

PEDESTRIAN & BICYCLE SAFETY STRATEGIES

Category A: Improvements Along the Roadway

- A1 - Provide sidewalks, walkways, and paved shoulders
- A2 - Provide street furniture and a secure walking environment
- A3 - Fill sidewalk gaps
- A4 - Add shared use paths
- A5 - Install speed feedback signs
- A6 - Install speed limit pavement markings
- A7 - Provide dedicated pedestrian, bicycle and/or transit lanes

Category B: Geometric Improvements at Crossing Locations

- B1 - Install marked crosswalks or enhance existing crosswalks*
- B2 - Provide bulb-out curbs*
- B3 - Provide crossing islands*
- B4 - Provide raised crossings for pedestrians and cyclists*
- B5 - Restrict on-street parking near crossing locations*
- B6 - Install a pedestrian overpass or underpass
- B7 - Extend median nose past crosswalk
- B8 - Relocate crosswalk to improve visibility of pedestrians
- B9 - Reduce corner radii to encourage lower turning speeds
- B10 - Modify curb corners to provide each crosswalk its own ramp
- B11 - Install a hardened centerline at intersections
- B12 - Reduce width of driveways
- B13 - Provide adequate crossing facilities at existing roundabout entries

Category C: Transit-Related Improvements

- C1 - Transit stop improvements
- C2 - Increase access to transit services

Category D: Bicycle Facilities

- D1 - Install marked bicycle lanes or enhance existing bicycle lanes
- D2 - Increase bicycle lane width
- D3 - Pave shoulders
- D4 - Install colored bicycle lanes at signalized intersections
- D5 - Provide separated bicycle facilities
- D6 - Provide bicycle boxes at intersections
- D7 - Install in-road bike lanes
- D8 - Implement a protected intersection
- D9 - Implement keyhole bike lanes
- D10 - Provide bike lanes, cycle track, or grade-separated bike path at roundabouts

Category E: Sign and Signal Improvements

- E1 - Install traffic signals
- E2 - Install or enhance pedestrian signals
- E3 - Improve pedestrian signal timing
- E4 - Restrict right-turns-on-red
- E5 - Install a Pedestrian Hybrid Beacon (PHB)*
- E6 - Install Rectangular Rapid Flashing Beacons (RRFBs)*
- E7 - Install a Pedestrian User Friendly Intelligent Intersection (PUFFIN) Crossing
- E8 - Install advance pedestrian warning signs*
- E9 - Install in-street pedestrian crossing signs*
- E10 - Install in-crosswalk lighting
- E11 - Install LED flashing signs
- E12 - Install automated pedestrian detection
- E13 - Implement a Leading Pedestrian Interval (LPI)
- E14 - Replace a 5-section signal head with a 4-section signal head
- E15 - Provide an accessible pedestrian signal
- E16 - Install "Yield To Peds" or "Turning Vehicles Yield/Stop for Peds" signs

- E17 - Install "Bikes May Use Full Lane" and fluorescent yellow-green ped/bike signs
- E18 - Install "Begin Right Turn Lane Yield To Bikes" signs
- E19 - Install RRFBs in advance of crossing RRFBs
- E20 - Install advance yield or stop lines*
- E21 - Implement a Barnes Dance (Pedestrian Scramble)
- E22 - Install "PED XING" pavement markings

Category F: Improve Pedestrian and Bicycle Safety through Other Measures

- F1 - Install or enhance school zone features
- F2 - On-street parking enhancements
- F3 - Pedestrian and driver education programs
- F4 - Implement a shared street
- F5 - Provide pedestrian streets or malls
- F6 - Enhanced railroad crossing safety
- F7 - Provide adequate lighting*
- F8 - Manage or restrict turning movements
- F9 - Consider relevant ADA requirements
- F10 - Provide pedestrian fencing
- F11 - Provide pedestrian railings

*** Please refer to Table 1 in the Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations (Page 16) which provides guidance on application of the specific countermeasure relative to facility types (number of lanes, speed limits, etc.)**

http://www.pedbikesafe.org/pedsafe/documents/STEP_Guide.pdf

CATEGORY A: IMPROVEMENTS ALONG THE ROADWAY

- **A1 - Provide sidewalks, walkways, and paved shoulders** Where to use - Areas without adequate sidewalks or walkways for pedestrians to safely travel outside of vehicle travel lanes.
- **A2 - Provide street furniture and a secure walking environment** Where to use - Areas with pedestrian facilities that lack buffer zones from travel lanes or that lack appropriate pedestrian amenities. Potential improvements include street furniture such as benches, bus shelters, trash receptacles and drinking fountains.
- **A3 - Fill sidewalk gaps** Where to use - Areas where sidewalk is existent but non-continuous.
- **A4 - Add shared use paths** Where to use - Areas where pedestrians and bicyclists would benefit from a dedicated network of off-roadway travel facilities, whether for access to recreation trails or to provide safe travel along routes only serviced by limited access roads.
- **A5 - Install speed feedback signs** Where to use - Corridors with high levels of pedestrian traffic where vehicles frequently travel above the posted speed limit, reducing their reaction time to crossing pedestrians.
- **A6 - Install speed limit pavement markings** Where to use - Areas with high levels of pedestrian traffic where drivers require additional reminders of the speed limit.
- **A7 - Provide dedicated pedestrian, bicycle, and/or transit lanes** Where to use - Corridors with high volumes of pedestrian, bicycle, or transit traffic. Combination lanes such as Ped/bike or bike/transit lanes may be used as well. Pedestrian lanes may be more appropriate on roads with moderate speeds and volumes while bicycles and transit are appropriate for roads with higher speeds and volumes.

CATEGORY B: GEOMETRIC IMPROVEMENTS AT CROSSING LOCATIONS

- **B1 - Install marked crosswalks or enhance existing crosswalks** Where to use - Any portion of a roadway at an intersection or between intersections. Crosswalk enhancements include high-visibility crosswalk markings at intersections or mid-block locations.
- **B2 - Provide bulb-out curbs** Where to use - Roadways with on-street parking with high travel speeds or wide crossing distances. Pedestrians benefit from shortened crossing distances and decreased vehicle turning speed.
- **B3 - Provide crossing islands** Where to use - High-volume roadways, roadways where the pedestrian signal is short, where pedestrian crossings are long, or where traffic signals are otherwise prone to change before pedestrians can finish their crossing or benefit from the ability to wait for traffic while completing their crossing .
- **B4 - Provide raised crossings for pedestrians and cyclists** Where to use - Local and collector roads with high speeds where driver visibility of pedestrians, and therefore reaction time, may be reduced.
- **B5 - Restrict on-street parking near crossing locations** Where to use - Locations with on-street parking near intersection or mid-block crosswalks. Restricting on-street parking improves visibility of crossing pedestrians.
- **B6 - Install a pedestrian overpass or underpass** Where to use - Areas where total separation of pedestrian and vehicle facilities is favorable, such as at highway and rail facilities.
- **B7 - Extend median nose past crosswalk** Where to use - Pedestrian and bicycle crossings with medians. Median nose extensions provide extra physical protection for crossing pedestrians against oncoming traffic.
- **B8 - Relocate crosswalk to improve visibility of pedestrians** Where to use - Crosswalk locations where poor visibility leads to safety concerns, including inadequate stopping sight distance.
- **B9 - Reduce corner radii to encourage lower turning speeds** Where to use - Intersection and driveway locations where large turning radii allow greater turning speed.
- **B10 - Modify curb corners to provide each crosswalk its own ramp** Where to use - Crosswalk corners where one pedestrian ramp services two crossing directions.
- **B11 - Install a hardened centerline** Where to use - Intersections where it is desirable to encourage slower turning speeds or tighter turning radii for left-turns.
- **B12 - Reduce width of driveways** Where to use - Driveways where excessive widths increase pedestrian exposure to vehicles entering or exiting the property.
- **B13 - Provide adequate crossing facilities at existing roundabout entries** Where to use - Roundabouts with inadequate crossing facilities across approach legs, including marked crosswalks, crossing islands, and appropriate signage.

CATEGORY C: TRANSIT-RELATED IMPROVEMENTS

- **C1 - Transit stop improvements** Where to use - Locations of stops along transit lines. Improvements include: Accessibility accommodations; Landscape buffers between vehicles and pedestrians; Physical shelters with seating; Adequate lighting; and, Information on transit services, such as schedules and route maps.
- **C2 - Increase access to transit services** Where to use - Areas where additional transit line stops would benefit pedestrian flow and overall safety. Also includes situating pedestrian crossings near transit stops.

