

# **GUIDELINES FOR THE INSTALLATION OF IN-ROADWAY WARNING LIGHTS**

## **Virginia Department of Transportation Traffic Engineering Division**

### **I. INTRODUCTION**

An illuminated crosswalk is a relatively new traffic control device that is being used throughout the nation to alert approaching motorists to the presence of pedestrians in or about to enter a marked midblock crosswalk or at a marked crosswalk on an uncontrolled approach at an intersection. It consists of a series of lighting units encased in durable housings and embedded in the pavement parallel with the marked crosswalk. The lights are activated by a pedestrian, either by pushbutton or passive detection, and are aimed to flash toward approaching traffic. They serve essentially the same function as traditional overhead flashing beacons, with the major differences being the location of the lights and the pedestrian activation feature. These light systems are known by many names, including in-pavement flashers, in-pavement flashing lights, pedestrian crosswalk warning systems, pedestrian crosswalk lights, crosswalk pavement lights, in-roadway warning systems, in-roadway lights, in-roadway warning lights, SMART crosswalks, intelligent road studs, flashing crosswalks, lighted crosswalks, in-pavement flashers, and “Santa Rosa lights,” among others.

In deference to the terminology used in the *Manual on Uniform Traffic Control Devices* (MUTCD) Section 4, these guidelines refer to In-Roadway Lights as In-Roadway Warning Lights (IRWL).<sup>1</sup>

As with any traffic control device, IRWLs are associated with advantages and disadvantages, appropriate and inappropriate locations, and preferred design features. IRWLs have been shown to have positive impacts on pedestrian safety; however, they are costly relative to more traditional warning devices and early installations have been associated with serious maintenance problems. (Some of these problems may have been addressed with the newer generations of these devices.) Therefore, it is important that they be installed judiciously and at locations where their effectiveness is maximized. Further, IRWLs should typically be considered only after other more traditional measures have been tried and proven unsuccessful. Finally, design guidelines should be based on guidance in the MUTCD.

The following guidelines are based on these principles and provide the Virginia Department of Transportation (VDOT) with guidance on when and where IRWLs should be considered for installation and on appropriate design details. IRWLs should be installed only at *marked* midblock crosswalks or *marked* crosswalks on uncontrolled approaches to intersections; therefore, these guidelines should be used in conjunction with existing VDOT guidelines for marked crosswalks.<sup>2</sup>

### **II. APPROPRIATE LOCATIONS TO INSTALL IN-ROADWAY WARNING LIGHTS**

The location being considered for an IRWL must have an identified pedestrian safety problem (pedestrian accidents, near misses, high pedestrian volumes, a sight distance problem, excessive speeding, etc.). The location must have a marked crosswalk with applicable warning signs.<sup>1</sup> It may be at either an intersection or mid-block. IRWLs shall not be used at crosswalks controlled by a yield or stop sign or traffic control signal.<sup>1</sup> If these criteria are met, further consideration of IRWLs should be based on the following step-by-step analysis:

1. *If the location does not currently have a marked crosswalk*, VDOT's most recent *Guidelines for the Installation of Marked Crosswalks*<sup>2</sup> shall be applied. See Attachment A.

- *If a marked crosswalk is not justified* according to Figure B3 in Attachment A, do not consider an IRWL.
- *If a marked crosswalk is justified*, Table B1 in Attachment A must identify an IRWL (a Level 4 device) as a potential special treatment at the crossing.

2. *If the location currently has a marked crosswalk*, VDOT's most recent *Guidelines for the Installation of Marked Crosswalks*<sup>2</sup> shall be consulted to determine if the crosswalk is justified. See Attachment A.

- *If the existing marked crosswalk is not justified*, do not consider an IRWL.
- *If the marked crosswalk is justified*, Table B1 in Attachment A must identify an IRWL (a Level 4 device) as a potential special treatment at the crossing.

3. If the *Guidelines for the Installation of Marked Crosswalks*<sup>2</sup> identify an IRWL as a potential special treatment at the crossing, the following additional guidance is suggested.

- *Alternative measures to mitigate the pedestrian safety problem should have been tried and proven unsuccessful or engineering judgment should have determined that other alternative measures are not feasible.* A typical example is some arrangement of the standard flashing beacon, either on continuous flash or pedestrian actuated.
- *The 85th percentile speed of vehicles approaching the crosswalk from either direction should not be more than 45 mph.*<sup>3,4</sup>
- *The average daily traffic (ADT) on the street being crossed should be between 5,000 and 30,000 vehicles per day,<sup>3,5</sup> or vehicular volume through the crossing should exceed 200 vehicles per hour in urban areas or 140 vehicles per hour in rural areas during peak-hour pedestrian usage.*<sup>4</sup>
- *The daily pedestrian crossing volume should be at least 100 pedestrians per day<sup>3,5</sup> or at least 40 pedestrians should regularly use the crossing during each of any 2 hours (not necessarily consecutive) during a 24-hour period.*<sup>4</sup>

- *The existing stopping sight distance from both directions should not be less than the minimums shown here.*

**Stopping Sight Distance (Feet)**  
(Height of Eye 3.5 ft; Height of Object 2.0 ft)

Design Speed* (mph)	25	30	35	40	45	50	55	60	65	70
Minimum Sight Distance	155	200	250	305	360	425	495	570	645	730

\*If the design speed is unknown, it may be assumed to be the posted speed limit unless the operating speed is lower at that point.

