



Toolbox of Safety Countermeasures

The Weld County Safety Action Plan has a toolbox of infrastructure countermeasures, from engineering and design solutions like signage or lane reconfiguration to education campaigns, that raise awareness about safe road behaviors.

Audience

This toolbox is simple, straightforward, and created for a wide range of users. Although the primary audience is transportation professionals and safety advocates in roles where they have an impact on what projects are implemented within their community (such as members of a Planning or Public Works department), this toolbox was designed to ensure that anyone could pick it up and understand what these countermeasures are, their benefits, and their applications.

Weld County has a variety of different contexts that affect which countermeasures are most appropriate for a given situation. This toolbox features 48 countermeasure tools broken into three sections, dividing countermeasures by the appropriate land use areas:



All Weld County Countermeasures (Rural-Urban)



Jurisdictions in Action Plan Countermeasures (Urban)



Unincorporated Countermeasures (Rural)

These countermeasures are also labeled with applicable emphasis areas (Behavioral, Environmental, Infrastructure, or Modes of Travel) to help make the transportation network safer and more accessible for all road users, regardless of the cause, location, or preferred travel method. The toolbox can be utilized in conversations around safety, especially in reaching a shared understanding about creating a safer roadway system for all.

With this toolbox, Weld County can tailor its approach to specific road user groups, locations, and conditions, ensuring a holistic and effective strategy towards creating safer roads for all users.



Attribute Descriptions

Each countermeasure includes the following:

Applicable Emphasis Area: Indicator of the primary type of crash the countermeasure is used to combat; however, this does not indicate an exhaustive list of crash types that could benefit from the countermeasure.

Name: The title of the countermeasure.

Description: 1-2 sentences describing the countermeasure.

Crash Reduction Factor: The potential reduction of crashes due to the implementation of a countermeasure for all crash severities and types, with exceptions for roadway lighting, cable median barrier, and all pedestrian and bicycle safety related countermeasures.

Cost: The relative cost for the countermeasure.

- \$ <\$10k
- \$\$ \$10k – \$100k
- \$\$\$ \$100k – \$1M
- \$\$\$\$ \$1M+

Traffic Consideration: Traffic considerations are factors (such as roadway geometry, traffic volume, and number of lanes) that help users decide if a countermeasure may be a good fit for a potential area or project; as behavioral countermeasures are not dependent on the existing geometry of the roadway network, general considerations (such as crash history) are the factors considered.





All Weld County Countermeasures

Emphasis Area	Name	Description	Crash Reduction Factor	Cost	Traffic Consideration
Behavioral	Mass Media Campaigns	Mass media campaigns are intensive communication and outreach activities focusing on key topics regarding safety, health, and well-being (such as driving under the influence) that use radio, television, print, social, and other mass media platforms.	Varies	\$\$	See NHTSA Countermeasures That Work: Mass Media Campaigns
Environmental	Road Safety Audit (RSA)	A RSA is a safety performance review of a roadway segment or intersection by a multidisciplinary team as a part of a project development process; RSAs investigate existing infrastructure, mode use, and other factors.	NA	\$	Can be employed on any type of facility and during any stage of the project development process, including existing facilities that are open to traffic. RSAs conducted during the pre-construction phase can be particularly effective because there is an opportunity to address a number of safety issues.
Environmental	Speed Limit Reduction / Slow Zones	1. Speed limit reductions, based on context and activity level, reduce crashes by lowering speeds and increasing sign frequency. 2. Slow zones designate lower speeds (15 - 20 mph) in areas with vulnerable populations, like parks, school zones, and neighborhoods.	25%	\$\$\$	1. - 2. <5,000 ADT
Environmental	Lateral Shift	A lateral shift is a shift of an otherwise straight street to reduce motor vehicle speeds, typically through the use of a median island.	NA	\$\$	Speed limit ≤ 35 MPH Midblock locations only, preferably near a streetlight
Environmental	Gateway Signing / Landscaping	Gateway signing / landscaping is a way to give warning to motorists entering a denser region of the county from a more rural area. Landscaping can also be used to calm traffic by visually narrowing the roadway.	30%	\$\$	

