

Rectangular Rapid Flashing Beacon (RRFB) Design Guide

April 29, 2024

Table of Contents

1. Overview	2
2. Acronyms and Definitions	3
3. Design Process	5
4. Design Considerations.....	6
4.1. Crossing Location	6
4.2. Cross-Sectional Enhancements and Geometric Changes	7
4.3. Number and Mounting Type of RRFB Units.....	9
4.4. Single vs Multi-Phase Crossings	11
4.5. Pedestrian Detection	11
4.6. Electrical.....	12
4.7. Roadway Lighting at the Crosswalk	13
4.8. Handhole Placement.....	14
4.9. Signing.....	14
4.10. Pavement Markings	15
5. Checklists.....	17
5.1. Pre-Design	17
5.2. Plan.....	17
5.3. Post-Construction	17
6. Design Resources	18

1. Overview

The Federal Highway Administration (FHWA) approved the use of Rectangular Rapid Flashing Beacons (RRFBs) under Interim Approval (IA) 21, which was published on March 20th, 2018. RRFBs are a pedestrian-actuated crossing enhancement with bright flashing lights. RRFBs may be used to supplement a standard crossing at a current uncontrolled marked crossing. Figure 1 shows a solar powered RRFB assembly at a school crossing.

The intent of this guide is to help designers make decisions related to RRFB placement and configuration. This guide does not provide guidance to determine if a RRFB should be placed. Refer to MN TEM section 9-5.02.02 and district guidelines for further information.

The following sections include an outline of the RRFB design process, RRFB design considerations, RRFB checklists, and a summary of available design resources.

Figure 1. Solar powered RRFB at a school crossing



2. Acronyms and Definitions

Table 1. Acronyms and Definitions

TERM	DEFINITION
Active Pedestrian Detection System	Enhanced pedestrian crossings where pedestrian beacons or signals are manually activated by a person pressing a pushbutton.
Americans with Disabilities Act (ADA)	A federal civil rights law that prohibits discrimination against people with disabilities in everyday activities. The ADA prohibits discrimination on the basis of disability just as other civil rights laws prohibit discrimination on the basis of race, color, sex, national origin, age, and religion. The ADA guarantees that people with disabilities have the same opportunities as everyone else to enjoy employment opportunities, purchase goods and services, and participate in state and local government programs.
Federal Highway Administration (FHWA)	An agency within the U.S. Department of Transportation that supports State and local governments in the design, construction, and maintenance of the Nation’s highway system (Federal Aid Highway Program) and various federally and tribal owned lands (Federal Lands Highway Program). Through financial and technical assistance to State and local governments, the Federal Highway Administration is responsible for ensuring that America’s roads and highways continue to be among the safest and most technologically sound in the world.
Interim Approval 21 (IA-21)	MUTCD Interim Approval for the optional use of Rectangular Rapid Flashing Beacons (RRFB) as pedestrian-actuated conspicuity enhancements for pedestrian and school crossing warning signs under certain limited conditions. Interim Approval allows interim use, pending official rulemaking, of a new traffic control device, a revision to the application or manner of use of an existing traffic control device, or a provision not specifically described in the MUTCD. Issued by FHWA on March 20, 2018.
Maintenance Access Route (MAR)	A 6-foot minimum clear distance, in accordance with section 8C.9.2 of the MNDOT Facility Design Guide, between any raised obstacles such as pushbutton stations, electrical foundations (signal, lighting, or cabinet), buildings, V curb, utility poles, sign posts, etc. MAR is needed for mechanical removal of snow and ice. A MAR is only required on the same route as the PAR.
Minnesota Manual on Uniform Traffic Control Devices (MN MUTCD)	A manual that establishes a uniform system of traffic control devices for streets, highways, bikeways and private roads open to public travel within Minnesota, and correlates and conforms to the National MUTCD.
Multi-Phase Crossing	A pedestrian crossing that requires pedestrians to activate pedestrian beacons or signals in the pedestrian refuge island in order to complete the crossing of a divided roadway.