Source: *Sight Distance*, Appendix C, Design Data, Vol. 1. Virginia Department of Transportation, Richmond, p. C-11, Revised 10/02.

4. *Although these guidelines were crafted to be as comprehensive as possible, they do not address all situations.* Therefore, the final decision as to whether to install an IRWL should be left to engineering judgment, and this decision should most likely be made by the district traffic engineer.

### III. DESIGN GUIDELINES

Information in the MUTCD, Chapter 4L, In-Roadway Lights, provides the basis for the IRWL design guidelines.<sup>1</sup>

### IV. OTHER CONSIDERATIONS

#### A. Detection of Pedestrians and Activation of Lights

The two methods of detecting a pedestrian and activating an IRWL are via pushbutton and passive detection. The former requires a pedestrian to push a button to activate the lights; the latter is automatic and requires no action by the pedestrian. Passive detection is done using microwaves, motion sensors, video detection, light trip beam, and pressure pads. Based on experiences to date, a light trip beam between bollards seems to operate the best.

Engineering judgment should be used to select the method of activation at each location and situation; however, the advantages and disadvantages listed on the next page should be considered.<sup>5,6</sup>

#### B. Liability

There are two primary liability issues associated with IRWLs:

1. liability associated with giving the pedestrian a possible false sense of security in that a right-of-way and/or that the motorist will stop may be assumed
2. liability associated with maintenance.

No specific cases regarding liability and legal actions are known, but IRWLs are relatively new; however, these issues of liability are not new to transportation engineers. It is suggested that driver and pedestrian education be provided prior to installation of IRWLs at a new location to ensure that both understand what is expected when the lights begin to flash. Because of the documented maintenance problems with IRWLs (some of which may have been addressed with the newer generations of these devices), particular attention should be paid to routine maintenance activities.

**Advantages and Disadvantages of Pushbutton and Passive Activation of IRWL**

<b>Type of Activation</b>	<b>Advantages</b>	<b>Disadvantages</b>
Pushbutton	<ul style="list-style-type: none"> <li>• Familiarity with detection device.</li> <li>• Generally more reliable, less expensive, and easier to maintain than passive detection.</li> <li>• Few false calls.</li> </ul>	<ul style="list-style-type: none"> <li>• Non-familiarity with detection device because expected pedestrian signals not present.</li> <li>• May interpret as giving right of way.</li> <li>• May interpret as causing approaching motorists to stop.</li> <li>• Difficult to determine duration of crossing time accurately.</li> </ul>
Passive	<ul style="list-style-type: none"> <li>• Since IRWLs warn <i>drivers</i>, it is considered better that pedestrians not have visual indication of device. Passive detection generally provides this feature.</li> <li>• Should be less confusing to pedestrians because it does not require them to act in any way other than crossing the street with caution and at their own discretion.</li> <li>• Makes pedestrians more responsible for their actions.</li> <li>• Less disruptive to traffic, as pedestrians typically wait until there is a natural gap in traffic before stepping off curb and activating device.</li> <li>• Since device is activated exactly when pedestrian needs it (as compared to some distance away from crosswalk at location of pushbutton), duration of flashing interval can be set more accurately.</li> </ul>	<ul style="list-style-type: none"> <li>• Some systems prone to false activations due to inclement weather, swaying trees, turning vehicles, pedestrians passing nearby, etc. Bollard gateway system using light beams seems to be best.</li> <li>• Generally less reliable, more expensive, and more difficult to maintain than pushbutton detection.</li> </ul>

**C. Use of Bollards**

If a bollard detection system is used, the bollards should be placed along the same line as each row of flashers, i.e., not inside the crosswalk marking lines. This will ensure that a pedestrian entering anywhere in the crosswalk will be detected.<sup>7</sup>

**D. Use of Supplementary Signs**

Supplementary signs that educate the motorist and pedestrian about the use of IRWLs should be considered. Examples are<sup>7</sup>:

- Yield To Pedestrians
- Flashing Crosswalk—Walk Between Posts To Activate (if bollards are used)
- Watch for Cars—Cross Only When It Is Safe To Do So.

