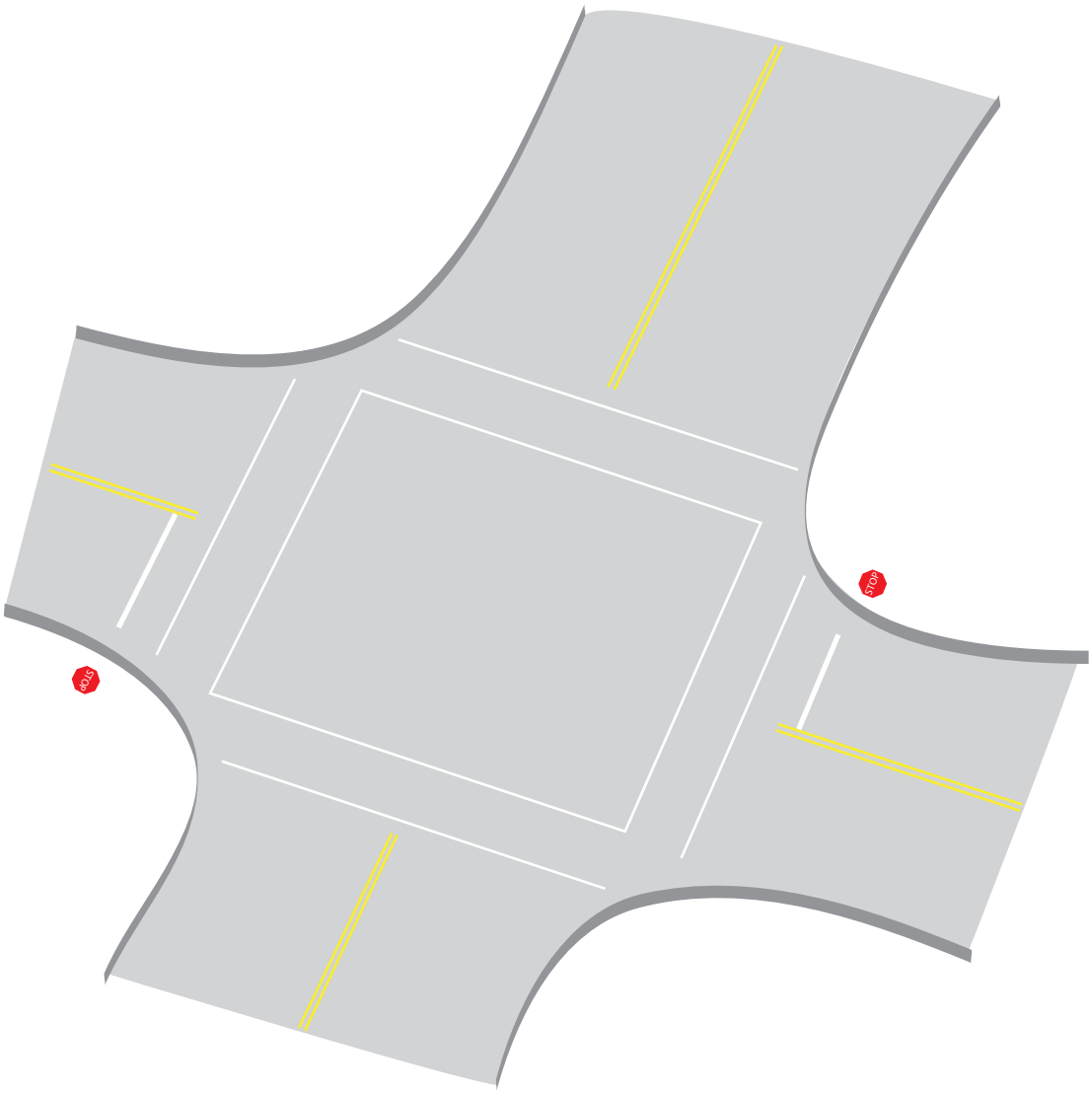
Strategic Intersection Safety Program Guide



U.S.Department of Transportation

Federal Highway Administration

Safe Roads for a Safer Future

Investment in roadway safety saves lives

Foreword

This Strategic Intersection Safety Program Guide serves as a tool to assist agencies at the State and local levels in developing strategic, systematic approaches for planning, developing, implementing, and maintaining an intersection safety program. This guide provides a step by step process for a strategic intersection safety program, including steps for the development of specific intersection safety action plans. It can assist in the development of the intersection-related portions of a State Strategic Highway Safety Plan (SHSP) and assist local agencies in aligning their intersection safety programs with the SHSP intersection safety goals. This guide also provides insights for how a strategic process for improving intersection safety can influence the selection of future projects that have measurable safety outcomes, such as reduction of specific crash types that help achieve strategic goals.

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16. Abstract

The Strategic Intersection Safety Program Guide is a tool to assist agencies at the State and local levels in developing strategic, systematic approaches for planning, developing, implementing, and maintaining an intersection safety program. It provides insights for how a strategic process for improving intersection safety can influence the selection of future projects that have measurable safety outcomes, such as reduction of specific crash types that help achieve strategic goals. This guide provides a step by step process for a strategic intersection safety program, including steps for the development of specific intersection safety action plans. It can assist in the development of the intersection-related portions of a State Strategic Highway Safety Plan (SHSP) and assist local agencies in aligning their intersection safety programs with the SHSP intersection safety goals. A summary is included of the intersection-related goals and improvement strategies incorporated by States in their current SHSPs as a resource for local agencies creating their own intersection safety program and for State agencies updating their SHSPs or developing an intersection safety program.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	$candela/m^2$	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
^oC	Celsius	1.8C+32	Fahrenheit	^oF
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	$candela/m^2$	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
(Revised March 2003)

TABLE OF CONTENTS

List of Figures

List of Tables

CHAPTER 1. INTRODUCTION

PURPOSE

The purpose of this Strategic Intersection Safety Program Guide is to provide assistance in planning, developing, implementing, and maintaining an intersection safety program for State and local agencies responsible for intersection safety. This guide describes, and lists reference materials for, a strategic process involving:

- Identification of intersection safety improvement needs.
- Development of strategic goals for an intersection safety program.
- Selection of scope for specific intersection safety action plans.
- Development of performance-based goals for intersection safety action plans.
- Selection of projects that include effective strategies and countermeasures.
- Implementation of projects.
- Evaluations of the effectiveness of the projects implemented.

This guide can be useful for developing a strategic intersection safety program for any State or local highway agency. In particular, this guide follows a process and framework that can be used to develop and implement a Strategic Highway Safety Plan (SHSP) and to prioritize projects in a Highway Safety Improvement Program (HSIP). The guide

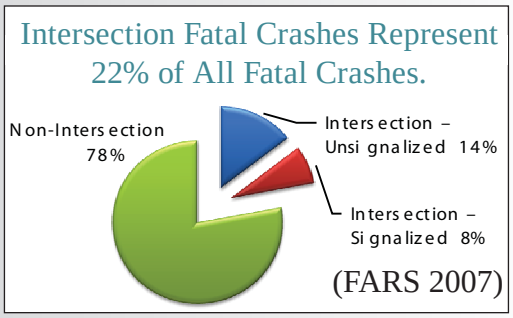


Figure 1. Chart. Distribution of Intersection Fatal Crashes

Intersections are a small portion of the highway system, but have a relatively high number of crashes.

- 39% of total crashes.
  - 52% at unsignalized intersections.
  - 48% at signalized intersections.
- 27% of total fatalities.
- 22% of total fatal crashes.
- 23% of total serious injuries.

(GES 2006, FARS 2007)

The **Highway Safety Improvement Program (HSIP)**, described in 23 USC Section 148, is a Federal-aid program that provides funding for infrastructure-related safety improvements that correct or improve a hazardous road location or feature, or address a highway safety problem.

Strategic Highway Safety Plans (SHSPs), which are a requirement of the HSIP, are statewide-coordinated safety plans that provide a comprehensive framework, and specific goals and objectives, for reducing highway fatalities and serious injuries on all public roads. Intersection safety is an important element in many States' SHSPs.

contains specific information for planning intersection safety improvements, which are often included in an Intersection Safety Emphasis Area within an SHSP or local intersection safety program.

This guide is a tool for State or local highway agency personnel who are responsible for improving safety at intersections, such as highway planners and managers involved with traffic operations, safety, and engineering; emergency medical services; law enforcement; and highway safety educators and advocates. It is applicable, and scalable, to any size and type of highway jurisdiction desiring to improve intersection safety.

SCOPE

The scope of this guide includes intersections in urban, suburban, and rural areas, with or without traffic control signals. The various road user types at intersections, including motorists, pedestrians, and bicyclists, are all considered in the guide's strategic process because of their importance to intersection safety.

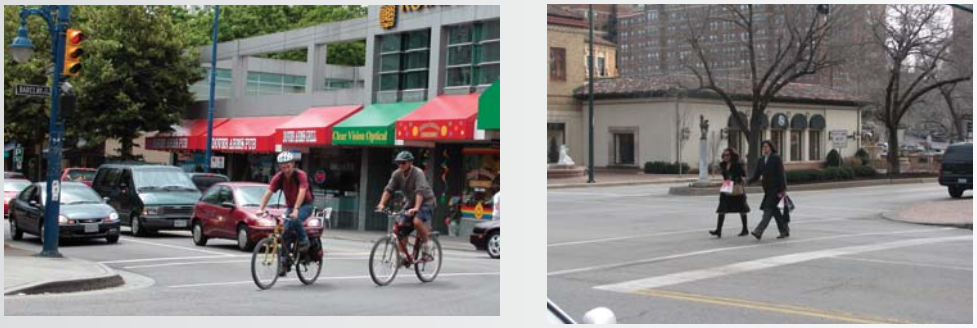


Figure 2. Photo. Bicycles and Pedestrians Crossing an Intersection
Bike Photo Credit: AAA Foundation for Traffic Safety

In this guide, the term **intersection** is used in a general sense to encompass both the area within the curbline limits of the intersecting roads and the intersection approaches.

