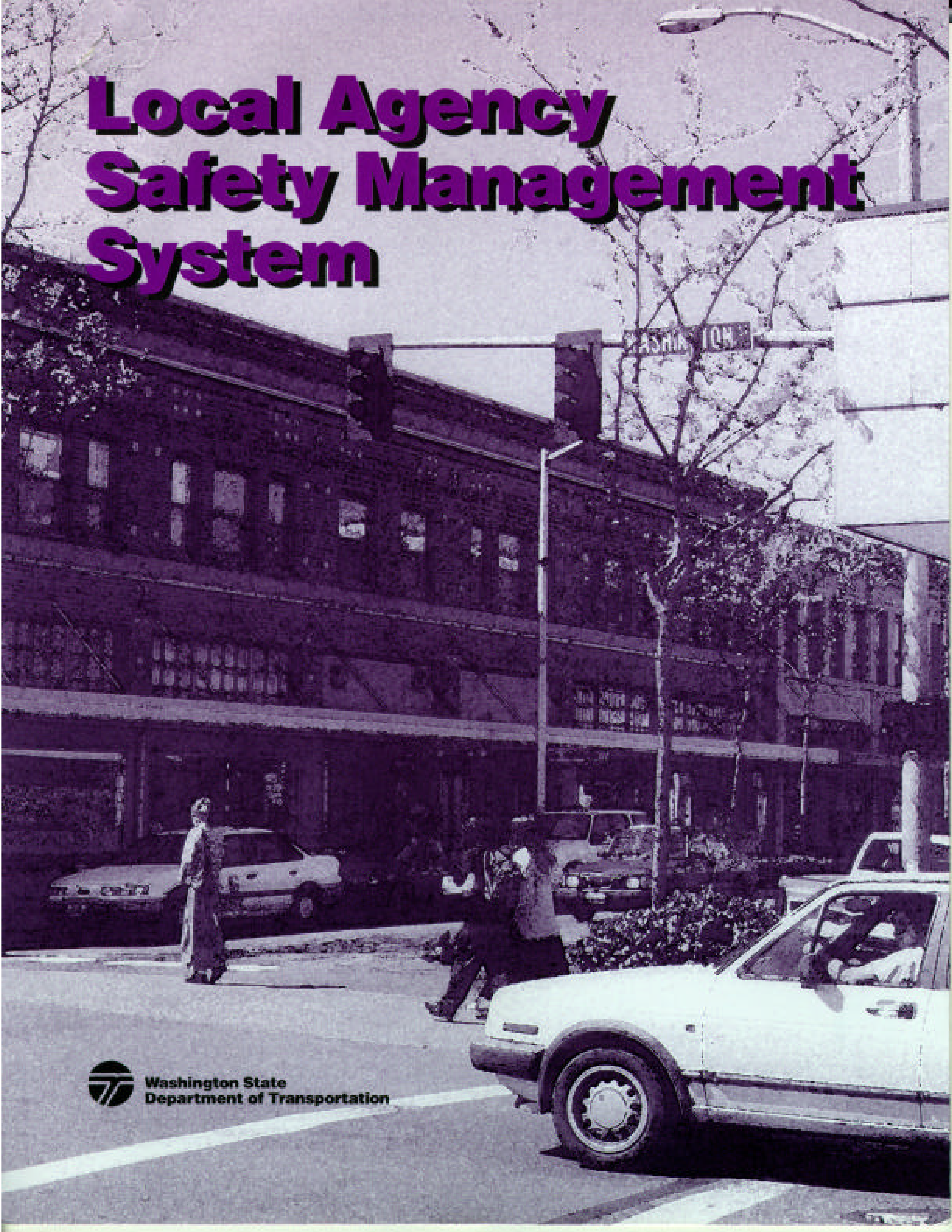
Local Agency Safety Management System



Washington State
Department of Transportation

Local Agency Safety Management System

January 1998

Washington State Department of Transportation
Transaid Service Center

Acknowledgments

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None of the writing, editing, or organizing would have been possible, however, had it not been for the time and effort contributed by the Local Agency SMS Committee. Members of this team were committed not just to the long process of bringing Safety Management to local agencies; they consistently demonstrated their overall commitment to public transportation safety through their valuable ideas, practical experience, and the gift of their valuable time over and above their "normal" workload.

Local Agency SMS Committee members are:

Gary Armstrong	City of Stanwood
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Ed Lagergren	WSDOT-Traffic Office
Harold Ocobock	Yakima County
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Tom Yake	Spokane County

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And last but by no means least, our thanks to the Washington Traffic Safety Commission for their valued support and for consistently providing the SMS Committee's excellent lunches.

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Introduction/Executive Summary

The purpose of this document is to provide Washington's local agencies a resource for implementing the Washington State Safety Management System. This system has been developed by local agency experts from jurisdictions all over the state. It incorporates all aspects of transportation including law enforcement, emergency services, and education, as well as engineering.

This is a guide only. It does not constitute a legal mandate nor does it represent authority, delegate responsibility, or establish standards of good practice for highway engineering, maintenance, or management. Rather, it is a compilation of thoughts and recommendations created by a committee of professionals representing many — though not all — agencies from around the state of Washington. Its intent is to provide a guideline from which local agencies may each choose to manage their transportation system safety resources.

By providing recommendations crafted to apply to local transportation system needs, the guide also seeks to assist local agencies in reducing the number and severity of collisions on their streets and roads. The complete context of safety management, as it applies to local streets and roads, includes all three safety elements of highway safety: the vehicle, the human (known as the traveler in the state Safety Management System (SMS)), and the roadway.

Traditionally, local agencies have focused their safety efforts primarily on their infrastructure responsibilities. This is where they possess regulatory authority and responsibility as owners/operators of their transportation networks. Thus, they establish and implement policy on planning, development, construction, and maintenance of these networks.

Although historically it has been within this realm that most agencies have focused their transportation safety improvement efforts, the SMS broadens the approach to transportation safety to incorporate the entire community of transportation safety stakeholders. It recognizes that emergency services, law enforcement, and education are equal partners with engineering in providing comprehensive and efficient management of local agency safety resources.

An SMS strengthens these efforts by integrating the engineering component of safety management with the law enforcement, education, and emergency services components. Through a collaborative process that emphasizes routine communication and information-sharing, safety needs can be identified and the resources necessary to address them can be coordinated.

Because of the importance of balancing the human and the vehicle elements of a local agency transportation system, the guide also recommends that all agencies consider the degree to which they can fund, facilitate, coordinate, and otherwise participate in all aspects of highway safety. Many local agencies are already implementing initiatives that do include human and vehicle elements. Examples include public education, neighborhood traffic control programs, emergency response needs, and vehicle noise and weight enforcement programs.

The Local Agency SMS Implementation Subcommittee, supported by the TransAid Service Center of the Washington State Department of Transportation (WSDOT), encourages all local agencies to utilize this document in the development and implementation of their transportation system safety policies. It is the opinion of the committee that consistent application of the principles herein will result in safer public roads and streets in the state of Washington.

There are two significant, and potentially helpful, legal considerations that an agency should be aware of with respect to implementing its SMS. The first is the existence of a federal statute included in Title 23 of the United States Code regarding discovery, the investigation phase of a lawsuit that precedes trial. The second is the doctrine of "discretionary immunity." Although neither of these provides immunity from suit, they do offer some protection in what can be gathered and used as evidence against agencies and when evidence may be used.

Section 409, Title 23 of the US Code, *Discovery and Admission as Evidence of Certain Reports and Surveys*, addresses discovery and evidence (what can be admitted at trial) and states that "reports, surveys, schedules, lists, or data compiled or collected" for the purposes of establishing safety enhancement at potential accidents sites does not have to be produced in a discovery request and cannot be admitted into evidence at a trial to determine the agency's negligence in a suit for damages. In other words, the information gathered is privileged. Although this does not make a local agency immune from suit concerning a collision at a particular location, for example, it does mean that the plaintiff will have to produce a different sort of evidence to prove their case. The plaintiff cannot use the agency's own good faith efforts to solve a problem to prove that the agency was aware of the problem and therefore negligent. The reason for this is that no agency would develop safety programs and keep such lists or reports if the information collected could be used against the agency to establish the fact of negligence.

Similarly in negligence cases, Evidence Rule 407 entitled *Subsequent Remedial Measures* is used in both state and federal courts. If a person trips and falls on a bad patch of sidewalk and the owner of the sidewalk repairs that patch after the accident and before trial, plaintiff cannot use the fact of the repair as evidence of or an admission of negligence on the part of the owner. The reason is again obvious: no one would make repairs if that act could be used against him or her. The evidence rules operate to encourage good behavior by protecting corrective actions.

The doctrine of “discretionary immunity” protects from suit certain acts on the part of governmental agencies and exists because “in an organized society there must be room for basic governmental policy decision and the implementation thereof, unhampered by the threat or fear of sovereign tort liability.”* The Washington Supreme Court has held that government actions are immune from suit when four conditions are met:

1. The act complained of must involve a basic governmental policy, program, or decision;
2. The act complained of must be essential to the realization of the policy, program, or decision;
3. The act requires the expertise or judgment of the agency involved; and
4. The agency involved has the authority or duty to take the challenged action.

Under this doctrine, for example, courts have held that WSDOT’s collection of accident data for use in planning highway projects is a “discretionary” function immune from tort liability.**

These are very important and powerful protections that an agency needs to keep in mind in implementing its SMS. All agencies should consult with their legal counsel for further information and advice on how these and other statues and doctrines, as well as local statutes and ordinances, apply to an agency’s given circumstances. This manual is not intended to be legal advice and should not be interpreted or relied on as such advice; it cannot substitute for an agency’s consultation with its legal counsel.

*Evangelical United Brethren Church of Adna v. State, 67 Wn 2d 246, 254 (1965).

**Jenson v. Scribner, 47 Wn. App. 478.483 (1990).

2:F:DP/SMS

The primary goal of a Safety Management System (SMS) is to prevent and reduce the number and severity of roadway collisions, transportation-related injuries, and property damage.

Section 1 explains what a Safety Management System is, how it works, what it's composed of, and what it can do for your local agency's safety program. More particularly, this section outlines the eight basic elements that make up a Safety Management System, explains what each element does and how it contributes to the system as a whole.

Section 1: Overview — Your Safety Management System

While the concept of safety management is not new, transportation safety in emergency services, law enforcement, and education within local agencies have not historically been organized into a single system. Neither have they been systematically integrated into road and street needs. This often results in random and inconsistent handling of safety issues. It is not uncommon for agencies to respond to safety needs after the urgency is illustrated by tragic results. The SMS integrates all these areas. SMS can, over time, help reduce the incidence of response-driven safety improvements in favor of planned, prioritized, and system-driven improvements.

Aside from the development of a predictive model, nothing in a Safety Management System is new. All the concepts and tools presented here have been around and many agencies in Washington have been implementing various safety management system elements for years. So you will recognize many parts of the system as things your agency is already doing or has had some involvement with.

An SMS organizes these functions, documents them, and provides basic tools for agencies to use as they are, modify them to specific needs, or use them as a guide to create new functions. The SMS is a logical, step-by-step process based on many existing local safety management processes, and it conforms to the "Decision Making Process" of the Washington State Highway Safety Management System.

What Can a Safety Management System do for You?

The primary goal of a Safety Management System is to prevent and reduce the number and severity of roadway collisions, transportation-related injuries, and property damage.

A Safety Management System (SMS) is a systematic process. This process provides objective information that helps agencies identify and prioritize safety needs, and choose cost-effective strategies to improve the safety of their transportation systems.

In safety management, one size does not fit all. Local agencies should tailor the implementation process to consider their individual needs, priorities, goals, and level of resources. This guide identifies a broad spectrum of considerations for agencies to evaluate and choose from. Your agency will need to determine for itself which of these can and should be implemented to maximize the use of your safety investment.

The analysis performed as a part of the System provides decision-makers objective information to help meet this goal. The system does not make decisions, but rather acts as a tool used as part of the decision-making process. In other words, the Safety Management System can be thought of as a tool or series of tools to assist in the management decision-making process. Its purpose is to provide consistent and accurate information based on actual conditions. It is the link between the decision-makers and the world of safety data that is available to support their decisions.

One important note: the safety decisions that your agency needs to make should drive both the data you collect and the level of analysis done within your safety management system. The whole purpose of the system is to provide useful and objective information to support the decision making process, not to collect needless data.

Your Safety Management System identifies safety needs involving all three transportation safety elements:

- Roadway — environment related
- Human — driver and special user related
- Vehicle

Your system also identifies your safety needs, helps evaluate remedial actions, and recommends related safety resources to address those needs in four general areas within the agency. These areas are known as the **Four E's**:

Engineering Education
Enforcement Emergency Services

Typical safety countermeasures — or methods for addressing safety issues — are shown in the list below and on the following pages.

