



COUNTERMEASURE GLOSSARY



Segment
Improvements



Bike and Pedestrian
Improvements



Intersection
Improvements



Visibility
Improvements



Signal Timing



Jurisdiction-wide
Maintenance



SEGMENT IMPROVEMENTS

Improve safety along roadway segments by addressing roadway departures, roadside hazards, passing conflicts, speed, pavement conditions, conflict points, and roadway geometry. Treatments include rumble strips, barriers, shoulder and curve improvements, pavement treatments, passing lanes, access management, and speed management.

Rumble/Mumble Strips



Shoulder or centerline rumble strips provide auditory and tactile feedback if motorists exit the travel lane. Sinusoidal mumble strips provide the same or better benefits of traditional rumble strips, but produce less exterior noise. The CDOT Roadway Design Guide references the AASHTO recommendation that a 4-foot width on the shoulder beyond the rumble strip is the minimum for safe bicycling. Rumble strips should not be installed with guardrail on shoulders that are less than 6 feet wide.

Guardrail



Provide a protective barrier between the roadway and roadside hazards, such as steep slopes (when horizontal-to-vertical ratio is 4:1 or greater), trees, utility poles, or bridge supports, to reduce crash severity. If the shoulder width is 6 feet or less, the guardrail should be offset an additional 2 feet from the edge of the paved shoulder. If the shoulder width is 8 feet or greater, no additional offset is required. To provide safe accommodations for bicyclists there should be at least 6 feet between the edgeline and the guardrail or the 6 feet between the edgeline and the edge of the paved shoulder. Guardrail design should be done in coordination with known wildlife movements to mitigate wildlife-vehicle collisions.

Raised Median or Center Barrier



Raised medians or barriers separate motorized vehicles traveling in opposing directions, reducing potential for head-on and sideswipe crashes. Where applicable median barriers should be designed in coordination with known wildlife movements to mitigate additional wildlife-vehicle collisions.

Roadside Design Improvements at Curves



Roadside design improvements such as flattened side slopes (more applicable to highway geometries), widened shoulder, or widened clear zone can provide drivers a chance to regain control of a vehicle. Such improvements help to mitigate run-off-road and head-on crashes.



Enhanced Curve Delineation

Enhanced curve delineation improves safety by clearly marking curves with signs, reflectors, and pavement markings, helping drivers navigate safely and reducing the risk of run-off-road crashes.



Curve Warning Signs

Use advance warning signs and advisory speed plaques to improve driver awareness of horizontal curves, encouraging speed reduction and reducing roadway departure crashes.



Edge Line

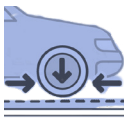
Edge lines can increase visibility of the edge of roadway to reduce the incidence of vehicles leaving the road.

Increase Shoulder Width



Increasing shoulder width enhances safety by providing additional space for vehicle recovery, emergency stops, breakdowns, and non-motorized users, reducing the risk of run-off-the-road crashes and other collisions.

High Friction Surface Treatment



High friction surface treatments apply aggregates to maintain or increase friction which can increase motorists' ability to stop and reduce crashes (Wet or Dry Conditions). Locations with high friction demand include horizontal curves, steep grades, and intersections where greater friction is needed to help keep vehicles on the road and reduces stopping distance, particularly in wet weather.



No-Passing Zone

No-passing zones are designed to enhance safety by preventing dangerous passing maneuvers in areas where visibility and road conditions make passing particularly hazardous.



Passing Lane

Provides passing opportunities on two-lane roadways, reducing risky passing maneuvers, driver frustration, and the potential for head-on crashes.

2 + 1 Lane Configuration



Provides alternating passing lanes in each direction, separated by a median barrier, allowing drivers to safely pass slower vehicles without entering opposing traffic. Where applicable median barriers should be designed in coordination with known wildlife movements to mitigate additional wildlife-vehicle collisions.



Pave Road

Enhance roadway surfaces and make targeted geometric improvements, particularly at curves, to improve vehicle stability, reduce roadway departure crashes, and extend pavement life.

Access Control Plan



Optimize the design and control of roadway access points, typically using medians at driveways and intersections, to reduce conflict points, limit left turn movements to strategic locations with updated intersection control, and add new pedestrian crossings.



Winter Maintenance

Remove snow and ice and apply anti-icing or deicing materials to improve roadway safety and mobility during winter weather.

Speed Management

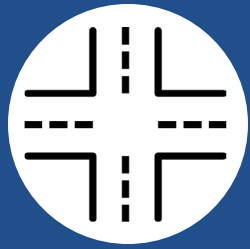


May include any or all of the following depending on roadway context, often implemented as part of a package of improvements to reduce operating speeds: roadway design changes to reduce vehicle speeds (such as horizontal curvature, lane shifts, speed tables, roundabouts, bulb outs, medians, narrowed lanes, optical speed bars, etc.), gateway treatments, roadway repurposing, evaluating to reduce speed limit, speed feedback signs, and automated speed enforcement. Reductions in speed limits generally should be paired with design improvements to facilitate driver compliance.



