks may be installed on 4-lane streets without a raised median and a 35 mph or less posted speed limit with ADT's exceeding 15,000 vpd with the installation of a pedestrian activated signal such as a HAWK or RRFB. The installation of HAWK beacons should satisfy the *MUTCD* Warrant requirements.

The FHWA recommends that the overuse of crosswalk markings should be avoided to maximize their effectiveness. Crosswalks and sign treatments (such as the "State Law – Yield to Pedestrians" and rectangular rapid flash beacon signs) should be used discriminately within a city so that the effectiveness of these treatments is not deteriorated by overuse. Although these treatments may be effective at individual locations, overuse of these treatments city-wide may lead to a decrease in their value as drivers become desensitized to them.

A Traffic Engineering Study is required to determine if the criteria and warrants are satisfied for the installation of a marked crosswalk at a particular location. The components of a crosswalk Traffic Engineering Study will vary by location and are more extensive than traffic signal evaluation studies and may include consideration of:

- Speed and volume on the street involved
- Pedestrian volume, age and level of mobility
- Location of pedestrian origins and destinations and crossing patterns
- Existing sidewalk network and sidewalk ramps
- Adequacy of sight distances and absence of sight obstructions
- Street characteristics including grade, curvature, pavement markings, pavement widths, number of vehicle and bicycle lanes
- Location of adjacent driveways
- On-street parking
- Street lighting
- Location of drainage structures
- Distance to nearest marked crossing
- Traffic signal progression
- Potential for rear-end crashes

m. Crosswalk Removal to Increase Use of Other Marked Crosswalks

From a pedestrian safety perspective, Wisconsin State Statute 346.24 (1) states that 'motorists are to yield to a pedestrian at an intersection with pedestrian facilities, whether the crosswalk is marked or not'. In general, removal of existing crosswalks should be avoided. In exceptional cases, closing a crosswalk or keeping a crosswalk closed may be justified even if a crosswalk meets the criteria outlined in the *City of De Pere Crosswalk Location Policy,* which is included in the Appendix to this report.

Closing a crosswalk and removing curb ramps with signs and barriers may be justified based on such factors as high traffic turn volumes, poor sight distance, or very low pedestrian demand. Conditions that contribute to the need for a crosswalk or crossing treatments may change over time resulting in an existing crosswalk no longer being needed. A review of any unprotected crosswalks should be conducted when a street is scheduled for reconstruction or resurfacing, to determine crosswalk use and need. Crosswalks, along with their pedestrian crossing enhancements, should be removed when street reconstruction or resurfacing is undertaken if the use of a crosswalk is less than half of that required for it to be warranted based on the criteria established in the City *Crosswalk Location Policy* for a new installation.

The extent of pedestrian inconvenience should be considered in these decisions when closing a crosswalk and removing curb ramps. Where crosswalk closures are required, only one leg of an intersection should be closed. Closing a crosswalk should include the public information process described below.

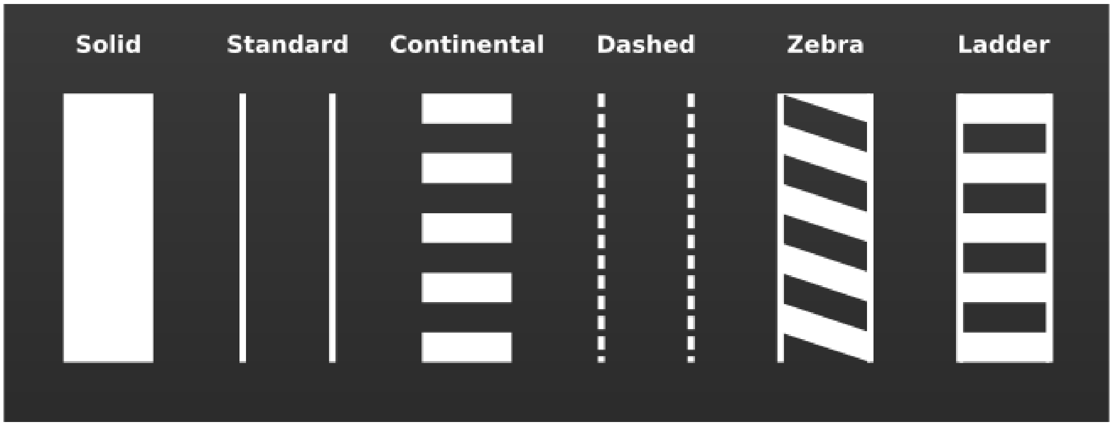
Crosswalk markings can be recommended for removal while leaving a crosswalk open, such as when an engineering evaluation indicates that other measures have not been effective and/or there are no significant safety advantages to marking the crosswalk.

No public notice is required to area residents when crosswalk removal is part of a roadway construction project. When a crosswalk is recommended for removal and not part of a roadway construction project, residents and property owners within a 300 foot walking distance to the crosswalk in question should be notified via mail. In addition, notices should be visibly posted for 7 days prior at the crossing location to inform the public of the intent to remove the crossing. City contact information would be provided on these mailings and notices. Should concerns arise from the public as a result of mailings or a notification sign at the crosswalk, City staff may initiate a more substantial public process with the concerned parties.

n. Crosswalk Striping Patterns

Because of the low approach angle that pavement markings are viewed by drivers, the use of longitudinal stripes in addition to or in place of the standard transverse markings can significantly increase crosswalk visibility to oncoming traffic. While research has not shown a direct link between increased crosswalk visibility and increased pedestrian safety, ‘high-visibility’ crosswalks have been shown to increase motorist yielding to pedestrian behavior as well as their ability to channelize the location of pedestrians crossing a street. Based on this benefit, the FHWA has concluded that ‘high-visibility’ pedestrian crosswalks have a positive effect on pedestrian and driver behavior. Figure 15 illustrates the different types of pedestrian crosswalk striping patterns.