Countermeasures used to improve intersection safety may apply to either or both of these areas. In other safety reports, crashes that occur within the curbline limits of the intersection are often called *intersection* crashes, while those that occur on the intersection approaches (usually within 250 feet of the intersection) are called *intersection-related* crashes. Both categories of crashes are critical to determining intersection safety needs and should be considered when prioritizing needs and assessing potential strategies and countermeasures.

Figure 3. Photo.
Signalized Intersection

Driveways and other access points on a road are essentially small intersections, and many of the intersection countermeasures discussed in this guide may apply to them.

The guide does not address interchanges, highway-rail grade crossings, or trail crossings; however, the guide may be applicable to intersections within, adjacent to, and affected by these highway features. Examples include intersections on interchange ramps, traffic signals modified for adjacent highway-rail crossings and/or light-rail crossings, and intersections adjacent to trails and multi-use paths.

An intersection **improvement strategy** is a treatment or method for improving safety at intersections. Each strategy may address a particular safety need or a particular intersection feature, and typically includes one or more countermeasures that can be implemented to improve safety.

An intersection **countermeasure** is a specific improvement made or action taken at an intersection to reduce the crashes of a target crash type or at a particular type of intersection.

- Engineering countermeasures involve a physical improvement such as a change in intersection type, geometry, or traffic control, or other physical improvement that may support non-engineering countermeasures.
- Non-engineering countermeasures may include targeted enforcement, educational campaigns, or emergency medical services (EMS) coordination.

Intersection safety **projects**:

- Implement strategies and countermeasures at specific intersections, or across a group of intersections of a certain type or with a common need.
- Provide individual or coordinated engineering and/or non-engineering strategies and countermeasures.
- Provide the needed resources, such as funding and administrative authority, to implement improvement strategies and countermeasures.

CHAPTER 2. ESTABLISHING A STRATEGIC INTERSECTION SAFETY PROGRAM

The strategic process described in this Guide for improving safety at intersections can assist in the development and implementation of an effective and efficient intersection safety program. Key elements of a strategic intersection safety program include:

- Forming a stakeholder group.
- Identifying intersection safety needs.
- Defining goals.
- Developing action plans and associated projects, which include strategies and countermeasures and the locations where they will be implemented.
- Evaluating the results.

A strategic process of this type typically leads to a balanced and cost-effective cyclical process of planning, implementation, and evaluation that addresses specific intersection safety and operational concerns at the highest-need locations.

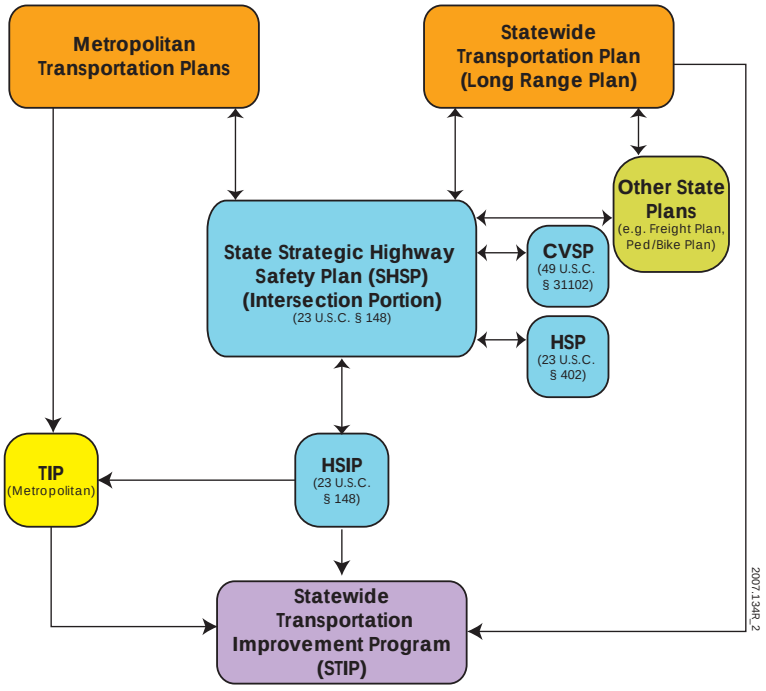
The process described here provides a logical planning approach that helps justify and coordinate intersection safety improvement initiatives within jurisdictions of any size. At the State level, for example, this process can be used to develop an intersection safety emphasis area for the SHSP and to develop action plans to implement the SHSP. This would serve as a major planning resource for implementing intersection safety projects through the transportation planning process. Figure 4 shows the relationship of an intersection safety portion of an SHSP to a typical overall transportation planning process in a State. It shows various safety improvement programs that may serve as resources for an intersection safety program. It also illustrates the relationships between the various plans, which can aid agencies in the coordination of their programs. The process can be important in integrating State and local intersection safety initiatives into long-range and short-range project planning and decision-making.

ROLE OF AN SHSP IN A STRATEGIC INTERSECTION SAFETY PROGRAM

A State's Strategic Highway Safety Plan (SHSP) should serve as a resource for any intersection safety program developed by a State or local agency. It is a strategic safety plan that can and should provide focus, coordination, and support for all road safety programs within a State or local agency. Importantly, an SHSP can include and coordinate safety programs in each of the 4Es (engineering, enforcement, education, and EMS). Therefore, any intersection safety program, whether at the State or local level, can and should help achieve the intersection safety goals in an SHSP because they would be part of the safety program and goals for the State.

"4Es" of Road Safety Programs:

- **E**ngineering.
- **E**nforcement.
- **E**ducation.
- **E**mergency Medical Services (EMS).



CVSP = Commercial Vehicle Safety Plan
HSP = Highway Safety Plan
TIP = Transportation Improvement Programs
HSIP = Highway Safety Improvement Program
STIP = Statewide Transportation Improvement Programs

Figure 4. Chart. SHSP Relationship to Other Planning Documents[(1)]

An SHSP is a cooperatively coordinated statewide safety plan that provides a comprehensive framework with specific data-driven goals and objectives for reducing fatalities and serious injuries on all public roads. The development of an SHSP is a Federal requirement for State DOTs. The goals, objectives, and emphasis areas outlined in the SHSP must be developed in consultation with public and private safety stakeholders at the Federal, State, and local levels.[(1)] The collaborative process allows for all highway safety programs in the State to align, focus, and leverage resources for defining and addressing safety challenges indicated by data analyses.

The State SHSP development process considers any road safety programs, regardless of jurisdiction, that may affect the statewide strategic safety goals.

Federal guidance for the development of State SHSPs is presented in *Strategic Highway Safety Plans: A Champion's Guide to Saving Lives.*[(1)]

All 50 States and the District of Columbia have developed an SHSP using processes approved by the Federal Highway Administration (FHWA).[(1)] This guide presents a summary of the overall strategic safety goals and strategic intersection safety goals as well as intersection improvement strategies found in the SHSPs. This summary, shown in Tables 1 through 8, illustrates the level of emphasis States have placed on intersection safety in their SHSPs. Such information can be useful for State and local agencies that are creating or updating their intersection safety programs.

Intersection safety programs should be updated periodically. For example, States may modify the emphasis areas and goals in their SHSP to reflect changing needs or because their original goals have been met. As SHSPs are modified, overall intersection safety program goals may need to be updated to reflect SHSP modifications. As of 2008, 45 of the 51 SHSPs included a strategic overall fatality reduction goal in the form of either an anticipated reduced fatality rate or a specific reduction in percentage or number of fatalities. Such goals typically reference a goal year or a time period over which the anticipated reduction will be achieved. Two States do not present an *overall* fatality-reduction goal, but present a fatality-reduction goal for each emphasis area in their SHSPs. One State indicates a goal of achieving zero fatalities without a target date. The remaining three States use a goal of fatality and/or injury reduction, but do not indicate a specific anticipated number, rate, or percentage for reduction. In addition to fatality-reduction goals, some SHSPs contain either injury-reduction or crash-reduction goals. Table 1 presents a summary of *overall* SHSP strategic safety goals, most of which are anticipated to be achieved in part by intersection safety strategies either described in the SHSP or in other intersection safety programs.

Figure 5. Photo. Logo of Maryland SHSP

Table 1. Crash Severity Levels Considered in Overall SHSP Goals

Crash severity levels considered	Number of SHSPs	Percent of all SHSPs
Overall SHSP Goals	**45**	**88.2**
Reduce fatalities	45	88.2
Reduce fatal crashes	3	5.9
Reduce serious, disabling, or incapacitating injuries or injuries requiring hospitalization	10	19.6
Reduce all injuries	7	13.7
Reduce all injury crashes	1	2.0
Reduce all crashes	2	3.9

Most SHSPs make intersection safety a focus area, or discuss strategies and countermeasures within other emphasis areas for improving intersection safety. SHSPs often present specific strategic intersection safety goals, identify the State's intersection safety needs, and/or guide investment decisions to achieve significant reductions in intersection-related fatalities and serious injuries. Some SHSPs specify the intersection safety projects they plan to implement, but more often SHSPs discuss the need for action plans and potential strategies and countermeasures to address strategic goals, while specific projects are defined when developing the action plans that implement the SHSPs.

Fifteen States include strategic intersection safety goals in their SHSPs. Table 2 presents a summary of the strategic intersection safety goals included in the State SHSPs.

