

Install YIELD Sign

Implementation of a YIELD (R1-2) sign to establish that approaching drivers must yield the right-of-way to conflicting traffic.



A YIELD sign controls traffic along this approach in a residential neighborhood.



A YIELD sign controls right turns along this skewed intersection approach.



A YIELD sign and supplemental yield line and YIELD pavement marking control each approach to this mini-roundabout.

Targeted Crash Types

- Right-angle

Problems Addressed

- Inappropriate intersection traffic control
- Excessive intersection conflicts

Conditions Addressed

- Intersections with low volumes and low speeds that are currently uncontrolled.
- Crash history or observed conflicts between vehicles failing to properly yield the right-of-way.

Considerations

- Install the YIELD sign on the near side of the intersection on the right-hand side of the approach to which it applies, as detailed in the MUTCD.
- With the exception of a roundabout, YIELD signs shall not be placed on all of the approaches to an intersection.
- YIELD sign may be supplemented with yield line, Yield Ahead (W3-2) sign, or YIELD word marking.
- YIELD signs should not be used for speed control.
- When a yield condition is new to an intersection approach, consider adding a NEW (W16-15P) plaque and/or red flag as a supplement to the YIELD sign for an interim period to educate the public of the change.
- YIELD sign may be installed for a channelized turn lane that is separated from adjacent lanes by an island, even if the adjacent lanes are controlled by a STOP (R1-1) sign.

Industry Standard

MUTCD

[Section 2A.16: Standardization of Location](#)

[Section 2B.08: YIELD Sign \(R1-2\)](#)

[Section 2B.09: YIELD Sign Applications](#)

[Section 2B.10: STOP Sign or YIELD Sign Placement](#)

Other Resources

[ITE Traffic Engineering Handbook](#)

[ITE Traffic Control Devices Handbook](#)

Select Examples

[Crown St. & Ridgecrest Dr., Salt Lake City, UT](#)

[Hinton Oaks Blvd. & Lynnwood Rd., Knightdale, NC](#)



Install STOP Sign

Implementation of a STOP (R1-1) sign to establish that approaching drivers must always come to a complete stop before entering an intersection.



Source: Lee Engineering, LLC

The STOP sign on this residential street is supplemented with a stop line and STOP word marking.



Source: VHB

This STOP sign controls two approach lanes.



Source: VHB

The STOP sign and Street Name signs are placed on the same sign support.

Targeted Crash Types

- Right-angle
- Bicyclist
- Pedestrian

Problems Addressed

- Inappropriate intersection traffic control
- Excessive intersection conflicts
- Inadequate intersection sight distance

Conditions Addressed

- Crash history or observed conflicts due to lack of proper traffic control.
- Limited visibility on one or more intersection approaches such that a full stop at the intersection is warranted.

Considerations

- Should be used to stop the lower-volume street based on a traffic study.
- Install the STOP sign on the near side of the intersection on the right-hand side of the approach to which it applies, as detailed in the MUTCD.
- STOP signs are not to be used as a speed control or traffic calming device.
- When a stop condition is new to an intersection approach, consider adding a NEW plaque and/or red flag as a supplement to the STOP sign for an interim period to educate the public of a change.
- May also be supplemented with stop line, Stop Ahead (W3-1) sign, STOP pavement marking, median STOP sign, or red retroreflective material on the STOP sign support.

Industry Standard

MUTCD

[Section 2A.16: Standardization of Location](#)

[Section 2B.05: STOP Sign \(R1-1\) and ALL WAY Plaque \(R1-3P\)](#)

[Section 2B.06: STOP Sign Applications](#)

[Section 2B.10: STOP Sign or YIELD Sign Placement](#)

Other Resources

[ITE Traffic Engineering Handbook](#)

[ITE Traffic Control Devices Handbook](#)

Implement All-Way Stop Control

Installation of STOP (R1-1) signs supplemented with the ALL WAY (R1-3P) plaque along all intersection approaches.



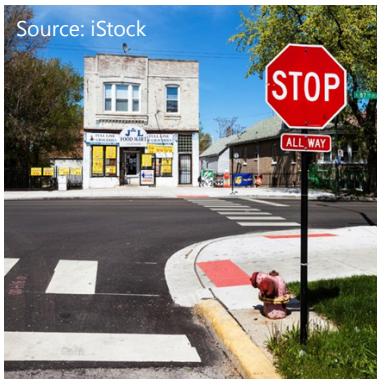
Source: Lee Engineering, LLC

The ALL WAY plaque is mounted below the STOP sign.



Source: VHB

A NEW plaque is used here to emphasize recently-implemented all-way stop control.



Source: iStock

The ALL WAY plaque here informs road users of the T-intersection's control type.

Targeted Crash Types

- Right-angle
- Bicyclist
- Pedestrian

Problems Addressed

- Inappropriate intersection traffic control
- Excessive intersection conflicts
- Inadequate intersection sight distance
- Vehicle conflicts with non-motorists

Conditions Addressed

- Limited sight distance from minor road approaches.
- Crash history or observed conflicts involving turning or through vehicles from the minor road.
- Interim traffic control when a traffic signal is needed.
- Intersection with high pedestrian volumes.
- Intersection of two similar residential collector streets.

Considerations

- Consider adding a NEW (W16-15P) plaque as a supplement to the STOP sign for an interim period.
- Consider installing advanced Stop Ahead (W3-1) signs and/or stop lines.
- Traffic volumes on both major and minor roads should be approximately equal.

Industry Standard

MUTCD

[Section 2A.16: Standardization of Location](#)

[Section 2B.05: STOP Sign \(R1-1\) and ALL WAY Plaque \(R1-3P\)](#)

[Section 2B.06: STOP Sign Applications](#)

[Section 2B.07: Multi-Way Stop Applications](#)

[Section 2B.10: STOP Sign or YIELD Sign Placement](#)

Other Resources

[NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections](#)

Select Examples

[JC Galloway Rd. & Mobleys Bridge Rd., Grimesland, NC](#)

[Cornwallis Rd. & N. Shiloh Rd., Garner, NC](#)

[Prairie St. & 7th St., St. Charles, IL](#)





Install Intersection Control Beacon

Installation of traffic signal faces for each approach of a stop-controlled intersection in which only flashing circular red or circular yellow signal indications are used. The flashing red indications supplement STOP (R1-1) signs and face the stop-controlled approaches; if the intersection does not operate under all-way stop control, then flashing yellow indications are installed to face the uncontrolled approaches. An Intersection Control Beacon is usually mounted over the center of an intersection; however, the beacons may be used at other suitable locations.



Source: VHB

The Intersection Control Beacon flashes red from the stop-controlled approach.



Source: UNC HSRC

The Intersection Control Beacon flashes yellow from the uncontrolled approach.



Source: VHB

This Intersection Control Beacon is used at an intersection adjacent to a crest vertical curve.



Targeted Crash Types

- Right-angle
- Opposing left turn
- Rear-end (major road)
- Rear-end (minor road)
- Pedestrian
- Bicyclist

Problems Addressed

- Non-compliance with intersection traffic control devices
- Inadequate visibility of intersection or intersection traffic control devices
- Speeding

Conditions Addressed

- Crash history or observed conflicts related to lack of driver awareness of the intersection or of the traffic control device.
- Citation history or observed non-compliance with traffic control.
- Intersections with poor nighttime visibility.
- Isolated rural intersections.
- Intersections characterized by high approach speeds.
- From the FHWA Report listed below: *"There is anecdotal evidence that suggests that the overhead beacons have been interpreted as indicating a four-way stop at locations that were in fact only a two-way stop. This has caused motorists to pull out in front of the approaching vehicles because they assumed the approaching vehicle would be stopping."* These observations suggest that overhead beacons should be limited to all-way stop-controlled intersections.

Considerations

- A beacon must be visible from every approach.
- Flashing yellow signal indications shall not face conflicting vehicular approaches.
- A flashing circular red indication supplements—and does not replace—a STOP sign.
- Public outreach may be needed to address motorists who may be confused by the intersection control beacon operation. Some motorists approaching a red flasher on the minor street may assume that the major street also receives a red flasher.
- The intersection control beacon will require a power source.

Industry Standard

MUTCD
[Section 4L.02: Flashing Beacons](#)

Select Examples

[US 258 & NC 42/43, Pinetops, NC](#)
[NH 11 & Depot Rd., New Durham, NH](#)

Other Resources

[NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections](#)
[Low-Cost Safety Enhancements for Stop-Controlled and Signalized Intersections, FHWA](#)
[Intersection Safety: A Manual for Local Rural Road Owners, FHWA](#)
[Strategies to Address Nighttime Crashes at Rural, Unsignalized Intersections, Iowa DOT](#)

Install Stop Line

A transverse pavement marking applied to the approach lane of a stop-controlled intersection to indicate where the motorist should stop.



Source: VHB

A 12-inch stop line is used to supplement the STOP sign at this residential intersection.



Source: Lee Engineering, LLC

This 24-inch stop line has been correctly installed at least 4 feet in advance of the marked crosswalk.

Targeted Crash Types

- Right-angle
- Pedestrian

Problems Addressed

- Inadequate motorist guidance
- Vehicle conflicts with non-motorists
- Non-compliance with intersection traffic control devices

Conditions Addressed

- Crash history or observed conflicts related to STOP (R1-1) sign violations.
- Citation history of noncompliance at STOP signs.
- Poor driver decision-making related to gaps in traffic due to poor vehicle placement at STOP signs (i.e., not pulling ahead far enough).

Considerations

- Stopping sight distance should be considered when determining the location of the stop line.
- Stop lines should be placed at least 4 feet in advance of the nearest crosswalk line at stop-controlled approaches. In the absence of a marked crosswalk, the stop line should not be placed less than 4 feet or more than 30 feet from the nearest edge of the intersecting traveled way.
- Stop lines shall be solid and white, extend across the subject approach lanes, and should be 12 to 24 inches wide.

Industry Standard

MUTCD

[Section 3B.16: Stop and Yield Lines](#)

Select Examples

[Hubbard Ave. & Park St., Middleton, WI](#)
[1st St. & Elliott Ave. N., Wenatchee, WA](#)
[26th St. & Pacific Ave., Virginia Beach, VA](#)

Other Resources

[Low-Cost Safety Enhancements for Stop-Controlled and Signalized Intersections, FHWA](#)

[Intersection Safety: A Manual for Local Rural Road Owners, FHWA](#)

[South Carolina Case Study: Systematic Intersection Improvements, FHWA](#)

[NCHRP 562 & TCRP 112: Improving Pedestrian Safety at Unsignalized Intersections](#)



Install Yield Line

A transverse pavement marking in the form of repeated isosceles triangles applied to the lane of a yield-controlled approach. The series of triangles are placed with the points of the triangle facing the approaching vehicle, so as to resemble a YIELD (R1-2) sign on the pavement.



Source: Lee Engineering, LLC

A Yield Here to Pedestrians sign is installed in combination with this yield line in advance of the pedestrian crosswalk across the uncontrolled approaches of a stop-controlled intersection.



Source: VHB

A yield line and YIELD word marking supplement the YIELD sign along the approach to this roundabout.

Targeted Crash Types

- Right-angle
- Pedestrian

Conditions Addressed

- Crash history or observed conflicts related to failure to yield the right-of-way.

Problems Addressed

- Inadequate motorist guidance
- Vehicle conflicts with non-motorists
- Non-compliance with intersection traffic control devices

Considerations

- Stopping sight distance should be considered when determining the location of the yield line.
- Improve effectiveness at pedestrian crossings by combining yield lines with Yield Here to Pedestrians (R1-5, R1-5a) signs and Pedestrian Crossing (W11-2) signs.

Industry Standard

MUTCD

[Section 3B.16: Stop and Yield Lines](#)

Other Resources

[NCHRP 562 & TCRP 112: Improving Pedestrian Safety at Unsignalized Intersections](#)

[NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections](#)

Select Examples

[A1A Beach Blvd. & 15th St., St. Augustine, FL](#)

[S. Pierce St. & E. Kings Hwy., Eden, NC](#)

Install Stop Beacon

A flashing beacon that is placed on top of a STOP (R1-1) sign. The Stop Beacon consists of one or more signal sections of a standard traffic signal face with a flashing circular red signal indication.



Source: VHB

This Stop Beacon has two horizontally-aligned signal indications.



Source: VHB

This Stop Beacon comprises a single signal indication above the STOP sign.



Source: VHB

This Stop Beacon has two vertically-aligned signal indications.



Targeted Crash Types

- Right-angle
- Rear-end (minor road)

Problems Addressed

- Non-compliance with intersection traffic control devices
- Inadequate visibility of intersection or intersection traffic control devices

Conditions Addressed

- Crash history or observed vehicle conflicts caused by non-compliance with intersection traffic control or lack of awareness of intersection traffic control.
- Existing STOP sign is not conspicuous in surroundings.
- Recent change in traffic control or traffic regulation at the intersection.
- Poor visibility of the intersection from stop-controlled approach(es).

Considerations

- One or two red beacons may be installed—see MUTCD Section 4L.05 for additional guidance.
- A power source (typically solar or electric) will be required.
- The beacon may be actuated to flash red when approaching vehicles are detected through loop detectors.
- This strategy can be used in conjunction with other strategies to increase sign conspicuity.

Industry Standard

MUTCD

[Section 2A.15: Enhanced Conspicuity for Standard Signs](#)

[Section 4L.05: Stop Beacon](#)

Other Resources

[Innovative Operational Safety Improvements at Unsignalized Intersections, Florida DOT](#)

[Safety Evaluation of Flashing Beacons at STOP-Controlled Intersections, FHWA](#)

Select Examples

[Ridge Rd. & E. Four Mile Rd., Cheyenne, WY](#)

[Hoover Hill Rd. & Kennedy Rd., Trinity, NC](#)



Install Traffic Control Signal

Any highway traffic signal by which traffic is alternately directed to stop and permitted to proceed. A signal may be considered when one or more of the nine warrants specified in the MUTCD are satisfied.

Source: VHB



A traffic signal controls the vehicular movements at this T-intersection.



Source: VHB

Traffic signals can be warranted by higher traffic volumes and proximity to a school crossing.



Source: VHB

This traffic signal offers a protected phase for left turns from the major road.

Targeted Crash Types

- Right-angle
- Pedestrian
- Opposing left turn

Conditions Addressed

- Crash history or observed conflicts between turning vehicles and opposing through vehicles.
- Where one or more of the nine MUTCD warrants for a traffic signal are met ([Section 4C.02](#)).

Problems Addressed

- Inappropriate intersection traffic control
- Excessive intersection conflicts
- Poor operational performance
- Vehicle conflicts with non-motorists

Considerations

- Conduct a traffic control needs study and check warrants in the MUTCD ([Section 4C.01](#)).
- Design for all types of users at the intersection.
- Inform business and property owners near the intersection early in the process and ensure proper design of access points to the properties.
- May need to widen the intersection to provide left-turn lanes for signalization.

Industry Standard

MUTCD

[Section 4C.01: Studies and Factors for Justifying Traffic Control Signals](#)

Other Resources

[Signalized Intersections: Informational Guide, FHWA](#)

[NCHRP Volume 12: A Guide for Reducing Collisions at Signalized Intersections](#)

[Traffic Signals, PEDSAFE](#)

Select Examples

[Babylon Rd. & Limekiln Pk., Maple Glen, PA](#)

[Covered Bridge Rd. & Buffalo Rd., Clayton, NC](#)

[21st St. & Graham Ave., Windber, PA](#)





Prohibit Turn Movement Using Signs

Installation of one or more signs—and possibly pavement markings—to prohibit certain movements at the intersection.

Targeted Crash Types

- Right-angle
- Opposing left turn
- Rear-end (major road)

Problems Addressed

- Excessive intersection conflicts
- Poor operational performance
- Misjudgment of gaps

Conditions Addressed

- Crash history or observed conflicts related to particular turning maneuvers (e.g., left turns), possibly at particular times (e.g., morning peak hour) and days (e.g., Monday – Friday).
- Insufficient gaps in major road traffic for left turns from major or minor road or through movements from minor road.
- Insufficient sight distance or lack of appropriate left-turn storage area to safely make a turning movement.
- Impractical to improve conditions with other treatments such as improved sight distance or turn lanes.

Considerations

- Using permanently-mounted supplementary legends, the turn prohibition may be applied such that it is in effect only during certain times and days of the week.
- Local business owners and residents may object if the restriction affects access to their property. The affected property owners should be notified prior to any restriction of their access. Restrictions should be justified to address a crash or other safety or operational problem.
- With no physical barrier or enforcement, violations to the turn restriction may occur.
- Drivers may take unanticipated alternative routes through private property or minor local streets to avoid the restriction(s).