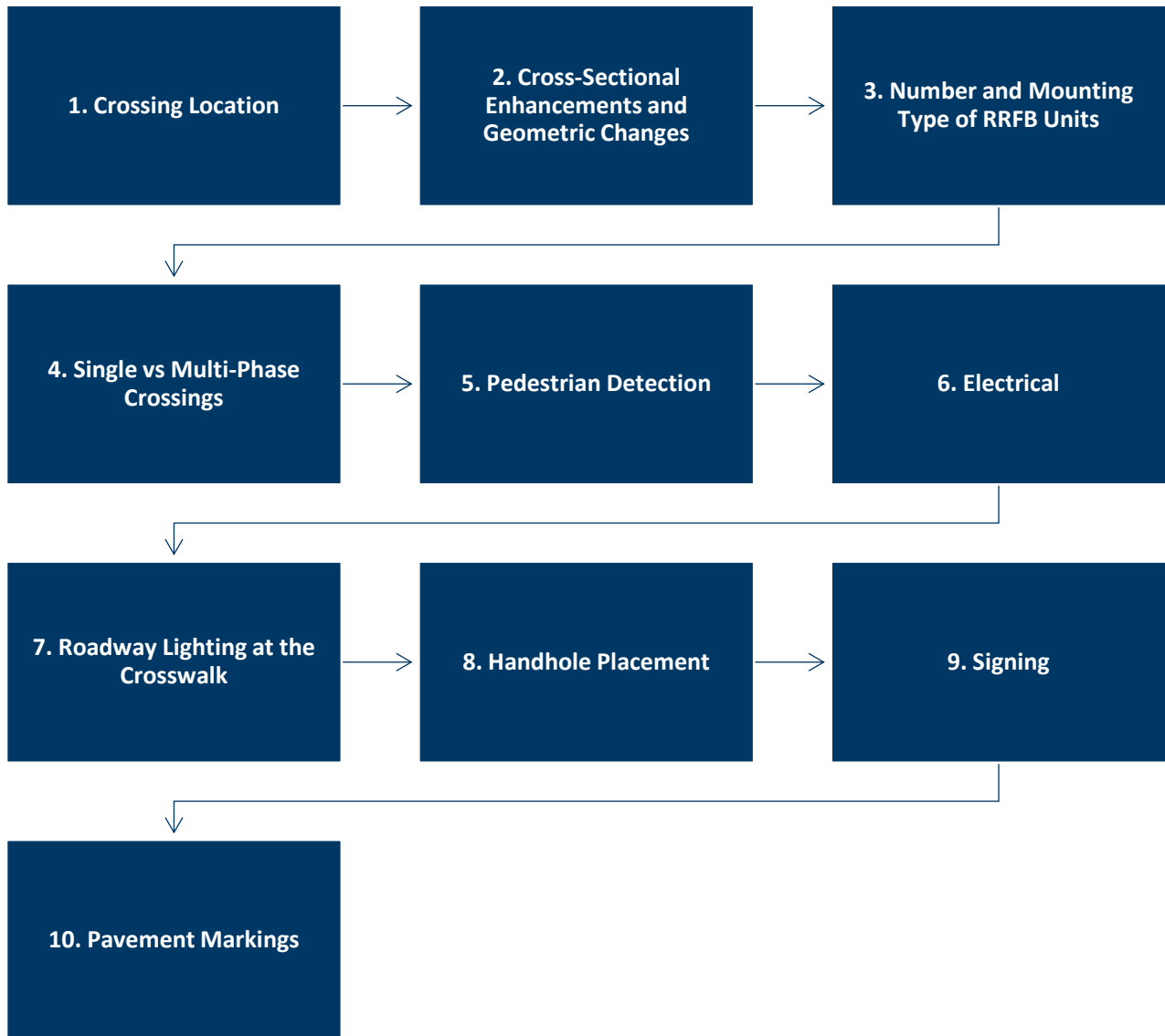
TERM	DEFINITION
Non-Motorized Facilities	Exclusive pedestrian and bicycle facilities such as sidewalks, shared use paths and trails.
Passive Pedestrian Detection	Enhanced pedestrian crossings where pedestrian beacons or signals are activated by sensors that detect the presence of pedestrians near pedestrian ramps.
Pedestrian Access Route (PAR)	A continuous and unobstructed walkway within a pedestrian circulation path that provides accessibility. A 6-foot minimum non-vehicular area for pedestrians to use when crossing the roadway. ¹
Pedestrian Hybrid Beacon (PHB)	A special type of hybrid beacon used to warn and control traffic at an un-signalized location to assist pedestrians in crossing a street or highway at a marked cross walk. The pedestrian hybrid beacon must be ADA-compliant, and, in most cases, the pedestrian hybrid beacon should be placed mid-block. Since the indications are displayed dark when in rest, it is not considered a traffic control signal.
Rectangular Rapid Flashing Beacon (RRFB)	A pedestrian-actuated crossing enhancement with bright flashing lights.
Single-Phase Crossing	A pedestrian crossing that requires one activation of the pedestrian beacons or signals.
Traffic Engineering Manual (TEM)	A reference guide that establishes traffic engineering related uniform guidelines and procedures, primarily for use by MnDOT.

¹ MnDOT’s Facility Design Guide (October 2021)

3. Design Process

Figure 2 summarizes the RRFB design process. While these steps are shown sequentially, some steps may overlap or are iterative. Design considerations related to each of these steps are further discussed in the next section.

