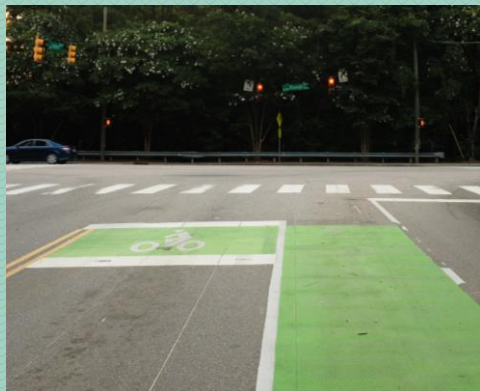


# Safety Countermeasure Glossary

North Carolina DOT 2025





# Overview

This glossary has been developed to assist organizations in identifying effective road safety countermeasures. Its purpose is to support the safety planning process, providing a user-friendly resource that focuses on the most effective treatments for a variety of road safety concerns. This glossary aims to simplify the selection of safety interventions, helping users to quickly identify the types of suitable countermeasures for different situations. Additional field review, data collection and/or engineering analysis is necessary to identify specific countermeasures appropriate to the site, context, and level of risk for serious injury and fatal crashes. Some countermeasures may follow a more rigorous warrant analysis as part of project development. All public roadways are subject to the Manual on Uniform Traffic Control Devices (MUTCD), and engineering countermeasures described in this glossary must adhere to the MUTCD.

The glossary is designed specifically for MPOs (Metropolitan Planning Organizations), RPOs (Rural Planning Organizations), and other organizations responsible for safety planning. This document provides resources to learn more about proven safety countermeasures and potential application. This is not a comprehensive list of all potential countermeasures that may be considered by an agency. These reflect countermeasures and safety strategies that have been vetted through research and evaluation by the Federal Highway Administration (FHWA), the National Highway Traffic Safety Administration (NHTSA) and NCDOT.

There are a range of cost-effective countermeasures that have been proven effective in reducing crashes in a variety of settings and contexts. They can be implemented individually or in combination depending on extent of the safety problem, budget, and context. Applying countermeasures incrementally can allow for more focused prioritization of a community's needs in a cost-effective manner. Applying countermeasures across the network – following a systemic approach – can increase the effectiveness of the countermeasures to improve safety in the community.

The glossary contains several key sections to guide users in selecting and applying road safety countermeasures:

- **Countermeasure Descriptions:** Summary descriptions of various safety countermeasures are provided, explaining their applicability and potential benefits. The guide focuses on countermeasures that address a wide range of safety issues, ensuring that they can be applied to various crash types and severities.
- **Crash Reduction, Crash Type and Severity:** Where a specific Crash Reduction Factor (CRF) has been identified and approved by NCDOT for a countermeasure within this glossary, that *expected percent crash reduction* is included in the description. The type of crash (i.e., pedestrian, all traffic) is included as well as the severity of crashes expected to be reduced for the specific CRF(s). Severity type refers to the most severe injury to any person or, if none injured, so designated.  
K = Killed; A = Suspected Serious Injury; B = Suspected Minor Injury; C = Possible Injury; O = No Injury.
- **Safety Benefit Information:** Where other benefits are realized by a countermeasure, such as reduced speed or increased community awareness, those are indicated with a series of icons.
- **Reference Links:** Users will find direct links to additional resources, such as the NCDOT Crash Reduction Factor (CRF) list (where applicable), providing further avenues for in-depth exploration of countermeasures and their effectiveness.

*\*All images, unless otherwise noted, are owned by NCDOT.*

# Additional Information

## Resources

*What is a CMF or CRF?* A Crash Modification Factor (CMF) is a multiplicative factor that describes the proportion of crashes that would be expected after implementing a countermeasure. A Crash Reduction Factor (CRF) is the percentage crash reduction that might be expected after implementing a given countermeasure. A (CRF) is equal to  $100 \times (1 - \text{CMF})$ . Engineering countermeasures are evaluated based on rigorous research to establish a CMF. Non-engineering countermeasures are evaluated based on qualitative factors and national practice. NCDOT uses criteria and warrants to develop projects for the [Highway Safety Improvement Program \(HSIP\)](#). NCDOT created additional guidance for application of [pedestrian and bicyclist countermeasures](#). The following resources provide more information about the countermeasures described in this glossary.

[NCDOT Crash Reduction Factor Sheet](#)

[Pedestrian Safety Guide and Countermeasure Selection System](#)

[Bicycle Safety Countermeasure Selection System](#)

[Crash Modification Factor Clearinghouse](#)

[Proven Safety Countermeasures | FHWA \(dot.gov\)](#)

[Countermeasures That Work | NHTSA](#)

## Additional Safety Benefits



Low-cost  
Implementation

The potential for implementing a countermeasure with minimal financial expenditure.



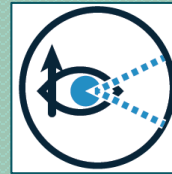
Speed  
Reduction

The advantage of decreasing vehicle speed to improve safety and control.



Increase Yielding

The enhancement of driver compliance in yielding to other road users, such as pedestrians and bicyclists.



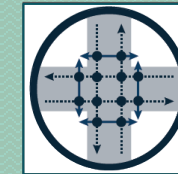
Increase  
Visibility

The improvement of sightlines and awareness for all road users, making potential hazards more easily noticeable.



Improve Emergency  
Response

The reduction in time required for emergency services to arrive at and respond to incidents.



Reduce  
Conflicts

Minimize conflicts where turning movements or paths of vehicles and additional road users could intersect, reducing the potential for collisions.



Bicyclist Safety

The addition of visibility or roadway improvements providing additional bicyclist safety benefits.

# Safety Countermeasure Glossary

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- Remove/Relocate Fixed Objects Out of Clear Zone
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- Chevron Signs on Horizontal Curves

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- Beverage Service Policies for Alcohol Servers and Retailers
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- Education and Enforcement for Drivers Under Age 21

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- High Visibility Enforcement
- Targeted Population Education

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- Safe Routes to School Program

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- Public Awareness of Risks of Driving at Unsafe Speeds
- Safe Community Programs
- Targeted Conventional Speed Enforcement Programs

These countermeasures are considerations for focus crash types, like those included in the [2024 NC Strategic Highway Safety Plan \(SHSP\)](#), additional countermeasures for all road users were identified but not included as they are not emphasis areas of the SHSP. In addition to traditional countermeasures, non-engineering countermeasures have been identified for their crash reduction capabilities.