Industry Standard

MUTCD

[Section 2B.18: Movement Prohibition Signs \(R3-1 through R3-4, R3-18, and R3-27\)](#)

[Section 2B.37: DO NOT ENTER sign \(R5-1\)](#)

[Section 3B.20: Pavement Word, Symbol, and Arrow Markings](#)

Other Resources

[NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections Left Turn Prohibitions, PEDSAFE](#)

Select Examples

[Nevada Rd. & Ramona Expwy., Perris, CA](#)
[University Dr. & Oxford Dr., Durham, NC](#)
[Atlantic Ave. & Ingram Dr., Raleigh, NC](#)



Source: Lee Engineering, LLC

A Movement Prohibition sign prohibits left turns during peak hours of traffic.



Source: VHB

Combination of pavement markings reading "RIGHT TURN ONLY" and a Movement Prohibition sign to prohibit left turns.



This overhead Movement Prohibition sign prohibits left turns during the morning and evening weekday peak hours.





Re-time Adjacent Traffic Signal

The modification of the traffic signal timing schemes at one or both of the nearby signalized intersections to create longer gaps in the traffic stream for turning maneuvers at the nearby unsignalized intersection.



Source: Lee Engineering, LLC



Source: Lee Engineering, LLC

Traffic engineers adjust the timing of a traffic signal at its control cabinet.

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Pedestrian

Problems Addressed

- Misjudgment of gaps
- Poor operational performance

Conditions Addressed

- Crash history or observed conflicts (right-angle) due to insufficient gaps in through traffic on major road.
- Long queues on minor road due to insufficient gaps in traffic on major road.

Considerations

- Changing the signal timing to benefit the adjacent unsignalized intersection may negatively impact the level of service and/or progression on the major road. Impacts should be considered not only for adjacent signals but the signalized corridor as a whole.
- May need to consult with other agencies (state, county, or local) to coordinate signal timing.

Other Resources

[NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections](#)
[Traffic Signal Timing Manual, FHWA](#)





Install Intersection Warning Sign(s)

Standard traffic sign used to indicate the presence of an intersection ahead.



Source: Lee Engineering, LLC

An Intersection Warning sign may be supplemented with an Advance Street Name plaque.



Source: VHB

A Combination Horizontal Alignment/Intersection sign simultaneously warns road users of multiple conditions.



Source: PennDOT

An Intersection Warning sign may be supplemented with various warning plaques.



Targeted Crash Types

- Right-angle
- Rear-end (major road)

Problems Addressed

- Inadequate visibility of intersection or intersection traffic control devices
- Speeding

Conditions Addressed

- Poor visibility of the intersection from approaches.
- Crash history or observed conflicts involving lack of awareness of intersection or traffic control.
- Observed speeding on approaches to the intersection.

Considerations

- Intersection Warning (W2-1 through W2-8) signs may be supplemented with an Advisory Speed (W13-1P) plaque.
- Other than the Circular Intersection (W2-6) sign and the T Symbol (W2-4) sign, Intersection Warning signs should not be used on approaches controlled by STOP (R1-1) signs, YIELD (R1-2) signs, or traffic signals.
- No more than two side road symbols should be displayed on the same side of the highway on an Offset Side Roads (W2-7) or Double Side Roads (W2-8) sign, and no more than three side road symbols should be displayed on a W2-7 or W2-8 sign.
- A Two-Direction Large Arrow (W1-7) sign may be used on the far side of a T-intersection in line with, and at approximately a right angle to, traffic approaching from the stem of the T-intersection. The W1-7 sign may be used with or without intersection traffic control signs.
- For intersections occurring within or immediately adjacent to horizontal curves, the Cross Road (W2-1) sign or Side Road (W2-2 or W2-3) sign may be combined with the Turn (W1-1) sign or Curve (W1-2) sign to create a combination Horizontal Alignment/Intersection sign (W1-10 series).
- The relative importance of the intersecting roadways may be shown by different widths of lines in the symbol.

Industry Standard

MUTCD

[Section 2C.46: Intersection Warning Signs \(W2-1 through W2-8\), Figure 2A-4, and Table 2C-4](#)

[Section 2C.11: Combination Horizontal Alignment/Intersection Signs \(W1-10 Series\)](#)

Other Resources

[Intersection Safety: A Manual for Local Rural Road Owners, FHWA](#)
[NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections](#)

Select Examples

[E. Cave Creek Rd. & N. Tranquil Trl., Carefree, AZ](#)
[PA 144 & US 322, Spring Mills, PA](#)
[Renner Blvd. & W. 95th St., Lenexa, KS](#)

Install Advance Traffic Control Warning Sign

Warning sign bearing a symbol of the approach's impending control type (i.e., stop or yield).



Source: Lee Engineering, LLC



Source: Lee Engineering, LLC

These Stop Ahead signs warn road users of an upcoming STOP sign.



Source: VHB

The Yield Ahead sign provides advance warning along this approach of the yield condition that lies just ahead.

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Rear-end (minor road)

Conditions Addressed

- Poor visibility of the intersection traffic control from one or more approaches.

Problems Addressed

- Inadequate visibility of intersection or intersection traffic control devices

Considerations

- An Advance Street Name (W16-8P or W16-8aP) plaque and/or Warning Beacon may be installed with the warning sign.
- If the visibility issue or condition is only present on one approach, this treatment may be used only on that approach.
- An Advance Traffic Control (W3-1 or W3-2) sign may be used for additional emphasis even when the visibility distance to the traffic control device is satisfactory.

Industry Standard

MUTCD

[Section 2C.36: Advance Traffic Control Signs \(W3-1, W3-2, W3-3, W3-4\).](#)

[Figure 2A-4 \(Use of Sign Shapes\)](#)

[Table 2C-4 \(Guidelines for Advance Placement of Warning Signs\)](#)

Other Resources

[Intersection Safety: A Manual for Local Rural Road Owners, FHWA](#)

Select Examples

[Wickham Rd. & Stadium Pkwy., Viera, FL](#)

[Howyers Branch Dr. & US 50, Aldie, VA](#)

Install Intersection Conflict Warning System (ICWS)

Intelligent Transportation System (ITS) technology used to warn motorists approaching an intersection of potential conflicts with other approaching vehicles. Such systems include detection of vehicles on the major road, minor road, or both.



This ICWS employs ground-mounted signing and Warning Beacons to warn major road drivers that one or more vehicles may be entering from the minor road.



This ICWS utilizes overhead signing and Warning Beacons to warn major road drivers that one or more vehicles may be entering from the minor road.

Targeted Crash Types

- Right-angle
- Rear-end (major road)

Problems Addressed

- Inadequate visibility of intersection or intersection traffic control devices
- Inadequate intersection sight distance
- Misjudgment of gaps
- Speeding

Conditions Addressed

- Crash history involving vehicles entering or crossing major road.
- Difficulty among drivers in determining appropriate gaps in traffic.
- Awareness of the intersection is lacking.
- High running speeds are typical of major road traffic.

Considerations

- There are applications designed for the major road approaches only, the minor road approaches only, or the approaches of both roads.
- Requires similar equipment to a traffic signal: controller, cabinet, detection devices (loops or video), and possibly LED message signs.
- Message should be simple and easily understood.
- Place at a distance from the intersection that would provide the approaching driver time to react.
- When ICWS design incorporates dynamic messages, some agencies program their devices to display random dots on the message screen when they are not working properly.

Other Resources

[Stop-Controlled Intersection Safety: Through Route Activated Warning System, FHWA](#)

[Innovative Operational Safety Improvements at Unsignalized Intersections, Florida DOT](#)

[NCHRP 613: Guidelines for Selection of Speed Reduction Treatments at High-Speed Intersections](#)

Select Examples

[US 24 & MO 15, Paris, MO](#)

[NC 42 & Castleberry Rd., Clayton, NC](#)

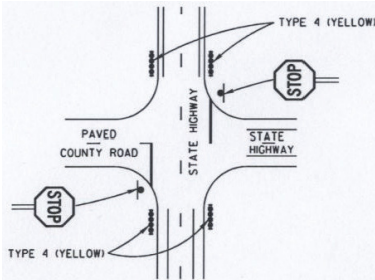
[Salem Church Rd. & Kingsland Rd., Richmond, VA](#)





Install Post-Mounted Reflective Delineators at Intersection

Implementation of post-mounted reflective delineators along the major road at the intersection to promote driver awareness of the intersection, especially during nighttime conditions.



Source: Idaho Transportation Dept.

Image from Figure 252.05-01 (Typical Interchange And Crossroad Delineation) of the Idaho Transportation Department Traffic Manual that illustrates typical delineator placement at a four-legged stop-controlled intersection.

Targeted Crash Types

- Right-angle
- Rear-end (major road)

Problems Addressed

- Inadequate visibility of intersection or intersection traffic control devices

Conditions Addressed

- History of nighttime crashes.
- Remote stretches in which intersections may not be conspicuous to drivers along the major road.
- Poor nighttime visibility of the intersection from at least one approach.

Considerations

- Delineators are considered guidance devices rather than warning devices.
- The color of the delineator should be consistent with the color of the edge lines.
- This treatment can be applied in multiple ways:
 - As delineators placed only at the intersection along roads that do not have delineators for the entire corridor; or
 - As different-colored delineators placed at the intersection when delineators are applied continuously along the entire corridor as a means of supplemental delineation of the roadway. For example, there are corridors in Idaho that have regularly-spaced white delineators to provide supplemental delineation of the roadway; the delineators at the unsignalized intersections are yellow to stand out from the white ones used along roadway segments.

Industry Standard

MUTCD
[Chapter 3F. Delineators](#)

Other Resources

[Idaho Department of Transportation Traffic Manual](#)

Select Examples

[Horseshoe Bend Rd. & Dry Creek Rd., Garden City, ID](#)
[Horseshoe Bend Rd. & Brookside Ln., Garden City, ID](#)
[E Four Mile Rd. & Space Dr., Cheyenne, WY](#)





Increase the Size of a Regulatory or Warning Sign

Replacement of an existing regulatory or warning sign with a larger one of the same kind.



Source: HSRC

This oversized STOP sign is supplemented by an Intersection Control Beacon.



Source: VHB

This oversized Advance Traffic Control sign requires two supports, which have been supplemented with reflective panels.

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Rear-end (minor road)
- Pedestrian
- Bicyclist

Problems Addressed

- Inadequate visibility of intersection or intersection traffic control devices
- Non-compliance with intersection traffic control devices
- Vehicle conflicts with non-motorists
- Speeding

Conditions Addressed

- Crash history or observed vehicle conflicts caused by non-compliance with traffic control device or lack of awareness of intersection traffic control.
- Existing sign is not conspicuous with respect to its surroundings.

Considerations

- Remove any visual clutter that may be inhibiting driver's view of the existing sign.
- Make sure the sign is not located too far off the edge of the roadway.
- Installation of larger sign may require additional or new sign posts or a post extension.
- This strategy can be used in conjunction with other strategies to increase sign conspicuity.
- Installation of larger STOP sign is often accompanied by other related strategies, such as installing a stop line, installing a second (duplicate) sign, or installing reflective panels on the sign supports.

Industry Standard

MUTCD

[Section 2A.15: Enhanced Conspicuity for Standard Signs](#)

[Section 2B.03: Size of Regulatory Signs](#)

[Section 2C.04: Size of Warning Signs](#)

Other Resources

[South Carolina Case Study: Systematic Intersection Improvements, FHWA](#)

[Stop Sign-Controlled Intersections: Enhanced Signs and Markings - A Winston-Salem Success Story, FHWA](#)

Select Examples

[SC 127 & US 221, Laurens, SC](#)

[Middletown Rd. & Pine St., Somers, CT](#)





Add a Duplicate Regulatory or Warning Sign

Installation of a second identical regulatory or warning sign on the left-hand side of the roadway or overhead to supplement an existing sign.



Source: PennDOT

The left-side Cross Road sign and related enhancements promote driver awareness of the intersection.



Source: VHB

The overhead STOP sign calls additional attention to the stop condition on this approach.



Source: PennDOT

The second Stop Ahead sign and STOP AHEAD markings notify approaching road users of the impending stop.



Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Rear-end (minor road)
- Pedestrian
- Bicyclist

Problems Addressed

- Inadequate visibility of intersection or intersection traffic control devices
- Non-compliance with intersection traffic control devices
- Vehicle conflicts with non-motorists
- Speeding

Conditions Addressed

- Crash history or observed vehicle conflicts caused by non-compliance with traffic control device or lack of awareness of intersection traffic control.
- Existing sign is not conspicuous in its surroundings.
- Wide or high-speed intersection approaches.

Considerations

- Remove any visual clutter that may be inhibiting driver's view of the existing sign.
- Take care not to overuse duplicate signing, as drivers may become accustomed to their presence and fail to respond as desired.
- This treatment can be used in conjunction with other treatments to increase sign conspicuity.
- When using left-side signing on a street without a median, a centerline should be considered.

Select Examples

- [Auburn Knightdale Rd. & Grasshopper Rd., Knightdale, NC](#)
- [E. Cave Creek Rd. & Tom Darlington Dr., Carefree, AZ](#)
- [E. Maple St. & N. Central Ave., Nicholasville, KY](#)

Other Resources

- [South Carolina Case Study: Systematic Intersection Improvements, FHWA](#)
- [Stop Sign-Controlled Intersections: Enhanced Signs and Markings - A Winston-Salem Success Story, FHWA](#)

Industry Standard

MUTCD

- [Section 2A.15: Enhanced Conspicuity for Standard Signs](#)
- [Section 2A.16: Standardization of Location](#)
- [Section 2A.17: Overhead Sign Installations](#)
- [Section 2A.18: Mounting Height](#)



Install Warning Beacon(s) on a Standard Regulatory or Warning Sign

Addition of a Warning Beacon to provide emphasis to an existing regulatory or warning sign. Warning Beacons should not be used with STOP (R1-1), DO NOT ENTER (R5-1), WRONG WAY (R5-1a), or Speed Limit (R2-1) signs.



Source: South Carolina DOT

A single Warning Beacon is mounted atop this Intersection Warning sign.



Source: VHB

A pair of Warning Beacons are used to supplement this warning sign.



Source: Lee Engineering, LLC

The School sign along this uncontrolled major road approach is supplemented with Warning Beacons.



Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Rear-end (minor road)
- Pedestrian
- Bicyclist

Problems Addressed

- Inadequate visibility of intersection or intersection traffic control devices
- Non-compliance with intersection traffic control devices
- Vehicle conflicts with non-motorists
- Speeding

Conditions Addressed

- Crash history or observed vehicle conflicts caused by non-compliance with traffic control device or lack of awareness of intersection traffic control.
- Existing sign is not conspicuous in its surroundings.
- May be used at obstructions in or immediately close to the roadway.
- May be used to emphasize a change in traffic control or traffic regulation at the intersection (e.g., turning restrictions).
- Beacons shall not face conflicting vehicular approaches.

Considerations

- Determine power source—solar power or hard-wired.
- Remove any visual clutter that may be inhibiting driver's view of the existing sign.
- Take care not to overuse Warning Beacons as drivers may become accustomed to their presence and fail to respond as desired.
- This treatment can be used in conjunction with other treatments to increase sign conspicuity.

Industry Standard

MUTCD

[Section 2A.15: Enhanced Conspicuity for Standard Signs](#)

[Section 4L.03: Warning Beacon](#)

Other Resources

[Innovative Operational Safety Improvements at Unsignalized Intersections, Florida DOT](#)

Select Examples

[Atlantic Ave. & Ingram Dr., Raleigh, NC](#)
[Jetton Rd. & Meta Rd., Cornelius, NC](#)
[NC 55 & NC 111, Indian Springs, NC](#)



Use LED Units Within a Regulatory or Warning Sign

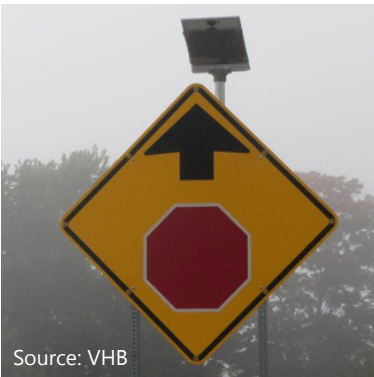
The embedding of light emitting diodes (LEDs) within a sign's symbol, legend, or border to increase its conspicuity.

Source: Lee Engineering, LLC



Source: VHB

The borders of the Pedestrian Crossing signs above are enhanced with LEDs, with the bottom assembly powered via the solar panel above the sign.