CATEGORY D: BICYCLE FACILITIES

- **D1 - Install marked bicycle lanes or enhance existing bicycle lanes** Where to use - Facilities with mixed vehicle and bicycle traffic with adequate space to accommodate a bicycle lane. Improvements include bike lanes abutting traffic lanes and buffered bike lanes.
- **D2 - Increase bicycle lane width** Where to use - Existing bicycle lanes that do not meet current standards with sufficient space to accommodate bicycle lane expansion.
- **D3 - Pave shoulders** Where to use - Rural roadways where bicyclists would benefit from a paved area separate from the travel lanes.
- **D4 - Install colored bicycle lanes at signalized intersections** Where to use - Bicycle lanes or other intersections with a high frequency of conflicts between vehicle and bicycle traffic. Applications can increase conspicuity of cyclists, identify conflict areas, and discourage illegal on-street parking.
- **D5 - Provide separated bicycle facilities** Where to use - Roads where bicycle facilities are desired but safety concerns prohibit traditional bike lanes or other in-lane bicycle facilities. Separated bicycle facilities include bicycle tracks, bicycle paths, and bike boulevards.
- **D6 - Provide bicycle boxes at intersections** Where to use - Signalized intersections frequented by a large volume of bicyclists that would benefit from priority placement at stop lights to place them safely ahead of vehicle traffic. Two-stage bicycle boxes can be located at sidestreets to allow bicycles to queue for left turns.
- **D7 - Install in-road bike lanes** Where to use - Roads with heavy bicycle traffic. Treatments include a buffered bike lane or shared lane markings.
- **D8 - Implement a protected intersection** Where to use - Signalized intersections with heavy bicycle traffic alongside vehicle traffic where physical separation and dedicated bike signals are required to adequately ensure bicycle safety.
- **D9 - Implement keyhole bike lanes** Where to use - Intersection approaches with a dedicated right turn lane concurrent with a bike lane.
- **D10 - Provide bike lanes, cycle tracks, or grade-separated bike paths at roundabouts** Where to use - Roundabouts on roads with existing bike lanes, cycle tracks, or where grade-separation would otherwise benefit bicyclists at the intersection.

CATEGORY E: SIGN AND SIGNAL IMPROVEMENTS

- **E1 - Install traffic signals** Where to use - Areas with inadequate gaps in traffic for pedestrian crossings, or where pedestrians experience excessive crossing delays. Locations must exceed MUTCD warrant thresholds.
- **E2 - Install or enhance pedestrian signals** Where to use - Signalized intersections with an exclusive pedestrian interval, where vehicle signals are not clearly visible to pedestrians or where there is complex signal phasing (such as a dedicated left-turn), at established school zone crossings, or at mid-block crossings.
- **E3 - Improve pedestrian signal timing** Where to use - Pedestrian signals currently performing inadequately for pedestrian demand. Improvements include: Signal coordination; Concurrent phasing; Exclusive pedestrian phasing; Leading pedestrian interval; and, Walk or Flashing Don't Walk timings.
- **E4 - Restrict right-turns-on-red** Where to use - Signalized intersections with exclusive pedestrian phases or high pedestrian volumes.

- **E5 - Install a Pedestrian Hybrid Beacon (PHB)** Where to use - Unsignalized pedestrian crossings across high-speed or high-volume roads. Should be installed with a marked crosswalk, countdown pedestrian signal heads, appropriate pedestrian detectors, overhead beacon lights, and appropriate "CROSSWALK STOP ON RED PROCEED ON FLASHING RED WHEN CLEAR" overhead signs with advisory pedestrian with diagonal downward pointing arrow signs located at the stop bars.

- **E6 - Install Rectangular Rapid Flashing Beacons (RRFBs)** Where to use - Uncontrolled marked crosswalks, particularly multilane crossings with speed limits less than 40 MPH. RREBs should be used in conjunction with pedestrian crossing signs and appropriate advance yield or stop pavement markings and signs.
- **E7 - Install a Pedestrian User-Friendly Intelligent Intersection (PUFFIN) Crossing** Where to use - Signalized crossings with a high frequency of older pedestrians (65 years or older) and/or pedestrians with disabilities which result in slower walking speeds. Improvements combine relocating the pedestrian signal to the same side of the road as the call button with sensors which detect how quickly pedestrians are crossing (allowing dynamic crossing times) and sensors which can cancel the called pedestrian phase if pedestrians leave the crossing area (crossing prematurely or walk away from the crossing location). May be used with traditional signalized intersections or PHBs.
- **E8 - Install advance pedestrian warning signs** Where to use - Crossing locations where pedestrian crossings may not be expected by motorists.
- **E9 - Install in-street pedestrian crossing signs** Where to use - Unsignalized marked crossings requiring reinforcement of preferred crossing locations for pedestrians and preferred stop or yield locations for vehicles. These signs include "STATE LAW Stop For Pedestrians In Crosswalk" signs.
- **E10 - Install in-crosswalk lighting** Where to use - Marked crossings requiring reinforcement of preferred crossing locations for pedestrians and preferred stop or yield locations for vehicles.
- **E11 - Install LED flashing signs** Where to use - Uncontrolled marked crosswalks, particularly multilane crossings with speed limits less than 40 MPH. LED flashing signs should be used in conjunction with appropriate advance yield or stop pavement markings and signs.
- **E12 - Install automated pedestrian detection** Where to use - Pedestrian crossings with button-actuated signals, particularly where a high frequency of users are disregarding the pushbutton or are visually impaired.
- **E13 - Implement a Leading Pedestrian Interval (LPI)** Where to use - Crossings where pedestrians move simultaneous to a conflicting turn phase. LPIs of 3 to 7 seconds help establish pedestrians within crosswalks and improves vehicle compliance with yielding to pedestrians within the crosswalk.
- **E14 - Replace a 5-section signal head with a 4-section signal head** Where to use - Turn lanes controlled by a 5-section signal head where permissive turn phases conflict with pedestrian crossings, limiting the left-turn phase to protected-only during a conflicting pedestrian walk cycle.
- **E15 - Provide an accessible pedestrian signal** Where to use - Crossing locations where accommodations are required for pedestrians with special needs, such as visual impairment.
- **E16 - Install "Yield To Peds" or "Turning Vehicles Yield/Stop for Peds" signs** Where to use - Signalized intersections where turning movements may conflict with a crossing pedestrian phase. Improvements include static and blank-out variants of "Yield To Peds" sign.

- **E17 - Install "Bikes May Use Full Lane" and fluorescent yellow-green ped/bike signs** Where to use - Roads where no bicycle lanes or adjacent shoulders are present and where travel lanes are too narrow for bicyclists and vehicles to operate side by side.
- **E18 - Install "Begin Right Turn Lane Yield To Bikes" signs** Where to use - Where vehicles enter an exclusive right-turn lane and must cross a bicycle lane.
- **E19 - Install RRFBs in advance of crossing RRFBs** Where to use - Midblock crossing locations where higher compliance with crossing RRFBs is desired. This may be due to low compliance at an existing crossing.
- **E20 - Install advance yield or stop lines** Where to use - Unsignalized mid-block crossings. Yield or stop lines placed 20 to 50 feet in advance of the crosswalk improve driver visibility of crossing pedestrians.
- **E21 - Implement a Barnes Dance (Pedestrian Scramble)** Where to use - Signalized intersections with a high frequency of pedestrian and/or bicycle crashes, or at intersections with high volumes of pedestrian and/or bicycle crossings, such as those within urban and urban core contexts. Features diagonal crosswalks through the middle of the intersection and a dedicated pedestrian phase allowing crossings in any direction through the intersection.
- **E22 - Install "PED XING" pavement markings** Where to use - In advance of crosswalks near the appropriate advance warning sign.

CATEGORY F: IMPROVE PEDESTRIAN AND BICYCLE SAFETY THROUGH OTHER MEASURES

- **F1 - Install or enhance school zone features** Where to use - School zones where drivers are speeding or not yielding to children in crosswalks. Improvements include: Police enforcement or well-trained adult crossing guards; Parking prohibition near intersections and crosswalks; Increased child supervision; Appropriate school zone signs and markings; and, a "Safe routes to school" program.
- **F2 - On-street parking enhancements** Where to use -Busy streets where motorists drive at excessive speeds. Enhancements include: Curb extensions; Parking meters; and Additional/diagonal on-street parking. Additional on-street parking creates an effective buffer between sidewalks and travel ways, and can serve as a traffic calming measure, reducing vehicle speeds and making drivers more alert.
- **F3 - Pedestrian and driver education programs** Where to use - Areas where risky or reckless behavior is exhibited by pedestrian and/or drivers resulting from misinformation regarding traffic law. Educational campaigns range from infrastructure changes to public relations campaigns and should be tailored to local needs and sensibilities.
- **F4 - Implement a shared street** Where to use - Streets with very low vehicle volume (approximately 100 or fewer vehicles per hour) and a balance of pedestrian, vehicle, and bicycle use. Shared streets should prioritize low-speed vehicle traffic balanced with pedestrian access and safety.
- **F5 - Provide pedestrian streets or malls** Where to use - Pedestrian commercial areas lacking adequate room for pedestrians to safely utilize the space unimpeded. This involves completely closing the street to vehicle traffic with the exception of emergency and service vehicle use.
- **F6 - Enhanced railroad crossing safety** Where to use - Railroad crossings lacking adequate facilities to assist mobility, vision, or hearing-impaired pedestrians. Safety measures include: Audible and visual devices (pedestrian signals with accompanying alarms or announcements indicating an approaching train); Crossing guard arms, swing gates, and tactile mats; Grade-separated crossing structures (overpass/underpass); and, Warning signs on channelized pathways approaching rail crossings.
- **F7 - Provide adequate lighting** Where to use - Crossings with inadequate or unequal street lighting around pedestrian facilities. Pedestrians should be lit from the traffic-approach side on both sides of the road to avoid creating a silhouette. Pedestrian-scale lighting enhances nighttime safety beyond crossing locations.
- **F8 - Manage or restrict turning movements** Where to use - Locations where specific turn movements cause excessive conflict with pedestrian traffic and alternative vehicular routes or turning opportunities can be accommodated.
- **F9 - Consider relevant ADA requirements** Where to use - Contextually relevant locations where ADA requirements are insufficient for expected users of pedestrian and bicycle facilities.
- **F10 - Provide pedestrian fencing** Where to use - uncontrolled pedestrian pathways, including roadside sidewalks, to encourage pedestrians and cyclists to cross as desired crossing locations.
- **F11 - Provide pedestrian railings** Where to use - Sidewalks and pathways where adjacent side-slopes are greater than 3:1.

