City of Albuquerque

Bicycle and Trail Crossings Guide

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Introduction

Background

New Mexico regularly has the highest (or among the highest) rate of pedestrian fatalities per capita in the nation, and Albuquerque crashes account for 42% of the state's fatal pedestrian-involved crashes. In 2019, 13% of pedestrians involved in a crash died as a result (NMDOT, 2019). Additionally, New Mexico ranks as the fifth worst state for bicyclist fatalities per capita and bicycle fatalities per bicycle miles traveled (Streetlight Data, 2021).

At least 52% of pedestrian fatal crashes in New Mexico occurred at locations without traffic signals or stop signs (the actual percentage is likely much higher, as over a quarter of police reports did not include crash location). Given the high rates of pedestrian and bicyclist fatalities, especially fatalities where no traffic control exists, creating safe pedestrian and bicyclist crossing opportunities throughout the City of Albuquerque is of high importance.

Albuquerque has hundreds of miles of off-street multi-use paths, providing excellent opportunities for walking and biking within the city. However, with the exception of the Bosque Trail and North Diversion Channel Trail (which have grade-separated crossings along their entire lengths), multi-use trails frequently intersect with wide, high-speed arterial roadways. Long block lengths in many parts of the city also create challenges for pedestrians trying to cross, as signalized pedestrian crossings are often placed over a half mile apart. More frequent and safer designated crossing locations are a means of addressing these safety issues and enhancing conditions for bicyclists, pedestrians, and trail users across Albuquerque.

Purpose

The purpose of this report is to provide clear and consistent guidance for the design and application of bicycle and pedestrian crossings within the City of Albuquerque. This report is divided into two parts. The first section describes **countermeasures** to improve safety at crossing locations. Countermeasures are ordered from least comprehensive to most comprehensive and include visibility treatments, signal treatments, and infrastructure treatments.

The second section provides a **three-step decision-making tool** on how apply crossing treatments to specific roadway contexts.

- Step 1 determines the **appropriateness of a location for a crossing** based on its Comprehensive Plan designations, distance from other crossings, proximity to transit, safety considerations, and presence of special generators and trails.
- Step 2 determines the **technical feasibility** of a location for a crossing based on engineering factors.
- Step 3 provides guidance on selecting **appropriate treatments** given a roadway's width, speed, and traffic volumes.

Role of the MUTCD

The Manual of Uniform Traffic Control Devices (MUTCD) serves as the primary reference for **design standards and signage placement**, while this document and the Development Process Manual (DPM) serve as the primary references in selecting a **crossing location** and the **appropriate treatment** for a crossing.

Introduction

Policy Guidance

The following Albuquerque plans and policies support the implementation of improved bicycle and pedestrian crossings and provide guidance on their design and location.

Comprehensive Plan: The Albuquerque/Bernalillo County Comprehensive Plan (Comp Plan) provides guidance on where pedestrian crossings should be prioritized based on Center and Corridor designations. Centers are areas within the metropolitan area that are planned for higher-intensity uses and include Downtown, Urban Centers, Activity Centers, Employment Centers, and Village Centers. Corridor designations help prioritize street elements and modes based on anticipated or desired users, and include Premium Transit Corridors, Major Transit Corridors, Main Street Corridors, Multi-Modal Corridors, and Commuter Corridors. See Comp Plan Figure 5-2 for a map of Albuquerque's Centers and Corridors. In the Comp Plan, Premium Transit, Major Transit, and Main Street Corridors are the highest priority locations for crossings, especially where these roadways intersect with a Center or transit station.

Development Process Manual: The City of Albuquerque's DPM provides guidance and standards on street design to ensure consistent high-quality infrastructure throughout the city and includes sections on the design and location of pedestrian/bicyclist crossings. The DPM recommends signalized crossings (through traffic signals or pedestrian hybrid beacons) at all existing traffic signals and at least every ½ mile. For crossings at unsignalized locations, the DPM provides a decision path to determine the appropriate design and level of vehicular control (DPM Figure 7.4.52).

Complete Streets Ordinance: The City of Albuquerque Complete Streets Ordinance requires that all roadway projects, excluding maintenance projects, be designed to "mitigate existing, insufficient multi-modal facilities" and include consideration of all modes of transportation. Per the Ordinance, Complete Streets should "allow comfortable and convenient street crossings and pedestrian access to adjacent land uses." The Complete Streets Ordinance encourages enhanced mid-block crossings with high-visibility markings and, where necessary, pedestrian hybrid beacons or traffic signals. Roadway projects are also required to include appropriate measures to facilitate the crossing of bicycle traffic.

Vision Zero Action Plan and Executive Order: The City of Albuquerque's Vision Zero Initiative has the goal of eliminating traffic fatalities in Albuquerque by 2040. The Vision Zero Action Plan outlines techniques for achieving this goal, including Complete Streets designs, speed management, and increasing opportunities for walking and rolling.

Crossing Design Elements

Introduction

The following section describes crossing design elements that can be installed to designate a pedestrian crossing. These include: **signal treatments**, **visibility treatments**, and **infrastructure treatments**.

The measures described in this report should rarely be installed as stand-alone treatments, as pedestrian crossings are safest when a combination of tools are used. For example, visibility treatments like crosswalks and signage can be combined with infrastructure treatments such as curb extensions or refuge islands to create a safer and more comfortable crossing.

Pedestrian crossings can be defined as either designated or undesignated crossings. Designated crossings can be either signalized or unsignalized; undesignated crossings are always unsignalized. Figure 1 and Figure 2 are examples of designated and undesignated crossings, while Figure 3 and Figure 4 are examples of signalized and unsignalized crossings, respectively.

Designated vs Undesignated Crossings

The City of Albuquerque's DPM defines **designated pedestrian crossings** as those "where pedestrians are encouraged to cross a roadway, as indicated by a combination of signal devices, signage, or pavement markings."

Undesignated crossings are locations without pavement markings, signal devices, or signage where pedestrians may legally cross a roadway. These crossings are typically at intersections with smaller streets that have sidewalk and may have a stop sign; pedestrians are expected and encouraged to cross at these locations but there are no formal signs or striping that indicate the presence of a pedestrian crossing. Designated pedestrian crossings generally provide a higher level of safety and comfort than undesignated crossings (see Table 1).

Table 1: DPM Table 7.4.43 Designated Pedestrian Crossing Types

TABLE 7.4.43 **Designated Pedestrian Crossing Types**		
↑ COMFORT / SAFETY	**Controlled Locations**	Traffic control device (signal or stop signs)
		Pedestrian hybrid beacon
	Uncontrolled Locations	Flashing beacon (rapid rectangular flash beacon, in-pavement flashers)
		Pedestrian refuge island
		Signage (in-street, overhead, or sign post)
		Marked crosswalk (no signs or signals)

State of New Mexico Law: Drivers are required by law in New Mexico to yield to pedestrians in a crosswalk (NM Stat §66-7-334). When crossing at any location other than a crosswalk or an unmarked crosswalk at an intersection (i.e. an undesignated crossing), pedestrians are allowed to cross but must yield to vehicles (NM Stat §66-7-335).

Signalized vs Unsignalized Crossings

Signalized crossings are associated with a traffic signal or other traffic control device that requires vehicle traffic to come to a complete stop. Generally, signalized pedestrian crossings are located only at intersections with a full traffic signal or at pedestrian hybrid beacons (PHBs), also referred to as HAWK signals.

Unsignalized crossings are designated crossings that do not have traffic signals and may be located at mid-block locations or intersections.

Crossing Design Elements

Figure 1: Designated Signalized Crossing at Tramway Blvd and Spain Rd

Figure 2: Undesignated Crossing at Garfield Ave and Richmond Dr

Figure 3: Designated Signalized Crossing at Lomas Blvd and Alvarado Dr

Figure 4: Unsignalized Designated Crossing at San Pedro Dr and Claremont Ave

Crossing Design Elements: Enhanced Visibility Treatments

Enhanced Visibility Treatments

Enhanced visibility treatments, including signage, crosswalk markings, advance stop or yield lines, in-street pedestrian crossing signs, overhead flashing lights, pedestrian-scale lighting, and rectangular rapid flashing beacons (RRFBs), can alert drivers to the presence of a crosswalk and increase the likelihood of drivers yielding at crossing locations.

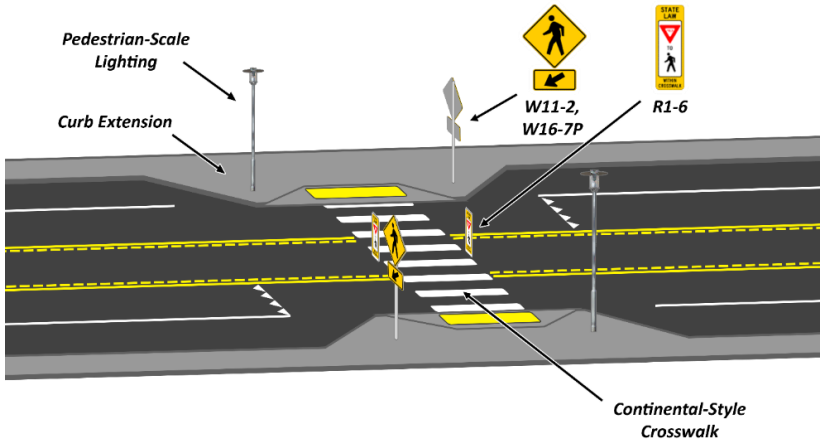
High-visibility crosswalk markings with signage can act as a stand-alone treatment on slower-speed, lower volume roadways (see Figure 5) or as complementary treatments to signalized crossings or RRFBs on high-speed, busier roadways.

Each enhanced visibility treatment in this report is meant to be installed with other visibility treatments and/or infrastructure treatments. For example, crosswalk markings can be paired with signage, curb extensions, pedestrian-scale lighting, and in-street pedestrian crossing signs to create a comfortable, high-visibility crossing location (see Figure 6).

All enhanced visibility treatments increase the visibility of the crossing for motorists, have minimal impacts on traffic operations, and are low-cost.

Figure 5: High Visibility Crosswalk Markings and Signage on Mountain Rd

Figure 6: Enhanced Visibility Treatments at Unsignalized Crossing



Crossing Design Elements: Enhanced Visibility Treatments

Signage

A variety of signs can designate a location as a crossing and alert drivers to the presence of pedestrians and bicyclists. Pedestrian crossing signs are usually installed at the crosswalk location and may have a placard with an arrow pointing to the crosswalk.

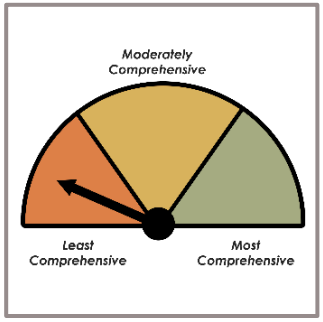


Figure 7: Bicyclist Crossing Signage at Indian School Rd near North Diversion Channel Trail

Benefits

Increases visibility: Signs can remind drivers that they are required by law to yield to pedestrians within a crosswalk and alert drivers to trail crossings or areas with high pedestrian/bicyclist activity.

Education: Signs educate and remind drivers that motorists must yield to people crossing.

Limitations

Not effective as stand-alone treatment: Signs must be accompanied with other crossing treatments to be effective.

Design Considerations

MUTCD compliance: Pedestrian crossing signs that communicate the location of a crosswalk are required to conform to standards contained in the MUTCD. The typical pedestrian crossing sign is a rotated square with a yellow or fluorescent green retroreflective background and a black silhouette of a pedestrian. Pedestrian crossings may also include “Yield to Pedestrian” signs, “Stop for Pedestrians” signs, or other signs that remind drivers of state laws requiring yielding or stopping for pedestrians within crosswalks.

Table 2 shows MUTCD-approved signs for crossing locations. Additional signs for school zones can be referenced in MUTCD Section 7B.08.

Advance stop or yield signs: When applied in conjunction with an RRFB, advance yield or stop signs should be located 30 to 50 feet in advance of the crosswalk (MUTCD R1-5 signs). Advance crossing signs have been associated with increased driver yielding rates and

help address concerns related to multiple threat crashes on multi-lane roadways.

Complementary Treatments

Signage alone is not sufficient to create a safe crossing location and should be accompanied with other treatments. Signage can be paired with:

- High visibility crosswalk markings
- Advance stop/yield lines
- In-street pedestrian crossing signs
- Pedestrian scale lighting
- RRFBs
- PHBs
- Infrastructure treatments such as pedestrian refuge islands, curb extensions/bulb-outs, raised crosswalks, and road diets

Location/Context

Although signage and crosswalk markings are adequate treatments for low-speed, low-volume roadways, these treatments alone are generally **not sufficient** in the following conditions:

- Where the speed limit is greater than 40 mph.
- Where pedestrians must cross two or three lanes a time, speed limits are 35 mph or above, and average daily traffic (ADT) is greater than 9,000.
- Where pedestrians must cross four or more lanes at a time, speed limits are above 30 mph, and ADT is greater than 9,000.

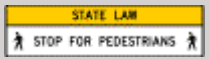
Crossing Design Elements: Enhanced Visibility Treatments

Table 2: Pedestrian and Bicycle Warning Signs, MUTCD

Image	*Name*	*MUTCD Reference*	*Image*	*Name*	*MUTCD Reference*
	**Pedestrian Warning Sign**	*W11-2* *Section 2C.50*		**Downward Diagonal Arrow (to be used with Pedestrian and/or Bicyclist Warning Sign)**	*W-16-7p* *Section 2C.50*
	**Bicycle Warning Sign**	*W11-1* *Section 2C.50*		**School Sign**	*S1-1* *Section 7B.08*
	**Bicycle and Pedestrian Warning Sign**	*W11-15* *Section 2C.50*		**Trail X-ing Plaque**	*W11-15P* *Section 2C.50*
	**Trail Crossing**	*W11-15a Section 2C.50*		**When Flashing Plaque**	*W16-13P* *Section 2C.50*

Crossing Design Elements: Enhanced Visibility Treatments

Table 3: Signs for Unsignalized Crossings, MUTCD

Image	*Name*	*MUTCD Reference*	*Image*	*Name*	*MUTCD Reference*
	**Yield Here to Pedestrians**	*R1-5* *Section 2B.11*		**Stop Here for Pedestrians**	*R1-5c* *Section 2B.11*
	**Yield Here to Pedestrians**	*R1-5a* *Section 2B.11*		**In-Street Pedestrian Crossing (Yield)**	*R1-6* *Section 2B.12*
	**Stop Here for Pedestrians**	*R1-5b* *Section 2B.11*		**In-Street Pedestrian Crossing (Stop)**	*R1-6a* *Section 2B.12*
	**Overhead Pedestrian Crossing (Yield)**	*R1-9* *Section 2B.12*		**Overhead Pedestrian Crossing (Stop)**	*R1-9a* *Section 2B.12*

Crossing Design Elements: Enhanced Visibility Treatments

High Visibility Crosswalk Markings

Crosswalk markings serve two primary purposes: 1) communicating to pedestrians the safest place to cross; 2) legally designating a location where vehicles must yield to those crossing. High visibility crosswalk marking types include continental, continental with transverse bars, and zebra, as shown in Figure 8. The DPM recommends continental-style crosswalks with or without transverse bars.

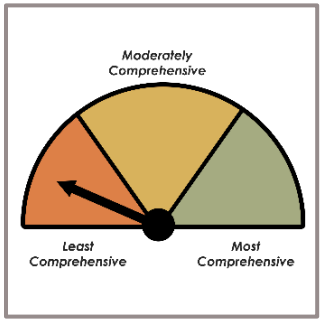
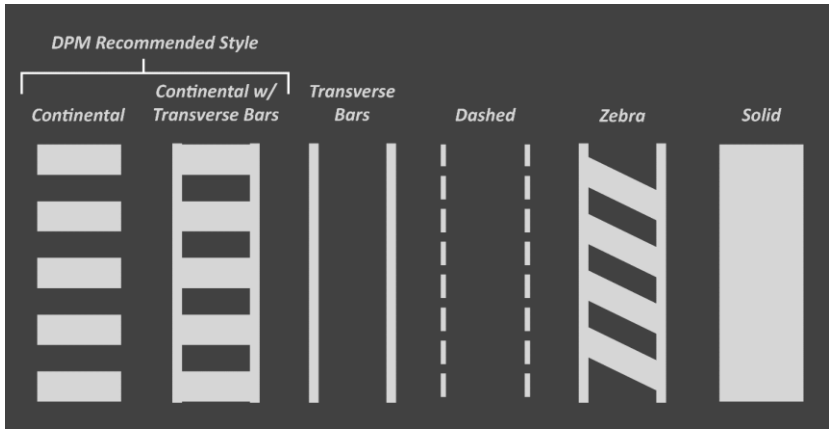


Figure 8: Crosswalk Marking Types



Benefits

Reduce pedestrian crashes: High visibility crosswalk markings may reduce pedestrian crashes by up to 40% (Chen et al., 2012), although some studies have shown that crosswalk markings alone without other visibility enhancements do not reduce crashes (Zegeer et al., 2005).

Increase driver yield rates: High visibility markings have been proven to increase driver yielding rates and are more easily detected by drivers than standard crosswalk designs (NCHRP, 2016). A study that examined driver yield rates on two-lane streets with speed limits of 25 or 30 mph indicated that in-street pedestrian crossing signs with high visibility signs and crosswalk markings had yield rates ranging from 82% to 91% (NCHRP, 2006).

Limitations

Not effective as stand-alone treatment: In most locations, crosswalk markings alone are not sufficient to allow pedestrians to safely cross the street. Along streets with traffic volumes greater than 12,000 ADT, crosswalk markings can increase crash rates if not installed with other crossing improvements (Zegeer et al., 2005).