Success Story: Lane Reconfigurations in Genesee County (Michigan)

A technical study in Genesee County was completed that evaluated more than 140 miles of four-lane roads to identify potential for reduction to three lanes. After analyzing traffic impact, crash history, and other operational features, a ranking of the best candidates for lane reconfigurations was created for easier project identification and prioritization. After implementing several lane reconfiguration projects, the Genesee County Metropolitan Planning Commission conducted a before-after analysis of 7 project locations over an 11-year period. Results showed an overall reduction of crashes:

- A 32% reduction in head-on crashes
- A 58% reduction in left-turn crashes
- A 35% reduction in rear-end crashes
- A 36% reduction in rear-end left-turn crashes
- A 33% reduction in side-swipe same side crashes
- A 39% reduction in side-swipe opposite side crashes
- A 32% reduction in all non-alcohol and non-deer crashes

The space created from the reduced lane can also be used in other ways to improve the roadway like added bike lanes, pedestrian pathways, or parking. Lane reconfiguration can improve safety, calm traffic, and provide better mobility/access for all road users.³

³ rdig.pdf





All Weld County Countermeasures

Emphasis Area	Name	Description	Crash Reduction Factor	Cost	Traffic Consideration
Infrastructure	All-Way Stop Control Conversion	All-way stop control converts either two-way stops or unwarranted signals to four-way stops, reducing wait times and making intersections more predictable. This countermeasure can also serve as a temporary solution for other, more expensive traffic control solutions, such as roundabouts.	70%	\$	<12,000 ADT(each approach) <=2 thru-lanes (each approach)
Infrastructure	Lane Narrowing	Lane narrowing shrinks roadway width while keeping the same number of lanes, slowing traffic, shortening pedestrian crossings, and allowing for the reclaimed space to be used for on-street parking or for adding bike/pedestrian facilities.	25%	\$\$	Avoid on truck routes
Infrastructure	Lane Reconfiguration	Lane reconfigurations reduce the number of lanes, cutting conflict points, crossing distances, and vehicle speeds. In rural areas without sidewalks, increasing the paved shoulder width by removing a travel lane can accommodate non-motorized users.	35%	\$\$-\$\$\$\$	4-to-2 thru lanes: <18,000 ADT 6-to-4 thru lanes: <36,000 ADT
Infrastructure	Lighting	Street lighting improves visibility, especially at intersections, crosswalks, and other high-traffic areas, reducing crashes and enhancing pedestrian safety.	20%	\$\$	History of nighttime crashes
Infrastructure	Reduced Left-Turn Conflict Intersections	Reduced left-turn conflict intersections redesign left turns to reduce crashes and improve safety. Common types include RCUTs (which modifies the cross-street approach) and MUTs (which modifies the major approaches).	35%	\$\$\$\$	Prior condition: stop-controlled or signalized





All Weld County Countermeasures

Emphasis Area	Name	Description	Crash Reduction Factor	Cost	Traffic Consideration
Infrastructure	Systemic Crossing Modifications	Systemic crossing modifications improve pedestrian safety and accessibility across busy streets with marked crosswalks, lighting, refuge islands, and clear signage.	30%	\$\$	See FHWA STEP Guide, Table 1
Infrastructure	Flashing Yellow Arrows (FYA)	FYA traffic signals feature a flashing yellow arrow in addition to the standard red, yellow, and green arrows. When illuminated, the FYA allows waiting motorists to make a left-hand turn after yielding to oncoming traffic. FYAs reduces driver confusion when turning.	25%	\$	See FHWA MUTCD, Chapter 4A.04
Infrastructure	Protected Left-turn Only Phasing	Protected left-turn only phasing provides a green arrow for left-turning vehicles while stopping oncoming traffic and parallel pedestrians. This phasing improves safety by limiting confusion and limiting traffic conflicts.	40%	\$-\$\$	See FHWA Pedestrian Safety Guide and Countermeasure Selection System, Left-Turn Phasing
Infrastructure	Retroreflective Backplates	Retroreflective backplates increase the visibility of traffic signals; they also alert drivers to intersections during power outages.	15%	\$	
Infrastructure	Modern Roundabout	1. Single-lane roundabouts reduce traffic speed, eliminate dangerous angle crashes, and shorten crossing distances for pedestrians. 2. Multi-lane roundabouts handle more traffic but have more conflicts than single-lane roundabouts. Turbo roundabouts add dividers to improve safety.	70%	\$\$- \$\$\$\$	<30,000 EADT <45,000 EADT