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LANE DEPARTURE SAFETY STRATEGIES

CATEGORY 1: KEEP VEHICLES FROM DEPARTING THE ROADWAY

CATEGORY 1A: CURVE SAFETY

- **1A i - Add spiral transitions to curve** Where to use - High speed curve locations where standard arc curves cause driver discomfort.
- **1A ii - Increase curve radius** Where to use - Curve locations where curve radii are insufficient to safely or comfortably navigate the curve.
- **1A iii - In-lane curve warning pavement markings** Where to use - Curve locations with curve warning signs in place continuing to experience lane departures.
- **1A iv - Static curve warning signs** Where to use - Curve locations without adequate curve warning signs to warn drivers of upcoming curve conditions, including curve speed advisory speed signs.
- **1A v - Fluorescent curve warning signs** Where to use - Curve locations where curve warning signs require increased daytime conspicuity against background environments.
- **1A vi - Changeable curve warning signs** Where to use - Curve locations requiring additional supplemental messaging, such as vehicles traveling too fast for the upcoming curve or where hazardous road conditions regularly occur.
- **1A vii - Flashing curve warning signs** Where to use - Curve locations with curve warning signs in place continuing to experience lane departures.
- **1A viii - Sequential flashing beacons** Where to use - Curve locations requiring additional emphasis and guidance for the upcoming change in horizontal alignment, particularly at night.
- **1A ix - Standard chevron signs** Where to use - Curve locations requiring additional emphasis and guidance for the upcoming change in horizontal alignment.
- **1A x - Oversized chevron signs** Where to use - Curve locations requiring chevron signs with greater conspicuity or where lane departures continue to occur.
- **1A xi - Improve superelevation** Where to use - Curve locations where the existing superelevation is insufficient or otherwise varies from the design superelevation.
- **1A xii - Install “Share The Road” signs** Where to use - Roads where no bicycle lanes or adjacent shoulders are present and where travel lanes are too narrow for bicyclists and vehicles to operate side by side. These signs are especially useful for high speed, high volume, or narrow lane roads.
- **1A xiii - Install “Bicycles May Use Full Lane” signs** Where to use - Roads where no bicycle lanes or adjacent shoulders are present and where travel lanes are too narrow for bicyclists and vehicles to operate side by side. These signs are especially useful for high speed, high volume, or narrow lane roads and are shown to have a higher compliance rate than “Share The Road” signs due to their clearer messaging.
- **1A xiv - Install optical speed bars and/or chevrons (speed reduction markings)** Where to use - Unexpected horizontal or vertical curves where drivers need to decelerate in advance. These markings should be used to supplement the appropriate warning signs and other necessary traffic devices.

CATEGORY 1B: PAVEMENT FRICTION

- **1B i - Resurfacing** Where to use - Locations where pavement condition is poor. Consideration should be given to the proximity to future resurfacing projects.
- **1B ii - Friction course application** Where to use - Locations, particularly curves or high-speed roads, where friction course application is preferable to geometric changes to the roadway. Friction course treatments include but are not limited to: permeable friction course; open graded friction course; chip seal; high-friction surface treatment; microsurfacing, slurry seal; thin hot-mix asphalt; and ultra-thin bonded wearing course.
- **1B iii - Pavement grinding patterns** Where to use - Locations, particularly curves or high-speed roads, where pavement grinding is preferable to geometric changes to the roadway. Pavement grinding patterns include but are not limited to diamond grinding and grooving.

CATEGORY 1C: AUDIBLE PAVEMENT MARKINGS

- **1C i - Football-shaped centerlines** Where to use - Locations where vehicles are crossing the centerlines. Football-shaped rumble strips produce more noise but less vibration compared to rectangular rumble strips.
- **1C ii - Rectangular centerlines** Where to use - Locations where vehicles are crossing the centerlines. Rectangular rumble strips produce more vibration but less noise compared to football-shaped rumble strips.
- **1C iii - Edgeline rumble stripes** Where to use - Locations where vehicles are crossing the edgeline due to driver inattentiveness. Edgeline rumble strips provide greater nighttime visibility, particularly in wet-weather conditions, compared to shoulder rumble strips.
- **1C iv - Shoulder rumble strips** Where to use - Locations where vehicles are crossing the edgeline due to driver inattentiveness. Shoulder rumble strips may be installed on existing shoulders without damaging existing edgeline pavement markings.
- **1C v - Transverse rumble stripes** Where to use - Locations where drivers need to be alerted to changing conditions not anticipated by an inattentive driver, such as the need to slow down approaching a curve.
- **1C vi - Profiled thermoplastic pavement markings** Where to use - Locations where a low-cost alternative to rumble strips is desired. Profiled thermoplastic performs especially well at night and in wet-weather conditions compared to standard thermoplastic pavement markings.
- **1C vii - Preformed rumble stripes** Where to use - Locations where a low-cost alternative is preferred to traditional transverse rumble strips.

CATEGORY 1D: NIGHTTIME VISIBILITY

- **1D i - Increase pavement marking retroreflectivity** Where to use - Locations where pavement markings require increased conspicuity at night or are worn and in need of refreshing.
- **1D ii - Install flashing beacons as advance warning** Where to use - Locations where roadway conditions or features require greater driver attention due to nighttime visibility limitations.
- **1D iii - Provide new highway lighting** Where to use - Locations without highway lighting which meet AASHTO and TAC requirements.
- **1D iv - Improve existing highway lighting** Where to use - Locations where current lighting is insufficient for present road conditions.
- **1D v - Provide wider edgelines (8’’)** Where to use - Locations requiring greater edgeline conspicuity, such as at alignment changes.
- **1D vi - Post-mounted delineators** Where to use - Short stretches featuring changes in horizontal alignment such as at curves or lane-reduction transitions. Can use in conjunction with oversized chevron signs.
- **1D vii - Improve sign retroreflectivity** Where to use - Locations where existing signs are damaged, worn, or otherwise insufficiently retroreflective to provide adequate nighttime visibility.
- **1D viii - Install retroreflective strips on sign poles** Where to use - Signs requiring additional conspicuity, particularly at night, especially curve warning signs, curve delineators, and WRONG WAY signs.
- **1D ix - Install or refurbish existing pavement edgelines and Reflective Pavement Markers** Where to use - Locations where pavement edgelines or Reflective Pavement Markers are either missing or sufficiently worn as to negatively impact driver awareness and visibility of the pavement edge.

CATEGORY 1E: SPEED MANAGEMEMNT

- **1E i - Decrease speed limit** Where to use - Locations exhibiting large number of speed-related run-off-the-road crashes.
- **1E ii - Install changeable speed warning signs** Where to use - Locations exhibiting large number of speed-related run-off-the-road crashes where the speed limit is deemed appropriate.

CATEGORY 1F: OTHER MEASURES

- **1F i - Increase lane width** Where to use - Locations where narrow lanes are found to contribute to lane departure type crash trends.
- **1F ii - Add median or increase existing median width** Where to use - Locations with high frequency of head-on crashes caused by vehicles traversing the median, including a Two-Way Left Turn Lane. Medians taking the place of a Two-Way Left Turn Lane should include median openings where appropriate.
- **1F iii - Add shoulders or increase existing shoulder width** Where to use - Locations where narrow shoulders are found to contribute to lane departure crash trends.
- **1F iv - Pav shoulder** Where to use - Locations where shoulders are nonexistent or comprised of grass, gravel or other composite material.
- **1F v - Install advance warning signs** Where to use - Unexpected road features or conditions requiring driver action or awareness.
- **1F vi - Limited sight distance signs** Where to use - In the vicinity of roadway alignment, foliage, or other structures which obstruct driver sight distance.
- **1F vii - Install “Lane Ends” signs** Where to use - Locations where a reduction in the number of lanes is imminent and drivers must merge from the upcoming dropped lane.

CATEGORY 2: PROVIDE FOR SAFE RECOVERY AFTER ROADWAY DEPARTURE

CATEGORY 2A: CLEAR ZONE MODIFICATION

- **2A i - Change clear zone width** Where to use - Locations where clear zone widths do not meet FDM criteria or are otherwise excessively narrow.
- **2A ii - Relocate fixed objects outside of clear zone** Where to use - Locations where fixed objects, such as trees, sign posts, and light posts, are located within the Clear Zone or otherwise do not meet roadside safety criteria in the FDM.