Table 2. Crash Severity Levels Considered in SHSP Intersection Goals

Crash severity levels considered	Number of SHSPs	Percent of all SHSPs
INTERSECTION GOALS	**15**	**29.4**
Reduce fatalities at intersections	6	11.8
Reduce combined fatal and serious injuries at intersections	2	3.9
Reduce combined fatal and serious injury crashes at intersections	3	5.9
Reduce combined fatal and all injury crashes at intersections	2	3.9
Reduce all injuries at intersections	2	3.9
Reduce all crashes at intersections	2	3.9

In State SHSPs for which a strategic intersection safety goal is not specifically given, the overall strategic goal may be applied proportionally to the strategic intersection goal. For example, if the overall strategic goal is to reduce fatal and serious injury crashes by 20 percent over the next five years, the strategic intersection safety goal could be to reduce fatal and serious injury intersection crashes by 20 percent over the same time period. In cases where the overall goal is to reduce a specific number of crashes, the intersection goal can be to reduce a percentage of that number of reduced crashes equal to the percentage of total crashes that occur at intersections.

Typically, States identify between four and eight emphasis areas in their SHSPs.

Currently, 25 States have identified intersection safety as an emphasis area in their SHSPs; 15 States include intersections as a subcategory in another emphasis area.

Most SHSPs identify and categorize their various safety programs into *emphasis areas*. Intersection safety is an emphasis area in about half of the States' SHSPs. Most of these States outline specific intersection improvement strategies for addressing the types of intersection crashes that are overrepresented in the data. In addition, intersection improvement strategies are often included in other safety improvement emphasis areas such as for pedestrians, older drivers, commercial motor vehicles, motorcycles, aggressive driving, distracted driving, impaired driving, speed, EMS, occupant protection, roadway departure, work zones, and data management. Consultation and coordination between the various emphasis areas is important to the successful development, planning, and implementation of safety projects and to achieving the strategic goals for the intersection safety program. Coordination between participating agencies also helps create the support required from all stakeholders to successfully address the jurisdiction's intersection safety needs.

Table 3 presents a summary of the emphasis areas in SHSPs that address intersection crashes with intersection-related strategies or countermeasures. Of the 51 State SHSPs available in 2008, 25 SHSPs include an emphasis area for intersection safety improvement. Fifteen additional

SHSPs list intersections as a subcategory under another emphasis area. Therefore, a total of 40 SHSPs have a specific intersection emphasis area or emphasis-area subcategory. Twenty-five SHSPs include intersection safety strategies in other emphasis areas such as pedestrians/bicyclists, older/restricted drivers, aggressive driving/speeding, railroad-highway grade crossings, and locations with potential for crash reduction. Few SHSPs include no strategies specifically related to intersection safety improvements.

Table 3. Intersection-Related Emphasis Areas Included in SHSPs

SHSP emphasis areas addressing intersection crashes	Number of SHSPs	Percent of all SHSPs
Specific intersection safety emphasis area	**25**	**49.0**
Intersections as a subcategory in another emphasis area:	**15**	**29.4**
Serious crash types	6	11.8
Infrastructure/ roadway/ environmental	9	17.6
Intersection strategies or countermeasures in other emphasis areas:[a]	**25**	**49.0**
Pedestrians/bicyclists	17	33.3
Older/restricted drivers	7	13.7
Aggressive driving/speeding	7	13.7
Railroad crossings	5	9.8
Building safer roadways	1	2.0
Continuing successful safety programs and initiatives	1	2.0
Design, construction and maintenance	1	2.0
Locations with potential for crash reduction	1	2.0
None of above	**4**	**7.8**

[a] Some SHSPs present intersection-related strategies in more than one emphasis area.

Although the level of detail and the content used to discuss intersection safety initiatives may vary between SHSPs, an SHSP that includes an intersection safety emphasis area helps provide a focus and framework for improving intersection safety on a comprehensive, coordinated basis.

Several documents that are relevant to, and can assist in, intersection safety program development include:

- FHWA *Transportation Planner's Safety Desk Reference.*[(2)]
- FHWA Public Roads, Vol. 6, No. 6, *Proactive Approach to Safety Planning.*[(3)]
- FHWA *Transportation Safety Planning Brochure.*[(4)]
- FHWA *National Agenda for Intersection Safety.*[(5)]
- FHWA *Making the Case for Transportation Safety—Ideas for Decision Makers.*[(6)]
- NCHRP Report 500, *Guidance for Implementation of the AASHTO Strategic Highway Safety Plan (Volumes 5 and 12).*[(7,8)]

- NCHRP Report 501, *Integrated Safety Management Process.*[9]
- NCHRP Report 546, *Incorporating Safety into Long-Range Transportation Planning.*[10]
- TRB Transportation Research Circular E-C025, *Safety-Conscious Planning.*[11]
- TRB Transportation Research Circular E-C041, *Supporting the Establishment of Safe Transportation Networks.*[12]

Figure 6. Photo. Cover of NCHRP Report 501

CHAPTER 3. STRATEGIC INTERSECTION SAFETY PROGRAM PROCESS

The strategic process for development, implementation, and evaluation of strategic intersection safety programs described in this section can be useful and applicable whether the program will be included in a statewide safety plan, such as an SHSP, or in a plan for a specific local jurisdiction.

Figure 7 illustrates the strategic process developing for an intersection safety program. The "Process Decisions/Determinations," shown in the first column of Figure 7, represent the major steps in the process. These steps are individually described as Steps A through L in this section of the guide. These process steps are associated with "Related Documents" and "Supporting Actions" identified in the center and right columns of Figure 7, respectively. The process shown in Figure 7 and described below is applicable to the development of any highway safety program, including an SHSP, but additional details relevant to intersection safety are presented as illustrations for this guide. Applying this SHSP-based process will help assure that the resulting intersection programs are compatible with the State's SHSP and that the planning process considers the various road safety improvements that may affect the State's strategic goals.

While Figure 7 shows each step in a particular order, it is important to recognize the iterative nature of the process, especially the steps involving the development of intersection safety action plans (Steps E through I). These steps may be reordered based on agency priorities, available resources, or the decisions made in other steps of the process. For example, the step in which strategies and countermeasures are chosen is shown prior to the step in which sites for implementation of these strategies and countermeasures are identified. This order was chosen to encourage agencies to select treatments based on needs identified from their data. However, once specific improvement sites are selected and studied, the specific list of strategies and countermeasures to be implemented may need to be reconsidered to fit the safety improvement needs of those specific sites. In addition, while performance-based goals are initially set prior to the selection of strategies and countermeasures, these goals may need to be modified to fit realistic expectations of crash reductions that will be provided by those countermeasures. The steps in the process have been given letters, rather than numbers, so as not to suggest an inflexible sequence.

STEP A—IDENTIFY KEY STAKEHOLDERS

An initial step in developing an intersection safety program is to identify key stakeholders and to bring them together in a task force or working group. This initial step requires managerial support and inclusion of participants with a diverse knowledge of intersection safety issues, including each of the "4Es": engineering, enforcement, education, and EMS. This helps assure that the intersection safety program can be appropriately developed, implemented, and coordinated, and that it will be comprehensive in nature.

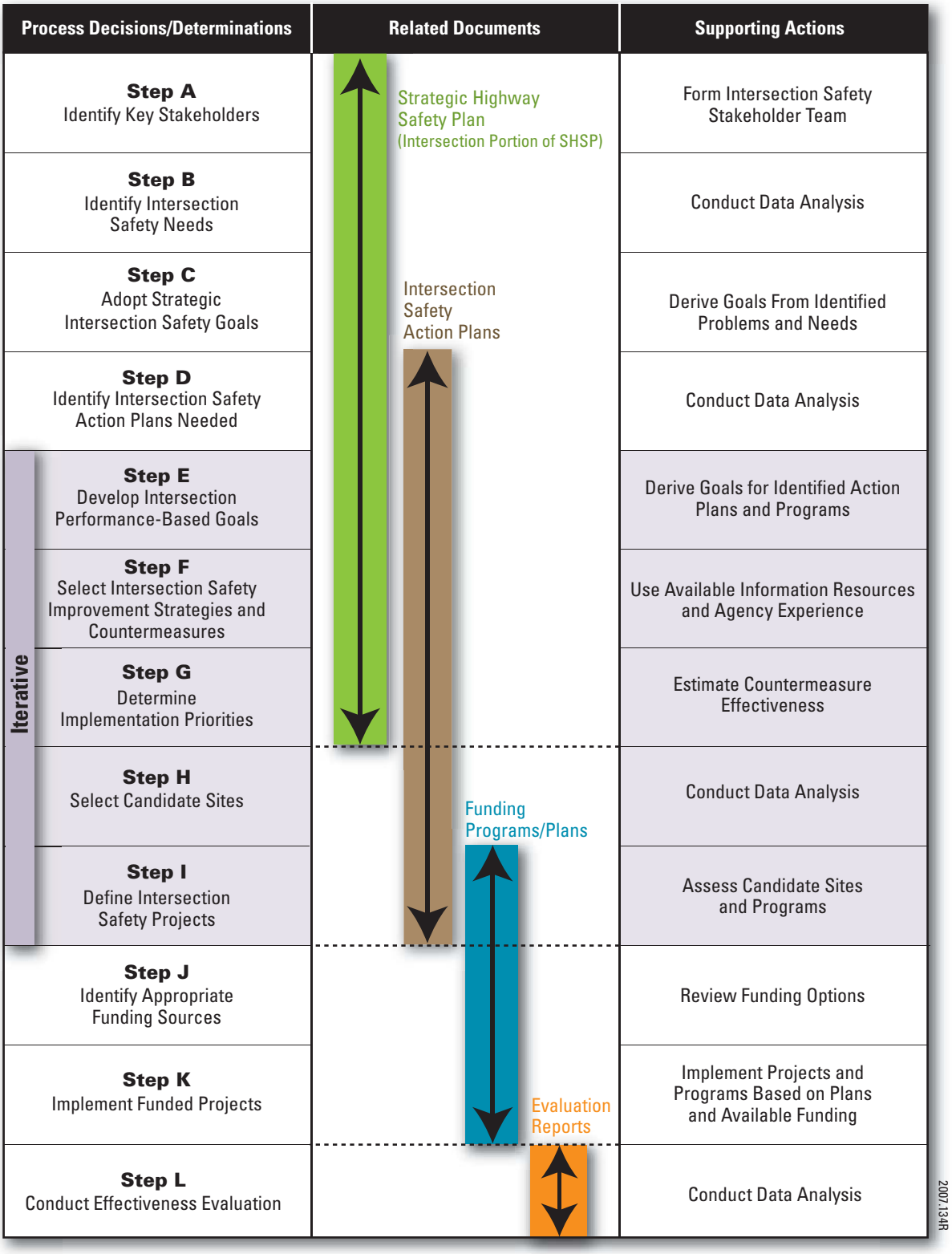


Figure 7. Chart. Process for Developing an Intersection Safety Program

The support activities should include:

- Gaining leadership and managerial support, sponsorship, and initiative.
- Forming a stakeholder working group with expertise on each of the 4Es, as well as expertise on data analysis.
- Initiating the program development process.