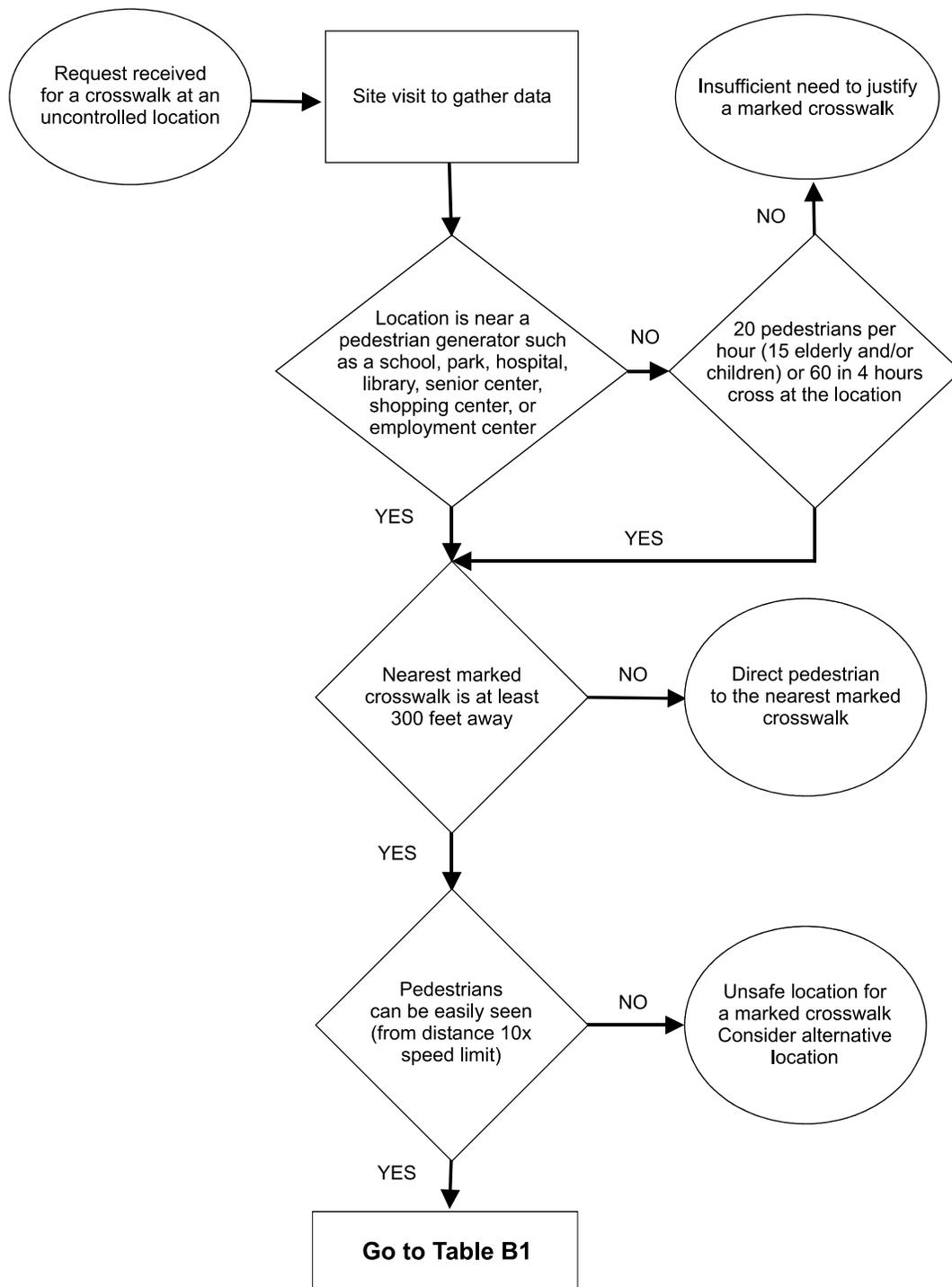
## REFERENCES

1. Federal Highway Administration. *Manual on Uniform Traffic Control Devices*, Chapter 4L, Part 4: Highway Traffic Signals, In-Roadway Lights. Washington, D.C., 2003.
2. Dougald, L. *Development of Guidelines for the Installation of Marked Crosswalks*. VTRC 05-R18. Virginia Transportation Research Council, Charlottesville, 2004.
3. Katz, Okitsu & Associates. *Illuminated Crosswalks: An Evaluation Study and Policy Recommendations*. Prepared for the City of Fountain Valley, California. Tustin, Calif., 2000.
4. California Department of Transportation. *MUTCD 2003 California Supplement, Part 4: Highway Traffic Signals, Section 4L.02 In-Roadway Warning Lights at Crosswalks*. Sacramento, 2004.
5. Whitlock & Weinberger Transportation. *An Evaluation of a Crosswalk Warning System Utilizing In-Pavement Flashing Lights* (Executive Summary). Prepared for the State of California Office of Traffic Safety and the Federal Highway Administration. Santa Rosa, Calif., 1998.
6. Miller, R., and Dore, G. *In-Pavement Flashing Crosswalks: State of the Art*. Article based on Fountain Valley Study conducted by Katz, Okitsu & Associates. <http://www.katzokitsu.com/peds.htm#articles>. Accessed September 5, 2003.
7. California Department of Transportation, Traffic Operations Program. *Interim Guidelines for Experimental Crosswalk Pavement Lights*. Sacramento, 2000.