# LANE DEPARTURE

## SAFETY COUNTERMEASURES

### Roadway and Geometric Improvements



#### CENTERLINE AND SHOULDER RUMBLE STRIPS / STRIPES

Rumble strips along road centerlines, edge lines, or both, alert drivers who are drifting out of their lane through an audible and physical response. This countermeasure is beneficial at alerting a drowsy or distracted driver and reducing the likelihood of a lane departure crash. The range in CRFs apply to centerlines, edge lines, or both, and is for non-freeway sections.

**EXPECTED CRASH REDUCTION**  
**22-40%**

Crash Type: Lane Departure  
Severity Type: All

Additional benefits:



[NCDOT CRF Sheet](#)



#### SAFETY EDGE

A Safety Edge is an edge of pavement safety feature that shapes the edge at an approximate 30-degree angle to help vehicles recover safely if they veer off the roadway. By facilitating a recovery onto the roadway, the Safety Edge improves overall safety for both primary and secondary crash scenarios.

**EXPECTED CRASH REDUCTION**  
**3%**

Crash Type: Run Off Road and Roll Over  
Severity Type: All

Additional benefits:



[NCDOT CRF Sheet](#)



#### SHOULDER WIDENING

Shoulder widening aids drivers in returning to their lane after departure and reduces lane departure crashes. Shoulder widening can reduce errant vehicles, improve safety by reducing the likelihood and severity of lane departure crashes. Additionally, it provides space for vehicles to pull onto during breakdowns or during object avoidance in roadways. The range in CRFs apply to rural 2-lane roadways and increase from 2' to 6', with higher values attributed to wider shoulder.

**EXPECTED CRASH REDUCTION**  
**13-33%**

Crash Type: Lane Departure  
Severity Type: All

Additional benefits:



[NCDOT CRF Sheet](#)



#### IMPROVE HORIZONTAL ALIGNMENT OF CURVE

Modifying the geometry of a roadway's curvature improves its alignment, reducing sharpness, improving driving predictability, and enhancing its visibility. This countermeasure is helpful in reducing lane departure crashes and in-turn increases safety for all road users. The CRF applies to 2-lane rural roadways.

**EXPECTED CRASH REDUCTION**  
**78%**

Crash Type: Lane Departure  
Severity Type: All

Additional benefits:



[NCDOT CRF Sheet](#)



#### IMPROVE SUPERELEVATION OF HORIZONTAL CURVE

Adjusting the banking angle of a roadway's curvature to better align with vehicle speeds and dynamics, enhance traction and reduce the likelihood of skidding or rollover, thereby increasing road safety by reducing the likelihood of lane departure crashes and in-turn increasing safety for all road users.

**EXPECTED CRASH REDUCTION**  
**40%**

Crash Type: Lane Departure  
Severity Type: All

Additional benefits:



[NCDOT CRF Sheet](#)



# LANE DEPARTURE

## SAFETY COUNTERMEASURES

### Signage, Delineation, and Roadside Improvements



#### NEW OR UPGRADED GUARDRAIL

Guardrail enhances roadside barriers to prevent vehicles from hazards outside of the roadway, such as steep embankments and culverts. Guardrails are designed to prevent roadway departures and redirect a vehicle's trajectory, reducing the severity of crashes in turn. The range in CRFs include 44% for fatal 4-lane undivided, 46% for fatal 4-lane divided, and 56% for fatal and A severity on rural 2-lane undivided.

**EXPECTED CRASH REDUCTION**  
**44-56%**

Crash Type: Lane Departure  
Severity Type: K, A

Additional benefits:



#### MEDIAN BARRIER

A median barrier utilizes a metal guardrail, tensioned cable, or concrete barrier on roadway medians to improve safety by reducing cross-median lane departure crashes. Median barriers also increase driver safety through roadside recovery and reducing secondary crashes. The range in CRFs include 72% for multilane divided and 75% for divided freeways. Non-cross median crashes are expected to increase with this treatment.

**EXPECTED CRASH REDUCTION**  
**72-75%**

Crash Type: Cross Median  
Severity Type: All

Additional benefits:



[NCDOT CRF Sheet](#)



#### REMOVE/RELOCATE FIXED OBJECTS OUT OF CLEAR ZONE

Widening clear zones and removing obstacles from the roadside provides a safer recovery area for vehicles and improves safety by reducing severity of roadway departure crashes. A widened clear zone can also improve safety by contributing to a better stopping sight distance.

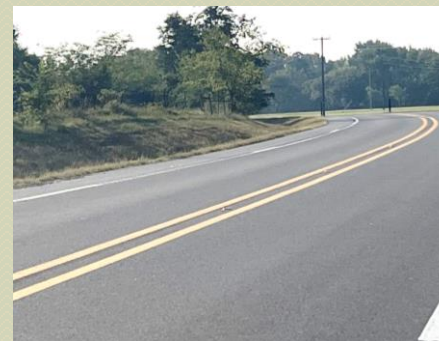
**EXPECTED CRASH REDUCTION**  
**38%**

Crash Type: All  
Severity Type: K, A, B, C

Additional benefits:



[NCDOT CRF Sheet](#)



#### LONGITUDINAL LONG LIFE PAVEMENT MARKINGS

Longitudinal long life pavement markings are applied to edge lines and centerlines to increase the visibility and lifespan of the pavement markings. The range in CRFs increase from 4" and 6", with higher values attributed to wider markings.

**EXPECTED CRASH REDUCTION**  
**13-18%**

Crash Type: Lane Departure  
Severity Type: All

Additional benefits:



[NCDOT CRF Sheet](#)



#### CHEVRON SIGNS ON HORIZONTAL CURVES

Chevron signs are designed to highlight roadway curves, enhance night-time and low-visibility delineation, and guide drivers through sharp horizontal curves, reducing lane departure and head-on crashes. Additionally, interim results from NCDOT show a 67% CRF in Lane Departure crashes for the installation of Sequential Lighted Chevron Systems.

**EXPECTED CRASH REDUCTION**  
**33%**

Crash Type: Rural 2-Lane Lane Departure  
Severity Type: All

Additional benefits:



[NCDOT CRF Sheet](#)





# INTERSECTION

## SAFETY COUNTERMEASURES

### Signage and Signals



#### INSTALL NEW SIGNAL

Implementing traffic signals at an intersection regulates vehicle flow and improves safety by clearly directing when vehicles should stop and go, aiding in reducing angle and left turn crashes. New signals can include enhanced signal heads, such as installation of high-visibility backplates (CRF 15-20%), dual red (CRF 33%), and near side signal heads (CRF 30%) to reduce driver confusion, increase visibility, and improve compliance.