Maintenance: Crosswalk markings need regular maintenance and re-painting to remain highly visible to drivers. Crosswalk markings are likely to last longer on the pavement if placed between the wheel path of vehicles.

Crossing Design Elements: Enhanced Visibility Treatments

Complementary Treatments

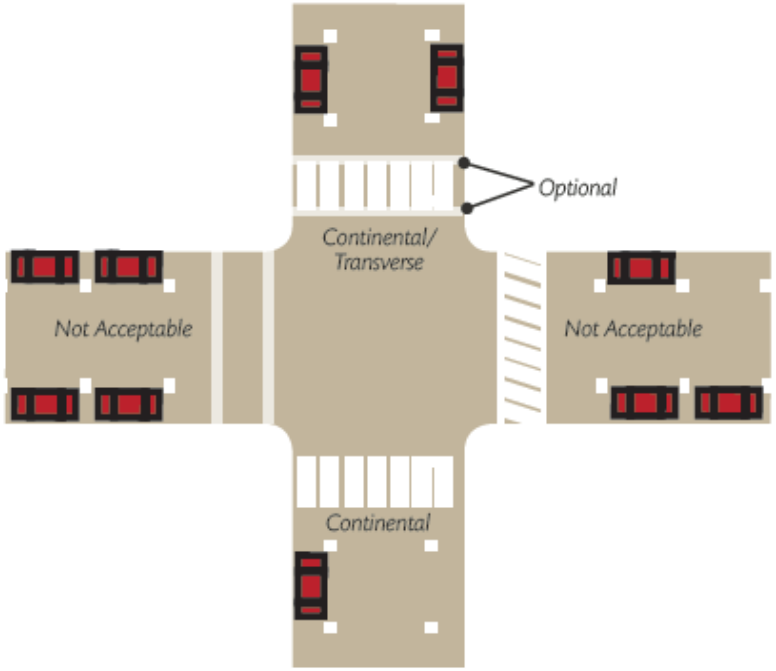
Crosswalk markings alone are not sufficient to create a safe crossing location and should be accompanied with other treatments such as:

- Warning signage
- Advance stop/yield lines
- In-street pedestrian crossing signs
- Pedestrian-scale lighting
- RRFBs
- PHBs
- Infrastructure treatments such as pedestrian refuge islands, raised crosswalks, curb extensions/bulb-outs, and road diets

Design Considerations

Recommended style: DPM section 7-4(E)(1)(ix) provides guidance on crosswalk markings, recommending high-visibility **continental** crosswalk markings for all crosswalks. Transverse bars may be placed in conjunction with continental crosswalk markings but should not be used as a stand-alone crosswalk. Figure 9 shows the DPM recommended crosswalk designs.

Figure 9: DPM Figure 7.4.72 Crosswalk Markings



Width: Per the DPM, crosswalks within Centers should be at least 10 feet wide and crosswalks outside of Centers should be at least 6 feet wide.

Pavement materials: DPM section 7-4(C) provides guidance on crosswalk pavement and marking materials. Alternative pavement materials, such as brick, pavers, permeable pavement, stamped concrete, or gravel, may be used to differentiate the crosswalk from the rest of the street (7-4(C)(7)).

Crossing Design Elements: Enhanced Visibility Treatments

Location/Context

In New Mexico, vehicles are not required to yield to pedestrians unless they are crossing within a marked crosswalk. Therefore, crosswalk markings should always be used in locations where driver yielding is desired, especially in locations where bicyclists and pedestrians would experience long delays while waiting for gaps in traffic. Figure 10 is an example of a bicycle crossing location without crosswalks where bicyclists must yield to vehicles before crossing.

Potentially Dangerous Applications

There are some contexts where marking a crosswalk without installing other crossing treatments can *decrease* safety for those attempting to cross. These contexts include:

- Roads with speed limits of 40 mph or greater
- Roads with four or more lanes, no raised median or refuge island, and ADT of 12,000 or greater
- Roads with four or more lanes with a raised median or refuge island with ADT of 15,000 or greater (Zegeer et al., 2005)

Marking a crosswalk in these locations without installing other treatments encourages pedestrians to cross at unsafe locations where vehicles are unlikely to yield, even if they are legally required to do so.

Figure 10: Bicyclist Crossing without Crosswalk Markings, Lomas Blvd and 14th St

Crossing Design Elements: Enhanced Visibility Treatments

Advance Stop/Yield Lines

Advance stop lines are a solid white line placed across the roadway before a crosswalk to indicate where a vehicle should stop to wait for pedestrians. Advance yield lines are similar but have a triangle "sharks teeth" design rather than a solid line.

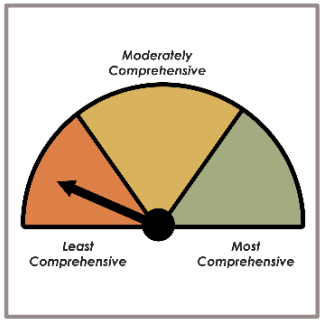


Figure 11: Advance Yield Line on Multi-Lane Crossing

Source: Toole Design Group

Benefits

Reduce multiple-threat crashes: Advance stop/yield lines can reduce pedestrian crashes by 25% (FHWA, 2013). By positioning vehicles behind a crosswalk, drivers in vehicle travel lanes on multi-lane roadways are more likely to see and yield to people crossing the street. They also allow pedestrians to better see oncoming traffic and respond if a vehicle does not yield.

Limitations

Motorist compliance: Advance stop/yield lines are not effective if vehicles stop beyond the line. Driver education and advance signage (see MUTCD R1-5 series signs in Table 2) can help increase compliance.

Maintenance: Like all pavement markings, advance stop/yield lines need regular maintenance to remain highly visible.

Parking restrictions: If on-street parking is present, parking should be restricted between advance stop/yield lines and the crosswalk to increase the visibility of pedestrians.

Complementary Treatments

Treatments that can complement advance stop/yield lines include:

- High visibility crosswalks (advance stop/yield lines should always be installed in conjunction with a crosswalk)
- Warning signage
- In-street pedestrian crossing sign
- Pedestrian-scale lighting
- RRFBs
- PHBs
- Infrastructure treatments such as pedestrian refuge islands, curb extensions/bulb-outs, raised crosswalks, and road diets

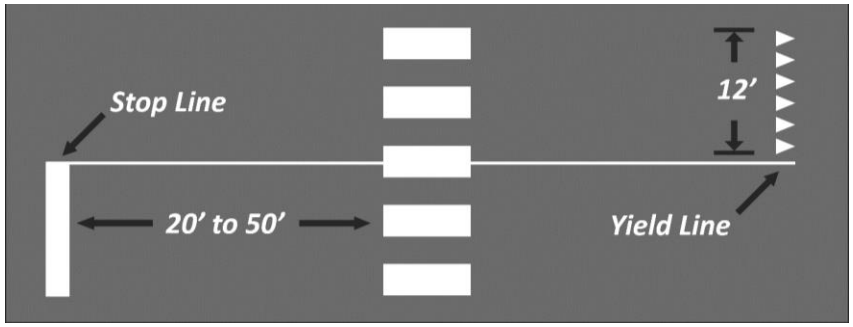
Crossing Design Elements: Enhanced Visibility Treatments

Design Considerations

Stop lines vs yield lines: Advance stop lines should be placed where vehicles are legally required to stop and wait for pedestrians, such as at stop signs, traffic signals, or PHBs. Advance yield lines should be placed where vehicles are legally required to yield to pedestrians, including unsignalized crosswalks and RRFBs.

Placement: Advance stop/yield lines should be placed 20-50' in advance of a crossing location (see Figure 12). Generally, 30' is an appropriate distance between a crosswalk and advance stop/yield lines (FHWA, 2013). The MUTCD recommends placing a stop line 40' from the crosswalk at *signalized* midblock crossings. For additional guidance on the placement and design of advance stop and yield lines, see MUTCD Section 3B.16.

Figure 12: Recommended Stop/Yield Line Layout

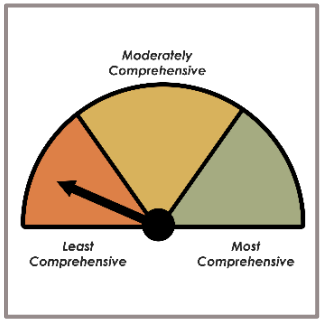


Location/Context

While advance stop/yield lines can be installed at any crosswalk, they are particularly effective at the following locations:

- Multi-lane roads with speed limits of 35 mph or greater
- Multi-lane roads with ADT of 15,000 or greater

In-Street Pedestrian Crossing Signs



In-street pedestrian crossing signs are placed in the middle of a street to serve as a reminder to motorists that they are required by law to yield to crossing pedestrians. Signs can be placed in a median, on lane lines, or on the yellow center line if no median is present.

Figure 13: In-Street Pedestrian Crossing Sign Example

Source: Visi Flash Pedestrian Safety Solutions

Crossing Design Elements: Enhanced Visibility Treatments

Benefits

Education: In-street pedestrian crossing signs educate and remind drivers that motorists must yield to people crossing.

Traffic calming: Signs placed in the roadway have a traffic calming effect by visually narrowing the roadway.

Limitations

Maintenance: In-street signs can be easily damaged and need to be replaced when struck.

Limited effectiveness on large roads: In-street pedestrian crossing signs are more effective on low-speed streets with two lanes (PBIC, n.d.).

Complementary Treatments

In-street pedestrian crossing signs can be installed in conjunction with the following treatments:

- High visibility crosswalks (in-street pedestrian crossing signs should always be installed in conjunction with a crosswalk)
- Warning signage
- Advance stop/yield lines
- Pedestrian-scale lighting
- RRFBs
- PHBs
- Infrastructure treatments such as pedestrian refuge islands, curb extensions/bulb-outs, raised crosswalks, and road diets

Design Considerations

MUTCD compliance: MUTCD yield sign R1-6 (see Table 2) should be used as in-street pedestrian crossing signs in New Mexico. Other signs, including roadside and overhead warning signs, can be installed in conjunction with R1-6 signs.

Placement: Signs can only be placed at unsignalized crossing locations and should comply with AASHTO breakaway requirements.

For further design considerations, reference MUTCD section 2B.12.

Location/Context

In-street pedestrian crossing signs can be installed on lower-speed, narrower roadways. They can be considered as a treatment on one to three lane roads with speed limits of 30 mph or less.

Crossing Design Elements: Enhanced Visibility Treatments

Overhead Flashing Lights

Overhead flashing lights are alternating yellow lights placed on a masthead above the roadway to indicate the presence of a crossing or school zone. Overhead flashing lights are an older technology that has been used extensively in the Albuquerque region.

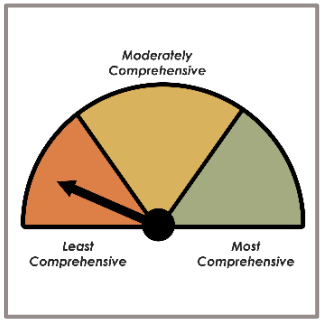


Figure 14: Overhead Flashing Lights Example

Source: FHWA

Benefits

Increases visibility: Overhead flashing lights can draw drivers' attention to a crossing location or school zone.

Minimal impacts on traffic operations: Overhead flashing lights do not reduce roadway capacity or create delay for motorists.

Limitations

Limited effectiveness as a stand-alone treatment: Overhead flashing lights are not effective by themselves and should be paired with other treatments to reduce crashes and increase driver yield rates.

Low motorist compliance: Compared to RRFBs, overhead flashing lights have lower motorist compliance because they are not as visible.

Complementary Treatments

Overhead flashing lights can be installed in conjunction with the following treatments:

- High visibility crosswalks
- Warning signage
- Advance stop/yield lines
- In-street pedestrian crossing signs
- Pedestrian-scale lighting
- Infrastructure treatments such as pedestrian refuge islands, curb extensions/bulb-outs, raised crosswalks, and road diets

Design Considerations

Overhead flashing lights can be continuously flashing or intermittently flashing only when a pedestrian is present. For overhead flashing lights at crossing locations, intermittent flashing systems can result in higher driver yield rates because a driver can be reasonably sure a pedestrian is present when the lights are activated. Overhead flashing lights that indicate a school zone should be activated continuously during posted school zone times. Further design guidance can be referenced in MUTCD Section 4L.03.

Crossing Design Elements: Enhanced Visibility Treatments

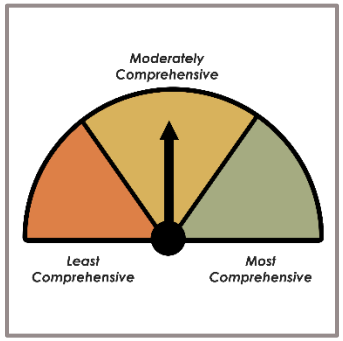
Location/Context

As RRFBs have similar installation and maintenance costs and are a more effective treatment at increasing driver yield rates, RRFBs are generally recommended instead of overhead flashing lights when designing new crossings. **Overhead flashing lights should not be considered a replacement for an RRFB when determining an appropriate crossing treatment.**

However, existing overhead flashing lights can remain in place to supplement high visibility crosswalk markings and signage or to indicate school zones. Crosswalk markings and signage without an RRFB or PHB can be installed in locations with shorter crossing distances, lower vehicle speeds, and lower traffic volumes.

Pedestrian-Scale Lighting

Pedestrian-scale lighting can help increase the visibility of pedestrians crossing at night and increase driver yield rates. Lighting should be placed between oncoming vehicles and the crossing location (FHWA, 2013).



Some level of illumination is required at all formal crossing locations. See DPM Section 7-4(M)(1)(ii) for illumination guidelines. Greater illumination is needed in areas with higher levels of pedestrian activity, including high-use trails, Centers, Main Street Corridors, and Premium Transit Station Areas.

Benefits

Reduce crashes: Intersection lighting can reduce pedestrian crashes by 42% (FHWA, 2021).

Increase comfort: Pedestrian-scale lighting helps pedestrians feel safe and comfortable while walking at night.

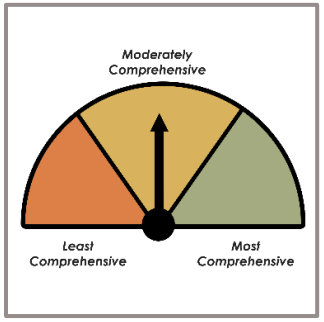
References

Local dark sky ordinances require shielded light fixtures to prevent light pollution. Integrated Development Ordinance (IDO) section 5-8(E)(1) lists requirements for pedestrian-scale lighting, including lighting levels, spacing, and height requirements. DPM section 7-4(M) contains additional standards for roadway lighting.

Figure 15: Pedestrian-Scale Lighting on Central Ave

Crossing Design Elements: Enhanced Visibility Treatments

Rectangular Rapid Flashing Beacon



Rectangular rapid flashing beacons (RRFBs) mounted overhead or on the roadside can notify drivers that pedestrians are crossing the roadway.

An RRFB device includes amber LED flashing lights that are installed to enhance pedestrian crossing warning signs at unsignalized crosswalks. RRFBs can be continuously flashing, pedestrian-activated using manual pushbuttons, or activated by passive pedestrian detection using automated sensors. Flashing lights are positioned, below a pedestrian sign and above an arrow placard pointing to the crosswalk.

RRFBs should always be installed with pedestrian or bicycle warning signage and high visibility crosswalks.

Benefits

Reduce crashes: RRFBs can reduce pedestrian crashes by up to 47% (NCHRP, 2017).

Increase driver yield rates: While yielding rates vary by city, studies show yield rates at RRFBs between 72% and 96% (Shurbutt & Houten, 2010). Another study saw yielding rates at night increase from 35% to 100% (NCHRP, 2016).

Minimal impacts on traffic operations: Because RRFBs are inactive when pedestrians are not present, they have minimal impacts on traffic operations and roadway capacity.

Reduce crossing delay: Because RRFBs are activated immediately, pedestrians do not need to wait to cross if drivers comply with the RRFB.

Figure 16: Rectangular Rapid Flashing Beacon on Multi-Lane Arterial

Source: Texas A&M Transportation Institute

Limitations

Over-use: Over-using RRFBs may reduce their effectiveness (FHWA, 2021).

Lower driver yield rates on wide roads: On wide, high-speed, or high-volume roadways, RRFBs resulted in a wide range of driver yield rates (25% to 73%), indicating that the effectiveness of RRFBs may be limited in these contexts (NCHRP, 2006).

Motorist compliance: While RRFBs draw drivers' attention to a crosswalk, drivers do not always yield to pedestrians waiting to cross the street without full traffic signals or PHBs requiring them to come to a complete stop.

Crossing Design Elements: Enhanced Visibility Treatments

Complementary Treatments

The following treatments can be installed in conjunction with an RRFB:

- High visibility crosswalks
- Warning signage
- Advance stop/yield lines
- In-street pedestrian crossing signs
- Pedestrian-scale lighting
- Infrastructure treatments such as pedestrian refuge islands, curb extensions/bulb-outs, raised crosswalks, and road diets

Figure 17 provides an example of complementary treatments that can be installed with RRFBs, including warning signage, high visibility crosswalks, refuge islands, curb extensions, and advance yield lines.