Typical Safety Countermeasures found in the Four "E's"

The Four "E's"	*Safety Countermeasures*
Engineering	**Citizen Comment Response Process**
	Traffic Control — Traffic signals; Railroad Signals; construction zone signing, regulatory signals, pavement marking, detours; utility zone signing, signals, pavement marking; maintenance zone signing and detours; emergency signing i.e., roadway closures.
	Roadside/Roadway Features — Guardrail; bridge rail; roadside objects i.e. utilities, trees, drainage; sidewalks
	Roadway Standards — Prospectus; design standards; standard plans; project plans; project specifications; completed projects; value engineering; safety deviations.
Education	**Driver Training/Education** — Adult training courses; school programs; public service campaigns.
	Special User Training/Education — Senior citizen driver training courses; bicycle training programs; public service campaigns.
Enforcement	**Utilities Controls** — Utility permits and policies; franchise agreements and policies.
	Legal/Judicial — Laws; speed limit enforcement; helmet use enforcement; Seatbelt use enforcement; enforcement of child safety seat use.

Emergency Services — **Emergency Response Programs** — Aid unit/ambulance availability and response; Fire fighting accessibility and response; Police accessibility and response.

Why Safety Management is a Good Idea

Implementing a systematic approach to managing safety resources is a sound management practice. An SMS can provide many direct and indirect benefits that justify the cost and the effort it takes to implement the system. The information it provides can improve an agency's efforts to save lives, reduce injuries, and save agency time and money. The systematic approach that characterizes an SMS can also play a substantial role in reducing agencies' injury claims and lawsuits by establishing a process that identifies action and documents the justification for actions taken or not taken. With these supporting SMS elements, liability can be reduced. .

Implementing your SMS provides a variety of important benefits by:

- Increasing the capability for reducing the number and severity of collisions.
- Focusing attention on safety needs that will result in a higher payback.
- Providing an efficient communication and information sharing network among all agency transportation safety administrators including Emergency Services, Law Enforcement, and Education
- Improving maintenance of safety investments.
- Providing greater certainty that the highest priority needs are identified.
- Integrating drivers and vehicles with roadways into safety programs.
- Identifying and promoting successful strategies and programs.
- Creating accurate, objective information for evaluating funding needs.

The most important benefit gained through an SMS will be fewer and less severe collisions on local roads and streets. These reductions are the result of consistent, systematic identification of the most critical safety needs and selection of the most effective countermeasures. That alone is typically all the benefit necessary to make SMS attractive to local engineers, managers and elected officials.

The goal of fewer and less severe injuries and collisions takes time to achieve because safety strategies — roadway and non-roadway environments such as public education, law enforcement and others — require a commitment to effort and funding for implementation. Another benefit is that local agencies can have improved administrative control and provide higher service levels. SMS grants decision-makers enhanced knowledge of safety defects, hazards, and needs, thereby allowing them to make more informed choices.

The result of refined knowledge about safety needs of all types will enable the budgeting, planning and programming processes to better integrate safety needs into normal procedures. And, when objective information is consistently provided through an SMS, safety needs should compete better for scarce transportation dollars.

An indirect benefit of an SMS is reduced tort exposure. Fewer and less severe collisions will result in fewer and smaller claims. This has the potential of providing a budget savings for many local agencies. While such savings are not the direct goal or purpose of an SMS, they certainly are a useful secondary benefit.

Your Safety Management System

The Collaborative Process

There are two basic parts to your SMS, a collaborative process represented by a standing Local Agency SMS Committee and an eight-element decision-making process. The SMS committee is a standing committee comprised of all major transportation safety stakeholders. It is also a cross discipline advisory committee covering engineering, education, enforcement, and emergency services. It meets regularly to provide a collaborative information sharing network to identify safety needs, discuss safety issues, and muster the available resources to address those needs.

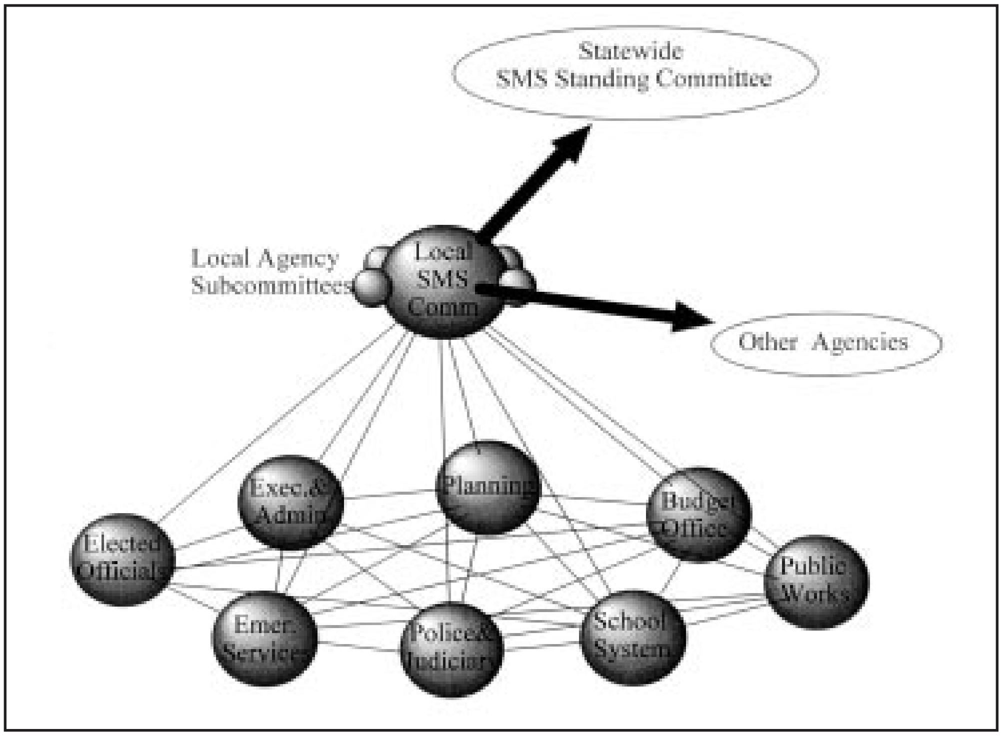


Figure 1-1 — The Local Safety Management Committee

The Eight Elements of an SMS Decision-Making Process

The eight SMS elements, when combined with good engineering judgment and effective implementation, should result in fewer and less severe collisions. They will also assist in reducing risk and agency liability.

This eight-element model can also be expanded or modified to whatever degree of complexity an agency desires. It could be expanded to include parks, paths, trails, transit providers, and others. Or, a scaled down model can be implemented within a smaller agency's capabilities and available resources. The benefit an agency receives from its SMS will be directly proportionate to the extent and degree to which the agency utilizes it.

An explanation of each of these eight elements follows Figure 1-2.

Figure 1-2 — The Eight Elements of an SMS

The Eight Elements of an SMS	
Local Policy	Establishes policy and responsibilities
Data Collection	Provides information to support decisions for identifying the safety inventory, needs, and countermeasures, and monitoring the results of safety decisions (system performance).
Data Analysis	Converts field data into usable information to assist decision makers in identifying safety needs and countermeasures, and monitoring the results of their decisions.
System Output	Presents the analyzed and processed data in a format that is usable to decision makers.
Project Prioritizing and Program Development	Includes final prioritizing of transportation safety needs, selecting cost effective solutions, and adopting safety policies, standards, procedures and programs.
Program Implementation	Carries out funded projects resulting in safety enhancements and educational, enforcement, and emergency programs.
Performance Monitoring	Measures and analyzes results of transportation safety decisions, countermeasures, and programs; provides information from which “out year” efforts are forecast and evaluated, and future work programs are developed.
Annual Safety Report	Reports, on an annual basis, the results of safety system work efforts, expenditures, and system performance.

The text on the following pages describes each of these elements in more detail. The tools used to put the system in place are described in a later section.

Summary

In Section 1 we have provided an overview of the basic elements and definitions that make up your Local Agency Safety Management System. We also have discussed the purpose and the major benefits of implementing your SMS. With this basic understanding we can now proceed to Section 2 which will provide a more detailed look at the individual pieces of the system and how they work together.

4:F:DP/SMS

This section provides users additional detail on the workings of a Safety Management System. The eight elements of an SMS are repeated and explained further. Particular attention is given to Data Collection, Data Analysis, and System Output — the SMS elements that make up the heart of a Safety Management System. A chart called the “Safety Needs Assessment Model” accompanies the text and illustrates what each of these elements does and how all three work together. The text following this chart reiterates some of the information from Section One and further explains the elements involved in Data Analysis and Data Output.

Section 2: How an SMS Works

The Collaborative Process

The SMS is comprised of two basic parts, a collaborative process and an eight element decision support process. The collaborative process is a formalized information sharing and networking system to:

- help identify emergent safety needs and issues,
- identify low cost and no cost safety resources to address transportation safety needs,
- coordinate community and inter/interagency partnerships, and
- assist in determining agency transportation safety policies, goals and strategies on a community basis in an advisory capacity.

The collaborative process operates on two levels, within the agency through a local agency SMS committee and external to the agency, on a statewide basis through agency participation in the WSDOT SMS Standing Committee.

Although daily on going communications and information sharing channels between the key SMS participants are a necessary part of the collaborative process, the Local SMS Committee is the primary method of it's implementation. It is a formally recognized group that is comprised of representatives from all transportation safety stakeholders within the agencies transportation system with the purpose of improving safety on the transportation system and reducing the number and severity of collisions. The Committee includes Emergency Services, Law Enforcement, Education, Public Works Departments, Transit, major industry, and any other major area affecting or affected by transportation safety.

The Local SMS Committee meets routinely to keep abreast of the changing needs. It will vary in size and formality depending on the size and complexity of the local agency. Small cities may have five or six individuals that meet for lunch once a month whereas a large city or county may be made up dozens of individuals with a sophisticated committee structure.

The committee meetings provide a routine forum for communicating safety needs and issues for discussion. They provide the means to make contacts and access the synergism of the full transportation safety community to identify creative solutions with a broad spectrum of input and a broad base of resources to carry them out. They provide the opportunity for a number of stakeholders to partner together with limited resources to accomplish solutions none of them could do alone. It also provides a forum to coordinate solutions to reduce or eliminate the waste of redundant efforts and communicate solutions that work or don't work.

This concept is also carried to the state level throughout the WSDOT SMS Standing Committee. The local agency has the opportunity to participate directly as a member. Through the SMS Standing committee the agency can bring issues to a forum with a statewide perspective and resource base.

More detailed information on developing a Local SMS Committee can be found in Section 3.

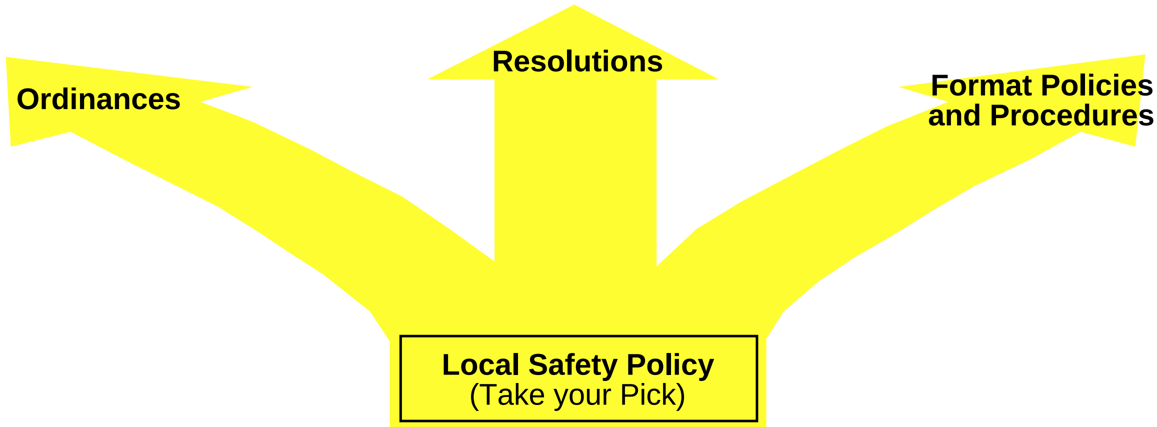
The Eight Elements of an SMS

Local Policy

The first element of an SMS — Local Policy — is a clearly written statement from the agency’s elected officials, which explains agency direction and assigns departmental safety implementation responsibilities. Locally adopted safety policies are not only good management practice but also, when applied properly, they can help an agency achieve certain “discretionary immunity” from tort claims. For further clarification it is recommended that your legal counsel be consulted on proper procedures to qualify for discretionary immunity.

A Local Safety Policy can take three forms:

- Ordinances
- Resolutions
- Formal Policy and Procedure rules.



Policies may be formal and documented or informal and de facto (that is, existing as a matter of fact). The two types are often viewed as equally valid and either format may be legally upheld. Formal and documented policies are more apt to be accepted as valid, while de facto policies will more often be tested in litigation and are likely to be controversial.