Source: VHB

The conspicuity of this Stop Ahead sign is enhanced with LED units, which are particularly valuable during foggy conditions.



Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Rear-end (minor road)
- Pedestrian
- Bicyclist

Problems Addressed

- Inadequate visibility of intersection or intersection traffic control devices
- Non-compliance with intersection traffic control devices
- Vehicle conflicts with non-motorists
- Speeding

Conditions Addressed

- Crash history or observed vehicle conflicts caused by non-compliance with traffic control device or lack of awareness of intersection traffic control.
- Existing sign is not conspicuous in its current surroundings.
- Poor sign visibility during low-light conditions.

Considerations

- LEDs can be set to flash or steady mode.
- LEDs have low power requirements and are typically powered by standalone solar panel units.
- Can be activated by vehicles or be on continuously throughout the day.
- Take care not to overuse LEDs in signs, as drivers may become accustomed to their presence and fail to respond as desired.
- Can be applied in conjunction with other treatments to increase sign conspicuity.
- LEDs must be red or white if used with STOP (R1-1) or YIELD (R1-2) signs, white if used with other regulatory signs, and white or yellow if used with warning or school signs

Select Examples

[Ohio 303 & Indian Hollow Rd., LaGrange, OH](#)
[Eber Rd. & US 20A, Monclova, OH](#)

Other Resources

[Embedded LEDs in Signs, FHWA](#)
[Innovative Operational Safety Improvements at Unsignalized Intersections, Florida DOT](#)

Industry Standard

MUTCD

[Section 2A.07: Retroreflectivity and Illumination](#)

[Section 2A.15: Enhanced Conspicuity for Standard Signs](#)

Install Reflective Panel on Sign Post

A strip of retroreflective material added to an existing sign post to enhance visibility of the sign during all lighting conditions.



Source: Lee Engineering, LLC



Source: PennDOT

Red reflective panels on the STOP sign supports make the stop condition more conspicuous.



Source: SCDOT

Yellow reflective panels on the two sign supports call attention to the warning of the impending stop control.

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Rear-end (minor road)
- Pedestrian
- Bicyclist

Problems Addressed

- Inadequate visibility of intersection or intersection traffic control devices
- Non-compliance with intersection traffic control devices
- Vehicle conflicts with non-motorists
- Speeding

Conditions Addressed

- Observed poor conspicuity of existing signs, particularly at night.
- Crash history or observed conflicts due to lack of awareness of the intersection or intersection traffic control, especially at night.
- Observations of non-compliance with intersection traffic control.

Considerations

- Color of strip should match the color of the background color of the sign, except strip color on YIELD (R1-2) and DO NOT ENTER (R5-1) signs shall be red.
- The retroreflective strip shall be at least 2 inches wide and shall extend the entire length of the post to within 2 feet of the ground
- Remove any visual clutter that may be inhibiting driver's view of the existing sign.
- This treatment can be used in conjunction with other treatments to increase sign conspicuity.
- The reflective post coverings/inserts should be replaced at the same frequency of the sign faces.

Industry Standard

MUTCD

[Section 2A.15: Enhanced Conspicuity for Standard Signs](#)

[Section 2A.21: Posts and Mountings](#)

Other Resources

[South Carolina Case Study: Systematic Intersection Improvements, FHWA](#)

[Intersection Safety: A Manual for Local Rural Road Owners, FHWA](#)

Select Examples

[Marsol Rd. & Woodhurst Ave., Mayfield Heights, OH](#)

[Bates Crossing Rd. & US 276, Travelers Rest, SC](#)

[Lake Iola Rd. & Blanton Rd., Dade City, FL](#)



Add Additional Retroreflective Sheeting Around the Perimeter of a Warning Sign

Addition of a solid yellow, solid fluorescent yellow, or diagonally striped black and yellow (or black and fluorescent yellow) strip of retroreflective sheeting around the perimeter of the warning sign to enhance the sign's conspicuity.



Source: VHB

The examples above illustrate the application of reflective perimeter sheeting to Cross Road, Pedestrian Crossing, and Stop Ahead warning signs.

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Rear-end (minor road)
- Pedestrian
- Bicyclist

Conditions Addressed

- Existing sign is not conspicuous in its surroundings.
- Crash history or observed vehicle conflicts caused by non-compliance with traffic control device.

Problems Addressed

- Inadequate visibility of intersection or intersection traffic control devices
- Vehicle conflicts with non-motorists
- Speeding

Considerations

- Strip of sheeting must be at least 3 inches wide around the perimeter of the warning sign.
- This treatment can be used in conjunction with other treatments to increase sign conspicuity.
- Attempt first to remove visibility obstructions or sign distractions before using this treatment.

Industry Standard

MUTCD

[Section 2A.15: Enhanced Conspicuity for Standard Signs](#)

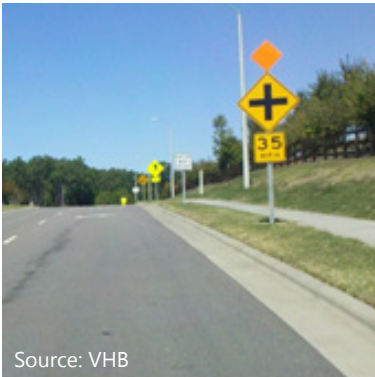
Install Red or Orange Flags to a Regulatory or Warning Sign

The addition of one or more red or orange flags made out of cloth or reflective sheeting above the sign.



Source: Lee Engineering, LLC

Red cloth flags are used to draw attention to the turn restrictions along this approach.



Source: VHB

The orange reflective sheeting installed above the Cross Road sign is used to increase conspicuity of the intersection warning.

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Rear-end (minor road)
- Pedestrian
- Bicyclist

Problems Addressed

- Inadequate visibility of intersection or intersection traffic control devices
- Non-compliance with intersection traffic control devices
- Vehicle conflicts with non-motorists
- Speeding

Conditions Addressed

- Crash history or observed vehicle conflicts caused by non-compliance with traffic control device or lack of awareness of intersection traffic control.
- Existing sign is not conspicuous in its surroundings.
- Recent change in traffic control or traffic regulation at the intersection (e.g., change in speed limit, turn restrictions). This is sometimes used as a short-term application to educate the motoring public for some period (e.g., one to three months) after the new condition is initiated.

Considerations

- Flag orientation should be 45 degrees to the vertical.
- Remove any visual clutter that may be inhibiting driver's view of the existing sign.
- Take care not to overuse the flags, as drivers may become accustomed to their presence and fail to respond as desired.
- This treatment can be used in conjunction with other treatments to increase sign conspicuity.
- May require periodic flag maintenance or replacement.

Industry Standard

MUTCD

[Section 2A.15: Enhanced Conspicuity for Standard Signs](#)

Select Examples

[Glenn Bridge Rd. & Old Shoals Rd., Buncombe, NC](#)

[NC 55 & NC 111, Indian Springs, NC](#)

[NC 97 & NC 39, Zebulon, NC](#)



Install Wider Longitudinal Pavement Markings

Increasing the width of center line, lane line, and/or edge line pavement markings on an intersection approach to better delineate the travel lanes and attract attention to the intersection ahead.

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Sideswipe, opposite direction
- Sideswipe, same direction
- Head-on

Problems Addressed

- Inadequate visibility of intersection or intersection traffic control devices
- Inadequate motorist guidance
- Speeding

Conditions Addressed

- Crash history or observed conflicts due to lack of awareness of the intersection or intersection traffic control.
- Crash history or observed conflicts due to vehicles encroaching upon the center line or edge of roadway.

Considerations

- Typical standard widths of lane lines are 4 to 6 inches.
- Determine the start of treatment based on the deceleration distance from the intersection (see AASHTO Green Book for deceleration distances).
- Coordinate the start of the wider markings with the location of the advanced warning sign.

Industry Standard

MUTCD

[Section 3A.06: Functions, Widths, and Patterns of Longitudinal Pavement Markings](#)

Other Resources

[NCHRP 613: Guidelines for Selection of Speed Reduction Treatments at High-Speed Intersections](#)

[Pavement Marking Demonstration Project: State of Alaska and State of Tennessee](#)



Center Line Pavement Markings in Median Crossing

Application of yellow longitudinal pavement markings to delineate the centerline of a median crossing that could be used to serve vehicles in both directions.



Source: VHB

Center line markings in a median aid drivers in properly placing their vehicles within the crossover.



Source: VHB

Center line markings have been applied to this median such that a buffer area is provided between opposing traffic in the crossover.

Targeted Crash Types

- Right-angle
- Opposing left turn
- Sideswipe, same direction
- Head-on

Problems Addressed

- Inadequate motorist guidance

Conditions Addressed

- Interlocking left turns on the major road.
- Side-by-side left-turn queuing in median.
- Observed driver confusion on where to position vehicle in the median.
- Crash history or observed conflicts in the median.

Considerations

- The design vehicle should be able to fit within the opening of the median.
- When the median is too narrow, queuing vehicles may encroach on the through lanes of the major road.
- Promotes two-stage crossing of major road.

Other Resources

[Innovative Operational Safety Improvements at Unsignalized Intersections, Florida DOT](#)
[NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections](#)

Select Examples

[U.S. 70 & Creekside Dr., Goldsboro, NC](#)



Center Line Pavement Markings on Minor Road Approach

Application of a double yellow center line on a minor road approach that extends at least 50 to 100 feet back from the stop line. Center line markings promote proper vehicle placement and attract attention to the intersection ahead.

Targeted Crash Types

- Opposing left turn
- Right-angle
- Sideswipe, opposite direction
- Head-on

Conditions Addressed

- Crash history or observed conflicts between stopped vehicles and turning or oncoming vehicles.
- Observed poor vehicle positioning at intersection.

Problems Addressed

- Inadequate visibility of the intersection or intersection traffic control devices
- Inadequate motorist guidance

Considerations

- The motorist needs adequate sight distance of the treatment to allow an appropriate amount of time to respond.
- May be desirable to enhance the centerline with retroreflective raised pavement markers (RRPMs).
- Center line placement may be used to help provide adequate room for turns from the major road.

Industry Standard

MUTCD
[Section 3B.01: Yellow Center Line Pavement Markings and Warrants](#)

Other Resources

[Stop Sign-Controlled Intersections: Enhanced Signs and Markings - A Winston-Salem Success Story, FHWA](#)

Select Examples

[2nd St. & Spring St., Winston-Salem, NC](#)
[Bradley Rd. & St. Johns Bluff Rd., Jacksonville, FL](#)
[E. Musser St. & N. Roop St., Carson City, NV](#)





Dotted Line Pavement Markings

Application of broken line markings to delineate the major road through lane across an intersection or median opening.



Source: South Carolina DOT

The dotted edge line continues through the intersection along this tangent section of roadway.



Source: VHB

This dotted edge line provides valuable delineation across an approach that intersects the major road on the outside of a horizontal curve.

Targeted Crash Types

- Right-angle
- Opposing left turn
- Rear-end (major road)

Problems Addressed

- Inadequate motorist guidance

Conditions Addressed

- Vehicles on minor road approaches are not positioning themselves appropriately before entering the major road.
- Vehicles in the median of a divided roadway are encroaching upon the major road through lane.

Considerations

- Dotted pavement marking color should match the color of the lane line it is extending.
- In addition to enhancing motorist guidance, this treatment can also (1) raise awareness of the intersection among drivers on both the major and minor road approaches and (2) indicate to minor road drivers exactly how far they can pull their vehicles forward without encroaching upon the major road through lane.
- A dotted line extension may encourage drivers to pull further ahead on the side street approach and inadvertently lead them to disregard pedestrians and bicyclists who may be present.
- May be particularly applicable at intersections within horizontal curves.

Industry Standard

MUTCD

[Section 3A.06: Functions, Widths, and Patterns of Longitudinal Pavement Markings \(Dotted lines\)](#)

[Section 3B.08: Extensions through Intersections or Interchanges](#)

Other Resources

[Innovative Operational Safety Improvements at Unsignalized Intersections, Florida DOT](#)
[NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections](#)

Select Examples

[Buffalo Rd. & Lake Wendell Rd., Wendell, NC](#)
[S. Main St. & Veterans St., Hollsopple, PA](#)
[Olanta Hwy. & N. Bethel Rd., Scranton, SC](#)





Lane Assignment Pavement Markings or Signing

Clarification of lane assignments through pavement markings and/or signing.



Source: VHB

Lane assignment pavement marking symbols and a sign provide guidance on lane assignments along this approach.



Source: VHB

These lane assignment pavement markings convey valuable information on this three-lane minor road approach.



Source: VHB

The lane assignment pavement markings at this T-intersection help notify the road user of the impending intersection.

Targeted Crash Types

- Rear-end (major road)
- Rear-end (minor road)
- Sideswipe, opposite direction
- Sideswipe, same direction

Conditions Addressed

- Crash history or observed conflicts related to driver confusion regarding proper lane use.

Problems Addressed

- Inadequate motorist guidance

Considerations

- Lane assignment signs and/or markings need to be visible to drivers.
- Overhead signs tend to be more visible than post-mounted signs on the shoulder but are far more expensive and can be aesthetically unappealing.

Industry Standard

MUTCD

[Section 2B.19: Intersection Lane Control Signs \(R3-5 through R3-8\)](#)

[Section 3B.20: Pavement Word, Symbol, and Arrow Markings](#)

Select Examples

[High St. & College Ave., State College, PA](#)

[County Road 73 & S. Southern Hills Dr., Hastings, NE](#)

Other Resources

[NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections](#)





Install Pavement Word and Symbol Markings

Pavement markings placed at or in advance of the intersection for the purpose of supplementing existing signs to guide, warn, or regulate traffic. Markings that would apply to unsignalized intersections include: STOP, YIELD, RIGHT (LEFT) TURN ONLY messages; lane-use and wrong-way arrows; and STOP AHEAD, YIELD AHEAD, SCHOOL XING, PED XING messages.



Source: PennDOT
These STOP AHEAD pavement markings supplement the Stop Ahead sign.



Source: PennDOT
These pavement markings remind approaching drivers of the speed limit and notify them of the impending intersection.



Source: Lee Engineering, LLC
The STOP pavement marking along this approach adds emphasis to the stop condition.



Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Rear-end (minor road)

Problems Addressed

- Inadequate visibility of intersection or intersection traffic control devices
- Inadequate motorist guidance

Conditions Addressed

- Poor visibility of the intersection from approaches, especially when caused by vegetation or other obstacles along the road (e.g., parked vehicles).
- Crash history or observed conflicts caused by lack of awareness of intersection.
- In areas where the roadside may be "cluttered" with posted signs.

Considerations

- Symbol messages are preferable to word messages.
- Letters or numerals should be six feet or more in height. The longitudinal space between words or symbols should be at least four times the height of the characters (low speed roads) and not more than 10 times the height of the characters.
- Text presented in multiple lines should be applied such that the first word of the message is the first word a driver encounters, and no more than three lines are recommended.
- Non-slick material should be used for markings with large surfaces.
- Message may not be visible during the winter.

Industry Standard

MUTCD

[Section 3B.20: Pavement Word, Symbol, and Arrow Markings](#)

Select Examples

[E. Chestnut St. & Line St., Mifflinburg, PA](#)

[Earlstown Rd. & Schempf Rd., Boalsburg, PA](#)

[Periwinkle Way & Dixie Beach Blvd., Sanibel, FL](#)

[NC 55 & NC 111, Seven Springs, NC](#)

Other Resources

[Innovative Operational Safety Improvements at Unsignalized Intersections, Florida DOT](#)

[NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections](#)
[Low-Cost Safety Enhancements for Stop-Controlled and Signalized Intersections, FHWA](#)

Install Dotted Turn Path Markings

Application of dotted line markings to delineate the path for turning maneuvers at the intersection.



The dotted turn path provides guidance for drivers turning left from a pair of turn lanes.



These dotted turn path markings are yellow because they guide left-turning drivers from the major road double yellow center line to the minor road double center line.

Targeted Crash Types

- Sideswipe, opposite direction
- Sideswipe, same direction
- Head-on

Problems Addressed

- Inadequate motorist guidance

Conditions Addressed

- Vehicles turning left at an intersection are not following an appropriate turning path.
- Need to guide motorists away from a raised median at an intersection.
- Multiple left- or right-turn lanes on a single approach.

Considerations

- Adding too many pavement markings within an intersection may be confusing to motorists.
- Dotted pavement marking color should match the color of the lane line it is extending.
- Dotted lane extension lines may be solid for extra restriction or emphasis.
- Requires frequent restriping to ensure visibility and effectiveness.