Design Considerations

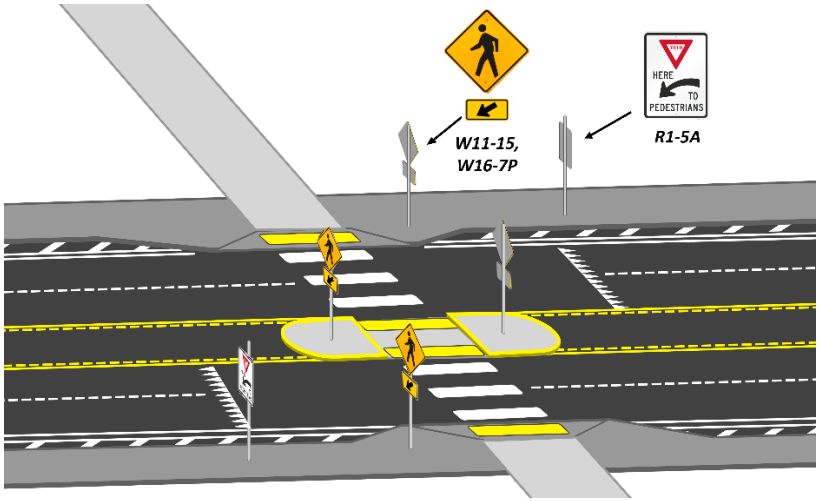
Intermittent flashing vs continuously flashing: Generally, intermittent flashing beacons result in greater driver yield rates than continuously flashing beacons. Intermittent flashing beacons are typically activated using a manual pushbutton or automated sensor. Because they do not flash constantly, drivers can be reasonably sure that a pedestrian is crossing the street when they are flashing (NCHRP, 2006).

Uncontrolled locations: FHWA guidance states that RRFBs shall not be installed at locations that are stop or yield-controlled unless the location is at a roundabout.

Sign position: If a roadway includes a center median, install the RRFB in the median as well as the sides of the roadway to increase visibility (FHWA, 2021).

Overhead vs roadside mounted: Overhead RRFBs can result in increased driver yield rates over roadside-mounted RRFBs (NCHRP, 2006).

Figure 17: RRFB with Complementary Treatments



Location/Context

RRFBs are commonly installed at high-volume or high-speed intersections or at school crossings. While some jurisdictions use RRFBs at all multi-lane unsignalized crosswalks, others prioritize locations with significant pedestrian safety issues so as to not diminish their effectiveness (NCHRP, 2016; FHWA, 2013).

RRFBs are most appropriate at multi-lane crossings with speed limits less than 40 mph (FHWA, 2021).

Crossing Design Elements: Signal Treatments

Signal Treatments

Signalized crossing treatments are those that force vehicles to stop because of the presence of a traffic signal. The two most common types of signalized crossing treatments are full traffic signals and PHBs, also known as HAWK signals (see Figure 18 and Figure 19).

Signalized crossings can provide safety and comfort for pedestrians and bicyclists because they provide a clear regulatory message that brings traffic to a complete stop. Signalized crossings also increase the connectivity of bicycle and pedestrian networks.

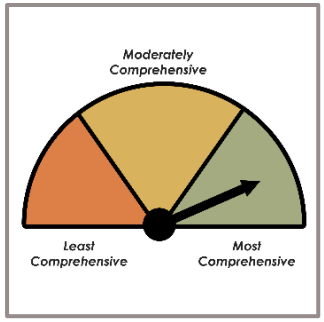
While signalized crossings are generally safer than unsignalized crossings, long crossing distances and high vehicle speeds can still contribute to a hostile pedestrian environment. Infrastructure treatments (discussed later in this report) such as curb extensions, refuge islands, and road diets can greatly increase the comfort of signalized pedestrian crossings. Signal treatments are also generally high-cost and may impact traffic operations.

Figure 18: Crossing at Full Traffic Signal on Taylor Ranch Rd

Figure 19: Pedestrian Hybrid Beacon on Central Ave

Crossing Design Elements: Signal Treatments

Full Traffic Signal



Full traffic signals are standard traffic signals that generally have pedestrian signal heads and associated countdown timers. Countdown timers help communicate to pedestrians how much time is remaining in the walk phase, aiding pedestrians in making decisions about when they should cross the street to avoid being caught in the middle of an intersection.

Figure 20: Traffic Signal on Lead Ave

Appropriateness

Because the MUTCD requires an engineering study of traffic conditions, pedestrian characteristics, and physical characteristics for a full traffic signal to be installed, traffic signals are rarely selected as a crossing treatment unless there is also a traffic-related need for a signal. Full traffic signals are generally installed where enhanced levels of traffic control are needed for vehicular movement or to address critical safety issues. However, signals have the added benefit of bringing traffic to a complete stop for pedestrians to cross the street.

Benefits and Limitations

Full traffic signals have high rates of motorist compliance and can reduce crashes by 33% (McGee et al., 2003). However, traffic signals need to be warranted per the MUTCD, which limits their application.

Complementary Treatments

While full traffic signals provide a high level of vehicle control, they are not inherently safe for pedestrian/bicyclist crossings. Intersections can have multiple conflict points during the pedestrian walk phase if vehicles are permitted to make left and right turns at the same time.

Additional treatments that make intersection crossings safer and more comfortable by addressing conflict points include:

- Warning signage
- High-visibility crosswalk markings
- Advance stop/yield lines
- Pedestrian-scale lighting

Crossing Design Elements: Signal Treatments

- Median refuge islands
- Leading pedestrian/bicycle intervals
- Right turn on red restrictions
- Curb extensions
- Raised crosswalks
- Road diets

References

MUTCD section 4C describes warrants for traffic signal installation. Pedestrian crossing volume can be used as a warrant for installing a traffic signal; however, the pedestrian signal warrant can be difficult to meet if inhospitable conditions deter pedestrians from crossing. Other criteria that can justify the installation of a traffic signal include vehicle volume, peak hour traffic, school crossings, coordinated signal systems, crashes, traffic flow, and rail crossings.

The DPM recommends installing pedestrian crossings at all at-grade signalized intersections (see Section 7-4(A)(7)(iii)(b)). The DPM also recommends installing signalized pedestrian crossings at key intersections between arterials and collectors.

The DPM provides general guidance on the spacing of traffic signals (see Section 7-4(A)(6)). Outside of Comprehensive Plan Centers, traffic signals should not be spaced less than ¼-mile apart without approval from the City Engineer.

Signalized pedestrian crossings (i.e. full traffic signals or PHBs) should be provided at intervals recommended in DPM Table 7.4.41 and 7.4.42. Spacing depends on functional classification and Comprehensive Plan Center/Corridor designations.

Pedestrian Hybrid Beacon/HAWK Signal

A pedestrian hybrid beacon (PHB) is a traffic control device commonly used to help pedestrians safely cross busy or higher-speed roadways at mid-block locations and uncontrolled intersections. PHBs result in higher vehicle yield rates than RRFBs because they clearly assign right of way and provide stop control for vehicles (FHWA, 2021).

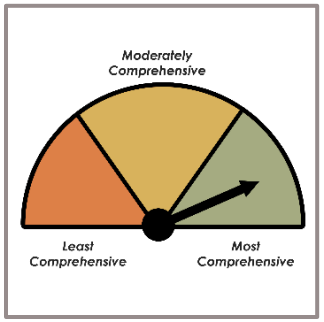


Figure 21: PHB on Lomas Blvd and Alvarado Dr

Source: City of Albuquerque

Crossing Design Elements: Signal Treatments

Benefits

The primary purpose of PHBs is to reduce crashes and improve driver yield rates to pedestrians.

Driver yield rates: Several studies have indicated that driver yielding rates at PHBs can be between 90 to 100 percent (NCHRP, 2006). In comparison to RRFBs or standard crosswalk signage, the steady red signal on PHBs provides a direct regulatory message that generally results in a more uniform response.

Reduce crashes: PHBs can reduce pedestrian crashes by 55%, total crashes by 29%, and serious injury and fatal crashes by 15% (FHWA, 2021). Crash analyses in Seattle, WA have documented that PHBs can reduce vehicle-vehicle crashes as well as pedestrian-vehicle conflicts (NCHRP, 2006).

Limitations

Cost: The primary limitation of PHBs is their cost. While less expensive than installing a full traffic signal, PHBs generally cost between $200,000 and $250,000.

Siting limitations: PHBs should not be installed within 100 feet of stop or yield controlled intersections (MUTCD 4F.02.4) and need to be installed in locations with adequate sight distance.

Complementary Treatments

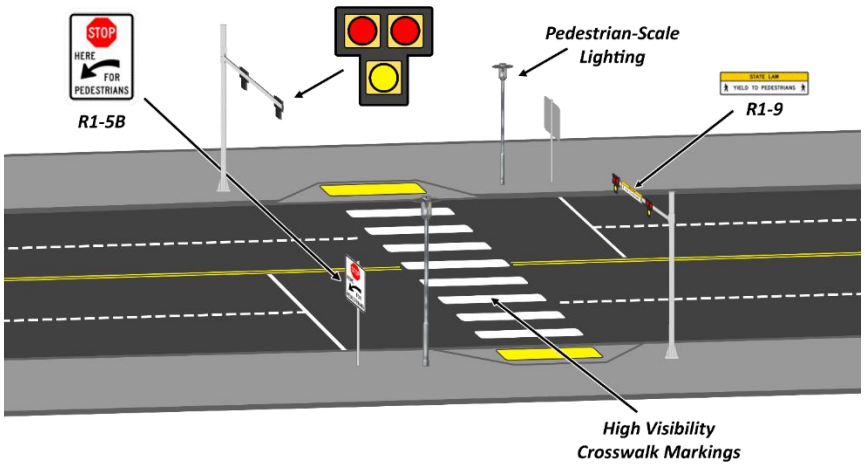
The MUTCD requires the following treatments at PHB locations (see Figure 22):

- Crosswalks (section 4F.01)
- Signage
- Advance stop lines

Other optional crossing treatments that can complement a PHB include:

- Pedestrian-scale lighting
- Infrastructure treatments such as pedestrian refuge islands, curb extensions/bulb-outs, and road diets

Figure 22: PHB Complementary Crossing Treatments



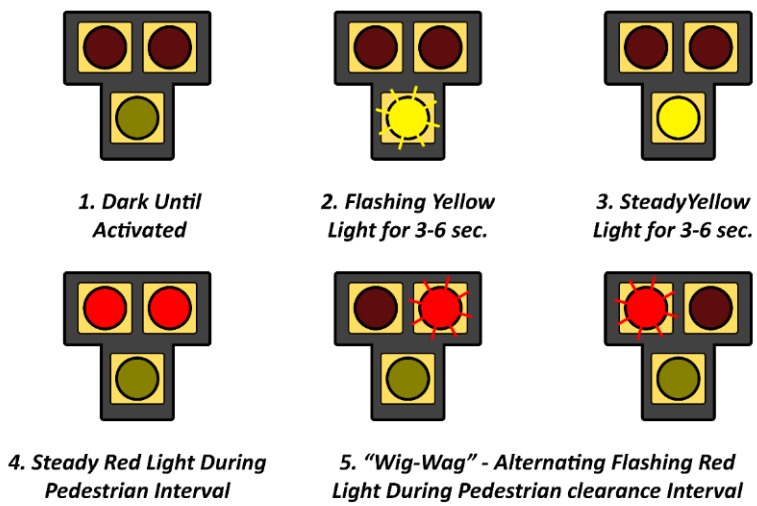
Design Considerations

Light cycles: PHBs remain dark until activated by a pedestrian (normally with a push-button). Once activated, they cycle through several signal phases: flashing yellow, steady yellow, steady red, and flashing red. The flashing red phase is referred to as the "wig-wag" phase and allows vehicles to proceed after stopping if the crosswalk is clear.

Bicycle considerations: PHBs can be especially effective at facilitating trail or bicycle boulevard crossings because low volume

roadways and trails are unlikely to meet warrants for full traffic signals. PHBs can be designed to improve level of service for bicyclists by providing bicycle signal heads and bicycle signal detectors. However, as bicyclists can enter the intersection more quickly than pedestrians, the wig-wag phase can introduce conflict points if vehicles fail to see a bicyclist before proceeding through the crossing. For this reason, the steady red light should be longer and the wig-wag phase should be shorter at PHBs with high volumes of crossing bicyclists (NACTO, 2014).

Figure 23: PHB Signal Cycle



Location/Context

PHBs can be installed at intersections or mid-block locations. While PHBs can be considered for most roadway contexts, they are most useful on high-speed, high-volume multi-lane roadways. Roadways where multiple-threat crashes are a concern and roadways with speed limits of 40 mph or greater should be prioritized for the installation of PHBs. PHBs can also be considered for areas with high populations of vulnerable road users, including children, people with disabilities, and older adults.

Crossing Design Elements: Infrastructure Treatments

Infrastructure Treatments

Infrastructure treatments greatly improve the safety and comfort of crossing locations. Infrastructure treatments that reduce vehicle speeds and shorten crossing distance can also reduce the need for traffic signals, PHBs, and RRFBs. Figure 24 and Figure 25 show examples of infrastructure treatments at crossing locations.

The infrastructure treatments considered in this guide include:

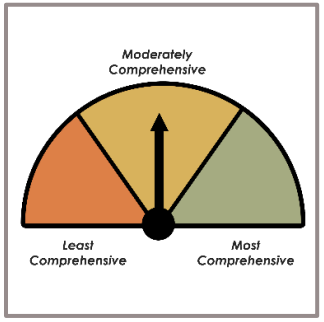
- Raised crosswalks
- Curb extensions/bulb-outs
- Pedestrian refuge islands
- Grade-separated crossings
- Road diets

Figure 24: Crossing with Road Diet, Curb Extension and Refuge Island

Figure 25: Raised Crosswalk with Curb Extension and In-Street Pedestrian Crossing Sign

Crossing Design Elements: Infrastructure Treatments

Raised Crosswalks



Raised crosswalks are crosswalks placed on top of a speed table that allow pedestrians to cross a street at the same level as the sidewalk. These treatments should be placed on low-speed, low-volume roads, though they may be placed on side streets that intersect major roads to help facilitate crossings (see Figure 26). Raised crosswalks can be installed at mid-block locations or at intersections.

Figure 26: Raised Crosswalk on Alameda Drain Trail

Benefits

Reduce crashes: Raised crosswalks can reduce vehicle/pedestrian crashes by 46% on local roads.

Increases yield rates: A study in Cambridge MA found yielding rates increased from 10% to 55% after installing raised crosswalks (FHWA, 2013).

Traffic calming: Raised crosswalks serve as a speed table and can reduce vehicle speeds by 6 to 11 mph.

Increases visibility: Raised crosswalks place pedestrians directly in a driver's field of vision.

Limitations

Limited roadway contexts: Raised crosswalks should only be installed on roadways with low speeds and traffic volumes.

Emergency response and transit routes: As large vehicles may not be able to navigate raised crosswalks, they should not be installed on emergency response routes or transit routes.

Complementary Treatments

Raised crosswalks can be complemented by:

- High-visibility crosswalk markings
- Warning signage
- Advance stop/yield lines
- In-street pedestrian crossing signs
- Pedestrian-scale lighting
- RRFBs
- Infrastructure treatments such as curb extensions/bulb-outs and road diets

Crossing Design Elements: Infrastructure Treatments

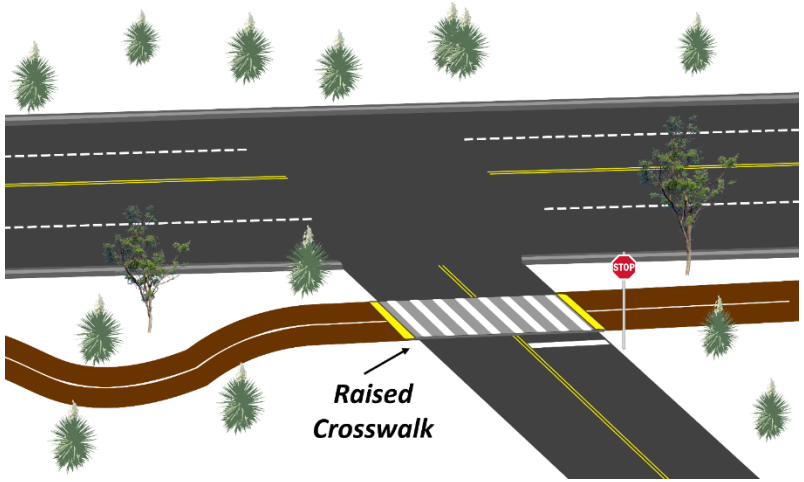
Design Considerations

Width: Raised crosswalks are generally at least 10 ft wide and span the entire width of the street.

Stormwater runoff: Raised crosswalks can reduce the hydraulic capacity of roadways and may require a hydraulic analysis to ensure that stormwater runoff will not exceed curb heights.

Setback from major roads: If installed on a local road intersecting with a major road, raised crosswalks should be set back from the main road to allow turning vehicles to see pedestrians. Additionally, tighter curb return radii and/or deceleration lanes can help slow turning traffic and increase driver yield rates. Figure 27 shows an example of a raised crossing on a sidepath parallel to a major street.

Figure 27: Raised Crosswalk on Side Street



Location/Context

Raised crosswalks are generally only appropriate on low speed, local roads (i.e. 1-3 lanes, speed limits of 30 mph or under, and ADT <9,000 [NMDOT, 2020]). They may be applied on sidepaths adjacent to major roadways (see Figure 27).

References

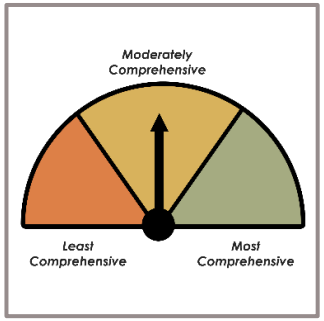
MUTCD Section 3B.25 includes instructions for appropriate pavement markings and signage on and approaching a speed hump.

The City of Albuquerque's Neighborhood Traffic Management Program includes speed humps and tables in its toolkit of traffic calming treatments for local roads.