Figure 8. Photo. Stakeholder Group

It is helpful to designate a diverse group of motivated partners and stakeholders that understand the importance of intersection safety and represent each of the 4Es. Personnel with experience in collecting, managing, and analyzing safety data should be included.

A Stakeholder group should include representatives from each of the 4Es—Engineering, Enforcement, Education, and EMS.

STEP B—IDENTIFY INTERSECTION SAFETY NEEDS

An important step in setting the proper direction for an intersection safety program is to analyze the best and most complete data available on the safety performance of intersections in the jurisdiction. This provides legitimacy for the goal-setting process and gives confidence that the key intersection safety issues are being addressed.

Potential Data Sources

- Crash records maintained by agencies within the jurisdiction or by the State.
- State SHSP.
- Intersection inventory data.
- Speed data.
- Driver records (e.g., enforcement, licensing, courts).
- EMS or trauma center data.

A preliminary analysis of intersection safety data and information is helpful in seeking initial managerial support. Such an analysis can identify the magnitude of intersection safety needs in the jurisdiction and the extent to which intersection safety should be a priority. This analysis should be based primarily on crash records. Definitions of key crash-related terms include:

- Crash —any contact between a vehicle and an object, either moving or fixed at any speed at which kinetic energy is measurably transferred or dissipated. Objects may include a vehicle, pedestrian, cyclist, animal, roadside barrier, any objects on or off the roadway, etc.
- Fatal crash—a crash in which one or more person dies at the scene or from crash-related injuries within 30 days of the crash.
- Fatality—a death that occurs as a result of a crash and within 30 days of the crash (A fatal crash may result in more than one fatality).

- Incapacitating injury—a crash-related injury, other than a fatal injury, that prevents the injured person from walking, driving, or normally continuing the activities the person was capable of performing before the injury occurred. An incapacitating injury is often referred to as a "serious injury" or a "disabling injury."

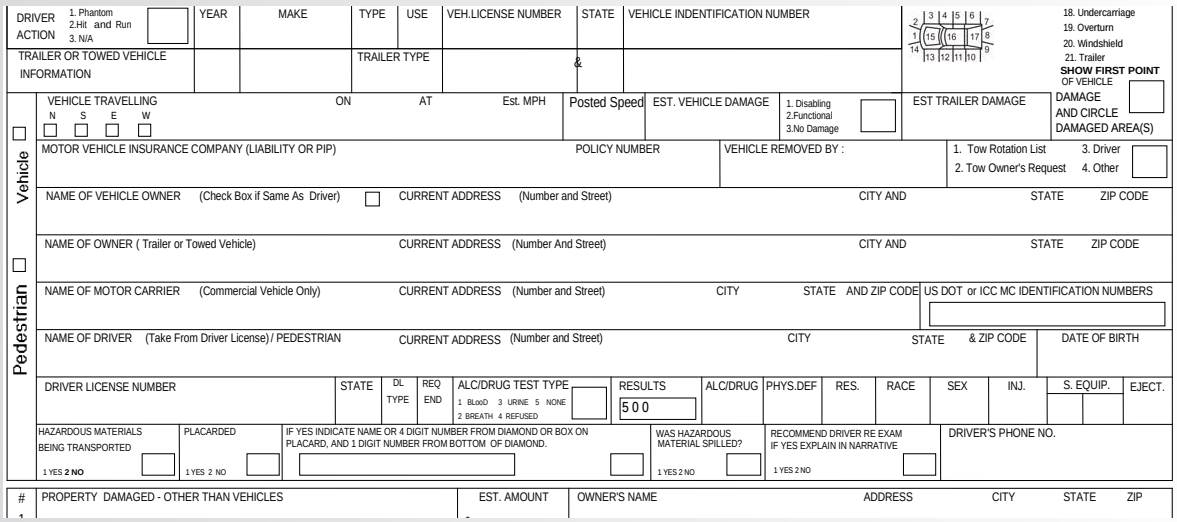

DRIVER ACTION 1. Phantom 2.Hit and Run 3. N/A | YEAR | MAKE | TYPE | USE | VEH.LICENSE NUMBER | STATE | VEHICLE INDENTIFICATION NUMBER
TRAILER OR TOWED VEHICLE INFORMATION | TRAILER TYPE
18. Undercarriage 19. Overturn 20. Windshield 21. Trailer SHOW FIRST POINT OF VEHICLE DAMAGE AND CIRCLE DAMAGED AREA(S)
Vehicle
VEHICLE TRAVELLING N S E W | ON | AT | Est. MPH | Posted Speed | EST. VEHICLE DAMAGE | 1. Disabling 2.Functional 3.No Damage | EST TRAILER DAMAGE
MOTOR VEHICLE INSURANCE COMPANY (LIABILITY OR PIP) | POLICY NUMBER | VEHICLE REMOVED BY : | 1. Tow Rotation List 2. Tow Owner's Request 3. Driver 4. Other
NAME OF VEHICLE OWNER (Check Box if Same As Driver) | CURRENT ADDRESS (Number and Street) | CITY AND STATE ZIP CODE
NAME OF OWNER (Trailer or Towed Vehicle) | CURRENT ADDRESS (Number And Street) | CITY AND STATE ZIP CODE
Pedestrian
NAME OF MOTOR CARRIER (Commercial Vehicle Only) | CURRENT ADDRESS (Number and Street) | CITY STATE AND ZIP CODE | US DOT or ICC MC IDENTIFICATION NUMBERS
NAME OF DRIVER (Take From Driver License) / PEDESTRIAN | CURRENT ADDRESS (Number and Street) | CITY STATE & ZIP CODE | DATE OF BIRTH
DRIVER LICENSE NUMBER | STATE | DL TYPE | REQ END | ALC/DRUG TEST TYPE 1 BLooD 3 URINE 5 NONE 2 BREATH 4 REFUSED | RESULTS 500 | ALC/DRUG | PHYS.DEF | RES. | RACE | SEX | INJ. | S. EQUIP. | EJECT.
HAZARDOUS MATERIALS BEING TRANSPORTED 1 YES 2 NO | PLACARDED 1 YES 2 NO | IF YES INDICATE NAME OR 4 DIGIT NUMBER FROM DIAMOND OR BOX ON PLACARD, AND 1 DIGIT NUMBER FROM BOTTOM OF DIAMOND. | WAS HAZARDOUS MATERIAL SPILLED? 1 YES 2 NO | RECOMMEND DRIVER RE EXAM IF YES EXPLAIN IN NARRATIVE 1 YES 2 NO | DRIVER'S PHONE NO.
| PROPERTY DAMAGED - OTHER THAN VEHICLES | EST. AMOUNT | OWNER'S NAME | ADDRESS | CITY | STATE | ZIP

Figure 9. Photo. Section of a Sample Police Crash Report

Crash reports provide an abundance of information for the analyst. While individual crash reports are important resources for an analyst investigating an individual intersection's safety needs and strategies, collections of such crash records are useful for evaluating systemwide intersection safety concerns, trends and needs.

Crash reports are a primary resource for safety analysis, providing the data and information needed for safety-related analyses such as driver and vehicle characteristics, weather and roadway conditions, and location information related to intersection crashes. Most crash reports also include a collision diagram, which can further help the analyst understand the sequence of events leading to crashes and provide insights into the safety issues that may need to be addressed in an intersection program.

Searchable electronic databases of crash reports allows the data analyst to more quickly and efficiently determine trend information such as the percentage of crashes that are occurring at intersections, the proportion of specific crash types to total crashes, and the prevalence of certain crash characteristics (e.g., alcohol involvement, speeding, age of driver, failure to obey traffic control devices).

Once a decision is made by the stakeholder group to initiate an intersection safety program or an intersection emphasis area within a safety plan, a more in-depth analysis of intersection safety data and information should be conducted to identify specific intersection safety needs that may be addressed by countermeasures. Identification of needs should be based on this data-driven process and on the experience and knowledge available to the stakeholder group.

Intersection safety data and related information, such as traffic volumes, may be available from State agencies as well as local jurisdictions. The stakeholders may have various crash databases created by their own agencies or derived from State-level data. The stakeholder group should attempt to review, if available, intersection crash frequencies, severities, patterns, types, and locations to determine safety needs. The collection, reporting, and availability of crash data is continuously improving as a result of data improvement projects and technologies, which in turn improve the quantitative identification of safety needs. State SHSPs are based on statewide safety data analyses and should be considered a resource for any development of intersection safety programs at the State and local level.

Consider supplementing data with local knowledge, such as:

- Local law enforcement.
- State traffic and maintenance engineers.
- Local engineering staff.
- Local residents and road users.