Industry Standard

MUTCD

[Section 3B.08: Extensions Through Intersections or Interchanges](#)

Select Examples

[Lincoln Dr. & N. Biltmore Cir., Phoenix, AZ](#)

[Reedie Dr. & Grandview Ave., Silver Spring, MD](#)

Other Resources

[Innovative Operational Safety Improvements at Unsignalized Intersections, Florida DOT](#)

[NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections](#)



Install Raised Pavement Markers

Devices placed on the roadway surface to better delineate the travel lanes and attract attention to the intersection ahead. They may be a ceramic non-reflective marker or include a lens or sheeting that reflects vehicle headlamps and can be used in conjunction with or as a substitute for longitudinal paint or thermoplastic markings.



Source: Lee Engineering, LLC

Standard reflective raised pavement markers enhance the lane lines on the approach to this intersection.



Source: Lee Engineering, LLC

Large ceramic markers are used here to enhance delineation of a painted island along the major road.

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Sideswipe, opposite direction
- Sideswipe, same direction
- Head-on

Conditions Addressed

- Crash history or observed conflicts related to poor visibility of intersection, particularly under nighttime or rainy conditions.

Problems Addressed

- Inadequate motorist guidance
- Inadequate visibility of intersection or intersection traffic control devices

Considerations

- Typical colors are white, yellow, and red, although other colors can be used for some specific applications.
- Raised pavement markers may be removed by snow plows; hence, the markers will need to be either recessed in the pavement or of the snowplowable type.
- Raised pavement markers are not desirable to use in bicyclists paths or to designate bike lane lines or edge lines, and they should not be used to delineate crosswalks.
- Non-retroreflective raised pavement markers should not be used alone without supplemental retroreflective or internally illuminated markers as a substitute for other types of pavement markings (MUTCD: Section 3B.11).
- May be particularly applicable for unusual geometrics and unlit intersections.

Industry Standard

MUTCD

[Section 3B.11: Raised Pavement Markers - General](#)

[Section 3B.12: Raised Pavement Markers as Vehicle Positioning Guides with Other Longitudinal Markings](#)

[Section 3B.13: Raised Pavement Markers Supplementing Other Markings](#)

[Section 3B.14: Raised Pavement Markers Substituting for Pavement Markings](#)

Other Resources

[Innovative Operational Safety Improvements at Unsignalized Intersections, Florida DOT](#)

[LED Raised Pavement Markers, FHWA](#)





Install or Modify Crosswalk Markings

Application or alteration of a marked path across the roadway that designates a crossing location for pedestrians.

Targeted Crash Types

- Pedestrian
- Bicyclist

Problems Addressed

- Vehicle conflicts with non-motorists

Conditions Addressed

- Crash history or observed conflicts between vehicles and non-motorists crossing the roadway.
- Observed vehicles not yielding to pedestrians in existing crosswalk or unmarked crosswalk.
- High volume of pedestrians in the area.
- A need to relocate crosswalk to allow stop line to be moved closer to intersection and provide better sight distance.
- School crossings.

Considerations

- Supplement the crosswalk with warning signs or beacons along uncontrolled approaches.
- If used on uncontrolled multilane approaches, a yield (or stop) line should be applied properly (see [MUTCD Section 3B.16](#)) and placed an adequate distance (20 to 50 feet) in advance of the crosswalk to give motorists and pedestrians a clear line of sight for one another. May be supplemented with a Yield Here to (Stop Here for) Pedestrians (R1-5, R1-5a, R1-5b, R1-5c) sign.
- The placement of the crosswalk should be near the pedestrian traveled pathway (extension of the sidewalk network) to deter jaywalking.
- Crosswalks should be accompanied by wheelchair ramps on either side to allow access for persons with disabilities.
- Crosswalk lines should not be used indiscriminately. An engineering study considering the factors described in [MUTCD Section 3B.18](#) should be performed before a marked crosswalk is installed at an uncontrolled location.
- For uncontrolled crosswalks on multilane streets of 10,000 ADT or more (15,000 ADT with a raised median), additional treatments should be considered to improve safety and facilitate crossings.
- Wider lines, wider crosswalks, and ladder or diagonal (high visibility) markings are easier for drivers to see. Continental or ladder markings should be placed between wheel paths to extend the service life of the markings.

Industry Standard

MUTCD

[Section 3B.18: Crosswalk Markings](#)

[Section 3C.05: Crosswalk Markings at Roundabouts](#)

[Section 7C.02: Crosswalk Markings \(Traffic Control for School Areas\)](#)

AASHTO Green Book

Section 2.6. The Pedestrian

Section 2.6.5 Intersections

Other Resources

[Marked Crosswalks and Enhancements, PEDSAFE](#)

[NCHRP 562 & TCRP 112: Improving Pedestrian Safety at Unsignalized Intersections](#)

[South Carolina Case Study: Systematic Intersection Improvements, FHWA](#)

[Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations Final Report and Recommended Guidelines, FHWA](#)

Select Examples

[Marsol Rd. & Woodhurst Ave., Mayfield Heights, OH](#)

[Casa Ybel Rd. & Periwinkle Way, Sanibel, FL](#)

[Stinson Dr. & Broughton Dr., Raleigh, NC](#)



Source: Lee Engineering, LLC

This crosswalk utilizes a combination of longitudinal and diagonal lines.



Source: Lee Engineering, LLC

This crosswalk utilizes transverse lines to increase its conspicuity.



Source: VHB

Two longitudinal lines delineate this crosswalk.





Install a Pedestrian Hybrid Beacon (PHB)

A push-button-activated pedestrian signal that stops vehicular traffic, allowing pedestrians to cross. The PHB is comprised of a yellow beacon centered below two red beacons that remain dark until activated, then flashes yellow for a few seconds, followed by a solid yellow, then a solid red during the WALK phase. At the end of the WALK interval, the vehicle signal will display an alternating flashing red allowing motorists to proceed after stopping and yielding to pedestrians on or approaching their half of the street. Once the pedestrian clearance interval is completed, the vehicle signal returns to a dark mode, and the pedestrian signal rests in a steady DON'T WALK (raised hand symbol). The PHB was originally referred to as the HAWK (High-intensity Activated crossWalk)

Source: Lee Engineering, LLC



A PHB in use as a pedestrian is crossing the street.



Source: Lee Engineering, LLC

A view of what a driver would see as they approach an intersection outfitted with a PHB.

Targeted Crash Types

- Pedestrian
- Bicyclist

Problems Addressed

- Vehicle conflicts with non-motorists

Conditions Addressed

- Crash history or observed conflicts between vehicles and non-motorists crossing at the intersection.
- High volume of crossing pedestrians or bicyclists at the intersection.
- Observed vehicles not yielding to pedestrians in crosswalk.
- High pedestrian delay due to few available gaps in traffic.

Considerations

- Used in combination with a crosswalk and pedestrian signal heads.
- Must meet MUTCD warrant for installation.
- Install a stop line along each approach approximately 60 feet advance of the crosswalk if overhead signal heads are used.
- The crossing is only across one side of the intersection. Side street vehicle traffic is not stopped. (While the 2009 MUTCD stated that the PHB should not be used within 100 feet of an intersection, the National Committee on Uniform Traffic Control devices has voted to eliminate that provision in the next MUTCD.)
- Public involvement meetings and education may be needed to introduce the public to the operation of the PHB. Police need to be educated, as well.
- Can be modified to better accommodate bicycle traffic (i.e., BikeHAWK).

Other Resources

[NCHRP 562 & TCRP 112: Improving Pedestrian Safety at Unsignalized Intersections](#)
[Pedestrian Hybrid Beacon Guide, Recommendations and Case Study, FHWA](#)
[Pedestrian Hybrid Beacon, FHWA](#)
[Safety Effectiveness of the HAWK Pedestrian Crossing Treatment, FHWA](#)
[Pedestrian Hybrid Beacon \(PHB\), PEDSAFE](#)
[Pedestrian Hybrid Beacon Fact Sheet, Wisconsin DOT](#)

Industry Standard

MUTCD
[Chapter 4F. Pedestrian Hybrid Beacons](#)

Select Examples

[Huron St. & Chapin St., Ann Arbor, MI](#)
[Pima Rd. & Jomax Rd., Scottsdale, AZ](#)
[Mendenhall Loop Rd., Juneau, AL](#)



Install Rectangular Rapid-Flashing Beacon (RRFB)

Traffic control device that combines a pedestrian warning sign with user-activated light-emitting diodes (LEDs). The device flashes amber when activated through a pedestrian push button or by pedestrian detection and then remains dark when not in use.



Source: Lee Engineering, LLC

This RRFB is activated by a pedestrian push button.



Source: Lee Engineering, LLC

This RRFB is used as a supplement to a School sign.



Source: Lee Engineering, LLC

Students cross the major road as the RRFB flashes.



Targeted Crash Types

- Pedestrian
- Bicyclist

Problems Addressed

- Vehicle conflicts with non-motorists

Conditions Addressed

- Crash history or observed conflicts between vehicles and non-motorists crossing at the intersection.
- High volume of crossing pedestrians or bicyclists at intersection.
- Vehicles observed not yielding to pedestrians in crosswalk.
- High pedestrian delay due to few available gaps in traffic.

Considerations

- Use in combination with a crosswalk, wheelchair ramps, advance warning signs or pavement markings, and overhead lighting.
- Not to be used on intersection approaches controlled by STOP (R1-1) or YIELD (R1-2) signs or traffic signals.
- Power source is typically hard-wired but may also be solar powered.
- Public involvement meetings and outreach may be needed to educate the public on RRFB operations.
- There is no MUTCD warrant for the RRFB, but approval is needed from FHWA if not already granted to your agency or state.
- May not be as effective on wider multilane streets or higher speed streets.

Industry Standard

MUTCD

[Interim Approval for Optional Use of Rectangular Rapid Flashing Beacon \(IA-11\)](#)

Other Resources

[Rectangular Rapid Flashing Beacon \(RRFB\), FHWA](#)

[Rectangular Rapid Flash Beacon \(RRFB\), PEDSAFE](#)

Select Examples

[Broadway Ave. & E. 55th St., Elmwood Park, NJ](#)

[Ann St. & S 3rd St., Wilmington, NC](#)



Install Bicycle Lane Pavement Markings Across the Intersection

Application of dotted pavement markings to extend a bicycle lane across an intersection or driveway.



Source: Lee Engineering, LLC



Source: Lee Engineering, LLC



Dotted pavement markings at these locations delineate the bicycle lane along the major road approach.

Targeted Crash Types

- Bicyclist

Problems Addressed

- Vehicle conflicts with non-motorists

Conditions Addressed

- Crash history or observed conflicts between turning vehicles and bicyclists.
- Perceived lack of awareness among drivers towards bicyclists.
- Inadequate bicycle guidance through intersection.
- Minor road traffic encroaching in the major road bicycle lane.
- Improved stopping location for sidestreet motorists entering the major street.

Considerations

- Provide adequate width for cyclists.
- Provide dotted pavement markings to extend the bicycle lane across the vehicle right-turn transition area where a right-turn lane is added, but not across a near-side lane drop that terminates in a right-turn lane.

Industry Standard

MUTCD

[Section 9C.04: Markings for Bicycle Lanes](#)

Select Examples

[Haywood Rd. & Craven St., Asheville, NC](#)

[E Cornwallis Rd. & S Tricenter Blvd., Durham, NC](#)

[Hilyard St. & E. 15th Ave., Eugene, OR](#)

[G St. NE & 10th St. NE, Washington, DC](#)

Other Resources

[Intersection Markings, BIKESAFE](#)



Install Sign(s) Warning of Pedestrians and Bicyclists

Warning sign to alert drivers of other roadway users and to encourage shared use of the facility. For unsignalized intersections, such signs are key along uncontrolled approaches.



Source: Lee Engineering, LLC

The Pedestrian Crossing sign alerts the driver that a crosswalk is present.



Source: VHB

Bicycle signs are often placed on the far side of unsignalized intersections to notify road users of the prevalence of bicycle traffic.



Source: VHB

School signs are used to warn approaching road users that school-children cross the uncontrolled major road at this intersection.



Targeted Crash Types

- Pedestrian
- Bicyclist

Problems Addressed

- Inadequate visibility of intersection or traffic control devices
- Vehicle conflicts with non-motorists

Conditions Addressed

- Poor visibility of the crossing from the approaches.
- Crash history or observed conflicts between vehicles and crossing pedestrians or bicyclists.
- High volume of special users (pedestrians, bicyclists, equestrian, etc.).

Considerations

- Studies show a decrease in motorist yielding rates for speeds above 25 mph.
- Additional treatments may be needed for high-volume, wide, and/or high-speed roadways.
- Options include in-street signs, post mounted signs, and overhead signs
- The use of STOP HERE FOR versus YIELD HERE TO PEDESTRIANS signs (R1-5 series) must be consistent with applicable state laws and their requirement for drivers to either stop for or yield to pedestrians.
- If used, stop lines may only be used at uncontrolled crosswalks in states where drivers are required to stop for pedestrians, and yield lines are to be used when drivers are required to yield for pedestrians.
- A Share the Road (W16-1P) plaque may be used with the Bicycle (W11-1) sign.

Industry Standard

MUTCD

[Section 2B.11: Yield Here to Pedestrians Signs and Stop Here For Pedestrians Signs \(R1-5 Series\)](#)

[Section 2B.12: In-Street and Overhead Pedestrian Crossing Signs \(R1-6 and R1-9 Series\)](#)

[Section 2C.49: Vehicular Traffic Warning Signs](#)

[Section 2C.50: Non-Vehicular Traffic Warning Signs](#)

[Chapter 7B: Signs](#)

Other Resources

[NCHRP 562 & TCRP 112: Improving Pedestrian Safety at Unsignalized Intersections](#)
[Signing, PEDSAFE](#)

Select Examples

[SE. Stanley Ave. & SE. Johnson Creek Blvd., Portland, OR](#)
[Holly Springs Rd. & Middlecrest Way, Holly Springs, NC](#)

Add Beacon to Standard Speed Limit Sign

Installation of a Speed Limit Sign Beacon to provide emphasis to a Speed Limit (R2-1) or School Speed Limit (S5-1) sign.



Source: Lee Engineering, LLC

This Speed Limit Sign Beacon has been installed over the roadway.

Source: VHB



Illustration of the application of a Speed Limit Sign Beacon above a standard Speed Limit sign.

Source: Lee Engineering, LLC



This Speed Limit Sign Beacon has been added to a School Speed Limit sign.

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Rear-end (minor road)
- Pedestrian
- Bicyclist

Problems Addressed

- Speeding

Conditions Addressed

- Crash history or observed vehicle conflicts caused by speeding.
- Speed limit change at agency boundary or significant land use change.
- Reduced speed entering school zones.

Considerations

- Beacon may be used on a fixed or variable Speed Limit sign.
- Beacons shall only be yellow.
- May be included within the border of a School Speed Limit (S5-1) sign (see [MUTCD Section 7B.15](#)).

Industry Standard

MUTCD

[Section 2A.15: Enhanced Conspicuity for Standard Signs](#)

[Section 4L.04: Speed Limit Sign Beacon](#)

Other Resources

[Innovative Operational Safety Improvements at Unsignalized Intersections, Florida DOT](#)



Install Speed Reduction Pavement Markings

Application of white pavement markings along both edges of an intersection approach lane to give drivers the impression that their speed is increasing. The markings should be perpendicular to the center line with a progressive decrease in spacing.



These speed reduction pavement markings are installed with a Side Road sign.

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Sideswipe, opposite direction

Problems Addressed

- Speeding
- Inadequate visibility of intersection or intersection traffic control devices

Conditions Addressed

- Citation history or observations of speeding on the approach to the intersection.
- Crash history or observed conflicts due to lack of awareness of the intersection.

Considerations

- If used, the markings should supplement the appropriate warning signs and other traffic control devices and not substitute for these devices.
- May be appropriate when the intersection lies within or just beyond an unexpectedly severe horizontal or vertical curve along the major road.
- Only lanes having a longitudinal line (center line, edge line, or lane line) on both sides of the lane should be considered for this treatment.
- Markings should not be wider than 12 inches nor extend more than 18 inches into the lane.

Industry Standard

MUTCD

[Section 3B.22: Speed Reduction Markings](#)

[Figure 3B-28. Example of the Application of Speed Reduction Markings](#)

AASHTO Green Book

Section 2.1.3 Vehicle Performance

Figure 2-25 Deceleration Distances for Passenger Vehicles Approaching Intersections

Other Resources

[Innovative Operational Safety Improvements at Unsignalized Intersections, Florida DOT](#)

[Low-Cost Safety Enhancements for Stop-Controlled and Signalized Intersections, FHWA](#)

[NCHRP 613: Guidelines for Selection of Speed Reduction Treatments at High-Speed Intersections](#)

Select Examples

[S. Redland Rd. & S. Ferguson Rd., Oregon City, OR](#)



Install Dynamic Speed Feedback Sign

A dynamic message sign that uses radar or laser technology to determine the speed of an approaching vehicle and then displays the speed to the driver. Such signs can be part of a temporary mobile speed trailer or permanently installed below a posted speed limit sign.