**EXPECTED CRASH REDUCTION**  
**34-67%\***

\*See NCDOT CRF Sheet for range in values  
Crash Type: Angle and Left Turn  
Severity Type: All

Additional benefits:



[NCDOT CRF Sheet](#)



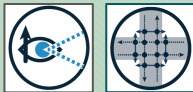
#### INSTALL ACTIVATED ADVANCED WARNING FLASHERS FOR SIGNAL

Installing an active advanced warning flasher for an existing signal at locations prone to red-light running or rear ends can be a valuable countermeasure, especially at signals with low approach sight distance. An active advanced warning flasher utilizes flashing lights to alert drivers to an upcoming signal, giving them time to slow down and prepare to stop.

**EXPECTED CRASH REDUCTION**  
**30%**

Crash Type: Red Light Running Crashes  
Severity Type: All

Additional benefits:



[NCDOT CRF Sheet](#)



#### FLASHING YELLOW ARROW LEFT-TURN SIGNAL

Implementing flashing yellow arrow for left turn signal phases is an effective strategy to improve vehicular and pedestrian safety at intersections, especially when protection is increased. This measure specifically addresses issues related to left turn crashes and helps enhance the efficiency of traffic movements. Additionally, this countermeasure helps drivers avoid confusion by signaling that caution is needed to determine if there is a sufficient gap in oncoming traffic.

**EXPECTED CRASH REDUCTION**  
**25-65%\***

\*See NCDOT CRF Sheet for range in values  
Crash Type: Left Turn, Same Roadway  
Severity Type: K, A, B, C

Additional benefits:



[NCDOT CRF Sheet](#)



#### DYNAMIC ALL RED EXTENSION

A dynamic all red extension (DARE) is a unique countermeasure which aims to reduce the potential for crashes during red light running. This dynamic system works by detecting the potential for red light running events and stopping the signal timing events in the "all red" phase to provide time for the offending vehicle to clear the intersection before the cross street receives a green indication.

**EXPECTED CRASH REDUCTION**  
**25%**

Crash Type: Red Light Running Crashes  
Severity Type: All

Additional benefits:



[NCDOT CRF Sheet](#)



#### INSTALL ALL WAY STOP CONTROL

**(INCLUDING STOP AHEAD)**  
Implementing all way stop control at two-way and minor intersections can be a viable traffic management strategy to enhance safety and manage traffic flow at lower volume intersections. The range in CRFs vary for converting minor stop control to all way stop control (72%) and converting minor stop control to all way stop control with new or existing overhead flashers installed (87%).

**EXPECTED CRASH REDUCTION**  
**72-87%**

Crash Type: All  
Severity Type: K, A, B, C

Additional benefits:



[NCDOT CRF Sheet](#)



# INTERSECTION

## SAFETY COUNTERMEASURES

### Geometric Treatments



#### ROUNABOUT

A roundabout replaces traditional intersections with circular layouts to reduce vehicle speeds, limit conflict points, improve traffic flow, and increase safety by reducing frontal impact crashes. The range in CRFs vary by two-lane and multilane configurations as well as urban and rural contexts. This crash reduction reflects the conversion of a minor stop control to a roundabout.

**EXPECTED CRASH REDUCTION**  
**78-84%**

Crash Type: All  
Severity Type: K, A, B, C

Additional benefits:



[NCDOT CRF Sheet](#)



#### REDUCED CONFLICT INTERSECTION (RCI)

A RCI reconfigures intersections to limit conflict points, reducing crash potential and improving safety. The most common type of RCI design eliminates left turns and throughs from side roads onto busy main roads. Examples of RCIs include Restricted Crossing U-Turn intersections (RCUT) and Median U-Turn (MUT) intersections. The range in CRFs vary by unsignalized versus signalized intersections and rural versus suburban areas.

**EXPECTED CRASH REDUCTION**  
**22-63%**

Crash Type: All  
Severity Type: K, A, B, C

Additional benefits:



[NCDOT CRF Sheet](#)



#### INTERSECTION CHANNELIZATION

An intersection channelization modifies intersection approaches with features like raised medians to manage traffic movements and improve safety by reducing rear-end and frontal impact crashes. Geometric modifications can also be made to reduce turning vehicle speeds, encourage yielding, and promote driver visibility of cross traffic.

**EXPECTED CRASH REDUCTION**  
**25%**

Crash Type: All  
Severity Type: All

Additional benefits:



[NCDOT CRF Sheet](#)



#### DEDICATED LEFT OR RIGHT TURN LANES AT INTERSECTIONS

Adding a dedicated left or right turn lane at intersections can reduce rear-end, sideswipe, and turning movement crashes. On roadways with high volumes, high turning movements, or high pedestrian crossings, these changes can be especially effective at increasing safety. The range in CRFs vary widely based on factors like signals, stop controls, number of legs, and urban verse rural settings.

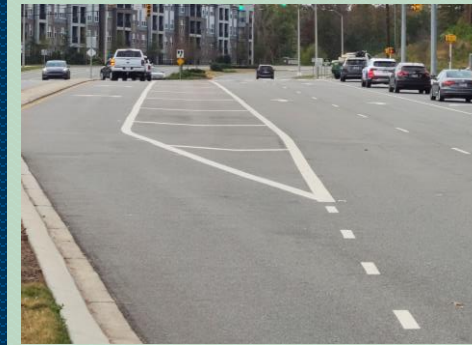
**EXPECTED CRASH REDUCTION**  
**4-62%**

Crash Type: Rear End, Left Turn and Sideswipe  
Severity Type: All

Additional benefits:



[NCDOT CRF Sheet](#)  
[FHWA | Dedicated Left- and Right-Turn Lanes](#)



#### POSITIVE OFFSET OF LEFT TURN LANES

Left turn lanes are shifted outward from the centerline of the road, creating a position that allows left turning drivers to have a less obstructed view of oncoming traffic. By shifting these lanes outward, positive offset turn lanes reduce this visual obstruction, improving sight distance and reducing the likelihood of conflicts and severe crashes. The range in CRFs vary by lanes and facility type.