A formal policy should:

- Be adopted by an agency's appropriate elected officials (usually expressed by signature of the agency's chief executive officer, such as the Mayor, City Manager, County Executive, or Chair of the Board of County Commissioners).
- Provide an explicit list or description of identified projects.
- Provide clear direction about what to do, in what order, and in what magnitude, to those implementing safety in each department.
- Be reviewed and updated routinely to reflect changing needs.

Data Collection, Data Analysis, and System Output

The second, third, and fourth SMS elements are the heart of your Safety Management System. They constitute the process that provides the information decision-makers use to identify and prioritize safety needs, select the most effective countermeasures, and monitor the performance of the decisions. Data collection, analysis, and reporting functions provide meaningful information to those in the agency who are responsible for reducing the number and severity of collisions.

These three components, working together as a process, are illustrated in the Figure on the following page and explained in more detail on the pages following the figure.

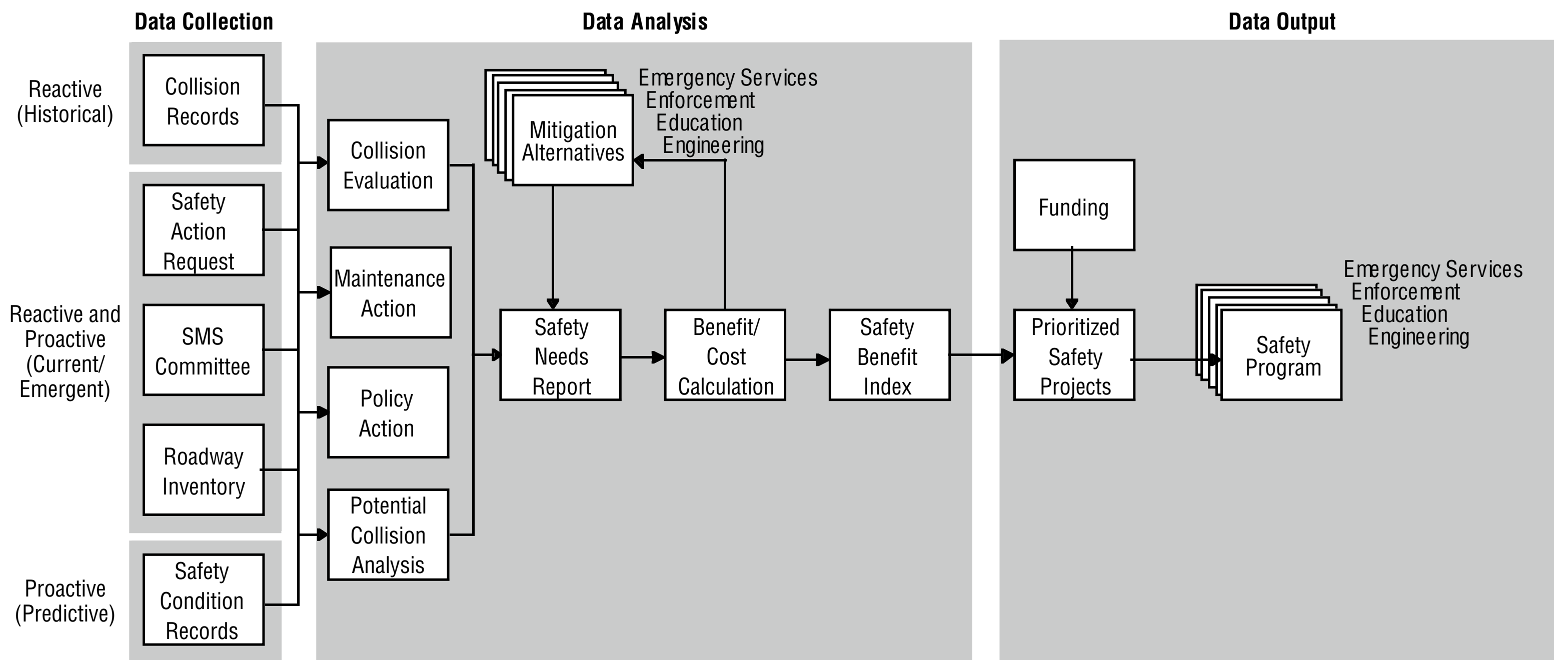


Figure 2-3 — Safety Needs Assessment Model

Data Collection

The second element of an SMS is data collection. A Local Agency SMS includes five sources for gathering safety-related data; those sources are:

- **Collision Records**
- **Safety Action Request Form**
- **SMS Committee**
- **Roadway Inventory**
- **Safety Condition Records**

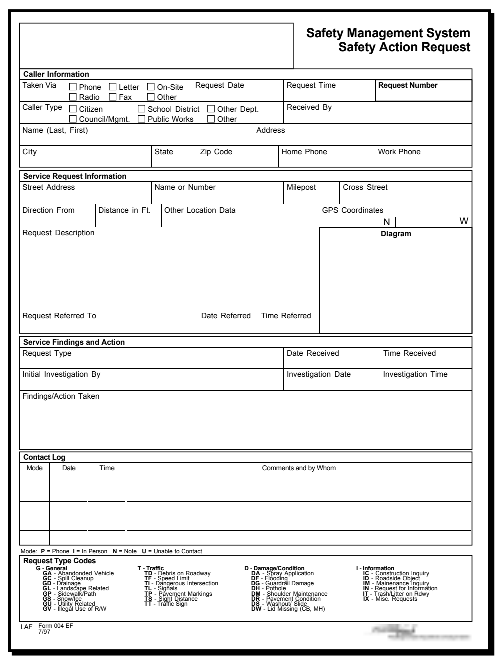
Collecting data from these sources provides agencies input about safety that includes reactive information based on actual history, and proactive information based on predictive information. These sources, explained in more detail below, also provide information about current needs based on emergent conditions.

Collision Records

Collision records have historical information on type, location, and causes of collisions. Collision record information can be obtained through the Washington State Patrol, Washington Department of Transportation Data Office, and the Local Agency's own police/sheriff reports.

Safety Action Request Form

Emergent needs, those safety needs that are observed by the public, agency employees, utility companies, police and fire personnel, etc. need to be recorded, assigned for action, and tracked through completion. The Safety Action Request Form, or a similar form developed by the local agency, provides a means to do this. It records pertinent information on the reported safety condition for either immediate corrective action, a policy action, or further analyzed and prioritized as a safety project for inclusion in the agency safety needs list.



Safety Management System
Safety Action Request

Caller Information

Taken Via ☐ Phone ☐ Letter ☐ On-Site ☐ Radio ☐ Fax ☐ Other | Request Date | Request Time | **Request Number**

Caller Type ☐ Citizen ☐ School District ☐ Other Dept. ☐ Council/Mgmt. ☐ Public Works ☐ Other | Received By

Name (Last, First) | Address

City | State | Zip Code | Home Phone | Work Phone

Service Request Information

Street Address | Name or Number | Milepost | Cross Street

Direction From | Distance in Ft. | Other Location Data | GPS Coordinates N W

Request Description | **Diagram**

Request Referred To | Date Referred | Time Referred

Service Findings and Action

Request Type | Date Received | Time Received

Initial Investigation By | Investigation Date | Investigation Time

Findings/Action Taken

Contact Log

Mode	Date	Time	Comments and by Whom

Mode: **P** = Phone **I** = In Person **N** = Note **U** = Unable to Contact

Request Type Codes

G - General
GA - Abandonded Vehicle
GC - Spill Cleanup
GD - Drainage
GL - Landscape Related
GP - Sidewalk/Path
GS - Snow/Ice
GU - Utility Related
GV - Illegal Use of R/W

T - Traffic
TD - Debris on Roadway
TF - Speed Limit
TI - Dangerous Intersection
TL - Signals
TP - Pavement Markings
TS - Sight Distance
TT - Traffic Sign

D - Damage/Condition
DA - Spray Application
DF - Flooding
DG - Guardrail Damage
DH - Pothole
DM - Shoulder Maintenance
DR - Pavement Condition
DS - Washout/ Slide
DW - Lid Missing (CB, MH)

I - Information
IC - Construction Inquiry
ID - Roadside Object
IM - Mainenance Inquiry
IN - Request for Information
IT - Trash/Litter on Rdwy
IX - Misc. Requests

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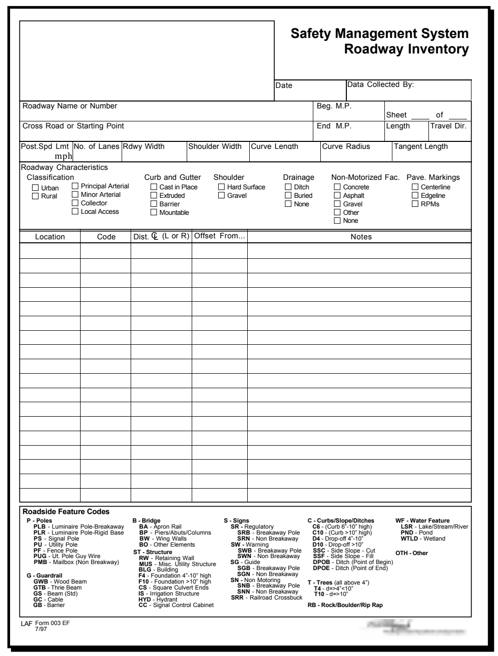
SMS Committee

The SMS Committee provides face-to-face interaction with all key transportation stakeholders in the agency, including emergency response, (i.e., fire departments and EMT units), law enforcement, and education. Through routinely scheduled meetings, safety problems, needs, and issues can be addressed. Identified needs can be submitted for agency policy action, processed through the Safety Action Request process, or addressed directly by the committee membership with existing resources.

It is through this committee that ideas are generated and issues raised for presentation at the state level through its representation on the State SMS Standing Committee.

Roadway Inventory



Safety Management System
Roadway Inventory

Date	Data Collected By:

Roadway Name or Number	Beg. M.P.	Sheet ____ of ____	
Cross Road or Starting Point	End M.P.	Length	Travel Dir.

Post.Spd Lmt mph	No. of Lanes	Rdwy Width	Shoulder Width	Curve Length	Curve Radius	Tangent Length

Roadway Characteristics

- Classification: ☐ Urban ☐ Rural; ☐ Principal Arterial ☐ Minor Arterial ☐ Collector ☐ Local Access
- Curb and Gutter: ☐ Cast in Place ☐ Extruded ☐ Barrier ☐ Mountable
- Shoulder: ☐ Hard Surface ☐ Gravel
- Drainage: ☐ Ditch ☐ Buried ☐ None
- Non-Motorized Fac.: ☐ Concrete ☐ Asphalt ☐ Gravel ☐ Other ☐ None
- Pave. Markings: ☐ Centerline ☐ Edgeline ☐ RPMs

Location	Code	Dist. ℄ (L or R)	Offset From...	Notes

Roadside Feature Codes

P - Poles
PLB - Luminaire Pole-Breakaway
PLR - Luminaire Pole-Rigid Base
PS - Signal Pole
PU - Utility Pole
PF - Fence Pole
PUG - Ut. Pole Guy Wire
PMB - Mailbox (Non Breakway)

G - Guardrail
GWB - Wood Beam
GTB - Thrie Beam
GS - Beam (Std)
GC - Cable
GB - Barrier

B - Bridge
BA - Apron Rail
BP - Piers/Abuts/Columns
BW - Wing Walls
BO - Other Elements

ST - Structure
RW - Retaining Wall
MUS - Misc. Utility Structure
BLG - Building
F4 - Foundation 4"-10" high
F10 - Foundation >10" high
CS - Square Culvert Ends
IS - Irrigation Structure
HYD - Hydrant
CC - Signal Control Cabinet

S - Signs
SR - Regulatory
SRB - Breakaway Pole
SRN - Non Breakaway
SW - Warning
SWB - Breakaway Pole
SWN - Non Breakaway
SG - Guide
SGB - Breakaway Pole
SGN - Non Breakaway
SN - Non Motoring
SNB - Breakaway Pole
SNN - Non Breakaway
SRR - Railroad Crossbuck

C - Curbs/Slope/Ditches
C6 - (Curb 6"-10" high)
C10 - (Curb >10" high)
D4 - Drop-off 4"-10"
D10 - Drop-off >10"
SSC - Side Slope - Cut
SSF - Side Slope - Fill
DPOB - Ditch (Point of Begin)
DPOE - Ditch (Point of End)

T - Trees (all above 4")
T4 - d=>4"<10"
T10 - d=>10"

RB - Rock/Boulder/Rip Rap

WF - Water Feature
LSR - Lake/Stream/River
PND - Pond
WTLD - Wetland

OTH - Other

LAF Form 003 EF
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The Roadway Feature Inventory Forms contain information on objects, both fabricated and natural, that lie along the roadway within the right of way. The information included in the inventory is useful in developing and implementing clear zone requirements and evaluating potential or actual collision locations

Safety Condition Records

These records provide the information for using the predictive function of your SMS. It includes those specific data elements that trigger a potential segment or location for investigation including physical description of the roadway geometrics such as the number of lanes, roadway width, shoulder width, vertical and horizontal curvature, speed limit, etc. Much of this data is an overlap of data included in the Roadway Features Inventory. Your agency may wish to modify the Roadway Feature form to combine the two or maintain separate Safety Condition Records with information pulled from the Roadway Inventory. Whichever method is used you will end up with information that can be used to take a proactive role of attempting to predict locations where there may be an increasing potential for collisions.