Source: VHB

A dynamic feedback sign displays the speed of an approaching vehicle.



Source: Lee Engineering, LLC

This dynamic feedback sign is applied to a school zone.



Source: Lee Engineering, LLC

The Speed Limit sign and dynamic feedback sign assembly can be moved from location to location using a mobile trailer such as this.



Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Rear-end (minor road)
- Pedestrian
- Bicyclist

Problems Addressed

- Speeding

Conditions Addressed

- Citation history or observations of speeding on approach to intersection.
- Change in speed limit or land use (e.g., change from rural to urban).
- Changeable speed limit by time and day of the week (e.g., during school hours).

Considerations

- Check that the radar or laser device has an unobstructed vantage of oncoming traffic.
- May be combined with an Intersection Warning sign.
- Most effective if dynamic feedback sign is installed with a Speed Limit sign.
- Need to determine the operating speed that will activate the sign. May be used with an LED flash that is activated if the motorist is traveling above a threshold speed.
- If solar-powered, the batteries should be checked on regular intervals. Used batteries represent a hazard waste stream for an agency.

Other Resources

[Speed Enforcement Program Guidelines, NHTSA](#)

[Innovative Operational Safety Improvements at Unsignalized Intersections, Florida DOT](#)

[Low-Cost Safety Enhancements for Stop-Controlled and Signalized Intersections, FHWA](#)

[Low Cost Local Road Safety Solutions, ATSSA](#)

[NCHRP 613: Guidelines for Selection of Speed Reduction Treatments at High-Speed Intersections](#)

Industry Standard

[MUTCD](#)

[Section 2B.13: Speed Limit Sign](#)

Select Examples

[Anderson St. & Perkins Rd., Durham, NC](#)

[US 24 & Flush Rd., Manhattan, KS](#)



Eliminate Turn Movements Using Design Alterations and Channelization

Application of physical means (e.g., raised islands or flexible posts) to eliminate certain movements at the intersection.



Source: Lee Engineering, LLC

This channelization prevents drivers from turning left from the minor road onto the major road.



Source: VHB

This channelization requires drivers to turn right from the minor approach.



Source: Lee Engineering, LLC

Channelization and delineators restrict drivers turning left from both the major and minor roads.



Targeted Crash Types

- Right-angle
- Opposing left turn
- Rear-end (major road)
- Pedestrian

Problems Addressed

- Excessive intersection conflicts
- Poor operational performance
- Misjudgment of gaps
- Vehicle conflicts with non-motorists

Conditions Addressed

- Crash history related to or observed conflicts involving left-turning vehicles.
- Insufficient gaps in major road traffic for left-turn or through movements from minor road.
- Observed driver confusion with respect to proper vehicle placement and maneuvers.
- Can eliminate a turning movement across a crosswalk and provide pedestrian refuge.

Considerations

- Alternative routes should be available and able to safely accommodate the diverted traffic.
- Stakeholders should be involved during planning stages, especially adjacent businesses or residents who may be affected by the access restriction.
- Consult with elected officials and emergency responders before initiating design work.
- To maximize effectiveness, channelizing devices should be maintained and kept clean and in good condition. Raised islands may be more difficult for snowplows.
- Channelizing islands need to be visible to approaching motorists through the use of signs, pavement markings, and the size of the island. Pedestrian crossings through the islands need to be ADA-compliant.
- Large vehicles (e.g., trucks, buses, and fire trucks) should be considered during planning and design.

Industry Standard

MUTCD

[Section 3H.01: Channelizing Devices](#)

[Chapter 3I. Islands](#)

[Section 2B.18: Movement Prohibition Signs](#)

AASHTO Green Book

Section 9.6.2: Channelization

Section 9.6.3: Islands

Other Resources

[Access Management in the Vicinity of Intersections, FHWA](#)

[Cost Effective Local Road Safety Planning and Implementation, ATSSA](#)

[NCHRP Report 500 Volume 5: A Guide for Addressing Unsignalized Intersection Collisions](#)

Select Examples

[Zion Church Rd. & Warren C. Coleman Blvd., Concord, NC](#)

[W. Foster Ave. & Atherton St., State College, PA](#)

[NC 42 & Verona Dr., Clayton, NC](#)



Replace Left-Turn and Through Movements with Right-Turn/U-Turn Combination

Conversion of minor road left turns and through movements to right turns and U-turns. There are several variations of this design, with some permitting direct left turns from the major road and others prohibiting left turns entirely.



Source: North Carolina DOT

Drivers must turn right and then complete a U-turn maneuver to turn left.



Source: VHB

This intersection incorporates delineators instead of concrete islands to force all drivers to turn right.



Source: Tennessee DOT Aerial

This aerial photograph shows the channelization at the intersection and the downstream U-turn bulb-out.



Targeted Crash Types

- Right-angle
- Opposing left turn
- Rear-end (major road)
- Pedestrian

Problems Addressed

- Excessive intersection conflicts
- Poor operational performance
- Misjudgment of gaps
- Vehicle conflicts with non-motorists

Conditions Addressed

- Crash history or observed conflicts involving left-turning vehicles or vehicles attempting to continue on the minor road by crossing the major road.
- Insufficient gaps in major road traffic for left-turn or through movements from minor road.
- Crash history or observed conflicts involving vehicles in median.
- Can eliminate a turning movement across a crosswalk and provide pedestrian refuge.

Considerations

- This treatment is typically applied along major roads whose geometric conditions are conducive to U-turn maneuvers (i.e., those characterized by a median and multiple lanes in each direction).
- A bulb-out (also known as a loon) may be needed to accommodate U-turn maneuvers for buses and other longer vehicles.
- Stakeholders should be involved during planning stages, especially adjacent businesses or residents that may be affected by the access restriction.
- Consult with elected representatives and emergency responders before initiating design work.
- Sufficient distance should be provided from the intersection to the U-turn.
- Appropriate signing should be incorporated to prevent motorist confusion.

Industry Standard

MUTCD

[Section 2B.18: Movement Prohibition Signs](#)

AASHTO Green Book

Section 9.9: Indirect Left Turns and U-turns

Other Resources

[Restricted Crossing U-Turn Intersections Video, FHWA](#)

[Median U-Turn Intersections Video, FHWA](#)

[Alternative Intersections/Interchanges: Informational Report \(AIIR\), FHWA](#)

[Low-Cost Safety Enhancements for Stop-Controlled and Signalized Intersections, FHWA](#)

[Innovative Operational Safety Improvements at Unsignalized Intersections, FDOT](#)

Select Examples

[US 15 & S. Seton Ave., Emmitsburg, MD](#)

[Tanbridge Rd. & Eastwood Rd., Wilmington, NC](#)

[US 1 & Cranes Creek Rd., Vass, NC](#)

[Linden Dr. NW & Lake Michigan Dr., Allendale, MI](#)



Close One or More Legs of the Intersection

Eliminating one or more intersection approaches (most likely along the minor road) to remove certain movements (e.g., left turns and through movements) that are experiencing a high number of conflicts or crashes. This treatment would be for locations where other treatments have been unsuccessful at solving the safety problem, and there is a reasonable alternative route for the affected users.



Source: Lee Engineering, LLC

These roads used to intersect, but the connection has been removed.



Source: Lee Engineering, LLC

A cul-de-sac was constructed as part of the closure of this former intersection leg.

Targeted Crash Types

- Right-angle
- Opposing left turn
- Rear-end (major road)

Problems Addressed

- Excessive intersection conflicts

Conditions Addressed

- Lack of available gaps for left-turn or through movements from minor road.
- Queuing on mainline that prevents left-turn or through movements from minor road.
- Crash history involving turning vehicles entering/exiting minor road.
- Other strategies have been unsuccessful at improving conditions at the intersection.
- Required vehicle movements can safely be accommodated at a nearby intersection.

Considerations

- Ensure there is an alternate route that can sufficiently accommodate the re-routed traffic.
- Stakeholders should be involved during planning stages, especially adjacent businesses or residents who may be affected by the access restriction.
- Consult with elected representatives and emergency responders early in project development.
- May need to provide a cul-de-sac or “hammerhead” treatment to accommodate vehicle turnarounds on the closed street.
- Maintain access for pedestrians and bicyclists and emergency response vehicles.

Industry Standard

MUTCD [Section 2C.66: Object Markers for End of Roadways](#)

Other Resources

[Access Management in the Vicinity of Intersections, FHWA](#)
[NCHRP Report 500 Volume 5: A Guide for Addressing Unsignalized Intersection Collisions, FHWA](#)
[Full Street Closure, PEDSAFE](#)

Select Examples

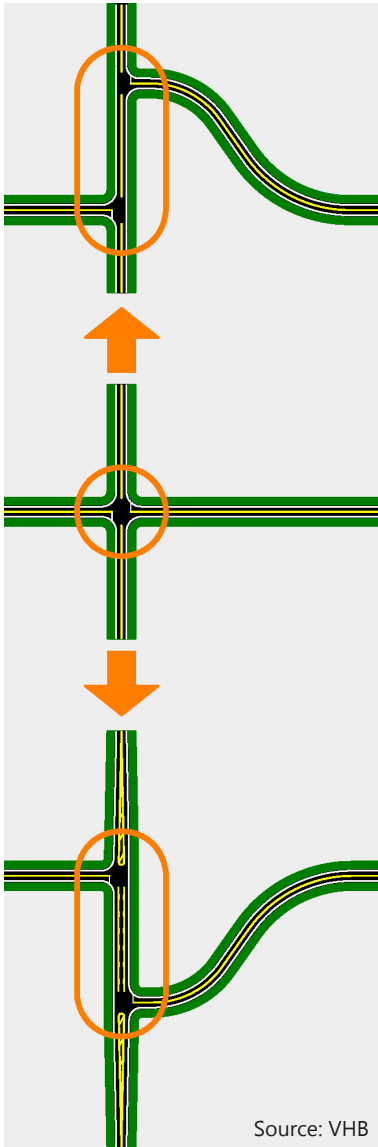
[Chambers Ln. & Jerome and Betty Warner Expy., Bennet, NE](#)
[NC 11 and Old Highway 11, Ahoskie, NC](#)
[Calder Way & Atherton St., State College, PA](#)





Convert Four-Legged Intersection to Two T-Intersections

Realignment of one or both minor road approaches such that a four-legged intersection is replaced by two three-legged intersections.



Source: VHB

A single four-legged intersection can be converted to two offset T-intersections by realigning one or both minor road approaches; this can be accomplished to require drivers continuing on the minor road to execute (1) a left-right combination (see top) OR (2) a right-left combination (see bottom).

Targeted Crash Types

- Right-angle
- Opposing left turn

Problems Addressed

- Excessive intersection conflicts
- Poor operational performance
- Misjudgment of gaps

Conditions Addressed

- Crash history or observed conflicts between vehicles on the major road and minor road vehicles making the through movement.
- High-speed angle crashes involving vehicles making through movement on minor road.
- Difficulty among minor road drivers in assessing available gaps in major road traffic.

Considerations

- Right-of-way will likely need to be acquired for each realigned approach.
- Incorporating auxiliary (i.e., left- or right-turn) lanes along the major road into the design can reduce the likelihood of rear-end collisions.
- Operational problems can occur if the two T-intersections are spaced too closely and the left-turns queues along the major street overlap.
- Certain combinations of factors may make the single four-legged intersection preferred over a pair of offset T-intersections.
- Implement appropriate traffic control devices for the new configuration.

Industry Standard

AASHTO Green Book
Section: 9.4.2 Alignment

Select Examples

[US 34 & Oakville Rd. SW, Albany, OR](#)
[NC 131 & NC 41, Bladenboro, NC](#)

Other Resources

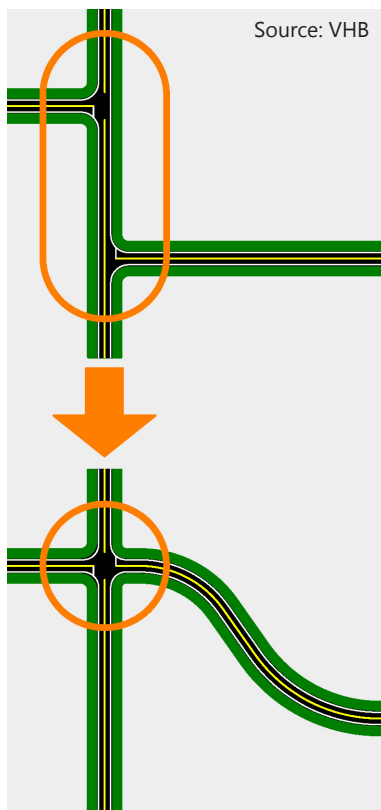
[NCHRP Report 500 Volume 5: A Guide for Addressing Unsignalized Intersection Collisions](#)





Convert Two Offset T-Intersections to a Single Four-Legged Intersection

Realignment of one or both minor road approaches such that both approaches intersect the major road at a single point.



Two T-intersections can be converted to a single four-legged intersection by realigning at least one leg, as illustrated above.

Targeted Crash Types

- Opposing left turn
- Rear-end (major road)
- Head-on (among opposing left turns)

Problems Addressed

- Poor operational performance
- Excessive intersection conflicts

Conditions Addressed

- High minor road through volume.
- Crash history or observed conflicts due to insufficient spacing between two adjacent T-intersections.
- Prevalence of rear-end crashes on major road, specifically ones involving "through" movements from the offset minor roads.

Considerations

- Additional right-of-way may be needed for each realigned approach.
- If the minor road through volumes are low, the intersection may be safer if left as two T-intersections.
- Certain combinations of factors may make offset T-intersections preferred over a single four-legged intersection.
- Implement appropriate traffic control devices for the new configuration.

Select Examples

[Bear Meadows Rd. & US 322, Boalsburg, PA](#)

[Ohio 124 & Pea Ridge Rd., Hillsboro, OH](#)

Other Resources

[NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections](#)

[Access Management Manual, Transportation Research Board](#)





Close Median Opening

Permanently blocking or removing the existing median opening to eliminate certain movements at the intersection (e.g., left turns or through movements to and from the minor road). These may be locations where it is impractical to improve sight distance or where it is inappropriate to install a traffic signal.

Targeted Crash Types

- Right-angle
- Opposing left turn
- Rear-end (major road)

Problems Addressed

- Excessive intersection conflicts
- Poor operational performance

Conditions Addressed

- Crash history or observed conflicts involving left-turning vehicles.
- Insufficient gaps in mainline traffic for left-turns from minor or major road or through movements from minor road.
- Crash history or observed conflicts involving vehicles in median.

Considerations

- Ensure that alternative routes are available and can safely accommodate the diverted traffic.
- Stakeholders should be involved during planning stages, especially adjacent businesses or residents who may be affected by the access restriction.
- Consult with elected representatives and emergency responders during planning stages.
- Ensure the median closure is obvious and is visible to motorists through signing or other means.
- Provide accessible design for pedestrian and bicyclist crossings through median that will not allow motor vehicles to pass.

Industry Standard

MUTCD

[Section 2B.18: Movement Prohibition Signs](#)

AASHTO Green Book

Section 2.5: Access Control and Access Management

Other Resources

[Access Management in the Vicinity of Intersections, FHWA](#)

[NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections](#)

Select Examples

[Filmore St. & Wade Ave., Raleigh, NC](#)

[Commonwealth Dr. & Eastwood Rd., Wilmington, NC](#)





Realign Intersection

Approaches to Reduce or Eliminate Intersection Skew

Realignment of at least one leg to bring the intersection angle closer to perpendicular.

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Pedestrian
- Bicyclist
- Head-on

Problems Addressed

- Inadequate visibility of intersection or intersection traffic control devices
- Inadequate intersection sight distance
- Excessive intersection conflicts
- Poor operational performance

Conditions Addressed

- Existing intersection skew angle makes it difficult for minor road drivers to detect approaching major road traffic.
- Existing intersection skew angle is conducive to high speeds among turning vehicles or noncompliance with STOP or YIELD signs.
- Observed difficulty for turning vehicles to remain in their proper lane due to skew angle.
- Crash history or observed conflicts related to poor sight distance from the minor road or poor visibility of the intersection from the major road due to the intersection skew angle.