**EXPECTED CRASH REDUCTION**  
**38-85%**

Crash Type: Left Turn  
Severity Type: All

Additional benefits:



[NCDOT CRF Sheet](#)





# PEDESTRIAN

## SAFETY COUNTERMEASURES

### Crossings



#### CROSSWALK

Crosswalks inform pedestrians of preferred crossing locations and alert drivers to the potential presence of pedestrians. Features such as high-visibility markings, lighting, refuge islands, and signage can enhance crosswalk visibility and safety. High visibility crosswalk enhancements use patterns that are visible to both the driver and pedestrian. The range in CRF values vary depending on the types of enhancements implemented.

**EXPECTED CRASH REDUCTION**  
**25-50%**

Crash Type: Pedestrian  
Severity Type: All

Additional benefits:



NCDOT CRF Sheet



#### PEDESTRIAN HYBRID BEACON (PHB)

A PHB (also known as a HAWK signal) is a traffic control device to help pedestrians cross high-speed and/or high-volume roadways at midblock crossings and uncontrolled intersections by cycling through flashing and steady yellow and red lights when activated by a pedestrian desiring to cross the street. A PHB should always be implemented with crosswalk markings and pedestrian crossing signage.

**EXPECTED CRASH REDUCTION**  
**55%**

Crash Type: Pedestrian  
Severity Type: All

Additional benefits:



NCDOT CRF Sheet



#### RECTANGULAR RAPID FLASHING BEACON (RRFB)

An RRFB is a passive control device utilizing flashing lights at pedestrian warning signs to help pedestrians safely cross roadways at midblock crossings and uncontrolled intersections. An RRFB increases visibility of the crossing by alerting vehicles to the presence of a pedestrian when actuated.

**EXPECTED CRASH REDUCTION**  
**47%**

Crash Type: Pedestrian  
Severity Type: All

Additional benefits:



NCDOT CRF Sheet



#### RAISED CROSSWALK

Raised crosswalks are ramped speed tables spanning the entire width of the roadway that allow pedestrians to cross at grade with the sidewalk, while also slowing down traffic at mid-block locations and increasing the visibility of pedestrians. They are typically demarcated with paint and/or special paving materials.

**EXPECTED CRASH REDUCTION**  
**46%**

Crash Type: Pedestrian  
Severity Type: K, A, B, C

Additional benefits:



PEDSAFE Countermeasure Toolkit



#### CURB EXTENSION / BULB OUT

A curb extension extends the sidewalk into the roadway shoulder, reducing the effective street width. This reduces pedestrian crossing distances and enhances pedestrian visibility. These safety enhancements can be implemented at mid-block and intersection locations.

**NO CRASH REDUCTION STUDY IDENTIFIED**

Additional benefits:



PEDSAFE Countermeasure Toolkit



#### RAISED MEDIAN/PEDESTRIAN REFUGE ISLAND

A raised median and pedestrian refuge island provides a safe area for pedestrians to stop at the midpoint of the road. This allows for a two-stage crossing where the pedestrian can focus on one direction of traffic at a time. They can be installed with or without a marked crosswalk.

**EXPECTED CRASH REDUCTION**  
**31%**

Crash Type: Pedestrian  
Severity Type: All

Additional benefits:



NCDOT CRF Sheet



# PEDESTRIAN

## SAFETY COUNTERMEASURES

### Walkways and Signalized Intersections



#### GRADE SEPARATED PEDESTRIAN WALKWAY

A grade separated pedestrian walkway provides a separate crossing over or under roadways, eliminating pedestrian-vehicle conflicts at intersections or roads. Pedestrian walkways can be implemented on a number of different roadway types and in a variety of user environments.

**EXPECTED CRASH REDUCTION**  
**85%**

Crash Type: Pedestrian  
Severity Type: All

Additional benefits:



[NCDOT CRF Sheet](#)



#### SIDEWALK

A sidewalk is a paved surface designated for pedestrian use parallel to the roadway, generally separated from the traffic lanes by a curb. Installing a sidewalk where currently none exists designates a safe and separate space for pedestrians along the roadway, reducing the risk of a pedestrian-vehicle crashes. This CRF applies to pedestrians walking along roadway.

**EXPECTED CRASH REDUCTION**  
**74%**

Crash Type: Pedestrian  
Severity Type: All

Additional benefits:



[NCDOT CRF Sheet](#)



#### PEDESTRIAN COUNTDOWN SIGNAL HEADS

A pedestrian signal head is a traffic signal at a signalized intersection exclusively intended for controlling pedestrian traffic. Pedestrian countdown heads display the remaining time for pedestrians to cross at signalized intersections, reducing uncertainty and improving compliance with pedestrian signals. The CRF value represents installing countdown pedestrian heads where no pedestrian heads exist.

**EXPECTED CRASH REDUCTION**  
**25%**

Crash Type: Pedestrian  
Severity Type: K, A, B, C

Additional benefits:



[NCDOT CRF Sheet](#)



#### LEADING PEDESTRIAN INTERVAL (LPI)

An LPI allows pedestrians to enter a crosswalk before vehicles are given a green light. Pedestrians are able to better establish their presence before vehicles begin to turn right or left through the crosswalk. The CRF value represents any intersection that has one or more crossings with an LPI.

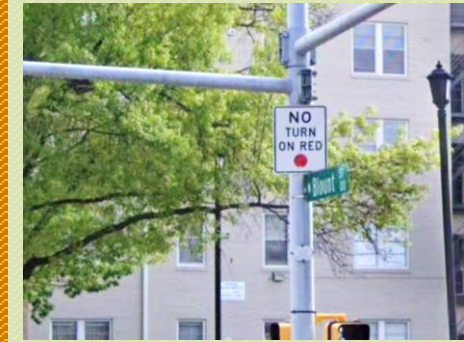
**EXPECTED CRASH REDUCTION**  
**13%**

Crash Type: Pedestrian  
Severity Type: All

Additional benefits:



[NCDOT CRF Sheet](#)



#### PROHIBIT RIGHT TURNS ON RED

Prohibiting right turns on red reduces pedestrian-vehicle conflicts by eliminating the opportunity for vehicles to turn right during a pedestrian crossing phase. When turning right on red, many vehicles are focused on locating gaps in vehicular traffic and may not notice a pedestrian in the crosswalk before turning. The CRF value represents a subjective evaluation from NCDOT and is not from a comprehensive safety study.