All Weld County Countermeasures

Emphasis Area	Name	Description	Crash Reduction Factor	Cost	Traffic Consideration
Infrastructure	Intersection Conflict Warning System (ICWS)	An ICWS provides warnings to drivers through warning signs and beacons of potential conflicting vehicles approaching an unsignalized intersection. ICWSs can be installed on the major and/or minor approach.	30%	\$-\$\$	History of angle crashes See FHWA MUTCD for signage and beacon placement guidance
Infrastructure	Corridor Access Management	Corridor access management reduces driveway density (i.e., the number of entry and exit points along the roadway, including intersections) to reduce trip delay and congestion, facilitate walking and biking, and enhance safety for all modes of transportation.	25%	\$-\$\$\$\$	Reanalyze access management after substantial land use changes or development, as travel patterns change, and at time of roadway widening or reconstruction.
Infrastructure	Dedicated Turn Lanes (Intersection) / Offset Turn Lanes	Dedicated turn lanes separate and protect turning vehicles from travel lanes, providing deceleration before a turn and storage of vehicles waiting to turn. Offsetting turn lanes increases visibility these vehicles, especially at locations with higher speeds or where free-flow or permissive movements are possible.	50%	\$\$\$	History of rear-end crashes and/or queueing-related issues





Jurisdictions in Action Plan Countermeasures

Emphasis Area	Name	Description	Crash Reduction Factor	Cost	Traffic Consideration
Behavioral	High-Visibility Saturation Patrols	A saturation patrol consists of law enforcement officers patrolling a specific area looking for impaired drivers; these patrols usually occur at times and locations where impaired-driving crashes commonly occur and should be publicized extensively and conducted regularly.	NA	\$\$	See NHTSA Countermeasures That Work: High-Visibility Saturation Patrols
Behavioral	Publicized Sobriety Checkpoints	Sobriety checkpoints are highly visible, regularly conducted stops of motorists at predetermined locations to investigate whether motorists are impaired. Stops are conducted per vehicle or at a regular interval (e.g., every third vehicle).	10%	\$\$	See NHTSA Countermeasures That Work: Publicized Sobriety Checkpoints
Behavioral	Automated Enforcement	Automated enforcement uses cameras to detect and document traffic violations like red light running and speeding, notifying vehicle owners by mail.	25%	\$\$	Data-informed location selection
Behavioral	Integrated Enforcement	Integrated enforcement is a type of high visibility enforcement focused primarily on behavioral activities, such as driving under the influence, speeding, and seat-belt usage, and is seen in both regular traffic enforcement / crash investigations and specialized checkpoints / saturation patrols.	Varies	\$\$	See NHTSA Countermeasures That Work: Integrated Enforcement
Infrastructure	Intersection Daylighting	Intersection daylighting improves the sight distance for road users as they enter and navigate an intersection by restricting curbside vehicle parking spaces or clearing of sight distances leading up to an intersection. Restrictions can be accomplished through the use of pavement markings and flexible guideposts.	30%	\$\$	Intersections with high pedestrian traffic History of crashes due to limited sight distance

Success Story: Carmel, Indiana, and the use of roundabouts

Carmel, Indiana, took their passion for roadway safety and channeled it into creating a town with more roundabouts than any other city in the U.S. This conversion of intersections into roundabouts lead to a 47% reduction in overall injury crashes. Their circular design reduces the likelihood of severe collisions by better managing speed and traffic flow, with roundabouts being well known for their safety and efficiency in managing traffic volumes.⁴

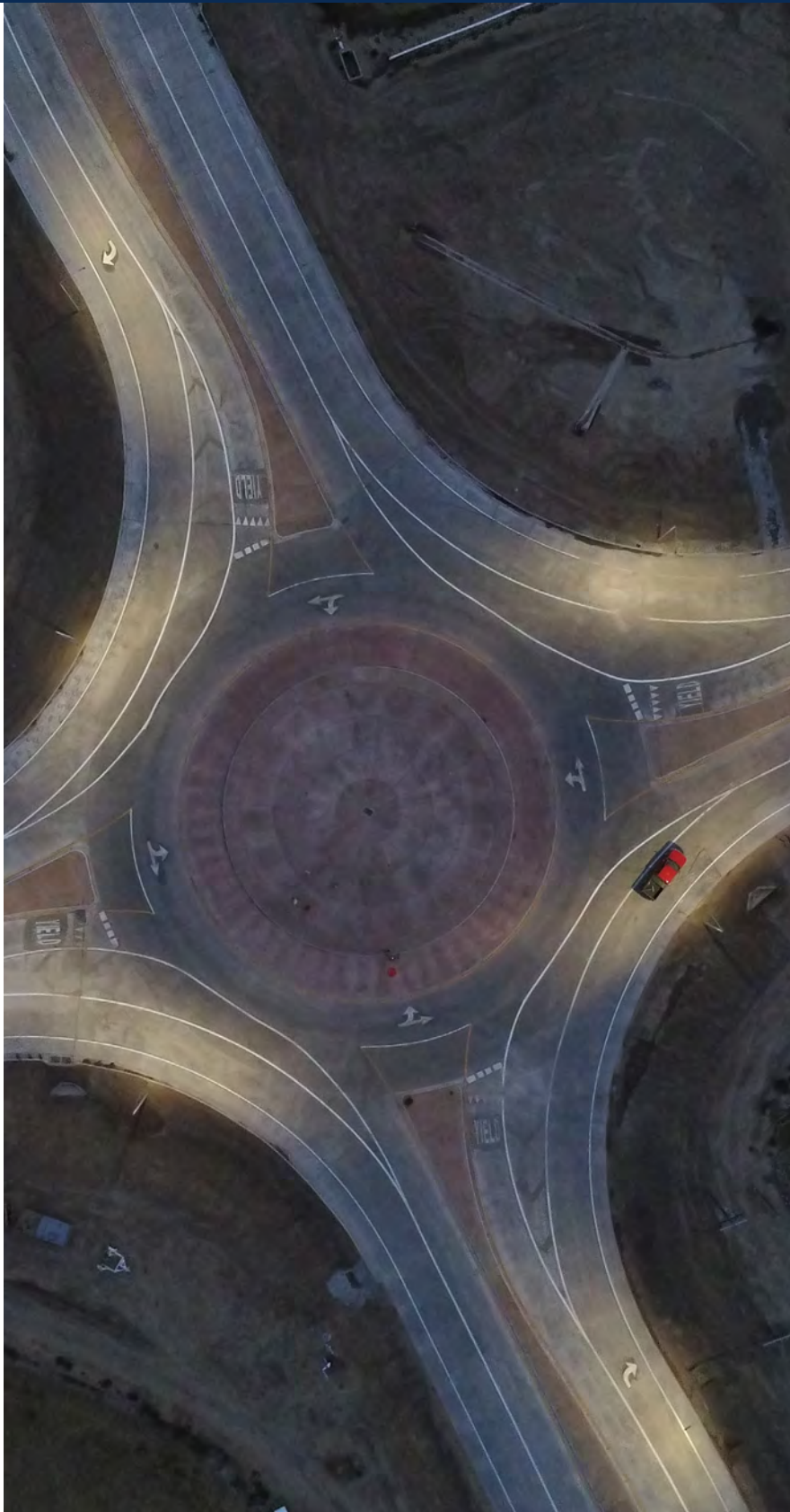
⁴ Yes, Carmel's roundabouts have a huge impact in reducing crashes | wthr.com





Jurisdictions in Action Plan Countermeasures

Emphasis Area	Name	Description	Crash Reduction Factor	Cost	Traffic Consideration
Infrastructure	Leading Pedestrian Intervals (LPI)	LPIs give pedestrians 3-7 seconds of crossing time before vehicles are given a green light; LPIs increase pedestrian visibility, increase the yielding behavior of motorists, and can provide additional time to cross.	10%	\$-\$\$	See Pedestrian Safety Guide and Countermeasure Selection System (PEDSAFE)- Leading Pedestrian Interval
Infrastructure	Raised Medians	Medians separate traffic, reducing head-on collisions and providing safe havens for pedestrians. Raised medians can be used in conjunction with corridor access management strategies (e.g., reducing driveway access points).	25%	\$\$\$\$	History of head-on and angle collisions
Infrastructure	Mini-Roundabout	Mini-roundabouts are smaller, single-lane versions of traditional roundabouts with traversable centers for larger vehicles without requiring additional ROW.	35%	\$\$-\$\$\$	<20,000 EADT
Modes of Travel	Raised Crosswalk / Raised Intersection	Raised crossings improve pedestrian safety and accessibility by slowing traffic and providing a level crossing surface flush with the sidewalk while simultaneously encouraging motorists to yield. Raised crossings can be extended to cover an entire intersection.	30%	\$\$	(see FHWA STEP Guide, Table 1)
Modes of Travel	Rectangular Rapid Flashing Beacon (RRFB)	RRFBs use flashing lights to improve safety at unsignalized crosswalks, especially multilane crossings under 40 mph.	45%	\$\$	(see FHWA STEP Guide, Table 1)





Jurisdictions in Action Plan Countermeasures

Emphasis Area	Name	Description	Crash Reduction Factor	Cost	Traffic Consideration
Modes of Travel	Pedestrian Hybrid Beacon (PHB)	PHBs use flashing lights to improve driver yielding to pedestrians at unsignalized crossings, especially on higher-speed roadways.	55%	\$\$\$	(see FHWA STEP Guide, Table 1)
Modes of Travel	High Visibility Crosswalk	High visibility crosswalks create a visible place for pedestrians and bicyclists to cross using a combination of high visibility crosswalk markings, parking restrictions, advance pavement markings/signs, curb extensions, and lighting.	40%	\$\$	Areas of high pedestrian traffic
Modes of Travel	Bicycle Lanes	Bicycle lanes make cycling safer and more comfortable by separating cyclists from traffic and pedestrian facilities using paint or physical barriers.	45%	\$\$	<6,000 ADT and <35 MPH
Modes of Travel	Curb Extensions	Curb extensions and bulb-outs shorten crossing distances, improve visibility, and reduce vehicle speeds by narrowing the roadway. Curbs can be extended at midblock crossings or at intersections.	30%	\$\$	Avoid at high truck-volume intersections





Unincorporated Weld County Countermeasures

Emphasis Area	Name	Description	Crash Reduction Factor	Cost	Traffic Consideration
Environmental	Center Line Buffer Area	A center line buffer area provides extra space between the two solid center line markings, further separating opposing directions of traffic. The width of the buffer area can range between two to ten feet.	35-90%*	\$	No-passing zones with adequate ROW History of head-on crashes
Environmental	Enhanced Curve Delineation	Enhanced curve delineation uses a combination of signs and pavement markings to significantly reduce curve crashes, such as chevrons, in-lane curve warning pavement markings, retroreflective strips on signposts, delineators, and dynamic warning signs / chevrons.	30%	\$\$	Existing sideslope and distance to roadside features History of roadway departure, nighttime crashes, or crashes during inclement weather
Environmental	Roadside Design Improvements at Curves	Roadside design improvements, including the establishment of clear zones, flattening slopes, adding or widening shoulders, or installing roadside barriers, allow for a safe recovery for a motorist who has left the roadway or to stop safely.	20%	\$-\$\$	History of lane departure crashes
Environmental	Local Road Safety Plan (LRSP)	A LRSP is a plan that identifies, analyzes, and prioritizes roadway safety improvements on local county roads utilizing public and stakeholder engagement, RSA, data analyses, and more.	25%		
Environmental	Rumble Strips & Stripes	Rumble strips and stripes (strips that have pavement markings painted over them) alert drivers to lane departure, reducing head-on and run-off-the-road crashes. Rumble strips/stripes can be placed at the center line, edge line, or on the shoulder.	15%	\$\$	Can be in both passing and no passing zones wherever an agency has identified risk factors (such as lane width, shoulder width, median type, horizontal curvature, or crash history)

Countermeasures in Action Washington County (Kansas) Curves

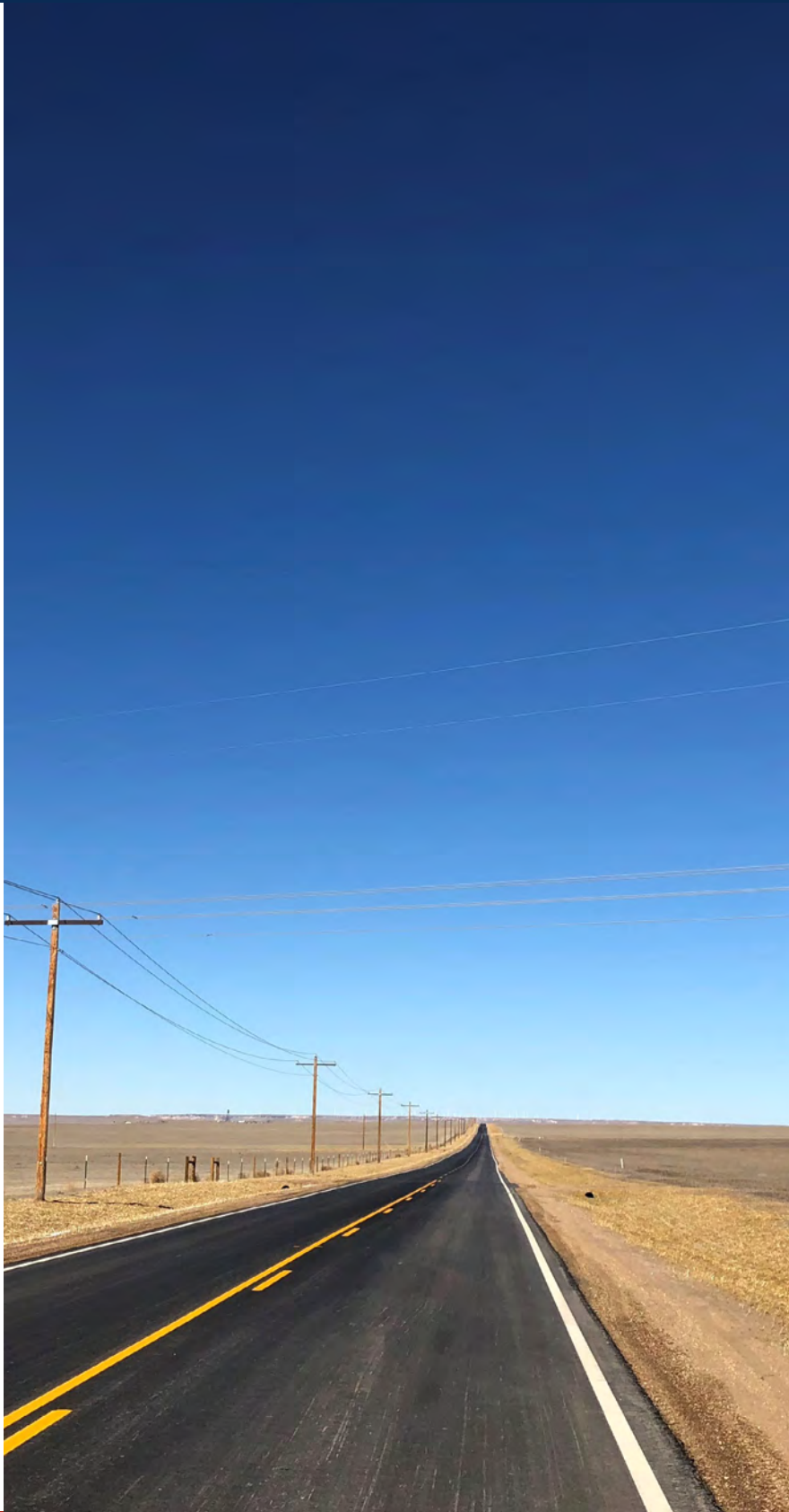
A study was performed in Washington County, Kansas, to address additional signing on curves to increase roadway curve visibility and safety. Through this study, improvements to existing and new signage were suggested as well as adjustments to advisory speeds to reduce crash volume and limit lane departures.