Crossing Design Elements: Infrastructure Treatments

Curb Extensions/Bulb Outs

Curb extensions or bulb-outs extend the pedestrian area into the roadway at intersections in order to shorten the distance required to cross a street, encourage slower driving, and reduce turning speeds.



Source: FHWA Traffic Calming E-Primer

Benefits

Reduces crossing distance: By extending the pedestrian realm, curb extensions reduce the distance required to cross a street and the amount of time a pedestrian is exposed to vehicle traffic.

Increases visibility of those waiting to cross: Curb extensions position pedestrians in a visible location to drivers, which can increase driver yield rates.

Traffic calming: By narrowing the roadway, curb extensions cause drivers to slow down and look for pedestrians. Curb extensions also tighten turn radii, which slows turning vehicles.

Creates space for landscaping/lighting: Curb extensions create additional space in the pedestrian realm for landscaping or lighting, which can further increase pedestrian visibility.

Limitations

Right-of-way constraints: The application of curb extensions may be limited along roadways with constrained right-of-way.

Bicycle lanes: If positioned in a bicycle lane, curb extensions can force bicyclists to merge with vehicle traffic, which introduces conflict points.

Reduces parking: Curb extensions are often built in the parking lane, which reduces the number of available parking spaces.

Vehicular delay: Curb extensions can increase delay for vehicles at locations with high volumes of turning traffic.

Crossing Design Elements: Infrastructure Treatments

Complementary Treatments

Curb extensions can be paired with:

- High-visibility crosswalk markings
- Warning signage
- Advance stop/yield lines
- In-street pedestrian crossing signs
- Pedestrian-scale lighting
- RRFBs
- PHBs
- Infrastructure treatments such as pedestrian refuge islands, raised crosswalks, and road diets

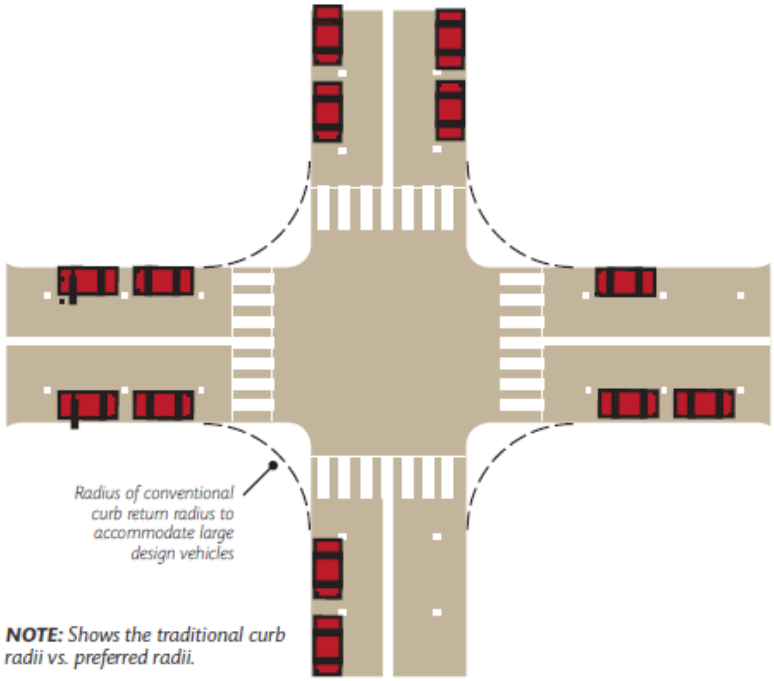
Design Considerations

Turn radii: Curb extensions should be designed with a wide enough turn radius for emergency vehicles and buses (see Figure 28). DPM Table 7.4.66 provides recommended curb return radii based on Comprehensive Plan Center and Corridor designations. The DPM recommends tighter turn radii in Centers and Premium Transit Station Areas and along Multi-Modal, Main Street, and Major Transit Corridors.

Location/Context

Curb extensions are highly versatile and can be implemented on almost any street type regardless of speed limit or traffic volumes, including local streets, collectors, and arterials. Curb extensions can be placed on all corners of an intersection or only one corner. They are often built on streets with on-street parking but can be implemented along streets without parking if there is enough right-of-way for vehicle travel lanes and/or bike lanes to remain unimpeded.

Figure 28: DPM Figure 7.2.95 Standard Curb Return Radii Diagram



Crossing Design Elements: Infrastructure Treatments

Pedestrian Refuge Islands

Pedestrian refuge islands are raised areas in the middle of a roadway that reduce crossing distance and facilitate two-stage crossings by giving pedestrians a place to wait for an adequate gap between vehicles before finishing the second leg of the crossing.

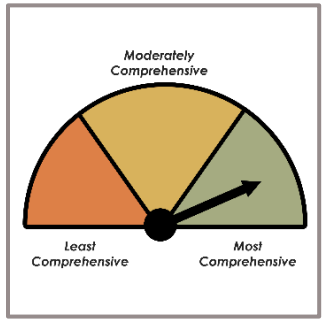


Figure 29: Pedestrian refuge island with high-visibility crosswalk and signage

Source: BikePedImages.org – Katy Lang

Benefits

Reduce crashes: Pedestrian refuge islands can reduce crash rates by 46% at marked crosswalks and 39% at unmarked crosswalks. They can also reduce motor vehicle crashes by 14% (FHWA Safety Program, n.d.).

Reduces crossing delay: By dividing a crossing into two stages, the amount of vehicle traffic and number of lanes to navigate at a time is effectively split in half. This reduces delay for people crossing as they do not need to wait as long for a gap in traffic.

Reduces crossing distance: By providing space for pedestrians in the median, refuge islands reduce the distance required to cross a street and the amount of time a pedestrian is exposed to vehicle traffic.

Traffic calming: Refuge islands visually narrow the roadway, which can reduce vehicle speeds.

Creates space for landscaping and lighting: Landscaping and/or pedestrian-scale lighting can be added to refuge islands to increase the visibility of pedestrians crossing.

Limitations

Vehicular access: Pedestrian refuge islands placed in a center turn lane limit vehicle left turns in that location.

Complementary Treatments

Pedestrian refuge islands can be installed to complement a full traffic signal or PHB or can be installed at unsignalized locations. Refuge islands can be paired with:

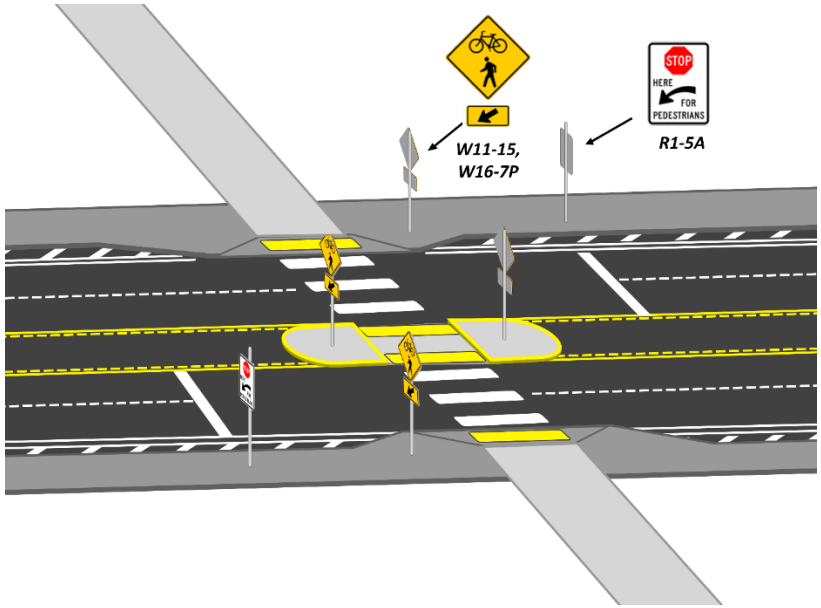
- High-visibility crosswalk markings

Crossing Design Elements: Infrastructure Treatments

- Warning signage
- Advance stop/yield lines
- In-street pedestrian crossing signs
- Pedestrian-scale lighting
- RRFBs
- PHBs
- Infrastructure treatments such as curb extensions, raised crosswalks, and road diets

Figure 30 shows examples of treatments that can complement a pedestrian refuge island, including curb extensions, signage, advance stop/yield lines, and high-visibility crosswalk markings.

Figure 30: Pedestrian Refuge Island Complementary Treatments



Design Considerations

Placement: Pedestrian median islands may be located at signalized or unsignalized intersections or at mid-block crossings.

Width: Per the DPM, pedestrian medians should be at least six feet wide to allow enough space for pedestrians and bicyclists to wait comfortably.

Vertical elements: The DPM recommends a raised curb or other vertical elements to separate the island from vehicle traffic.

ADA accessibility: Pedestrian medians should be ADA accessible and include detectable warning signals.

Location/Context

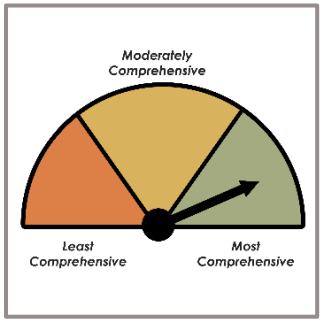
The DPM recommends installing refuge islands on roads with three or more lanes, traffic volumes over 12,000 ADT, and/or speeds over 30 mph.

Pedestrian medians may be especially effective at the following locations:

- In areas with vulnerable populations who may take a longer time to cross the street, including children, people with mobility-related disabilities, and older adults
- Along designated bicycle routes
- Where there are high-volume pedestrian and/or bicycle crossings

Crossing Design Elements: Infrastructure Treatments

Grade-Separated Crossings



Grade-separated crossings allow bicyclists/pedestrians to cross a street by passing underneath it via a tunnel or crossing over it via a bridge. This type of crossing eliminates pedestrian/bicyclist interactions with motor vehicles at crossing locations, providing a safe and comfortable crossing experience and improving multi-modal connectivity. They can be especially useful where trail crossings intersect with major arterials or highways, as they allow trail users to pass through high-speed, high-volume areas without experiencing intersection conflict points.

Figure 31: Grade-Separated Underpass on North Diversion Trail

Source: primepassages.com

Figure 32: Grade-Separated Bridge on Paseo del Norte Trail

Source: primepassages.com

Benefits

Safety and comfort: Grade-separated crossings provide high levels of safety and comfort at crossings by eliminating interactions with vehicles.

Minimize pedestrian/bicyclist delay: Grade-separated crossings minimize delay by allowing pedestrians/bicyclists to cross without waiting for a traffic signal or for vehicles to yield at crosswalks.

No impact on traffic operations: By completely separating bike/pedestrian crossing activity, grade-separated crossings allow bicyclists, pedestrians, and motorists to traverse an intersection without causing delays for other users.

Crossing Design Elements: Infrastructure Treatments

Limitations

Increase travel distance: Grade-separated crossings can add distance and delay if they are positioned out of the direction of travel. Pedestrians are especially sensitive to out-of-direction travel and may choose to risk crossing a street at-grade if the crossing location is inconvenient. Studies indicate that 95% of pedestrians will use a grade-separated crossing if it does not add distance to their route, but if using the crossing takes 50% longer than crossing at-grade, very few people will use the facility (Mead et al., 2014). Generally, grade-separated crossings within an existing trail network see higher usage because they do not create out-of-direction travel.

Cost: Grade-separated crossings are the most expensive crossing treatment of available options. Traffic calming with enhanced pedestrian crossings can be a far more cost-effective intervention and, in many cases, contributes to a more convenient and connected pedestrian network.

Design Considerations

Choosing between above or below-grade crossings: Whether a grade-separated crossing should be above or below the roadway depends on its site characteristics and costs. Bicyclists tend to prefer crossing below a roadway because a tunnel or underpass allows them to build up speed and momentum to ascend on the other side. Additionally, below-grade crossings generally allow for gentler ramp slopes than above-grade crossings. However, below-grade crossings have additional considerations and maintenance needs due to drainage, lighting, and possible graffiti removal (FHWA, 2013).

ADA compliance: Grade-separated crossings should be ADA compliant with ramps for wheelchair access (generally a 5% grade). For above-grade crossings, long ramps may be needed to meet ADA requirements. Stairs can be considered in addition to ramps where ramps add significant travel distance. More information on ADA compliant design can be found in the Public Rights of Way Accessibility Guidelines (PROWAG).

Wayfinding: Pedestrians/bicyclists are more likely to go out of the direction of travel to use grade-separated crossings if wayfinding signage is provided.

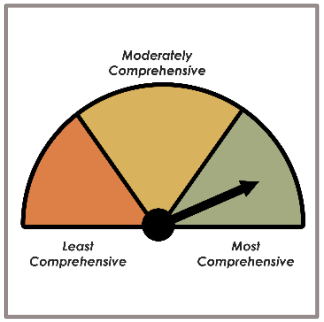
Location/Context

Grade-separated crossings should be considered in the following contexts:

- Where there is a need to provide bicyclist/pedestrian connectivity across rivers, railroads, or highways
- Multi-use trails or other off-road paths
- High volume, high speed roadways

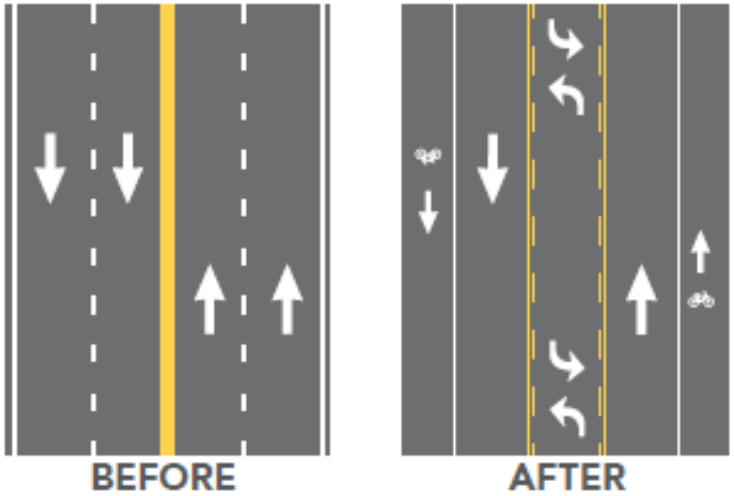
Crossing Design Elements: Infrastructure Treatments

Road Diets



A road diet encourages slower driving speeds and re-allocates space to other modes of travel. The DPM distinguishes between a **road reconfiguration**, which reduces the number of vehicle travel lanes, and **road restriping and narrowing**, which maintains the same number of travel lanes but narrows general purpose lanes to create space for other modes. Road diets that remove travel lanes but add two-way left turn lanes can have operational benefits for auto traffic because the center turn lane reduces delay from left-turning vehicles (FHWA, 2014).

Figure 33: Example of a Road Diet



Source: Federal Highway Administration

Benefits

Reduces crossing distance: By removing vehicle travel lanes, road diets decrease crossing distance and reduce the need for signalized crossings or RRFBs.

Reduce crashes: Road diets have been shown to decrease crashes by 19-47% (FHWA, 2014).

Multi-modal connectivity: Road diets increase space for bike lanes, sidewalks, transit stops, and street amenities.

Traffic calming: Road diets can reduce vehicle speeds and speed differentials by narrowing the roadway and reducing the number and width of travel lanes. On roads with only one travel lane in each direction, speeds are limited by the lead vehicle, which creates a more uniform and slower speed along the roadway (FHWA, 2014).

Low cost: Many road diets can be achieved through restriping, which has low costs and can be done at the same time as regular roadway maintenance.

Limitations

May increase congestion: If a road diet is implemented along a roadway with traffic volumes approaching its designed capacity, removing general purpose lanes may increase congestion. However, congestion also serves to slow travel speeds and can encourage the adoption of other modes of transportation.

Crossing Design Elements: Infrastructure Treatments

Complementary Treatments

Treatments that can complement a road diet include:

- High visibility crosswalk markings
- Warning signage
- Advance stop/yield lines
- In-street pedestrian crossing signs
- Pedestrian-scale lighting
- RRFBs
- PHBs
- Infrastructure treatments such as pedestrian refuge islands, curb extensions/bulb-outs, and raised crosswalks

Figure 34 and Figure 35 demonstrate an example of a crossing before and after a road diet has been implemented.

Design Considerations

Street element widths: General purpose lanes can be narrowed to 10-11' without impacting traffic operations. DPM Table 7.2.29: Street Element Dimensions recommends travel lane width for roadways based on functional classification and Comprehensive Plan Center and Corridors Designations. The table also recommends the widths of other street design elements, including sidewalks, bike lanes, and buffer zones which should be incorporated into a road diet.

Figure 34: Crossing at Zuni Rd Before Road Diet

Figure 35: Crossing at Zuni Rd After Road Diet

Crossing Design Elements: Infrastructure Treatments

Location/Context

Road diets can be applied on any roadway with a designed capacity higher than actual vehicle traffic volumes. The Mid-Region Council of Governments (MRCOG) produces a Potential Road Diets Candidates Map that shows regional roadways with excess capacity. It defines road diet candidates based on the number of general purpose travel lanes and traffic volume along a corridor. On roadways with excess capacity, removing general purpose lanes may not have a significant impact on traffic operations or congestion.

Road diets can also be implemented along roadways with traffic volumes that are approaching their designed capacity if there is a need for improved multi-modal facilities or identified safety issues along the roadway. Additional congestion may occur when a road diet is applied where traffic volumes exceed the roadway capacity. In these cases, motorists may choose to drive along another route, travel during non-peak hours, switch modes, or forgo unnecessary trips. Decision-makers should consider whether parallel facilities have the capacity to absorb some trips that might be redistributed to other corridors when a road diet is implemented.