In most States, a State agency such as the Department of Motor Vehicles or the Department of Transportation maintains records of intersection crashes. In many cases, however, location-based crash data is only available for the State-maintained highway system. The completeness of available crash data for intersections on local road systems varies widely by jurisdiction. A key data limitation in many jurisdictions is the lack of accurate location data for crashes, which can affect the accuracy of determining which intersections have the greatest needs. For example, a crash that is reported as being even 100 feet away from where it actually happened may be attributed to conditions (such as road design, lighting, or traffic control) that are different from those at the actual crash site.

A review of the "4E" efforts currently devoted to intersection safety in the jurisdiction should be performed. Crash types and patterns are strongly influenced by such items as intersection design, traffic control, levels of enforcement, and education campaigns. Fatality rates may be influenced by the timeliness of EMS arrival, particularly at rural intersections. Thus, it is most useful to have an intersection inventory that could be referenced when identifying safety needs, including items such as:

- Number and types of intersection designs.
- Traffic controls at intersections (traffic signal, stop sign, or other).
- Intersection traffic volumes.
- Red-light-running education, enforcement, and camera programs.
- Other relevant data about the intersection or related programs.

Other sources of information that may be considered include:

- Speed data.
- Interagency agreements.
- Driver records.
- Safety audits.
- EMS/trauma center data.
- Identified high-crash locations.
- Existing plans and programs.
- Motorist complaints.

If not included in an inventory database or otherwise readily available, data on intersection characteristics may be obtained through a review of crash databases or copies of police crash reports.

STEP C—ADOPT STRATEGIC INTERSECTION SAFETY GOALS

> A **strategic intersection safety goal** is a target that establishes a direction and focus for efforts to improve safety at intersections.

Strategic goals are long-term goals that provide a direction and focus for present and future intersection safety improvement efforts. This step establishes high-level strategic goals for improving intersection safety over a specified period of time. An example strategic goal may be to reduce the current number of intersection fatalities by 15 percent over the next five years. While the SHSP sets statewide strategic goals for overall highway safety improvement, some States adopt strategic goals for specific emphasis areas, such as intersection safety, in their SHSP (shown previously in Table 2). Setting clear strategic goals is critical to the development of a successful intersection safety program. Strategic goals help define the scope of improvements to be considered and are used to help measure the success of program implementation. Later, they can help establish the need for changes in future projects, improvement strategies, implementation approaches, and goals.

Development, adoption, or recommendation of strategic goals for an intersection safety program may be the responsibility of the stakeholders involved, but also may be mandated by legislation, decision-makers, and/or other strategic plans or policies.

Key considerations for establishing a meaningful strategic goal for an intersection safety program include:

- *Strategic goals should address identified intersection safety needs.* Strategic goals should define the expected improvements in the identified intersection safety needs areas. The reasonableness of those expectations can be improved as identification of needs improves with the use of better data, information, analyses, and insights from the relevant experience and knowledge of stakeholders and partners.
- *Strategic goals should reflect consensus of the stakeholder group.* The consensus for goals from diverse stakeholders helps gain greater multi-discipline support for their efforts to achieve the goals. A strategic goal should be developed in coordination with surrounding or overarching jurisdictions. This coordination will increase support from outside agencies who are working toward similar or complementary goals.
- *Strategic goals should be quantitative.* They should include anticipated improvement in relevant, measurable safety outcomes. Strategic goals should include numbers or percentages to express an expected crash reduction outcome over a specified period of time. Defining an appropriate goal is often an iterative process, in that experience with treatments and improvement projects may provide data that help to better define the crash reductions that can be expected.

- *Strategic goals should be broad and high level in scope.* The scope of strategic goals for intersection safety should define the expected jurisdiction-wide impact on intersection safety. Performance-based goals, discussed below in Step E, are designed to address specific crash types or intersection types, while strategic goals for the intersection safety program should incorporate the expected results from all elements of the program combined. Strategic goals may result from an iterative process as the performance-based goals are refined. As measures of effectiveness from the implemented projects and programs become available, expected reductions in crashes can be more accurately defined.
- *Strategic goals for intersection safety should be compatible and coordinated with other goals.* The strategic goals of other agencies, organizations, and programs should be considered during the development of strategic intersection safety goals. Strategic goals for intersection safety should support the safety goals of overarching jurisdictions and programs, such as striving to achieve a portion of the State or Federal crash-reduction goals. A reasonable approach for determining intersection safety strategic goals may be to base them on the proportion of intersection crash needs or problems that may exist within broader or higher level strategic safety goals. For example, if an SHSP strategic safety goal is to reduce the number of fatal crashes by 400 in 5 years, and fatal intersection crashes have historically averaged 25 percent of all fatal crashes per year, then an intersection strategic safety goal might reasonably be a reduction of 100 fatal crashes, or 25 percent of the total fatal crashes, in 5 years. Such proportional goal setting using crash history data may also be reasonable for defining a jurisdiction's intersection safety strategic goals.

The following are a few examples of strategic goals that could support an overall intersection safety program or an SHSP intersection emphasis area:

- Decrease fatal crash rate at intersections from 1.1 to 0.8 fatalities per million entering vehicles by 2012.
- Reduce the number of intersection-related fatalities and serious injuries to less than 100 by 2015.
- Reduce fatal and serious injury intersection crashes from 961 in 2007 to no more than 850 in 2014.
- Experience ten fewer fatalities at intersections each year for the next 25 years.

Goal-Setting Tips

- The strategic intersection safety goal should be challenging, but achievable.
- Goal setting is often an iterative process; as measures of effectiveness from the implemented projects and programs become available, expected reductions in crashes can be better defined.
- Goal setting requires a continuous balancing of intersection safety needs and available funding.

After the strategic goals for an intersection safety program have gained consensus and approval from leadership, they should be reflected in other transportation plans, including any future updates of the SHSP.

STEP D—IDENTIFY INTERSECTION SAFETY ACTION PLANS NEEDED

Intersection safety action plans (sometimes called implementation plans) are used to coordinate, define, and implement the various projects needed to achieve an intersection safety program's strategic goals. A strategic intersection safety program may need one or several intersection safety action plans. It may be most effective to address different categories or types of intersections, crashes, or projects. For example, an agency might choose to develop separate action plans for signalized and unsignalized intersections. In this step, the stakeholder group must determine which intersection or crash types may benefit from their own action plan.

For a few States, the intersection emphasis area of the SHSP is comprehensive enough to serve as an intersection safety action plan. However, most SHSPs provide a broad overview of intersection needs and strategies, and should be supported by more detailed action plans. These action plans should be guided by the goals and priorities outlined in the SHSP. A benefit of developing action plans separate from the SHSP intersection emphasis area includes allowing more agile and tailored intersection action plans, updated without the higher-level approvals required for SHSP modifications.

Intersection safety action plans should be developed to have a positive impact on achieving the strategic goals developed in Step C. Action plans are normally developed after the strategic goals are approved to assure they help to achieve these goals. However, preliminary action plans may need to be drafted or developed in parallel with the development of the strategic goals to ensure their likelihood of being accepted or to achieve a desired outcome for the overall intersection safety program.

Steps E through K, presented below, describe the process of developing the intersection safety action plan(s) chosen by the stakeholder group. In summary, these steps describe the process of:

- *Developing performance-based goals*—To define the anticipated safety improvement impacts of addressing each priority need using the selected countermeasures and improvement strategies.
- *Selecting and prioritizing improvement strategies and countermeasures*—To determine the countermeasures and improvement strategies that can most effectively address the priority needs.
- *Selecting implementation sites*—To identify the locations where selected countermeasures will have the greatest potential for reducing target crash types.
- *Planning and designing projects*—To deliver and implement the selected countermeasures and improvement strategies for the identified priority needs, which may be incremental due to funding limitations and administrative priorities.

These steps describe the basic elements of developing an intersection safety action plan; however, they are not rigidly defined, and in practice, they will likely be iterative. For example, once implementation sites have been selected, the strategies and countermeasures chosen previously may be reevaluated for appropriateness for the sites chosen. Also, performance-based goals that

are originally based on the needs defined during the initial data analysis may be revised after specific countermeasures and sites are chosen in order to ensure that the performance-based goals are realistically achievable.

A sample intersection safety action plan is available from FHWA.[13]

STEP E—DEVELOP INTERSECTION PERFORMANCE-BASED GOALS

Intersection performance-based goals are shorter-term goals that contribute toward achieving the intersection strategic goals and may address only one portion of the intersection safety program. For an intersection safety program, performance-based goals are a reflection of anticipated improvements in safety intended to be achieved with a specific action plan. Intersection improvement strategies and countermeasures and specific improvement sites will be selected in subsequent steps to achieve these performance-based goals. The performance-based goals are intended to be achieved by implementation of the intersection safety action plans, and may be applicable to the same time period or a shorter time period than the overall strategic intersection safety goals.

In developing performance-based goals for an intersection safety action plan, the selected goals should:

- *Fit within the framework set by the strategic intersection safety goals.* The performance-based goals should support the strategic intersection safety goal(s) and should serve as elements of the action plan for achieving the strategic goal(s). The performance-based goals will be used to assess the ability of the intersection safety action plan to help achieve the strategic intersection safety goal.
- *Address specific intersection crash types that have been identified in the needs analysis.* For example, if nighttime crashes have been identified as a safety problem, a performance-based goal might define the percentage reduction in nighttime fatal and injury crashes that should be achieved by the intersection safety action plan.
- *Be re-evaluated and redefined periodically.* The development of performance-based goals for intersections is based on data analysis that identifies particular intersection and crash types as high priority. As these priorities are addressed over time, other intersection and crash types may be elevated in importance and become new priorities. Thus, performance-based goals should regularly be reevaluated and redefined.