Figure 15: Pedestrian Crosswalk Striping Patterns



Standard Crosswalks: The standard treatment for marked crosswalks at intersections consist of two 6 to 8-inch wide white pavement marking stripes that delineate the sides of the pedestrian walking area. The stripes should be perpendicular (transverse) to the direction of vehicle travel and parallel to the direction of pedestrian travel.

High Visibility Crosswalks: High-visibility crosswalks should be marked using the 'Continental' or 'Ladder' pattern of crosswalk striping, which consists of a series of 18 to 24-inch wide stripes parallel to the curb for the length of the crossing.

When standard markings are converted to 'Continental' or 'Ladder' markings, the side stripes may remain, since removal is costly, but the side stripes should not be maintained. To the extent possible, 'Continental' or 'Ladder' pattern crosswalks should be designed with the stripes placed to avoid vehicle wheel paths to reduce long-term maintenance costs.

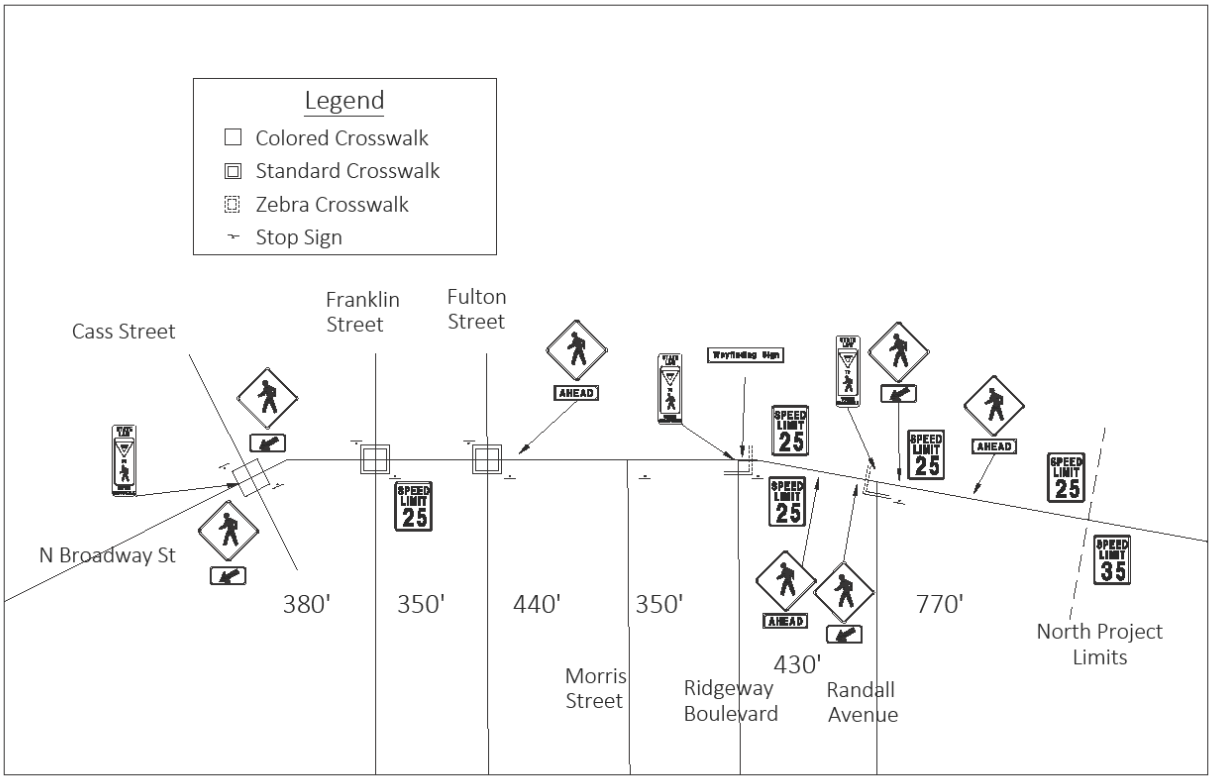
High visibility markings may be used at the following locations:

- Where mid-block crossings are installed
- Across uncontrolled traffic at partial STOP sign controlled intersections
- Where crossings are installed on streets having an ADT of 4,000 vpd or more
- In high pedestrian areas of business districts, campuses, and commercial areas where significant distractions to motorists and pedestrians are likely to occur
- Within school zones or as shown on a school walking route plan
- When an engineering study indicates a need for additional visibility

4. Broadway Street Pedestrian and Traffic Safety Recommendations

For reference purposes, Figure 16 identifies existing traffic signing and pavement marking controls along the study segment of Broadway Street.