The information collected through these five sources is used to develop transportation safety policies, remedial maintenance actions, safety standards, or construction projects and programs.

Data Analysis

The third element of an SMS is data analysis. The initial identification of safety needs occurs through three primary methods: The first is a sorting process used to determine who should address an emergent safety concern and how that concern should be addressed — whether by policy, immediate maintenance, or a programming action.

This procedure, done within the Safety Action Request process and/or for the SMS Committee, is typically handled and resolved through assessment by knowledgeable individuals within the Road and Street Departments.

The second data analysis method — that done for collisions that have occurred — employs longer, more objective, quantifiable processes, which are explained below and on the following pages.

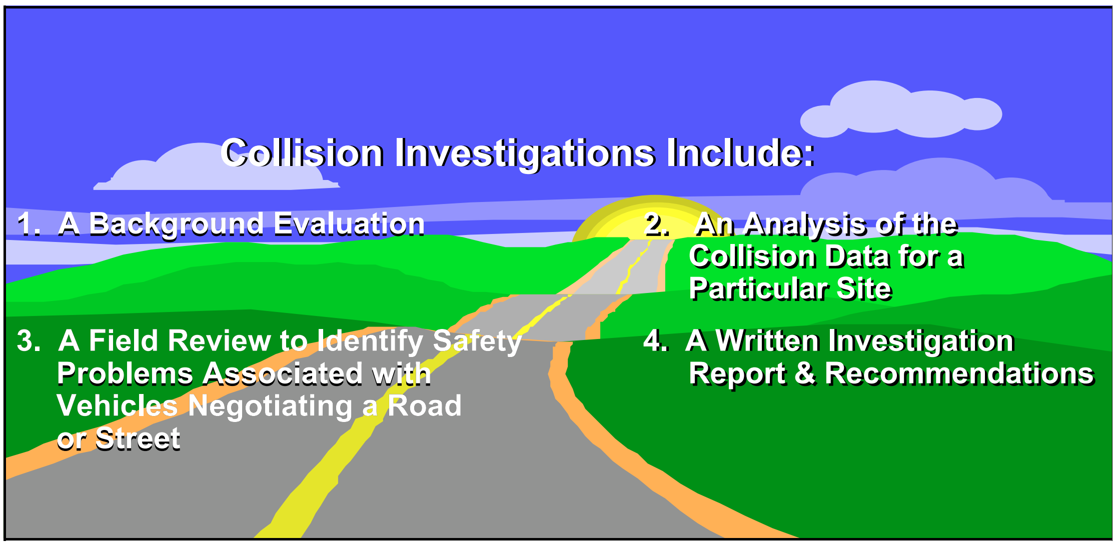
The third is a method of evaluating the roadway network for risk. It evaluates the potential for collisions based on certain roadway features such as roadway geometrics and roadside objects. This process is currently in development.

Once the safety needs have been identified, countermeasures can be selected, projects prioritized, and programs built, policies established, or maintenance actions taken.

Collision Investigation

A collision investigation can vary from review of a single incident to a comprehensive evaluation. Investigation of a single incident can do no more than document existing conditions for further review or analysis as required. Any contributing factors that can be remedied, or apparent problems should be brought to the attention of those persons responsible. This type of information can also be useful to identify specific or general maintenance or engineering parameters that should be addressed.

Collision investigation can also include a more complete evaluation of a collision location history. Such investigation can consist of four steps as shown below:



A. Background Evaluation

This step of the Collision Investigation process looks at the history and planned activities of the study location. To eliminate fluctuations in collision history, there should be enough history to span a typical time period, or to include major changes in circumstances. Typically, a traffic collision historyspans a five-year period unless changes in circumstances or traffic patterns limit the time period. Changes in traffic controls, construction, or major maintenance items are noted; including significant changes in traffic volumes or patterns. The research should also be expansive enough to note any significant changes affecting drivers or pedestrians at the study location.

Records on proposed projects or mitigations can identify planned revisions. Be sure to note the scope and timeframe of any revisions planned for the study location.

Several information sources are available for investigating the history at a study location: maintenance personnel, law enforcement officers, local citizens, operations or maintenance records, and any previous collision studies are all good sources.

B. Collision Assessment

This part of the Collision Investigation looks for factors leading to unusually high proportions of traffic collisions; it will also help identify driver judgment errors and other factors leading to traffic collision trends. Such factors include: pavement surface conditions, lighting conditions, weather conditions, times of day, days of week, months of year, etc. Look at the percentage of collisions occurring under each of these factors.

In addition, look for patterns of a particular direction of travel or attempted maneuver for each collision type. Common driver maneuvers during collisions will lead to specific observances during the field review. Traffic counts can be used to determine collision rates, relate traffic collisions to maneuvering attempts, or evaluate the need for warrant studies.

There is more than one level of analysis that can be used to arrive at reasonable conclusions. Appendix H explains these analysis levels in detail and provides formulae used to calculate collision numbers and rates.

C. Field Review

A Field Review provides first-hand information on the location's physical attributes and how drivers negotiate through the study location. It will also provide clues such as skid marks, tire markings on curbing, worn pavement markings, or off pavement rutting that will assist in understanding the nature of the problem and selection of the ultimate countermeasure.

Note signs of driver difficulty such as evasive action to avoid collisions or difficult maneuvering. Turning traffic may also be counted to determine turning percentages. Watch vehicles negotiate the location during a time period when collisions occur. Notice any correctable roadway features, whether it's signing, striping, or geometrics. Short traffic counts may be taken to verify or update older counts, and short delay studies may be conducted to note traffic backups or the presence of other problems.

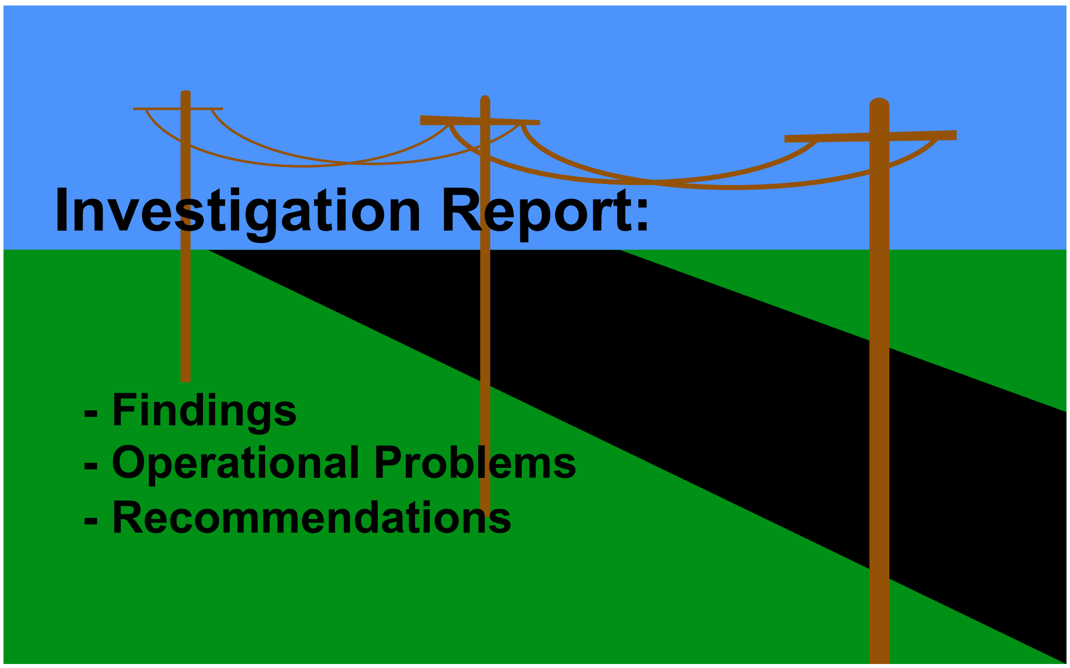
Signalized locations may require monitoring of cycle lengths or "green time." Field measurements may also be taken to verify deficient instances or widths necessary to maintain smooth traffic flow or to note physical limitations to economic construction.

Investigators may determine or evaluate recommendations during this step. The field review may also include field data collection to support recommendations. Field data collection assists with analysis and project scoping.

D. Written Investigation Report and Recommendations

Finally, the Written Investigation Report will document findings, operational problems, and recommendations for reducing traffic collisions at the study location. A structured format will add consistency to investigations and make them easier to compare with each other. It will also aid the development of a database program to store investigations for easy access and tracking.

Appendix J contains a sample investigation report for a local agency.

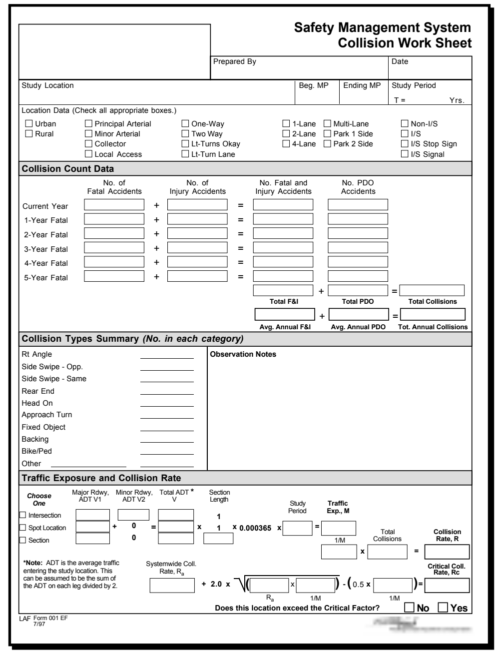


The investigation report will consist of three sections: findings, operational problems, and recommendations. **Findings** will summarize information from the Background Evaluation, the Collision Assessment, and the Field Review. **Operational Problems** will identify sources causing collisions and specific driver difficulties which may lead to accidents. The third section, **Recommendations**, will propose action for short-term, intermediate term, and/or long term solutions.

Once the collision investigation has been completed, Data Analysis can proceed with the **Critical Collision Location Analysis**, the selection of a corrective strategy, and the prioritizing of projects. These steps in the Data Analysis process are explained below.

Critical Collision Location Analysis

Once a collision rate has been calculated for a particular location, it can be compared to the Critical Collision Rate to determine if it warrants inclusion in the corrective strategy and programming processes. The output of the critical collision location analysis is a list of collision locations classified by collision rate and whether the location exceeds the critical collision rate. The **Collision Work Sheet** in **Appendix E** is an example of a tool to use for generating this list of classified collision locations.



Safety Management System Collision Work Sheet

Prepared By | Date

Study Location | Beg. MP | Ending MP | Study Period T = Yrs.

Location Data (Check all appropriate boxes.)

☐ Urban ☐ Rural
☐ Principal Arterial ☐ Minor Arterial ☐ Collector ☐ Local Access
☐ One-Way ☐ Two Way ☐ Lt-Turns Okay ☐ Lt-Turn Lane
☐ 1-Lane ☐ 2-Lane ☐ 4-Lane
☐ Multi-Lane ☐ Park 1 Side ☐ Park 2 Side
☐ Non-I/S ☐ I/S ☐ I/S Stop Sign ☐ I/S Signal

Collision Count Data

	No. of Fatal Accidents		No. of Injury Accidents		No. Fatal and Injury Accidents		No. PDO Accidents		
Current Year		+		=					
1-Year Fatal		+		=					
2-Year Fatal		+		=					
3-Year Fatal		+		=					
4-Year Fatal		+		=					
5-Year Fatal		+		=					
					Total F&I	+	Total PDO	=	Total Collisions
					Avg. Annual F&I	+	Avg. Annual PDO	=	Tot. Annual Collisions

Collision Types Summary *(No. in each category)*

Rt Angle
Side Swipe - Opp.
Side Swipe - Same
Rear End
Head On
Approach Turn
Fixed Object
Backing
Bike/Ped
Other

Observation Notes

Traffic Exposure and Collision Rate

Choose One ☐ Intersection ☐ Spot Location ☐ Section

Major Rdwy, ADT V1 + Minor Rdwy, ADT V2 (0, 0) = Total ADT* V x Section Length (1, 1) x 0.000365 x Study Period = **Traffic Exp., M** (1/M)

1/M x Total Collisions = **Collision Rate, R**

*Note: ADT is the average traffic entering the study location. This can be assumed to be the sum of the ADT on each leg divided by 2.