**EXPECTED CRASH REDUCTION**  
**25%**

Crash Type: Pedestrian  
Severity Type: K, A, B, C

Additional benefits:



[NCDOT CRF Sheet](#)





# BICYCLIST

## SAFETY COUNTERMEASURES

### Bike Lanes and Bikeways



**BIKE LANE**

A bicycle lane is a designated lane for bicyclists, separated from vehicular traffic by pavement markings. Bike lanes enhance bicyclist safety by designating a particular area for bicyclists, reducing bike-vehicle interactions. A bike lane typically requires a five-foot minimum width. Bike lanes should have appropriate markings to reflect changes in turn lanes and other conflict zones to alert drivers of the potential for conflict while maneuvering across bike lanes. The range in CRFs vary from 42% for urban four-lane roadways to 45% for urban two-lane roadways.

**EXPECTED CRASH REDUCTION**  
**42-45%**

Crash Type: Bicycle  
Severity Type: All

Additional benefits:



NCDOT CRF Sheet



**BUFFERED BIKE LANE**

A buffered bike lane enhances the safety of a traditional bike lane by adding a lateral buffer zone via pavement markings between a bike lane and vehicle traffic or parking lanes. This enhancement enlarges the gap between vehicle traffic and bicyclists, increases visibility to all users, and provides a wider margin of error for vehicles who leave their lane of travel. The range in CRFs vary from 58% for urban two-lane roadways to 63% for urban four-lane roadways.

**EXPECTED CRASH REDUCTION**  
**58-63%**

Crash Type: Bicycle  
Severity Type: All

Additional benefits:



NCDOT CRF Sheet



**SEPARATED BIKE LANES (CONVERSION)**

Separated bike lanes add a vertical element, such as a curb, flexible posts, or on street parking, to further separate a standard bike lane from vehicle traffic. Horizontal separation is also required to achieve a separated bike lane. The range in CRFs vary from 41% for urban four-lane roadways to 47% for urban two-lane roadways.

**EXPECTED CRASH REDUCTION**  
**41-47%**

Crash Type: Bicycle  
Severity Type: All

Additional benefits:



NCDOT CRF Sheet

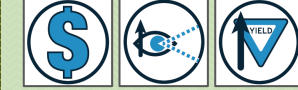


**GREEN-COLORED PAVEMENT FOR BICYCLE FACILITIES**

Green colored pavement can be used to increase the conspicuity of bike lanes and bike-vehicle conflict areas. The green pavement can be applied along the entire corridor, limited to the bicycle symbol and arrow pavement markings when approaching and departing an intersection, or when supplementing the dotted lines approaching an intersection to indicate the conflict zone.

**NO CRASH STUDY IDENTIFIED**

Additional benefits:



NACTO | Colored Bike Facilities  
MUTCD 11th Edition



# BICYCLIST

## SAFETY COUNTERMEASURES

### Intersection and Visibility Improvements



#### ADVANCED STOP LINE (ASL) / BIKE BOX

A bike box is a designated space for bicyclists at the head of traffic lanes at intersections and is designated by a green pavement marking. This countermeasure enhances visibility, reduces conflicts with right turning vehicles, and allows bicyclists to position themselves in turn lanes ahead of vehicles. Bike boxes are positioned just beyond an advanced stop line marking for vehicles.

NO CRASH STUDY IDENTIFIED

Additional benefits:



[PedBikeSafe: Evaluation of Bicycle-Related Roadway](#)



#### SIGNAL IMPROVEMENTS FOR BICYCLES (INCLUDING SIGNAL TIMING, BIKE SIGNALS)

Adjustments to traffic signal timing accommodate bicycle speeds and movements and bicycle detection systems can help cyclists safely cross intersections while minimizing delay for all users. At signalized intersections that require road users to be detected to initiate a green light, detection should be designed to accommodate bicyclists. Signals which provide dedicated phasing for protected bicycle movements increase compliance and overall safety. This CRF applies to altering signal timing to align with the Institute of Transportation Engineers recommendations.

EXPECTED CRASH REDUCTION  
37%

Crash Type: Bicycle and Pedestrian  
Severity Type: All

Additional benefits:



[PedBikeSafe: Evaluation of Bicycle Related Roadway Measures](#)



#### PROTECTED INTERSECTION

Protected intersections use vertical elements to physically separate bicycle and vehicle movements and reduce conflict points. Refuge Islands and staging areas give bicyclists and pedestrians safe areas to separate from vehicle traffic to plan and complete their movements. For vehicle right turning movements, islands are installed to separate vehicles from bicyclists and position vehicles into a more perpendicular position when traveling through the crosswalk, improving a driver's vision of the bicyclist.

NO CRASH STUDY IDENTIFIED

Additional benefits:



[University Transportation Center | Dissecting the Additional Safety Benefits of Protected Intersections](#)



#### MEDIAN AND CROSSING TREATMENTS FOR BICYCLES

Crossing enhancements and median refuge treatments assist in the crossing movements of bicyclists and are designed to improve safety by increasing bicyclist visibility, improving yielding rates, and alerting drivers to the potential presence of bicyclists. Opportunities for treatment include mid-block, intersection, and trail crossings in both urban and rural contexts. Bicyclist median islands provide refuge space for bicyclists waiting to complete their movement. This CRF was part of a study which utilized fencing, median brick planters, and pedestrian islands.

EXPECTED CRASH REDUCTION  
86%

Crash Type: Bicycle and Pedestrian  
Severity Type: K

Additional benefits:



[CMF Clearinghouse Study](#)





# SPEED

## SAFETY COUNTERMEASURES

### Signage, Signals, and Geometric Treatments



#### GATEWAY TREATMENTS

Gateway treatments introduce visual and physical cues to alert drivers to a change in the roadway context and encourage drivers to reduce speed, enhancing safety. Including features such as wayfinding signage, medians, roadside structures, monuments, or landscaping can increase driver attentiveness and manage speeds.

**EXPECTED CRASH REDUCTION**  
2-32%

Crash Type: All  
Severity Type: K, A

Additional benefits:



[DOT | Safe System Roadway Design Hierarchy](#)



#### MINI-ROUNDABOUT

A mini-roundabout is a smaller roundabout that slows down traffic at minor urban/suburban intersections, reducing the likelihood of crashes, reducing speeds, and improving traffic flow where a stop-controlled intersection would likely be used in its place.