CATEGORY 2B: VEHICULAR CONTROL

- **2B i - SafetyEdgeSM** Where to use - Locations with narrow paved shoulders or grass shoulders where pavement-edge-related crashes occur. Additional testing may be needed to qualify the application of Safety EdgeSM.
- **2B ii - Flatten side slopes** Where to use - Locations where clear zone side slopes do not meet FDM criteria or are otherwise excessively tall.

CATEGORY 3: REDUCE CRASH SEVERITY WHEN RECOVERY IS NOT POSSIBLE

CATEGORY 3A: LONGITUDINAL BARRIERS

- **3A i - Cable barrier** Where to use - Locations where roadside barriers are desired to arrest vehicles departing the roadway, preventing them from deflecting back into traffic or from reaching oncoming traffic lanes or other hazardous roadside conditions.
- **3A ii - Guardrail barrier** Where to use - Locations where roadside barriers are desired to prevent vehicles from deflecting back into traffic or from reaching oncoming traffic lanes or hazardous roadside conditions.
- **3A iii - Concrete barrier** Where to use - Locations where roadside barriers are desired to deflect vehicles into the shoulder or use with travel lanes where significant roadside hazards exist, such as at bridges.
- **3A iv - Concrete wall** Where to use - Locations where roadside barriers are desired to deflect vehicles into the shoulder or use with travel lanes where significant roadside hazards exist, such as at bridges. Concrete walls assist in noise reduction from roadside traffic to neighboring developments.
- **3A v - Crash cushions at fixed roadside features** Where to use - Locations where roadside fixed objects such as roadside barriers cannot be relocated outside the roadway or clear zone.

CATEGORY 3B: ROADSIDE FIXED OBJECTS

- **3B i - Increase lateral offset of utility poles** Where to use - Locations where utility poles are located within the Clear Zone or otherwise do not meet roadside safety criteria in the FDM.
- **3B ii - Reduce longitudinal density of utility poles** Where to use - Locations where the number or spacing of utility poles poses a greater risk to vehicles departing the roadway.
- **3B iii - Increase lateral clearance between the traveled way and objects within clear zone** Where to use - Locations where objects are located within the clear zone but are unable to be relocated based on the FDM criteria.

● = Low-Cost Countermeasure

● = Moderate-Cost Countermeasure

● = High-Cost Countermeasure

The majority of the countermeasure information was obtained from FHWA’s “Roadway Departure Safety” website. This information is supplemented with additional countermeasure considerations from the FHWA’s CMF Clearinghouse.

SIGNALIZED INTERSECTION SAFETY STRATEGIES

Category A: Reduce frequency and severity of intersection conflicts through traffic control and operational improvements

- A1 - Replace permissive left turns with protected left turns
- A2 - Optimize change and clearance intervals
- A3 - Restrict or eliminate turning maneuvers
- A4 - Employ signal coordination
- A5 - Employ emergency vehicle preemption
- A6 - Remove unwarranted signal
- A7 - Change green signal to flashing yellow arrow for permissive left turns
- A8 - Install/implement pedestrian signal improvements
- A9 - Install bicycle signal
- A10 - Install transit signal priority technology
- A11 - Modify night-time flash period (replace with steady operation)
- A12 - Change left-turn phase permission (protected/permissive modification)

Category B: Reduce intersection conflicts through geometric improvements

- B1 - Provide/improve turn lane channelization
- B2 - Improve geometry of pedestrian and bicycle facilities
- B3 - Utilize innovative intersection geometry
- B4 - Corridor access management - implement median closures
- B5 - Provide right-turn lanes at intersections
- B6 - Convert T intersection to a continuous green T intersection
- B7 - Install left-turn lane
- B8 - Install acceleration/deceleration lanes
- B9 - Change intersection skew angle

Category C: Improve sight distance at signalized intersections

- C1 - Clear sight triangles
- C2 - Increase positive turn lane offset

Category D: Improve driver awareness of intersections and signal control

- D1 - Improve visibility of intersections and signal control
- D2 - Improve visibility of signals and signs at intersections
- D3 - Install/add one signal head per lane
- D4 - Install larger 12" signal heads
- D5 - Install signal backplates/retroreflective backplates
- D6 - Install intersection warning devices
- D7 - Convert pole mounted to overhead signals
- D8 - Install supplemental pole-mounted signal on near-side approach
- D9 - Install flashing beacons as advance warning
- D10 - Advance street name signs
- D11 - Convert signal from diagonal span wire to box span
- D12 - Convert signal from span wire to mast arm

Category E: Improve driver compliance with traffic control devices

- E1 - Provide public information and education
- E2 - Provide targeted conventional enforcement of traffic laws
- E3 - Post reasonable, safe, and consistent speed limits on intersection approaches
- E4 - Install red-light indicator lights
- E5 - Install red-light cameras
- E6 - Install an actuated advance warning dilemma zone protection system at high-speed signalized intersections

Category F: Improve access management near signalized intersections

- F1 - Modify driveway access
- F2 - Corridor access management - implement median closures

Category G: Improve safety through other infrastructure treatments

- G1 - Improve drainage in intersection and on approaches
- G2 - Provide high friction surface treatment in intersection and on approaches
- G3 - Coordinate closely spaced signals near at-grade railroad crossings
- G4 - Relocate signal hardware out of clear zone
- G5 - Restrict or eliminate parking on intersection approaches
- G6 - Convert a conventional signalized intersection to a signalized superstreet
- G7 - Resurface pavement
- G8 - Improve lighting
- G9 - Deactivate red-light camera

For a more comprehensive list of countermeasures relevant to pedestrians and bicyclists at signalized intersections, please refer to the "Pedestrian & Bicycle Safety Strategies"

SAFETY CONCERN	SIGNALIZED COST		
	● Low	● Moderate	● High
High frequency of right-angle crashes attributed to:			
nearby driveways		F2	F1
traffic from cross street	A2, A3	E2	B6, D11, D12
skewed intersection			B9
poor sight distance	A1, A12, C1, G5	C2, G4	B3
drivers misjudging gaps	A1, A12		
not enough gaps for drivers	A1, A12	A4, B4	B6, G6
driver unaware of intersection	D1, D2, D5, D6, D9	C2	B4
nighttime conditions	A11, D1, D2, D5	G8	
right turning vehicles hit from side	A3, C1, G5	B1, G4	
High frequency of rear-end crashes attributed to:			
left turning vehicles hit from behind	A1, A12	B1	B3, G6
left opposing vehicles hit from behind		B1	B3
right turning vehicles hit from behind	A3	B1, B5	
standing water on roadway		G1, G7	
vehicles unable to stop safely (skidding)		G2, G7	
driver unaware of intersection	D1, D2, D5, D9, D10	D3, D4, D8	D7
nighttime conditions	A11, D1, D2, D5	D4, G8	D7
speed differentials of vehicles		A4, E3, E6	B7, B8
sudden stops	A2, A3, D10	A4, D3, G9	B7
High frequency of left-turn crashes attributed to:			
left turn vehicles hit by opposing traffic	A1, A3, A7, A12, C1	B1, B4	B3, G6
nighttime conditions	A11, D1, D2, D5	G8	
High frequency of sideswipe crashes attributed to:			
vehicles within intersection	A1, A12	B1	
sudden maneuvers at intersection	D10		
High frequency of pedestrian/bicycle crashes:			
on school routes or near generators of ped/bike traffic	A8	B2, E2, H1	
vehicle/bicycle sideswipes on approaches		A9, G1, H1	
with left turning vehicles	A1, A3, A12	A9, H1	
Address overall safety issues:			
violation of traffic laws	E1	A9, E2	
intersection near railroad crossing		G3	
intersection near fire station		A5	
excessive delay	A6		G6
disobedience of traffic signal	A6	A9, D3, D8, E4, E5	
intersection frequented by transit services		A10	

The majority of the countermeasure information and the format of this information was obtained from FHWA's "Signalized Intersection Safety Strategies". This information was supplemented with additional countermeasure considerations from FHWA's CMF Clearinghouse