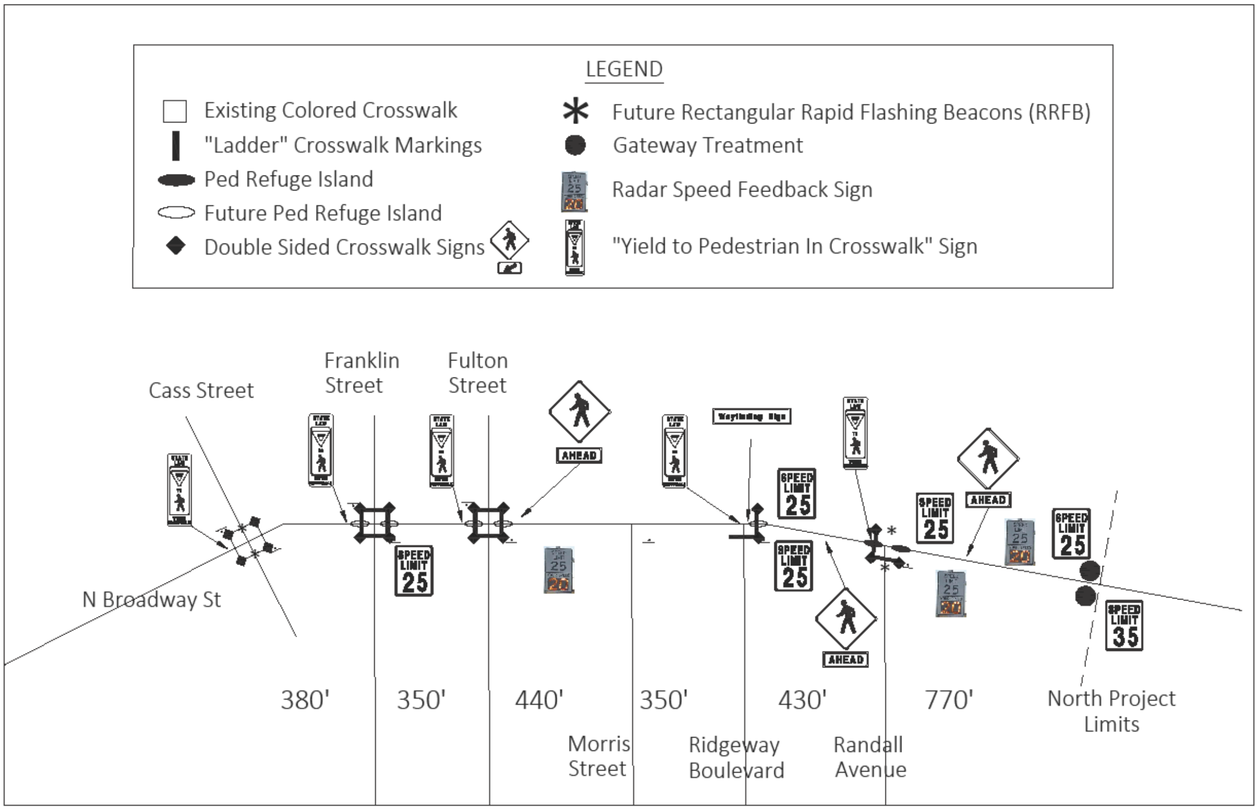
Figure 16: Existing Broadway Street Signing and Pavement Markings



As shown on Figure 16, all intersections have pedestrian crosswalks except at Morris Street which is a constructed with a narrow 12-foot wide pavement width. The types of existing pedestrian crossing markings at the study intersections varies. Most of the Broadway Street pedestrian crossings are signed with yellow pedestrian crossing signs and arrows. The pedestrian crossing at Randall Avenue includes ‘advance’ pedestrian crossing signage. The 25 mph speed limit is signed at numerous locations along Broadway Street. The posted speed on Broadway Street north of the study segment is 35 mph.

Figure 17 indicates the pedestrian safety and traffic control signing enhancements recommended for the study segment of Broadway Street.

Figure 17: Pedestrian Safety and Traffic Speed Taming Recommendations



As shown on Figure 17, it is recommended to:

1. Upgrade all existing crosswalk markings on Broadway Street, except at Cass Street, to ‘Continental’ or ‘Ladder’ style design to increase driver awareness of pedestrian crossing locations. This treatment also has the effect of establishing the study segment of Broadway Street with a higher density urban context to influence driver traffic speed perceptions. This recommendation does not include the colored crosswalks at Cass Street.

2. Construct a 4 or 6-foot wide pedestrian median refuge island with in-street ‘Yield to Pedestrians in Crosswalk’ signs at the Randall Avenue intersection as shown on Figure 18. Also, reconstruct the existing median island on the north approach to Cass Street so that the island extends past the crosswalk to provide a sheltered crosswalk within the median. Future pedestrian median refuge islands should be considered at the Franklin and Fulton Street and at the Ridgeway Boulevard intersections as part of a tiered pedestrian safety evaluation process.

Figure 18: Pedestrian Median Refuge Island Design

As shown on Figure 18, 6-foot wide pedestrian refuge islands will require widening the Broadway Street intersection approaches by 2-feet on each side of the street. The intersection approach widening is minimized to reduce any impacts to the mature streets trees in the Broadway Street Historic District. Under this recommendation Broadway Street would operate with 10-foot wide center lanes and 11-foot wide curb lanes. It is noted that the two-foot widening would be tapered back to the existing street curbs within a distance of 100 feet. It is recognized that this 2-foot widening may cause removal of some mature street trees at each intersection. Even though this measure may remove some mature trees, this recommendation is considered critical to improving pedestrian safety due to the high availability of 'individual' one-way traffic gaps compared to the relatively low number of 'combined' two-way traffic gaps on Broadway Street. An additional benefit of constructing pedestrian median refuge islands includes their ability to tame traffic speeds.