Crossing Design Elements Summary

Enhanced visibility treatments, signal treatments, and infrastructure treatments each have unique benefits and limitations. In general, more comprehensive treatments are more costly and/or have more significant impacts on traffic operations. However, more comprehensive treatments also have greater benefits for increasing the comfort and safety of a crossing location.

Table 4 summarizes the benefits and limitations of each crossing treatment. Table 5 summarizes complementary techniques for each crossing treatment to assist in determining which treatments can be combined to create a holistic design for a crossing location.

Crossing Design Elements: Summary Tables

Table 4: Benefits and Limitations Summary Table

		Enhanced Visibility							Signal		Infrastructure				
		Warning Signage	High Visibility Crosswalk Markings	Advance Stop / Yield Lines	In-Street Pedestrian Crossing Signs	Overhead Flashing Lights	Pedestrian-Scale Lighting	RRFB	Full Traffic Signal	PHB	Raised Crosswalks	Curb Extensions	Pedestrian Refuge Islands	Grade-Separated Crossings	Road Diets
Benefits	Increases Visibility	X	X	X	X	X	X	X		X	X	X			
	Education	X			X										
	Increases Yield Rates		X					X	X	X	X				
	Reduces Crashes		X	X			X	X	X	X	X		X	X	X
	Traffic Calming				X						X	X	X		X
	Increases Comfort						X		X	X	X	X	X	X	X
	Minimal Impacts on Traffic	X	X	X	X	X	X	X						X	
	Reduces Crossing Delay							X					X	X	
	Reduces Crossing Distance											X	X		X
	Creates Space for Amenities											X	X		X
	Low Cost	X	X	X	X										X
	Increases Multi-Modal Connectivity								X	X				X	X
Limitations	Not Effective as Stand-Alone Treatment	X	X	X	X	X	X								
	Maintenance		X	X	X		X							X	
	Motorist Compliance			X		X		X							
	Can Impact Parking			X								X			
	Limited Effectiveness on Large Roads	X	X		X	X					X				
	High Cost								X	X				X	
	Increases Crossing Travel Distance													X	
	Impacts Bicycle Lanes											X			
	Impacts Traffic Operations								X	X	X	X	X		X
	Siting Limitations								X	X		X	X	X	

Crossing Design Elements: Summary Tables

Table 5: Complementary Treatments Summary Table

		Enhanced Visibility							Signal		Infrastructure				
		Warning Signage	High Visibility Crosswalk Markings	Advance Stop/Yield Lines	In-Street Pedestrian Crossing Signs	Overhead Flashing Lights	Pedestrian-Scale Lighting	RRFB	Full Traffic Signal	PHB	Raised Crosswalks	Curb Extensions	Pedestrian Refuge Islands	Grade-Separated Crossings	Road Diets
Complementary Techniques	Warning Signage		X	X	X	X	X	X	X	X	X	X	X		X
	High Visibility Crosswalk Markings	X		X	X	X	X	X	X	X	X	X	X		X
	Advance Stop/Yield Lines	X	X		X	X	X	X	X	X	X	X	X		X
	In-Street Pedestrian Crossing Signs	X	X	X		X	X	X			X	X	X		X
	Pedestrian-Scale Lighting	X	X	X	X	X		X	X	X	X	X	X	X	X
	RRFB	X	X	X	X		X				X	X	X		X
	PHB	X	X	X	X		X					X	X		X
	Raised Crosswalks	X	X	X	X	X	X	X	X			X	X		X
	Curb Extensions/Bulb Outs	X	X	X	X	X	X	X	X	X	X		X		X
	Pedestrian Refuge Islands	X	X	X	X	X	X	X	X	X		X			X
	Road Diets	X	X	X	X	X	X	X	X	X	X	X	X		

Crossing Applications & Roadway Context

The following section provides guidance on the selection and application of bicycle and pedestrian crossings. **Step 1** outlines a process for determining if a site is an appropriate and/or desired location for a crossing. Criteria include Comprehensive Plan designations, crash and safety factors, proximity to other crossing locations, proximity to transit, presence of pedestrian generators, and whether the crossing is located along a multi-use trail.

Step 2 provides guidance on the technical feasibility of a crossing location, and considers sight distances, proximity to cross-streets, and whether driver yielding behavior is desired.

After a site has been selected and determined to be a feasible location for a crossing, appropriate crossing treatments can be selected. **Step 3** recommends crossing design treatments, including enhanced visibility crosswalks, rectangular rapid flashing beacons, and pedestrian hybrid beacons. Guidance on crossing treatment applications is based on roadway factors such as the number of lanes a pedestrian must cross at a time, posted speed limit, and average daily traffic (ADT).

Figure 36 demonstrates the process for selecting a crossing location and appropriate treatments.

Figure 36: Three Step Flow Chart for Crossing Selection

Crossing Applications & Roadway Context

Step 1: Site Selection

City of Albuquerque Guidance

The first step in the decision-making process for adding a new crossing is determining the appropriateness of a particular location. The Albuquerque/Bernalillo County Comprehensive Plan and DPM identify the general desirability of crossing locations based on Center and Corridor designations, the spacing between crossings, and other factors. Specific crossing locations may be based on the presence of transit stops, trails that intersect with a major roadway, and the presence of pedestrian generators.

Desired spacing for pedestrian crossings by Center and Corridor type are provided in Section 7-4(A)(7): Designated Pedestrian Crossings of the DPM. For a map of Centers and Corridors designations, reference the Albuquerque/Bernalillo County Comprehensive plan or the interactive Comprehensive Plan map on the City's website.

Key Considerations in Determining the Appropriateness of a Pedestrian Crossing

- Center or Corridor Designation
- Spacing Between Crossings
- Transit Stops
- Multi-use Trails
- Pedestrian Generators
- Identified Safety Concerns

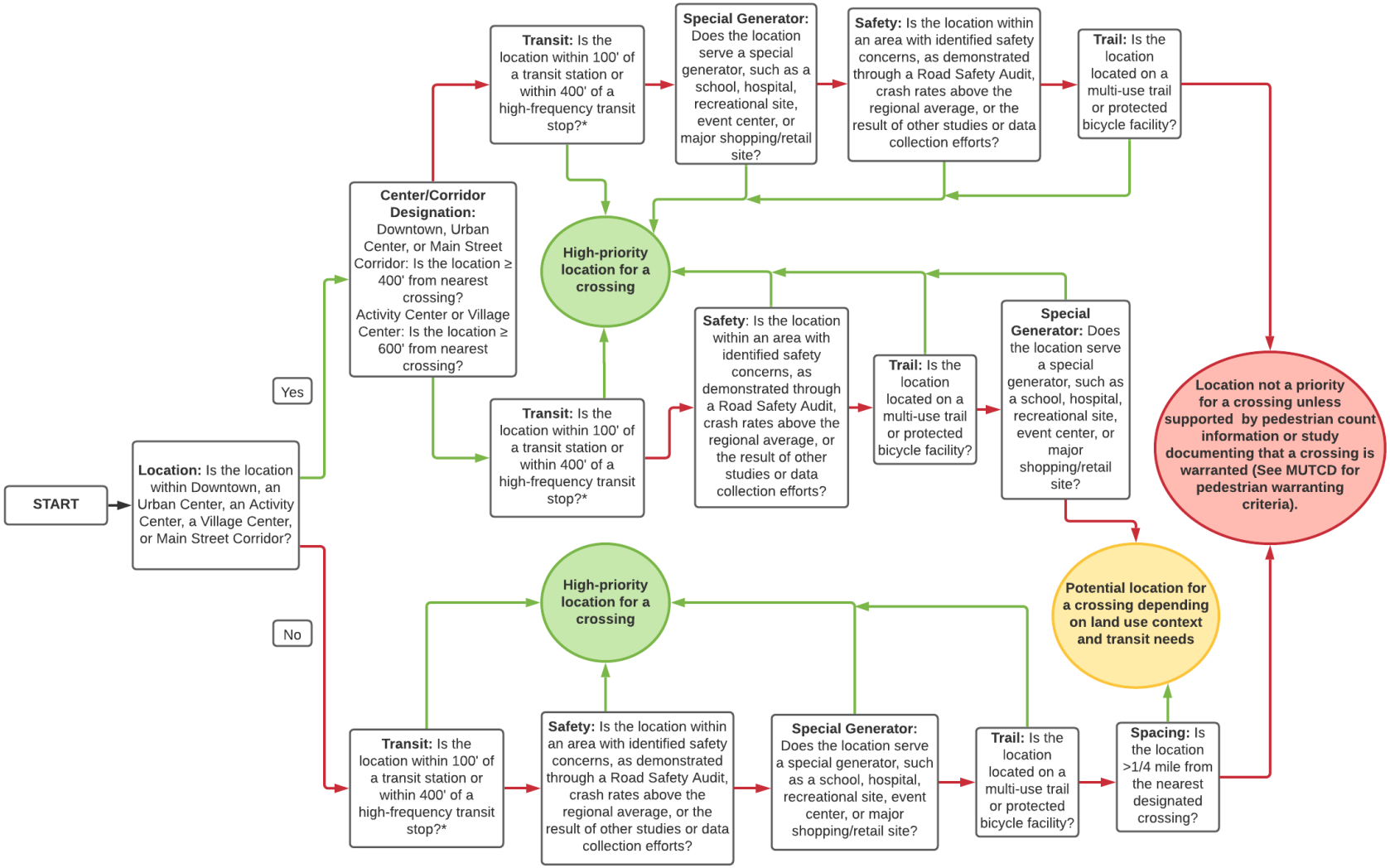
Pedestrian Crossing Warranting Criteria

The MUTCD includes criteria for pedestrian volume warrants to install a PHB or full traffic signal. Warranting studies are required for installation of a full traffic signal. However, for PHB installation, MUTCD warranting criteria are guidelines rather than standards and are therefore not legally required. A warranting study is not needed to install a PHB if a crossing location meets site selection criteria in Step 1 (see Figure 36); however, a warranting study may be conducted at locations that do not meet general policy guidance for a crossing facility.

Figure 37 summarizes the DPM guidance in a flow chart that can be used to determine whether a location is a priority for installing crossing treatments.

Crossing Applications & Roadway Context

Figure 37: Site Selection Flowchart



**High-frequency is defined as transit service at least every 30 minutes during normal operating hours.*

Step 2: Site Feasibility

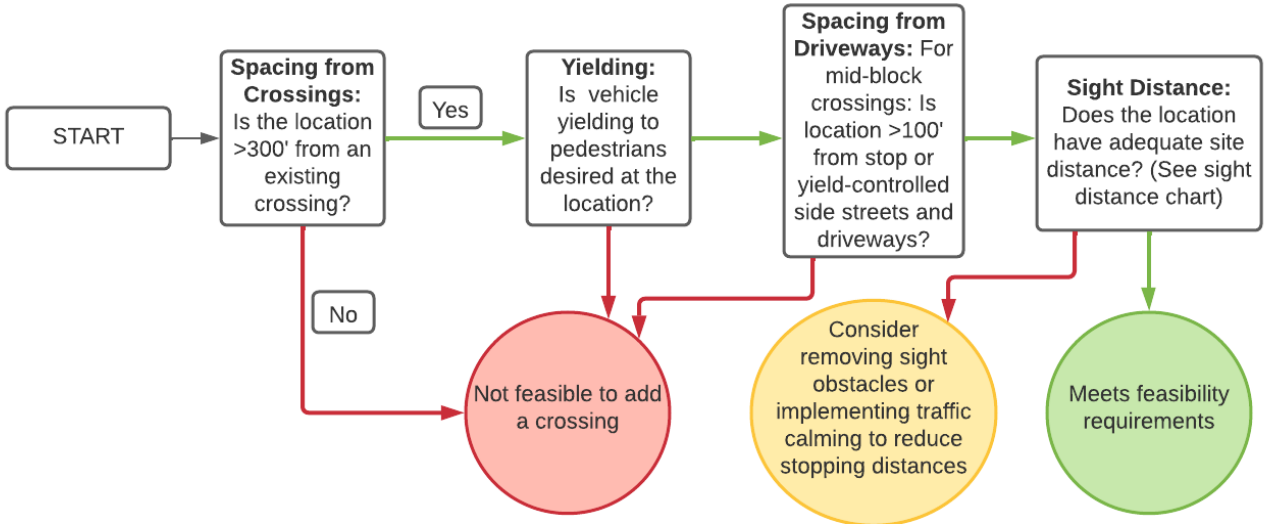
The second step in the decision-making process is determining whether the site is technically feasible for building a new crossing. Technical feasibility factors include distance from existing crossings and intersections and sight distance. Figure 38 is a flowchart that that can be used to determine if it is feasible to install a crossing at a particular location.

Another factor that impacts site feasibility is whether drivers yielding to pedestrians is desired. In New Mexico, drivers are legally required to yield to pedestrians in striped crosswalks. In some locations where stopping for pedestrians could create dangerous conditions for other road users, it may not be feasible to install crosswalks.

Table 6: DPM Table 7.4.64 Minimum Stopping Sight Distance

TABLE 7.4.64 **Minimum Stopping Sight Distance**							
Design Speed (MPH)	Upgrades			Flat	Downgrades		
	9%	6%	3%	0%	-3%	-6%	-9%
25	140 ft.	145 ft.	150 ft.	155 ft.	160 ft.	165 ft.	175 ft.
30	180 ft.	185 ft.	200 ft.	200 ft.	205 ft.	215 ft.	230 ft.
35	225 ft.	230 ft.	240 ft.	250 ft.	260 ft.	275 ft.	290 ft.
40	270 ft.	280 ft.	290 ft.	305 ft.	315 ft.	335 ft.	355 ft.
45	320 ft.	330 ft.	345 ft.	360 ft.	380 ft.	400 ft.	430 ft.
50	375 ft.	390 ft.	405 ft.	425 ft.	450 ft.	475 ft.	510 ft.

Figure 38: Site Feasibility Flowchart



Crossing Applications & Roadway Context

Step 3: Crossing Design Selection

Once a site has been chosen and determined to be a feasible location for a crossing, appropriate crossing treatments can be selected. Crossing designs vary based on the following conditions:

- Level of traffic (ADT)
- Posted speed limit (MPH)
- Number of lanes a pedestrian must cross at a time

As a general rule, crossing designs should have increased visibility features and increased levels of vehicle control as speeds, traffic volumes, and roadway width increase.

Enhanced crosswalks with high visibility pavement markings and signage are appropriate for streets with lower volumes, speeds, and number of lanes. For wider, busier roads, more comprehensive designs are needed to draw motorists' attention to the crossing and encourage them to stop or yield to people crossing. RRFBs are generally appropriate for roads where speed limits are 35 mph or lower or where pedestrians need to cross only one or two lanes at a time. For roads with higher speed limits and more lanes to cross, a PHB or other traffic signal where vehicles must come to a complete stop is the minimum recommended crossing treatment.

Methodology

The recommendations in this report are adapted from the FHWA *Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations*, which compiled recommendations based on the MUTCD and studies of safety and driver compliance at crossing locations. The FHWA guidance specifically recommends crossing treatments based on a roadway's number of vehicle travel lanes, posted speed limits, and average daily traffic (ADT).

This report makes the following changes to the FHWA's guidance to adapt it to an Albuquerque context:

- **Number of Crossing Lanes:** Instead of total vehicle travel lanes, this report uses the total number of lanes a pedestrian must cross at a time to calculate the appropriate crossing treatment. For example, a four-lane road with no refuge island requires a pedestrian to cross all four lanes at a time, and the treatments recommended in the four-lane category should be referenced. However, if a refuge island were installed, a pedestrian would only need to cross two lanes at a time and the two-lane category should be referenced.
- **ADT per Crossing Stage:** ADT is also adjusted to reflect the traffic volume a pedestrian will encounter on each stage of the crossing. If a pedestrian must cross both directions of travel at a time, total ADT should be used to determine the crossing design. However, if a refuge island separates the crossing into two stages, ADT should be divided in half to reflect the traffic volume a pedestrian will encounter on each stage of the crossing.

The purpose of using crossing lanes and ADT per crossing stage is to encourage the use of refuge islands, road diets, and speed limit reductions, which can dramatically improve pedestrian safety while reducing the need for more costly interventions such as PHBs. The adjustments also provide additional nuance to the FHWA guidance for Albuquerque's wider arterial roadways. See the appendices for a list of additional changes to the FHWA guidance and rationale.

Crossing Applications & Roadway Context

Application

Table 8 and Figure 39 through Figure 42 provide guidance on selecting the appropriate crossing treatments based on roadway context. Either the table or flow charts can be used to select a crossing treatment. Highlighted cells in the table are treatments that should always be considered, while un-highlighted cells are optional treatments (see Table 7).

The recommended overall crossing designs include the following treatment types:

- Crosswalk markings and signage
- Rectangular rapid flashing beacons
- Pedestrian hybrid beacons

For each crossing location, only one of the recommended crossing designs should be selected. Complementary treatments that can be added to the overall crossing design include advance stop or yield lines, in-street pedestrian crossing signs, and raised crosswalks. Other treatments described in the Crossing Design Elements section of this report can also be used to complement the overall crossing designs but are not included in the selection tool. See the Crossing Design Elements section for additional information about the design and application of each treatment.

Users of this guide are strongly urged to run multiple roadway configuration scenarios for each crossing location before selecting a treatment. Applying a median refuge island, road diet, and/or speed limit reduction may reduce the need for more costly and comprehensive treatments like a PHB. For examples on how to apply the guidance using multiple roadway scenarios, see the Trail Crossing Profiles section of this report.

