

The background features a complex geometric design composed of various blue and light gray shapes. A prominent feature is a large, light gray triangle pointing downwards, which is partially overlaid by several blue shapes. These include a large blue triangle pointing upwards, a smaller blue triangle pointing downwards, and several blue trapezoidal and triangular shapes that create a layered, architectural effect. The overall aesthetic is clean, modern, and professional.

# **APPENDIX F: SAFETY COUNTERMEASURES TOOLBOX**

## Segment Countermeasures

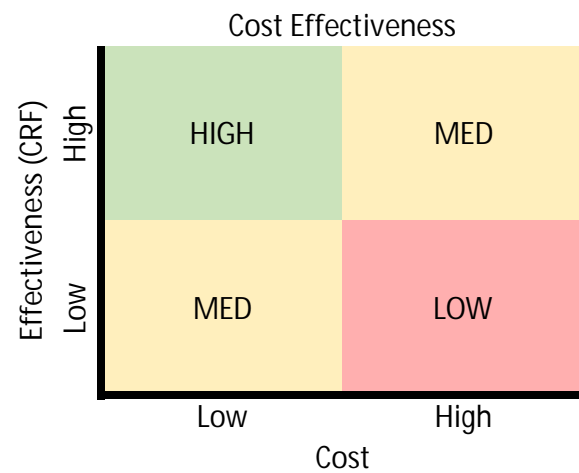
Emphasis Area	Safety Countermeasure	Crash Reduction Factor (CRF)	Applicable Crashes	Unit Cost	Cost Effectiveness	Application Guidance	Urban	Rural
Speeding	Set Appropriate Speed Limits for All Road Users	NA	All	NA	NA	Locations identified with speed related issues and/or crashes	X	X
Speeding	Install Variable Speed Limit Signs	0.34	Interstate	\$54,000 Each	LOW	1. Roadways that are susceptible to significant changes over a short amount of time (e.g., congestion, crashes, weather, work zones) 2. Freeways and high-speed arterials with Posted speed limits greater than 40 MPH	X	X
Speeding	Install Driver Feedback Speed Limit Signs	NA	All	\$10,000 Each	NA	Targeted locations required speed compliance over a short distance	X	X
Speeding	Install Driver Feedback Speed Limit Signs on Rural Curves	0.05 - 0.07	Rural Curves	\$10,000 Each	LOW	Rural roadways with curves		X
Speeding	Re-Evaluate Speed Based on Roadway Context, Built Environment, and Existing Road Users	NA	All	NA	NA	Locations where speed limits doesn't fit the build environment and existing roadway context	X	X
Speeding	Traffic Calming - Lane Narrowing	0.32	All	\$39,000 per Mile	LOW	If a lower 85th percentile speed is desired	X	
Speeding	Traffic Calming - Wider Lane Lines	0.32	All	\$21,000 per Mile	LOW	If a lower 85th percentile speed is desired	X	
Speeding	Traffic Calming - Medians (Back-To-Back Curb)	0.32	All	\$264,000 per Mile	MED	If a lower 85th percentile speed is desired	X	
Speeding	Traffic Calming - Bulbouts	0.32	All	\$36,000 Each	LOW	If a lower 85th percentile speed is desired	X	
Bicyclist	Install Bicycle Lane	0.31 - 0.49	Bicycle	\$21,000 per Mile	LOW	ADT ≥ 3000 and Posted Speed Limit ≥ 25 MPH	X	X
Bicyclist	Install Buffered Bicycle Lane	NA	Bicycle	\$26,000 per Mile	NA	1. High Traffic Volumes, 2. Regular Truck Traffic, or 3. Posted Speed Limit > 35 MPH	X	
Bicyclist	Install a Separated Bicycle Lane (Curb Separated, Cycle Track or Multi-Use Path)	NA	Bicycle	\$553,000 per Mile	NA		X	
Bicyclist	Convert a Traditional or Buffered Bicycle Lane to a Separated Bicycle Lane with Flexible Delineator Posts	0.532	Bicycle	\$45,000 per Mile	MED	Existing bicycle lane present	X	
Bicyclist	4-Lane to 3-Lane Road Diet Conversion with Installation of Bicycle Lanes	0.19 - 0.47	All	\$40,000 per Mile	MED-LOW	ADT less than 25,000 and with repaving project	X	X
Bicyclist	Install Bicycle Ramp	NA	Bicycle	\$10,000 Each	NA	Connects bicyclists from the road to the sidewalk or a shared use path; transition cyclists out of roadway when vehicle movements become complicated, or when pavement narrows and can no longer accommodate separate bike lane (on high-speed, low-comfort routes)	X	X

## Segment Countermeasures

Emphasis Area	Safety Countermeasure	Crash Reduction Factor (CRF)	Applicable Crashes	Unit Cost	Cost Effectiveness	Application Guidance	Urban	Rural
Bicyclist	Install Shared Sidewalk Sign	NA	Bicycle	\$6,000 per Mile	NA	Signs communicate to pedestrians that bicyclists may also use the sidewalk and that bicyclists must yield to pedestrians. May be prohibited in downtown areas due to high pedestrian volumes; would require wider sidewalks (10' min) in order to accommodate both modes.	X	X
Bicyclist	Install Floating Transit Island	NA	All	\$28,000 per Island	NA	An in-street transit boarding island is used in conjunction with a separated bikeway, separating transit traffic from bicycle traffic, reducing conflict between the two modes, and lowering the risk of collision.	X	
Rear-End, Left-Turn, Speeding, Pedestrian	4-Lane to 3-Lane Road Diet Conversion	0.19 - 0.47	All	\$22,000 per Mile	LOW	ADT less than 25,000 and with repaving project	X	X
Pedestrian	Upgrade Existing Crosswalk to a High-Visibility Crosswalk at Midblock Locations (Lighting, Enhanced Signing, Enhanced Pavement Markings, Lighting, In-Pavement Signage, etc.)	0.25 - 0.4	Pedestrian	\$37,000 per Crossing	LOW	Multilane roadway crossing with AADT > 10,000	X	
Pedestrian	Install a High-Visibility Crosswalk at Midblock Locations (Lighting, Enhanced Signing, Enhanced Pavement Markings, Lighting, In-Pavement Signage, etc.)	0.25 - 0.4	Pedestrian	\$36,000 per Crossing	LOW	Multilane roadway with AADT > 10,000	X	
Pedestrian	Install Raised Crosswalk	NA	Pedestrian	\$71,000 Each	NA	A raised crosswalk is a pedestrian crosswalk that is typically elevated 3-6 inches above the road or at sidewalk level. A raised crosswalk improves safety by increasing crosswalk and pedestrian visibility and slowing down motorists.	X	X
Pedestrian	Install Medians and Pedestrian Refuge Islands in Urban and Suburban Areas	0.56	Pedestrian	\$958,000 per Mile (Urban)	HIGH	Multilane roadway, 35 MPH or greater speed limit, Mix of pedestrian and Vehicle Traffic, AADT > 9,000	X	
Pedestrian	Install Medians with Marked Crosswalks	0.46	Pedestrian	\$1,052,000 per Mile	HIGH	Multilane roadway, 35 MPH or greater speed limit, Mix of pedestrian and Vehicle Traffic, AADT > 9,000	X	X
Pedestrian	Install Pedestrian Hybrid Beacons (PHB) or HAWK	0.547	Pedestrian	\$200,000 Each	MED	Midblock Crossings, Speed Limit > 35 MPH, Multilane Roadway, AADT > 9,000	X	
Pedestrian	Install a Rectangular Rapid Flashing Beacons (RRFB)	0.474	Pedestrian	\$15,000 per Crossing (2)	MED	Speed Limits < 40 MPH, Multilane Roadway	X	
Pedestrian	Install Sidewalk or Walkways	NA	Pedestrian	\$634,000 per Mile	NA	All Roadways with no existing sidewalk	X	X
Cross-Median Crashes	Install Median Barriers on Divided Highways (Cable Barrier, Metal Guardrail, Concrete Barrier)	0.97	Cross Median	\$1,913,000 per Mile	HIGH	High-speed, fully controlled access roadways for locations where the median is 30 ft in width or less and the average daily traffic (ADT) is greater than 20,000 vehicles per day (vpd)		X
Cross-Median Crashes	Install Median Barriers on Divided Highways (Cable Barrier, Metal Guardrail, Concrete Barrier)	0.97	Cross Median	\$394,000 per Mile	HIGH	High-speed, fully controlled access roadways for locations where the median is 30 ft in width or less and the average daily traffic (ADT) is greater than 20,000 vehicles per day (vpd)		X
Cross-Median Crashes	Install Median Barriers on Divided Highways (Cable Barrier, Metal Guardrail, Concrete Barrier)	0.97	Cross Median	\$466,000 per Mile	HIGH	High-speed, fully controlled access roadways for locations where the median is 30 ft in width or less and the average daily traffic (ADT) is greater than 20,000 vehicles per day (vpd)		X

## Segment Countermeasures

Emphasis Area	Safety Countermeasure	Crash Reduction Factor (CRF)	Applicable Crashes	Unit Cost	Cost Effectiveness	Application Guidance	Urban	Rural
Vehicle	Implement Corridor Access Management Principles on Urban Roadways - Driveway Consolidation	0.25 - 0.31	Fatal & Injury	\$7,000 per Driveway	LOW	All Roadways	X	
Vehicle	Implement Corridor Access Management Principles on Rural 2-Lane Roadways - Driveway Consolidation	0.05 - 0.23	All	\$7,000 per Driveway	LOW	All Roadways		X
Nighttime Crashes	Provide Highway Lighting	0.28	Nighttime	\$300,000 per Mile	MED	All Roadways	X	X
Multiple	Perform Road Safety Audits	0.1 - 0.6	All	\$25,000 per Location	MED-LOW	All Roadways	X	X
Run Off Road	Install 6" Edge Line (Both Sides of Road)	0.12 - 0.36	All	\$7,000 per Mile	LOW	Rural two-lane highways		X
Run Off Road	Install Edge Line Rumble Strips	0.13 - 0.51	Fatal & Injury	\$9,000 per Mile	LOW	Rural two-lane highways		X
Head-On	Install Centerline Rumble Strips	0.44 - 0.64	Head-on (Fatal & Injury)	\$5,000 per Mile	LOW	Rural two-lane highways		X
Run off Road Curve	Install Post-Mounted Delineators	0.15	Run Off Road	\$4,000 per Mile	LOW	Rural roadways with existing signage		X
Curve	Review, Install and/or Upgrade Curve Signage (Warning signs, Speed Advisory Plaques, Chevrons) to Provide Enhanced Delineations (Pavement Markings, Delineators, etc.)	0.148 - 0.6	All	\$2,000 per Curve	LOW	Rural roadways with curves		X
Curve	Improve Roadside Design on Curves (Clear Zone Improvement, Slope Flattening, Shoulder Installation/Widening, Barrier/Guardrail, etc.)	0.08 - 0.44	All	Varies per Curve	NA	Rural roadways with curves		X
Curve	Install In-Lane Curve Warning Pavement Markings	0.348 - 0.384	All	\$3,000 per Curve	LOW	Rural roadways with curves		X
Curve	Install Retroreflective Strips on Curve Signage	NA	All	\$1,000 per Curve	NA	Existing curve warning signage		X
Run Off Road	Install Safety Edge with Repaving Projects	0.11 - 0.21	All	\$121,000 per Mile	LOW	All rural two-lane roadways		X
Curve	Install High Friction Surface Treatment (HFST) on Curve	0.485	Fatal & Injury	\$53,000 per Curve	MED	Rural roadways with curves		X
Multiple	Install Raised Medians on Roadways with Existing TWLTL	0.71	All	\$928,000 per Mile	HIGH	Roadways with TWLTL	X	
Run Off Road	Shoulder Widening on Rural Roads	0.229	All	\$32,000 per Mile	LOW	Rural Multilane Roadways		X
Run Off Road	Provide 2-Ft Paved Shoulder on Rural 2-Lane Roadways	0.11 - 0.34	All	\$298,000 per Mile	MED	Rural 2-Lane Roadways without shoulders		X
Run Off Road	Shoulder Widening on Rural Roads	0.229	Rural	\$32,000 per Mile	LOW	Rural Multilane Roadways		X



## Intersection Countermeasures

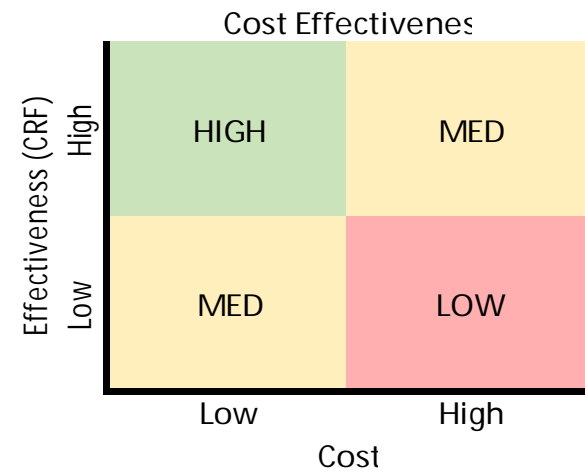
Emphasis Area	Safety Countermeasure	Crash Reduction Factor (CRF)	Applicable Crash Types	Unit Cost	Cost Effectiveness	Application Guidance	Signal	No Signal
Intersection	Install Retroreflective Backplates/Boarders	0.15	All	\$275 Each	LOW	All Signalized Intersections without backplates	X	
Pedestrian	Upgrade Existing Crosswalk to High-Visibility Crosswalk (Lighting, Enhanced Signing, Enhanced Pavement Markings, In-Pavement Signage, etc.)	0.25 - 0.4	Pedestrian	\$37,000 per Crossing	LOW	Select improvements consistent with Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations, Table 1 - Application of pedestrian crash countermeasures by roadway feature; <a href="https://www.fhwa.dot.gov/innovation/everydaycounts/edc_5/docs/STEP-guide-improving-ped-safety.pdf">https://www.fhwa.dot.gov/innovation/everydaycounts/edc_5/docs/STEP-guide-improving-ped-safety.pdf</a>	X	X
Pedestrian	Install High-Visibility Crosswalk (Lighting, Enhanced Signing, Enhanced Pavement Markings, In-Pavement Signage, etc.)	0.25 - 0.4	Pedestrian	\$36,000 per Crossing	LOW	Select improvements consistent with Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations, Table 1 - Application of pedestrian crash countermeasures by roadway feature; <a href="https://www.fhwa.dot.gov/innovation/everydaycounts/edc_5/docs/STEP-guide-improving-ped-safety.pdf">https://www.fhwa.dot.gov/innovation/everydaycounts/edc_5/docs/STEP-guide-improving-ped-safety.pdf</a>	X	X
Pedestrian	Modify Signal Phasing to Include a Leading Pedestrian Interval (LPI); include No Right Turn on Red Signage	0.13	Pedestrian	\$3,000 per Intersection	LOW	Signalized Intersection with high turning volumes and high pedestrian crossings	X	
Pedestrian	Close Slip Lane	0.3	Pedestrian	\$40,000 per Each	LOW	Modifies the corner of an intersection to remove the sweeping right turn lane for vehicles. Results in shorter crossings for pedestrians, reduced speed for turning vehicles, better sight lines, and space for landscaping and other amenities.	X	X
Pedestrian Angled	Centerline Hardening	NA	Angled	\$5,500 per Intersection	NA	Centerline hardening makes intersections safer for pedestrians by encouraging drivers to make left turns at slower speeds.	X	
Pedestrian	Add Sidewalk	0.8	Pedestrian	\$4,500 per Intersection	MED	Adding sidewalks provides a separated and continuous facility for people to walk along the roadway. Adding sidewalks improves safety by minimizing collisions with pedestrians walking in the road.	X	X
Pedestrian	Extended Time Pushbutton	NA	Pedestrian	\$500 per Each	NA	A pushbutton that can be pressed to request extra time for using the crosswalk, beyond the standard crossing time. Ideal near senior-serving land uses.	X	
Pedestrian, Transit	Co-Locate Bus Stops and Pedestrian Crossings	NA	Pedestrian	NA	NA	Place bus stops and pedestrian crossings in close proximity to allow transit riders to cross the street safely.		X
Pedestrian, Vehicle	Install Intersection Lighting	0.33 - 0.38	Nighttime	\$31,000 per Intersection	LOW	All Intersections Without Lighting	X	X
Pedestrian, Vehicle	Implement Corridor Access Management Principles on Urban Roadways	0.25 - 0.31	Fatal & Injury	\$7,000 per Driveway	LOW	Limiting or eliminate driveways within the functional area of an intersection (upstream and downstream), as determined by stopping sight distance	X	X
Vehicle	Implement Corridor Access Management Principles on Rural 2-Lane Roadways	0.05 - 0.23	All	\$7,000 per Driveway	LOW	Limiting or eliminate driveways within the functional area of an intersection (upstream and downstream), as determined by stopping sight distance	X	X
Angled, Left-Turn	Provide Left-Turn Lanes at the Intersection	0.28 - 0.48	Rural	\$300,000 per Lane	MED	Major leg approaches at intersections with significant turning volumes and history of turn-related crashes	X	X

## Intersection Countermeasures

Emphasis Area	Safety Countermeasure	Crash Reduction Factor (CRF)	Applicable Crash Types	Unit Cost	Cost Effectiveness	Application Guidance	Signal	No Signal
Angled	Create Positive Off-Set of Existing Left-Turn Lanes at an Intersection	0.356	All	\$16,000 per Intersection	LOW	Offset increases with design speed and approaches a value of 2.0 ft, which provides unrestricted sight distance when opposing left-turn vehicle is a passenger car. An offset of 1.0 ft accommodates design speeds 45 mph and below; offset of 1.5 ft accommodates design speeds up to 70 mph, unrestricted left-turn sight distance is provided by a 3.5-ft offset. When opposing left turn is a truck a 2.5-ft offset would accommodate design speeds of 40 mph and lower, and a 3.0-ft off et would provide adequate sight distance for design speeds up to 70 mph ( <a href="https://onlinepubs.trb.org/Onlinepubs/trr/1992/1356/1356-004.pdf">https://onlinepubs.trb.org/Onlinepubs/trr/1992/1356/1356-004.pdf</a> ), page 6 of 9.	X	X
Angled, Left-Turn	Provide Right-Turn Lanes at the Intersection	0.14 - 0.26	All	\$150,000 per Lane	LOW	Major leg approaches at intersections with significant turning volumes of history of turn-related crashes	X	X
Angled, Left-Turn	Install Reduced Left-Turn Conflict Control Intersection Type (RCUT, MUT, Etc..)	0.22 - 0.63	Fatal & Injury	\$767,000 per Intersection	MED-HIGH	All intersections with significant angled and left-turn crash issues	X	X
Multiple	Convert Existing Intersection to Modern Roundabout	0.41 - 0.82	All	\$2,500,000 per Intersection	HIGH	All Intersections	X	X
Intersection	Apply Systemic Application of Multiple Low-Cost Countermeasures at Stop-Controlled Intersections (advanced warning signs, retroreflecting sign posts, pavement marking, doubling signs, oversized signs, flashing beacons, etc.)	0.1 - 0.27	All	\$19,000 per Intersection	LOW	All Stop-Controlled Intersections with crash issues		X
Multiple	Appropriately Time the Yellow Change Interval	0.08 - 0.12	All	NA	NA	Signalized Intersections	X	
Intersection	Install High Friction Surface Treatment (HFST) at Intersections	0.201	All	\$16,000 per Intersection	LOW	All Intersections	X	X
Multiple	Perform Road Safety Audits	0.1 - 0.6	All	\$5,000 per Intersection	MED-LOW	All Intersection	X	X
Multiple	Perform an Intersection Control Evaluation (ICE) Study and Implement Results	NA	All	\$225,000 per Intersection	NA	All Intersection	X	X
Angled, Left-Turn	Change a Permissive Only to Flashing Yellow Arrow	0.4 - 0.5	Left-Turn	\$8,000 per Intersection	LOW	All permission only signals	X	
Angled, Left-Turn	Change permissive left-turn phasing to protected only or protected/permissive	0.05 - 0.21	Left-Turn	\$8,000 per Intersection	LOW	Signalized intersections with left turn issues	X	
Angled, Left-Turn	Change a 5-section "doghouse" protected/permissive left turn to flashing yellow arrow protected/permissive left turn	0.07 - 0.25	Left-Turn	\$8,000 per Intersection	LOW	All intersections with doghouse signal head	X	
Bicycle Signal / Exclusive Bike Phase	Install a separate traffic signal directing bicycle traffic across an intersection, or add an exclusive phase to the signal cycle specifically for cyclists (could be used for pedestrians also). Separates bicycle movements from conflicting motor vehicle, streetcar, light rail, or pedestrian movements.	NA	Bicycle	\$21,000 per Intersection	NA	Appropriate at locations with high volumes of cyclists or pedestrians, such as at major trail crossings or near schools or university campuses.	X	
Bicycle	Add Bicycle Treatments at Intersections (Bike Box, Intersection Crossing Markings, Two Stage Turn Queue Boxes, Combined Bike Lane/Turn Lane)	NA	Bicycle	\$9,000 per Intersection	NA	Intersection with Bicycle Lanes on approaches	X	X
Pedestrian	Construct Protected Intersection	NA	Pedestrian	\$650,000 per Intersection	NA	Protected intersections use corner islands, curb extensions, and colored paint to delineate bicycle and pedestrian movements across an intersection. Slower driving speeds and shorter crossing distance increase safety for pedestrians. Separates bicycles from pedestrians	X	

## Intersection Countermeasures

Emphasis Area	Safety Countermeasure	Crash Reduction Factor (CRF)	Applicable Crash Types	Unit Cost	Cost Effectiveness	Application Guidance	Signal	No Signal
Angle	Right-in-Right-out Access Treatment	0.45	All	\$50,000 per Driveway	MED	Price per driveway	X	X
Pedestrian	Raised Intersection/Raised Crossing	0.36	All	\$30,000 per Each	LOW	Per crosswalk	X	
Intersection	Adequate Number/Visibility of Signal Heads	0.15	All	\$24,000 per Intersection	LOW	Assumes one additional signal head per approach	X	X
Pedestrian	Pedestrian Only Crossing Phase	0.35	All	\$50,000 per Intersection	LOW		X	
Pedestrian	Install Pedestrian Signal Heads	0.25	All	\$7,000 per Intersection	LOW	Per intersection cost, includes APS units	X	
Pedestrian	Install Pedestrian Refuge Island	0.46	All	\$30,000 per Each	MED	Per island, assumes island is 50 feet long and 10 feet wide	X	
Pedestrian	Install High Visibility Crosswalk Markings	0.4	All	\$2,500 per Crossing	LOW	Per crosswalk, assumes crosswalk if 60 feet long and 10 feet wide	X	X
Pedestrian	Install Pedestrian Hybrid Beacons (PHB) or HAWK	0.547	All	\$200,000 per Each	MED	Midblock Crossings, Speed Limit > 35 MPH, Multilane Roadway, AADT > 9,000	X	
Pedestrian	Install a Rectangular Rapid Flashing Beacon (RRFB)	0.474	All	\$15,000 per Crossing (2)	LOW	Speed Limits < 40 MPH, Multilane Roadway	X	
Speeding	Traffic Calming - Bulbouts	0.32	All	\$36,000 Each	LOW	If a Lower 85th percentile speed is desired	X	



## Non-Engineering Countermeasures

Category	Safety Countermeasure	Description
Better Data	Improve Crash Data Collection	Improve the accuracy, breadth, and consistency of crash data by creating a near-miss and unreported crash database, developing a standardized electronic reporting form for all crashes, forming agreements with shared mobility operators to acquire crash data, and/or creating a multi-jurisdiction crash database that can be updated by paramedics, police, City staff, and hospitals.
Education	Bicycle Safety Education Events	Partner with local bike shops and other partners to host events/fairs to educate residents on bicycle safety. For example, host rides to introduce residents to new bicycle facilities as they are opened; offer tune ups at safety fairs.
Education	Youth Education	Launch a countywide transportation safety education campaign targeting youth that covers a wide range of topics, such as alcohol and drug impairment, speeding, and potentially distracted driving. Local schools can also be partners in promoting safe driver behavior during school pick-up and drop offs. Educational campaigns that involve both students and parents can be more impactful as they involve parents, who are actually driving, and students, who may not only remind their parents but also retain safe driving behavior if they eventually drive.
Education	Education Campaigns for Vulnerable Groups	Launch targeted public education campaigns for seniors, non-English speaking populations, or other vulnerable groups.
Education	Pilot Demonstration Safety Projects	Implement pilot demonstration safety projects. Projects can either be implemented on a temporary basis (tactical urbanism) or permanent basis with room for modification (quick builds).
Education	Public Information Campaigns	Launch public safety education campaigns. Example campaign topics include safe speeds, yielding to pedestrians, distracted driving, drinking and driving, awareness of bicyclists and pedestrians, appropriate crosswalk behavior, rail safety, moving over for EMS vehicles, etc. Campaigns may include yard signs, wall boards/posters in prime injury-corridor neighborhoods, ads on bus exteriors, radio ads, etc. Public education may also involve making safety and crash data publicly available on project websites, the City's data portal, social media, and other avenues as appropriate.
Maintenance	Keep Roadways Clear of Debris	A smoothly paved surface free of debris enhances safety for vehicles and bicyclists.
Partnerships	Safe Routes to School	Establish a Safe Routes to School (SRTS) program in partnership with school districts.
Policies and Programs	Update City Policies and Standards	Update policies, standards, and guidelines on topics such as signal timing, street design, street lighting, complete streets, and pedestrian crossings to incorporate current best practices and improve safety for all modes.
Policies and Programs	Neighborhood Slow Zones	Develop a neighborhood slow zone program to allow neighborhoods to request treatments to slow motor vehicles to 15 to 20 mph using traffic calming features, signs, and markings. Selected locations are typically in areas serving children, seniors, public transit users, commercial activity, and pedestrian/bicycle activity.
Policies and Programs	Targeted Enforcement and Deterrence	Use crash history and corridors on the High Injury Network as one criterion for where to concentrate enforcement efforts. Add extra patrols to look for distracted drivers as part of a statewide distracted driving campaign, with focus on where data indicates that the most traffic safety benefit can be realized. Implement deterrence policies that are highly visible, such as publicized sobriety checkpoints, saturation patrol, and other forms of high visibility enforcement that are effective for safety outcomes.