3. If it is not feasible to install pedestrian median refuge islands on Broadway Street due to their street tree impact it is recommended to install double sided 'Yield to Pedestrian in Crosswalk' signs on curbside poles that support 'Pedestrian

Crosswalk' signs. These double sided signs should be installed on both the east and west curbs of Broadway Street to avoid sign obstruction by traffic traveling in the curb lanes of the four-lane wide roadway.

4. It is recommended to consider the installation of 'Rectangular Rapid Flashing Beacons' (RRFB) at the Randall Avenue intersection where currently there is a school bus stop and at the Cass Street intersection, which provides pedestrian access to the Fox River Trail. This action would be installed as part of a tiered pedestrian safety evaluation process.

5. It is recommended to install a northbound radar speed feedback sign on Broadway Street south of Fulton Street and north of Randall Avenue as well as a southbound radar speed feedback sign north of Randall Avenue to tame traffic speeds along Broadway Street.

6. It is recommended to construct 'gateway' signing treatments at the North City Limit to inform drivers they are entering a reduced speed land use context with pedestrian activity.

7. It is recommended that all crosswalks on Broadway Street be signed with double sided pedestrian crossing and arrow signs on both sides of the street as shown on Figure 19.

Figure 19: Double Sided Pedestrian Crosswalk Signs

8. It is recommended that the City of De Pere investigate the feasibility of constructing a new pedestrian path connection between Broadway Street and the Fox River Trail to improve and focus pedestrian crossing activity between Morris Street and Randall Avenue. The presence of pedestrians at specific focused crossing points can be expected to enhance pedestrian safety as drivers will expect pedestrian activity at these locations.

Resource Documents

1. *Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations*, FHWA Publication HRT-o4-100, September, 2005
2. *Pedestrian Hybrid Beacons, Chapter 4F, Manual on Traffic Control Devices, December,,2009*
3. *Improving Pedestrian Safety at Unsignalized Crossings*, NCHRP Report 562
4. *Unsignalized Intersection Improvement Guide,* Institute of Transportation Engineers
5. *Achieving Multimodal Networks – Applying Design Flexibility & Reducing Conflicts*, FHWA, August, 2016
6. *Pedestrian Hybrid Beacon Guide – Recommendations and Case Study*, FHWA Safety Program
7. *Pedestrian Hybrid Beacon,* Proven Safety Countermeasures*, FHWA -SA-12-012*
8. *Safety Effectiveness of the HAWK or Pedestrian Hybrid Beacon,* Texas Transportation Institute, TR News 280, May-June, 2012
9. *Rectangular Rapid Flashing Beacon (RRFB), FHWA -SA-09-009, May 2009*
10. *Pedestrian Facilities User Guide – Providing Safety and Mobility,* FHWA -RD-01-102, March, 2002
11. *Crosswalk Guidelines,* San Francisco Municipal Transportation Agency, May, 2014
12. *Policy and Standards for Pedestrian Crossings,* City of Columbia, Missouri, October, 2000
13. *Guidance for Installation of Pedestrian Crosswalks on Minnesota State Highways,* October, 2005
14. *Pedestrian Safety and Crosswalk Installation Guidelines,* City of Stockton, CA, 2003
15. *Guidelines for the Installation of Marked Crosswalks,* Virginian Department of Transportation
16. *De Pere Bicycle and Pedestrian Plan,* City of De Pere, Wisconsin

Appendix

City of De Pere
Crosswalk Location Policy

City of De Pere Crosswalk Policy

June 29, 2017

Background

Wisconsin State Statute, 346.24(1) states that 'motorists are required to yield to pedestrians at an intersection with pedestrian facilities, whether the crosswalk is marked or not'.

The purpose of marked crosswalks at intersections or midblock locations is to indicate optimal or preferred locations for pedestrians to cross a street. Marked crosswalks are intended to provide pedestrians with a feeling of confidence that it is safe to cross a street at a marked location and to give drivers adequate warning to expect that pedestrians will be in the roadway. However, marked crosswalks can also prompt many pedestrians to feel a false sense of safety when using a marked crosswalk.

This policy covers where and how to mark crosswalks, related to the following topics:

- General Crosswalk Location Principles
- Traffic Engineering Studies
- Marking Crosswalks at Unsignalized Intersections
- Marking Crosswalks at Controlled Intersections
- Marking Crosswalks at Mid-Block Locations
- Removal of Crosswalk Markings
- Crosswalk Stripping Patterns

This policy replaces the existing City Department of Public Works policy on 'Crosswalks on Through Streets', dated March 12, 2012.

General Crosswalk Location Principles

It is recognized that pedestrians are sensitive to out-of-the-way travel and that reasonable accommodations should be made to make crossings both convenient and safe allowing pedestrians to cross streets at regular intervals.

The following general principles should be considered when identifying pedestrian crosswalk locations:

1. Arterial street crosswalk locations should be consistent with the City of De Pere *Bicycle and Pedestrian Plan*. Depending on the street network configuration and intersection spacing, pedestrians in dense urban areas should not be expected to walk more than 400 feet out their way to cross a street to reach their destination.
2. Marked crosswalks should be installed where there is:
    a. A substantial conflict between vehicle and pedestrian movements,
    b. Where significant pedestrian concentrations occur,
    c. Where pedestrians would not otherwise recognize the proper place to cross, and
    d. Where traffic movements are controlled
3. Crosswalks should not be installed at locations where sidewalks do not exist.

The widely used national guideline regarding crosswalk markings is documented in the *Manual on Uniform Traffic Control Devices* (*MUTCD*) Section 3B-17 and 3B-18 (6). It states that crosswalks should be marked at all intersections where there is a substantial conflict between vehicular and pedestrian movements.