Table 7: Notes on Crossing Treatment Selection Matrix

Notation	Definition
(No markings)	Not an appropriate treatment
X	Treatment may be considered
X	Treatment *should always* be considered

85th Percentile Speed vs Posted Speed Limit

85th percentile is the speed at or below which 85 percent of all vehicles are observed to travel under free-flowing conditions. In many cases, 85th percentile speeds are higher than the posted speed limit.

At the discretion of the City Engineer, 85th percentile speed may be used in place of posted speed limit when selecting appropriate crossing treatments. In areas with identified safety concerns, using 85th percentile speed rather than posted speed can more accurately reflect actual vehicle speeds and appropriate safety countermeasures.

Crossing Applications & Roadway Context

Table 8: Crossing Treatment Selection Matrix

			Recommended Crossing Designs			Complementary Treatments		
Number of Crossing Lanes	Speed Limit	ADT Per Crossing Stage	Crosswalk Markings and Signage	RRFB	PHB	Stop or Yield Lines	In-Street Crossing Sign	Raised Crosswalk
One lane	≤ 30 mph	<9,000	X			X	X	X
		9,000 to 15,000	X			X	X	
		>15,000	X	X	X	X	X	
	35 mph	<9,000	X	X	X	X		
		9,000 to 15,000	X	X	X	X		
		>15,000	X	X	X	X		
	≥ 40 mph	<9,000		X	X	X		
		9,000 to 15,000		X	X	X		
		>15,000		X	X	X		
Two lanes	≤ 30 mph	<9,000	X			X	X	X
		9,000 to 15,000	X	X	X	X	X	
		>15,000	X	X	X	X	X	
	35 mph	<9,000	X	X	X	X		
		9,000 to 15,000		X	X	X		
		>15,000		X	X	X		
	≥ 40 mph	<9,000		X	X	X		
		9,000 to 15,000		X	X	X		
		>15,000		X	X	X		

Crossing Applications & Roadway Context

			Recommended Crossing Designs			Complementary Treatments		
Number of Crossing Lanes	Speed Limit	ADT Per Crossing Stage	Crosswalk Markings and Signage	RRFB	PHB	Stop or Yield Lines	In-Street Crossing Sign	Raised Crosswalk
Three Lanes	≤ 30 mph	<9,000	X	X	X	X	X	X
		9,000 to 15,000	X	X	X	X	X	
		>15,000	X	X	X	X	X	
	35 mph	<9,000	X	X	X	X		
		9,000 to 15,000		X	X	X		
		>15,000			X	X		
	≥ 40 mph	<9,000			X	X		
		9,000 to 15,000			X	X		
		>15,000			X	X		
Four or More Lanes	≤ 30 mph	<9,000	X	X	X	X		
		9,000 to 15,000		X	X	X		
		>15,000		X	X	X		
	35 mph	<9,000		X	X	X		
		9,000 to 15,000		X	X	X		
		>15,000			X	X		
	≥ 40 mph	<9,000			X	X		
		9,000 to 15,000			X	X		
		>15,000			X	X		

Figure 39: Crossing Treatment Selection Flowchart, One Lane Crossings

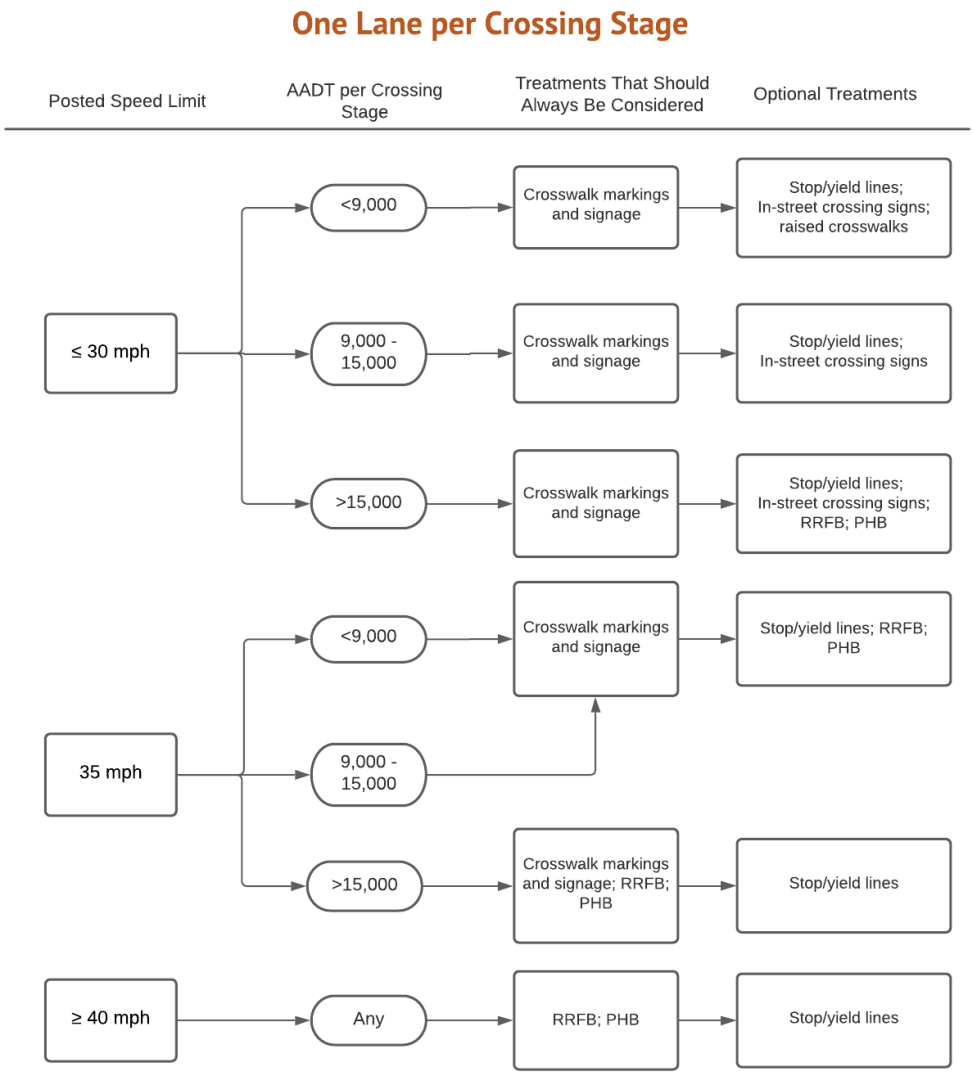


Figure 40: Crossing Treatment Selection Flowchart, Two-Lane Crossings

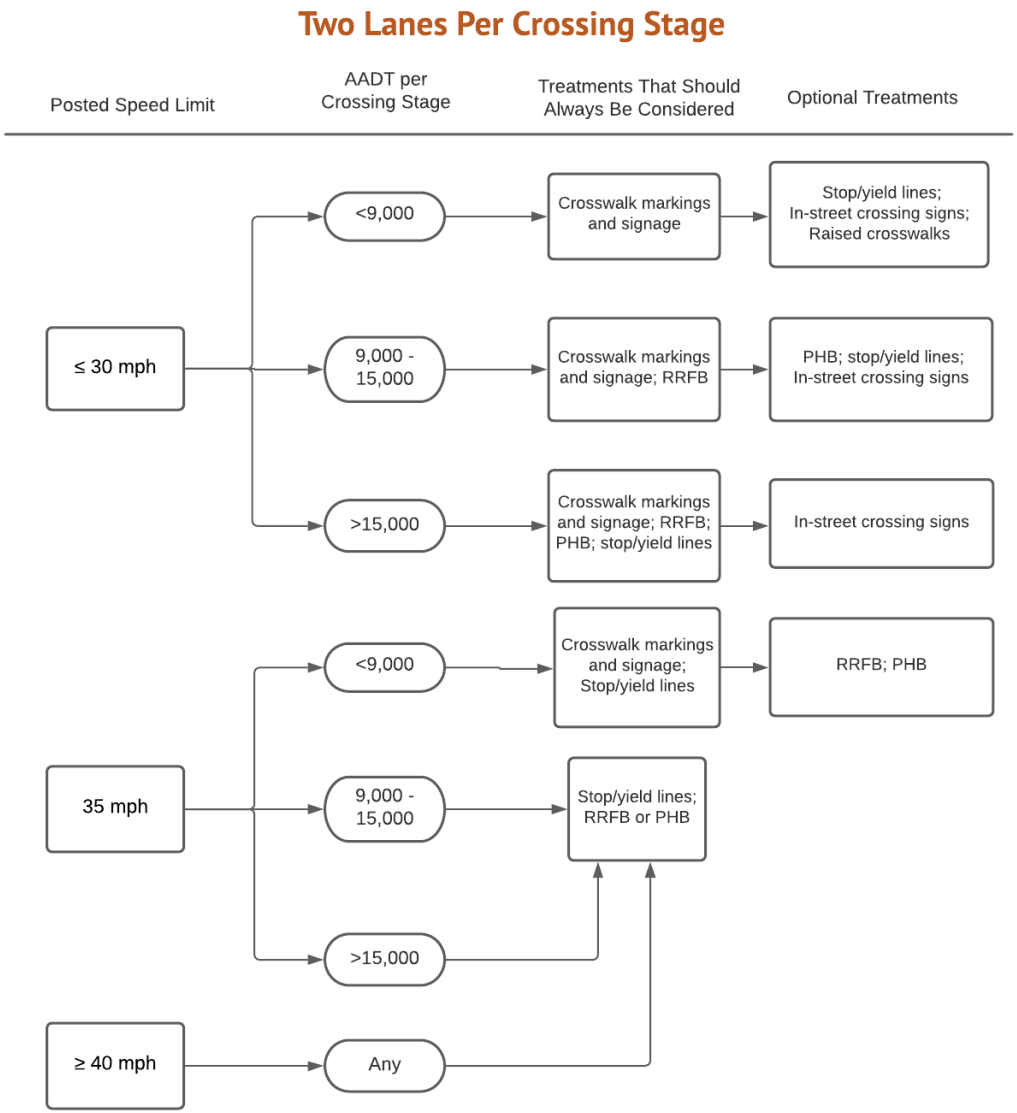


Figure 41: Crossing Treatment Selection Flowchart, Three-Lane Crossings

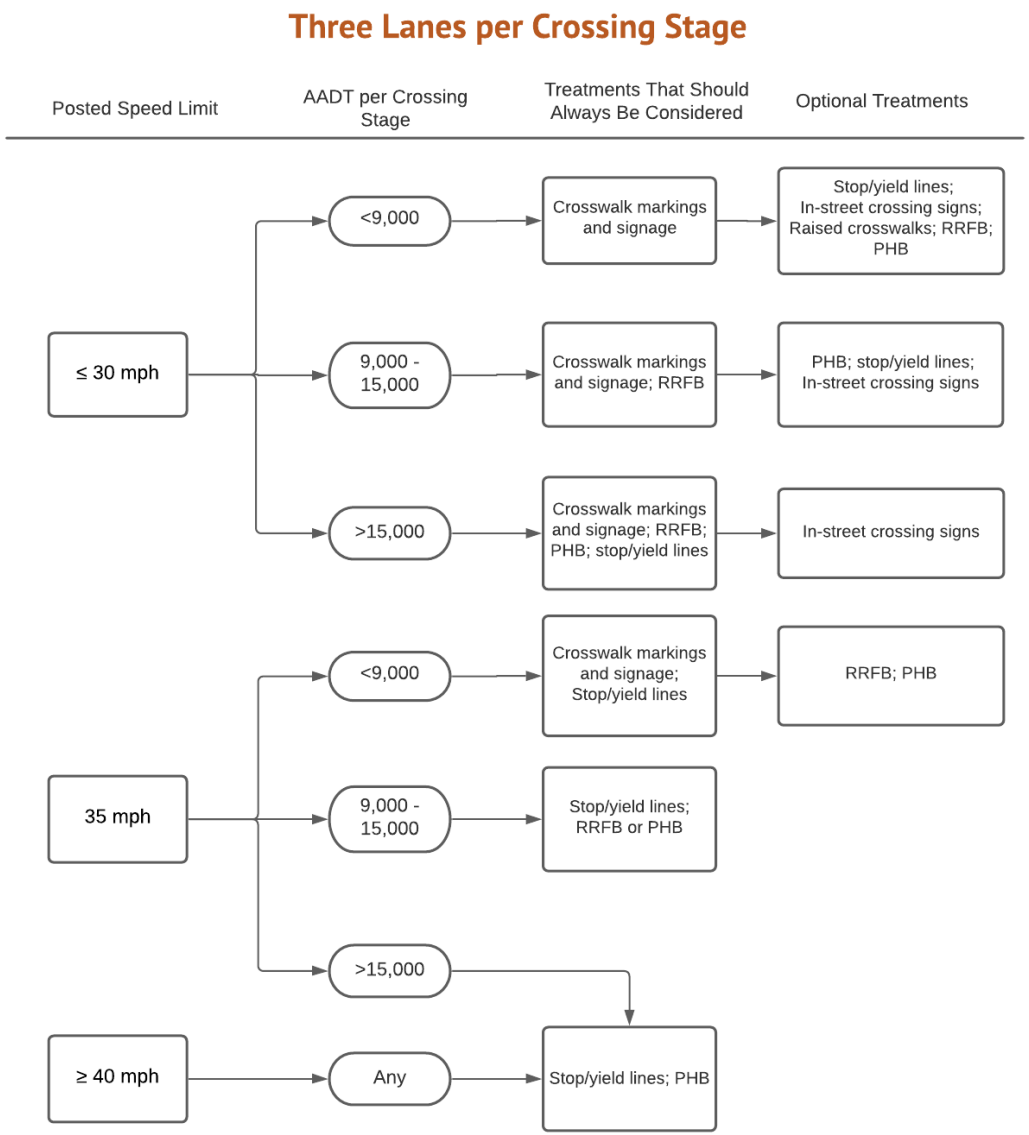
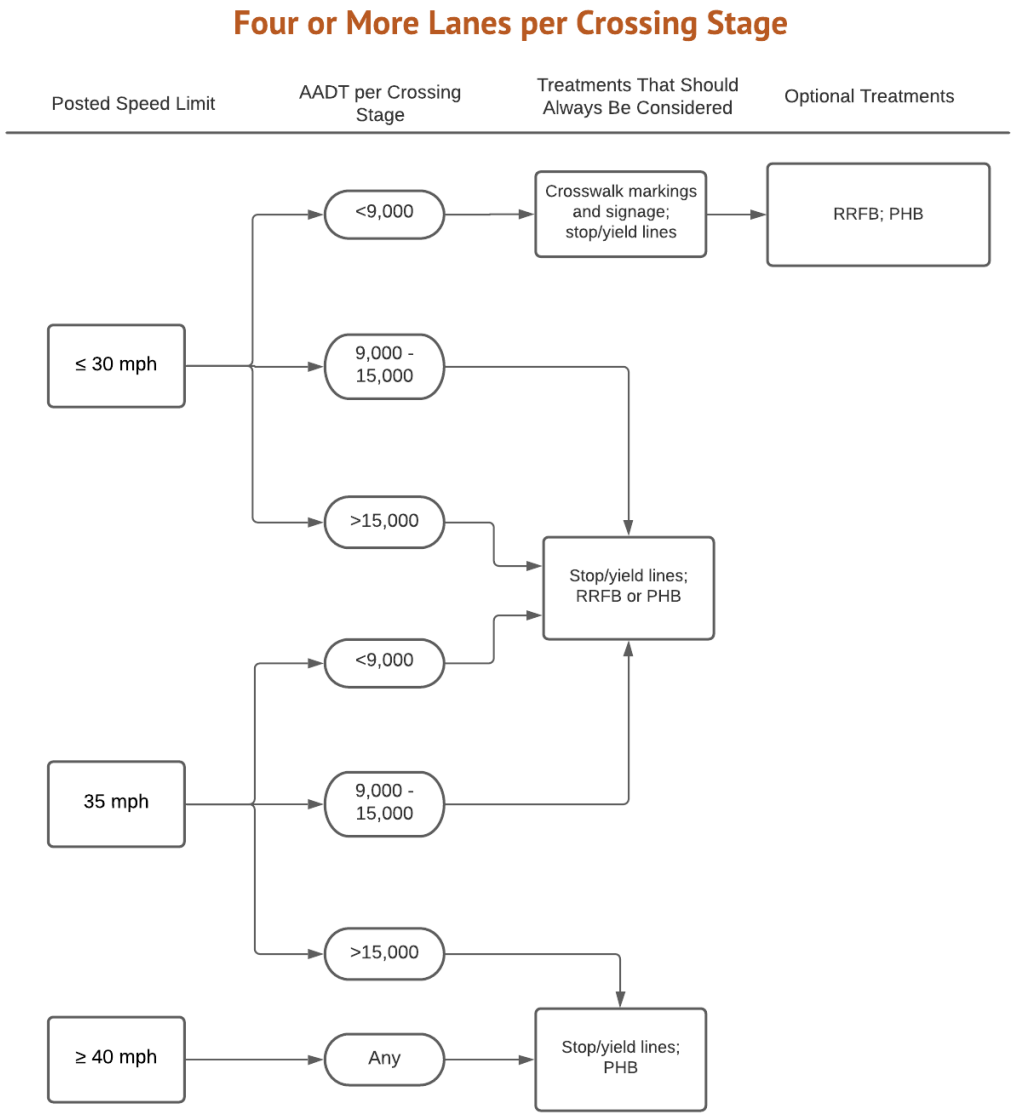


Figure 42: Crossing Treatment Selection Flowchart, Four or More Lane Crossings



Trail Crossing Profiles and Example Applications

Juan Tabo Blvd

Existing Conditions

The **Paseo de las Montañas Trail** crosses Juan Tabo Blvd between Menaul Blvd and Candelaria Rd. Table 9 describes the existing conditions along Juan Tabo Blvd at the crossing location.