**EXPECTED CRASH REDUCTION**  
59%

Crash Type: All  
Severity Type: K, A, B, C

Additional benefits:



[NCDOT CRF Sheet](#)



#### VARIABLE SPEED LIMIT (VSL)

A variable speed limit dynamically adjusts speed limit signage based on traffic, weather, and road conditions to emphasize safe driving speeds and traffic flow. VSL is particularly effective on urban and rural freeways and high-speed arterials with posted speed limits greater than 40 mph.

**EXPECTED CRASH REDUCTION**  
29%

Crash Type: All  
Severity Type: All

Additional benefits:



[Crash Modification Factor Clearinghouse](#)



#### DYNAMIC SPEED FEEDBACK SIGNS

A dynamic speed feedback sign displays current vehicle speeds to drivers, encouraging drivers to adjust speed to safe levels, deterring speeding, and encouraging behavioral change. The placement of dynamic speed feedback signs is most effective in targeted and short-distance areas, such as school zones.

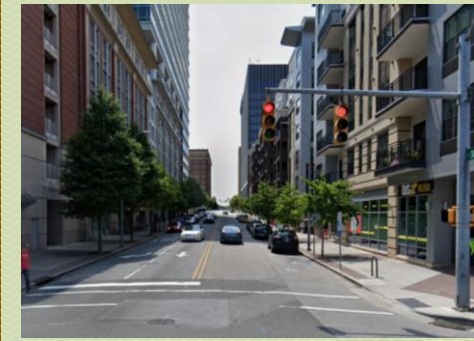
**EXPECTED CRASH REDUCTION**  
46%

Crash Type: All  
Severity Type: All

Additional benefits:



[NCDOT CRF Sheet](#)



#### OPTIMIZED SIGNAL TIMING

Optimizing signal timing by adjusting traffic signals based on the appropriate speed limit can reduce congestion and improve traffic flow, enhance safety by promoting safe speeds, and reduce the potential for rear end crashes. Optimized signal timing encourages safer driving behavior and can be preempted for emergency response.

**EXPECTED CRASH REDUCTION**  
15%

Crash Type: All  
Severity Type: All

Additional benefits:



[NCDOT CRF Sheet](#)



# MOTORCYCLE

## SAFETY COUNTERMEASURES

### Roadside, Signage, and Geometric Treatments



#### MOTORCYCLE RUB RAIL UNDER TRADITIONAL GUARDRAIL

Installation of motorcycle rub rail adds an additional protective rail below traditional W-beam guardrail to reduce injury and severity for motorcyclists in crashes. Rub rail can be installed on new guardrail projects or retrofitted to existing and acts as a shield to buffer motorcyclists from the existing pylons supporting traditional guardrail. The range in CRF values represent a subjective evaluation from NCDOT and is not from a comprehensive safety study.

EXPECTED CRASH REDUCTION  
40-75%

Crash Type: Motorcycle Barrier Hit  
Severity Type: K, A, B, C

Additional benefits:



[NCDOT CRF Sheet](#)



#### FULL PAVED SHOULDERS TO ACCOMMODATE ROADSIDE MOTORCYCLE RECOVERY

A paved shoulder provides a recovery zone for motorcyclists during lane departure movements, reducing the likelihood of a crash occurring, improving the recovery opportunity from lane departures, and reducing the severity of crashes.

NO CRASH STUDY IDENTIFIED

Additional benefits:



[NCHRP | A Guide for Addressing Collisions Involving Motorcyclists](#)



#### PULL OFF AREA WITH ROADWAY INFORMATIONAL SIGNAGE

A pull off area is a designated safe space for motorcyclists to pull off and rest. Pull off areas are specifically helpful in rural areas where long stretches of roadway without stops can add to driver fatigue. These areas can also help provide additional wayfinding, route guidance, and information. The CRF value represents a subjective evaluation from NCDOT and is not from a comprehensive safety study.

EXPECTED CRASH REDUCTION  
20%

Crash Type: Motorcycle  
Severity Type: All

Additional benefits:



[NCDOT CRF Sheet](#)



#### MAINTAIN THE ROADWAY TO MINIMIZE SURFACE IRREGULARITIES, IMPROVE DRAINAGE AND DEBRIS

Maintaining a roadway with minimal surface irregularities and free of standing water ensures a road surface that is smooth and predictable for motorcyclists, reducing hazards and the likelihood of a crash.

EXPECTED CRASH REDUCTION  
40%

Crash Type: Wet  
Severity Type: All

Additional benefits:



[NCDOT CRF Sheet](#)





# CROSS-CUTTING

## SAFETY COUNTERMEASURES

### Roadway Design



#### INTERSECTION AND ROADWAY LIGHTING

Lighting enhances visibility at intersections and along roadways to reduce nighttime crashes by illuminating potential hazards and increasing driver and pedestrian awareness. Intersection and roadway lighting can include overhead single and dual arm masts illuminating the entire cross section of the roadway as well as approach lighting for deceleration/acceleration lanes. Roadside or median lighting installed in advance of each approach of a crosswalk can help illuminate crossing pedestrians. The range in CRF values vary for roadway segments (69%) to standard intersections and roundabouts (77%).

**EXPECTED CRASH REDUCTION**  
**69-77%**

Crash Type: Night  
Severity Type: K

Additional benefits:



[NCDOT CRF Sheet](#)



#### IMPROVE HORIZONTAL ALIGNMENT (AT CURVE OR AT SKEWED INTERSECTION)

Improving horizontal alignments, either along a curve or by reconfiguring a skewed intersection, reduces the potential for roadway departures and head-on crashes. These changes allow drivers to anticipate and effectively navigate the roadways in a predictable and safe manner. The range in CRFs include both curve alignments and skew alignments at intersections.

**EXPECTED CRASH REDUCTION**  
**20-78%**

Crash Type: All  
Severity Type: All

Additional benefits:



[NCDOT CRF Sheet](#)



#### HIGH FRICTION SURFACE TREATMENT

A high friction surface treatment (HFST) utilizes high friction materials with the pavement to improve tire grip and reduce skidding and sliding. High Friction Surface Treatment is particularly beneficial on roadway sections prone to rear ends and lane departure crashes, especially on curves, ramps, and intersection approaches. Review the NCDOT Hydroplaning Mitigation Selection Guide for additional pavement mitigation, signage and geometric strategies for addressing wet crashes. The range in CRF values are specifically for HFST treatments on curves (52%) and ramps (86%).

