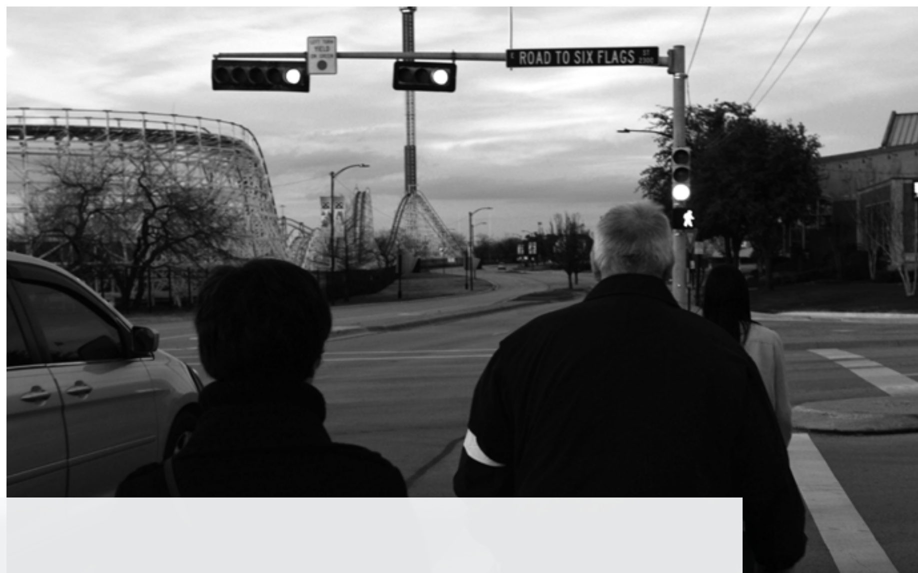

NORTH CENTRAL TEXAS COUNCIL OF GOVERNMENTS

ROADWAY SAFETY PLAN APPENDICES

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A2. COUNTERMEASURE OR STRATEGY SELECTION

The tables below are an expansion on each emphasis area's strategies to prevent fatal and serious injuries. Each table lists a final selection of recommended countermeasures with a demonstrated history of crash reductions when deployed according to federal and state resources.[1] Each table shows on which type(s) of roads each countermeasure should primarily be deployed and if it is a systemic or location specific countermeasure. An estimated reduction in fatal and serious injuries and cost-to-benefit ratio for each countermeasure are also provided if available from at least one state or federal source. Finally, each countermeasure is prioritized using a high (H), medium (M), or low (L) priority score. High priority projects are those that need to be implemented in the next one to two years. Medium priority countermeasures are those to be deployed in two to five years. Low priority countermeasures are those to be deployed over a five-year or longer time frame.

Table A1 Recommended Countermeasures by Emphasis Area

Intersections

Priority	Countermeasure	Category	Primary Implementation Road Type(s)	Systemic or Hotspot Locations?	Estimated Reduction in Fatal and Serious Injuries	Cost to Benefit Ratio
H	Systemic low-cost urban intersection improvements	Engineering	Urban divided roads	Systemic	10%	4 to 1
H	Yellow Change Intervals	Engineering	Signalized urban arterial intersections	Hotspot locations	12%	4 to 1

[1] Countermeasures from one or more of the following sources: FHWA Proven Safety Countermeasures, NHTSA Countermeasures that Work, TxDOT Solutions for Saving Lives on Texas Roadways, and TxDOT Highway Safety Improvement Program 2021.

H	Signal head backplates with reflective borders	Engineering	Signalized urban arterial intersections	Hotspot locations	15%	4 to 1
H	Improve data systems for identifying specific intersections and intersection types at high probability for serious injury crashes.	Engineering	All roadways	Systemic		
M	Reduce red light running	Engineering, Enforcement	Intersections with a history of red light running	Hotspot locations		4 to 1
M	Reduced Left-Turn Conflict Intersections	Engineering	Signalized urban arterial intersections	Hotspot locations	22%	4 to 1
L	Corridor Access Management	Engineering	Signalized urban arterial intersections	Hotspot locations	25%	4 to 1
L	Left and Right Turn Lanes at Two-Way Stop Controlled Intersections	Engineering	Signalized urban arterial intersections	Hotspot locations	36%	4 to 1
L	Build roundabouts	Engineering	Intersections where traffic data indicates a safety benefit	Targeted locations	78%	