CATEGORY A: REDUCE FREQUENCY AND SEVERITY OF INTERSECTION CONFLICTS THROUGH TRAFFIC CONTROL AND OPERATIONAL IMPROVEMENTS

- **A1 - Replace permissive left turns with protected left turns** Where to use - Signalized intersections with a high frequency of crashes between left turning and opposing through vehicles. A properly timed protected left-turn phase can also help reduce rear-end and sideswipe crashes between left-turning vehicles and the through vehicles behind them.
- **A2 - Optimize change and clearance intervals** Where to use - Signalized intersections with a high frequency of crashes related to change interval lengths that are possibly too short, including angle crashes. Rear-end crashes may also be a symptom of short change intervals.
- **A3 - Restrict or eliminate turning maneuvers** Where to use - Signalized intersections with a high frequency of crashes related to turning maneuvers. For right turn on red (RTOR), the target of this strategy is right-turning vehicles that are involved in rear-end or angle crashes with cross-street vehicles approaching from the left or vehicles turning left from the opposing approach, and crashes involving pedestrians.
- **A4 - Employ signal coordination** Where to use - Signalized intersections with a high frequency of crashes involving major street left-turning and minor street right-turning vehicles where adequate safe gaps in opposing traffic are not available. Major road rear-end crashes associated with speed changes can also be reduced by re-timing signals to promote platooning.
- **A5 - Employ emergency vehicle preemption** Where to use - Signalized intersections where normal traffic operations impede emergency vehicles and where traffic conditions create a potential for conflicts between emergency and non-emergency vehicles.
- **A6 - Remove unwarranted signal** Where to use - Signalized intersections where the traffic volumes and safety record do not warrant a traffic signal.
- **A7 - Change green signal to flashing yellow arrow for permissive left turns** Where to use - Signalized intersections with high frequency of crashes involving left-turning and opposing through vehicles. The flashing yellow arrow (FYA) can be used in place of the simple circular green light and other signals to help convey the message that left-turning drivers need to yield to on-coming traffic.
- **A8 - Install/implement pedestrian signal improvements** Where to use - Signalized intersections with conflicts between vehicles and pedestrians crossing at the intersection, high volume of crossing pedestrians or bicyclists, vehicles not yielding to pedestrians in crosswalk, and high pedestrian delay due to few available gaps in traffic. Measures can include increasing pedestrian clearance intervals (or increasing the cycle length for pedestrian crossing), implementing leading pedestrian interval and installing pedestrian pushbuttons and pedestrian countdown signals.
- **A9 - Install bicycle signal** Where to use - Signalized intersections with conflicts between vehicles and bicycles crossing at the intersection, high volume of bicyclists, vehicles not yielding to bicyclists.
- **A10 - Install transit signal priority technology** Where to use - Signalized intersections with a high frequency of crashes involving transit services, including buses, streetcars, trams, etc.
- **A11 - Modify night-time flash period** Where to use - Signalized intersections experiencing a high frequency of crashes occurring during the nighttime flashing operation period. Measures include adjusting the length of the flashing operation period or replacing it entirely with steady signal operation.
- **A12 - Change left-turn phase permission (protected/permissive modification)** Where to use - Signalized intersections with a high frequency of left-turn crashes versus opposing through vehicles. Permission modification includes any change to or from protected or permissive phasing for any given left-turn approach.

CATEGORY B: REDUCE INTERSECTION CONFLICTS THROUGH GEOMETRIC IMPROVEMENTS

- **B1 - Provide/improve turn lane channelization** Where to use - Signalized intersections with a high frequency of rear-end collisions resulting from conflicts between: (1) vehicles turning and following vehicles; and (2) vehicles from downstream intersection crossing traffic lanes to enter turn lane. The channelization can also provide a pedestrian refuge area and reduce pedestrian crossing distance.
- **B2 - Improve geometry of pedestrian and bicycle facilities** Where to use - Signalized intersections with high frequencies of pedestrian and/or bicycle crashes and on routes serving schools or other generators of pedestrian and bicycle traffic. Measures can include curb radius reduction, curb extension, pedestrian refuge/raised median, and raised intersections.
- **B3 - Utilize innovative intersection geometry** Where to use - Signalized intersections with high levels of crashes on a leg where other low-cost strategies have not been successful or are not considered appropriate.
- **B4 - Corridor access management - implement median closures** Where to use - Signalized intersections with patterns of crashes related to particular turning maneuvers where drivers have difficulties finding an acceptable gap in traffic.
- **B5 - Provide right-turn lanes at intersections** Where to use - Signalized intersections with conflicts between right-turning vehicles and following vehicles, and significant right-turn volume along major road.
- **B6 - Convert T intersection to a continuous green T intersection** Where to use - Signalized T intersections experiencing a high frequency of angle crashes or where increased travel efficiency will benefit adjacent coordinated signal performance or will otherwise benefit a corridor’s overall performance.
- **B7 - Install left-turn lane** Where to use - Signalized intersections with a high frequency of rear-end crashes related to left-turning vehicles slowing to execute their turn.
- **B8 - Install acceleration/deceleration lanes** Where to use - Roads with high speeds where vehicles entering from the sidestreet require sufficient time to accelerate before safely merging or decelerate before turning.
- **B9 - Change intersection skew angle** Where to use - Intersections with a problematic skew angle. Ideal skew angles of 90° are safer to navigate and more desirable than narrower skew angles.

CATEGORY C: IMPROVE SIGHT DISTANCE AT SIGNALIZED INTERSECTIONS

- **C1 - Clear sight triangles** Where to use - Signalized intersections where there is a high frequency of crashes between vehicles turning right on red from one street and through vehicles on the other street or crashes involving left turning traffic where landscaped medians are present.
- **C2 - Increase positive turn lane offset** Where to use - Signalized intersections where there is a high number of crashes due to turning vehicles limiting the sight distance. Left-turning vehicles can limit the sight distance of left turning vehicles and opposing through vehicles. Right-turning vehicles can limit the sight distance of right-turning cross street traffic.

CATEGORY D: IMPROVE DRIVER AWARENESS OF INTERSECTIONS AND SIGNAL CONTROL

- **D1 - Improve visibility of intersections on approach(es)** Where to use - Signalized intersections with a high frequency of crashes attributed to drivers being unaware of the presence of the intersection.
- **D2 - Improve visibility of signals and signs at intersections** Where to use -Signalized intersections with a high frequency of right-angle and rear-end crashes occurring because drivers are unable to see traffic signals and signs sufficiently in advance to safely negotiate the intersection being approached.
- **D3 - Install/add one signal head per lane** Where to use - Signalized intersections with a high frequency of crashes caused by driver indecision in lane assignment.
- **D4 - Install larger 12” signal heads** Where to use - Signalized intersections with a crash history or observed conflicts involving lack of awareness of the intersection or traffic control and observed speeding on approaches to the intersection.

- **D5 - Install signal backplate/retroreflective backplates** Where to use - Signalized intersections with poor visibility of the intersection from approaches, a crash history or observed conflicts involving lack of awareness of the intersection or traffic control, and observed speeding on approaches to the intersection.
- **D6 - Install intersection warning devices** Where to use - Signalized intersections with poor visibility of the intersection from approaches, conflicts involving lack of awareness of the intersection or traffic control, and observed speeding on approaches to the intersection. Intersection warning devices can include warning signs, beacons, and transverse rumble strips.
- **D7 - Convert pole mounted to overhead signals** Where to use - Signalized intersections with poor visibility of the intersection from approaches, a crash history or observed conflicts involving lack of awareness of the intersection or traffic control, and observed speeding on approaches to the intersection.
- **D8 - Install supplemental pole-mounted signal on near-side approach** Where to use - Signalized intersections with poor visibility of the intersection from approaches, a crash history or observed conflicts involving lack of awareness of the intersection or traffic control, and observed speeding on approaches to the intersection.
- **D9 - Install flashing beacons as advance warning** Where to use - Signalized intersections with poor visibility of the intersection from approaches, a crash history or observed conflicts involving lack of awareness of the intersection or traffic control, and observed speeding on approaches to the intersection.
- **D10 - Advance street name signs** Where to use - Signalized intersections with high frequency of crashes involving driver distraction related to wayfinding. These crashes include rear-end as well as side-swipe crashes.
- **D11 - Convert signal from diagonal span wire to box span** Where to use - Signalized intersections configured with a diagonal span wire, particularly where exhibiting a high frequency of angle crashes.
- **D12 - Convert signal from span wire to mast arm** Where to use - Signalized intersections configured with a diagonal span wire, particularly where exhibiting a high frequency of angle crashes.

CATEGORY E: IMPROVE DRIVER COMPLIANCE WITH TRAFFIC CONTROL DEVICES

- **E1 - Provide public information and education** Where to use - Signalized intersections with a high frequency of crashes related to drivers either being unaware of (or refusing to obey) traffic laws and regulations that impact traffic safety (especially red-light running, speeding, and not yielding to pedestrians).
- **E2 - Provide targeted conventional enforcement of traffic laws** Where to use - Signalized intersections with a high frequency of crashes related to drivers either being unaware of (or refusing to obey) traffic laws and regulations that impact traffic safety.
- **E3 - Post reasonable, safe, and consistent speed limits on intersection approaches** Where to use - Signalized intersections with a high frequency of crashes attributed to drivers who intentionally disobey posted approach speed limits.
- **E4 - Install red-light indicator lights** Where to use - Signalized intersections with a high frequency of crashes related to drivers running red lights.
- **E5 - Install red-light cameras** Where to use - Signalized intersections with a high frequency of crashes related to drivers running red lights.
- **E6 - Install an actuated advance warning dilemma zone protection system** Where to use -Signalized intersections where drivers have high approach speeds. May be implemented on isolated or closely-spaced high-speed intersections.

CATEGORY F: IMPROVE ACCESS MANAGEMENT NEAR SIGNALIZED INTERSECTIONS

- **F1 - Modify driveway access** Where to use - Signalized intersections with high crash frequencies related to driveways adjacent to the intersection. Generally, driveways within 250 feet of the intersection are the greatest concern.
- **F2 - Corridor access management - implement median closures** Where to use - Approaches to signalized intersections with a high frequency of crashes involving drivers making turns across medians.