The Federal Highway Administration (FHWA) advises that the overuse of crosswalk markings should be avoided to maximize their effectiveness. Crosswalks and sign treatments (such as the “State Law – Yield to Pedestrians” and rectangular rapid flash beacon signs – RRFB’s) should be used discriminately within a city so that the effectiveness of these treatments is not deteriorated by overuse. Although these treatments may be effective at individual locations, overuse of these treatments city-wide may lead to a decrease in their value as drivers can become desensitized to them.

National pedestrian safety research studies documented in the FHWA Report HRT-04-100, *‘Safety Effects of Marked versus Unmarked Crosswalks at Uncontrolled Locations’*, September, 2005 concluded that there is no significant effect on pedestrian crashes between marked versus unmarked crosswalks under the following conditions:

- Two-lane streets
- Multilane streets without raised medians and ADT’s below 12,000 vpd
- Multilane streets with raised medians and ADT’s below 15,000 vpd

The research report also concludes that crosswalks should not be marked on 2-lane roadways with ADT’s greater than 9,000 vpd, or 4-lane roadways with average daily traffic (ADT’s) greater than 12,000 vpd, unless other special treatments such as median refuge islands, curb extensions, overhead lighting, pedestrian activated signals or warning lights are provided along with a Traffic Engineering Study that concludes pedestrian safety will be improved by the special treatments.

For multilane streets with ADT’s above these volumes, it can be expected that there will be a significant increase in pedestrian crashes on streets with marked crosswalks, compared to streets with unmarked crosswalks (after controlling for traffic ADT and pedestrian ADT). Table 1 provides initial guidance on whether an uncontrolled location might be a candidate for a marked crosswalk and/or whether additional geometric and/or traffic control improvements are needed.

Marked crosswalks may be installed on 4-lane streets without a raised median with a 35 mph or less posted speed limit and ADT’s exceeding 15,000 vpd with the installation of a pedestrian signal such as a ‘High-Intensity Activated Crosswalk’ (HAWK) beacon’ or ‘Rectangular Rapid Flashing Beacon’ (RRFB’s) as shown on Table 1. The installation of HAWK beacons should satisfy the *MUTCD* Warrant requirements. Figure 1 provides a Crosswalk Request and Enhancement Process Flow Chart based on the information in Table 1 and the crosswalk location principles described above.

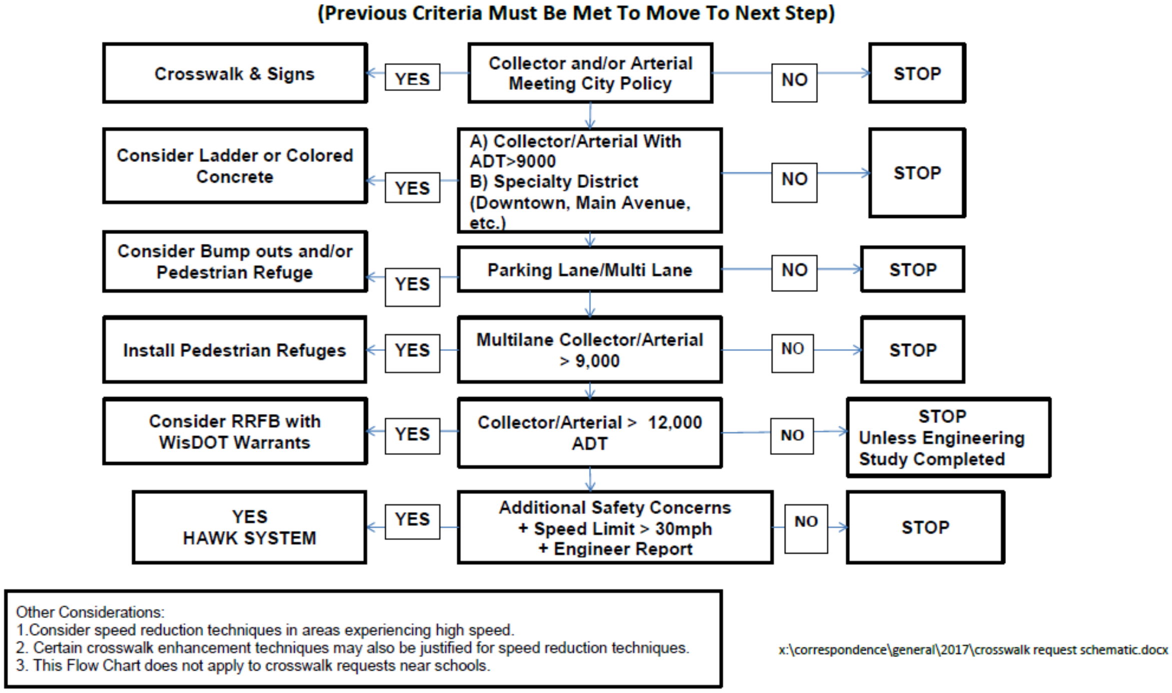
Table 1: Guidelines for Installing Marked Crosswalks and Other Needed Pedestrian Safety Improvements at Uncontrolled Locations*

Roadway Type (Number of Travel Lanes and Median Type)	Vehicle ADT < 9,000			Vehicle ADT >9,000-12,000			Vehicle ADT >12,000-15,000			Vehicle ADT >15,000		
	Speed Limit (mph)**											
	<30	35	40	< 30	35	40	< 30	35	40	<30	35	40
Two lanes	C	C	P	C	C	P	C	C	N	C	P	N
Three lanes	C	C	P	C	P	P	P	P	N	P	N	N
Multilane (4 of more lanes) with raised median***	C	C	P	C	P	N	P	P	N	N	N	N
Multilane (4 or more lanes) without raised median	C	P	N	P	P	N	N	N	N	N	N	N