Examples of intersection performance-based goals include:

- By 2012, reduce by ten percent the number of right-angle crashes involving one or more vehicles making a left-turn maneuver.
- Achieve a five-percent reduction in intersection fatalities and serious injuries involving pedestrians each year for the next three years.
- Reduce the number of intersection-related crashes caused by drivers failing to yield to traffic control devices by 50 by 2010.

Current practice for many States is to set their performance-based goals at yearly intervals measured over the life of the strategic intersection safety program. Intersection stakeholder groups should establish performance-based goals related to current safety measures, conditions, and activities to assess progress over the period of the strategic intersection safety plan or SHSP safety goals.

STEP F—SELECT INTERSECTION SAFETY IMPROVEMENT STRATEGIES AND COUNTERMEASURES

The intersection performance-based goals developed in the previous step address specific intersection improvement needs or target crash types (e.g., right-angle crashes, red-light running crashes, crashes involving older drivers) identified as concerns by a highway agency. In this step, the stakeholder group selects improvement strategies and countermeasures to address the target intersection and crash types. An intersection improvement strategy is a treatment or method for improving safety at intersections. Each strategy includes one or more countermeasures that typically address a particular intersection feature or a particular safety need. Each countermeasure is a specific improvement that can be made or a specific action that can be taken at an intersection to reduce the number of crashes of a specific target crash type. Countermeasures are the specific actions taken to implement intersection improvement strategies. Countermeasures include physical improvements such as changes to the roadway geometry (e.g., alignment and cross section) and traffic control improvements. Actions such as targeted enforcement for speeding or red-light running, educational campaigns, and improvement in emergency medical services (EMS) coordination, are also considered countermeasures.

Several resources are available to assist highway agencies in selecting appropriate strategies and countermeasures for improving safety at intersections. These include:

- NCHRP Report 500, *Guidance for Implementation of the AASHTO Strategic Highway Safety Plan (Volume 5 for unsignalized intersections and Volume 12 for signalized intersections).*[7,8]
- FHWA *Signalized Intersections: Informational Guide.*[14]
- NCHRP Report 501, *Integrated Safety Management Process.*[9]
- FHWA *Roundabout Guide.*[15]
- NHTSA *Countermeasures that Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices.*[16]
- FHWA *Guidelines and Recommendations to Accommodate Older Drivers and Pedestrians.*[17]
- FHWA *Intersection Safety Briefing Sheets.*[18,19] http://www.ite.org/library/IntersectionSafety/briefing.asp

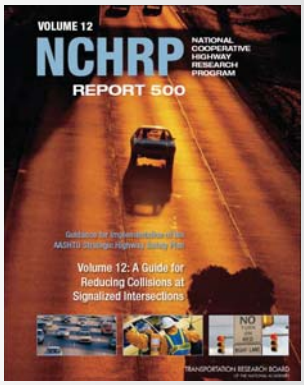


Figure 10. Photo. Cover of NCHRP Report 500

Volumes 5 and 12 of the NCHRP Report 500 guides present comprehensive lists of strategies and countermeasures for improving safety at intersections. These guides address engineering, education, and enforcement strategies and countermeasures. A related guide in Volume 15 of the NCHRP Report 500 series presents strategies for improving EMS,[20] and guides for speed reduction on low- and high-speed facilities are under development.

Using these resources in combination with local knowledge of successful strategies, highway agencies should develop a list of promising improvement strategies that should be considered for inclusion in the intersection safety action plan. Strategies should be identified as "promising" if they address the specific intersection priority needs and performance-based goals that have been developed.

As an example, the signalized intersection guide presented in Volume 12 of NCHRP Report 500[8] lists the strategy *Revise Geometry of Complex Intersections*; this strategy consists of several countermeasures, including:

- Convert a four-leg intersection to two T-intersections.
- Convert two T-intersections to one four-leg intersection.
- Improve intersection skew angle.
- Remove deflection in through-vehicle path.
- Close intersection leg.

In addition to selecting improvement strategies and countermeasures that address existing intersection crash patterns, improvements that minimize road hazards may be considered. This approach is illustrated in the Federal *"Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users"* (SAFETEA-LU), which requires States, as part of the SHSP, to identify opportunities to minimize hazardous road conditions and to establish a schedule of safety projects for crash prevention. A prevention approach provides an opportunity for the intersection safety program to be proactive in providing strategies and countermeasures that address potential intersection safety concerns or crash patterns before they develop.

SAFETEA-LU
Safe Accountable Flexible Efficient Transportation Equity Act:
A Legacy for Users

Figure 11. Photo. SAFETEA-LU Logo

The selection of appropriate strategies and countermeasures (also encouraged in SAFETEA-LU) should consider input from representatives of the 4Es; engineering, enforcement, education, and EMS. The stakeholder group formed in Step A of the strategic intersection safety program process may serve this purpose. A combination of strategies and countermeasures from each of the 4Es should be thoughtfully considered in the intersection safety action plans.

Once promising strategies have been identified, the stakeholder group must choose specific countermeasures to implement the chosen strategies. Some of the strategies identified can be addressed with a single countermeasure, while other strategies may be best implemented with multiple countermeasures.

FHWA has recently published a *Desktop Reference for Crash Reduction Factors*, [21] which can help an agency evaluate the potential effectiveness of particular strategies or countermeasures. A crash reduction factor (CRF) is the percentage crash reduction that might be expected from implementing a given countermeasure. The *Desktop Reference* presents estimates of the crash reduction that might be expected at an intersection if a specific countermeasure, or group of countermeasures, is implemented at the intersection. While the *Desktop Reference* only includes countermeasures for which CRFs have been quantified, it may also serve as a useful resource to highway agencies in identifying appropriate intersection countermeasures. FHWA has published other documents based on the *Desktop Reference* that are useful resources as well, including:

- FHWA Briefing Sheet 5, *Traffic Signals.*[18]
- FHWA Briefing Sheet 8, *Toolbox of Countermeasures and Their Potential Effectiveness for Intersection Crashes.*[19]
- FHWA Briefing Sheet, *Toolbox of Countermeasures and Their Potential Effectiveness for Pedestrian Crashes.*[22]

NCHRP Report 617, *Accident Modification Factors for Traffic Engineering and ITS Improvements*,[23] also provides estimates of the safety impacts of various countermeasures, including intersection treatments.

In addition to evaluating potential effectiveness of strategies and countermeasures, consideration should be given to feasibility (political, financial, social acceptance, etc.), and to practicality (such as choosing countermeasures that do not violate driver expectancy for the region or that can be implemented in local conditions). Countermeasure selection must also consider applicable agency policies, State laws, and other institutional constraints.

A majority of States have identified intersection-related strategies and/or countermeasures in their SHSPs. The strategies and countermeasures found in the current SHSPs for each State are provided in Tables 4 through 8 as a resource for agencies in choosing appropriate strategies and countermeasures.

Table 4. Intersection-Related Strategy Categories Included in SHSPs

Intersection-related strategy categories	Number of SHSPs	Percent of all SHSPs
Traffic control strategies	40	78.4
Geometric design strategies	37	72.5
Additional engineering strategies	44	86.3
Education strategies	25	49.0
Enforcement strategies	37	72.5
EMS strategies	6	11.8

Table 5. Intersection Traffic Control Strategies and Countermeasures Included in SHSPs

Traffic control strategies and countermeasures	Number of SHSPs	Percent of SHSPs with intersection-related strategies*
Improve visibility of signing and marking	25	53.2
Improve/update signal timing	17	36.2
Add phasing/protected left-turn phases	15	31.9
Add pedestrian signals/countdown signals	14	29.8
Signal head improvements (larger, LEDs, backplates)	12	25.5
Add/improve signal coordination	11	23.4
Optimize clearance intervals	9	19.1
Provide better guidance/delineation	9	19.1
Install flashing beacons on stop signs or overhead at stop-controlled intersections	7	14.9
Prohibit right turn on red	7	14.9
Add supplementary signs and markings	6	12.8
Add/improve pedestrian phasing	5	10.6
Provide stop bar	5	10.6
Add vehicle detection devices on approaches for dilemma zone	3	6.4
Install or remove signals according to MUTCD warrants	3	6.4

* Based on the 47 SHSPs that included at least one intersection-related strategy.

Table 6. Intersection Geometric Design Strategies and Countermeasures Included in SHSPs

Geometric design strategies and countermeasures	Number of SHSPs	Percent of submitted SHSPs with intersection-related strategies*
Improve sight distance/clear sight triangles	22	46.8
Improve pedestrian crossings	21	44.7
Add, offset, or lengthen left-turn lanes	20	42.6
Provide/consider roundabouts	19	40.4
Add, offset, or lengthen right-turn lanes	12	25.5
Provide channelization	9	19.1
Add turn restrictions/indirect left-turn treatments	7	14.9
Provide acceleration lanes	6	12.8
Reduce intersection skew	6	12.8
Build bypass lanes at T-intersections	3	6.4
Change 4-leg intersection to two offset 3-leg intersections/one-way pairs	3	6.4
Provide deceleration lanes	2	4.3

* Based on the 47 SHSPs that included at least one intersection-related strategy.

Table 7. Additional Intersection-Related Engineering Strategies and Countermeasures Included in SHSPs

Additional engineering strategies and countermeasures	Number of SHSPs	Percent of submitted SHSPs with intersection-related strategies*
Provide better access management near intersections	24	51.1
Provide or improve intersection lighting	21	44.7
Identify, prioritize, and track improvements at high-crash locations	20	42.6
Install active control devices at rail-highway grade crossings	13	27.7
Provide advance warning signs/flashers	13	27.7
Conduct intersection safety audits	10	21.3
Install transverse rumble strips on intersection approaches	10	21.3
Employ ITS and/or new technologies	9	19.1
Improve data collection, sharing, and analysis	8	17.0
Install advance street name signs	6	12.8
Install dynamic warning signs/flashers	6	12.8
Eliminate parking near intersections	4	8.5
Improve intersection planning and design policies	4	8.5
Post approach intersection speeds (regulatory or advisory)	4	8.5

* Based on the 47 SHSPs that included at least one intersection-related strategy.