CATEGORY G: IMPROVE SAFETY THROUGH OTHER INFRASTRUCTURE TREATMENTS

- **G1 - Improve drainage in intersection and on approaches** Where to use - Signalized intersections with a high frequency of crashes that are related to wet pavement from poor drainage. Such crashes involve vehicles that hydroplane and, hence, are not able to stop when required.
- **G2 - Provide high friction surface treatment in intersection and on approaches** Where to use - Signalized intersection approaches where skidding is determined to be a problem, especially in wet conditions.
- **G3 - Coordinate closely spaced signals near at-grade railroad crossings** Where to use - Signalized intersections in close proximity to at-grade railroad crossings with a high frequency of crashes. This situation presents a significant potential for vehicle-train crashes, but vehicle-vehicle crashes could also occur if drivers try to speed through an intersection to avoid waiting in a queue near the railroad crossing.
- **G4 - Relocate signal hardware out of clear zone** Where to use - Signalized intersections where signal hardware is located within the clear zone or is a sight obstruction (particularly on high-speed approaches).
- **G5 - Restrict or eliminate parking on intersection approaches** Where to use - Signalized intersections with permitted parking on the approaches that may present a safety hazard either by blocking sight distance or due to parking maneuvers.
- **G6 - Convert a conventional signalized intersection to a signalized superstreet** Where to use - Signalized intersections experiencing excessive conflicts or delays, particularly with regard to left and U-turn traffic.
- **G7 - Resurface pavement** Where to use - Signalized intersection approaches where skidding is determined to be a problem, especially in wet conditions.
- **G8 - Improve lighting** Where to use - Signalized intersections experiencing a high frequency of nighttime crashes.
- **G9 - Deactivate red-light camera** Where to use - Signalized intersections with a high frequency of rear-end crashes caused by drivers wary of automated red-light cameras.

- = Low-Cost Countermeasure
- = Moderate-Cost Countermeasure
- = High-Cost Countermeasure

The majority of the countermeasure information and the format of this information was obtained from FHWA’s “Signalized Intersection Safety Strategies”. This information was supplemented with additional countermeasure considerations from FHWA’s CMF Clearinghouse

UNSIGNALIZED INTERSECTION SAFETY STRATEGIES

Category A: Improve management of access

- A1 - Corridor access management - reduce driveway conflicts
- A2 - Corridor access management - modify driveway access
- A3 - Corridor access management - reduce number of intersections
- A4 - Corridor access management - implement median closures

Category B: Reduce conflicts through geometric design improvements

- B1 - Provide left-turn lanes at intersection
- B2 - Provide zero or positive offset left-turn lanes at intersections
- B3 - Provide left or right-turn bypass lanes on shoulders at T-intersections
- B4 - Provide left-turn acceleration lanes in median at divided highway high speed intersections
- B5 - Provide right-turn lanes at intersections
- B6 - Provide offset right-turn lanes at intersections
- B7 - Provide full-width paved shoulders in intersection areas
- B8 - Modify allowed turning maneuvers through geometric improvements
- B9 - Convert four-legged intersections to offset T-intersections
- B10 - Convert offset T-intersections to four-legged intersections
- B11 - Realign intersection approaches to reduce or eliminate intersection skew
- B12 - Reduce or extend curb radius
- B13 - Install medians and pedestrian crossing islands
- B14 - Install roundabout or mini roundabout

Category C: Improve sight distance

- C1 - Clear sight triangles on stop- or yield-controlled approaches to intersections or in the medians of divided highways near intersections
- C2 - Change horizontal and/or vertical alignment of approaches to provide more sight distance
- C3 - Eliminate parking that restricts sight distance
- C4 - Install fence instead of wall to provide clear sight distance

Category D: Improve availability of gaps and assist drivers in judging gaps

- D1 - Install an intersection conflict warning system (ICWS)
- D2 - Re-time adjacent signals to create gaps at stop-controlled intersections

Category E: Improve driver awareness

- E1 - Improve visibility of intersections by providing enhanced signing and delineation
- E2 - Improve visibility of the intersection by providing lighting
- E3 - Install splitter islands on the minor-road approach to an intersection
- E4 - Provide a stop line on minor-road approaches
- E5 - Install transverse rumble strips on intersection approaches
- E6 - Provide supplementary stop signs mounted over the roadway
- E7 - Provide pavement markings with supplementary messages (e.g. STOP AHEAD)
- E8 - Provide improved maintenance and retroreflectivity of stop signs
- E9 - Install flashing beacons at stop-controlled intersections
- E10 - Add a warning beacon to an existing regulatory or warning sign (Provide flashing beacons at stop controlled intersections)
- E11 - Provide intersection warning signs
- E12 - Provide Advance Traffic Control Warning signs (Install advance warning signs (positive guidance))
- E13 - Install post-mounted reflective delineators at the intersection
- E14 - Install reflective strips on sign posts
- E15 - Provide a yield line on yield-controlled approaches
- E16 - Replace standard stop sign with flashing LED enhanced stop sign
- E17 - Install red or orange flags with a regulatory or warning sign
- E18 - Enhance pedestrian signing
- E19 - Replace transverse crosswalk markings with high visibility markings
- E20 - Provide advance yield line

- E21 - Install crosswalk on one minor approach
- E22 - Install object maker sign or keep right sign

Category F: Choose appropriate intersection traffic control

- F1 - Provide all-way stop-control at appropriate intersections
- F2 - Provide roundabouts at appropriate locations
- F3 - Provide pedestrian hybrid beacon
- F4 - Provide rectangular rapid flashing beacon
- F5 - Convert a unsignalized intersection to an unsignalized restricted crossing U-turn (also known as a J-turn)
- F6 - Install a traffic signal
- F7 - Install high-emphasis crosswalks

Category G: Improve compliance with traffic control devices and traffic laws

- G1 - Provide targeted enforcement to reduce stop sign violations
- G2 - Provide targeted public information and education on safety problems at specific intersections
- G3 - Install pavement markings PED XING in advance of crossings
- G4 - Install STATE LAW STOP FOR PEDS signs in advance of crossings

Category H: Reduce operating speeds

- H1 - Provide targeted speed enforcement
- H2 - Provide traffic calming on intersection approaches through a combination of geometric and traffic control devices
- H3 - Post reasonable, safe, and consistent speed limits on intersection approaches
- H4 - Provide speed reduction pavement markings
- H5 - Provide a dynamic speed feedback sign
- H6 - Provide smooth lane narrowing
- H7 - Raised bicycle crossings
- H8 - Raised intersections

Category I: Guide motorists more effectively

- I1 - Provide turn path markings
- I2 - Provide a double yellow centerline on the median opening of a divided highway at intersections
- I3 - Provide a double yellow centerline on the minor road approaches
- I4 - Provide dotted edge-line extensions

For a more comprehensive list of countermeasures relevant to pedestrians and bicyclists at unsignalized intersections, please refer to the “Pedestrian & Bicycle Safety Strategies”

CATEGORY A: IMPROVE MANAGEMENT OF ACCESS

- **A1 – Corridor access management - reduce driveway conflicts** Where to use - Unsignalized intersections with high crash frequencies related to driveways adjacent to the intersection. Generally, driveways within 250 feet of the intersection are the greatest concern.
- **A2 – Corridor access management - modify driveway access** Where to use - Driveways located near unsignalized intersections that experience high crash frequencies but that cannot practically be closed or relocated.
- **A3 – Corridor access management - reduce number of intersections** Where to use - Corridors with many intersections in close proximity and a high number of intersection related crashes. Reducing the number of intersections reduces the number of conflict points and can improve traffic flow along the corridor.
- **A4 – Corridor access management - implement median closures** Where to use - Unsignalized intersections that have observed conflicts with left-turning vehicles from the major or minor road, finding acceptable gaps from minor road, and where driveway access causes delay and/or collisions.