Systemwide Coll. Rate, R_a + 2.0 x $\sqrt{(R_a \times 1/M)}$ - (0.5 x 1/M) = **Critical Coll. Rate, Rc**

Does this location exceed the Critical Factor? ☐ No ☐ Yes

LAF Form 001 EF 7/97

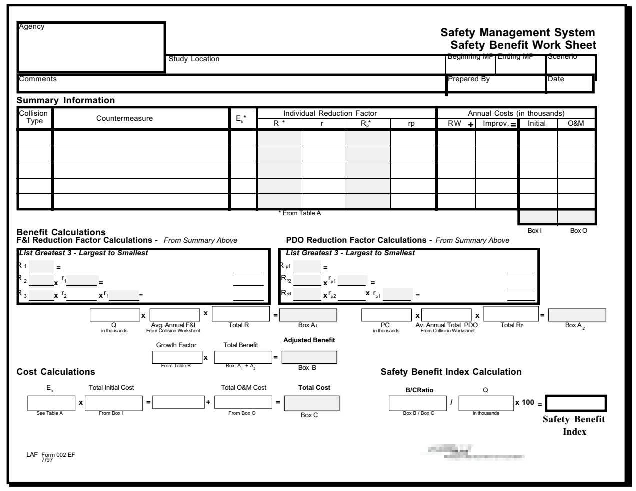
Corrective Strategy Selection

After the collision locations have been identified and classified, the system then uses a Benefit Cost method to assist in the selection of a corrective action that is most effective for the cost. A detailed description of how this is done is discussed in Section 3. The **Safety Benefit Work Sheet** in **Appendix F** is available as a tool in selecting the best corrective action(s).

Safety Benefit Index

With the location(s) identified and countermeasure(s) selected, the next step is calculating a Safety Benefit Index to prioritize the projects.

The Benefit/Cost Ratio is used to calculate the Safety Index, which provides a relative priority ranking for program or project selections; this Index is calculated as the number of equivalent fatal and injury collisions reduced over a ten year period for each $10,000 spent on the countermeasure or combination of countermeasures. Use the **Safety Benefit Work Sheet** in **Appendix F** in making these calculations.



System Outputs

Data collection and analysis provide the information the system requires to identify and generate lists of safety needs by priority as well as by trends, feature inventories, countermeasures, and cost benefit analyses. The fourth element of the system, System Outputs, can produce the following examples:

- ***Priority Lists*** **—** Lists of needs and defects, usually by category, with relative priority shown. These are often used to recommend safety needs which should be funded first or safety projects which should be addressed in the field first.
- ***Budget and Program Recommendations*** **—** Management's conclusions resulting in annual budget and program recommendations to elected officials. May have alternative or optional recommendations for officials to consider and deliberate.
- ***Statistical Data*** **—** Includes trends, needs, and performance of existing system by collision category, driver, or roadway factor.
- ***Roadway Feature Inventory*** **—** An inventory of known roadway features, both fabricated and natural, by type. Useful in quantifying maintenance and safety service level status.
- ***Alternative Mitigations/Countermeasures*** **—** An array of options for mitigating known hazards. May be applied to the agency internally or externally.

- ***Road Standard Revisions* —** Periodic recommendations for revisions to road standards reflecting latest knowledge of data collection, analysis, and local policy.
- ***Cost Benefit Analysis* —** While it is difficult to objectively place monetary value on safety needs, traditional public practice does so in an effort to be cost effective and responsible to the public.
- ***Countermeasures* —** Specific programs or goals intended to reduce collision rates and severity.

Project Prioritization and Program Development

These are the fifth element of an SMS. There are numerous individuals throughout the agency making decisions on a daily basis trying to reduce the number and severity of collisions on the agency's transportation system. These decision makers reside at all levels and within all disciplines of the management process. Their decisions can be implemented through improved emergency responses, driver education, and law enforcement, and/or through engineering needs identification, prioritization, and countermeasure selection. In general, a local agency's management process takes place within the following areas, and an agency's safety decision-makers are found within these processes:

- Policy Development
- General Administration
- Education
- Law Enforcement
- Judicial
- Fire Response
- Medical Response
- Planning
- Program Development
- Project Development
- Construction
- Maintenance

Agency decision-makers include:

- Council/Commission Members
- Agency administrators and staff making decisions in the policy making, planning, programming, project development, construction, and maintenance processes (i.e., Public Works Director, City Manager, Engineer, Street Supervisor, etc.).
- Board of Adjustments and Hearing Examiners
- Police Chief/Sheriff
- Emergency Services Administrators:
    - Hospitals/Trauma Centers/Regional EMS and Trauma Care Councils
    - Fire Chief
    - Medic I Services Administrator
    - Ambulance Services Administrator
    - Disaster Response Administrator
- Judicial Process:
    - Lawyers
    - Prosecutor's Office
- Risk Management:
    - Tort Claims Investigator
    - Insurance Companies
- Local Safety Council Representative
- Superintendent of Public Schools
- Public Transit Administrator

Project Implementation

The sixth SMS element — Project Implementation — is the action of carrying out decisions based on output from the SMS analysis. Project implementation includes such actions as implementing policies, design standards, and construction and maintenance procedures, as well as the selection, prioritization, and construction of specific safety projects based on Benefit/Cost analysis and the Safety Benefit Index. It also includes implementing safety programs identified by the analysis that cover the entire transportation network. Examples of such programs are guardrail programs, speed enforcement programs, driver safety education programs, emergency response routing, etc.

Monitoring Performance

Evaluating the effectiveness of modifications (or mitigations) at a high collision location is an essential part of any safety program and is the seventh element of an SMS. Such evaluations not only determine how effective the various types of modifications have been in reducing traffic collisions, but also aid in achieving the maximum safety benefits per dollar spent in the Safety Program.

After the improvements are installed, the analysis of traffic and collision data should be continued to evaluate the effectiveness of the installed improvements in meeting the expected goals. This effort is very necessary in order to increase the accuracy of future improvement selections.

Traffic operations at high collision locations should be monitored soon after the improvement has been installed to see if there are any serious, unexpected problems. If problems are observed, consider action to alter the improvement (if minor) to address the problems.

If the location is reflecting a higher number of collisions than anticipated or if collision severity exceeds expectations following completion of the safety improvement, the location should be flagged as high-collision and immediately reevaluated to see what is causing the unexpected number of collisions. Then, corrective action should be taken, if necessary. There is the possibility that the number of collisions may increase immediately after an improvement simply because drivers are not accustomed to the change at the location. Caution in this analysis is encouraged.

Annual Safety Report

The last SMS element, an annual report to the agency’s elected officials, is vital in emphasizing safety management system effectiveness. Such a report provides policy-makers information and benchmarks that indicate whether or not their service levels are being achieved, and whether or not their desired safety goals are being accomplished. Given this information at an appropriate time of the year — preferably prior to policy development and decision time — policy and decision makers can revise policies and decisions to enhance or reduce effort levels as they desire.

Summary

In Section 2 we have examined, in detail, how the SMS works. We have looked at the Collaborative Process, the eight elements in the SMS decision process, and provided a model for identifying safety needs, prioritizing those needs, and determining countermeasures to address those needs. In the next section we will introduce and examine several “tools” to assist your agency in implementing your system.

5:F:DP/SMS

Section 3 Tools to Get Your SMS Started

This third and last section discusses the steps involved in implementing your Safety Management System and explains what tools will be most helpful to use during the implementation process. This section specifically covers the entire implementation process — from developing your local safety policy and setting up a local SMS Committee, to collecting safety information, gathering roadway inventory data, conducting collision investigations, and selecting countermeasure strategies. Also covered here are sections on “Future Safety Needs,” “SMS Program Evaluation,” and the “how to’s” of putting together a Safety Management System Annual Report.

Section 3: Implementation Assistance and Tools

Implementation Recommendations and Agency Resources

A Local Agency SMS can be implemented through a series of steps which can be embellished or modified at any time. Each step is a process that supports and interacts with previous and subsequent steps.

Each step also contains numerous tasks of varying complexity depending on the size of the agency. These tasks apply to the three primary safety elements mentioned earlier: **Vehicle**, **Human**, and **Roadway**.

An agency's capability — using staff resources — for implementing tasks that apply to each of these elements will fall into one of three categories: high, medium, and low:

Level A (High) An agency which has a Traffic Engineer or a functional equivalent, and staff support. Level A agencies are usually larger cities and counties that maintain full time, dedicated traffic professionals.

Level B (Med.) An agency which does not have a Traffic Engineer or a functional equivalent. Level B agencies will usually have Professional Engineers in the position of City or County Engineer as well as engineering staff support, although it may not be dedicated exclusively to traffic safety.

Level C (Low) An agency which does not have professional engineers. Level C agencies use consultant services, the Washington State Department of Transportation, or larger cities or counties to provide their professional expertise. Smaller cities at this level will typically have full time people managing street maintenance. All counties are required by law to have Professional Engineers in the position of County Engineer.

A chart illustrating these three agency capability levels toward each task can be found in **Appendix A**. These levels are not a mandate or a statement of good engineering practice; rather, they represent an "ideal" level of safety achievement. This ideal is a target for agencies but recognizes that not all of them may currently be able to reach it. Therefore, the chart provides capability levels — and their corresponding resources — that are currently adequate (or are anticipated to be adequate) to complete these activities.

Developing a Local Safety Policy

Cities and Counties operate within a government system that includes policy makers and policy implementors. Policy makers are the elected officials in whom the public has placed trust and responsibility for making decisions about the public welfare. Elected officials are recognized by the courts as having legal, discretionary authority to establish policy. This discretionary authority, if properly adopted and implemented, may cover many aspects of local government transportation system operations and services.

Those implementing policy are the various individuals within departments who have responsibility for managing adopted budgets in the execution of capital and operational programs. This distinction is important to safety management because ***individuals implementing policy must be careful not to make policy*** but work within the parameters of policy adopted by elected officials.

The courts of this state have differentiated between what they have interpreted as “executive level” policy, i.e., formally adopted by elected officials, and management level administrators making “operational, discretionary decisions.” Official policy adopted by elected officials may be immune from certain tort claims because elected officials have legal authority to make discretionary policy decisions. Managers and others may or may not have the legal right to make discretionary decisions and when made, those decisions probably do not have the protection of discretionary immunity.

Policies that result in specific services or decisions about services and programs, are commonly described in traffic case law as the “standard of care” created by agency action. When an incident — which could be alleviated by reasonable action — occurs, local agencies must defend their actions. The best posture for such a defense is a set of consistently followed formal policies.

Policies inconsistently followed not only yield inconsistent results, they also degrade agency defense strategies in litigation. Officially adopted policy may carry with it “discretionary” authority which informal policy may lack. Case law recognizes appropriately established policy and discredits informal policy which has been created by management decision. Agencies using formal policy procedures generally achieve public policy goals with greater understanding than those without formal procedures.

Fundamental Policies

There are certain local agency policy decisions fundamental to providing local government services which can effect safety. These are policies granted by the State Constitution or by state law. Examples of policies which might be thought of as “fundamental” are:

> **Budgeting** — Perhaps the most fundamental discretionary responsibility of local agency elected officials is deciding what gets funded and what doesn’t. Officials must decide not only which needs get funded and in what amounts but, by state law, they must also balance the budget. This inevitably means that many needs are not selected for funding and remain unmet. Adopted budgets become de facto policy as expressions of service level intentions. Within the field of traffic safety, this policy determines how scarce revenues are distributed across many categories of need.
>
> The best example of a fundamental policy is the agency budget process. If agency budget procedures include elected officials considering alternative program options or levels, and legislatively deciding which programs to fund (as opposed to managers making such decisions), the elected officials’ decision is probably immune from certain tort claims.

Risk Management Policies — Risk management is a local agency responsibility. Whether to be insured, self-insured, have risk management standards for operating departments, or accept risk as it comes, are among the options local governments can consider. Strong risk management policies might set standards of operating care for departments to follow as well as make recommendations for claim processing. They can also track claims and losses and become important monitoring and tracking elements within traffic safety. Risk managers are often consulted along with legal advisors, public works managers, and others when assessing the risks of claims, suits, and circumstances.

Existing risk management policies and systems are easily accessed through the City and County Risk Management Pool organizations as well as through cities and counties operating independent risk management systems. These systems provide numerous good examples of procedures which may be considered by agencies wishing to set up their own risk management organizations.

Risk Management principles, like SMS, are very broad and normally encompass all agency services and systems. Integrating all agency service provisions into a single risk organization to establish policy, achieves consistency of practice and provides a focus point for elected officials to deal effectively with risk decisions.

Local Safety Policy Implementation Methods

As stated earlier, any one of three methods can be used to implement a local safety policy:

1. **Ordinance**
2. **Resolution**
3. **Formal Policy and Procedure rules**

Each of these methods is acceptable and should meet the following goals:

- Adoption by an agency's appropriate elected officials (usually indicated by signature of the agency's chief executive officer, such as the Mayor, City Manager, County Executive, or Chair of the Board of County Commissioners)
- Provide an explicit list or description of identified projects. This only needs to be an identification — not project scope or other detailed technical definitions. Projects' more technical aspects can be determined by the implementing agency or department.

- Be specific. Policies should not be vague goal statements but should provide absolute direction to individuals implementing policy in each department. They should say what to do, in what order, and in what magnitude.
- Contain an ***absolute value, cap, or limit*** to expenditures that are included in adopted budget documents. This is particularly important when lists of needs which exceed annual or immediate fiscal resources have been identified. The policy makers can prioritize — thereby balancing the level of effort required to address safety needs, with annual budget capability.

Some agencies within Washington apply one or more of the above policy methods to many of their routine procedures for road and street departments. Such agencies adopt highly refined work programs containing all the detail included in this document and more.

It is not the intent here, however, to recommend that agencies apply these models to every routine procedure. Instead, it is recommended that agencies select specific areas that they consider most critical to transportation safety, and which could carry some protection through discretionary immunity. This is considered the minimum level of policy development an agency should consider. It is recommended that the agency consult their legal counsel for advice in what is specifically needed for discretionary immunity.

Topics for Safety Policy Development

Policies exist in an organization in a written or unwritten format. The written format is typically more defined, easier to apply and defend. Either will carry certain duties and responsibilities for an agency. Involvement with and review of litigation, claims, collisions, and other ongoing processes to include complaints, construction, maintenance activities provide an opportunity to review policies, procedures for application, update or appropriateness. This can be useful in keeping the SMS as relevant as possible.

The following areas are important and should be considered in development and adoption of local agency policies:

- ***A local agency safety management system*** — Federal law provides certain protection for local agencies which clearly employ a safety management system. For example, lists of identified needs commonly exceeding budget capability cannot be used against such agencies in litigation.
- ***Collision Investigation Procedures*** — Local agencies should clearly identify what steps should be taken in a collision investigation, who should be involved, and what their responsibility should be.

- ***Regulatory sign change requests or procedures* —** must be done consistent with the principles recommended by the MUTCD. In addition to those principles, local agencies should have policies covering how to review sign change requests, apply appropriate standards and guidelines, and concluding recommendations. These policies should also define who has what responsibility and who ultimately makes decisions.
- ***Traffic Control Processes* —** Local agencies should document traffic control processes and decisions. This would include all aspects of traffic control, signing, and all other activities related to safety. This should also include all of the existing system which should reflect consistency and accuracy with the policies and procedures of the agency.
- ***Speed limits* —** All speed limit changes should be done consistent with the principles recommended by the MUTCD and state law. In addition, local agencies should have policies covering how to review speed limit change requests, apply appropriate standards and guidelines, and how to complete recommendations. All changes should define responsibilities and assign decision-making authority. Finally, speed limit changes must be confirmed by ordinance or as otherwise allowed by local regulation.
- ***School pedestrian accommodation* —** should be accomplished in conjunction with school transportation directors. Local Agencies should consider having written policies stipulating their criteria for providing facilities, signing, or other special considerations for pedestrians.
- ***Road and Street Operations* —** Desired levels of service in providing traffic and maintenance services are policies which dramatically influence highway safety. Maintenance frequencies for features like signals, illumination, signs, pavement markings, and surfaces all contribute to transportation system risk exposure. Local agencies' decisions about service goals ultimately dictate costs and budgets.
- ***Maintenance Activities* —** When considering maintenance frequencies for traffic features such as pavement markings, agencies should consider being more aggressive about maintaining quality markings where weather, surface maintenance practices, and traffic wear are more acute than normal. For example, agencies whose local conditions result in poor quality markings might consider striping twice yearly instead of once on roads and streets where volumes and conditions would justify the cost.

  Maintenance areas to be covered in policy development should include:

  - Snow and ice procedures
  - Road and street emergency dispatch or call-out procedures
  - Road and street pavement marking maintenance programs
  - Road and street sign and signal maintenance programs

  - Road and street pavement maintenance programs
  - Road and street shoulder maintenance programs
  - Road and street roadside hazard mitigation programs.
  - Road and street illumination policy
  - Standards for construction
  - Deviation procedures

- ***Right-of-Way Use* —** Washington State law gives many individuals and groups the legal right to use publicly owned road right-of-way for private or utility purposes. The same law allows local governments, who are legally responsible for the right-of-way, to establish the standard of care these outside users must provide in their use of public right-of-way. Adopting appropriate policies for right-of-way use will provide the standard of care for utility users that agencies desire. A common challenge experienced by local agencies has been the creation of utilities standards that establish reasonable clear zones, runoff areas, and protection or mitigation of immovable utility objects.

- ***Road and Street Design Standards* —** Besides being data factors, road standards are also adopted or de facto local policy. They influence the cost to construct and maintain roads and streets, and impact costs for utilities and others who utilize the right-of-way. Road standards are also important policy statements of safety standards, determining more than any other decision what the prospective local standard of care is. They are based on universal engineering guidelines but should reflect local agencies' unique needs and character.

  When working with federal-aid projects, local agencies must follow the Local Agency Guidelines manual promulgated by the Assistant Secretary for TransAid. Beyond the minimum standards set by state law, local agencies may choose to use AASHTO guidelines to establish their own local road and street standards, or adopt other references as standards. Given the unique character of local roads and streets, it may be in the best interests of local agencies to formulate their own standards and adopt them as official policies. When doing so, it is good practice to follow universal guidelines, such as those contained in AASHTO rules or in WSDOT Highway Design and Maintenance Manuals; agencies can, however, customize the fit for local needs. There are many excellent examples of very good local agency road and street standards in this state and agencies might be advised to review them in the process of updating their own local standards. Agencies should also review the AASHTO design standards and adopt those determined to be appropriate for the agency.

It is recommended that agencies refer to the WSDOT *Standard Specifications,* the APWA Standard Specifications, the WSDOT Local Agency Guidelines, and APWA, where applicable.

- ***Other Explicit Road and Street Safety Mitigation Programs* —** such as utility poles, guardrail programs, bridge end treatments or other programs which incrementally address hazard reduction over years of budgets and time.

The Local SMS Committee

An essential tool for implementing an SMS is a local SMS Committee. This committee functions as an ongoing network for identifying the community's transportation safety issues, needs, and resources while it works together to achieve maximum safety system performance. A Local SMS Committee plays a significant role in transportation safety and should improve the quality and nature of local coordination and information sharing.

There is no single model for a Local SMS Committee which will fit every agency. The committee's exact size, makeup, and structure should fit each individual agency's needs. It may be helpful to review other agencies' methods for forming a committee; however, each agency's processes are unique and will need to be modified to accommodate your agency.

A local SMS committee should also be an organized, multi-disciplinary team responsible for ongoing SMS communications, coordination, development, implementation, and evaluation activities at the local level — as defined by the organization creating the committee. And, it should be made up of all major system users, including organization representatives both inside and outside the agency.

The following list can be used as a guide to avoid omitting an organization or an individual with valuable input and a vested interest in an agency's safety functions:

Local SMS Committee Membership

Representatives from:

- Public works departments
- Local Law Enforcement Agencies (Police Chief, Sheriff, and State Patrol)
- School districts
- Emergency Service Providers (ambulance, fire, hospital, etc.)
- Local organizations, public and private
- Appropriate state and federal organizations
- Elected Officials
- Regulatory Agencies (development permitting agencies)
- Public School Districts
- PTA
- Port Districts
- Indian Nations
- Agency department heads (Program Development, Budget, Planning, Design, Construction, Maintenance, and Traffic Operations)
- Insurance and/or Risk Managers
- Budget and Financial Controllers
- Transit Administrators
- Major Destinations (Universities, Fairgrounds, Stadiums, and Coliseums, large occupancy buildings and malls)
- Major Industries (construction, agriculture, etc.)
- Washington State Department of Transportation
- Airports
- Railroads
- Others (as the region desires)

Note: Representatives of federal organizations might be members of a local SMS committee if their organizations are responsible for public facilities within the region defined by the committee. Examples: the Park Service, the Bureau of Indian Affairs, or other federal agencies which operate or influence local transportation facilities.

To form a Local SMS Committee, some (or all) of the stakeholders listed on the previous pages should be contacted, briefed on the purpose of the meeting, and if possible, sent a meeting agenda in advance.

As previously stated, a local agency can establish a formal or an informal SMS committee. In either case, the committee should meet on a regularly scheduled basis to insure that emergent needs are adequately identified and communication channels remain active. Because the committee will generate recommendations with budget implications for some or all member organizations, the meetings and procedures should be recorded with minutes and distributed.

In a small agency, one individual may be responsible for several functions; thus, smaller agency SMS committees may consist of a few individuals and require minimal structure, yet represent a large number of management functions. Conversely, populations and organizations in larger cities and urbanized counties can be extensive and may require a formal committee structure.

Local SMS Committee Organization

An example of how to structure a Local Agency SMS Committee can be found in **Appendix B**.

Local SMS Committee Products and Implementation

The Safety Committee is advisory because of the independent nature of each agency, organization, and institution. Therefore, the products of committee work should be offered in the form of safety goals, specific program recommendations, project/program recommendations, and/or proposal of partnering and resource sharing. The committee could strive to develop annual safety system evaluations, conclusions, and program recommendations to be given to member organizations prior to their internal annual budget cycles. Each member organization would then be responsible for considering committee recommendations as it formulates subsequent annual budgets and programs. Specific committee recommendations might be of the following nature and type:

- Proposed Policy Revisions
- Proposed Programs (public education, code enforcement, emphasis patrolling, etc.)

- Proposed Specific Projects (coordination of annual TIPs for traffic considerations, individual project coordination, etc.)
- Operation or Maintenance related (signal coordination, lane alignments, traffic feature consistency, i.e., what warning device to use where and when, maintenance levels, work zone practices, etc.)
- Proposed Standards and Modifications (road and street design standards, utility accommodation standards, development review standards, etc.)
- Emergency Services procedures (routing, response standards, boundary coordination, etc.)
- Propose Education (Senior Citizen Drivers Ed., Public Service Campaigns etc.)
- Enforcement (Multi jurisdictional coordination)
- Available resources (workforce, funds, equipment, etc.)

The Local SMS Committee is a key element in making an SMS work. This is particularly true for small cities where vehicle collisions are fairly rare. Most safety issues are emergent in nature and require immediate identification, solutions, and shared resources due to small budgets. All agencies should establish active local transportation SMS Committees. The exact size, shape and process of each is not as important as the fact that they be formed and operate effectively for coordination and safety collaboration. Agencies should also consider being represented on the State Standing Committee where they will have access to statewide resources and a voice in statewide safety issues.

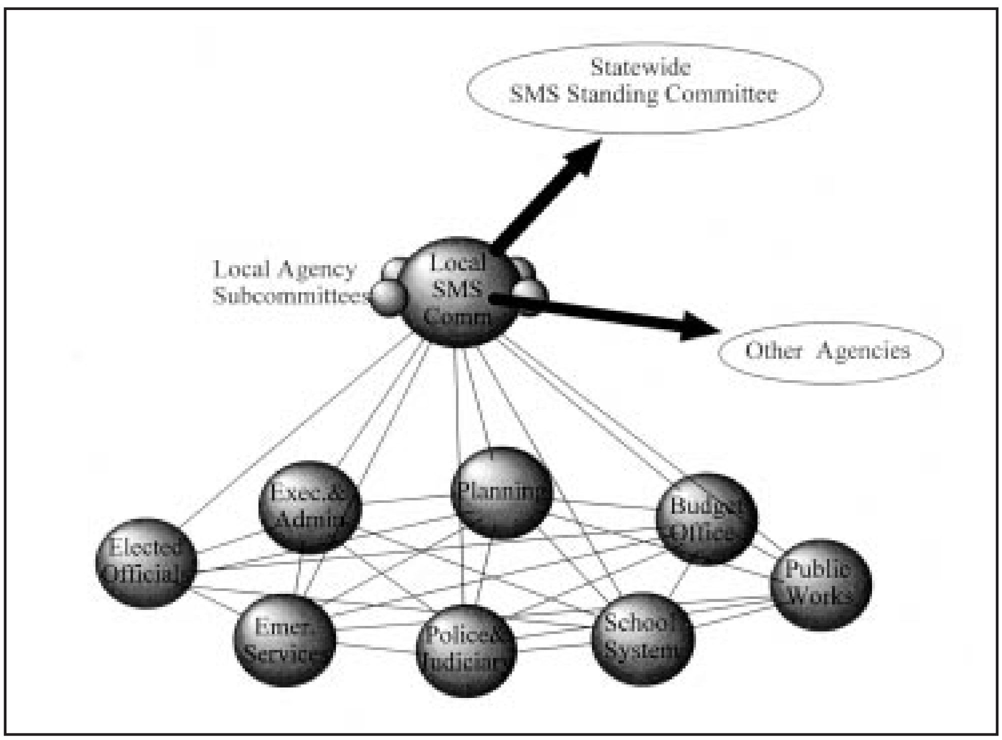


Figure 3-4 — The Local Agency Safety Management Committee

The State SMS Committee

A Local SMS Committee will have two major opportunities to address safety issues — once at the local level, once at the state level through the State SMS Committee. At the local level, the local SMS Committee is the primary network for a local agency's transportation safety community. This local committee strives to ensure that opportunities to improve safety are continuously identified, considered, implemented where appropriate, and evaluated for performance.

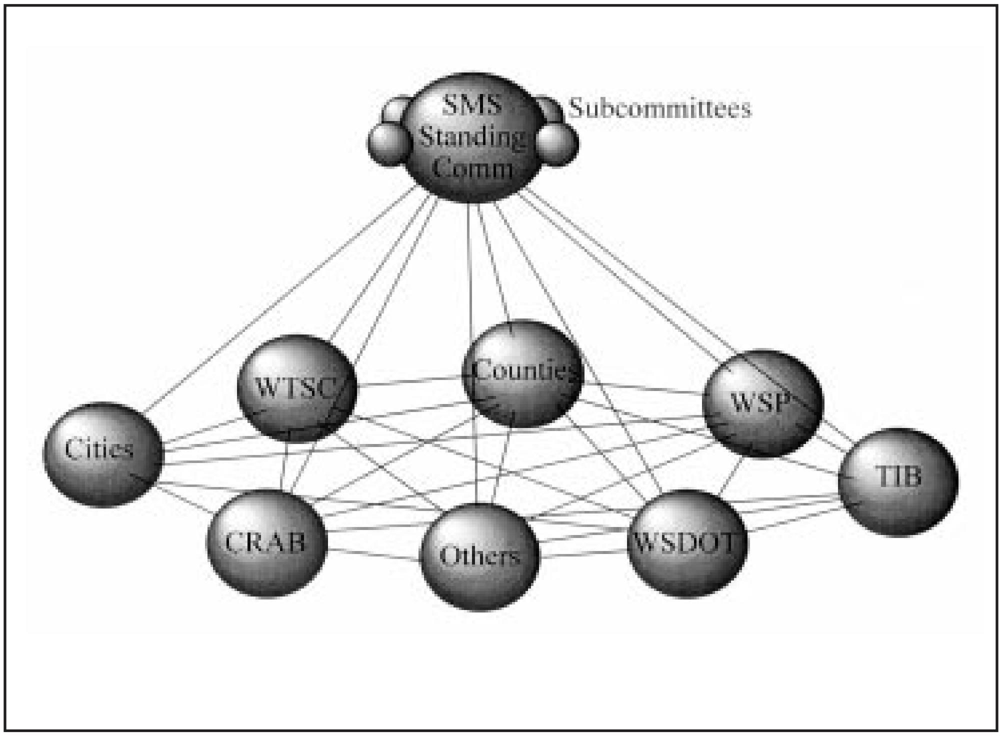


Figure 3-5 — Washington State Department of Transportation SMS Standing Committee

At the state level, a local SMS committee can participate in the Washington State Highway Safety Management System Standing Committee.

The state committee is an organized, multi-disciplinary team responsible for ongoing SMS communications, coordination, development, implementation and evaluation activities at the state level. It has members representing federal, state, regional, and local organizations both public and private. This state committee provides a statewide network for sharing safety resources, methods, solutions, and support at both program and project levels. (See the illustration above.)

Safety Action Requests

Identifying emergent safety needs is critical to providing transportation safety. One of the best methods for doing this is collecting users' observations of the transportation system, then directing remedial action to the appropriate area within the agency. These users' observations are often the early warning signs of problems that are beginning to develop. Many times, they can be addressed at minimal cost before a collision occurs. Two features have been included in the SMS to provide this type of immediate input — the SMS Committee and the Safety Action Request process.

Washington Counties are required by Washington Administrative Code (WAC) to maintain some form of formal complaint recording system. This requirement is contained in the standards of good practice promulgated by the County Road Administration Board (CRAB), and it is recommended that cities do this as well.

While WAC's require counties to maintain complaint systems, it is recommended that a documentation system of notice received be created in all agencies. This system would receive complaints and observations concerning safety from citizens, police officers, agency staff, utilities, and all other users/observers of the roadway system,

The primary function of such system is to support the Local Agency Safety Management System. However, it can be used for other matters brought to the agency's attention by observers of the road and street system. The system will work well for many applications, but will have greater value when applied universally.

How to Collect Safety Information

This information on the Safety Action Request Forms will be used for several applications: first, it is accepted into the SMS database for evaluation and prioritization; secondly, it is categorized consistent with the "types of requests" contained on the form for inclusion in annual reporting to elected officials. The investigation, contact log, and action records provide documentation of efforts resulting from the request.

For the above reasons, it is imperative that this form be filled out thoroughly and accurately. The absence of information will hinder an agency's ability to respond, prolong evaluation, and extend the time that an unsafe condition exists.

A Safety Action Request Form and instructions for completing it, are in **Appendix C**.

Roadway Inventory Data

Although the data collection process (and the data inventory form) support the Local Agency Safety Management System, the gathered roadway inventory data has other uses in engineering and maintenance operations.

Data on roadside features is very useful for at least two purposes: to establish a clear zone regulation by collecting inventory information to delineate features within such a zone; or, to record inventory data for potential collisions to prioritize action on roadway sections, intersections, or spot locations.

Agencies will want to evaluate the data contained in their forms to determine what is useful. The idea here is to maximize the use of pertinent information through broad distribution and to ensure that only useful information is collected. Other agency systems can also be used as information sources and this data can be used to support other systems.

A Roadway Inventory Form has been provided within Appendix D to assist in collecting and storing information about your roadways. Feel free to modify this form to meet your agency's needs.

Selecting Countermeasure Strategies

At least two, and up to four alternate strategies should be analyzed to determine the most cost effective solution to correct the problem areas identified in the collision data. The following elements are part of each of the strategies.

After the cost of the strategy is identified, the appropriate reduction factor is identified by matching the collision type(s) with the countermeasures that might be used. The appropriate collision reduction factor can be selected using the design life of the countermeasure and the number and types of collisions associated with that collision type.

Benefit/Cost

The Benefit/Cost Ratio is widely recognized as a good tool to develop a set of relative priorities. It is a reasonable assumption that no agency has the resources to implement all desirable projects at any given time. By using current benefit and cost information, it is logical that the greatest benefit would be achieved by implementing projects with a higher ratio over those with a lower one.

Calculation of this benefit/cost (B/C) ratio is the primary tool for determining a priority ranking for a specified problem, solution, or countermeasure. A value greater than one implies that the benefit of a solution, or countermeasure, is greater than its cost of implementation.

Implementation of the B/C ratio requires determining a relative measure for the estimated collision reductions that will result from a proposed countermeasure. It is extremely important that the user understand the factors that provide the basis for calculating the B/C ratio. This tool is intended to provide a sound, relatively objective methodology for ranking solutions. Only then will there be adequate comfort that the B/C ratio is meaningful and acceptable. Factors to be considered include:

Improvement Cost	Total Construction Cost (less R/W)
R/W Cost	Total cost of acquiring any land or right-of-way needed to construct the strategy
Initial Cost	Total cost of any capital construction necessary to implement the strategy (improvement costs plus R/W)
Annual O&M Cost	Annual cost of operating and/or maintaining the strategy
Collision Type	Identified types in the Collision Data Work Sheet
Element	Type of countermeasure selected from the charts to correct the identified Collision Type
Reduction Factor	The estimated reduction in collisions for a given countermeasure
Life	The Years for which the strategy is designed, or for which it has an estimated life.
Fatal	The number of Fatal collisions the selected element would mitigate
Injury	The number of Injury collisions the selected element would mitigate
F&I	Sum of fatal collisions and injury collisions
PDO	The number of Property Damage Only collisions the selected element would mitigate

Benefit/Cost Calculation

Benefit Cost ratios require relatively simple calculations. However, the factors used to make the calculations are somewhat more sophisticated. A few, like numbers of collisions, are simple statistics that may be readily gathered from traffic collision reports already gathered within the state. Other factors, such as the collision reduction factor, will require development and/or judgment by the user. Over time, these factors will become more accurate as historical information is collected to refine them. Until then, we are dealing with degrees of benefit between projects or countermeasures so that selections can be made.

The factors must be used consistently when comparing relative costs and solutions. **Assumed Reduction Factors** can be found in **Table A** in **Appendix F**.

Benefit, B

The benefit of the countermeasure can be calculated by determining the yearly cost of the fatal and injury collision reductions, and adding the yearly cost of the property damage collision reductions. Then, divide this total by the total cost of the project annualized over its service life. The total benefit (B) is expressed mathematically by:

$B = Q(F + I)(R) + P_c(P)(R_p)$; Where

F = annual number of collisions involving fatalities during the study period

I = Average annual number of collisions involving injured people for the period of the study

P = Average annual number of collisions involving only property damage for the period of the study

R = reduction of fatal and injury collisions by type (from Table A — **Appendix F**)

R_p = reduction of property damage only collisions by type (from Table A — **Appendix F**)

P_c = Average cost, in thousands of $, per property damage only collision

Q = Weighted cost, in thousands of $, of fatal and injury collisions

$$Q = \frac{(F_c \times F) + (I_c \times I)}{F + I}$$ Where:

I = Average annual number of injuries for period of study

I_c = Average cost per injury in thousands of $

F = Average annual number of fatalities for period of study

F_c = Average cost per fatality in thousands of $

Cost, C

The total cost of the countermeasure or combination of countermeasures, is calculated by determining the annualized initial cost of the countermeasure and adding the annual maintenance and operations costs. It is expressed mathematically by:

$C = E_k(C_i)+C_m$; Where:

E_k = Capital recovery factor based on countermeasure life (From Table B — **Appendix F**)

C_i = Estimated initial cost of the countermeasure (cost of the improvement including R/W) in thousands of $

C_m = Estimated annual maintenance and operating cost of the countermeasure in thousands of $

B/C Ratio

The B/C ratio then simply becomes the benefit divided by the cost.

$$\frac{B}{C} = \frac{Q(F+I)R + P_c P R_p}{E_k C_i + C_m}$$

Safety Index Definition

The Safety Index provides a relative priority ranking for program or project selections derived from collision data and analyzed for mitigation options. The Safety Index is simply the relative benefits of a solution measured by the number of equivalent fatal/injury collisions — reduced over 10 years — per $10,000 dollars spent on the project. The Safety Index is calculated by

$$\frac{B/C}{Q} \times 100$$

A Safety Benefit Work Sheet is provided in **Appendix F**.

SMS Program Evaluation

The overall effectiveness of any safety program may be measured in the following three distinct areas:

1. **Increase or decrease in collisions and collision severity at improved sites.**
2. **Total reduction in cost of collision damage (Economic Loss).**
3. **Return on investment of improvement expenditures.**

This type of information is summarized from actual experience data and can be presented in graphical or tabular form.

Figure 3-6 shows a Tabular summary identifying the overall costs and benefits of the traffic safety program. The same Benefit/Cost summary could be used by local agencies to evaluate safety programs within respective areas of responsibility. The information is broken down by type of improvement and covers one- and two-year periods before and after the implementation of improvements. The method of comparison used is a ratio of one- and two-year annual net benefits to initial investment costs. These ratios evaluate the relative merits of each phase of the transportation safety program. However, they are indicative only of the rate of return on the initial investment regardless of ultimate cost-effectiveness.

Various other types of summaries can be prepared for official evaluation of program effectiveness; they include:

- **The origin and distribution of funds for safety improvements**
- **Comparison of actual results with forecast results**
- **Overall progress in reducing the number of identified high collision locations on the system**
- **The scope of work remaining**
- **The reflection of safety program findings in new construction standards and procedures.**

The traffic safety concepts in this chapter have been presented along with several methods of attacking the problem of highway collisions, development and implementation of safety improvements, and the evaluation of these improvements. The evaluation reflects — in dollar terms — what the collision analysis efforts are accomplishing, and permits comparisons to support efforts in Transportation Safety.

Continued enhancement of roadway safety depends in part on maintaining current knowledge of system and user experience and performance. This knowledge requires a constant state of awareness, monitoring and record keeping. To local agencies, this mostly includes the roadway environment but, to other agencies, it also includes the driver and vehicles. Tasks included in program monitoring are:

1. **Collision Rate Awareness —** Collision rate awareness is critical to statistical analysis. The simple number of collisions by itself, without considering traffic volume, is only partly useful. A more complete evaluation can be made by calculating the number of collisions per million miles driven based on the traffic volume.
2. **Collision Severity —** This information is also important in monitoring performance. Reducing the severity of collisions is also important. High volume facilities may have high rates of low severity incidents and a low volume location may have higher severity rates with lower numbers of collisions. The collision severity needs to be taken into consideration since the causes and solutions are generally different between high and low severity collisions.
3. **Collision Locations —** Accurate location data is absolutely essential to effective safety programming. Even the simplest highway safety system requires that location information be maintained. This may be as simple as a pin map showing annual accidents or an electronic database with infinite sorting capability.