Roadway and Lane Departures

Priority	Countermeasure	Category	Primary Implementation Road Type(s)	Systemic or Hotspot Locations?	Estimated Reduction in Fatal and Serious Injuries	Cost to Benefit Ratio
M	Rumble Strips	Engineering	Rural divided highways and 2-lane roadways	Systemic	13-64%	12 to 1
M	High Friction Surface Treatment / Pavement Friction Management	Engineering	Rural 2-lane roadways	At curves, on/off ramps and bridges, crosswalks	20-63%	2 to 1
M	Concrete and cable median barriers	Engineering	Rural Divided highways	Systemic	97%[A]	4 to 1
M	Wider Edge Lines	Engineering	Rural 2-lane roadways	Systemic	22-37%	25 to 1
M	Enhanced delineation on curves (signage, marking, advanced warning upgrades)	Engineering	Rural 2-lane roadways	At curves with a history of Run off the Road Crashes	15-60%	
L	Safety Edge	Engineering	Rural 2-lane roadways	Systemic	11%	700 to 1
L	Modernize Rail and Approach Guardrail	Engineering	Rural Roadways	At bridges, systemic		2 to 1

A - Cross median crashes only

Speeding

Priority	Countermeasure	Category	Primary Implementation Road Type(s)	Systemic or Hotspot Locations?	Estimated Reduction in Fatal and Serious Injuries	Cost to Benefit Ratio
H	Improve the effectiveness of educational techniques, tools, and strategies for speeding by demographic group	Education	All roads	Systemic	9%	9 to 1
H	Increase and sustain high visibility speeding enforcement.	Enforcement	All roads	Systemic		
M	Reduce speed limits to be more appropriate for bicyclists and pedestrians	Engineering	Urban roads	Systemic	26%	
M	Variable speed limits	Engineering	Urban and rural freeways, urban arterials, work zones	Hotspot locations	51%	9 to 1 - 40 to 1
M	Speed safety cameras and automated enforcement*	Engineering, Enforcement	Urban arterials	Hotspot locations	20-47%	

L	Build or redesign roadways with traffic calming countermeasures and "self-enforcing" speed	Engineering	Urban roads	Hotspot locations		

*The legality of automated speed detection and enforcement in Texas would need to be clarified by TxDOT and the Texas Transportation Council before implemented.

Occupant Protection

Priority	Countermeasure	Category	Primary Implementation Road Type(s)	Systemic or Hotspot Locations?	Estimated Reduction in Fatal and Serious Injuries	Cost to Benefit Ratio
M	Safety Belt Education - Younger Drivers	Education	All Roads	Systemic		13 to 1
M	Safety Belt Enforcement	Enforcement	All Roads	Systemic	16%	13 to 1
M	Safety Seat Installation and Fitting Workshops	Education	All Roads	Systemic		

Motorcycle

Priority	Countermeasure	Category	Primary Implementation Road Type(s)	Systemic or Hotspot Locations?	Estimated Reduction in Fatal and Serious Injuries	Cost to Benefit Ratio
M	Motorcycle Safety Education and Enforcement	Education, Enforcement	All Roads	Systemic		11 to 1
M	Motorcycle Helmet Use and Protective Gear Education and Training	Education	All Roads	Systemic		

Bicyclist and Pedestrian

Priority	Countermeasure	Category	Primary Implementation Road Type(s)	Systemic or Hotspot Locations?	Estimated Reduction in Fatal and Serious Injuries[B]	Cost to Benefit Ratio
H	Pedestrian lighting at urban intersections and midblock crossings	Engineering	Urban arterials and collector roadways	Systemic	42%[C]	
H	Improve driver and pedestrian safety awareness and behavior	Education	All roads	Systemic		9 to 1