CATEGORY B: REDUCE CONFLICTS THROUGH GEOMETRIC DESIGN IMPROVEMENTS

- **B1 – Provide left-turn lanes at intersections** Where to use - Unsignalized intersections with a high frequency of crashes resulting from the conflict between (1) vehicles turning left and following vehicles and (2) vehicles turning left and opposing through vehicles.
- **B2 – Provide zero or positive offset left-turn lanes at intersections** Where to use - Unsignalized intersections with a high frequency of crashes between vehicles turning left and opposing through vehicles, as well as rear-end crashes between through vehicles on the opposing approach. Also at intersections on divided highways with medians wide enough to provide the appropriate offset but can be implemented on approaches without medians if sufficient width exists.
- **B3 – Provide left or right-turn bypass lanes on shoulders at T-intersections** Where to use - At three-legged unsignalized intersections on two-lane highways with moderate through and turning volumes, especially intersections that have a pattern of rear-end collisions involving vehicles waiting to turn left from the highway.
- **B4 – Provide left-turn acceleration lanes in median at divided highway high speed intersections** Where to use - Unsignalized intersections with conflicts due to speed differential between entering vehicles and through vehicles, high left-turn volumes onto high-speed major roads, and significant delay for left-turning vehicles waiting for a suitable gap on the major road.
- **B5 – Provide right-turn lanes at intersections** Where to use - Unsignalized intersections with a high frequency of rear-end crashes resulting from conflicts between (1) vehicles turning right and following vehicles and (2) vehicles turning right and through vehicles coming from the left on the cross street.
- **B6 – Provide offset right-turn lanes at intersections** Where to use - Unsignalized intersections with a high frequency of crashes between vehicles on the minor road that are turning left, turning right, or proceeding straight through, and vehicles on the major road.
- **B7 – Provide full-width paved shoulders in intersection areas** Where to use - Unsignalized intersections on divided highways with no shoulder or shoulder widths less than 8 feet that experience a high proportion of run-off-road crashes as a result of avoidance maneuvers or a high proportion of rear-end crashes that could have been avoided had a full-width paved shoulder been provided.
- **B8 – Modify allowed turning maneuvers through geometric improvements** Where to use - Unsignalized intersections with patterns of crashes related to particular turning maneuvers where it is impractical to reduce that pattern of crashes by improving sight distance or providing a left-turn or shoulder bypass lane. Also, at locations where it is possible to restrict or eliminate turning maneuvers by providing channelization or by closing the median opening (Replace direct left-turn with right-turn/U-turn).
- **B9 – Convert four-legged intersections to offset T-intersections** Where to use - Unsignalized four-legged intersections with very low through volumes on the cross street.
- **B10 – Convert offset T-intersections to four-legged intersections** Where to use - Unsignalized offset T-intersections where through volumes on the cross street are very high.
- **B11 – Realign intersection approaches to reduce or eliminate intersection skew** Where to use - Unsignalized intersections with a high frequency of crashes resulting from insufficient intersection sight distance and awkward sight lines at a skewed intersection.
- **B12 – Reduce or extend curb radius** Where to use - Unsignalized intersections with observed vehicles making right-turn movements at high speeds, high pedestrian traffic, poor visibility of on-coming traffic for pedestrians waiting to cross the road, and a crash history or observed conflicts between bicyclists and/or pedestrians and right-turning vehicles.
- **B13 – Install medians and pedestrian crossing islands** Where to use - Unsignalized intersections with crossings that span multiple lanes and observed difficulty of pedestrians finding safe gaps in traffic to cross.
- **B14 – Install roundabout or mini-roundabout** Where to use - Unsignalized intersections with a crash history or observed conflicts related to speeding through the intersection.

CATEGORY C: IMPROVE SIGHT DISTANCE

- **C1 – Clear sight triangles on stop- or yield-controlled approaches to intersections or in the medians of divided highways near intersections** Where to use - Unsignalized intersections or medians with restricted sight distance and patterns of crashes related to lack of sight distance, where sight distance can be improved by clearing roadside or median obstructions without major construction.
- **C2 – Change horizontal and/or vertical alignment of approaches to provide more sight distance** Where to use - Unsignalized intersections with restricted sight distance due to horizontal and/or vertical geometry and with patterns of crashes related to that lack of sight distance that cannot be ameliorated by less expensive methods.
- **C3 – Eliminate parking that restricts sight distance** Where to use - Unsignalized intersections with restricted sight distance due to parking.
- **C4 – Install fence instead of wall provide clear sight distance** Where to use - Unsignalized intersections with restricted sight distance due to the presence of walls.

CATEGORY D: IMPROVE AVAILABILITY OF GAPS AND ASSIST DRIVERS IN JUDGING GAPS

- **D1 – Install an intersection conflict warning system (ICWS)** Where to use - Unsignalized intersections with a crash history involving vehicles entering or crossing the major road, difficulty among drivers in determining appropriate gaps in traffic, and awareness of the intersection is lacking.
- **D2 – Re-time adjacent signals to create gaps at stop-controlled intersections** Where to use - Unsignalized intersections (between signalized intersections) with a high frequency of right-angle or turning related crashes due to a lack of sufficient gaps in through traffic on the major road.

CATEGORY E: IMPROVE DRIVER AWARENESS

- **E1 – Improve visibility of intersections by providing enhanced signing and delineation** Where to use - Unsignalized intersections that are not clearly visible to approaching motorists, particularly approaching motorists on the major road. The strategy is particularly appropriate for intersections with patterns of rear-end, right-angle, or turning crashes related to lack of driver awareness of the presence of the intersection. Measures can include installing larger or supplementary regulatory and warning signs at intersections or providing dashed markings (extended left edge-lines) for major-road continuity across the median opening at divided highway intersection.
- **E2 – Improve visibility of the intersection by providing lighting** Where to use - Unsignalized, unlit intersections with substantial patterns of nighttime crashes. In particular, patterns of rear-end, right-angle, or turning crashes on the major-road approaches to an unsignalized intersection may indicate that approaching drivers are unaware of the presence of the intersection.

● **E3 – Install splitter islands on the minor-road approach to an intersection** Where to use - Minor road approaches to unsignalized intersections where the presence of the intersection or the stop sign is not readily visible to approaching motorists. The strategy is particularly appropriate for intersections where the speeds on the minor road are high.

- **E4 – Provide a stop line on minor-road approaches** Where to use - Approaches to unsignalized intersections having traffic control devices that are not currently being recognized by some approaching motorists. Locations should be identified by patterns of crashes related to lack of driver recognition of the traffic control device (e.g., right-angle crashes related to stop sign violations).
- **E5 – Install transverse rumble strips on intersection approaches** Where to use - Approaches to unsignalized intersections with traffic control devices that are not currently being recognized by some approaching motorists. Locations should be identified by patterns of crashes related to lack of driver recognition of the traffic control device (e.g., right-angle crashes related to stop sign violations). Rumble strips should be considered after an adequate trial of less intrusive treatments.
- **E6 – Provide supplementary stop signs mounted over the roadway** Where to use - Unsignalized intersections with patterns of right-angle crashes related to lack of driver awareness of the presence of the intersection. In particular, it might be appropriate to use this strategy at the first stop-controlled approach (possibly of a series) located on a long stretch of highway without any required stops, or at an intersection located after a sharp horizontal curve.
- **E7 – Provide pavement markings with supplementary messages, such as STOP AHEAD** Where to use - Unsignalized intersections with patterns of rear-end, right-angle, or turning crashes related to lack of driver awareness of the presence of the intersection.
- **E8 – Provide improved maintenance and retroreflectivity of stop signs** Where to use - All stop-controlled intersections.
- **E9 – Install flashing beacons at stop-controlled intersections** Where to use - Unsignalized intersections with patterns of right-angle crashes related to lack of driver awareness of the intersection on an uncontrolled approach and lack of driver awareness of the stop sign on a stop-controlled approach.
- **E10 – Add a warning beacon to an existing regulatory or warning sign (Provide flashing beacons at stop controlled intersections)** Where to use - Unsignalized intersections with a crash history or observed vehicle conflicts caused by non-compliance with a traffic control device or lack of awareness of intersection traffic control and where the existing sign is not conspicuous in its surroundings.
- **E11 – Provide intersection warning signs** Where to use - Unsignalized intersections with poor visibility of the intersection from approaches, a crash history or observed conflicts involving lack of awareness of the intersection or traffic control, and observed speeding on approaches to the intersection.
- **E12 – Provide Advance Traffic Control Warning signs (Install advance warning signs (positive guidance)** Where to use - Unsignalized intersections with poor visibility of the intersection traffic control from one or more approaches.
- **E13 – Install post-mounted reflective delineators at the intersection** Where to use - Unsignalized intersections with a history of nighttime crashes, remote stretches in which intersections may not be conspicuous to drivers along the major road, and poor nighttime visibility of the intersection.
- **E14 – Install reflective strips on sign posts** Where to use - Unsignalized intersections with 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, and observations of non-compliance with traffic control.
- **E15 – Provide a yield line on yield-controlled approaches** Where to use - Unsignalized intersections with a crash history or observed conflicts related to failure to yield to the right-of-way.
- **E16 – Replace standard stop sign with flashing LED enhanced stop sign** Where to use - Unsignalized intersections with a crash history or observed vehicle conflicts caused by non-compliance with traffic control device or lack of awareness of intersection traffic control, an existing sign that is not conspicuous in its current surroundings, and poor sign visibility during low-light conditions.
- **E17 – Install red or orange flags with a regulatory or warning sign** Where to use - Unsignalized intersections with conflicts caused by non-compliance with traffic control device or lack of awareness of intersection traffic control, an existing sign that is not conspicuous in its surroundings, and a recent change in traffic control or traffic regulation.
- **E18 – Enhance pedestrian signing** Where to use - Use such signs as a Pedestrian Warning sign (W11-2), Turning Vehicles Yield to Peds sign (R10-15), Pedestrian Crossing Sign (R1-5, R1-9, R9-2, R9-3), and In-Street Pedestrian Crossing Sign (R1-6) at unsignalized intersections with conflicts between vehicles and pedestrians crossing the roadway, vehicles that are not yielding to pedestrians in existing crosswalk or unmarked crosswalk.
- **E19 – Replace transverse crosswalk markings with high visibility markings** Where to use - Unsignalized intersections with conflicts between vehicles and pedestrians crossing the roadway, vehicles that are not yielding to pedestrians in existing crosswalk or unmarked crosswalk.
- **E20 – Provide advance yield line** Where to use - Unsignalized intersections with conflicts between vehicles and pedestrians crossing the roadway, vehicles that are not yielding to pedestrians in existing crosswalk.
- **E21 – Install crosswalk on one minor approach** Where to use - Unsignalized intersections with conflicts between vehicles and pedestrians crossing the minor street approach where there is no existing crosswalk.
- **E22 – Install object marker sign or keep right sign** Where to use – Unsignalized intersections along divided roadways with painted, grass, or raised medians.