Table 9: Juan Tabo Blvd Existing Conditions

Existing Conditions	Paseo de las Montañas Trail @ Juan Tabo Blvd
General Purpose Lanes	6
Raised Median/Refuge Island	Yes
Crossing Lanes	3
Total ADT	23,000
ADT per Crossing Stage	11,500
Speed Limit	40
Functional Classification	Principal Arterial
Comprehensive Plan Corridor Designation	Multi-Modal

The existing crossing includes a median refuge, overhead flashing lights, and bicycle/pedestrian warning signage (see Figure 43). There are no marked crosswalks or advance stop or yield lines at the crossing. Roadway-scale overhead lighting is present on both sides of the roadway near the crossing location.

Figure 43: Existing Trail Crossing at Juan Tabo Blvd

The trail crossing is located 700’ from an unsignalized crossing at Claremont Ave to the north and 1700’ from a signalized crossing at Candelaria Rd to the north. To the south, the crossing is located 900’ from a signalized crossing at Menaul Blvd (see Figure 44).

Figure 44: Adjacent Crossing Locations at Juan Tabo Blvd

Juan Tabo Blvd

Alternatives

The recommended treatments for the crossing of the Paseo de las Montañas Trail at Juan Tabo Blvd depend on the roadway's speed, number of lanes, and ADT. While ADT cannot be controlled, changing the speed limit and number of lanes influences the appropriate options for recommended crossing treatments.

Option 1: Keep the current configuration and install a PHB

If no changes are made to the speed limit and number of general purpose lanes on Juan Tabo Blvd, the only appropriate crossing treatment option is a PHB.

Option 2: Change roadway design characteristics or operations

2A: Reduce the speed limit and install an RRFB or PHB

If the speed limit on Juan Tabo Blvd were reduced from 40 mph to 35 mph, either RRFBs or PHBs could be considered for the crossing treatment. Additional traffic calming treatments may be needed to ensure that vehicles comply with the reduced speed limit.

A PHB would provide a safer and more comfortable crossing environment as trail users still need to cross three lanes of traffic at a time. However, because they are expensive to install and impact traffic operations, PHBs should be prioritized at locations with higher traffic volumes and populations of vulnerable road users who may not be able to use an RRFB safely.

2B: Reduce the number of lanes and install an RRFB or PHB

If a road diet were introduced (from six lanes to four lanes) either RRFBs or PHBs could be considered. Juan Tabo Blvd is identified on MRCOG's Potential Road Diet Candidates Map.

Recommendation

Option 2A and/or 2B with RRFB

The following recommendations should be used in combination for the crossing of the Paseo del Las Montañas Trail at Juan Tabo Blvd:

- Keep the existing refuge island, reduce the speed limit and/or number of general purpose lanes, and replace overhead flashing lights with an RRFB.
- If the speed limit is reduced, additional traffic calming treatments, such as lane narrowing, could further encourage driver compliance.
- Add crosswalk markings and advance stop/yield lines to increase the crossing's visibility and reduce the likelihood of multiple threat crashes.
- Add accessibility features such as truncated domes in the median refuge.
- If the RRFB is to be activated automatically, ensure that it can detect pedestrians crossing from both the sidewalk and the trail.
- At time of design, ensure that overhead lighting levels meet DPM requirements.

Changing the roadway configuration eliminate the need for a more costly PHB. In addition to cost, RRFBs have an advantage over PHBs because they can be activated immediately, reducing delay for trail users crossing the road.

Trail Crossing Profiles and Example Applications

Eubank Blvd

Existing Conditions

The **Paseo de las Montañas Trail** crosses Eubank Blvd between Indian School Rd and Snow Heights Blvd. Table 10 describes the existing conditions along Eubank Blvd at the crossing location.

Table 10: Eubank Blvd Existing Conditions

Existing Conditions	Paseo de las Montañas Trail @ Eubank Blvd
General Purpose Lanes	6
Raised Median/Refuge Island	Yes
Crossing Lanes	3
Total ADT	31,000
ADT per Crossing Stage	15,500
Speed Limit	40
Functional Classification	Principal Arterial
Comprehensive Plan Corridor Designation	None

The existing crossing at Eubank Blvd includes a median refuge, overhead flashing lights, and bicycle/pedestrian warning signage (see Figure 45). There are no marked crosswalks or advance stop or yield lines at the crossing. Roadway-scale overhead lighting is present on both sides of the roadway near the crossing location.

Figure 45: Existing Trail Crossing at Eubank Blvd

The trail crossing is located 500’ from a signalized crossing at Snow Heights Blvd to the north and 800’ from a signalized crossing at Indian School Rd to the south (see Figure 46).

Figure 46: Adjacent Crossing Locations at Eubank Blvd

Trail Crossing Profiles and Example Applications

Eubank Blvd

Alternatives

The recommended treatments for the crossing of the Paseo de las Montañas Trail at Eubank Blvd depend on the roadway's speed, number of lanes, and ADT. Changing the number of lanes influences the appropriate options for recommended crossing treatments. Because of the corridor's high traffic volumes, reducing the speed from 40 mph to 35 mph does not change the recommended treatment options.

Option 1: Keep the current roadway configuration and install a PHB

If no changes were made to the number of general purpose lanes on Eubank Blvd, the only appropriate crossing treatment option is a PHB.

Option 2: Change roadway design characteristics or operations

Reduce the number of general purpose lanes and install an RRFB or PHB

If a road diet were introduced (from six lanes to four lanes) either RRFBs or PHBs could be considered. However, Eubank Blvd may not be a candidate for a road diet if traffic volumes are projected to grow in the future. The threshold for inclusion on MRCOG's Road Diets Candidates map is an ADT below 35,000, and Eubank Blvd has an ADT of 31,000.

Recommendation

Option 1 with PHB

The following recommendations should be used in combination for the crossing of the Paseo del Las Montañas Trail at Eubank Blvd:

- Keep the existing median refuge island and install a PHB at the Eubank Blvd crossing location.
- Per the MUTCD, marked crosswalks, advance stop lines, and signage shall be installed with PHBs to increase its visibility and reduce the risk of multiple threat crashes.
- Add accessibility features such as truncated domes in the median refuge.
- At time of design, ensure that overhead lighting levels meet DPM requirements.

While PHBs are more costly than RRFBs, it is likely not feasible to reduce the number of lanes on Eubank Blvd given its high traffic volumes. A PHB at the crossing location will bring vehicles to a complete stop, which will allow trail users to safely cross the busy and high-speed arterial.

Wyoming Blvd

Existing Conditions

The **Paseo de las Montañas Trail** crosses Wyoming Blvd between Indian School Rd and Constitution Ave. Table 11 describes the existing conditions along Wyoming Blvd at the crossing location.

Table 11: Wyoming Blvd Existing Conditions

Existing Conditions	Paseo de las Montañas Trail @ Wyoming Blvd
General Purpose Lanes	6
Raised Median/Refuge Island	Yes
Crossing Lanes	3
Total ADT	31,000
ADT per Crossing Stage	15,500
Speed Limit	40
Functional Classification	Principal Arterial
Comprehensive Plan Corridor Designation	Multi-Modal

The existing crossing at Wyoming Blvd includes a median refuge, overhead flashing lights, and bicycle/pedestrian warning signage (see Figure 47). There are no marked crosswalks or advance stop or yield lines at the crossing. Roadway-scale overhead lighting is present on both sides of the roadway near the crossing location.

The trail also crosses a frontage road parallel to Wyoming Blvd, which includes signage and a median refuge island between Wyoming Blvd and the frontage road. There is a concrete barrier between Wyoming Blvd and the frontage road that may make it more difficult to drivers to see pedestrians waiting to cross and may reduce driver yield rates.

Figure 47:Existing Trail Crossing at Wyoming Blvd

The trail crossing is located 1000’ from a signalized crossing at Indian School Rd to the north and 1600’ from a signalized crossing at Constitution Ave to the south (see Figure 48).

Figure 48: Adjacent Crossing Locations at Wyoming Blvd

Wyoming Blvd

Alternatives

The recommended treatments for on Wyoming Blvd at the Paseo de las Montañas crossing depend on the roadway's speed, number of lanes, and ADT. Changing the number of lanes influences the appropriate options for recommended crossing treatments. Because of the corridor's high traffic volumes, reducing the speed from 40 mph to 35 mph does not change the recommended treatment options.

Option 1: Keep the current roadway configuration and install a PHB

If no changes were made to the number of general purpose lanes on Wyoming Blvd, the only appropriate crossing treatment option is a PHB.

Option 2: Change roadway design characteristics or operations

Reduce the number of general purpose lanes and install an RRFB or PHB

If a road diet were introduced (from six lanes to four lanes) either RRFBs or PHBs could be considered. However, Wyoming Blvd may not be a candidate for a road diet if traffic volumes are projected to grow in the future. The threshold for inclusion on MRCOG's Road Diets Candidates map is an ADT below 35,000, and Wyoming Blvd has an ADT of 31,000.

Recommendation

Option 1 with PHB

The following recommendations should be used in combination for the crossing of the Paseo del Las Montañas Trail at Wyoming Blvd:

- Keep the existing median refuge island and install a PHB at the Wyoming Blvd crossing location.
- Per the MUTCD, marked crosswalks, advance stop lines, and signage shall be installed with PHBs to increase its visibility and reduce the risk of multiple threat crashes.
- Add accessibility features such as truncated domes in the median refuge.
- At time of design, ensure that overhead lighting levels meet DPM requirements.

While PHBs are more costly than RRFBs, it is likely not feasible to reduce the number of lanes on Wyoming Blvd given its high traffic volumes. A PHB at the crossing location will bring vehicles to a complete stop, which will allow trail users to safely cross the busy and high-speed arterial. A PHB would also address visibility issues caused by the concrete wall barrier between Wyoming Blvd and the frontage road.

Trail Crossing Profiles and Example Applications

San Mateo Blvd

Existing Conditions

The **Paseo del Nordeste Trail** crosses San Mateo Blvd between Montgomery Blvd and Comanche Rd. Table 12 describes the existing conditions along San Mateo Blvd at the crossing location.

Table 12: San Mateo Blvd Existing Conditions

Existing Conditions	Paseo del Nordeste Trail @ San Mateo Blvd
General Purpose Lanes	6
Raised Median/Refuge Island	Yes
Crossing Lanes	3
Total ADT	25,000
ADT per Crossing Stage	12,500
Speed Limit	40
Functional Classification	Principal Arterial
Comprehensive Plan Corridor Designation	Major Transit

The existing crossing at San Mateo Blvd includes a median refuge and overhead bicycle warning signage (see Figure 49). There are no marked crosswalks or advance stop or yield lines at the crossing. Roadway-scale overhead lighting is present on both sides of the roadway near the crossing location. Unlike similar trail crossings, the crossing at San Mateo Blvd does not have overhead flashing lights or pedestrian crossing signage.

Figure 49:Existing Trail Crossing at San Mateo Blvd

The trail crossing is located 2000’ from a signalized crossing at Montgomery Blvd to the north and 600’ from a signalized crossing at Comanche Rd to the south (see Figure 50).

Figure 50: Adjacent Crossing Locations at San Mateo Blvd

Trail Crossing Profiles and Example Applications

San Mateo Blvd

Alternatives

Per the recommended crossing treatments guidelines, crossing treatments for San Mateo Blvd at the Paseo del Nordeste Trail depend on the roadway's speed, number of lanes, and ADT. Changing the speed limit and number of lanes influences the appropriate options for recommended crossing treatments.

Option 1: Keep the current roadway configuration and install a PHB

If no changes were made to the speed limit and number of general purpose lanes on San Mateo Blvd, the only appropriate crossing treatment option is a PHB.

Option 2: Change roadway design characteristics or operations

2A: Reduce the speed limit and install an RRFB or PHB

If the speed limit on San Mateo Blvd were reduced from 40 mph to 35 mph, either RRFBs or PHBs could be considered for the crossing treatment. Additional traffic calming treatments may be needed to ensure that vehicles comply with the reduced speed limit.

A PHB would provide a safer and more comfortable crossing environment as trail users still need to cross three lanes of traffic at a time. However, because they are expensive to install and impact traffic operations, PHBs should be prioritized at locations with higher traffic volumes and populations of vulnerable road users who may not be able to use an RRFB safely.

2B: Reduce the number of lanes and install an RRFB or PHB

If a road diet were introduced (from six lanes to four lanes) either RRFBs or PHBs could be considered. San Mateo Blvd is identified on MRCOG's Potential Road Diet Candidates Map.

Recommendation

Option 2A and/or 2B with RRFB

The following recommendations should be used in combination for the crossing of the Paseo del Nordeste Trail at San Mateo Blvd:

- Keep the existing median refuge island, introduce a road diet and/or speed limit reduction, and replace flashing lights with an overhead RRFB.
- If speed limit is reduced, add additional traffic calming treatments to encourage driver compliance.
- Add crosswalk markings and advance stop/yield lines to increase the crossing's visibility and reduce the likelihood of multiple threat crashes.
- Add accessibility features such as truncated domes in the median refuge and on sidewalk curb ramps.
- If the RRFB is to be activated automatically, ensure that it can detect pedestrians crossing from both the sidewalk and the trail.
- At time of design, ensure that overhead lighting levels meet DPM requirements.

Changing the roadway configuration would allow the City to install an RRFB rather than a more costly PHB. In addition to cost, RRFBs have an advantage over PHBs because they can be activated immediately, reducing delay for trail users crossing the road.

Trail Crossing Profiles and Example Applications

Carlisle Blvd

Existing Conditions

The **Paseo del Nordeste Trail** crosses Carlisle Blvd between Montgomery Blvd and Comanche Rd. Table 13 describes the existing conditions along Carlisle Blvd at the crossing location.

Table 13: Carlisle Blvd Existing Conditions

Existing Conditions	Paseo del Nordeste Trail @ Carlisle Blvd
General Purpose Lanes	6
Raised Median/Refuge Island	Yes
Crossing Lanes	3
Total ADT	21,000
ADT per Crossing Stage	10,500
Speed Limit	35
Functional Classification	Minor Arterial
Comprehensive Plan Corridor Designation	Major Transit

The existing crossing at Carlisle Blvd includes a median refuge, overhead flashing lights, and bicycle/pedestrian warning signage (see Figure 51). There are no marked crosswalks or advance stop or yield lines at the crossing. Roadway-scale overhead lighting is present on both sides of the roadway near the crossing location.

Figure 51:Existing Trail Crossing at Carlisle Blvd

The trail crossing is located 1150’ from a signalized crossing at Montgomery Blvd to the north and 1400’ from a signalized crossing at Comanche Rd to the south (see Figure 52).

Figure 52: Adjacent Crossing Locations at Carlisle Blvd

Trail Crossing Profiles and Example Applications

Carlisle Blvd

Alternatives

Based on the guidance provided in this report and the posted speed limit and traffic volume along Carlisle Blvd, an RRFB with pedestrian refuge island is an appropriate treatment for the crossing of the Paseo del Nordeste Trail.

Additional options include the application of a road diet for traffic calming and general safety purposes. Reducing the number of lanes would not influence the types of crossing treatments that can be applied.

Option 1: Keep the existing roadway configuration, replace overhead flashing lights with an RRFB, and apply enhanced crosswalk markings

High visibility crosswalk markings and an RRFB in place of flashing lights would enhance driver awareness and more clearly demarcate the pedestrian crossing.

Option 2: Keep the existing roadway configuration and install a PHB

If no changes were made to the speed limit and number of general purpose lanes on Carlisle Blvd, a PHB is an appropriate crossing treatment option. Installation of a PHB would require motorists to come to a complete stop. While a PHB would affect traffic operations, the crossing location is spaced far enough from existing traffic signals to minimize impacts.

Recommendation

Option 1: Apply enhanced crosswalk markings

The following recommendations should be used in combination for the crossing of the Paseo del Nordeste Trail at Carlisle Blvd:

- Keep the existing median refuge at the crossing and replace overhead flashing lights with an RRFB
- Add crosswalk markings and advance stop/yield lines to increase the crossing's visibility and reduce the likelihood of multiple threat crashes.
- Add accessibility features such as truncated domes in the median refuge.
- If the RRFBs is to be activated automatically, ensure that it can detect pedestrians crossing from both the sidewalk and the trail.
- At time of design, ensure that overhead lighting levels meet DPM requirements.

This recommendation allows the City to keep the roadway configuration on Carlisle Blvd. Additions of RRFBs, crosswalk markings, yield lines, and truncated domes would be cost-effective and would enhance the visibility and safety for trail users crossing the street.

Pennsylvania St

Existing Conditions

Claremont Ave crosses Pennsylvania St between Candelaria Rd and Menaul Blvd along a proposed bike boulevard route. Table 14 describes the existing conditions along Pennsylvania St at the intersection.

Table 14: Pennsylvania St Existing Conditions

Existing Conditions	Claremont Ave @ Pennsylvania St
General Purpose Lanes	2
Raised Median/Refuge Island	No
Crossing Lanes	2
Total ADT	7,000
ADT per Crossing Stage	7,000
Speed Limit	25
Functional Classification	Major Collector
Comprehensive Plan Corridor Designation	None

There are no existing crossing treatments at the intersection of Claremont Ave and Pennsylvania St (see Figure 53). There are stop signs controlling traffic on Claremont Ave, but no traffic control devices on Pennsylvania St. There is one roadway-scale overhead light on the southeast corner of the intersection.