**EXPECTED CRASH REDUCTION**  
**52-86%**

Crash Type: Wet  
Severity Type: All

Additional benefits:



[NCDOT Hydro Mitigation Guide](#)  
[NCDOT CRF Sheet](#)



#### CORRIDOR ACCESS MANAGEMENT

Corridor access management implements strategies like medians and turning restrictions to manage roadway access points for vehicles. Corridor access management also includes reducing driveway densities along a corridor and reducing crash potential by controlling vehicle movements and limiting conflict points. Many of the countermeasures comprising corridor access management such as raised medians and intersection channelization can be found with CRFs within this glossary

**NO CRASH STUDY IDENTIFIED**

Additional benefits:



[FHWA | Safety Evaluation of Access Management Policies and Techniques](#)



# CROSS-CUTTING

## SAFETY COUNTERMEASURES

### Roadway Design and Signage



#### RAISED MEDIAN

A raised median provides a protective deterrent to vehicles departing the lane and hitting or crossing the median. A raised median also reduces head-on and angle crashes by limiting turning movements at intersections and driveways. A raised median has additional benefits for pedestrians, bicyclists, and cross-median collisions with vehicles. The range in CRF values vary by rural multilane arterial (12%), urban multilane arterial (22%), and (39%) urban two-lane roadway.

**EXPECTED CRASH REDUCTION**  
**12-39%**

Crash Type: All  
Severity Type: K, A, B, C

Additional benefits:



[NCDOT CRF Sheet](#)



#### ROAD DIETS

Road diets involve reducing the number or width of through travel lanes. Including a raised median, in combination with a center turn lane, can reduce angle and head-on crashes. Other features such as shoulders, bicycle lanes, or sidewalks can also be considered when repurposing the travel lane width to other transportation features. The value for the CRF varies significantly by the types of changes. A four-lane to three-lane conversion with a two-way left turn lane can result in a 29% decrease in crashes.

**EXPECTED CRASH REDUCTION**  
**29%**

Crash Type: Rear End and Left Turn  
Severity Type: All

Additional benefits:



[NCDOT CRF Sheet](#)



#### WARNING SIGNAGE

Warning signage can be utilized to address all road user groups and is implemented to alert users to the presence of safety concerns or roadway risks, create awareness, and reduce the potential of crashes. Warning signs are placed in advance of and at locations where there is crash risk or where other road users, such as bicyclists, may enter the roadway unexpectedly. The CRF value represents a subjective evaluation from NCDOT and is not from a comprehensive safety study.

**EXPECTED CRASH REDUCTION**  
**15%**

Crash Type: All  
Severity Type: All

Additional benefits:



[NCDOT CRF Sheet](#)



#### IMPROVE MARKINGS AND DELINEATION

Enhancing a sign's conspicuity by adding high-visibility reflectors, reflective signpost strips, larger signage, or enhanced pavement markings promotes greater visibility at night-time and in low-visibility environments, providing opportunities to inform and warn users of roadway features and crossings.

**EXPECTED CRASH REDUCTION**  
**15%**

Crash Type: All  
Severity Type: All

Additional benefits:



[NCDOT CRF Sheet](#)

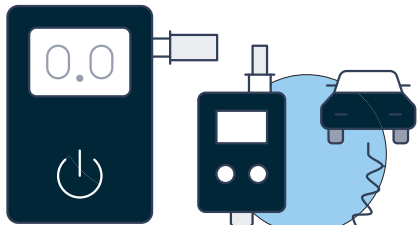




# NON-ENGINEERING

## SAFETY COUNTERMEASURES

### Impairment



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#### ALCOHOL IGNITION INTERLOCKS

An alcohol ignition interlock prevents vehicles from starting before a driver provides a breath sample that is below a pre-set level. This device is designed to prevent drivers from operating a vehicle while under the influence of alcohol. The installation of an alcohol ignition interlock is typically installed for individuals during a probationary period related to a prior alcohol related incident. This countermeasure is designed to prevent impaired driving and related vehicle crashes.

**EXPECTED CRASH REDUCTION**  
**26%**

**Crash Type:** Impaired  
**Severity Type:** K

**Additional benefits:**



[Alcohol Ignition Interlocks | NHTSA](#)  
[Official NCDMV: Ignition Interlock Devices \(ncdot.gov\)](#)



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#### BEVERAGE SERVICE POLICIES FOR ALCOHOL SERVERS AND RETAILERS

Beverage service policies are implemented to educate and manage alcohol service and sales, reducing impaired driving incidents and enhancing road safety for all users. It is a primary goal of these policies to provide training and education on responsible alcohol services like recognizing signs of intoxication and safe practices on dealing with problem customers.

**EXPECTED CRASH REDUCTION**  
**23%**

**Crash Type:** Single Vehicle Night  
**Severity Type:** K, A, B, C

**Additional benefits:**



[NCHRP | A Guide for Reducing Alcohol Related Collisions](#)



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#### PUBLICIZED SOBRIETY CHECKPOINTS

Publicized sobriety checkpoints use high-visibility and enforced checkpoints to deter and catch impaired drivers, enhancing road safety for all users. The use of such checkpoints can be implemented in conjunction with holidays or regional events that are prone to high driver impairment.

**EXPECTED CRASH REDUCTION**  
**17%**

**Crash Type:** Impaired  
**Severity Type:** All

**Additional benefits:**

[Publicized Sobriety Checkpoints | NHTSA](#)



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#### EDUCATION AND ENFORCEMENT FOR DRIVERS UNDER AGE 21

Targeting young drivers with education and enforcement programs can reduce underage drinking and driving and promote life-long safer practices. Education programs with youth should be coordinated with enforcement activities.

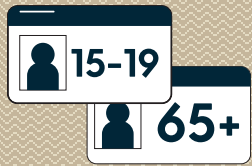
**EXPECTED CRASH REDUCTION**  
**51%**

**Crash Type:** Impaired  
**Severity Type:** All

**Additional benefits:**



[NCHRP | A Guide for Reducing Alcohol Related Collisions](#)  
[NCDMV | Teen Drivers](#)



# NON-ENGINEERING

## SAFETY COUNTERMEASURES

### Young/Older Drivers



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#### IN-PERSON RENEWAL AND VISION TEST REQUIREMENTS

Vision tests require drivers to renew their license in-person with a passing vision test on a reoccurring basis to ensure they are fit to drive, improving safety for all road users. Older drivers and people with limited vision are most vulnerable to experiencing unsafe driving conditions, especially when signage is not visible and poorly designed lighting makes it difficult to navigate on the roadway. The countermeasure has limited evaluation evidence but adheres to principles of human behavior and may be effective if implemented well.