Table 8. Intersection-Related Education, Enforcement, and EMS Strategies Included in SHSPs

Education, enforcement, and EMS strategies	Number of SHSPs	Percent of submitted SHSPs with intersection-related strategies*
EDUCATION STRATEGIES	**25**	**53.2**
Educate users about high-crash locations / safety issues	8	17.0
Educate users about intersection traffic controls	8	17.0
Educate designers about safety improvements	5	10.6
Educate drivers about gap acceptance	4	8.5
Educate consultants and developers about access management	2	4.3
ENFORCEMENT STRATEGIES	**37**	**78.7**
Provide automated red-light enforcement	27	58.4
Provide targeted law enforcement at intersections	23	48.9
EMS STRATEGIES	**6**	**12.8**
Provide signal preemption for emergency vehicles	6	12.8

* Based on the 47 SHSPs that included at least one intersection-related strategy.

STEP G—DETERMINE IMPLEMENTATION PRIORITIES

This step develops priorities for implementation of the selected intersection improvement strategies and countermeasures. The following should be considered when determining implementation priorities:

- *Effectiveness*—The highest priority should generally be assigned to strategies that have been proven to be effective and whose crash reduction effectiveness is high. Information sources on crash reduction effectiveness estimates have been presented above in the discussion of Step F. Some strategies and countermeasures have been subjected to well-designed effectiveness evaluations, while others have not been adequately evaluated. To help in the selection process, the strategies in the NCHRP Report 500 guides have been classified as Proven (P), Tried (T), or Experimental (E). Proven strategies are those that have been used in one or more locations and that have been shown to be effective through properly designed evaluations. Tried strategies are those that have been implemented in a number of locations and may even be accepted as standard approaches, but for which there have not been found valid evaluations. Experimental strategies are those that have been suggested and that at least one agency has considered sufficiently promising to try on a small scale in at least one location.

Highway agencies should not overlook local experience with a particular strategy in deciding which strategies to use in their action plans. If a strategy has been successful in improving safety at one location, it should be considered for implementation at other locations.

- *Cost*—The implementation cost of strategies and countermeasures for improving intersection safety varies widely. For example, the cost of realigning an intersection approach is substantially higher than the cost of installing an advance warning sign. In addition, the cost for implementing a given strategy may vary from one location to another. Agencies should weigh the potential benefit of implementing an expensive but highly effective treatment at a limited number of locations (such as building an interchange) against the potential benefit of less expensive and less effective treatments that can be applied on a broader scale (such as installing turn lanes and adding signal phases). One factor to consider is that implementing certain treatments in conjunction with others may reduce costs.
- *Implementation Time*—In several cases, the implementation time will depend on such factors as the agency's procedures, the need for additional right-of-way, the need for environmental review, the number of stakeholders involved, contractor availability, and the presence of any controversial situations. The time it takes to implement the countermeasure has implications for when its impact on achieving the performance-based and strategic goals may be seen.
- *Complementary Strategies and Countermeasures*—Highway agencies should select a range of strategies and countermeasures that complement one another and increase the overall safety effectiveness of improvements rather than using just one strategy or countermeasure. For example, if crashes related to left turns are the greatest intersection safety

concern for a highway agency, installing left-turn lanes at a large number of intersections might be less effective than installing left-turn lanes at a smaller number of intersections but complementing those left-turn lanes with other related improvements such as protected left-turn signal phasing or improved sight distance.

Priorities may be based on quantitative analysis, such as benefit-cost or cost-effectiveness analyses. At this stage, analyses should consider safety performance for typical intersections, but need not consider specific intersection sites.

STEP H—SELECT CANDIDATE SITES

This step involves the selection of candidate sites for intersection improvements based on implementation priorities and the crash history or future expected safety performance of specific intersections. This step applies primarily to engineering and enforcement improvements. Education and EMS strategies are more typically area-wide or systemwide in nature and are not generally targeted at specific sites.

As part of the development of an intersection safety action plan, the participating highway agencies should consider the specific intersections at which engineering improvements or enforcement activities should be implemented. The list of improvement sites may include known high-crash locations, but may also include other locations with crash patterns that may be addressed with specific strategies or countermeasures.

Many highway agencies have developed software tools for screening the highway network to identify candidate improvement sites. The NCHRP Report 500, Volume 21, *Guide for Addressing Safety Data and Analysis in Developing Emphasis Area Plans*[24] includes a chapter on intersection safety that suggests how crash data can be analyzed to identify candidate improvement locations. The primary procedure in the above guide describes procedures for the analysis of high-quality intersection databases that include:

- Accurate assignment of mileposts or other location coordinates to each crash.
- Intersection inventory files with site characteristics (e.g., number of intersection legs, traffic control type, major- and minor-road traffic volumes) that are linkable to the crash data.

Alternative procedures for selecting candidate sites are also provided in the NCHRP Report 500 guide for application to less complete data sets in which the crashes are not accurately referenced to a milepost or when an intersection inventory file is not available.

The FHWA *SafetyAnalyst* software,[25] planned for release in 2009, will provide analytical tools to help highway agencies identify candidate improvement sites and determine appropriate countermeasures.

Figure 12. Photo.
***SafetyAnalyst* Logo**

One tool under consideration for the *SafetyAnalyst* software

will enable a user to choose a particular countermeasure and identify sites that would be appropriate for implementation of that countermeasure.

Individual highway agencies may also have their own analytical tools for use in identifying candidate improvement sites.

A list of specific intersections to be considered for safety improvements in the intersection safety action plan should be developed. Depending on a number of factors, including the available budget and the cost of the countermeasures selected, it will not necessarily be possible to program safety improvements for all intersections with safety needs. The list of intersections developed in this step and the strategies and countermeasures applied at these intersections should achieve the performance-based goals established for the intersection safety action plan.

A variety of approaches to categorizing and prioritizing safety needs and allocating resources to those needs accordingly may be used when selecting the sites for implementation of the intersection safety action plan. Ideally, resources are allocated so that the projects with the greatest impact on achieving the strategic goals are funded. Each jurisdiction and its planning partners may use any of the following approaches to help make these prioritization and funding decisions:

- An *individual project approach*, sometimes called a *traditional safety management approach*, prioritizes projects targeted at addressing individual intersections with the highest safety needs relative to other intersections. The intersections are identified by ranking each intersection in terms of number or rate of crashes, fatalities, and/or injuries. The intersections with the greatest safety needs may experience a variety of crash types. An intersection safety program based on this approach typically provides projects for as many high-crash intersections as practical and implements safety improvement strategies and countermeasures that are appropriate for the particular needs of each intersection.
- A *systematic safety approach* prioritizes projects targeted at addressing sets of intersections with similar safety needs. The specific safety needs may be most apparent at a particular type of intersection, such as skewed intersections, three-leg intersections, or intersections with permissive left-turn phasing. An intersection safety program based on this approach typically includes projects that implement a particular countermeasure, or set of countermeasures, to address specific safety needs only at the intersections with crashes of a specific target crash type above a particular threshold. The specific intersections that should be included in the program may be determined with a benefit/cost analysis, which will indicate the intersections for which the benefits expected from the selected countermeasure(s) are greater than the costs of implementation, as well as by the total available budget. This approach can be effective for implementing projects that address a particular type of safety need at many intersections, often using lower-cost countermeasures and strategies.
- A *systemwide approach* is similar to the systematic approach in that it prioritizes projects targeted at addressing particular safety needs at particular types of intersections. However, an intersection safety program that uses a systemwide approach implements projects in which a particular countermeasure or set of countermeasures with demonstrated effectiveness are applied to all intersections, systemwide, that may benefit from the countermea-

sure. In this approach, the number of intersections that receive the treatment depends on available resources over time, rather than on a cost-benefit analysis at each intersection. That is, a jurisdiction may choose to implement the countermeasure one corridor at a time as funding allows, rather than in a priority order based on crash history. This approach is often appropriate when the crash type being addressed is difficult to predict for individual intersections, but could eventually occur at any intersection of the specified type. This approach is effective for implementing projects at a particular type of intersection (e.g., high-speed signalized intersections or rural stop-controlled intersections) systemwide, often using lower-cost countermeasures and strategies.

- A *combination approach* combines the approaches described above to coordinate projects for particular intersections to deliver countermeasures that address various safety needs in a cost-effective, efficient, and/or synergistic manner. Such an approach may be appropriate to accommodate a broad range of intersection safety improvement needs and to take advantage of funding or organizational cycles, and construction and maintenance schedules. The combination approach must include sufficient strategies and countermeasures to meet the crash reduction goal, so care must be taken when estimating the benefits of projects that may overlap.

STEP I—DEFINE INTERSECTION SAFETY PROJECTS

This step defines specific projects that will implement the safety strategies and countermeasures at the candidate intersections as prioritized in the previous steps. Improvement projects may be implemented as stand-alone projects at specific intersections or groups of intersections, such as along a particular corridor. However, the intersection safety improvements may also be provided as a coordinated part of a large-scale project involving an intersection. A number of factors should be considered when defining intersection projects, including:

4E projects are defined in this guide to include both the physical infrastructure improvements, which are referred to as *projects*, as well as enforcement and education efforts, which are often described as *programs*.

- *Established implementation priorities*—Improvement strategies and countermeasures that have been previously identified in Step G as implementation priorities, because they address the identified intersection safety needs, should be considered high priority and included in the list of intersection projects to be implemented.
- *Safety performance of specific intersections*—Specific intersections that are identified as high-crash locations, or that have crash patterns that may be addressed with specific strategies or countermeasures, should be considered high priority and included in the list of intersection projects to be implemented.
- *Systemwide safety performance of intersections*—Specific intersection concerns or crash patterns that are prevalent across the State, or throughout a system of intersections, should be considered high-priority safety issues to be addressed by intersection safety projects.