Figure 2. Design Process Flowchart



4. Design Considerations

4.1. Crossing Location

This Design Guide assumes that the decision to install an RRFB has already been made and that a general location has been identified and coordinated with the District Traffic Engineer. Guidance in this section is intended for “fine-tuning” the crossing location. Refer to MnDOT’s [Traffic Engineering Manual](#) and district guidelines for further information regarding RRFB placement.

The RRFB system should be located using various assessments, including evaluating the location of origins and destinations, and the proximity to intersections, traffic signals, pedestrian hybrid beacons or other RRFBs. Considerations for evaluating potential crossing locations are summarized in Table 2.

Table 2. Crossing Location Considerations

TOPIC	CONSIDERATIONS
Pedestrian Routes	<ul style="list-style-type: none">• Seek input from local stakeholders familiar with pedestrian patterns and preferred crossing location.• Consider existing and proposed land uses, possible origins and destinations for non-motorized users, and network connectivity. If there is an existing crossing that pedestrians use, consider maintaining the crossing location. If there is a pedestrian crossing, but many pedestrians cross elsewhere, evaluate the RRFB's effectiveness at both locations.<ul style="list-style-type: none">○ <u>Example</u>: If a non-motorized facility intersects a roadway mid-block, consider placing the crossing mid-block because there is a higher likelihood that pedestrians will cross there instead of walking to the nearest intersection.• Consider demographic characteristics, such as those listed in the Minnesota Walks Report, of pedestrians that will use the RRFB.<ul style="list-style-type: none">○ <u>Example</u>: When near a school, consider that kids are more likely to cross midblock without a crossing than to walk to a crossing.○ <u>Example</u>: When near a retirement community, place the crossing near the building's entrance or near the destination(s) that pedestrians are most likely headed to, such as, parks, bus stops, grocery stores, etc.

TOPIC	CONSIDERATIONS
Intersection Control	<ul style="list-style-type: none"> RRFBs shall not be used for crosswalks across approaches controlled by YIELD signs, STOP signs, traffic control signals, or pedestrian hybrid beacons, except for the approach or egress from a roundabout (FHWA Interim Approval IA-21).
Sightlines	<ul style="list-style-type: none"> When placing RRFBs, consider potential sightline obstructions, such as trees or parked cars. Refer to MnDOT's Facility Design Guide for sight distance calculations.
In-Place Infrastructure and Drainage Features	<ul style="list-style-type: none"> Consider impacts to existing drainage features and other inplace infrastructure. For example, it may be more cost-effective to locate the pedestrian ramps away from an existing drainage inlet. Consider accessible pedestrian pushbutton placement criteria and whether it will conflict with existing infrastructure. Consider boulevard width, cross slope, location of sidewalk and non-motorized facilities, crossing distance, available right of way, etc. For example, it may be beneficial to shift the crossing location to a less space-constrained area or an area that provides shorter crossing distances. For mid-block locations, RRFBs shouldn't be placed within turn lanes or turn lane tapers.

4.2. Cross-Sectional Enhancements and Geometric Changes

A roadway’s cross section or intersection configuration can impact safety at crossings by reducing crossing distances, slowing vehicle speeds, and improving visibility. Consider the following:

- Bump outs
- Pedestrian refuges
- Lane width reductions
- Lane reductions (road diet)
- Vertical road elements such as raised crosswalks or raised intersections
- Z Crossing (also known as staggered crossing, see Figure 3 for an example)

Figure 3. Z Crossing¹



Other considerations include:

- Parking restrictions to maintain sightlines
- Bus stop locations
 - Does the existing bus stop block sightlines of pedestrian crossings?
 - If an existing bus stop remains in place will the bus be stopping in the crossing?
- Existing utilities and infrastructure
 - Identify infrastructure and utilities impacts
 - Coordinate with other design units for removal or relocation of impacts, such as light poles, inlets, or utility lines

More information related to the topics above can be found on MnDOT's [Pedestrians Design and Engineering](#) webpage.

Americans with Disabilities Act (ADA) compliant pedestrian ramps are required at RRFB locations. Refer to MnDOT's Curb Ramp Standard Plan 5-297.250 for more information.

¹ MnDOT's Best Practices for Pedestrians and Bicycle Safety (January 2021)

4.3. Number and Mounting Type of RRFB Units

4.3.1. Mounting Type of RRFB Units

Table 3 shows guidance for the placement and mounting type of the RRFB unit based on lane and road configuration. In accordance with the FHWA interim Approval IA-21, when ground mounted, the RRFB shall be placed on both left- and right-hand sides of the roadway. On a divided highway, the left-hand side beacon should be installed on the median, rather than the far-left side of the roadway. Designers should evaluate RRFB visibility for each approach.