Wildlife-Vehicle Crash Mitigation

Being developed as part of separate project.



INTERSECTION IMPROVEMENTS

Improve intersection safety by reducing conflict points, managing speeds, increasing awareness, and improving the organization of vehicle and pedestrian movements. Treatments include turn lanes, access restrictions, roundabouts, traffic signals, enhanced stop control, warning systems, geometric modifications, and other intersection safety treatments.



Positive Left Turn Offsets

This intersection design improves the sight distance for drivers making left turns, reducing the likelihood of collisions with oncoming traffic.



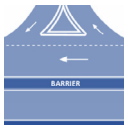
Left Turn Median Acceleration Lane

Allow left-turning vehicles to enter a median acceleration lane, gain speed, and merge with through traffic, reducing speed differentials and conflict potential.



Dedicated Turn Lane

Auxiliary turn lanes provide physical separation between turning traffic (that is slowing or stopped) and adjacent through traffic at approaches to intersections or driveways.



Convert Full Movement Access to RISO or $\frac{3}{4}$ Movement

Restricting left turn movements at uncontrolled intersections reduces vehicle conflicts, reduces crashes and improves the movement of traffic.

Roundabout



Roundabouts are circular intersections that safely and efficiently move traffic. Roundabouts feature channelized, curved approaches that reduce vehicle speed, entry yield control that gives right-of-way to circulating traffic, and counter wise flow around a central island that minimizes conflict points.

Far Side Two-Direction Large Arrow Sign at T-Intersections



Two-direction large arrow signs on the far side of T-intersections improve driver guidance, enhance visibility, and reduce roadway departure and intersection crashes.



Signal

This includes converting a stop-controlled intersection to a signalized intersection



Oversized Double-Posted Stop Signs

Large stop signs on both sides of the roadway to increase sign visibility, and improve driver awareness.



Cross Rumble Strips at Stop-Controlled Approaches

Transverse rumble strips in advance of stop-controlled intersections to alert drivers, encourage speed reduction, and improve stop sign compliance.



Hardened Centerline

Extends the centerline of a road to the crosswalk using delineators or other means, reducing left turning motorist speeds, which can minimize left turn crashes into pedestrians.



Tighten the Turn Radius

Tighten the turn radius at an intersection to slow turning vehicles, reduce exposure, and increase visibility of pedestrians.



Red Light Cameras

Red light cameras enhance safety by automatically detecting and recording vehicles that run red lights, deterring traffic violations and reducing the risk of intersection-related collisions.

Intersection Conflict Warning System (ICWS)



Provide activated warnings to drivers at intersections where poor sight distance or gap acceptance have contributed to higher crash rates. They are typically comprised of static signing, a dynamic element, and detection



SIGNAL TIMING

Modify traffic signal timing and phasing to reduce conflicts, improve pedestrian and bicycle safety, and provide safer and more efficient vehicle movements. Treatments include protected turn operations, pedestrian intervals and timing, red-light protection, turn restrictions, and signal coordination.



Leading Pedestrian Intervals (LPI)

LPIs give pedestrians a head start when crossing an intersection and reduce crashes by making pedestrians more visible to right or left turning vehicles.



Prohibit Right Turn on Red

Eliminates the conflict between right-turning vehicles and pedestrians/bicyclists crossing the intersection or with cross-traffic.



Red Protection / Decision Zone Detection

Predicts red light runner based on speed and distance. Delays the perpendicular green by a few seconds to prevent a near-miss and actual crashes.

Appropriate Left Turn Signal Operation



At locations with visibility issues or limited gaps, only allow left turns with a green arrow. This can also be implemented when a pedestrian in the conflicting crosswalk activates a pedestrian signal or at certain times of day. Protected-permitted operations may mitigate crash issues where visibility is adequate and gaps are more available. Use a flashing yellow arrow (FYA) when permitted movements are allowed. Flashing yellow arrows can also be set to be gap dependent, such that a red arrow will continue (and the FYA will not begin) until there is a detected gap in opposing traffic.

Pedestrian-Protected Left Turn Signal Operation



Uses signal phasing to separate left-turning vehicles from pedestrians only when pedestrians activate the crossing, eliminating the need for drivers to yield to pedestrians while turning.



Protected-Only Right Turn Operation

Only allow right turns with a green arrow (requires exclusive right turn lane).



Pedestrian Recall Signal Timing

The walk phase is automatically called every cycle.



Shorten the Cycle Length

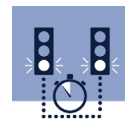
Adjust the signal timing to reduce the wait time before the "WALK" phase.



Extend the "WALK" Phase

Extend the "WALK" (and associated flashing "DON'T WALK") phase to occur for a longer time period (at least for the full phase of the parallel green).

Signal Coordination



Synchronize traffic signals in a corridor to create smooth traffic flow, reducing stop-and-go driving, and minimizing the likelihood of collisions at intersections. In corridors with closely spaced signals, coordination can result in tighter platoons of vehicles, resulting in larger gaps for left turning vehicles at unsignalized intersections and pedestrians crossings between signals. Signals can also be timed to reduce operating speed.



BIKE & PEDESTRIAN IMPROVEMENTS

Reduce conflicts between motor vehicles and people walking and bicycling by providing dedicated facilities, safer crossings, and greater separation from motor vehicle traffic. Treatments include sidewalks, bicycle facilities, shared-use paths, enhanced crossings, reduced crossing distances, and two-stage bicycle crossings.

New or Upgraded Pedestrian Crossing



This may include one or more of the following depending on context: high visibility crosswalk and signs, shortened crossing distance, pedestrian refuge medians, raised crosswalks, Rapid Rectangular Flashing Beacons (RRFB), Pedestrian Hybrid Beacon, traffic signal, or overpass/underpass. To meet ADA standards pedestrian crossings are required to connect to a pedestrian walkway.



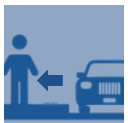
Shorten Pedestrian Crossing Distance

Remove or narrow turn lanes, through lanes, or parking lanes and/or tighten the turn radius at an intersection to reduce the crossing distance and exposure of pedestrians at a crossing.



New or Upgraded Bike Facility

Add a dedicated protected on-street bike facility or shared-use path.



Setback of Shared-Use Path

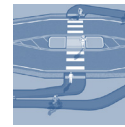
Bend the sidewalk or shared-use path parallel to a major street to cross the minor street 15 to 25 feet prior to the intersection to allow a driver to yield to the path crossing and cross traffic separately.



New or Upgraded Sidewalks

Sidewalks provide a designated space for pedestrians that are separated from travel lanes used by motorized vehicles.

Painted Median for Two-Stage Bicycle Crossing



A painted yellow median island at least 6' wide on major road approaches of a side-street stop-controlled intersection with shoulder and median rumble strips effectively creates narrow travel lanes to slow approaching vehicles while also allowing a two-stage crossing for bicyclists.



VISIBILITY IMPROVEMENTS

Improve drivers' ability to recognize approaching traffic, roadway alignment, traffic controls, and other potential hazards with sufficient time to respond. Treatments include removing sight obstructions, improving signal visibility, installing advance warning signs, and evaluating locations where roadway geometry limits sight distance.



Remove Obstacles that Impair Sight Lines

Increase the line of sight by clearing vegetation and embankments, relocating objects (signs, fences, etc.), and implementing parking restrictions.



Improve Signal Visibility

Remove obstructions, add signal heads, add signal heads in more visible locations, and/or add advance warning signage or beacons.



Advance Warning Signage

Signs can be placed ahead of signalized intersections, curves, or other hazards to inform drivers of upcoming conditions or actions they need to take.

Further Study to Address Intersection Visibility



At stop-controlled intersections where topography may impair sightlines (e.g., horizontal or vertical curves in the roadway, or rock faces) further study may be warranted to evaluate the appropriate mitigation strategy, which may include speed management, restricting left turn movements, or other countermeasures.

Evaluation of roadway network alternatives may be needed.



JURISDICTION- WIDE MAINTENANCE

Maintain and upgrade traffic control devices, pedestrian facilities, lighting, and other safety infrastructure across the roadway network to provide consistent visibility, accessibility, and operation.



Regular Maintenance of Crosswalk

Maintain crosswalks to be clearly visible at all times.



Yellow and All-Red Change Intervals

It is imperative that the yellow and red change intervals be appropriately timed and assessed frequently.



Backplates with Retroreflective Borders

Backplates added to a traffic signal head improve the visibility of the illuminated face of the signal by introducing a controlled-contrast background.



One Signal Head per Lane

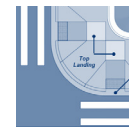
Increases visibility of signal heads and reduces potential for motorist confusion about signal phase.

Regular Maintenance of Faded Signage/Striping on Major Roads

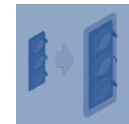


Regular maintenance of faded signage and striping on major roads enhances safety by ensuring that traffic control devices remain visible and effective, helping drivers navigate safely and reducing the risk of collision.

ADA Compliant Directional Curb Ramps



Retrofitting existing curbs or constructing new curbs to comply with ADA standards, while also providing two ramps per intersection corner (from the sidewalk grade to the street crossing grade) to direct pedestrians in the correct orientation of the crosswalk. As compared to diagonal curb ramps, directional curb ramps can shorten the crossing distance, minimize pedestrian conflict with traffic, and improve visibility and predictability of pedestrians.



Upgrading to 12" LED Signal Heads

Signal replacement, including upgrading to 12" LED signal heads, enhances safety by improving signal visibility and reliability, ensuring that drivers can clearly see and respond to traffic signals.



Lighting

Adding lighting can improve visibility of the intersection and roadway and mitigate vehicle-vehicle conflicts and vehicle-pedestrian/bicyclist conflicts.