These guidelines include intersection and midblock locations with no traffic signals or stop signs on the approach to the crossing. They do not apply to school crossings. A two-way center turn lane is not considered as a median. Crosswalks should not be installed at locations that could present an increased safety risk to pedestrians, such as where there is poor sight distance, complex or confusing designs, a substantial volume of heavy trucks, or other dangers, without first providing adequate design features and/or traffic control devices. Adding crosswalks alone will not make crossing safer, nor will they necessarily result in more vehicles stopping for pedestrians. Whether marked crosswalks are installed, it is important to consider other pedestrian facility enhancements (e.g., raised crosswalks, traffic signal, roadway narrowing, enhanced overhead lighting, traffic taming measures, curb extensions), as needed to improve the safety of the crossing. These are general recommendations, good engineering judgement should be used in individual cases for deciding where to install crosswalks.
** Where the speed limit exceeds 40 mph marked crosswalks alone should not be used at unsignalized locations.

The Legend for Table 1 is as follows:
C = Candidate sites for marked crosswalks. Marked crosswalks must be installed safely and selectively. Before installing new marked crosswalks, an engineering study is needed to determine whether the location is suitable for a marked crosswalk. For an engineering study, a site review may be sufficient at some locations, while a more in-depth study of pedestrian volume, vehicle speed, sight distance, vehicle mix, etc. may be needed at other sites. It is recommended that a minimum of 20 pedestrian crossings per hour (or 15 elderly and/or child pedestrians) exist at a location before placing a high priority on the installation of a marked crosswalk.
P = Possible increase in pedestrian crash risk may occur if crosswalks are added without other pedestrian facility enhancements. These locations should be closely monitored and enhanced with other pedestrian crossing improvement measures, if necessary, before adding a marked crosswalk.
N = Marked crosswalks alone are not sufficient, since crash risk may be increased due to providing a marked crosswalk alone. Consider using other treatments, such as traffic taming treatments, traffic signals with pedestrians signals where warranted, or other substantial crossing improvements to improve crossing safety for pedestrians.
******* The raised median or crossing island must be at least 4 feet wide and 6 feet long to adequately serve as a refuge area for pedestrians in accordance with MUTCD and American Association of State Highway and Transportation Officials (AASHTO) guidelines.
Source: *Guidance for Installation of Pedestrian Crosswalks on Minnesota State Highways,* October, 2005

Figure 1: Crosswalk Request and Enhancement Process Flow Chart



Traffic Engineering Studies

A traffic engineering study is required to determine if the guidelines in this Policy and *MUTCD* warrants are satisfied for the installation of a marked crosswalk at a particular location. The components of a Traffic Engineering Study will vary by location, but typically should include consideration of:

- Speed and volume on the street involved
- Pedestrian volume, age and level of mobility
- Location of pedestrian origins and destinations and crossing patterns
- Existing sidewalk network and sidewalk ramps
- Adequacy of sight distances and absence of sight obstructions
- Street characteristics including grade, curvature, pavement markings, pavement widths, number of vehicle and bicycle lanes
- Location of adjacent driveways
- On-street parking
- Street lighting
- Location of drainage structures
- Distance to nearest marked crossing
- Traffic signal progression
- Potential for rear-end crashes

Crosswalk Markings at Unsignalized Intersections
Pedestrian crosswalks should not be installed at street intersections that are not controlled by a traffic signal, a STOP sign or a YIELD sign unless all of the following criteria are met:

- The speed limit is 40 mph or less; and
- There are 20 or more pedestrians using the crossing per hour during the peak morning and evening traffic time periods (lower volumes may be considered if a large percentage of the pedestrians consist of young, elderly or disabled pedestrians; or 15 or more pedestrians per hour during multiple hours throughout the day; and
- The two-way traffic ADT for the street exceeds 4,000 vpd; and
- A sidewalk or adequate shoulder is provided for use by pedestrians on both sides of the street approach; and
- There is not another crosswalk across the same roadway within 400 feet of the intersection; and
- Adequate stopping sight distance (equal to or exceeding that for the posted speed) is available in both directions as determined in accordance with guidance contained in the American Association of State Highway and Transportation Officials (AASHTO) '*Policy on the Design of Highways and Streets'*.

Additional design treatments such as crosswalk signing, pedestrian median refuge islands, advance stop bars, HAWK beacons or RRFB's should be considered for crosswalks on streets with four or more moving traffic lanes. The installation of HAWK or RRFB's should satisfy the following criteria.

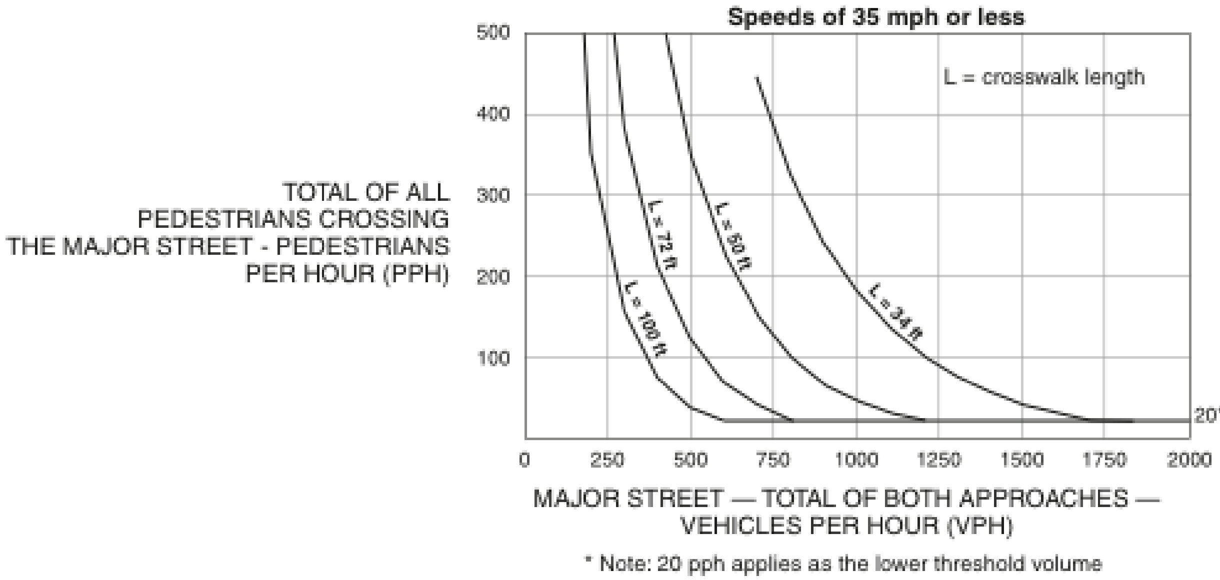
HAWK beacons can be evaluated for marked crosswalk locations with significant pedestrian demand that satisfy the *Manual on Uniform Traffic Control Devices* (*MUTCD)* traffic speed and volume warrants. In general, they should be used if:

1) There are an insufficient number of gaps in traffic to permit pedestrians to cross;
2) Vehicle speeds on the major street are too high to permit pedestrians to cross safely; or
3) Pedestrian delay is excessive.

Bus stop and school crossings are frequently good locations to consider HAWK beacons.

Figure 2 from the *MUTCD* identifies threshold criteria for the installation of HAWK beacons, shown with curves, for various crosswalk lengths based on the number of pedestrians and traffic volume for streets with traffic speeds of 35 mph or less. If pedestrian and traffic volumes exceed the threshold curve criteria, a HAWK beacon may be considered.

Figure 2: MUTCD Recommended Traffic Thresholds for HAWK Beacon Consideration



The WisDOT *Traffic Guidelines Manual,* Section 4-5-2 indicates that RRFB's may be considered based if the following conditions exist:

- Location is an uncontrolled pedestrian crossing.
- Minimum volume* thresholds should be met:
  - 20 or more pedestrians during a single hour (any four consecutive 15-minute time periods) of an average day, or
  - 18 or more pedestrians during each of any two hours of an average day, or
  - 15 or more pedestrians during each of any three hours of an average day.
    *Young (<12), elderly (>85) and disabled pedestrians count 2X toward volume thresholds. Additionally, seasonal day volumes can be used in place of average day volumes if the crossing is a known tourist area.
- A minimum vehicle volume of 1,500 vehicles per day.
- Maximum of four lanes crossed, unless there is a raised median, in which case it can be five lanes.
- There exists a minimum of 300 feet between the subject crossing and the nearest controlled pedestrian crossing or intersection traffic control device on the state trunk highway system. Consideration should be given to extending this distance beyond 300 feet if the proposed crosswalk location falls within an auxiliary turn lane for the nearby intersection or if the standing queue from the intersection extends over the proposed crosswalk location.
- The approach speed is posted at 40 mph or less.
- Adequate stopping sight distance exists based on FDM 11-10-5 or greater than 8 times the posted speed limit.

Crosswalk Markings at Controlled Intersections
Unless a pedestrian crossing is prohibited, marked crosswalks should be provided at all intersection approaches controlled by traffic signals. Intersection approaches controlled by STOP signs can be recommended for marked crosswalks if any of the following conditions apply:

- Crosswalk is located in a school area; or
- Elderly or disabled pedestrian volumes of 20 or more per hour are expected during the peak hour of pedestrian demand; or
- Pedestrian volumes of 60 or more are expected during the peak hour of pedestrian demand and traffic volumes of 6,000 vpd are expected to cross over the crosswalk; or
- Safety or efficiency reasons dictate directing pedestrians to a particular leg of an intersection; or STOP sign approach on a major or minor arterial street.

Crosswalk Markings at Mid-Block Locations
Mid-block crosswalks should only be installed if marked and established by a Traffic Engineering Study and approved by City Council action. Midblock crossings should only be installed at locations where pedestrians would be expected to need to cross the street. Because mid-block pedestrian activity is not expected by drivers, additional safety measures including signage, parking restrictions and HAWK beacons or RRFB's should be installed. Other pedestrian safety measures can include curb bulbouts. Mid-block crosswalks should only be installed if the following conditions exist:

- Mid-block crosswalks should be considered only if there is sufficient demand according to the following criteria:
  - Pedestrian volumes exceed 40 or more during the peak hour of pedestrian demand; or
  - Significant pedestrian trip generators (such as schools, parks or commercial buildings) are on both sides of the street between controlled intersections.
- The location is more than 300 feet from a controlled intersection;
- Adequate stopping sight distance exists between approaching motorists and pedestrians starting to cross the proposed crosswalk;
- The crosswalk location has adequate street lighting; and
- Safety considerations attributed to roadway configuration, traffic volumes or speeds do not preclude establishing a crosswalk.

Removal of Crosswalk Markings
These guidelines should not be used to justify removal of existing crosswalk markings. In most circumstances, additional safety measures should be considered prior to removal of crosswalk markings.

In general, removal of existing crosswalks should be avoided. In exceptional cases, closing a crosswalk or keeping a crosswalk closed may be justified even if a crosswalk meets the criteria outlined elsewhere in this Policy.

Closing a crosswalk and removing curb ramps with signs and barriers may be justified based on such factors as high traffic turn volumes, poor sight distance, or very low pedestrian demand. Conditions that contribute to the need for a crosswalk or crossing treatments may change over time resulting in an existing crosswalk no longer being needed. A review of any unprotected crosswalks should be conducted when a street is scheduled for reconstruction or resurfacing, to determine crosswalk use and need. If the use of a crosswalk is less than half of that which would be required for it to be warranted based on the criteria established in the City *Crosswalk Location Policy* for a new installation, the crosswalk should not be replaced and any other treatments removed when the reconstruction or resurfacing is undertaken.

The extent of pedestrian inconvenience should be considered in these decisions. Where crosswalk closures are required, only one leg of an intersection should be closed. Closing a crosswalk should include the public information process described below.

Crosswalk markings can be recommended for removal while leaving a crosswalk open, such as when a traffic engineering evaluation determines that other measures have not been effective and/or there are no significant safety advantages to not marking the crossing.

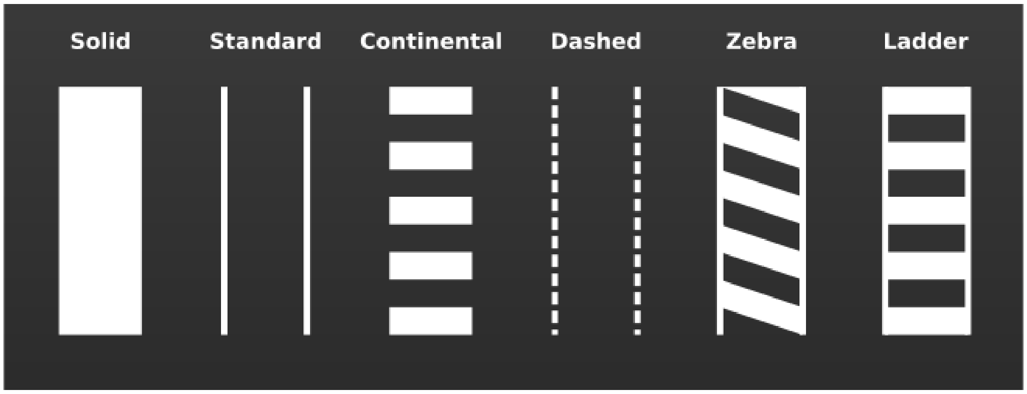
No public notice is required to area residents when crosswalk removal is part of a roadway construction project. When a crosswalk is recommended for removal and not part of a roadway construction project, residents and property owners within a 300 foot walking distance to the crosswalk in question should be notified via mail. In addition, notices should be visibly posted for 7 days prior at the crossing location to inform the public of the intent to remove the crossing. City contact information would be provided on these mailings and notices. Should concerns arise from the public in response to that mailing or from a notification sign at the crosswalk, City staff may initiate a more substantial public process with the concerned parties.

Crosswalk Striping Patterns

Various crosswalk striping patterns are available to designate pedestrian crossing locations. The ‘standard’ striping pattern for marked crosswalks at intersections consist of two 6 to 8-inch wide white pavement marking stripes that delineate the sides of the pedestrian walking area. The stripes should be perpendicular (or transverse) to the direction of vehicle travel and parallel to the direction of pedestrian travel.

Because of the low approach angle at which pavement markings are viewed by drivers, the use of longitudinal stripes in addition to or in place of the ‘standard’ transverse markings can significantly increase the visibility of a crosswalk to oncoming traffic. While research has not shown a direct link between increased crosswalk visibility and increased pedestrian safety, ‘high-visibility’ crosswalks have been shown to increase motorist yielding and channelization of pedestrians, leading the FHWA to conclude that ‘high-visibility’ pedestrian crosswalks have a positive effect on pedestrian and driver behavior. Figure 2 illustrates the different types of pedestrian crosswalk markings.

Figure 2: Crosswalk Striping Patterns



'High-Visibility' markings shall be used at the following locations:

- Where mid-block crossings are installed
- Across uncontrolled traffic at partial stop sign controlled intersections
- Where crossings are installed on streets having an ADT of 4,000 vpd or more
- In high pedestrian areas of business district, campuses, commercial areas where significant distractions to motorists and pedestrians are likely to occur.
- Within school zones or as shown on a school walking route plan
- When a Traffic Engineering Study indicates a need for additional visibility
- Where crosswalk treatments are used for raised pavements

Care should be taken to ensure that 'high-visibility' markings do not weaken or distract from other crosswalks where 'standard' markings are used.

'High-visibility' crosswalks should be marked using the 'Continental' or 'Ladder' pattern of crosswalk striping, which consists of a series of 18 to 24-inch wide stripes parallel to the curb for the length of the crossing. The 'Ladder' marking retains the transverse side stripes of the 'standard' crosswalk in addition to the 'Continental' parallel strips. To the extent possible, 'Continental' or 'Ladder' crosswalk markings should be designed with the stripes located to avoid traffic wheel paths to reduce long-term maintenance needs.