- *Economic assessment* – An economic assessment of proposed projects should be conducted. The projects that are likely to be the most cost effective may be given higher priority than those projects with lower cost-effectiveness measures.
- *Economies of scale*—Combining improvements at adjacent intersections into corridor or area-wide projects may reduce the combined implementation cost and make the overall project more cost effective. An increase in cost effectiveness may also be achieved by implementing improvements at an intersection at which other improvements are already planned.

STEP J—IDENTIFY APPROPRIATE FUNDING SOURCES

This step involves the identification of appropriate funding sources for implementation of each project in the intersection safety action plan. A broad range of potential funding sources should be considered and may be combined, including Federal, State, and local funding, as well as private industry and organizational programs.

Potential funding sources from Federal programs for intersection safety projects include:

- *Highway Safety Improvement Program (HSIP)*—The HSIP is a "core funding" program administered by FHWA, which apportions funds to States for a range of eligible activities focused primarily on infrastructure-related safety improvements on any public road.
- *National Highway System (NHS) Program*—The NHS program can fund safety improvements for intersections located on the National Highway System.
- *Surface Transportation Program (STP)*—The STP provides flexible funding that may be used by State highway agencies for projects on any Federal-aid highway. STP funds may not be used on local roads and rural minor collectors.
- *Congestion Mitigation and Air Quality (CMAQ) Program*—The CMAQ program can fund intersection improvements that reduce congestion and improve air quality. Such projects often improve safety, as well.
- National Highway Traffic Safety Administration (NHTSA) programs—NHTSA programs focus on enforcement, education, and EMS activities for improving road safety.
- Federal Motor Carrier Safety Administration (FMCSA) programs—FMCSA programs focus on enforcement and education programs for maintaining and improving commercial motor carrier industry safety, including safety of their operations, vehicles, and drivers.

Potential funding sources from State and local jurisdictions may include grants or other funding specifically designated for highway safety, public safety, public health, or roadway construction or maintenance. Private funding may be available for improving intersection safety through private industry, non-profit organizations, and coalitions that have an interest in improving employee or community safety. Commercial developers often provide funding for intersection safety improvements to mitigate the traffic operational impacts of their developments, such as changing traffic patterns or increased traffic volumes.

Obtaining public funding for intersection safety improvement projects often requires approvals and programming within a government planning process based on Federal, State, and local funding criteria and regulations. For example, Federally-funded road projects would be included in the State Transportation Improvement Program (STIP), and, if in a metropolitan area, included in the Transportation Improvement Program (TIP) that is administered by the metropolitan planning organization (MPO). A strategic intersection safety program developed using the steps in this guide, which follow the typical transportation planning process, can be instrumental in obtaining and coordinating the needed project funding for intersection improvements.

STEP K—IMPLEMENT FUNDED PROJECTS

This step involves implementing the intersection projects for which funding has been identified. Incremental or staged implementation of the intersection projects may be appropriate when funding is limited or restricted. Staged implementation of engineering/infrastructure improvements typically involves pre-design (e.g., environmental and right-of-way clearances), design, and construction. Staged implementation of enforcement, education, and EMS projects may involve planning (e.g., operations design), pilot projects, and full project execution. Staged implementation of different types of projects at a given location may also be critical to program outcomes. For example, staging a road improvement project prior to an enforcement project may allow engineers to incorporate traffic control devices that may assist law enforcement officers in their efforts.

STEP L—CONDUCT EFFECTIVENESS EVALUATION

This step provides an assessment of the impacts of intersection projects that have been implemented, and identifies how they may be improved for future implementations. The purpose of the effectiveness evaluation of intersection projects is to determine the degree to which the intersection safety goals have been achieved. Without this evaluation step, it would be difficult to show that the projects are effective in helping to reach the strategic goals, and program continuation may be difficult to justify. Also, if the evaluation finds that intersection projects are not performing as well as expected, it is important to recognize this as early as possible so resources can be redirected toward other projects that could potentially be more effective. Alternatively, if the evaluation finds that intersection projects are resulting in greater crash reduction benefits than anticipated, consideration can be given to increasing their use. Such evaluations may serve as eligibility criteria for the use of certain funding.

One of the most meaningful evaluations used to demonstrate effectiveness and to quantify achievement toward the strategic goals is a before-after study. A before-after study compares crash frequencies and rates before project implementation to those after project implementation. Ideally, three to five years of crash data from both the before period and the after period are used in the study. Comparing data from fewer years, especially in the after period, is often necessary. Shorter evaluation periods may be acceptable but may introduce the potential to capture anomalies in the data that provide less accurate results. Crashes are infrequent and randomly dispersed (both over time and throughout the roadway system); therefore, most projects can only be meaningfully evaluated for their effectiveness a few years after implementation. However,

some projects may lend themselves to other forms of evaluation that can serve as interim measurements before complete crash data is available. These might include traffic conflict studies, public opinion surveys, behavioral studies (observed seatbelt use, for example), and speed studies. These surrogate measures are typically associated with potential crashes, so an evaluation of these trends may help an agency estimate expected trends in crash frequency as well as how well the project will help meet the strategic goals. Ultimately, evaluations based on crash data analyses are desirable.

Enforcement projects may be evaluated by measuring traffic speeds or instances of red-light- running.

Education programs may be evaluated by surveys of the target audience.

EMS programs may be evaluated by noncrash measures, such as dispatch times, response times, transport times, and medical outcomes.

The NCHRP Report 500, Volume 21, *Guide for Addressing Safety Data and Analysis in Developing Emphasis Area Plans*[24] provides guidance on sources of safety data. This guide presents effectiveness evaluation procedures that can be applicable to jurisdictions that have extensive safety data files (i.e., crash, roadway inventory, intersection inventory, traffic) as well as those with limited safety data (i.e., crash data only).

There are a variety of computer programs that may be helpful in efficiently evaluating safety projects and treatments. *SafetyAnalyst*[25] is a new software that provides a set of tools for analyzing a State's entire network of intersections, a subset of intersections, or a single intersection. The *SafetyAnalyst* countermeasure evaluation tool is capable of assessing the safety effectiveness of a single countermeasure at specific intersections or the collective effectiveness of a group of countermeasures in which the same countermeasures were implemented at specified intersections. Before-after evaluations can be conducted with *SafetyAnalyst* to determine whether a project has resulted in a percentage change in intersection crash frequencies or a shift in the proportion of specific intersection collision types.

Once the benefits of an intersection improvement are determined, the effectiveness of the project can be determined and compared to other improvements. The measure of effectiveness most often used in safety is determined by dividing the resulting benefit by the improvement cost (called the B-C ratio). The actual crash benefits, such as the number of lives or injuries saved, should be converted to a monetary estimate value that can be compared to the improvement costs. The B-C ratio for different improvements can then be compared to determine the more cost effective improvement types. Evaluators may assign an estimated localized benefits factor for crash impacts or may utilize factors used by others, such as insurance organizations or the public agencies. However, it is important to understand that safety treatments can still be desirable even if the B-C ratio is below a value of one, which would seem to indicate that the benefit derived may be of less worth than the improvement cost. This is because the assigned benefits value is only useful in comparing the effectiveness between improvements. It is not helpful for assessing an individual improvement's merit, because the assigned benefit value can not truly represent the total losses resulting from crashes.

The evaluation of intersection safety projects after their implementation helps to ensure that each project is as effective as possible at reducing the number of intersection fatalities and severe injuries. Evaluation results are useful in determining the content and focus of future projects that should optimize the cost effectiveness of intersection safety projects and help to achieve the strategic goals.

CHAPTER 4. SUMMARY

This Strategic Intersection Safety Program Guide has been developed to assist State and local agencies responsible for improving intersection safety. It describes how to plan, develop, implement, and maintain an intersection safety program. The process presented here involves a diverse group of intersection safety stakeholders representing each of the "4Es" (engineering, enforcement, education, and EMS), who work together to identify both intersection needs and treatments in each of these areas. The process involves setting goals, developing action plans, implementing treatments, and evaluating projects. It is adaptable to changing safety needs, and provides a process for changing the strategies to meet those needs over time.

The strategic process steps include:

- Identifying key stakeholder group.
- Identifying intersection safety needs.
- Adopting strategic intersection safety goals.
- Identifying intersection safety actions plans needed.
- Developing intersection performance-based goals.
- Selecting intersection safety improvement strategies and countermeasures.
- Determining implementation priorities.
- Selecting candidate sites.
- Defining intersection safety projects.
- Identifying appropriate funding sources.
- Implementing funded projects.
- Conducting effectiveness evaluation.

The process is a logical planning approach that helps justify and coordinate intersection safety improvement initiatives within and between jurisdictions of any size. At the State level, this process can be used to develop or improve an intersection safety emphasis area for the State's Strategic Highway Safety Plan (SHSP). At the local government level, this process can be used to create an effective program that can both support, and be supported by, their State's SHSP to improve intersection safety across the jurisdiction.

The guide reflects the Federally-recommended SHSP process that may be considered applicable by any jurisdiction for their intersection safety program. Summaries of the overall safety goals, intersection safety goals, and intersection safety strategies contained in the 51 SHSPs in 2008 are provided as an information resource.

The strategic approach for an intersection safety program presented in this guide can help any jurisdiction efficiently and effectively reduce intersection and intersection-related hazards, crashes, and crash-related impacts including fatalities, injuries, and property damage. These potential safety improvements can be maximized by following this data-driven and coordinated approach, which helps jurisdictions prioritize, justify, and implement the projects, strategies, and countermeasures that provide the greatest safety benefits for the specific needs of the jurisdiction.

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