H	Crosswalks Visibility Enhancements / Improve pedestrians' visibility at crossing location	Engineering	Urban arterials and collector roadways	Systemic	40%	
H	Rectangular Rapid Flashing Beacons	Engineering	Urban arterials and collector roadways at midblock locations	Hotspot locations	47%	
H	Leading Pedestrian Interval	Engineering	Urban signalized intersections	Hotspot locations	13%	
H	Pedestrian Hybrid Beacons	Engineering	Urban arterials and collector roadways	Hotspot locations	15%	
H	511 - Motorist Call-In Number / Motorist Assistance Patrols	Emergency Response, Education	Freeways	Systemic		38 to 1
H	Safe Routes to School Programs	Education, Engineering, Enforcement	Roads near schools	Systemic	43%	
M	Add Midblock Crossings	Engineering	Urban arterials and collector roadways	Hotspot locations	46-56%	
M	Median and crossing pedestrian refuge islands	Engineering	Midblock crossings on urban roads	Systemic	46-56%	

L	Add Shared Lanes / Bicycle Lanes	Engineering	Urban roads	Systemic	30-49%	
L	Safe Path between Intersections/Walk ways/ improve pedestrian networks	Engineering	Urban roads	Systemic	65-89%	
L	Road Diets (Roadway Reconfiguration)	Engineering	Urban roads with less than 25,000 ADT	Hotspot locations	19-47%	
B - Pedestrian and bicyclist specific injuries only C - Nighttime injuries only						

Impaired Driving

Priority	Countermeasure	Category	Primary Implementation Road Type(s)	Systemic or Hotspot Locations?	Estimated Reduction in Fatal and Serious Injuries	Cost to Benefit Ratio
H	Increase impaired driving enforcement, especially on weekend nights and an impaired driving educational campaign	Enforcement, Education	All roads	Targeted locations with a history of impaired driving crashes	11-20%[D]	
M	Implement technology to prevent wrong-way crashes.	Engineering	Freeways	Systemic		
L	Implement technology to alert drivers to the presence of a wrong way driver	Education	Freeways	Systemic		

D - When enforcement and paid media were used together

Distracted Driving

Priority	Countermeasure	Category	Primary Implementation Road Type(s)	Systemic or Hotspot Locations?	Estimated Reduction in Fatal and Serious Injuries	Cost to Benefit Ratio
H	Reduce fatalities and serious injuries by identifying and implementing education and awareness strategies to reduce distracted driving.	Education	All roads	Systemic		9 to 1
L	Improve and increase enforcement capabilities for addressing distracted driving	Enforcement	All roads	Systemic		

Safety Countermeasures

FHWA Proven Safety Countermeasures

The FHWA's Proven Safety Countermeasures are a collection of countermeasures and strategies effective in the reduction of fatal and serious injury crashes on the nation's road networks. Transportation agencies are strongly encouraged to consider the implementation of these proven safety countermeasures to assist in accelerating the achievement of their safety goals.

Speeding Proven Countermeasures

Variable Speed Limits

Speed limits are established initially through engineering studies based on characteristics such as traffic volumes, operating speeds, roadway characteristics and crash history. However, roadway conditions are susceptible to change in a short time frame. (Examples include congestion, crashes, weather, etc.) Drivers typically determine their operating speeds under ideal weather conditions on straight roadway segments that have adequate sight distances with a good quality of pavement. If these ideal roadway conditions do not exist or do not meet the driver's expectations, there is a greater probability that a driver error can result in a crash. Providing Variable Speed Limits which can adapt to the changing circumstances of the road's conditions can reduce crash frequency and severity.

Variable Speed Limits use the current information of the road segment, like traffic speed, traffic volumes, weather, and road surface conditions, to determine the appropriate speeds and display them to drivers. Safety performance and traffic flow are improved using this strategy by reducing speed variance or improving speed harmonization. Variable Speed Limits also provide information in advance of slowdowns and potential lane closures which improves driver expectation and can reduce the probability of secondary crashes. They can also mitigate adverse weather conditions and slow faster-moving traffic as it approaches queues or bottlenecks on the roadway network.

Speed is a predictor of crash survival. As speed increases, the probability of a fatal and serious injury crash also increases. Variable Speed Limits reduce speeds so that human injury tolerances are aided in three ways; improving visibility, providing additional time for drivers to slow down and stop, and reducing impact forces. The ideal applications for Variable Speed Limits are congestion, traffic incidents such as crashes, work zones, and inclement weather. The safety benefits of Variable Speed Limits can reduce crashes on freeways up to 34 percent for total crashes, 65 percent for rear end crashes, and 51 percent for fatal and serious injury crashes. There is also a benefit-to-cost ratio range between 9:1 – 40:1 according to the Federal Highway Administration.