Figure 53:Existing Crossing at Pennsylvania St

The intersection is located 1250’ from a signalized crossing at Candelaria Rd to the north and 1250’ from a signalized crossing at Menaul Blvd to the south (see Figure 54).

Figure 54: Adjacent Crossing Locations at Pennsylvania St

Pennsylvania St

Alternatives

Pennsylvania St at Claremont Ave is a low-speed and low-volume two-lane roadway. As such, no changes to the existing configuration are needed to add crossing treatments.

Option 1: Keep the existing roadway configuration and install crosswalk markings and signage

If no changes were made to the speed limit and number of general purpose lanes on Pennsylvania St, the appropriate crossing treatment is high-visibility crosswalk markings and signage.

Recommendation

Apply crosswalk markings and signage

The following recommendations should be used in combination for the crossing at Pennsylvania St and Claremont Ave:

- Add continental-style crosswalk markings across Pennsylvania St.
- Add pedestrian warning signage.
- Ensure that nighttime lighting levels are adequate.
- At time of design, ensure that overhead lighting levels meet DPM requirements. Additional lighting will likely be needed.
- Additional optional treatments include in-street pedestrian crossing signs, advance yield lines, and raised crosswalks.
    - While advance yields lines can be installed on two-lane streets, their main purpose is to prevent multiple threat crashes on multi-lane roads.
    - Raised crosswalks can be installed on streets with less than 9,000 ADT and help to slow traffic and increase the visibility of pedestrians crossing the street.

Golf Course Rd

Existing Conditions

Marna Lynn Ave crosses Golf Course Rd between Paradise Blvd and Paseo del Norte Blvd. Table 15 describes the existing conditions along Golf Course Rd at the intersection.

Table 15: Golf Course Rd Existing Conditions

Existing Conditions	Marna Lynn Ave @ Golf Course Rd
General Purpose Lanes	4
Raised Median/Refuge Island	Raised median w/out refuge island
Crossing Lanes	2
Total ADT	26,000
ADT per Crossing Stage	13,000
Speed Limit	40
Functional Classification	Minor Arterial
Comprehensive Plan Corridor Designation	Major Transit

There are no existing crossing treatments at the intersection of Marna Lynn Ave and Golf Course Rd (see Figure 55). There are stop signs controlling traffic on Marna Lynn Ave, but no traffic control devices on Golf Course Rd. Golf Course Rd has a 10'-wide raised concrete median, but no designated spaces in the median for pedestrian refuge islands. There is no overhead lighting at the intersection.

Figure 55:Existing Crossing at Golf Course Rd

The intersection is located 1500' from a signalized crossing at Paradise Blvd to the north and 2100' from a signalized crossing at Paseo del Norte Blvd to the south (see Figure 56).

Figure 56: Adjacent Crossing Locations at Golf Course Rd

Golf Course Rd

Alternatives

Per the recommended crossing treatments guidelines, crossing treatments for Golf Course Rd at Marna Lynn Ave depend on the roadway's speed, number of lanes, and ADT. The selected alternative also depends on the decision to restrict or maintain options for left turns at the intersection.

Option 1: Keep the existing roadway configuration and install a PHB

If no changes are made to the speed limit and the geometry of the roadway is unchanged, the most appropriate crossing treatment is a PHB.

Option 2: Change roadway design and operations characteristics by adding a refuge island and RRFB or PHB

If the speed limit on Golf Course Rd were reduced from 40 mph to 35 mph and refuge islands were added to the median, a crossing could be provided with an RRFB and crosswalk markings. A PHB may still be considered for additional safety benefits. Additional traffic calming treatments may be needed to ensure that vehicles comply with the reduced speed limit.

Recommendation

Option 2 with RRFB/PHB and refuge island, pending further study

Further engineering analysis is needed determine if there are adequate sight lines at the intersection to install a crossing with RRFB. A PHB may be desired to bring traffic to a complete stop to ensure greater driver yielding rates.

A pedestrian refuge island is desired for this location; however, installing this feature at the intersection with Marna Lynn Ave would limit use of one of the left turn bays (depending on the location for the crossing). Additional consideration should be given to the effects of limiting access at the intersection.

The following additional recommendations should be used in combination for the crossing at Golf Course Rd and Marna Lynn Ave:

- Reduce the posted speed limit to 35 mph.
- Install crosswalk markings and advance stop/yield lines to increase the crossing's visibility and reduce the likelihood of multiple threat crashes.
- Add accessibility features such as truncated domes.
- Install adequate lighting to meet DPM-required lighting levels.

Appendices

Definitions

Advance Stop/Yield Lines: Pavement markings placed 20 to 50 feet ahead of a crosswalk that indicate where vehicles should wait for pedestrians and bicyclists to cross.

Average Daily Traffic: The average 24 hour volume of vehicles on a roadway segment, calculated by dividing the total volume during a year by 365 days.

Controlled Pedestrian Crossing: a location where vehicles in all directions are managed with traffic control devices that may facilitate pedestrian crossing (DPM 7-4(A)(2)).

Crosswalk Markings: Pavement markings that indicate a crosswalk's location. Styles include solid, standard, continental, dashed, zebra, and ladder. Ladder, continental, and zebra markings are considered "high visibility" crosswalk markings.

Designated Crossing: A crossing where pedestrians are encouraged to cross a roadway, as indicated by a combination of signal devices, signage, or pavement markings (DPM 7-4(A)(2)).

Full Traffic Signals: Standard traffic signals with pedestrian signal heads and countdown timers.

Grade-Separated Crossing: A bridge or underpass that allows bicyclists or pedestrians to cross a road without interacting with vehicles.

In-Pavement Lights: Raised pavement markers installed on both sides of a crosswalk which may contain LED strobe lighting that emanate outward in the direction of oncoming traffic. They can either be continuous or pedestrian-activated. Also referred to as Crosswalk Warning Systems.

Median Refuge Islands: A median with a space for pedestrians to wait for a gap in traffic, allowing two-stage crossings across multi-lane roads. Also referred to as a pedestrian refuge island, crossing island, or pedestrian safety island.

Mid-Block Crossing: a designated pedestrian crossing not located at an intersection. Mid-block crossings provide direct access to destinations and reduce the distance between intersections with designated crossings (DPM 7-4(A)(2)).

Multiple Threat Crashes: Crashes that occur on roadways with two or more vehicle travel lanes in the same direction. Occurs when a driver in one lane stops for pedestrian while a driver in another lane continues and strikes the person crossing the street.

Pedestrian Hybrid Beacons (PHB): A pedestrian-activated traffic signal that brings vehicles to a complete stop until pedestrians have finished crossing. Also referred to as a high-intensity activated crosswalk (HAWK) signal.

Rectangular Rapid Flashing Beacons (RRFB): An overhead or roadside-mounted sign equipped with flashing LED lights to alert drivers of an unsignalized crossing location. They can be either continuously flashing or pedestrian-activated.

Road Diet: A range of techniques to encourage slower travel speeds and create space for pedestrian, bicycle, and transit users (DPM 7-6).

Signalized Crossing: A designated pedestrian crossing where traffic is forced to stop and the pedestrian is protected by a traffic signal or pedestrian-activated signal device (DPM 7-4(A)(2)).

Signalized Intersection: An intersection where vehicles are managed through a traffic signal. Pedestrian crossings are typically provided at signalized intersections (DPM 7-4(A)(2)).

Stopping Sight Distance: The length of roadway visible to the driver and sufficiently long enough to enable a vehicle traveling at or near the design speed to stop or change lanes before reaching a stationary object in its path (DPM 7-6).

Uncontrolled Intersection: Intersections without any signage or traffic control (DPM 7-116).

Uncontrolled Pedestrian Crossing: a location where pedestrians may cross a roadway where vehicles are not controlled. Pedestrian crossings with pavement markings and signage are an example of both uncontrolled and designated pedestrian crossings (DPM 7-4(A)(2)).

Undesignated Crossing: Locations without pavement markings, signal devices, or signage where pedestrians are expected to cross the roadway.

Unsignalized Crossing: Pedestrian crossings without a traffic signal. Unsignalized pedestrian crossings may have other features to alert drivers to the presence of pedestrians, including signage, crosswalk markings, and rectangular rapid flashing beacons.

Unsignalized Intersection: An at-grade intersection in which the flow of traffic is not controlled by a traffic signal. Unsignalized intersections may be STOP-sign controlled, YIELD sign-controlled, or uncontrolled (DPM 7-6).

Appendices

Crossing Treatments Guidelines Methodology

Table 16 documents which FHWA's vehicle lane categories align with Albuquerque's guidance that uses crossing lanes rather than total vehicle travel lanes.

Table 16: FHWA Vehicle Travel Lane Categories

Albuquerque Category	FHWA Category
One lane	2 lanes (1 lane in each direction)
Two lanes	3 lanes with raised median (1 lane in each direction)
Three lanes	3 lanes without raised median (1 lane in each direction with a two-way left-turn lane)
Four or more lanes	4+ lanes without raised median (2 or more lanes in each direction)

Table 17 documents other changes that were made to the FHWA guidance and the reasoning behind the adaptations.

Table 17: Changes to FHWA Crossing Treatments Guidance

Change to FHWA Guidance	Rationale
Added advance stop/yield lines to all one-lane crossings	The FHWA states that advance stop/yield lines are a candidate treatment for any uncontrolled pedestrian crossing. However, implementation on one-lane crossings should not be prioritized as the primary purpose of advance stop/yield lines is to prevent multiple threat crashes.
Added RRFB as a treatment for one-lane crossings with ADT over 15,000 and ≥40 mph speeds	Other jurisdictions, including Portland Bureau of Transportation, Colorado DOT, and Virginia DOT, allow RRFBs instead of PHBs on two and three lane streets w/ refuge islands where ADT > 15,000 and speed limits are 40 mph.
Added RRFB as a treatment on two-lane crossings with ADT over 15,000 and ≥40 mph speeds	Other jurisdictions, including Colorado DOT and Virginia DOT, allow RRFBs instead of PHBs on two-lane roads without refuge islands where ADT > 15,000 and speed limits are 40 mph.
Adding raised crosswalks to one, two, and three lane roadways with ≤ 30 mph speeds and ADT < 9,000	Typical application for raised crosswalks per the NMDOT Transportation Design Manual
Removed curb extensions, road diets, and refuge islands from the tables and figures	Removed for clarity and to reduce redundancy. These treatments can be considered for all roadways regardless of speed, ADT, or number of lanes.
Removed optional crosswalk markings and signage where RRFBs or PHBs are the minimum required crossing design	Removed for clarity and to reduce redundancy. Crosswalk markings and signage are a required component of RRFBs and PHBs per the MUTCD.
Highlighted crosswalk markings, RRFBs and PHBs as treatments that should always be considered for the following contexts: -One lane crossings with speeds of 35 mph and ADT >15,000 -Two-lane crossings with speed limits ≤ 30 mph and ADT >15,000 -Three-lane crossings with speed limits ≤ 30 mph and ADT >15,000	FHWA guidance did not mark any treatment as “should always be considered” for these categories. Highlighting treatments encourages users to consider all available options before making a decision.

Change to FHWA Guidance	Rationale
Highlighted crosswalk markings and RRFBs as treatments that should always be considered for the following contexts: -Two-lane crossings with speed limits ≤ 30 mph and ADT between 9,000 and 15,000 -Three-lane crossings with speed limits ≤ 30 mph and ADT between 9,000 and 15,000	FHWA guidance did not mark any treatment as "should always be considered" for these categories. Highlighting treatments encourages users to consider all available options before making a decision. Although PHBs can still be considered, PHBs were not highlighted in these contexts because less comprehensive treatments are adequate for lower speed/volume roadways.
Highlighted RRFB and PHB as treatments that should always be considered for four-lane crossings with speed limits ≤ 30 mph and ADT between 9,000 and 15,000. Removed the option for crosswalk markings and signage for this context.	FHWA guidance did not mark any treatment as "should always be considered" for these categories. Highlighting treatments encourages users to consider all available options before making a decision. Crosswalk markings and signage were removed because it is not an adequate treatment for four-lane medium volume roadways.

Appendices

Crash Modification Factors

Treatment	CMF Countermeasure Title	CMF	Crash Type and Severity	Roadway Classification and Context	Source
Full Traffic Signal	Install Traffic Signal	.77	All types, Injury Crashes	Road Type not Specified; Urban	McGee et al., 2003
PHB	Install pedestrian hybrid beacon (PHB or HAWK) with advanced yield or stop markings and signs	.43	Vehicle/Pedestrian, All Severities	Minor Arterial; Urban/Suburban	Zegeer et al., 2017
RRFB	Install rectangular rapid flashing beacon (RRFB)	.53	Vehicle/Pedestrian, All Severities	Minor Arterial; Urban/Suburban	Zegeer et al., 2017
High Visibility Crosswalk Marking	Install high-visibility crosswalk	.6	Vehicle/Pedestrian, All Severities	Road Type not Specified; Urban	Li Chen, Cynthia Chen, and Reid Ewing, 2012
Advance Stop/Yield Lines	Install advanced yield or stop markings and signs	.75	Vehicle/Pedestrian, All Severities	Minor Arterial; Urban/Suburban	Zegeer et al., 2017
Pedestrian Refuge Islands	Install raised median with marked crosswalk (uncontrolled)	.54	Vehicle/Pedestrian, All Severities	Principal Arterial; Urban/Suburban	Zegeer et al., 2002
Raised Crosswalk	Install raised pedestrian crosswalk	.55	Vehicle/Pedestrian, Injury Crashes	Local; Urban/Suburban	Elvik, R. and Vaa, T., 2004
Road Diet	Road diet (Convert 4-lane undivided road to 2-lanes plus turning lane)	.63	All types; Injury Crashes	Principal Arterial; Urban	Abdel-Aty et al., 2014

Appendices

References

Alta Planning + Design. (n.d.). Small Town and Rural Design Guide. https://ruraldesignguide.com/

Blackburn, L., Zegeer, C. V., & Brookshire, K. (2018). Guide for improving pedestrian safety at uncontrolled crossing locations (No. FHWA-SA-17-072). United States. Federal Highway Administration. Office of Safety. https://safety.fhwa.dot.gov/ped_bike/step/docs/STEP_Guide_for_Improving_Ped_Safety_at_Unsig_Loc_3-2018_07_17-508compliant.pdf.

Chen, L., Chen, C., & Ewing, R. (2012). The relative effectiveness of pedestrian safety countermeasures at urban intersections—Lessons from a New York City experience. In Transportation Research Board (TRB) 91st Annual Meeting, Washington, DC.

FHWA (2013). Pedestrian Safety Guide and Countermeasure Selection System. http://www.pedbikesafe.org/pedsafe/index.cfm.

FHWA (October 2021). Proven Safety Countermeasures. https://safety.fhwa.dot.gov/provencountermeasures/

FHWA Safety Program. (n.d.). Safety Benefits of Raised Medians and Pedestrian Refuge Areas. https://safety.fhwa.dot.gov/ped_bike/tools_solve/medians_brochure/

FHWA. (2014). Road Diet Informational Guide. https://safety.fhwa.dot.gov/road_diets/guidance/info_guide/ch2.cfm#s212

Hillsborough County MPO. (2014). Bicycle / Pedestrian Design Treatments & Criteria: At Grade and Separated Pedestrian Crossings & On-Street Bicycle Lane Configurations. https://planhillsborough.org/wp-content/uploads/2015/04/Design_Treatments_Ped_xing_Bike_Striping-20041.pdf

Mead, J., Zegeer, C., & Bushell, M. (2014). Evaluation of pedestrian-related roadway measures: A summary of available research. Pedestrian and Bicycle Information Center. Chapel Hill, NC, UNC Highway safety Research Center, 115.

NACTO. (2014). Urban Bikeway Design Guide: Hybrid Beacon for Bike Route Crossing of Major Street. https://nacto.org/publication/urban-bikeway-design-guide/bicycle-signals/hybrid-beacon-for-bike-route-crossing-of-major-street/.

NCHRP (2006). NCHRP Report 562: Improving Pedestrian Safety at Unsignalized Crossings. Washington, DC: The National Academies Press. https://doi.org/10.17226/13962.

NCHRP (2016). NCHRP Synthesis 498: Application of Pedestrian Crossing Treatments for Streets and Highways. Washington, DC: The National Academies Press. https://doi.org/10.17226/24634

NCHRP (2017). NCHRP Report 841: Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments. Washington, DC: The National Academies Press. DOI: https://doi.org/10.17226/24627

NMDOT (2020). New Mexico Department of Transportation Design Manual. https://www.dot.nm.gov/infrastructure/engineering-publications/design-manual/

NMDOT. (2019). New Mexico Pedestrian Crash Statistics, 2015-2019. https://gps.unm.edu/sites/default/files/traffic/NM_Pedestrian_Report_15-19.pdf.

Pedestrian and Bicycle Information Center (PBIC). (n.d.) Safe Routes to School Guide. http://guide.saferoutesinfo.org/engineering/marked_crosswalks.cfm#street

Shurbutt, J., & Van Houten, R. (2010). Effects of Yellow Rectangular Rapid-Flashing Beacons on Yielding at Multilane Uncontrolled Crosswalks (No. FHWA-HRT-10-043). United States. Federal Highway Administration. Office of Safety Research and Development.

Streetlight Data. (2021) Special Report: Bike Safety Shift. https://learn.streetlightdata.com/bike-safety-shift-special-report.

Zegeer, C. V., Stewart, J. R., Huang, H. H., Lagerwey, P. A., Feaganes, J. R., & Campbell, B. J. (2005). Safety effects of marked versus unmarked crosswalks at uncontrolled locations final report and recommended guidelines (No. FHWA-HRT-04-100). United States. Federal Highway Administration. Office of Safety Research and Development.