Considerations

- Stakeholders should be involved early in the decision-making process to address any concerns.
- This approach to improving intersection safety should be considered after less-restrictive measures have been tried and have not solved the problem.
- Measures should be taken to alert drivers to the changes in conditions before, during, and after construction.
- Additional right-of-way may be required.

Industry Standard

AAHSTO Green Book
Section 9.4.2: Alignment
Section 9.4.3: Profile

Select Examples

[Daly Waldrop Rd. & US 258, Kinston, NC](#)

Other Resources

[Innovative Operational Safety Improvements at Unsignalized Intersections, Florida DOT](#)
[NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections](#)
[Intersection Safety: A Manual for Local Rural Road Owners, FHWA](#)
[NCHRP 613: Guidelines for Selection of Speed Reduction Treatments at High-Speed Intersections](#)
[Modify Skewed Intersections, PEDSAFE](#)





Modify Horizontal and/or Vertical Alignment of Intersection Approach

Horizontal or vertical realignment of at least one leg of the intersection to improve sight distance to and from the intersection.

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Rear-end (minor road)

Problems Addressed

- Inadequate visibility of intersection or intersection traffic control devices
- Inadequate intersection sight distance

Conditions Addressed

- Crash history related to poor intersection sight distance from the stop-controlled minor road.
- Crash history related to poor visibility of the intersection from the major or minor road approach.
- Horizontal curvature at or near the intersection inhibits intersection sight distance.
- Vertical curvature at or near the intersection inhibits intersection sight distance.

Considerations

- Owners of businesses and homes whose properties and access points will be affected by the realignment should be involved early in the decision-making process to address any concerns.
- Because this treatment is costly, consider lower-cost treatment alternatives first.
- Additional right-of-way may be required.

Industry Standard

AASHTO Green Book
Section 9.4.2: Alignment
Section 9.4.3: Profile

Other Resources

[Innovative Operational Safety Improvements at Unsignalized Intersections, Florida DOT](#)
[NCHRP Report 500 Volume 5: A Guide for Addressing Unsignalized Intersection Collisions](#)
[Intersection Safety: A Manual for Local Rural Road Owners, FHWA](#)





Reduce Intersection Curb Radius

Reconstruction of the edge of traveled way at the intersection to provide a smaller corner radius, which can (1) reduce the turning speeds of right-turning vehicles (or left-turning onto a one-way street), (2) shorten the distance of pedestrian crossings, and (3) improve visibility between motorists and pedestrians.



Source: PEDSAFE (Michael Hintze)

Reducing the curb radius decreases the pedestrian crossing time and distance and forces turning vehicles to slow down.

Targeted Crash Types

- Pedestrian
- Bicyclist

Problems Addressed

- Vehicle conflicts with non-motorists
- Non-compliance with intersection traffic control devices

Conditions Addressed

- Observed vehicles making right-turn movements at high speeds.
- Observed right-turning vehicles failing to comply with STOP (R1-1) sign.
- Crash history or observed conflicts between pedestrians and/or bicyclists and vehicles making right turns.
- Each of the above conditions could also apply to left turns onto a one-way street.

Considerations

- Providing a curb radius that is too small may result in larger vehicles (e.g., trucks and buses) driving over the curb, creating potential for conflicts with pedestrians and bicyclists at the corner and damaging the curb.
- Designs must accommodate emergency vehicles and drainage at the corner.
- A larger “effective” radius can be established when a bicycle lane line, parking lane line, or edge line is used to direct vehicles away from the curb line or edge of pavement.
- Smaller radii will provide for a shorter crossing distance and will place pedestrians in a more visible position before they step into the street.

Industry Standard

AASHTO Green Book

Section 2.1.2: Minimum Turning Path of Design Vehicles

Section 9.6.1: Types of Turning Roadways, Effect of Curb Radii on Pedestrians

Other Resources

[Curb Radius Reduction, PEDSAFE](#)
[Curb Radii Revisions, BIKESAFE](#)





Increase Intersection Curb Radius

Reconstruction of the edge of traveled way at the intersection to provide a larger corner radius, which will better accommodate turning trucks and other large vehicles.

Targeted Crash Types

- Rear-end (major road)
- Rear-end (minor road)
- Sideswipe, opposite direction

Problems Addressed

- Excessive intersection conflicts
- Poor operational performance

Conditions Addressed

- Turning trucks or other large vehicles routinely drive over the curb and onto pedestrian facilities and signs adjacent to the roadway.
- Turning trucks or other large vehicles routinely encroach upon other lanes when completing their maneuver, perhaps causing temporary gridlock or forcing other vehicles to back up or change lanes.

Considerations

- The benefits of providing additional space on the roadway to accommodate large turning vehicles should be weighed against the drawbacks of lengthening the pedestrian crossing.
- While a single circular arc between the edges of pavement of the intersecting roadways provides the simplest design, two alternatives are available for accommodating large vehicles: (1) a three-centered curve, or (2) a simple offset curve with connecting tapers. Each alternative may more closely mimic the turning path of large vehicles.
- If a larger radius is required to accommodate trucks or buses, consider installing a channelizing island with the tail pointing upstream to promote slower right turns. The island should be raised, large enough to accommodate pedestrians, and fully pedestrian-accessible.

Industry Standard

AASHTO Green Book

Section 2.1.2: Minimum Turning Paths of Design Vehicles





Install Raised Intersection

An elevated area encompassing the entire intersection that includes ramps on all approaches. Stamped concrete or other textured and colored materials are often installed within its limits. The height of the intersection typically matches the sidewalk (i.e., back of curb) adjacent to the intersection. This treatment is typically used as part of an overall traffic calming program and where there is a high concentration of pedestrians.

Targeted Crash Types

- Pedestrian
- Bicyclist

Problems Addressed

- Speeding
- Vehicle conflicts with non-motorists

Conditions Addressed

- Crash history or observed conflicts related to speeding on approach to the intersection.
- Crash history or observed conflicts between vehicles and crossing pedestrians and/or bicyclists.
- High volume of crossing pedestrians and/or bicyclists at the intersection.

Considerations

- This treatment is typically applied in urban or residential settings.
- Do not use if intersection is on a sharp curve or steep grade.
- The raised intersection can be disruptive to large vehicles and may slow emergency response vehicles.
- Due to the crosswalk raised to the level of the curb, additional treatments should be placed to accommodate persons with vision impairments, including, tactile warning strips along the entire interface of the walkway and the street.
- Special considerations are needed for drainage.
- Special considerations are needed for snowplows; for example, placing a flexible delineator post at each change in elevation can signal to snowplow operators that they should lift their blades.

Other Resources

[Raised Pedestrian Crossing, PEDSAFE](#)
[Pennsylvania's Traffic Calming Handbook, Pennsylvania DOT](#)
[Traffic Calming Library, ITE](#)

Select Examples

[Granite St. & Pearl St., Cambridge, MA](#)
[Clematis St. & Narcissus Ave., West Palm Beach, FL](#)



Reduce the Width of the Travel Lanes on Major Approach to Intersection

Reduction in lane widths using pavement markings, raised pavement markers, shoulder rumble strips, or some combination thereof; such applications can be effective in reducing vehicle speeds along intersection approaches.



Source: FHWA

The major lanes here were narrowed from 12 ft. to 10 ft., and rumble strips were installed in the median and along the outside of the edge line.



Source: FHWA

This installation features a double yellow line pavement marking and rumble strips fully covering the width of the median.

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Pedestrian
- Bicyclist

Conditions Addressed

- Observations of speeding on approach to the intersection.

Problems Addressed

- Vehicle conflicts with non-motorists
- Speeding

Considerations

- Narrower traffic lanes will provide for wider shoulders for bicyclists and a greater separation between motor vehicles and pedestrians on the sidewalk.
- Pavement markings, raised pavement markings, and rumble strips will require ongoing maintenance.
- Narrowing the lanes may have an adverse effect on capacity and level of service.
- Consider volumes of buses, trucks, and other large vehicles.
- If rumble strips are considered, assess suitability of existing pavement structure to support them. Edge line rumble strips are not conducive to bicycle traffic and may create a noise issue for nearby residents.

Industry Standard

MUTCD

[Chapter 3B. Pavement and Curb Markings](#)

[Section 3J.01: Longitudinal Rumble Strip Markings](#)

AASHTO Green Book

Section 4.3: Lane Widths

Other Resources

[Two Low-Cost Safety Concepts for Two-Way STOP-Controlled, Rural Intersections on High-Speed Two-Lane, Two-Way Roadways, FHWA](#)

[Innovative Operational Safety Improvements at Unsignalized Intersections, Florida DOT](#)

[Low-Cost Safety Enhancements for Stop-Controlled and Signalized Intersections, FHWA](#)

Install Splitter Island on Minor Road Approach

Channelizing island used to separate opposing lanes of traffic and accommodate a left-side STOP (R1-1) sign. This serves to (1) increase awareness of the intersection, (2) guide traffic into the intersection, (3) improve the visibility of the STOP sign on the intersection approach, and (4) provide separation between entering and exiting vehicles.



This grass splitter island creates separation between vehicles entering and exiting the minor road.



A Keep Right sign increases the conspicuity of this splitter island.



A supplemental left-side STOP sign is placed in this splitter island.



Targeted Crash Types

- Right-angle
- Rear-end (minor road)

Problems Addressed

- Inadequate motorist guidance
- Inadequate visibility of intersection or intersection traffic control devices
- Noncompliance with intersection traffic control devices

Conditions Addressed

- Crash history or observed vehicle conflicts related to lack of awareness of intersection or intersection traffic control.
- Crash history or observed vehicle conflicts between vehicles turning from major road and vehicles on minor road approach.
- Limited visibility of standard right side STOP sign.
- High speeds along minor road.

Considerations

- Drainage, truck turning paths, and the size of the median should all be considered in the design of the island.
- Pavement markings, raised reflective pavement markers, and Keep Right (R4-7) signs will enhance the visibility of the raised median and reduce the chance of it being struck by a passing motorist.
- In settings with regular pedestrian traffic, the raised island can serve as a pedestrian refuge and must accommodate pedestrian accessibility.

Industry Standard

MUTCD

[Chapter 3I: Islands](#)

AASHTO Green Book

Section 9.6.3: Islands, Divisional Islands

Select Examples

[Ashe Ave. & Dexter Pl., Raleigh, NC](#)

[Lake Myra Rd. & Eagle Rock Rd., Wendell, NC](#)

Other Resources

[Innovative Operational Safety Improvements at Unsignalized Intersections, Florida DOT](#)

[Low-Cost Safety Enhancements for Stop-Controlled and Signalized Intersections, FHWA](#)

[Intersection Safety: A Manual for Local Rural Road Owners, FHWA](#)

[NCHRP 613: Guidelines for Selection of Speed Reduction Treatments at High-Speed Intersections](#)



Install Left-Turn Lane on Major Road

An auxiliary lane exclusively for the deceleration and storage of left-turning vehicles.



Source: VHB

A left-turn lane removes left-turning vehicles from the through lane.

Targeted Crash Types

- Right-angle
- Opposing left turn
- Rear-end (major road)

Problems Addressed

- Poor operational performance
- Excessive intersection conflicts

Conditions Addressed

- Crash history or observed conflicts between turning vehicles and following vehicles or opposing through vehicles.
- Long queues due to vehicle stopped in through lane waiting to make left turn.
- Vehicle tracks and rutting on right side of road due to through vehicles bypassing left-turning vehicles.
- Heavy left-turn volumes.

Considerations

- Check left-turn warrants (see NCHRP 193 report referenced below).
- For locations with opposing left-turn lanes, consider offsetting the left-turn lanes to improve visibility between turning vehicles and oncoming traffic.
- Adding a turn lane may require additional right-of-way.
- The length of the left-turn lane should be sufficient to accommodate the predominant left-turn storage demand.
- Because the addition of a lane will increase the distance for crossing pedestrians, consider providing a refuge island where appropriate.

Industry Standard

MUTCD

[Section 3B.20 Pavement Word, Symbol, and Arrow Markings](#)

AASHTO Green Book

Section 9.7.3: Design Treatments for Left-Turn Maneuvers

Other Resources

[NCHRP 193: Development of Left-Turn Lane Warrants for Unsignalized Intersections](#)

[NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections](#)

[Intersection Safety: A Manual for Local Rural Road Owners, FHWA](#)

[Safety Effectiveness of Intersection Left- and Right-Turn Lanes, FHWA](#)

Select Examples

[Pheasant Branch Rd. & Co. Rd. K, Middleton, WI](#)

[E. Delilah Rd. & N. Franklin Blvd., Pleasantville, NJ](#)





Extend the Left-Turn Lane

Increasing the length of an existing left-turn lane to provide additional deceleration and storage for turning vehicles.

Targeted Crash Types

- Rear-end (major road)
- Sideswipe, same direction

Problems Addressed

- Poor operational performance
- Excessive intersection conflicts

Conditions Addressed

- Queues in existing left-turn lane extend into adjacent through lane.
- Crash history or observed conflicts between vehicles waiting to turn left and following vehicles.
- High left-turn volume.
- Vehicle tracks and rutting on right side of road due to through vehicles bypassing queued vehicles waiting to turn left.

Considerations

- Extending the lane may require additional right-of-way and utility relocation.
- Check left-turn warrants (see NCHRP 193 reference below).
- The length of the left-turn lane is based on the entering taper, deceleration length, and storage length.

Select Examples

[Capital Blvd. & Paragon Park Rd., Raleigh, NC](#)

Industry Standard

AASHTO Green Book
Section 9.7: Auxiliary Lanes

Other Resources

[NCHRP 193: Development of Left-Turn Lane Warrants for Unsignalized Intersections](#)
[NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections](#)





Install Left-Turn Acceleration Lane

An auxiliary lane that allows left-turning vehicles from the minor road to accelerate along the major road before merging into the through lane.



The photos above show two vantages of the same T-intersection; the top photo shows the major road left-turn lane and channelization, while the bottom photo shows the major road left-turn acceleration lane.

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Sideswipe, same direction

Problems Addressed

- Poor operational performance
- Misjudgment of gaps

Conditions Addressed

- Crash history or observed conflicts on major road due to speed differential between entering vehicle and through vehicles.
- High left-turn volume onto high-speed or high-volume major road.
- Crash history or observed conflicts from high volume of trucks or recreational vehicles turning left onto a higher-speed roadway.
- Significant delay for left-turning minor road traffic waiting for a suitable gap on the major road.
- Promotes a two-stage left turn onto the major road.

Considerations

- Acceleration lanes that are poorly marked or too long may confuse drivers along the major road and appear as an additional through lane.
- If left-turn acceleration lanes are considered a new treatment for a community, a public meeting or information campaign may be needed to introduce citizens to this treatment.
- If narrower lanes are typically used, consider increasing the width of the acceleration lane to 14 feet to better accommodate the motorists turning from the side street.
- Because the addition of a lane will increase the distance for crossing pedestrians, consider a refuge island where appropriate.
- May not be practical if there are driveways and intersections spaced within the acceleration lane that would conflict with left-turn movements into those access points.

Other Resources

[NCHRP Report 650: Median Intersection Design for Rural High-Speed Divided Highways](#)
[Innovative Operational Safety Improvements at Unsignalized Intersections, Florida DOT](#)
[NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections](#)
[Chapter 5: At-Grade Intersections, Road Design Manual, Minnesota DOT](#)

Industry Standard

MUTCD
[Section 3B.04 White Lane Line Pavement Markings and Warrants](#)
[Section 3B.20 Pavement Word, Symbol, and Arrow Markings](#)
AASHTO Green Book
 Section 9.7: Auxiliary Lanes

Select Examples

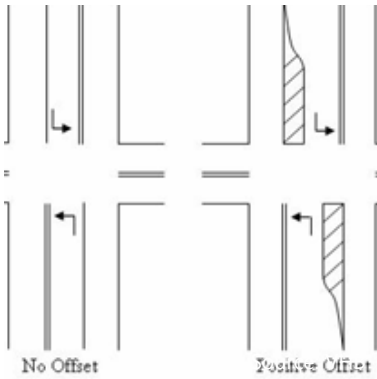
[61st Ave. & Happy Valley Rd., Phoenix, AZ](#)
[Periwinkle Way & Donax St., Sanibel, FL](#)
[Cabrillo Hwy. & Santa Lucia Canyon Rd., Lompoc, CA](#)
[Arendel St. & Tom Mann Rd., Newport, NC](#)





Provide Offset Left-Turn Lanes

Separating opposing left-turn lanes from their adjacent same-direction through lanes via a parallel or tapered offset to improve the left-turning drivers' visibility of opposing through and right-turning traffic.



Source: FHWA

This diagram illustrates the difference between left-turn lanes with no offset and those with positive offset.



Source: Lee Engineering, LLC

This offset left-turn lane provides space for an additional STOP sign.



Source: VHB

Offset has been provided at the end of this left-turn lane along a multilane median-divided roadway.



Targeted Crash Types

- Right-angle
- Opposing left turn
- Rear-end (major road)
- Sideswipe, opposite direction
- Head-on

Problems Addressed

- Inadequate intersection sight distance
- Misjudgment of gaps

Conditions Addressed

- Poor sight distance of oncoming traffic due to presence of opposing left-turning vehicles or landscaping in the median.
- Crash history or observed conflicts between left-turning and opposing through vehicles.
- Opposing left-turn maneuvers overlap (e.g., left-turning vehicles cross paths).

Considerations

- Requires adequate median width to provide offset; narrowing of existing through lanes may provide some or all of the necessary width.
- The width of the intersection may increase with the addition of the offset, resulting in a longer crossing distance for pedestrians.
- The paint caret to create the left-turn offset may be used to accommodate an additional in-street (or median) STOP (R1-1) sign for wide street approaches. If STOP signs are placed in the street, breakaway posts should be used.

Select Examples

- [1st St. & Fillmore St., Phoenix, AZ](#)
- [North Point Blvd. & Republic Square Drv./Service Rd., Winston-Salem, NC](#)

Industry Standard

- *AASHTO Green Book*
- Section 9.7.3: Design Treatments for Left-Turn Maneuvers, Offset Left-Turn Lanes

Other Resources

- [Innovative Operational Safety Improvements at Unsignalized Intersections, Florida DOT](#)
- [Intersection Safety: A Manual for Local Rural Road Owners, FHWA](#)
- [NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections](#)



Install Right-Turn Lane along Major Road

An auxiliary lane (or taper) exclusively for the deceleration and storage of right-turning vehicles.



Source: VHB



Source: VHB

Right-turn lanes can help alleviate rear-end crashes in rural areas such as these, where turns are less expected.



Source: Lee Engineering, LLC

This urban right-turn lane has been installed along a stop-controlled approach.

Targeted Crash Types

- Rear-end (major road)

Problems Addressed

- Poor operational performance
- Excessive intersection conflicts

Conditions Addressed

- Crash history or observed conflicts between right-turning vehicles and following vehicles.
- Significant right-turn volume along major road.

Considerations

- Adding a lane may require additional right-of-way and utility relocation.
- Because the addition of a right-turn lane will increase the crossing distance for pedestrians, consider a refuge island when appropriate.
- Check that the sight triangle remains clear.
- Channelize the right turn for an increased turning radius with the option of creating a free-flowing right turn under yield control, though not recommended for areas with moderate to high pedestrian crossings.

Industry Standard

MUTCD

[Section 3B.20 Pavement Word, Symbol, and Arrow Markings](#)

AASHTO Green Book

Section 9.7: Auxiliary Lanes

Other Resources

[NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections](#)
[Intersection Safety: A Manual for Local Rural Road Owners, FHWA](#)
[Safety Effectiveness of Intersection Left- and Right-Turn Lanes, FHWA](#)

Select Examples

[Pleasant Ridge Rd. & Highland Grove Rd., Summerfield, NC](#)
[Fairbanks Dr. & Clarks Branch Dr., Raleigh, NC](#)





Extend the Right-Turn Lane

Increase the length of an existing right-turn lane to provide additional deceleration and storage area for turning vehicles.

Targeted Crash Types

- Rear-end (major road)

Problems Addressed

- Poor operational performance
- Excessive intersection conflicts

Conditions Addressed

- Right-turning vehicles frequently impede through traffic despite the existing right-turn lane.
- Crash history or observed conflicts between vehicles turning right and following vehicles.
- High right-turn volume.
- High speeds on major road.

Considerations

- Extending the lane may require additional right-of-way and utility relocation.
- Length of right-turn lane is based on the entering taper, deceleration length, and storage length.

Industry Standard

AASHTO Green Book
Section 9.7: Auxiliary Lanes

Other Resources

[NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections](#)





Install a Right-Turn Acceleration Lane

An auxiliary lane that allows right-turning vehicles from the minor road to accelerate along the major road before merging into the through lane.

Targeted Crash Types

- Right-angle
- Rear-end (major road)

Problems Addressed

- Excessive intersection conflicts
- Poor operational performance

Conditions Addressed

- Crash history or observed conflicts due to speed differential of entering right-turn vehicles and through vehicles.
- High right-turn volumes onto major road.
- High running speeds on major road.
- Crash history or observed conflicts involving trucks or other large vehicles entering higher-speed major road.

Considerations

- Acceleration lanes that are poorly marked or too long may confuse other drivers and appear as an additional through lane.

Industry Standard

AASHTO Green Book
Section 9.7: Auxiliary Lanes

Select Examples

[US 13 & US 264 Alt., Farmville, NC](#)

Other Resources

[NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections](#)





Provide Offset Right-Turn Lane

Separation of the right-turn lane from adjacent through lane via a parallel or tapered offset to improve the sight distance for drivers stopped at the minor road approach.



An offset right-turn lane can help improve poor sight distance for drivers stopped on the minor road approach.

Targeted Crash Types

- Right-angle
- Rear-end (major road)

Problems Addressed

- Inadequate intersection sight distance
- Excessive intersection conflicts

Conditions Addressed

- Poor sight distance of oncoming traffic from minor road approach due to presence of right-turning vehicles.
- History of crashes involving minor road drivers whose vantage was blocked by right-turning vehicles on the major road.

Considerations

- The width of the intersection may increase with the addition of the offset, resulting in a longer crossing distance for pedestrians.
- Ensure that the sight triangle remains clear. The lane should be moved far enough to the right so as not to obstruct the view of oncoming traffic for the minor road driver.
- Through lane widths may be narrowed to provide accommodate right-turn offset.
- Should not be needed where on-street bike lanes exist.

Industry Standard

MUTCD

[Section 3B.04 White Lane Line Pavement Markings and Warrants](#)

AASHTO Green Book

Section 9.3: Types and Examples of Intersections

Other Resources

[NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections](#)

Select Examples

[US 18 & US 218, Floyd, IA](#)

[US 218 & C57, Cedar Falls, IA](#)

[US 54 & Rte. D, Jefferson City, MO](#)





Install Bypass Lane at T-Intersection

Installation of additional pavement at three-legged (T) intersection to allow through vehicles to maneuver around left-turning vehicles on the major road.



Source: VHB

A bypass lane allows a through vehicle to pass a slowing or stopped left-turning vehicle.

Targeted Crash Types

- Rear-end (major road)

Problems Addressed

- Poor operational performance
- Excessive intersection conflicts

Conditions Addressed

- Crash history or observed conflicts between left-turning vehicles and following vehicles.
- Long queues on major road due to through vehicles waiting for a vehicle to turn left.
- Heavy left-turn volume.
- Observed through drivers overtaking left-turning vehicles on right side of road.

Considerations

- Shoulder area should be structurally suitable to withstand repeated use by vehicles and possibly trucks.
- Additional right-of-way may be required.
- Striping must be implemented for driver guidance on the shoulder, and if the shoulder is used as a bypass lane, motorists will be travelling along the edge of the pavement.

Select Examples

[MD 194 \(Francis Scott Key Hwy.\) & Brown Rd., Taneytown, MD](#)

[Norris Lake Rd. NW & Nowthen Blvd. NW, Elk River, MN](#)

[SR 177 & SR 4, Alta Vista, KS](#)

Other Resources

[Intersection Safety: A Manual for Local Rural Road Owners, FHWA](#)

[NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections](#)

[Minnesota's Best Practices and Policies for Safety Strategies on Highways and Local Roads, Minnesota DOT](#)



Provide Pedestrian Refuge Island

Installation of raised island within a roadway that provides an area for pedestrians to wait before crossing the remainder of the roadway, allowing pedestrians to make a two-stage crossing.



The refuge island allows pedestrians to make this multilane crossing in two stages.



This refuge island aids pedestrians crossing the two-lane urban arterial.



Pedestrian crossing this minor road approach can take refuge in the channelizing island.

Targeted Crash Types

- Pedestrian
- Bicyclist

Problems Addressed

- Vehicle conflicts with non-motorists

Conditions Addressed

- Crash history or observed conflicts between vehicles and pedestrians.
- Heavy pedestrian traffic crossing the major road.
- Crossings that span multiple lanes of traffic.
- Poor visibility between oncoming drivers and pedestrians waiting to cross the road.
- Reduced exposure for crossing pedestrians is desired.
- Observed difficulty of pedestrians finding safe gaps in traffic to cross road.

Considerations

- Island design should accommodate pedestrians with disabilities and should provide pedestrians with a clear path through the island.
- FHWA recommends 4 feet as minimum width (and 8 feet as preferred minimum width).
- Include appropriate signing and pavement markings to make the island and crossing visible to motorists.
- Appropriate detectable warning features (i.e., dome detectable warning strips of contrasting color) should be incorporated at each interface of the island and roadway surface to serve persons with visual impairment.

Industry Standard

MUTCD

[Section 3I.06: Pedestrian Islands and Medians](#)

AASHTO Green Book

Section 9.6.3: Islands

Other Resources

[Crossing Islands, PEDSAFE](#)

[NCHRP 562 & TCRP 112: Improving Pedestrian Safety at Unsignalized Intersections](#)

[Median Handbook, FDOT](#)

[FHWA Proven Safety Countermeasures](#)

Select Examples

[Myrtle Ave. & Sixth St., Eureka, CA](#)

[Marshland Rd. & Mathews Dr., Hilton Head Island, SC](#)



Install a Roundabout

A form of circular intersection in which vehicles travel counterclockwise around a central island and entering traffic must yield to circulating traffic.

Targeted Crash Types

- Right-angle
- Opposing left turn

Problems Addressed

- Speeding
- Excessive intersection conflicts
- Inappropriate intersection traffic control
- Poor operational performance

Conditions Addressed

- Consider as an alternative to signalization.
- High crash frequency or severity, resulting in a need to reduce conflict points at the intersection.
- Congestion related to high numbers of left-turning vehicles.

Considerations

- May require additional right-of-way to construct a radius that accommodates a large design vehicle.
- Best at intersections having relatively balanced approach volumes or high numbers of left-turning traffic.
- Incorporating splitter islands and horizontal deflection into the design of the approach legs is key so that traffic entering the circular roadway is naturally encouraged to decrease its speed.
- Consider sight distance for all approaches when designing the aesthetics in the center. Truck aprons are also typically needed to accommodate off-tracking.
- Where dual approach or departure lanes exist, alternate accommodations are sometimes incorporated for visually-impaired pedestrians; these may include signals, PHBs, RRFBs, or raised crosswalks.
- In areas where roundabouts are uncommon, public involvement and education are necessary components for project success.

Industry Standard

MUTCD

[Sections 2B.43 Roundabout Directional Arrow Signs](#)

[Section 2B.44 Roundabout and Circulation Plaque](#)

[Section 2B.45 Examples of Roundabout Signing](#)

[Chapter 3C. Roundabout Markings](#)

AASHTO Green Book

Section 9.3.4: Roundabouts

Section 9.10: Roundabout Design

Other Resources

[NCHRP 672: Roundabouts: An Informational Guide, FHWA](#)

[Innovative Operational Safety Improvements at Unsignalized Intersections, Florida DOT](#)

[NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections](#)

[NCHRP 613: Guidelines for Selection of Speed Reduction Treatments at High-Speed Intersections](#)

[Evaluating the Performance and Safety Effectiveness of Roundabouts, Michigan DOT](#)

[Roundabouts, PEDSAFE](#)

Select Examples

[Old Bethlehem Pk. & Station Rd., Quakertown, PA](#)

[VIDEO: Old Bethlehem Pk. & Station Rd., Quakertown, PA](#)

[Ulysses St. & S. Golden Rd., Golden, CO](#)

[E. Kings Hwy. & S. Pierce St., Eden, NC](#)

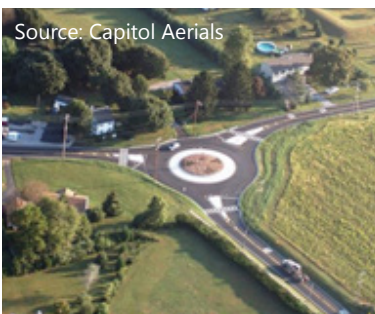


Source: PennDOT

This aerial photograph shows an urban, four-legged roundabout.



Critical guidance is provided through pavement markings along this multilane approach.



Source: Capitol Aerials

This aerial photograph shows a rural, three-legged roundabout.



Install a Mini-Roundabout

Similar to a larger roundabout with a circular roadway in which all approaches operate under yield control and traffic moves in a counterclockwise direction. Mini-roundabouts are typically constructed within the existing right-of-way of low-speed urban or suburban environments and may feature a traversable center island and splitter islands that channelize vehicles onto the circular roadway.



Source: VHB

The striping on the center island of this mini-roundabout enhances low-light visibility.



Source: Lee Engineering, LLC

The pedestrian accommodations at this mini-roundabout are quite similar to a full-size modern roundabout.



Source: VHB

This center island of this three-legged mini-roundabout is fully traversable.



Targeted Crash Types

- Right-angle
- Opposing left turn

Problems Addressed

- Speeding
- Excessive intersection conflicts
- Inappropriate intersection traffic control
- Poor operational performance

Conditions Addressed

- Crash history or observed conflicts related to speeding through the intersection.
- An alternative to all-way stop control at intersections characterized by low speeds, low volumes, and few heavy vehicles.
- Locations with limited right-of-way.
- Breaks up long streets and provides traffic calming for pedestrians and bicyclists.

Considerations

- Design should minimize driving over the mountable center island as much as possible.
- Diameter may not be sufficient to accommodate U-turn maneuvers of large vehicles that are possible at larger roundabouts. Some agencies have allowed the left turn in front of the mini roundabout for emergency vehicles or long vehicles (trucks, buses, or vehicles pulling trailers).
- Splitter islands on approaches to mini-roundabouts may comprise of pavement markings only.
- Proper deflection of the approaching vehicle will encourage slower speeds through the intersection.
- A raised center island can be visually enhanced during low-light conditions through striped-pattern pavement markings on its center island.
- Should include YIELD (R1-2) signs—and not STOP (R1-1) signs—on all approaches.

Industry Standard

MUTCD

[Sections 2B.43 Roundabout Directional Arrow Signs](#)

[2B.44 Roundabout and Circulation Plaque](#)

[2B.45 Examples of Roundabout Signing Chapter 3C. Roundabout Markings](#)

AASHTO Green Book

Section 9.3.4: Roundabouts

Section 9.10: Roundabout Design

Other Resources

[NCHRP 672: Roundabouts: An Informational Guide, FHWA](#)
[Mini-Roundabouts, FHWA](#)

Select Examples

[E Cholla St. & N. 68th St., Phoenix, AZ](#)
[Woodmill Dr. & Mifflin Rd., Dover, DE](#)

Install a Residential Traffic Circle

Comprises a circular raised center island at the intersection of two neighborhood streets and is installed for traffic calming or aesthetic purposes. Unlike a mini-roundabout, a residential traffic circle is typically characterized by (1) a non-traversable center island, (2) no splitter islands on the intersection approaches, and (3) either yield control or no control.



Source: Lee Engineering, LLC

The large, landscaped center island provides a traffic calming effect along this wide and straight residential street.



Source: City of Seattle

This traffic circle is characterized by no control on the approaches and a large tree in the center island.



Source: Lee Engineering, LLC

This traffic circle incorporates signing in its center island.

Targeted Crash Types

- Right-angle

Problems Addressed

- Speeding

Conditions Addressed

- Crash history or observed conflicts related to speeding through the intersection.
- An alternative to all-way stop control.
- Can be a key element of a comprehensive street calming program.

Considerations

- Small intersection curb radii complement this treatment to discourage high-speed right turns.
- Larger vehicles (e.g., school buses, emergency vehicles) may need to make left turns in front of the circle to avoid encroaching upon the island.
- Agencies (or homeowner associations) must maintain the landscaping. Ensure that any landscaping in the middle of the circle does not impede sight distance.
- Provide adequate signing (see MUTCD for details).

Industry Standard

MUTCD

[Sections 2B.43 Roundabout Directional Arrow Signs](#)
[2B.44 Roundabout and Circulation Plaque](#)

[2B.45 Examples of Roundabout Signing](#)

[Chapter 3C. Roundabout Markings](#)

AASHTO Green Book

Section 9.3.4: Roundabouts

Other Resources

[Mini-Circles, PEDSAFE](#)

[Mini-Circles, BIKESAFE](#)

[NCHRP Report 672 – Roundabouts: An Informational Guide](#)

Select Examples

[E. Chaparral Rd. & N. 70th Pl., Scottsdale, AZ](#)

[NE 62nd St. & 29th Ave. NE, Seattle, WA](#)

Install Curb Extensions at the Crosswalk

A sidewalk extension (also known as a bulb-out) into the intersection at a crosswalk. This reduces the pedestrian crossing distance and shortens their exposure time with regard to traffic.



The curb extensions at this intersection promote improved sight lines between pedestrians and approaching drivers.

Targeted Crash Types

- Pedestrian

Problems Addressed

- Speeding
- Vehicle conflicts with non-motorists

Conditions Addressed

- Crash history or observed conflicts between vehicles and pedestrians.
- High pedestrian traffic across the road.
- Poor visibility of oncoming traffic for pedestrians waiting to cross the road.
- Reduces pedestrian exposure when crossing the road.
- When provided along a stop-controlled approach, this treatment allows for improved placement of STOP (R1-1) signs that are more visible to motorists.

Considerations

- Ensure design accommodates buses and other larger vehicles turning at the intersection.
- Curb ramps should be designed to comply with ADA requirements.
- Typically applied where on-street parking is permitted.
- Design must include proper drainage measures.

Other Resources

[NCHRP 562 & TCRP 112: Improving Pedestrian Safety at Unsignalized Intersections](#)
[Curb Extensions, PEDSAFE](#)

Select Examples

[SW Ellsworth St. & SW 5th Ave., Albany, OR](#)
[Old San Carlos Blvd. & Third St., Fort Myers Beach, FL](#)
[Patton Ave. & College St., Asheville, NC](#)

Restrict Driveway Access

Limiting access to and from driveways within the effective influence area of the intersection. Access may be restricted through raised medians, signing, channelizing islands, or a combination of these treatments.



Source: VHB

A No Left Turn sign and channelizing island are used to restrict left turns from this driveway, which is located less than 150 feet from a four-legged intersection.

Targeted Crash Types

- Right-angle
- Rear-end (major road)

Problems Addressed

- Excessive intersection conflicts
- Poor operational performance

Conditions Addressed

- Crash history or observed conflicts involving vehicles turning into or out of driveways near an intersection.
- Can be effective to channelize vehicles entering and egressing businesses and private driveways, particularly where there is a wide area of adjoining pavement.

Considerations

- Ensure that alternative access driveways can safely accommodate ingress and egress.
- Include stakeholders during planning stages, especially those businesses or residents who may be affected by the limited access.
- Compliance may be low if the restrictions are implemented using signs alone.
- Driveway diverters need to be fully pedestrian accessible.
- Painting raised curbs and island faces can make them more visible to motorists.
- May be implemented as part of a comprehensive corridor access management plan.

Industry Standard

MUTCD

[Section 2B.18: Movement Prohibition Signs](#)

[Section 3H.01 Channelizing Devices](#)

[Chapter 3I. Islands](#)

AASHTO Green Book

Section 2.5: Access Control and Access Management

Other Resources

[NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections Access Management in the Vicinity of Intersection, FHWA](#)

Select Examples

[Poor Boy Farm Rd. & Smithfield Rd., Knightdale, NC](#)

[NC 86 & Saw Mill Rd., Hillsborough, NC](#)

[SR 1752 & SR 1529, Lumberton, NC](#)



Clear Intersection Sight Triangles

Removal of overgrown foliage or other objects (e.g., signs, vehicular parking, utility poles, fences) obstructing the sight triangle without involving major construction.



Source: Lee Engineering, LLC



Source: Lee Engineering, LLC

In both images, sight triangles were improved by creating a buffer area between the approaching through lane and near edge of roadway.



Source: VHB

Site distance could be improved at this intersection by trimming the vegetation.

Targeted Crash Types

- Right-angle
- Rear-end (major road)

Problems Addressed

- Inadequate intersection sight distance
- Inadequate visibility of intersection or intersection traffic control devices

Conditions Addressed

- Inadequate sight distance at intersection due to obstructions in the sight triangle (in the median or on the roadside).
- Crash history or observed conflicts due to inadequate sight distance.

Considerations

- Removal of obstructions on private property will require coordination with property owners.
- Agency policy or local ordinances regarding planting and landscaping features on property corners should be reviewed, revised as necessary, and enforced.
- The position of the minor road stop line may be adjusted to improve visibility from the minor road approach.
- If adequate sight distance cannot be maintained, consider appropriateness of an all-way stop condition.

Industry Standard

AASHTO Green Book
Section 9.5.2: Sight Triangles

Other Resources

[NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections](#)
[Intersection Safety: A Manual for Local Rural Road Owners, FHWA](#)





Eliminate Parking at or near the Intersection

Restricting vehicular parking that inhibits intersection sight distance to enhance sight lines between drivers and pedestrians.



Source: VHB

Enforcement may be necessary to ensure compliance with parking regulations.



Source: VHB

Eliminating parking helps drivers see oncoming traffic from both directions of the major road.

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Pedestrian

Problems Addressed

- Inadequate intersection sight distance
- Inadequate visibility of intersection or intersection traffic control devices
- Vehicle conflicts with non-motorists

Conditions Addressed

- Inadequate sight distance from minor road approaches due to parked vehicles on major or minor roads.
- Crash history or observed conflicts related to obstructed view from parked vehicles.
- Parked vehicles regularly obstruct view of intersection traffic control devices.
- Poor visibility between crossing pedestrians and drivers.

Considerations

- Pavement markings and signing are the basic devices to delineate the restricted area. Although more costly, physical restrictions (e.g., use of curb to eliminate parking area) can be more effective.
- Affected property owners should be consulted prior to removing parking along their property frontage.
- Parking restrictions may need to be enforced.
- Minor approach stop lines may be adjusted for improved side-street visibility, but pedestrian crosswalks must be considered when placing stop line.
- If stop or yield lines are used at a crosswalk of an uncontrolled multilane approach, parking should be prohibited in the area between the stop or yield line and the crosswalk.

Industry Standard

MUTCD

[Sections 2B.46 Parking, Standing, and Stopping Signs, 2B.47 Design of Parking, Standing, and Stopping Signs, and 2B.48 Placement of Parking, Stopping, and Standing Signs](#)

[Sections 3B.15 Transverse Markings, 3B.16 Stop and Yield Lines, and 3B.19 Parking Space Markings](#)

AASHTO Green Book

Section 9.5.2: Sight Triangles

Other Resources

[Parking Restrictions \(at Crossing Locations\), PEDSAFE](#)

[NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections](#)

Select Examples

[S. Park St. & E. Commerce St., Greenville, AL](#)

[Main St. & N. First Ave., Knightdale, NC](#)





Install Transverse Rumble Strips on the Intersection Approach

Application of depressions or raised areas across the surface of an approach lane to produce an audible and tactile warning of the impending intersection.



Source: VHB

Raised transverse rumble strips warn drivers on this approach of the upcoming intersection.



Source: VHB

Transverse rumble strips are installed ahead of this yield-controlled intersection.



Source: VHB

Transverse rumble strips are applied along this multilane stop-controlled approach.

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Rear-end (minor road)

Problems Addressed

- Inadequate visibility of intersection or intersection traffic control devices
- Speeding

Conditions Addressed

- Crash history or observed conflicts due to lack of awareness of the intersection.
- Citation history or observations of speeding on approach to intersection.

Considerations

- Use in combination with Intersection Warning (W2-1 through W2-8), Advance Traffic Control (W3-1 or W3-2), or Pedestrian Crossing (W11-2) signs.
- Noise generated from vehicles traversing the rumble strips can be an issue when residences are in close proximity to the intersection.
- Can require significant maintenance activities, especially on approaches characterized by high volumes of truck traffic.
- Raised rumble strips should not be used in areas where snowplowing is conducted.

Industry Standard

MUTCD

[Section 3J.02: Transverse Rumble Strip Markings](#)

Select Examples

[Crest Rd. & Allen Rd., East Flat Rock, NC](#)

[County Road 833 & FL 80, Clewiston, FL](#)

Other Resources

[Innovative Operational Safety Improvements at Unsignalized Intersections, Florida DOT](#)

[Low-Cost Safety Enhancements for Stop-Controlled and Signalized Intersections, FHWA](#)

[Intersection Safety: A Manual for Local Rural Road Owners, FHWA](#)

[NCHRP 613: Guidelines for Selection of Speed Reduction Treatments at High-Speed Intersections](#)





Install High-Friction Surface Treatment on Intersection Approach

Application of epoxy and aggregate combination to pavement to increase the surface friction of the roadway.



Source: FHWA

Above is a close-up view of a typical aggregate used in high-friction surface treatments.

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Rear-end (minor road)

Problems Addressed

- Non-compliance with intersection traffic control devices

Conditions Addressed

- Crash history related to skidding vehicles and/or wet-weather crashes.
- Observed braking difficulties during wet conditions.
- High-speed approaches.

Considerations

- Length of treated section will depend on sight distance, queue lengths, and approach speed.
- Pavement markings will need to be reapplied after surface friction treatment is applied.

Other Resources

[Low-Cost Safety Enhancements for Stop-Controlled and Signalized Intersections, FHWA](#)

[A Road Surface Treatment for Critical Safety Spot Locations that Helps Vehicles Stay in Their Lane, FHWA](#)





Install Intersection Lighting

Installation of street lamps to illuminate the intersection at night.



Source: VHB
Intersection lighting improves nighttime visibility of pedestrians.



Source: VHB
Awareness of this intersection among major road drivers is increased by the street lighting.

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Rear-end (minor road)
- Pedestrian
- Bicyclist

Conditions Addressed

- History of nighttime crashes.
- Poor nighttime visibility of the intersection.
- Poor nighttime visibility of crossing pedestrians and/or bicyclists.

Problems Addressed

- Inadequate visibility of intersection or intersection traffic control devices
- Vehicle conflicts with non-motorists

Considerations

- Remote areas may be isolated from a power source.
- Especially helpful for intersections near parks, churches, schools, hospitals/clinics, and other facilities associated with nighttime activities.
- Provide adequate lighting for crossing pedestrians; wide streets may require lighting on both sides of the crosswalk.
- Consult local policies or legal code statutes on lighting.

Industry Standard

AASHTO Green Book
Section 3.6.3: Lighting (General)
Section 7-52: Lighting (Rural and Urban Arterials)
Section 9.11.5: Lighting (Intersections)

Other Resources

[Reducing Late-Night/Early-Morning Intersection Crashes by Providing Lighting, FHWA](#)
[Lighting and Illumination, PEDSAFE](#)
[Cost Effective Local Road Safety Planning and Implementation, NACE](#)
[Intersection Safety: A Manual for Local Rural Road Owners, FHWA](#)



Relocate Bus Stop

Repositioning of a bus stop near an intersection due to sight distance obstruction or congestion or conflicts caused by the bus, or to accommodate safer pedestrian crossings.



Source: VHB

This pedestrian's vision of traffic approaching in the adjacent lane is blocked by the bus she just exited.



Source: VHB

This bus stop is located on the near side of the stop-controlled intersection because there is no sidewalk on the far side.

Targeted Crash Types

- Pedestrian
- Right-angle

Problems Addressed

- Inadequate intersection sight distance
- Excessive intersection conflicts
- Vehicle conflicts with non-motorists

Conditions Addressed

- Crash history or observed conflicts caused by poor visibility of oncoming traffic due to location of bus stop.
- Existing bus stop is not wheelchair accessible.
- Unsafe location for pedestrians to cross the road at the bus stop.

Considerations

- Ensure that suitable access to and from the new transit stop location is provided in accordance with the Americans with Disabilities Act.
- Provide adequate space to load and unload wheelchairs.
- If a power source is available, consider provide lighting at bus stop for personal security and bus operator visibility.
- A far-side bus stop location is typically preferred for improved intersection visibility and vehicle operation. Pedestrians should be encouraged to cross behind the bus.

Industry Standard

AASHTO Green Book
Section 4.19: Bus Turnouts

Other Resources

[Access to Transit, PEDSAFE](#)
[Transit Stop Improvements, PEDSAFE](#)



Conduct Targeted STOP Sign Enforcement

The law enforcement practice of detecting and citing motorists who fail to stop at a STOP (R1-1) sign.

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Pedestrian
- Bicyclist

Conditions Addressed

- Crash history related to or observed instances of noncompliance with STOP signs.

Problems Addressed

- Noncompliance with intersection traffic control devices

Considerations

- Targeted sites should be selected based on crash experience or citizen complaints related to STOP sign violations.
- The public should be informed about the reasons for the targeted enforcement and site selection through public information materials and educational outreach.
- Limited police resources should be assigned to locations based on perceived safety risks and needs.
- Both the highway and the law enforcement agencies should be involved in the planning of the enforcement effort.
- If the site was selected as a result of public complaints, the police should follow up with the requesting citizen or citizen group.

Other Resources

[NCHRP Report 500 Volume 5: A Guide for Addressing Unsignalized Intersection Collisions](#)
[Police Enforcement, PEDSAFE](#)





Conduct Automated STOP Sign Enforcement

The law enforcement practice of detecting and citing motorists who fail to stop at a STOP (R1-1) sign using automated camera technology. Typically, this involves a camera that automatically captures a video clip of a noncompliant vehicle when sensors perceive that the vehicle has not stopped before entering the intersection.



Source: Capt. Glenn Hansen



Source: Capt. Glenn Hansen

Both photos above show vantages of the same automated STOP sign enforcement camera.

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Pedestrian
- Bicyclist

Conditions Addressed

- Crash history related to or observed instances of noncompliance with STOP signs.

Problems Addressed

- Noncompliance with intersection traffic control devices

Considerations

- Clearly identify the safety problem caused by STOP sign violations in the community.
- Consider traditional enforcement before initiating automated enforcement.
- Review site conditions to confirm that engineering measures are correct (e.g., STOP sign is visible and placed correctly) before implementing automated enforcement.
- Review the state and local jurisdiction's legislation on the use of automated enforcement.
- Inform the public of the intent to implement and explain why it is being used.

Select Examples

[Temescal Canyon Rd., Los Angeles, CA](#)

Other Resources

[DC Street Safe: Stop Signs, Metropolitan Police Department](#)
[Automated Enforcement Systems, PEDSAFE](#)





Conduct Targeted Speed Enforcement

The practice by law enforcement officers of detecting and citing speeding motorists at locations identified as having frequent speeding. Detection methods may include the use of radar or laser devices or vehicle pacing.

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Pedestrian
- Bicyclist

Conditions Addressed

- Crash history or observed conflicts related to speeding at or near the intersection.

Problems Addressed

- Speeding

Considerations

- Selection of targeted locations may be based on crash history, citizen complaints, or prior enforcement history.
- Inform the public of the intent to implement and explain why it is being used.
- Enforcement should be part of a speed management program and should involve both highway and law enforcement agencies in the planning of the enforcement effort and selection of enforcement sites.
- If the site was selected as a result of public complaints, police should follow up with the requesting citizen or citizen group.

Other Resources

[Speed Management: A Manual for Local Rural Road Owners, FHWA](#)

[Speed Management Safety, FHWA](#)

[NCHRP Report 500 Volume 5: A Guide for Addressing Unsignalized Intersection Collisions](#)





Conduct Automated Speed Enforcement

The use of camera-based technology to automatically detect speeding vehicles and record identifying information about the vehicle and/or driver.



Source: Lee Engineering, LLC

This SUV is deployed for automated speed enforcement through photos.



Source: Lee Engineering, LLC

This Photo Enforcement Zone sign notifies approaching drivers of the automated speed enforcement ahead.



Source: VHB

These speed enforcement cameras are positioned in advance of a pedestrian crossing of the uncontrolled major road at the unsignalized intersection ahead.

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Pedestrian
- Bicyclist

Conditions Addressed

- Crash history or observed conflicts related to speeding at or near the intersection.

Problems Addressed

- Speeding

Considerations

- Clearly identify if excessive speed is a safety problem in the community.
- Inform the public of the intent to implement and explain why it is being used.
- Enforcement should be part of a speed management program and should involve both highway and law enforcement agencies in the planning of the enforcement effort and selection of enforcement sites.
- Consider traditional enforcement before initiating automated enforcement.
- Review the state and local jurisdiction's legislation on the use of automated enforcement.
- If the site was selected as a result of public complaints, police should follow up with the requesting citizen or citizen group.

Other Resources

[Speed Management: A Manual for Local Rural Road Owners, FHWA](#)

[Speed Management Safety, FHWA](#)

[NCHRP Report 729: Automated Enforcement for Speeding and Red Light Running](#)