Appropriate Speed Limits for All Road Users

Speed control is one of the most important ways in reducing the number of fatal and serious injury crashes. Speed is a particularly important factor on non-limited access roadways where there is a mix of vehicles and vulnerable road users. Drivers may drive at speeds which feel reasonable for them but are not reasonable for all the roadway users on that system, particularly vulnerable users, including children and senior citizens.

A driver traveling at 30 miles per hour who hits a pedestrian has a 45 percent chance of killing or seriously injuring them. At 20 miles per hour, that percentage drops to five percent according to the Federal Highway Administration (FHWA). Numerous major cities across the United States have reduced their local speed limits to reduce fatal and serious injury crashes, with most having to secure State legislation authorization to do so.

When setting a speed limit, a range of factors should be considered such as pedestrian and bicyclist activity, crash history, land use context, intersection spacing, driveway density, roadway geometry, roadside conditions, roadway functional classification, traffic volume, and observed speeds.

Roadway Departure Proven Countermeasures

Wider Edge Lines

Roadway departures account for over half of all traffic fatalities in the United States according to the FHWA. The risk of roadway departure increases if drivers cannot clearly identify the edge of the travel lanes and see the road alignment ahead. Wider Edge Lines strengthen the visibility of lane boundaries compared to the traditional edge lines. The minimum normal edge line width is four inches, edge lines become "wider" when that is increased to the maximum normal line width of six inches, according to the FHWA.

The ideal applications for Wider Edge Lines are for pavement and shoulder widths, where there is a presence of curves in the road, and where there is a history of nighttime crashes. The safety benefit of Wider Edge Lines can reduce crashes up to 37 percent for non-intersection, fatal and serious injury crashes on rural, two-lane roads and 22 percent for fatal and serious injury crashes on rural freeways. There is also a benefit-to-cost ratio of 25:1 for fatal and serious injury crashes on two-lane rural roads, according to the FHWA. Wider Edge Lines are relatively low cost and can be implemented using existing equipment during maintenance procedures like re-striping and resurfacing, with the only additional cost being the increased materials. The Wider Edge Lines may also improve the guidance of automated vehicles' sensors in the future as they continue to increase on roadways.

Median Barriers

Median Barriers are longitudinal barriers that separate opposing traffic on a divided roadway that are designed to redirect vehicles that strike the barrier from either side. Median Barriers significantly reduce the number of cross-median crashes. These cross-median crashes are often attributed to the high speeds that occur on divided highways. Median Barriers can be cable, metal-beam, or concrete.

Cable barriers are flexible barriers, made from steel cables mounted on weak steel posts. These result in less occupant impact force as the barrier absorbs energy from the crash and redirection of the vehicle. Cable barriers usually require more frequent maintenance and repair than other barrier types.

Metal-Beam guardrails are semi-rigid barriers, where the beam is mounted to a steel or wooden post. These are designed to deform and deflect, which results in absorbing some of the crash energy and redirection of the vehicle. Metal-Beam guardrails usually do not require maintenance after minor impacts. These barriers deflect less than cable barriers, which means they can be located closer to objects where space is limited.

Concrete barriers are rigid and result in little to no deflection. These barriers redirect rather than absorb energy from the impact. Concrete barriers infrequently require maintenance after minor impacts.

Intersection Proven Safety Countermeasures

Yellow Change Intervals

The Yellow Change Interval is the length of time that the yellow signal indication is displayed following a green signal indication. The yellow signal notifies roadway users that the green signal has ended and that a red signal will appear soon. According to the Federal Highway Administration, running the red-light signal is the leading cause of severe crashes at signalized intersections. This means that the yellow signal interval must be appropriately timed. When the interval is too short, this may result in drivers failing to stop safely and causing unintentional red-light running. When the interval is too long, this may result in drivers using the yellow signal as an addition to the green signal and cause intentional red-light running. Timing calculation should be conducted using factors such as: the speed of approaching and turning vehicles, driver perception and their reaction time, vehicle deceleration, and intersection geometry.