Unincorporated Weld County Countermeasures

Emphasis Area	Name	Description	Crash Reduction Factor	Cost	Traffic Consideration
Environmental	Shoulder Installation / Widening	Installing or widening shoulders provides space for disabled vehicles, maintenance, and other safety activities. Safety edges can be installed on new or widened existing shoulders.	25%	\$\$\$	Most Effective When ADTs >1,000
Environmental	Wider Edge Lines	Wider edge lines improve visibility, reducing roadway departure crashes, especially on rural two-lane highways. Adding center and edge lines where they are missing further improves safety.	35%	\$\$	Applicable to all facility types (e.g., freeways, multilane divided or undivided highways, two lane highways) Commonly installed on rural two-lane highways, particularly those with a history of single-vehicle roadway departure crashes
Environmental	Clear Zone	Clear zones are areas along the roadside that have been cleared of natural materials and debris, compacted, and leveled; the width of a clear zone depends on a variety of factors, including traffic volumes, speeds, slopes, fixed objects, terrain, and other factors that affect risk.	20%	\$-\$\$\$\$	
Infrastructure	Systemic Stop-control Modifications	Systemic stop-control modifications improve intersection visibility with advanced warning signs, retroreflective panels, enlarged signs, rumble strips, and cross-traffic warning signs.	25%	\$\$	History of stop-sign running or nighttime crashes
Infrastructure	Striping Center Lines / Edge Lines	Roadway striping, in the form of center lines and edge lines, separates the opposing flows of traffic and indicates the edge of the paved roadway from the shoulder/the adjacent graded materials.	25%	\$	History of head-on crashes





Unincorporated Weld County Countermeasures

Emphasis Area	Name	Description	Crash Reduction Factor	Cost	Traffic Consideration
Infrastructure	Approach Rumble Strips	Approach rumble strips are transverse rumble strips installed into the pavement ahead of stop-controlled approaches; when crossed by tires, these create a physical vibration and an audible warning that alerts the motorist of the upcoming approach so that they can safely stop in time.	30%	\$	History of failure to yield and related crashes
Infrastructure	Dynamic Curve Warning System (DCWS)	DCWSs aim to decrease vehicle speeds at a curve by displaying dynamic feedback of vehicle speed to speeding drivers; messaging could be the driver's speed, "SLOW DOWN," or activation of warning devices. Sequential DCWSs are a series of solar-powered, LED-enhanced chevrons installed through a curve.	45%	\$\$-\$\$\$	Applicable at horizontal curve locations History of high-speed and/or roadway departure crashes
Infrastructure	Cable Median Barrier	Cable median barriers protect against fixed roadside hazards, reducing fatal and serious crashes.	25%	\$\$\$	History of median crossover or head-on collisions
Modes of Travel	Safety Edge	Safety edges provide a smooth transition between paved roadway and shoulders, preventing tire damage and vehicle loss of control while increasing pavement durability.	0.25	\$\$\$	Curb-less/guardrail-less roadways
Modes of Travel	High Friction Surface Treatment (HFST)	A HFST is a layer of specialized aggregate locked onto the roadway surface that improves the friction capability for vehicles and should be used at interchange ramps, horizontal curves, intersections, and locations with high-friction demand.	45%	\$\$	History of run-off road, inclement weather, and/or motorcycle crashes