Table 3. RRFB Placement

Presence of Refuge Island	Cross Sectional Crossing Distance (Feet) (See Notes A & B)	Left Side RRFB	RRFB On Refuge Island	Overhead RRFB (See Note D)	Right Side RRFB
With Refuge Island	0-30 (Less than 3 lanes)	Optional	Required (See Note C)	Optional	Required
With Refuge Island	>30-52 (3 lanes or more)	Optional	Required (See Note C)	Recommended	Required
Without Refuge Island	0-40 (Less than 3 lanes)	Required (See Note E)	-	Optional	Required
Without Refuge Island	>40-57 (3 lanes or more)	Required	-	Recommended	Required

Note A) If the crossing distance is larger than the values in this table and/or has a speed limit above 45 miles per hour, reconsider the use of an RRFB.

Note B) Crossing distance is measured from face-of-curb to face-of-curb. Either measured to the far side of road or refuge island (where present), for each crossing stage. In the absence of curbs, this is measured from the:

- Edges of pavement, where the driving surface is adjacent to a gravel shoulder.
- Edges of the traversable roadway, where the driving surface transitions to adjacent driveways or parking surfaces.

Note C) An RRFB may be mounted overhead and/or on the refuge island based on engineering judgement. Pedestrian detection should be installed on the refuge island, even if there is no RRFB on the refuge island.

Note D) Consider the visibility and sightlines of right- and left- (or median-) side RRFB units when determining whether to use overhead RRFBs. For example, sightlines may be impacted by presence of horizontal or vertical curvature in the roadway, presence of obstacles such as vegetation or infrastructure on the side of the roadway, or lateral offset of the RRFB unit. Note that lateral offset requirements vary depending on presence of curb, see Standard Plan 5-297.701 for Standard Sign Placement.

Note E) If an overhead RRFB is installed, a left side RRFB is not required.

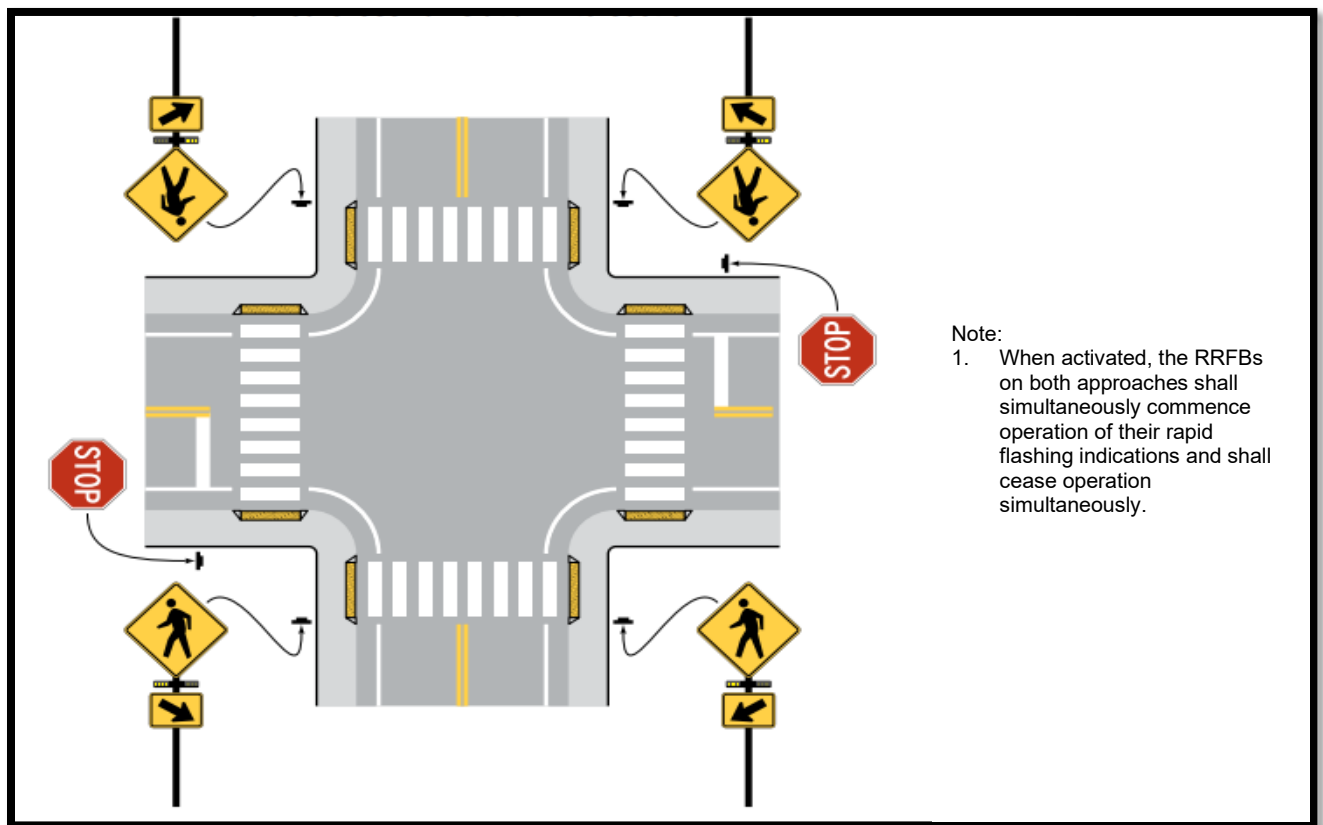
When sight distances approaching a crosswalk are less than deemed necessary by the engineer, an additional RRFB may be installed in advance of the crosswalk. Any additional RRFBs installed in advance of the crosswalk are supplemental; they shall not be a replacement for the RRFBs at the crosswalk itself.

When an overhead RRFB is being used, it should be located over the center of the lanes or where optimum visibility is achieved.

Best practice is to place mid-block RRFBs downstream of the crossing, when possible. This provides better sightlines between pedestrians and approaching vehicles.

RRFBs may be installed at an intersection with more than one crosswalk on the same uncontrolled approach (See Figure 4). If used, RRFBs may be installed facing only one direction of travel at the first crosswalk that traffic encounters. If this configuration is used, all four RRFBs shall simultaneously flash when the system is activated. Because of this, this configuration may not be desirable for multi-phase crossings. A downside of this configuration is that turning vehicles from the side street may not have visibility to the RRFB. For example, if the RRFBs are only facing approaching eastbound and westbound traffic, a vehicle making a turn from the northbound or southbound approaches wouldn't have visibility to the RRFBs.

Figure 4: Example of RRFBs at Uncontrolled, Marked Crosswalks at an Intersection¹



¹ Figure 4L-1, MUTCD, 11th Edition, published by FHWA at https://mutcd.fhwa.dot.gov/kno_11th_Edition.htm

4.3.2. Pole and Foundation Types

Overhead RRFBs will be placed on TS pole and TS pole foundations. Mast arm length should be long enough to allow for overhead RRFBs to be centered over approach lane(s) and such that overhead signs do not overlap. If a push button is attached to a TS pole, an adaptor extension is required.

Non-overhead RRFBs can be mounted on the following:

- Signal head pedestal pole (with base), as listed on MnDOT’s APL
- Four-inch diameter straight pedestal pole (shaft)
- Square tube post (only to be used for solar powered systems)

All pedestal mounted RRFB systems should use a light foundation design E. If a push button is attached to a pedestal pole, a saddle adaptor is required.

4.4. Single vs Multi-Phase Crossings

If the RRFB is being placed across bi-directional traffic and a 6-foot minimum¹ raised pedestrian refuge, then a multi-phase crossing is recommended.

Other reasons to consider a multi-phase crossing include:

- To maximize the flashing when pedestrian is present
- To force the pedestrian to look by having them push the pushbutton both times
- High traffic volumes and low gap availability²

4.5. Pedestrian Detection

4.5.1. Audible Message

Pedestrian Detection shall have an audible component. The audible component shall say, “Warning lights are flashing.” The message shall be spoken twice.

4.5.2. Pushbutton Placement

Pushbuttons, in ADA-compliant locations, should be installed with any RRFB, unless passive detection is used. Pushbuttons used at traffic signals or pedestrian hybrid beacons have different operational features when compared to a RRFB. Vibro-tactile pushbuttons shall not be used at RRFBs.

For pushbuttons to be accessible, they should be placed in accordance with the guidance in the MN MUTCD, Section 4E.8³ and located as shown in the RRFB Accessible Push Button Location Details. Note

¹ MnDOT’s Facility Design Guide (October 2021)

²See Figure 6 of Clark County’s Pedestrian Crossing Policy for additional guidance: https://clark.wa.gov/sites/default/files/dept/files/public-works/Traffic/Pedestrian_Crossing_Policy.pdf

³ 2011 MN MUTCD published by MnDOT at <https://www.dot.state.mn.us/trafficeng/publ/mutcd/index.html>

that pushbuttons should not be placed in the pedestrian ramp. It is also important to maintain a 6-foot maintenance access route (MAR) to allow for proper winter maintenance.

From a cost, space, and maintenance perspective, pushbuttons should be mounted on the same post as the RRFB system. However, pushbuttons may be mounted separately from the RRFB system.

4.5.3. Passive Detection

- This section is in development and MnDOT does not have design guidance for Passive Detection (which is permitted in the National MUTCD, 11th Edition and 2023 PROWAG).

4.6. Electrical

4.6.1. Source of Power

RRFBs can be powered via solar power, or via hardwire connection to a source of power. Coordination will be needed with the district, Local Unit of Government, and Electrical Services Section to make this decision.

Please note: Hardwired RRFBs need to be approved by a Nationally Recognized Testing Laboratory (NRTL), such as UL. At this time, there's no RRFBs approved by NRTL and hardwired application are not approved.

For hardwired systems, conduit is needed from each pole to the controller cabinet. The conduit will have one 4/C 14 AWG (for the light bar) and one 1/C 6 AWG insulated grounding wire. Each pole with a pushbutton will need one 2/C 14 AWG. Each standalone pushbutton pedestal will also need a 1/C 6 AWG insulated grounding wire.

These are a few things to consider when determining how the RRFB system will be powered:

- Solar panels need sufficient sunlight to meet power needs
- Hardwire systems require a source of power in proximity of the RRFB
- Solar batteries must be replaced every few years and solar panels must be replaced every 25-30 years or less

4.6.2. System Communication

In accordance with FWHA IA-21 "All RRFB units associated with a given crosswalk (including those with an advance crossing sign, if used) shall, when actuated, simultaneously commence operation of their rapid-flashing indications and shall cease operation simultaneously." The communication that allows units to flash simultaneously can be implemented wirelessly or via hardwiring. Additional connectivity may be added to access or monitor the RRFB system remotely.

Note the following regarding hardwired and wireless communication:

- For hardwired communication
 - Trenching or boring of conduit is required

- For wireless communication
 - Each RRFB unit uses a radio (typically integrated with the controller cabinet)
 - Solar-powered systems have wireless communication

4.6.3. Cabinets

The types of cabinets used for an RRFB system vary depending on power type:

- Solar powered systems use a pole mounted RRFB controller cabinet
- Hardwired systems use a pole mounted controller cabinet, as well as a service cabinet

For solar-powered systems, the solar panel size affects the controller cabinet type. The size is affected by how much wattage is needed based on factors such as the number of RRFB lights being powered, estimated sunlight on the shortest day of the year, passive sensors, pushbuttons, and remote connectivity. The controller cabinet may be integrated with the solar panel, or may be a separate component.

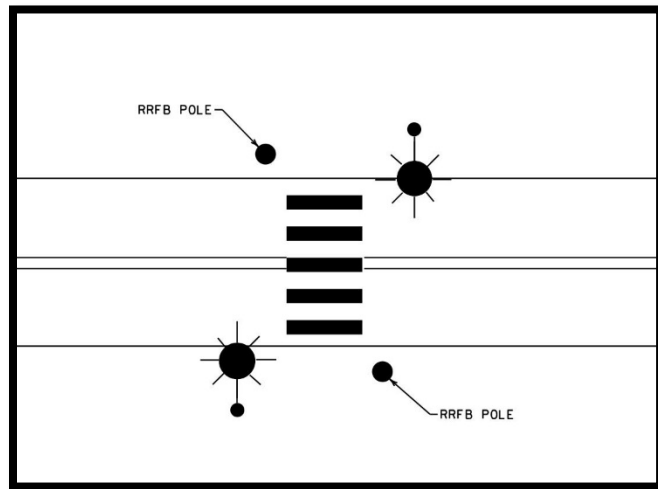
For hardwired systems, a service cabinet will be required for the connection to a source of power. It is recommended that either a Pole Mounted Type B service cabinet (typically used for roadway lighting), or a Rural Lighting and Flasher (RLF) cabinet be used. Both can be found on MnDOT's Approved/Qualified Products List.

4.7. Roadway Lighting at the Crosswalk

The [FHWA Pedestrian Lighting Primer](#) shows recommended lighting standards for crossings. The entire crossing, including any refuge area in the roadway and sidewalks or shoulders adjacent to the crosswalk should be lit.

Lighting increases a driver's ability to see a pedestrian in low light conditions, especially when the pedestrian does not activate the RRFB system. When installing lighting, poles should be installed in advance of the crosswalk, as shown in Figure 5, so pedestrians are not backlit. When placing the poles, make sure they are offset adequately to not impact visibility of the RRFB and to avoid obscuring sightlines to pedestrians waiting to cross.

Figure 5. RRFB Lighting Placement



4.8. Handhole Placement

Handholes may need to be installed with the system if it is hardwired. If it is determined that handholes are needed for the RRFB, see guidance in MnDOT's [Traffic Control Signal Design Manual](#). Handholes should be located outside of the pedestrian access route (PAR) and, preferably, outside of the sidewalk.

4.9. Signing

Figure 6 shows the recommended signing, which will vary based on proposed conditions and the RRFB mounting type.

The following are considerations related to signing:

- If parking is allowed on the segment, a parking restriction shall be placed 30' in advance of the crossing. If parking is not allowed, a R8-3 (NO PARKING) sign should be placed prior to the R1-5B (STOP HERE FOR PEDESTRIANS).
- Consider use of in-street signs R1-6C or R1-6A (In-Street Pedestrian Crossing Signs). See Chapter 6 of MnDOT's [Traffic Engineering Manual](#) for guidance.
- RRFBs shall not be used for crosswalks across approaches controlled by YIELD signs, STOP signs, traffic control signals, or pedestrian hybrid beacons, except for the approach or egress from a roundabout¹.
- Consider sign density and sightlines when placing signs and omit or move existing signs as needed. For example, on divided highways, DO NOT ENTER or KEEP RIGHT signs at median openings could block sightlines to the RRFB and may need to be moved or omitted.
 - See Chapter 6 of MnDOT's [Traffic Engineering Manual](#) for more information on sign spacing and additional considerations.

¹ FHWA Interim Approval IA-21 (March 2018)

4.10. Pavement Markings

All RRFB's shall have crosswalk markings that follow the guidance below:

- Part 3 and 7 of the [MN MUTCD](#)
- [MnDOT Pavement Marking Typical Details](#) – Crosswalks

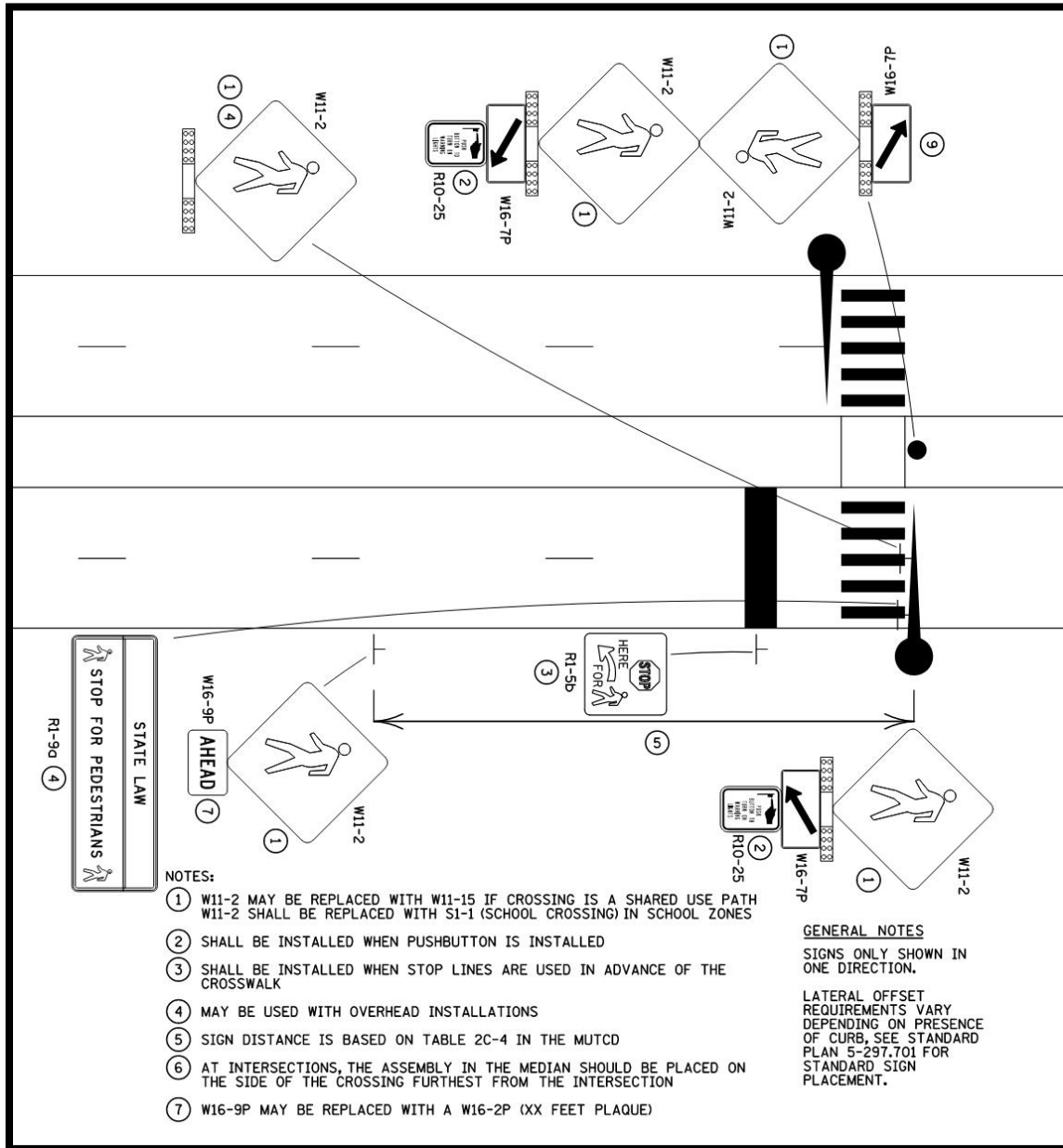
Stop lines may be used in accordance with Part 3 of the MN MUTCD. For mid-block locations, refer to MnDOT Pavement Marking Typical Details – Stop Line at Unsignalized Mid-Block Crosswalks.

Advance stop lines, which are placed 20 to 50 feet in advance of the crossing, are recommended for multilane roads to reduce the risk of stopped vehicles from blocking sightlines to a person crossing or to the RRFB from approaching drivers.

A visual of stop lines and crosswalk markings (blocks) is provided in Figure 6.

Word symbols such as "SCHOOL XING" OR "PED XING" may also be used in accordance with the Part 3 of the MN MUTCD or Chapter 13 of the TEM

Figure 6. Signing Layout at a Mid-Block Crossing with a Refuge Island



5. Checklists

5.1. Pre-Design

- Identify who is responsible for maintenance, operations, and ownership
 - Complete agreements
- Identify who will pay for the system
 - Identify cost split (if applicable)
- Locate existing utilities and request a Gopher State One Call for design locates
- Get concurrence from the District Traffic Engineer or designee on the location

5.2. Plan

- Title Sheet
- Statement of Estimated Quantities, Abbreviations, Legend
- Tabulation of Standard Plans and Plates
- RRFB System Details
- Intersection Details
- RRFB Layout Sheets (System A, B, C, etc.)
- Wiring Diagram (only for hardwired systems)
- “For Information Only” Plan Sheet(s) (if applicable, for example, modifying or replacing an RRFB system)
- RRFB System Signing Details
- Applicable plan sheets for other disciplines (i.e., soils & construction notes, utilities, alignment, removals, construction, drainage, temporary traffic control, lighting, roadway signing, pavement markings, etc.)
- Get concurrence from the District Traffic Engineer or designee on design approach

5.3. Post-Construction

- Update MnDOT’s Traffic Asset Management System (TAMS) Inventory
- Consider implementing annual educational campaigns
- Report the RRFB on [the statewide interim approvals website](#)
- Archive as-built data, plans, and agreements/permits

6. Design Resources

Details, Standard Plans, and Standard Plates

- Curb Ramp Design (Standard Plan 5-297.250): <https://standardplans.dot.state.mn.us/>
- Pavement Marking Typical Details:
<https://www.dot.state.mn.us/trafficeng/pavement/typicaldetail/index.html>
- Sign Mounting Standard Plans and Details:
<https://www.dot.state.mn.us/trafficeng/signing/plans.html>

Manuals

- Minnesota Manual on Traffic Control Devices (MN MUTCD):
<https://www.dot.state.mn.us/trafficeng/publ/mutcd/>
- Traffic Engineering Manual (TEM):
<https://www.dot.state.mn.us/trafficeng/publ/tem/index.html>
- Signal Design Manual: <https://www.dot.state.mn.us/trafficeng/signing/publications.html>
- Standard Signs and Markings Manual and Summary:
<http://www.dot.state.mn.us/trafficeng/publ/signsmanual/index.html>

Special Provisions (Division SS)

- <https://www.dot.state.mn.us/pre-letting/prov/>

Approved Product List

- <https://www.dot.state.mn.us/products/>

Other Resources

- MUTCD Interim Approval 21 - RRFBs at Crosswalks
https://mutcd.fhwa.dot.gov/resources/interim_approval/ia21/index.htm
- FHWA Rectangular Rapid Flashing Beacon <https://highways.dot.gov/safety/proven-safety-countermeasures/rectangular-rapid-flashing-beacons-rrfb>
- FHWA Pedestrian Hybrid Beacons <https://highways.dot.gov/safety/proven-safety-countermeasures/pedestrian-hybrid-beacons>
- FHWA Medians and Pedestrian Refuge Island <https://highways.dot.gov/safety/proven-safety-countermeasures/medians-and-pedestrian-refuge-islands-urban-and-suburban-areas>
- "Rectangular Rapid Flash Beacon" in PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System. FHWA, (2013).

- Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)
- MnDOT Accessibility Webpage: <https://www.dot.state.mn.us/ada/design.html>
- MnDOT Pedestrians Design and Engineering Webpage:
<https://www.dot.state.mn.us/peds/design-engineering.html>