According to the FHWA, the safety benefits of Yellow Change Intervals can reduce red light running by 36-50 percent, have an 8-14 percent reduction in total crashes, and have a 12 percent reduction in crashes resulting with an injury.

Backplates with Reflective Borders

Traffic signals with the addition of a backplate improve the visibility of the illuminated signal face by creating a controlled-contrast background. Creating the backplate with a 1–to–3-inch yellow retroreflective border adds even more improved visibility to the traffic signal. Those traffic signals that are equipped with a retroreflective backplate are more visible and conspicuous in both daytime and nighttime conditions. The reflective backplate is recognized as a human factor enhancement of the traffic signal's visibility, conspicuity, and orientation for both older and color vision deficient drivers. The reflective backplate is also advantageous during power outages when the traffic signal would otherwise be dark, providing a visible indication for motorists to stop at the intersection ahead.

Adding a retroreflective border to the existing traffic signal's backplate is a low-cost treatment. This can be possible by adding retroreflective tape to the existing backplate or by purchasing a backplate with an existing retroreflective backplate. According to the FHWA, the safety benefit of retroreflective backplates can have a reduction of total crashes by 15 percent.

Roundabouts

A roundabout is an intersection with a circular configuration that safely and efficiently moves traffic. Their curved approaches reduce speed, yielding when entering give the right-of-way to circulating traffic, and counterclockwise flow around a central island that helps minimize conflict points. By reducing speeds and minimizing conflict points, fatal and serious injury crashes are substantially reduced. It also creates a more ideal environment for pedestrians and bicyclists. Roundabouts are also an efficient measure in terms of keeping non-motorists moving by reducing delay and queueing when compared to other intersection types.

Pedestrian and Bicyclist Proven Safety Countermeasures

Rectangular Rapid Flashing Beacons

Marked crosswalks or pedestrian warning signs can improve safety for pedestrians crossing roadways, but at certain times may not be adequate for drivers to visibly locate these crossing locations and yield to pedestrians. A Rectangular Rapid Flashing Beacon (RRFB) can be installed at uncontrolled and marked crosswalks, to increase driver awareness and enhance the prominence of pedestrians. These can also be installed to accompany any existing pedestrian warning signs. RRFBs are made of two rectangular shaped yellow indicators, each with a light-emitting diode light source. They flash with an alternating high frequency when activated by the pedestrian to increase the prominence of the pedestrian at the crossing.

RRFBs can be applicable to many different types of pedestrian crossings but are particularly effective at multilane crossings with speed limits of less than 40 miles per hour. According to the FHWA, RRFBs can result in motorists yielding rates as high as 98 percent at marked crossings, however, this can vary depending on the location, posted speed limit, the pedestrian crossing distance, one- or two-way road, and the number of lanes on the roadway. RRFBs also have the added safety benefit of reducing pedestrian crashes up to 47 percent according to the FHWA.

Crosswalk Visibility Enhancements

Poor lighting conditions, obstructions such as parked cars, and roadway curvature reduce the visibility at crosswalks which contribute to transportation safety issues. On roadways where vehicle volumes exceed 10,000 Average Annual Daily Traffic, a marked crosswalk alone is usually not sufficient. There are three main visibility enhancements: high-visibility crosswalks, lighting, and signage and pavement markings.

High-Visibility Crosswalks

These crosswalks use patterns that are visible to both drivers and pedestrians from further distances compared to the traditional transverse line crosswalks.

Improved Lighting

The goal of crosswalk lighting should be to illuminate with a positive contrast to increase visibility and make it easier to identify pedestrians. Lighting should be carefully placed in forward locations to eliminate creating a silhouette effect over the pedestrian.

Enhanced Signage and Pavement Markings

On multilane roads, enhanced signage in advance of crosswalks can make drivers more attentive to potential upcoming pedestrians. Signage can also be supplemented with Stop or Yield bar pavement markings.

Lighting

According to the FHWA, the nighttime fatality rate is three times higher than the daytime rate. At nighttime vehicles traveling at higher speeds may not have adequate reaction time to stop at a hazard or change in the road by the time they become visible by their headlights. Lighting can be applied continuously along road segments and at specific locations such as at intersections and crosswalks and other areas with high pedestrian activity to reduce the chances of crashes occurring.