NO CRASH STUDY IDENTIFIED

Additional benefits:



[NHTSA | Countermeasures](#)



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#### COMMUNITY EDUCATION ABOUT GRADUATED DRIVER LICENSING REQUIREMENTS

Graduated driver licensing programs are focused on easing beginning drivers into traffic scenarios by gradually exposing them to greater driving skills. North Carolina law includes requirements for youth drivers in advance of receiving a full drivers license. These requirements can be supplemented with local driver training courses. The range in CRF values represents a study focusing on a multi-stage licensing system (at least three stages) that embodies a true graduation from lower to higher risk driving conditions.

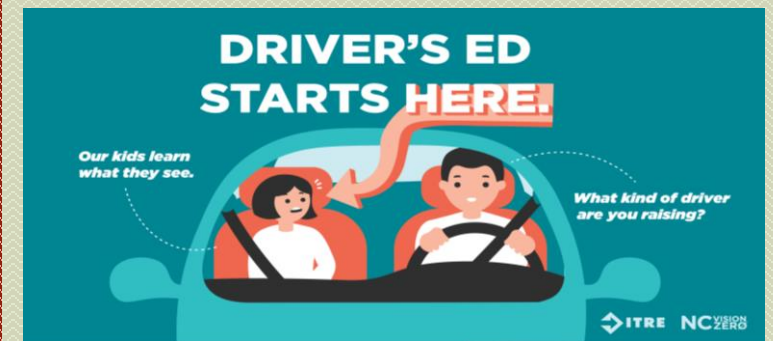
EXPECTED CRASH REDUCTION  
7-8%

Crash Type: Teen Driver  
Severity Type: K, A, B, C

Additional benefits:



[Effectiveness of Graduated Driver Licensing in Reducing Motor Vehicle Crashes](#)



#### EDUCATION AND TRAINING

Education and training programs are aimed at informing new road users about safe driving practices to improve overall road safety. Parents and guardians often have the first opportunity to instill driving habits and have the best ability of enforcing positive driving habits. Driver's education can be focused on programs that reflect those of high injury crash types, driving risks, or targeted towards specific user groups. These could include safety courses, and public awareness campaigns on pedestrian and bicycle safety. Examples may include resources for conducting training, webinars, educational brochures, and safety toolkits.

NO CRASH STUDY IDENTIFIED

Additional benefits:



[NHTSA | Strategies of Behavior Change](#)





# NON-ENGINEERING

## SAFETY COUNTERMEASURES

### Seat Belts and Car Seats



#### CAR SEAT CHECKS and GIVEAWAYS

Car seat checks, often sponsored by health agencies and fire departments, inspect how car seats are installed in personal vehicles. These community events can also serve as opportunities to give away car seats to people who cannot afford to purchase a car seat. There is limited evaluation evidence to car seat checks, but the countermeasure adheres to principles of human behavior and may be effective if implemented.

NO CRASH STUDY IDENTIFIED

Additional benefits:



NHTSA | Countermeasures



#### HIGH VISIBILITY ENFORCEMENT

Targeted conventional enforcement programs focus law enforcement efforts to areas with high incidents of unbelted crashes to deter unsafe driving behaviors. The most common high visibility seat belt law enforcement method consists of short (typically lasting for 2 weeks), intense, highly publicized periods of increased belt law enforcement, frequently using checkpoints, saturation patrols, or enforcement zones. Partnerships with local organizations can promote planned enforcement events, alerting the community about the safety trends related to wearing seat belts and using car seat restraints.

NO CRASH STUDY IDENTIFIED

Additional benefits:

NHTSA | High-Visibility Seat Belt Law Enforcement



#### TARGETED POPULATION EDUCATION

Targeted education programs for populations over-represented in crashes with unbelted vehicle occupants reinforce safe driving habits. Media, messages and marketing approaches are tailored to impacted populations and local culture. The primary measure of program effectiveness is based on restraint usage while a secondary measure is a change in crash severity and crash data for unrestrained vehicle occupants.

NO CRASH STUDY IDENTIFIED

Additional benefits:



NCHRP | A Guide for Increasing Seatbelt Use



# NON-ENGINEERING

## SAFETY COUNTERMEASURES

### Vulnerable Road Users



#### MOTORCYCLIST EDUCATION AND AWARENESS

Motorcyclist education and awareness programs aim to educate motorcyclists and drivers on safe riding and driving practices to improve overall safety and reduce potential crashes. Written and in-person skills training opportunities can also enhance driver awareness, provide education on defensive driving, and improve helmet compliance.

NO CRASH STUDY IDENTIFIED

Additional benefits:



[NHTSA | Motorcycle Safety](#)



#### SAFE ROUTES TO SCHOOL PROGRAM

Safe Routes to School programs encourage and enable safer walking and biking routes for students by promoting physical activity, creating awareness to the community, reducing congestion around schools, and enhancing safety for students. The practices are especially important for educating children at a young age and instilling positive safe practices.

EXPECTED CRASH REDUCTION  
13%

Crash Type: Pedestrian and Bicycle  
Severity Type: K, A, B, C

Additional benefits:



[CMF Clearinghouse](#)





# NON-ENGINEERING

## SAFETY COUNTERMEASURES

### Speed Management



#### PUBLIC AWARENESS OF RISKS OF DRIVING AT UNSAFE SPEEDS

Public awareness campaigns and programs on the risks of driving at unsafe speeds aim to educate the public about the severity of speeding related crashes and promote safer driving behaviors. Promotional materials, public service announcements and dedicated conversations at local civic events about speed are ways these campaigns can be delivered within the community.

NO CRASH STUDY IDENTIFIED

Additional benefits:



#### SAFER COMMUNITY PROGRAMS

Safer community programs are local initiatives that promote traffic safety through community involvement and education. By partnering with public health, social services, school and community organizations, these programs can be delivered to underserved communities often over-represented by serious injury and fatal crashes.

EXPECTED CRASH REDUCTION  
12%

Crash Type: All  
Severity Type: All

Additional benefits:



#### TARGETED CONVENTIONAL SPEED ENFORCEMENT PROGRAMS

Targeted conventional speed enforcement programs focus law enforcement efforts to areas with high incidents of speeding to deter unsafe driving behaviors. Community education programs can support awareness of speeding problems and alert the public of roads where enforcement will be focused.

EXPECTED CRASH REDUCTION  
18%

Crash Type: All  
Severity Type: K, A, B, C

Additional benefits:

