

Intersection Countermeasure Selection

Table 1 Priority Intersection Infrastructure Strategy Sheets

1. Signal Install/Improvement

Description: Installing signals or improving signal attributes or operation to reduce conflict points or reduce likelihood of severe crashes



Category	Eligible Countermeasures	Target Facility	CRF/Effectiveness	Estimated Implementation Cost Per Location	HSIP Funding	Notes
Signal Install/Improvement	Backplates with Retroreflective Borders	Signalized Intersections	<u>15% (All Crashes)</u>	\$10,000 (1)	Eligible	Requires signal strength evaluation
Signal Install/Improvement	Increase Red Signal Head Size	Signalized Intersections	<u>42% (Angle Crashes)</u>	\$400 to \$2,500 (1)	Eligible	
Signal Install/Improvement	Adjust Yellow Change Intervals	Signalized Intersections	<u>36-50% Reduction in red light running</u>	\$5, 000 to \$ 30,000 (1)		FHWA Proven Countermeasure (12)
Signal Install/Improvement	A Properly Timed Protected Left Turn Phase (Left Turn Only Green Light)	Signalized Intersections	<u>16% reduction of left-turn crashes (CMF ID: 4578)</u>	\$5,000 to \$ 10,000		
Signal Install/Improvement	Restrict Or Eliminate Turning Maneuvers (Including Right Turns On Red)	Signalized Intersections	<u>Reduce 100% crashes related to the affected turning maneuver. 45-62% reduction of crashes. (FL, VA studies)</u>	Since this strategy is implemented through signing, its cost is low. (5)		

2. Warning Signage

Description: Installing signage or improving visibility of signs to raise awareness and information on the upcoming intersection



Category	Eligible Countermeasures	Target Facility	CRF/Effectiveness	Estimated Implementation Cost Per Location	HSIP Funding	Notes
Warning Signage	Improved Signage	Unsignalized Intersections	<u>30% (All Severities)</u>	\$5,000 to \$8,000	Eligible	
Warning Signage	Add Reflective Material to Sign Post	Unsignalized Intersections	<u>6% (All Crashes)</u>	\$100 (10)	Eligible	
Warning Signage	LED-Enhanced Stop Signs	Unsignalized Intersections	<u>13% (All Severities)</u>	\$5,000 to \$15,000	Eligible	
Warning Signage	Improve Signage Visibility and Reflectivity	Unsignalized Intersections	<u>10% Reduction in injury and fatal crashes</u> <u>15% Reduction in nighttime crashes</u>	\$150 (10)	Eligible	FHWA Proven Countermeasure (12)

3. Geometric and Sight-line Improvements

Description: Eliminating or improving intersection approach angles, sight distance, and turning radii



Category	Eligible Countermeasures	Target Facility	CRF/Effectiveness	Estimated Implementation Cost Per Location	HSIP Funding	Notes
Geometric and sight-line improvements	Change intersection sight distance/arterials with closely spaced (about ½ mile maximum) signals	Intersection	<u>32% reduction of all crashes</u>	\$5,000 to \$50,000 (1)		
Geometric and sight-line improvements	Improve Angle Of Channelized Right Turn Lane	Right Turn Lane	<u>44.2-43.6% reduction of all crashes</u>	\$50,000 to \$200,000, assuming no additional right-of-way is not required. (8)		CMF Clearinghouse

4. Non-motorist Improvements

Description: Improving visibility and shortening crossings for pedestrians and bicyclists, and adjusting signal operations and physical barriers to protect non-motorist movements



Category	Eligible Countermeasures	Target Facility	CRF/Effectiveness	Estimated Implementation Cost Per Location	HSIP Funding	Notes
Non-motorist Improvements	Install pedestrian Hybrid Beacon	Pedestrian crossings	<u>55%</u> <u>Reduction in pedestrian crashes</u>	Initial leg: \$68,000–\$133,000 Cost of subsequent legs: \$29,000–\$80,000 (9)	Eligible	FHWA Proven Countermeasure (12)
Non-motorist Improvements	Implement Leading Pedestrian Interval (LPI)	Intersections With High Turning Vehicle Volumes	<u>13%</u> <u>Reduction in pedestrian-vehicle crashes at intersections</u>	\$5,000 to \$15,000 (1)	Eligible	FHWA Proven Countermeasure (12)
Non-motorist Improvements	Conduct Pedestrian Road Safety Audits	Pedestrian Crossings	<u>10-60%</u> <u>Reduction in total crashes</u>	\$2,000 to \$5,000 (6)	Eligible	FHWA Proven Countermeasure (12)
Non-motorist Improvements	Pedestrian Refuge	Pedestrian Crossings on Wide Roadways	<u>Raised Median</u> <u>46%</u> <u>Reduction in pedestrian crashes</u> <u>Pedestrian Crossing Island</u> <u>56%</u> <u>Reduction in pedestrian crashes</u>	\$12,000 (7)	Eligible	FHWA Proven Countermeasure (12)
Non-motorist Improvements	Install Pedestrian Countdown Signals	Signalized Intersections	<u>9% reduction in ped crashes and a 12% reductions in rear end crashes</u>	\$ 5,000 to 15,000 (1)	Eligible	FHWA Evaluation Study

Non-motorist Improvements	Create Pedestrian Safety Zone Program	School zone, or other high-risk pedestrian dense areas	<u>37 % reduction in crashes at school zones</u>	School zone signs cost around \$200 each (7)	Eligible	Has been used effectively in other states
---------------------------	---------------------------------------	--	--	--	----------	---

5. Roundabout

Description: Roundabouts can replace signals, two-way stop controls, and all-way stop controls at both urban and rural intersections. Roundabouts are utilized for managing speed and transitioning traffic from high-speed to low-speed environments, as well as eliminating conflict points from traditional intersections and reducing severe crashes.



Category	Eligible Countermeasures	Target Facility	CRF/Effectiveness	Estimated Implementation Cost Per Location	HSIP Funding	Notes
Roundabouts	Replace Intersections With Roundabouts	Signalized/un signalized crossings	<u>78%-82% reduction in severe crashes</u>	\$250,000 (2)	Eligible	FHWA Proven Countermeasure (12)

6. Add or Adjust Lanes

Description: Add/remove dedicated turn lanes, change lane widths, and lane assignments/configuration



Category	Eligible Countermeasures	Target Facility	CRF/Effectiveness	Estimated Implementation Cost Per Location	HSIP Funding	Notes
Add/Adjust Lanes	Improve Left-Turn Channelization (Providing Definite Paths For Vehicles To Follow)	Signalized Intersections	<u>LEFT-TURN LANES</u> 28-48% <u>Reduction in total crashes</u>	Where reallocation of available width by restriping is all that is needed, costs can be relatively low. Where redesign and construction are necessary, costs will be moderate. ~\$50,000 (3)		FHWA Proven Countermeasure (12)
Add/Adjust Lanes	Improve Right-Turn Channelization	Signalized Intersections	<u>RIGHT-TURN LANES</u> 14-26% <u>Reduction in total crashes</u>	Low- Moderate ~\$50,000 (3)		FHWA Proven Countermeasure (12)
Add/Adjust Lanes	Restrict Access To Properties Using Driveway Closures Or Turn Restrictions	Near Signalized Intersections	5-23% <u>Reduction in total crashes along 2-lane rural roads</u> 25-31% <u>Reduction in injury and fatal crashes along urban/suburban arterials</u>	Since this strategy is implemented through signing, its cost is low. (5)		FHWA Proven Countermeasure (12)

7. Other/Miscellaneous

Description: Miscellaneous intersection improvements



Category	Eligible Countermeasures	Target Facility	CRF/Effectiveness	Estimated Implementation Cost Per Location	HSIP Funding	Notes
Misc.	Installation of automated red-light enforcement cameras	High Speed Facilities	40% <u>Reduction in traffic signal running crashes</u>	\$60,000 to \$100,000 (11)	Eligible	

Sources:

(1) *Low-Cost Safety Enhancements for Controlled and Signalized Intersection*

<https://books.google.com/books?id=mQ86AQAAMAAJ&pg=PP9&lpg=PP9&dq=implementation+cost+of+signal+change+interval&source=bl&ots=gY-CqDIDLs&sig=ACfU3U3ScxUwtKHIL2lhrzw2slaf4zVZtw&hl=en&sa=X&ved=2ahUKEwizyOGZ58PqAhWnl3IEHaK8DckQ6AEwDXoECAoQAQ#v=onepage&q&f=true>

(2) *Federal Highway Administration Office of Safety*

https://safety.fhwa.dot.gov/intersection/innovative/roundabouts/case_studies/fhwasa09018/#:~:text=of%20the%20roundabouts,-.Cost,way%20acquisitions%20that%20were%20needed.

(3) *Signalized Intersection Safety Strategies – Provide or Improve Right-Turn Channelization*

https://safety.fhwa.dot.gov/intersection/other_topics/fhwasa08008/sb2_improve_rightturn_channel.pdf

(4) *Transportation of KY. Appendix D: Detailed Cost Estimates. 2015.*

<https://transportation.ky.gov/Planning/Planning%20Studies%20and%20Reports/Appendix%20D%20-%20Detailed%20Cost%20Estimates.pdf>

(5) *Unsignalized Intersection Safety Strategies – Restrict or eliminate Turning Maneuvers by Signing*

https://safety.fhwa.dot.gov/intersection/other_topics/fhwasa08008/ub11_restrict_turning.pdf

(6) *FHWA Road Safety Audit Guidelines 2006*

https://safety.fhwa.dot.gov/rsa/guidelines/documents/FHWA_SA_06_06.pdf

(7) *Evaluation of Pedestrian-Related Roadway Measures: A Summary of Available Research 2014*

http://www.pedbikesafe.org/pedsafe/countermeasures_detail.cfm?CM_NUM=57#:~:text=Crosswalks%20can%20range%20from%20%24100,a%20crosswalk%20costs%20around%20%2412%2C000.

http://www.pedbikeinfo.org/cms/downloads/PedestrianLitReview_April2014.pdf#page=104&zoom=100,69,338

(8) *Zeeger, C., Seiderman, C., Lagerwey, P., Cynecki, M., Ronkin, M., & Schneider, R. (2002). Pedestrian*

Facilities Users Guide. US Department of Transportation, Federal Highway Administration.

McLean: Federal Highway Administration. Retrieved from

<https://www.fhwa.dot.gov/publications/research/safety/01102/01102.pdf>

(9) *NCHRP: Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities: A Guidebook 2017*

<https://www.nap.edu/download/24678>

(10) *FHWA Sign Retro-reflectivity Guidebook 2009*

<https://www.dot.state.mn.us/stateaid/trafficsafety/retroreflectivity/fhwa-sign-retroreflectivity-guidebook.pdf>

(11) *CDC Motor Vehicle Safety*

[https://www.cdc.gov/motorvehiclesafety/calculator/factsheet/redlight.html#:~:text=Costs,-Costs%20will%20be&text=A%20standard%20digital%20camera%20system,%2C%20and%20Salwin%2C%202001\).&text=However%2C%20most%20red%2Dlight%20cameras,does%20not%20enforce%20both%20violations.](https://www.cdc.gov/motorvehiclesafety/calculator/factsheet/redlight.html#:~:text=Costs,-Costs%20will%20be&text=A%20standard%20digital%20camera%20system,%2C%20and%20Salwin%2C%202001).&text=However%2C%20most%20red%2Dlight%20cameras,does%20not%20enforce%20both%20violations.)

(12) FHWA Proven Safety Countermeasures

<https://safety.fhwa.dot.gov/provencountermeasures/>

Segments Countermeasure Selection

Table 1 Priority Segment Infrastructure Strategy Sheets

1. Lane Departure Improvements

Description: Improvements to help keep vehicles in the lane of travel or on the roadway, help them avoid collisions when leaving the roadway, or reduce crash severity when doing so



Category	Eligible Countermeasures	Target Facility	CRF/Effectiveness	Estimated Implementation Cost Per Location	HSIP Funding	Notes
Lane Departure Improvements	Install the Safety Edge	Rural Road Segments	<u>11%</u> <u>Reduction in fatal and injury crashes</u>	1.5 inches high would be \$536 per mi. 3.0 inches high would be \$2,145 per mi. (4)	Eligible	FHWA Proven Countermeasures (6)
Lane Departure Improvements	Median Cable Barriers, concrete barriers, beam guardrails	Divided highway	<u>Median Barriers Installed on Rural Four-Lane Freeways</u> <u>97%</u> <u>Reduction in cross-median crashes</u>	\$10,000 to \$20,000 per intersection (2)	Eligible	
Lane Departure Improvements	Implement roadside design improvements such as clear zones, slope flattening, and adding or widening shoulders	Curves	<u>Slope flattening: 3% reduction of cross median, fixed object and run off road crashes</u> <u>Shoulder widening: 22.9% reduction of all crashes if 4 to 12ft</u>	Adding striped shoulders can cost as little as 1,000 per mile. (2)		

Lane Departure Improvements	Install high friction surface treatment (HFST)	Horizontal Curves	<u>52%</u> <u>Reduction in wet road crashes</u> <u>24%</u> <u>Reduction in curve crashes</u>	\$20, 000 to \$ 50,000 per location (1)		FHWA Proven Countermeasure (6)
Lane Departure Improvements	Install longitudinal rumble strips and stripes	Two-lane Roads	<u>Center Line Rumble Strips</u> <u>44-64%</u> <u>Head-on, opposite-direction, and sideswipe fatal and injury crashes</u> <u>Shoulder Rumble Strips</u> <u>13-51%</u> <u>Single vehicle, run-off-road fatal and injury crashes</u>	Below \$6,000 (5)	Eligible	FHWA Proven Countermeasure (6)
Lane Departure Improvements	Implement enhanced delineation treatments	Horizontal curves	<u>Chevron Signs</u> <u>25%</u> <u>Reduction in nighttime crashes</u> <u>16%</u> <u>Reduction in non-intersection fatal and injury crashes</u>	\$50 to \$150 per sign plus installation costs (2)	Eligible	FHWA Proven Countermeasure (6)

2. Traffic Calming

Description: Slowing traffic speeds through improvements that lead to natural speed reductions



Category	Eligible Countermeasures	Target Facility	CRF/Effectiveness	Estimated Implementation Cost Per Location	HSIP Funding	Notes
Traffic Calming	Speed Humps	2-lane local road, urban and suburban	<u>40-50% reduction in all crashes</u>	\$1,000 each (2)	Eligible	CMF ID: 134
Traffic Calming	Lane narrowing	>2 lane rural road, divided by median	<u>56% reduction in all crashes</u>	The cost for restriping a kilometer of street to bike lanes or reducing the number of lanes to add on-street parking is \$5,000 to \$10,000 per mile. Constructing a raised median or widening a sidewalk can cost \$100,000 or more per mile. (2)	Eligible	
Traffic Calming	Warning Signage	Horizontal curves	<u>Chevron Signs</u> <u>25%</u> <u>Reduction in nighttime crashes</u> <u>16%</u> <u>Reduction in non-intersection fatal and injury crashes</u>	\$50 to \$150 per sign plus installation costs (2)	Eligible	
Traffic Calming	Transverse Rumble Strips	Two-lane Roads	<u>25.5% reduction of all crashes (CMF ID: 2705)</u>	\$3,000 to \$5,000 per intersection (1)	Eligible	

Traffic Calming	Chicanes or Curvature (Change The Horizontal Curve Radius From Greater Than 1500m To Between 600m And 1500m)	Undivided Rural Roads	<u>Varies based on curve radius</u>	Costs for landscaped chicanes are approximately \$10,000 (for a set of three chicanes) on an asphalt street and \$15,000 to \$30,000 on a concrete street. (2)	Eligible
-----------------	--	-----------------------	-------------------------------------	--	----------

3. Corridor Access Management

Description: Limiting conflict points with driveways and access points by controlling or reducing entry and exit points along a roadway



Category	Eligible Countermeasures	Target Facility	CRF/Effectiveness	Estimated Implementation Cost Per Location	HSIP Funding	Notes
Access Management	Right-in/Right-out Only	Corridors with frequent Driveways and Intersections	<u>5-23% Reduction in total crashes along 2-lane rural roads</u> <u>25-31% Reduction in injury and fatal crashes along urban/suburban arterials</u>	No additional cost if part of original construction (2)		FHWA Proven Countermeasure (6)
Access Management	Driveway Closure, consolidation or relocation	Facilities with Driveways	<u>7% reduction of all crashes (CMF ID: 442)</u>	A well-designed, landscaped partial street closure at an intersection typically costs approximately \$10,000 to \$25,000. (2)		

Access Management	Raised Medians	Facilities with Driveways	<u>39% reduction of all crashes (CMF ID: 3034)</u>	\$15,000 to \$30,000 per 100 ft (2)	Eligible	Preventing across-roadway movements
Access Management	Lower speed one-way or two-way off-arterial circulation roads	Off-arterial Circulation Roads		\$20,000 to \$200,000 per mile, depending on length of treatment and whether the conversion requires modification to signals. (2)		

4. Non-motorist Improvements

Description: Improving paths or adding separated lanes for non-motorist travel, as well as crossings, signals, and refuge



Category	Eligible Countermeasures	Target Facility	CRF/Effectiveness	Estimated Implementation Cost Per Location	HSIP Funding	Notes
Non-motorist Improvements	Conduct pedestrian road safety audits	Walkways	<u>10-60% Reduction in total crashes</u>	\$ 2,000 to \$5,000 (3)	Eligible	FHWA Proven Countermeasure (6)
Non-motorist Improvements	Install pedestrian walkways, shared use paths, and sidewalks.	Walkways	<u>Sidewalks 65-89% Reduction in crashes involving pedestrians walking along roadways</u>	The cost for concrete curbs and sidewalks is approximately \$15/linear foot for curbing and \$11/square foot for walkways.(2)	Eligible	FHWA Proven Countermeasure (6)
Non-motorist Improvements	Buffered Bike Lanes	Bike lane	<u>Installing bike lanes: 58 to 60% reduction of urban vehicle/bicycle crashes</u>	\$5,000 to \$50,000 per mile (2)	Eligible	

5. Road Diet

Description: A Road Diet often involves converting an existing four-lane undivided roadway to a three-lane roadway consisting of two through lanes and a center two-way left-turn lane (TWLTL). This roadway reconfiguration, can improve safety, calm traffic, provide better mobility and access for all road users.



Category	Eligible Countermeasures	Target Facility	CRF/Effectiveness	Estimated Implementation Cost Per Location	HSIP Funding	Notes
Road Diet	Road Diet with Two Way Left Turn Lane	Four-lane Undivided Roadway	<u>4-Lane → 3-Lane Road Diet Conversions</u> 19-47% <u>Reduction in total crashes</u>	The cost for restriping a mile of four-lane street to one lane in each direction plus a two-way, left-turn lane and bike lanes is about \$5,000 to \$20,000 (2)	Eligible	FHWA Proven Countermeasure (6)

6. Roadway Widening

Description: Add/reconfigure lanes, change lane widths, and lane assignments/configuration



Category	Eligible Countermeasures	Target Facility	CRF/Effectiveness	Estimated Implementation Cost Per Location	HSIP Funding	Notes
Roadway Widening	Increase Shoulder Width	2-lane roadway	<u>It varies by proposed and existing width. 22.9% reduction of all crashes if 4 to 12 ft. CMF ID: 6657</u>	\$100,000 or more (5)	Eligible	
Roadway Widening	Increase Lane Width	2-lane roadway	<u>Depending on 'to' and 'from' width</u>	\$100,001 and up (5)		CMF ID: 2995

7. Other/Miscellaneous

Description: Miscellaneous segment improvements



Category	Eligible Countermeasures	Target Facility	CRF/Effectiveness	Estimated Implementation Cost Per Location	HSIP Funding	Notes
Misc.	Dynamic Speed Feedback Signs	High Speed Facilities	5-7% <u>Reduction in crashes</u>	\$10,000 to \$15,000 to purchase the speed-monitoring trailer or sign, plus the cost to move the trailer to different locations and to monitor the trailer	Eligible	

Sources

(1) *Low-Cost Safety Enhancements for Controlled and Signalized Intersection*

<https://books.google.com/books?id=mQ86AQAAMAAJ&pg=PP9&lpg=PP9&dq=implementation+cost+of+signal+change+interval&source=bl&ots=qy-CqDIDLs&sig=ACfU3U3ScxUwtKHIL2lhrzw2slaf4zVZtw&hl=en&sa=X&ved=2ahUKEwizyOGZ58PqAhWnl3IEHaK8DckQ6AEwDXoECAoQAQ#v=onepage&q&f=true>

(2) Zeeger, C., Seiderman, C., Lagerwey, P., Cynecki, M., Ronkin, M., & Schneider, R. (2002). *Pedestrian*

Facilities Users Guide. US Department of Transportation, Federal Highway Administration.

McLean: Federal Highway Administration. Retrieved from

<https://www.fhwa.dot.gov/publications/research/safety/01102/01102.pdf>

(3) FHWA Road Safety Audit Guidelines 2006

https://safety.fhwa.dot.gov/rsa/guidelines/documents/FHWA_SA_06_06.pdf

(4) FHWA Safety Evaluation of the Safety Edge Treatment

<https://www.fhwa.dot.gov/publications/research/safety/hsis/11025/index.cfm>

(5) FHWA Manual for Selecting Safety Improvements on High Risk Rural Roads

<https://safety.fhwa.dot.gov/hsip/hrrr/manual/sec45.cfm#s45a>

(6) FHWA Proven Safety Countermeasures

<https://safety.fhwa.dot.gov/provencountermeasures/>