Guidance for Installation of Pedestrian Crosswalks on Michigan State Trunkline Highways

Michigan Department of Transportation

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Engineering Manual Preamble

This manual provides guidance to administrative, engineering, and technical staff. Engineering practice requires that professionals use a combination of technical skills and judgment in decision making. Engineering judgment is necessary to allow decisions to account for unique site-specific conditions and considerations to provide high quality products, within budget, and to protect the public health, safety, and welfare. This manual provides the general operational guidelines; however, it is understood that adaptation, adjustments, and deviations are sometimes necessary. Innovation is a key foundational element to advance the state of engineering practice and develop more effective and efficient engineering solutions and materials. As such, it is essential that our engineering manuals provide a vehicle to promote, pilot, or implement technologies or practices that provide efficiencies and quality products, while maintaining the safety, health, and welfare of the public. It is expected when making significant or impactful deviations from the technical information from these guidance materials, that reasonable consultations with experts, technical committees, and/or policy setting bodies occur prior to actions within the timeframes allowed. It is also expected that these consultations will eliminate any potential conflicts of interest, perceived or otherwise. MDOT Leadership is committed to a culture of innovation to optimize engineering solutions.

The National Society of Professional Engineers Code of Ethics for Engineering is founded on six fundamental canons. Those canons are provided below.

Engineers, in the fulfillment of their professional duties, shall:

1. Hold paramount the safety, health, and welfare of the public.
2. Perform Services only in areas of their competence.
3. Issue public statement only in an objective and truthful manner.
4. Act for each employer or client as faithful agents or trustees.
5. Avoid deceptive acts.
6. Conduct themselves honorably, reasonably, ethically and lawfully so as to enhance the honor, reputation, and usefulness of the profession.

Background

The Michigan Department of Transportation's (MDOT) overall mission includes the provision of safe and efficient transportation facilities for all road users. Determining when and where to provide appropriate treatments such as marked crosswalks and pedestrian signing is often complicated. Elements that can affect decisions on whether to install crossing treatments and what type include:

- Posted speed limit of the roadway
- Volumes of vehicular and pedestrian traffic
- Number of travel lanes and geometry of the roadway at the crossing location
- Profile of pedestrian traffic (proportion of crosswalk used by elderly or children)
- Type of roadway
- Setting (urban or rural)

All of the elements listed above can influence decision making on whether a crosswalk should be installed at a given location and if additional treatments should be considered. Not providing a uniform approach to pedestrian crossing treatments can create confusion for both motorists and pedestrians, resulting in a potential to lessen the effectiveness of pedestrian crossings.

The objective of this guidance document is to establish a step-by-step procedure to evaluate the use of various pedestrian crossing treatments. This guidance is expected to provide crosswalk treatments that meet both motorist and pedestrian expectations and consistency on trunkline routes. Recent pedestrian research studies, existing crosswalk guidelines used by other governmental agencies, manuals on traffic control devices, and state statute were reviewed in order to establish this guidance document.

Crosswalk Location Evaluation Procedures

Evaluation of a proposed crosswalk location for potential crossing treatments on state trunkline routes should include the following four basic steps:

1) Identification and Description of the Crossing Location
2) Physical Data Collection
3) Traffic Data Collection and Operational Observations
4) Application of Data to Determine Appropriate Treatments

Step 1: Identification and Description of the Proposed Crossing Location

a) Identify the pedestrian crossing location including the major street and the specific location of the crossing
b) Determine if the crossing location connects both ends of a shared-use path.
c) Note the posted speed along the major street at the crossing location.
d) Identify the existing traffic control, if any, and any existing crossing treatments (signs, markings or physical treatments), street lighting and curb ramps.
e) Identify lane use (setting) on either side of crossing.

Step 2: Physical Data Collection

a) Determine the existing roadway configuration including the number of lanes and the presence of raised medians or refuge islands at the crossing location.
b) Identify the nearest marked or protected crossing and measure the distance to this proposed crossing.
c) Measure the stopping sight distance (SSD) on all vehicular approaches to the proposed crossing. If the SSD is less than eight times the posted speed limit, determine if improvements (such as removal of obstructions) are feasible means to mitigate the inadequate SSD. Consider traffic calming treatments that would encourage lower driving speeds.

Step 3: Traffic Data Collection and Operational Observations

a) Gather or collect pedestrian crossing volumes during the peak hours of use. This will typically involve AM, midday, and PM peaks hours. Locations near schools may only require two hours of data collection, corresponding to school opening and closing times. Pedestrian volumes should include and differentiate between pedestrians and bicyclists, the number of young, elderly and/or disabled pedestrians. For locations where school crossing traffic is anticipated, the volume of student pedestrians (school age pedestrians on their way to/from school) should also be noted separately. Whenever possible, pedestrian and bicycle volumes should be collected during weather months and conditions that represent peak crossing activity. Consider gathering data before, during and after special events or near venues that generate large pedestrian volumes such as stadiums, conventions centers, theaters, etc.
b) Collect hourly and average daily traffic (ADT) volumes for vehicle traffic along the roadway at the crossing location, including truck volumes and turning movements simultaneously with pedestrian data.

Step 4: Application of Data to Determine Appropriate Treatments

a) Using the available data, utilize the following to determine appropriate treatment(s) for signalized, stop-controlled or uncontrolled locations :
    - Figure 1 (see page 8) – Pedestrian Crossing Treatment Flow Chart at Controlled Crossings,
    - Figure 2 (see page 9) – Pedestrian Crossing Treatment Flow Chart at Uncontrolled Crossings and
    - Table 1 (see page 10) – Criteria for Types of Crossing Treatments at Uncontrolled Locations (if applicable)
b) Consider and incorporate the following additional evaluation considerations as appropriate in:
    - Figure 3a (see page 11) – Installation of Pedestrian Hybrid Beacon or Rectangular Rapid Flashing Beacon Signs on Low Speed Roadways (≤ 35 mph)

If an electronic device is being considered, submit Form 1597 to MDOT Signal

Operations to request a study for any electronic pedestrian device.

Types of Crossing Treatments at Uncontrolled Locations

Four primary types of uncontrolled crossing treatments are discussed below. These treatments consider the physical roadway conditions, vehicle volumes, pedestrian volumes and posted speed limit at the potential crossing location. Table 1 should be used to determine which crossing type should be applied. All crossing types shall include ADA compliant sidewalk ramps. An uncontrolled location includes mid-block and unsignalized intersections where mainline of the state trunkline does not stop.

Crossing Type A:

- Marked special emphasis crosswalk (See MDOT PAVE 945 series)
- Standard pedestrian warning signs (W11-2) (See MDOT Traffic Sign Design, Placement and Application Guide). Evaluate need for advanced signing.
- If the location is a designated school crossing then standard school crossing signs (S1-1) should be used.

Crossing Type B:

- Marked special emphasis crosswalk (See MDOT PAVE 945 series)
- Standard pedestrian warning signs (MDOT Traffic Sign Design, Placement and Application Guide). Evaluate need for advanced warning signs.
- Geometric improvements (such as median nose extensions, curb extensions, pork chop island, tighter curb radius or median refuge islands) or consider pedestrian activated Rectangular Rapid Flashing Beacons (RRFB) if criteria are met in Figure 3a or 3b (see page 11). Submit form 1597 to MDOT Signal Operations to request a study for any electronic pedestrian device.
- Consider use of in-street yield to pedestrian crossing sign (R1-6) in low speed urban setting if the local unit of government has adopted the Michigan Uniform Traffic Code for Cities Townships and Villages.
- Additional pavement markings may be required such as double yellow centerline

or cross hatching in advance of a median refuge island.

- If the location is a designated school crossing then standard school crossing signs (S1-1) should be used.
- Consider curb extensions if on-street parking is present and storm drainage structures can be accommodated.
- If pedestrian volume falls above the RRFB limit line on Figure 3a or 3b, go to Crossing Type D.

Crossing Type C:

- Where the posted speed is greater than or equal to 45 mph, determine if modifications can be made to the geometrics of the roadway or signal timing adjusted to calm traffic to reduce travel speeds (85th) thus allowing the road to have a lower the posted speed limit and a raised median and/or pork chop island can be installed. A lower posted limit must be supported by a speed study. If so, go to Crossing Type B
- If not possible or if pedestrian volumes fall above the Rectangular Rapid Flashing Beacon (RRFB) limit line on Figure 3a or 3b, go to Crossing Type D

Crossing Type D:

- Crossing has the following configurations:
  - 4 Lanes with speed greater than or equal to 45 mph and ADT greater than or equal to 12,000 vpd
  - 5 Lanes with refuge island or 4 lane with raise median with speed greater than or equal to 45 mph and ADT greater than or equal to 15,000 vpd
  - 5 Lanes with speed greater than or equal to 45 mph and ADT greater than or equal to 12,000 vpd
  - 6 Lanes with speed greater than or equal to 40 mph and ADT between 1,500 and 12,000 vpd or ADT greater than 12,000 vpd for all posted speeds.
- 3 or more through lanes in a given direction and posted speed 40 mph or greater.
- Consider the Pedestrian Hybrid Beacon (PHB), pedestrian traffic signal or grade separated pedestrian crossing. Submit form 1597 to MDOT Signal Operations to request a study for any electronic pedestrian device.

- Must consider corridor signal progression, grades, physical constraints and other engineering factors.

Table 1 lists the number of lanes crossed to reach refuge and the number of multiple threat lanes per crossing. This information does not directly play into the use of Table 1, but does provide important context to help distinguish the crossing types and support the difference in recommended crossing treatments.

Additional crossing treatments for consideration can be found in Best Design Practices for Walking and Bicycling in Michigan. http://www.michigan.gov/documents/mdot/MDOT_Research_Report_RC1572_Part6_387521_7.pdf

Minimum Vehicle Volume for Treatments

Crossing treatments should generally not be installed at locations where the ADT is lower than 1,500 vehicles per day. Exceptions may be made at school crossing locations where the peak hour vehicle traffic exceeds 10% of the ADT. School crossings are defined as locations where 10 or more student pedestrians are crossing in any given hour and the crossing is a designated school walking route. Treatments for roadways with greater than 1,500 vehicles per day should be installed based on the criteria in Figure 1, Table 1 and the information in Figure 3 (a or b depending on posted speed limit).

Minimum Pedestrian Volume for Treatment at Uncontrolled Crossing Locations

The base threshold for consideration of an enhanced crossing treatment at an uncontrolled location is 20 pedestrians per hour. This threshold is consistent with national guidance and policies adopted by other states and cities.

The Minimum Pedestrian Volume Thresholds are as follows:

- 20 pedestrians per hour* in any one hour, or
- 18 pedestrians per hour* in any two hours, or
- 15 pedestrians per hour* in any three hours, or
- 10 school age (grades K-12) pedestrians traveling to or from school in any one hour and the crossing is a designated school walking route

*Young, elderly, and disabled pedestrians count two times towards volume thresholds

Definition of a Pedestrian Median Refuge and Minimum Median Refuge Width

A pedestrian median refuge island is defined as a location in the middle of a pedestrian crossing where a pedestrian can take refuge, separating the crossing into two segments, across each direction of approaching traffic. A painted center median or a painted turn lane does not

constitute a pedestrian refuge. A pedestrian refuge must include some type of raised median as described below:

- A raised median nose at an intersection (next to a left turn bay for example) can only be considered a pedestrian refuge for the adjacent crosswalk if the median is at least four feet wide and the left turn volume is less than 20 vehicles per hour. This low left turn volume means that during most pedestrian crossings there will not be a vehicle in the left turn lane as they cross the street.
- A raised median at a mid-block pedestrian crossing must be at least six feet wide (preferably 8 feet wide) and includes curb ramps or a walkway at grade through the median. For shared-use path crossing locations, a 10 foot median refuge width is desirable to accommodate bicycles with child trailers, recumbent bicycles and tandem bicycles.

Distance to Nearest Marked or Protected Crossing

The Pedestrian Crossing Treatment Flow Chart in Figure 2 includes consideration of spacing criteria for an uncontrolled crossing to the nearest marked or signalized crossing. The flowchart requires that a new uncontrolled mid-block crossing be at least 300 feet from the nearest crossing. However, this spacing criterion can be waived if the proposed crossing serves a shared-use path or the pedestrian crossing volume exceeds twice the minimum threshold. This criterion is subject to engineering judgment. In urban conditions, where a typical block length is 400 feet, the engineer may want to consider allowing a minimum of 200 feet, provided that the pedestrian crossing:

- Does not cross any left or right turn lanes or their transitions, where it is anticipated that vehicles will be changing lanes
- Is not near an intersection area where it will create undue restriction to vehicular traffic operations.

Pedestrian Crossing Treatments at Higher Speed Roadways with Rural Character

There may be conditions that necessitate the installation of pedestrian crossings where speeds are higher and special consideration is warranted. Engineering judgment should be applied and consideration given to providing an uncontrolled crosswalk. Engineering judgment should also be used in rural scenarios at shared use path crossings. Pedestrian warning signs may be adequate in some situations.

Figure 1
Pedestrian Crossing Treatment Flow Chart for Controlled Crossing

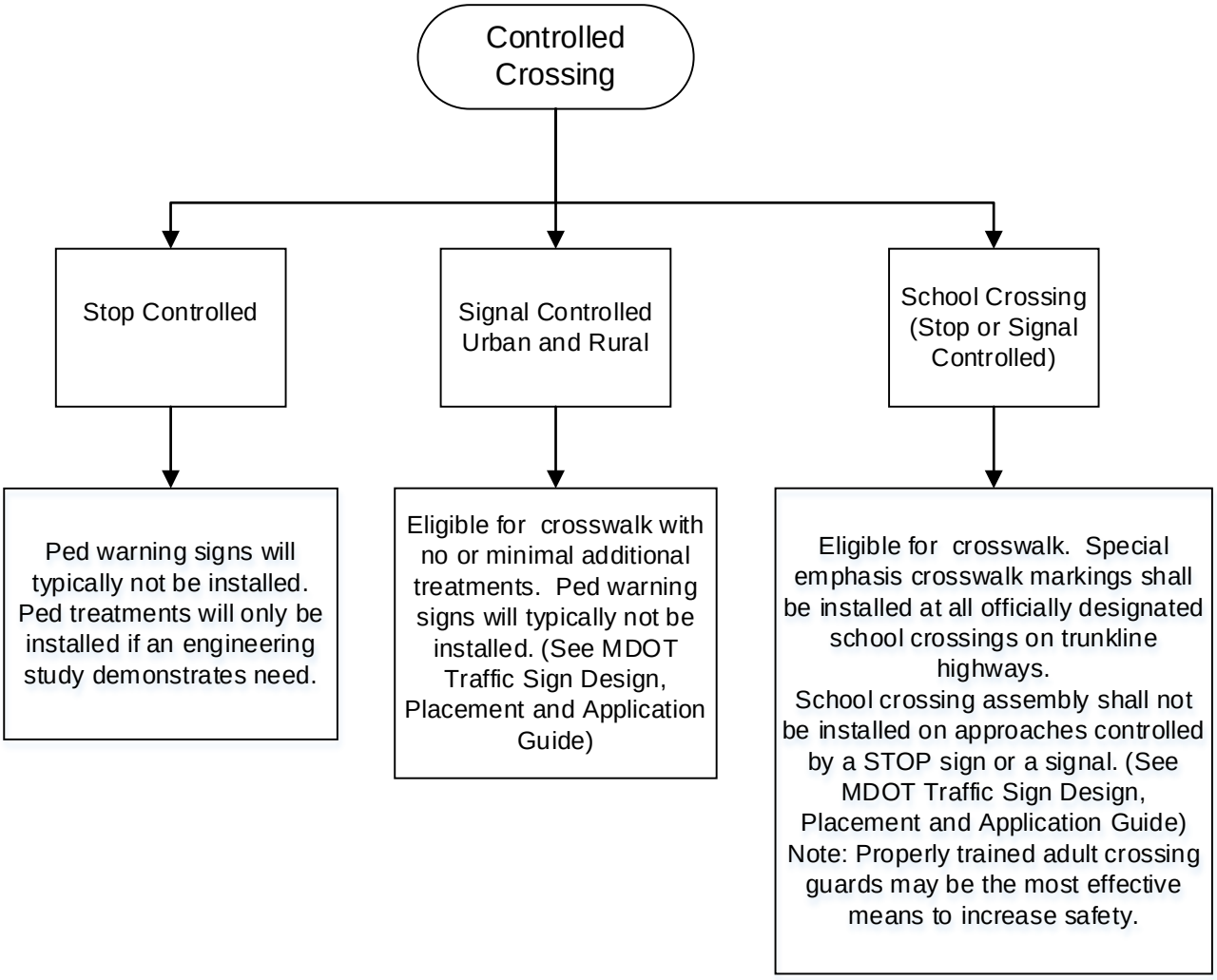


Figure 2
Pedestrian Crossing Treatment Flow Chart for Uncontrolled Crossing

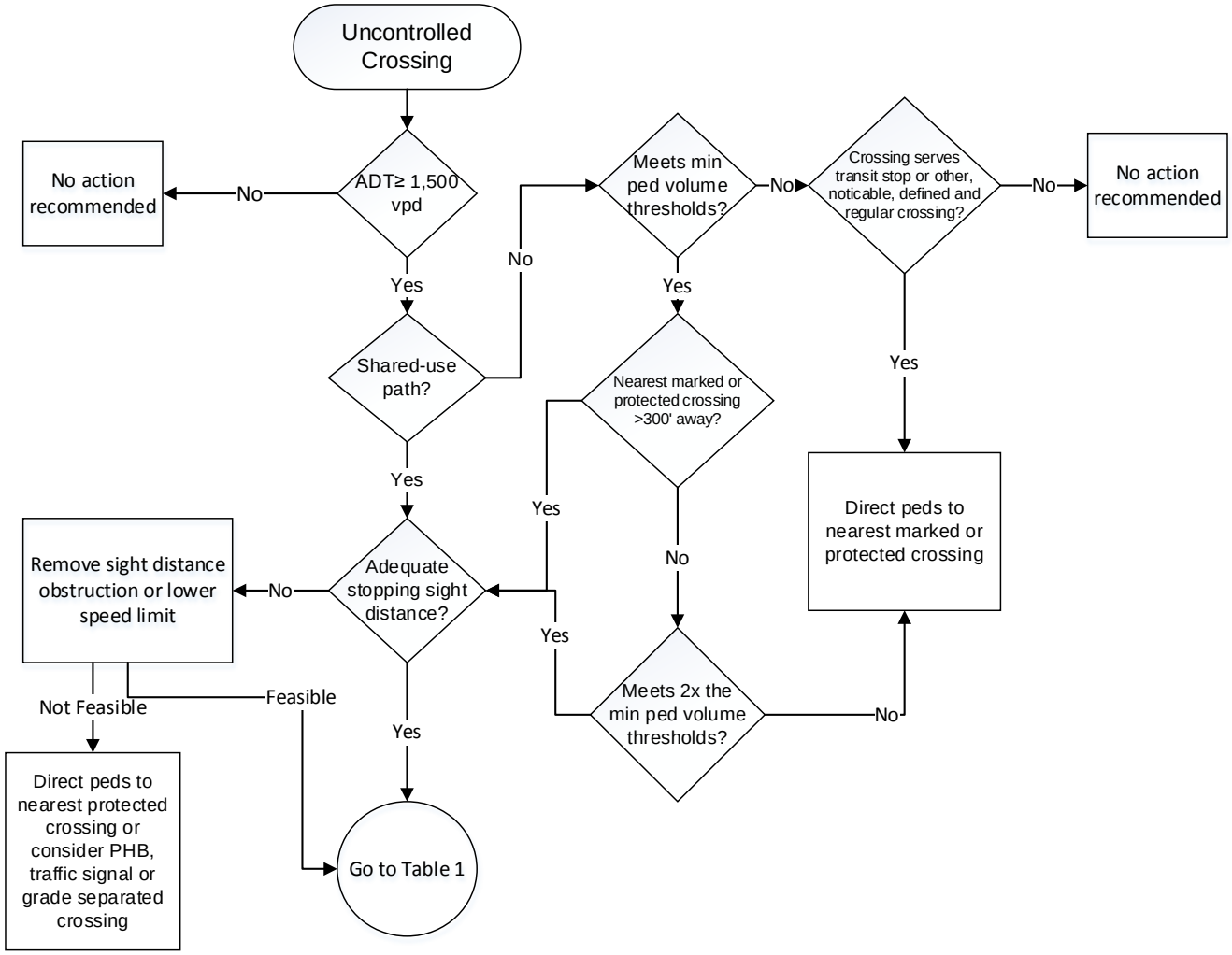


Table 1
Criteria for Types of Crossing Treatments at Uncontrolled Locations

Roadway configuration	# of lanes crossed to reach a refuge	# of multiple threat lanes* per crossing	Roadway ADT and Posted Speed															
			1,500 - 9,000 vpd				9,000 - 12,000 vpd				12,000 - 15,000 vpd				>15,000 vpd			
			≤ 30 mph	35 mph	40 mph	≥ 45 mph	≤ 30 mph	35 mph	40 mph	≥ 45 mph	≤ 30 mph	35 mph	40 mph	≥ 45 mph	≤ 30 mph	35 mph	40 mph	≥ 45 mph
2 Lanes (one way street)	2	1	A	A	A	B	A	A	B	B	A	A	B	B	A	A	B	B
2 Lanes (two way street with no median)	2	0	A	A	A	B	A	A	B	B	A	A	B	B	A	A	B	B
3 Lanes w/refuge island or 2 Lanes w/raised median	1	0	A	A	A	B	A	A	B	B	A	A	B	B	A	B	B	B
3 Lanes (center turn lane)	3	1	A	A	B	B	A	B	B	B	A	B	B	B	A	B	B	B
4 Lanes (two way street with no median)	4	2	A	B	B	C	A	B	C	C	A	B	C	D	B	B	C	D
5 Lanes w/ refuge island or 4 lanes w/raised median	2	2	A	A	B	B	A	B	B	C	A	B	C	C	B	B	C	D
5 Lanes (center turn lane)	5	2	A	B	C	C	B	B	C	C	C	C	C	D	C	C	C	D
6 lanes (two way street with or without median)	3 to 6	4	A	B	D	D	B	B	D	D	D	D	D	D	D	D	D	D

* Minimum pedestrian volumes (page 6) must be met before consideration of uncontrolled crossing treatments.

See page 4 and 5 for detailed description of treatments for Crossing Type A, B, C and D.

Figure 3a
Installation of Pedestrian Hybrid Beacon or Rectangular Rapid Flashing Beacon Signs on Low Speed Roadways (≤ 35 mph)

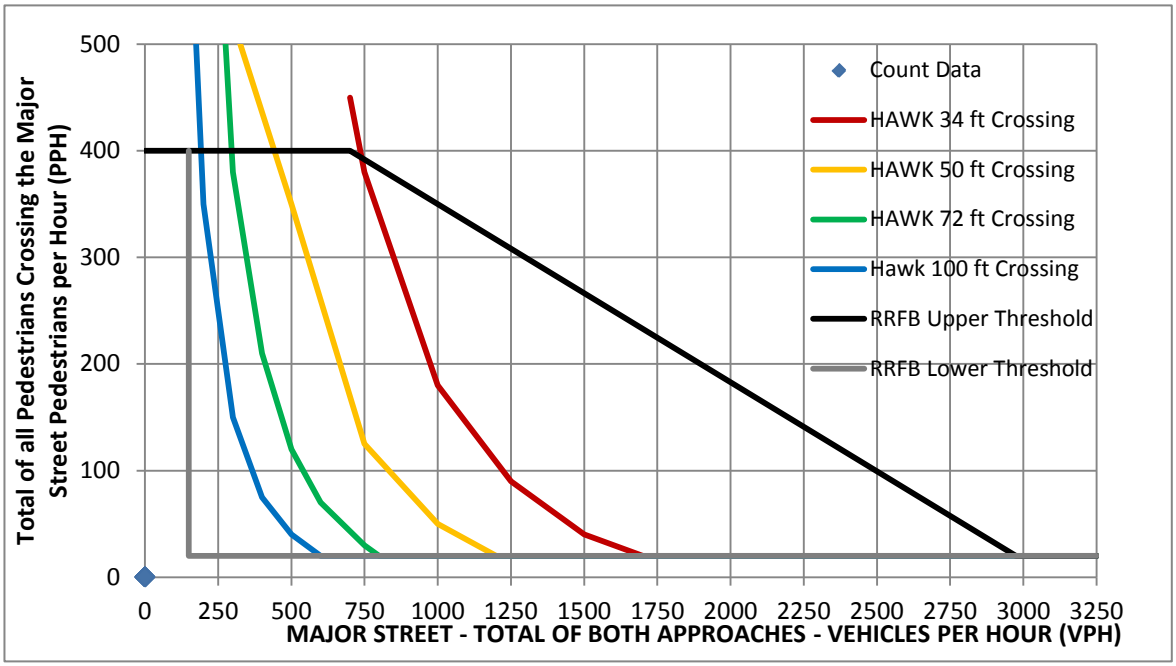
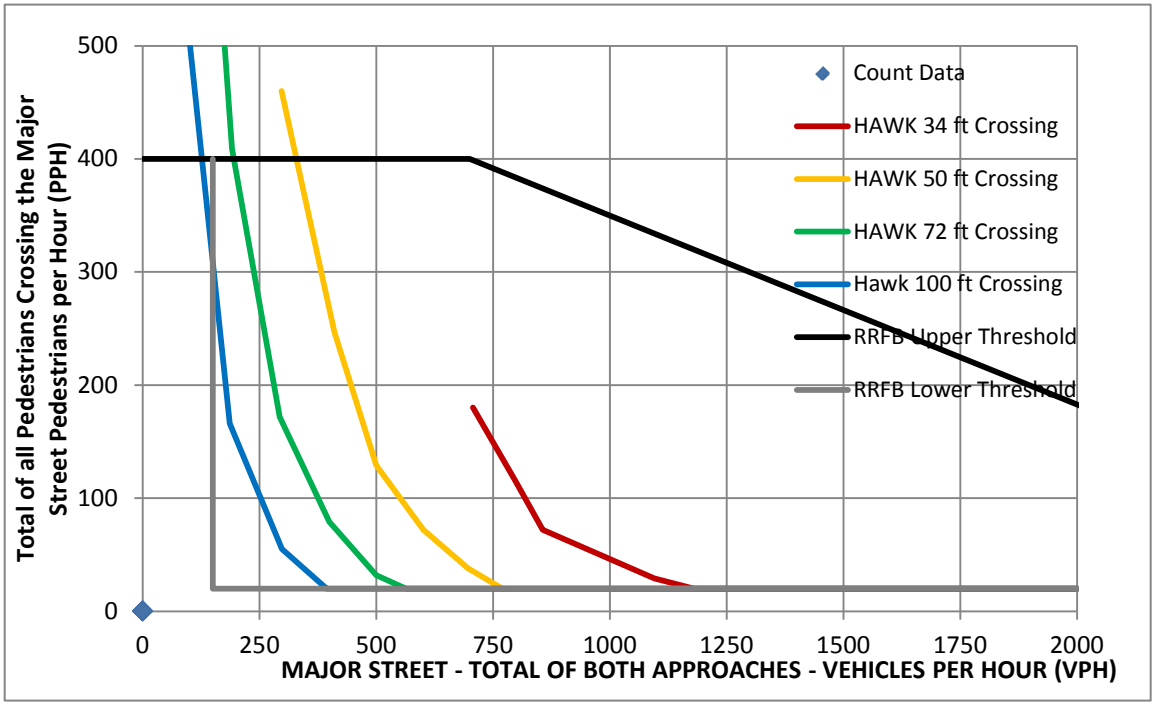


Figure 3b
Installation of Pedestrian Hybrid Beacon or Rectangular Rapid Flashing Beacons Signs on High Speed Roadways > 35 mph)



*See MMUTCD for pedestrian signal warrant graphs. Submit form 1597 to MDOT Signal Operations to request a study for any electronic pedestrian device.

Traffic Control Device Guidance

Crosswalk Pavement Marking Guidance

Crosswalk markings at an intersection shall be two 6 inch transverse markings as specified in the Pavement Marking Standard for Intersection, Stop Bar and Crosswalk Markings.
http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_pave-945-b.pdf

Crosswalk markings for established school crossings and mid-block locations shall be Special Emphasis 12" longitudinal markings as specified in the Pavement Marking Standard for Intersection, Stop Bar and Crosswalk Markings.
http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_pave-945-b.pdf

Pavement marking materials shall be placed as specified in the Pavement Marking Materials Usage Guidelines.
http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_pavemark_material-guide.pdf

Crosswalk Signing Guidance

Guidance for signing can be found in the MDOT Traffic Sign Design, Placement and Application Guidelines.
http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_signing_design_placement_application_guidelines.pdf

Traffic Signal Guidance

Guidance for the installation of traffic signals can be found in the MDOT document Traffic Signals A Guide for Their Proper Use.
http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_signal_guideforuse.pdf

References

1) Michigan Manual on Uniform Traffic Control Devices, 2011.
2) Safety Effects of Marked vs Unmarked Crosswalks at Uncontrolled Locations: Final Report and Recommended Guidelines, Zeeger, C.V. and others, U.S. Department of Transportation, Federal Highway Administration, September 2005.
3) City of Boulder Pedestrian Crossing Treatment Installation Guide, November 2001.
4) Improving Pedestrian Safety at Unsignalized Crossings, Kay Fitzpatrick and others, Transit Cooperative Research Program Report 112 and National Cooperative Highway Research Program Report 562, 2006.
5) The Effects of Advance Stop Lines and Sign Prompts on Pedestrian Safety in a Crosswalk on a Multilane Highway, Van Houten, R., Journal of Appiled Behavior Analysis, Number 3, pages 245-251, Fall 1988.
6) Pedestrian Facilities Users Guide – Providing Safety and Mobility, Zegeer, C.V. and others, Federal Highway Administration publication number FHWA-RD-01-102, March 2002.
7) Safety Analysis of Marked Versus Unmarked Crosswalks in 30 Cities, Zeeger, C.V. and others, ITE Journal, January 2004.