CATEGORY F: CHOOSE APPROPRIATE INTERSECTION TRAFFIC CONTROL

- **F1 – Provide all-way stop-control at appropriate intersections** Where to use - Unsignalized intersections with patterns of right-angle and turning crashes and moderate and relatively balanced volumes on the intersection approaches.
- **F2 – Provide roundabouts at appropriate locations** Where to use - Unsignalized intersections that are experiencing right-angle, rear-end, and turning crashes. Roundabouts are appropriate at most intersections, and at intersections with large traffic delays roundabouts are oftentimes a superior alternative to all-way stop or signalization. Roundabouts can also be very effective at intersections with complex geometry (e.g., more than four approach roads) and intersections with frequent left-turn movements.
- **F3 – Provide pedestrian hybrid beacon** Where to use - Unsignalized intersections on roadways signed at 40 MPH or less with conflicts between vehicles and non-motorists crossing at the intersection, high volume of crossing pedestrians or bicyclists, vehicles not yielding to pedestrians in crosswalk, and high pedestrian delay due to few available gaps in traffic.
- **F4 – Provide rectangular rapid flashing beacon** Where to use - Unsignalized intersections on roadways signed above 40 MPH with conflicts between vehicles and non-motorists crossing at the intersection, high volume of crossing pedestrians or bicyclists, vehicles not yielding to pedestrians in crosswalk, and high pedestrian delay due to few available gaps in traffic.
- **F5 – Convert a unsignalized intersection to an unsignalized restricted crossing U-turn (also known as a J-turn)** Where to use - Unsignalized intersections with 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, and conflicts involving vehicles in the median.
- **F6 – Install a traffic signal** Where to use - Unsignalized intersections which satisfy the requirements of the MUTCD Section 4C, including: 8-hour vehicle volumes, 4-hour vehicle volumes, peak hour vehicle volumes, pedestrian volumes, school crossing proximity, the presence of a coordinated signal system or roadway network, or an at-grade rail crossing.
- **F7 – Install high-emphasis crosswalks** Where to use - Unsignalized intersections with pedestrian crossings.

CATEGORY G: IMPROVE COMPLIANCE WITH TRAFFIC CONTROL DEVICES AND TRAFFIC LAWS

● **G1 – Provide targeted enforcement to reduce stop sign violations** Where to use - Unsignalized intersections where stop sign violations and patterns of crashes related to stop sign violations have been observed. Crash types potentially related to stop sign violations include right-angle and turning collisions.

● **G2 – Provide targeted public information and education on safety problems at specific intersections** Where to use - Jurisdictions that have experienced a large number of safety problems at unsignalized intersections.

● **G3 – Install PED XING pavement markings** Where to use – Unsignalized intersections with uncontrolled pedestrian crossings, particularly at locations where crossings may not be expected by motorists.

● **G4 – Install STATE LAW STOP FOR PEDS signs** Where to use – Unsignalized intersections with uncontrolled pedestrian crossings, particularly along low speed roadways.

CATEGORY H: REDUCE OPERATING SPEEDS

● **H1 – Provide targeted speed enforcement** Where to use - Unsignalized intersections where speed violations and patterns of crashes related to speed violations are observed. Crash types potentially related to speed violations include right-angle, rear-end, and turning crashes.

● **H2 – Provide traffic calming on intersection approaches through a combination of geometric and traffic control devices** Where to use - Specific approaches to unsignalized intersections that are experiencing crash types potentially related to speed violations, specifically right-angle, rear-end, and turning collisions.

● **H3 – Post reasonable, safe, and consistent speed limits on intersection approaches** Where to use - Unsignalized intersections experiencing a high frequency of speed related violations or crashes.

● **H4 – Provide speed reduction pavement markings** Where to use - Unsignalized intersections with a citation history or observations of speeding on the approach to the intersection and conflicts due to lack of awareness of the intersection.

● **H5 – Provide a dynamic speed feedback sign** Where to use - Unsignalized intersections with a citation history or observations of speeding on approach to intersection, change in speed limit or land use (e.g., change from rural to urban), and changeable speed limit by time and day of the week (e.g., during school hours).

● **H6 – Provide smooth lane narrowing** Where to use - high-speed, uncontrolled approaches of two-lane two-way stop-controlled intersections with low traffic volumes to reduce speeds when approaching such intersections. Lane narrowing can be accomplished through pavement markings or a combination of pavement markings and edge line/shoulder/median rumble strips.

● **H7 – Raised bicycle crossings** Where to use - Unsignalized intersections experiencing a high frequency of vehicles failing to yield to pedestrians and/or bicycles, especially across dedicated pedestrian/bicycle paths.

● **H8 – Raised intersections** Where to use - Unsignalized intersections experiencing a high frequency of vehicles failing to yield to pedestrians and/or bicycles, especially involving vehicles approaching intersections at high speeds.

CATEGORY I: GUIDE MOTORISTS MORE EFFECTIVELY

● **I1 – Provide turn path markings** Where to use - Complex unsignalized intersections with a high frequency of crashes related to turning vehicle positioning (e.g., sideswipe crashes).

● **I2 – Provide a double yellow centerline on the median opening of a divided highway at intersections** Where to use - Unsignalized intersections on divided highways that are experiencing a high degree of crashes caused by side-by-side queuing and angle stopping within the median area.

● **I3 – Provide a double yellow centerline on the minor road approaches** Where to use - Unsignalized intersections with conflicts between stopped vehicles and turning or oncoming vehicles and poor vehicle positioning.

● **I4 – Provide dotted edge-line extensions** Where to use - Unsignalized intersections with vehicles on the minor approaches not positioning themselves appropriately before entering the major road and vehicles in the median of a divided roadway that are encroaching upon the major road through lane.

- = Low-Cost Countermeasure
- = Moderate-Cost Countermeasure
- = High-Cost Countermeasure

SAFETY CONCERN	UNSIGNALIZED COST		
	● Low	● Moderate	● High
High frequency of right-angle crashes attributed to:			
nearby driveways	A2, C1, C3	A1, B6, B8	
traffic from cross street	C1, C3, D2, E4	B6, B8, D1	A3, F2, F6
skewed intersection			B11, C2, F2
poor sight distance	C1, C3, C4, H3	D1	C2, F2
drivers misjudging gaps	H3, H6	A4, D1	F2, F5
not enough gaps for drivers	D2, F1	A4	B9, F2, F5, F6
driver unaware of intersection	E1, E4-E14, E16, E17	E3	
nighttime conditions	E8	E2	
failure to yield at stop or yield sign	E1, E4, E15, E20	G1	F2
possible signal location			F2, F6
heavy but balanced traffic flow			F2
speed differentials for vehicles	H3, H6	A4, H1, H2	F2, H8
High frequency of rear-end crashes attributed to:			
left turning vehicles hit from behind	B3	B1, B2, B3	F2
left opposing vehicles hit from behind		B2	F2
trucks and RVs entering divided highway		B4	
speed differentials of entering vehicles		B4	F2
right turning vehicles hit from behind		B5, B6	B11, F2
approaching vehicles hit from behind		B7	
no left turn lane and high opposing traffic		B8	
driver unaware of intersection	E1, E5-E14, E16, E17	E3	
nighttime conditions		E2	
speed differentials of vehicles	H3, H4, H6	H1, H2, H5	F2
High frequency of left-turn crashes attributed to:			
left turn vehicles hit by opposing traffic	E22	B1	B10, B14, C2, F2, F5, F6
trucks and/or RVs entering divided highway		B4	
no left turn lane and high opposing traffic		B8	F6
nighttime conditions	E10	E2	
heavy but balanced traffic flow			F2
nighttime conditions			C2
High frequency of sideswipe crashes attributed to:			
speed differential of entering vehicles	H6		F2
vehicles within intersection	I1, I2	B12	
vehicles approaching intersection	E15, I3		
High frequency of run off road crashes:			
approaching intersection	I4	B7	
High frequency of pedestrian/bicycle crashes:			
with approaching vehicles	E18-E20, E21, F7, G3, G4	B12-B13, F3-F4, H2, H7	F6, H8
Address overall safety issues:			
violation of traffic laws	G2	G1	

The majority of the countermeasure information and the format of this information was obtained from FHWA’s “Unsignalized Intersection Safety Strategies”. This information was supplemented with additional countermeasure considerations from FHWA’s CMF Clearinghouse