## **ATTACHMENT A**

### **KEY PAGES FROM GUIDELINES FOR THE INSTALLATION OF MARKED CROSSWALKS**

Key pages from *Guidelines for the Installation of Marked Crosswalks*<sup>2</sup> are provided here for the user's convenience. The flowchart is used to determine the justification for marking a crosswalk. The table then identifies possible alternative enhancement measures to consider at the crossing. These measures are categorized into five levels, and an IRWL (a Level 4 device) should be identified as an appropriate enhancement measure in order for the step-by-step progression in Section II of the IRWL guidelines to proceed.



**Figure B3. Flowchart for Justifying Installation of Marked Crosswalks at Uncontrolled Intersections.**

**Table B1. Recommendations for Considering Marked Crosswalks and Other Needed Pedestrian Improvements at Uncontrolled Locations<sup>a</sup>**

	≤ 9,000 ADT			> 9,000 ADT to ≤ 12,000 ADT			> 12,000 ADT to ≤ 15,000 ADT			> 15,000 ADT		
	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph <sup>b</sup>
2 lanes												
3 lanes												
+ + 4 lanes, raised median <sup>c</sup>												
+ + 4 lanes, no median												

 **Candidate sites for marked crosswalks.** Marked crosswalks must be installed carefully and selectively. First, 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, but a more in-depth study of pedestrian volume, vehicle speed, sight distance, vehicle mix, etc., may be needed at other sites. If the speed limit is less than or equal to 30 mph, use **Level 1** or **Level 2** devices. If the speed limit exceeds 30 mph, use **Level 2** devices. *Refer to Level 1 and Level 2 devices in the Special Treatments section.*

 **Probable candidate sites for marked crosswalks.** Pedestrian crash risk may increase if marked crosswalks are added without other pedestrian facility enhancements. Add **Level 3** or **Level 4** devices if feasible. *Refer to Level 3 and Level 4 devices in the Special Treatments section.*

 **Marked crosswalks alone are insufficient, since pedestrian crash risk may increase if only marked crosswalks are provided.** Consider using **Level 5** devices if feasible. If not feasible, use multiple treatments from **Level 2**, **Level 3**, or **Level 4** devices. *Refer to Level 5 devices in the Special Treatments section.*

<sup>a</sup>These guidelines include intersection and mid-block locations with no traffic signal or stop sign on the approach to the crossing. They do not apply to school crossings. A two-way center turn lane is not considered a median. Crosswalks should not be installed at locations that could present an increased safety risk to pedestrians, such as where there is poor site distance, complex or confusing designs, substantial volumes of heavy trucks, or other dangers, without first providing adequate design features and/or traffic control devices. Adding crosswalks alone will not make a crossing safer or necessarily result in more drivers stopping for pedestrians. Whenever marked crosswalks are installed, it is important to consider other pedestrian facility enhancements, as needed, to improve the safety of the crossing (for example, raised median, traffic signal, roadway narrowing, enhanced overhead lighting, traffic calming measures, curb extensions). **These are general recommendations; an engineering study should be performed to determine where to install marked crosswalks.**

<sup>b</sup>Where the posted speed limit or 85<sup>th</sup> percentile speed exceeds 40 mph, marked crosswalks alone should not be used at uncontrolled intersections with an ADT greater than 15,000.

<sup>c</sup>The raised median or refuge island must be at least 4 feet (1.2 meters) wide and 6 feet (1.8 meters) long to adequately serve as a refuge area for pedestrians.

## **Special Treatments**

There are a number of innovative treatments for pedestrians at uncontrolled crossing locations. Level 1 devices are typically less costly to install and are found at locations with potentially lower levels of vehicle/pedestrian conflict. Level 2 through 5 devices can be more costly to install and are used at locations with an ascending order of potential vehicle/pedestrian conflicts.

### **Level 1 Devices**

- Standard Crosswalk
- Raised Mid-Block Crosswalk
- Rumble Strips

### **Level 2 Devices**

- High Visibility Crosswalks

### **Level 3 Devices**

- Refuge Islands
- Split Pedestrian Crossover (SPXO)
- Bulbouts

### **Level 4 Devices**

- Overhead Signs and Flashing Beacons
- In-Roadway Warning Lights (IRWLs)

### **Level 5 Devices**

- Pedestrian-Actuated Signals
- Grade-Separated Crossings