Safety Management System Annual Report

An annual safety report, submitted by the appropriate authority (Public Works Director, County Road Engineer, Traffic Engineer, etc.) to the elected officials of the city or county, serves many purposes and might include the following:

- An introduction briefing elected officials on the status of transportation system safety management within the city or county. This might briefly review safety efforts from both the program and project perspectives. It might also include the city's or county's previous goals and objectives as well as recommendations for new goals and objectives.
- A statistical report on collision numbers and rates by type, including but not limited to: vehicle categories, pedestrian, equestrian, bicycle, age groups, and other categories. The report could compare agency statistical results with comparable rates published in the Washington Traffic Safety Commission annual reports, thereby allowing comparison of agency statistics with statewide results.[*]
- A review of local transportation safety coordination.
- Identification of high collision locations, advising elected officials of efforts to analyze and develop mitigation proposals for them.

[*]There is no equitable comparison of agency statistics. All agencies are unique and should not necessarily compare their statistics against those of other agencies. The rating process is not a goal-setting exercise, nor does it set an agency's standard of care. Agencies are advised therefore to review their statistics for purposes of personal relativity only and ought not to make decisions predicated on other agencies' results. Each agency should set its own goals and objectives.

Figure 3-6

Safety Management System
Performance Evaluation Worksheet

Traffic Safety Program (One Year Before and One Year After) From (Year) To (Year)	Prepared By	Date Prepared

Type of Improvement	Number of Projects		Number of Collisions				Number of Fatalities	Change in Collisions					Cost of Projects (x1000)	Collision Cost Savings (x1000)	Benefit / Cost Ratio
			Total	PDO	Injury	Fatal		Total	PDO	Injury	Fatal	Killed			
		Before													
		After													
		Before													
		After													
		Before													
		After													
		Before													
		After													
		Before													
		After													
		Before													
		After													
		Before													
		After													
		Before													
		After													
Total Program		Before													
		After													

Note: - = Decrease

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Washington State Department of Transportation

- A review of collision rates in a risk management context, advising elected officials on what efforts might be considered to reduce risk exposure and reduce collisions or collision severity.
- A review of the effectiveness of current safety-related programs, advising elected officials on what opportunities might exist to improve related program effectiveness in the interests of reducing collisions and collision severity.
- A report on specific safety related tasks, projects, or other assignments previously given by elected officials.
- A review of previously adopted safety programs or projects, examining their safety experience in the new mode versus the old. This is an important component of the annual monitoring element of an SMS.
- Timely enough submittal to allow for utilization by elected officials in considering the following year's annual budget and programs. As a budget recommendation, the report should include specific projects or programs and their recommended funding
- Levels and priorities. Elected officials seeking safety goals might wish to add or deduct from an agency's recommended safety-related programs or projects.
- Act as a vehicle for the local agency to formally adopt the report by ordinance, along with its recommendations or amendments. This would formalize a safety program and project priorities as matters of agency policy.

Future Safety Needs

A model for predicting safety needs is currently under development and will be included in the Washington State Local Agency SMS. This procedure will help in predicting collision probabilities based on collision history data and roadway characteristics.

Predictive capabilities have recently been researched through work accomplished at the University of Washington under the direction of Professor Fred Mannering. This appears to be the most recent work to date that is applicable to this effort. The work was based on extensive data collected in the city of Bellevue, and on highways under the jurisdiction of the Washington State Department of Transportation (WSDOT). These efforts were accomplished in the City of Bellevue by Mr. Mark Poch, and for WSDOT, by Mr. John Milton.

The predictive model intends to follow the development formulas and methods used in these research efforts. Both research efforts are related and use an approach that can be adapted to high and low volume facilities, in both urban and rural environments. The following outlines the process for developing this procedure.

The Proactive Element

Substantial — and recent — research directed at predicting collisions based on a roadway's environment has just been completed. Milton and Mannering (1996)[(1)], [(2)] have finalized an analysis of all collisions on all Washington State, non-interstate highways over a two year period. And, Poch and Mannering (1996) [(3)] analyzed all collisions on all city of Bellevue streets over a three-year period.

Both of these approaches used regression analyses to equate collision probabilities with various elements of a roadway's environment. This work resulted in models that can allow predictions of collision areas. While these models are not as specific to a detailed location or number of collisions as historical data, they do provide enough information to identify program and system solutions as compared to site specific solutions.

The work of Milton, Poch, and Mannering will be validated for a broader cross section of roadway conditions by correlation with samples from other cities and from county roads across the state. While the models may require minor modifications to achieve appropriate statistical validity, a correlation can be accomplished across the spectrum of city and county roadways.

Smaller agencies may have some difficulty collecting the necessary data. But, by virtue of their smaller physical size, these agencies typically have fewer problem areas. Because of this, development of secondary models is also planned. These levels will provide secondary degrees of correlation to account for more limited roadway environment data collection. Significant value can still be obtained by using these secondary models.

While some additional data may be necessary, the models will be developed to minimize data requirements.

Predicting Collision Locations

The primary roadway environment variables listed below, provide the basis for predicting collision areas in intersections in Poch and Mannering's research. More specific subsets of these variables are used for the analysis.

- Number of intersection legs
- Sight distance restriction
- Number of lanes and configurations
- Greater than ±5 percent grade
- Horizontal curvature
- Signing or signal controls
- Intersection in the central business district

- Intersection, residential area
- Functional Classification as Local, Collector, Minor arterial, or Principal arterial
- Speed limits

The following roadway environment variables are used in straight (tangent) roadway sections in Milton and Mannering's research.

- Milepost
- Length of Section
- Total Lanes and Configuration
- Roadway and Lane Widths
- Shoulder Width and Configuration
- Vertical and Horizontal Curvature
- Tangent Information
- Curb or Wall
- Median
- Urban/Rural
- Posted Speed Limits
- Functional Class

Traffic Volumes

Traffic volumes for the active element will begin with the same historical data as the reactive element. We anticipate further development of population growth and traffic prediction models. Ideally, we would be able to look at land use plans and growth patterns to predict impacts on existing streets and roads and take a proactive approach to both development and redevelopment. As these methodologies are developed and implemented, the quality of predictive data should improve. Traffic engineers and land use planners have successfully applied growth predictions to historical data, and that data provides a good starting point.

We expect the active element to be most useful in working with land developers to address potential problem areas before they are constructed.

The traffic variables used for intersection areas are:

- **Total intersection volumes**
- **Total approach and opposing volumes**
- **Through and turn volumes**

The variables for straight (tangent) sections are:

- **Average annual daily traffic**
- **Truck and combinations volumes**
- **Peak hour factor**

Again, more specific subsets of these data elements are used for the analysis.

For additional information, see the Washington Traffic Safety Commission article “Monitoring Performance and Annual Safety Report” in **Appendix G**.

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Collision Rate	The number of collisions occurring for a given unit of vehicle exposure, expressed as collisions per million vehicles or as collisions per million vehicle miles.
Average Daily Traffic (ADT)	The total traffic volume during a given time period divided by the number of days in that time period.
Countermeasure Analysis	A procedure to determine the best countermeasure from a group of alternatives.
Countermeasure Improvement	A physical or operational measure designed to reduce the severity and number of traffic collisions. This countermeasure extends to enforcement training, projects, signs, operations and other reasonable actions.
Exposure	A measure of the how frequently vehicles are exposed to collisions.
High Collision Location	A geographical spot, intersection or section of roadway that is experiencing a greater number of collisions than a predetermined cut-off value, average rate or critical rate for the location.
Intersection-Related Collision	A vehicle related collision that occurs within the defined area of an intersection as a result of vehicle operations.
Location Analysis	A procedure to analyze a high-collision location that determines appropriate countermeasures for the location's collision experience.
Mid-Block Collision	A vehicle-related collision that occurs within the city limits that is not intersection-related.
Property Damage Only Collision (PDO)	A vehicle-related collision where no injuries or fatalities occur.

Road Section Collision	A vehicle related collision which occurs on a road section outside the city limits.
Severity Index	The average cost per collision at a specific location.
Spot Location Collision	Specific identifiable point on the road or street system consisting of 0.10 mile or less in length, and for which collision location identification may be the same as for mid-block.
Traffic Records System	The personnel, equipment, facilities, information, and procedures necessary to correlate collision data with vehicle, driver and/or highway data to identify the causes of traffic collisions and the means of preventing them.

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Appendix A

Approximate Agency Capabilities for Implementing Tasks

Approximate agency capabilities for implementing tasks with staff resources at a given level are:

Level A ● = High capability

Level B ◉ = Medium capability

Level C ○ = Low capability

Applies to:
Vehicle Element
Human Element
Roadway Element

Level	A	B	C
1. Local Policy			
Revenue Distribution	●	◉	◉
Risk Management	●	◉	○
Road Standards	●	●	●
Right of Way Use	●	●	◉
Service Goals	●	●	○

Level	A	B	C
2. Data Collection			
Collision Records	●	●	●
Traffic Studies	●	●	○
Condition/Maintenance Records	●	●	◉
Claim Records	●	●	●
Hazard Inventories	●	◉	○
Complaints	●	●	◉
Transportation Management Sys.	●	●	◉
Land Use Plans	●	◉	○
Traffic Counts	●	●	○
External Influences	●	◉	○
Regional TIPs	●	●	●
School Transportation	●	●	◉
Special User Groups	●	●	●

Level A ● = High capability

Level B ◉ = Medium capability

Level C ○ = Low capability

Level	A	B	C
3. Data Analysis			
Collision Frequency	●	●	○
Collision Analysis	●	●	○
Hazard Analysis	●	◉	○
Mitigation Alternative Analysis	●	●	○
Priority Analysis	●	◉	○
Traffic Forecasts/Predictions	●	◉	○
User Group Needs	●	●	○

Level	A	B	C
4. System Outputs			
Priority Lists	●	●	◉
Budget and Program Recommend.	●	●	○
Statistical Data	●	◉	○
Safety Feature Inventory	●	●	○
Mitigation Alternative Choices	●	◉	○
Road Standard Revisions	●	●	◉
Cost Benefit Analysis	●	◉	○
Countermeasure Recommendations	●	●	○

Level	A	B	C
5. Decisions			
Adopted Budgets	●	●	●
Adopted Programs			
engineering (projects)	●	●	●
educational	●	●	◉
enforcement (law judicial)	●	●	●
emergency services	●	●	◉
Policy Revisions	●	◉	◉
Road Standard Revisions/Updates	●	◉	◉

Level A ● = High capability

Level B ◉ = Medium capability

Level C ○ = Low capability

Level	A	B	C
6. Implementation (in the four program areas of engineering, education, enforcement and emergency services)			
Transportation Improvement Plan	●	●	●
Maintenance Projects	●	●	○
Development Requirements	●	●	●
External Mitigations	●	◉	◉
Driver Awareness Programs	●	●	○
Enforcement Programs	●	●	◉
Seasonal Needs and Awareness	●	●	○
Pedestrian Programs	●	●	◉
Equestrian Programs	●	◉	○
Bicycle Programs	●	◉	○
Health (special population) Programs	●	◉	○
Work Zone Signing	●	●	●
School Transportation Needs	●	●	◉
Equipment Condition Enforcement	●	◉	○
Railroad Crossings	●	◉	◉
Local Road and Street Standards	●	●	◉
Regional Coordination	●	●	●

Level	A	B	C
7. Monitoring Performance			
Annual Collision Results	●	●	●
Collision Severity Trends	●	●	◉
Collision Locations	●	●	●
Risk Management	●	●	◉

Level	A	B	C
8. Annual Safety Report	●	●	●

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Chair (elected)*

- Term of office — One year
- Elected at large from membership
- Votes for tie breaking only
- Chairs meetings, appoints sub-committees when needed, etc.

Secretary (elected)*

- Term of office — One year
- Elected at large from membership
- Voting member as well
- Keeps minutes, schedules meetings, sends notices, prepares supportive documentation from meeting procedures.

Membership

(One member/vote per agency/organization.) Actual participation unlimited. Agencies are encouraged to send anyone who would support the collaboration process.

Note: Some local transportation Safety Committees might want to consider electing only the Secretary and utilize rotating chairs. In that case, the elected Secretary would automatically become the Chair next year. This would promote continuity.

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Appendix C — Safety Action Request Form and Instructions

Caller Information

Taken via: Check the appropriate box, indicating the mode of information receipt.

Request date: The date of receipt of the request or notice.

Request Time: The time of day the request or notice is received.

Request Number: Adopt a numbering code to maintain some sequence of information flow. It is recommended that the numbering be sequential, including a digit for the record itself plus a suffix for the year. For example, Request no. 96123 would be the 123rd report received in 1996.

Caller Type Check the appropriate box, indicating the information source.

Received By The name of the person taking the information.

Name The name of the person contacting the agency to give the information.

Address Mailing address of the named person providing the information brought to the agency's attention.

Home/Work Phone A telephone number where the person can be reached during day work hours. The other telephone number would be a night or off-work hours number. The goal is to record numbers where the person can be reached by agency respondents.

Service Request Information

Street Address This box should be filled in with the street address of the location or whatever locator information is available. The GPS coordinates will not be known unless a field investigator conducts an investigation.

Name or Number	
Milepost	Milepost location if applicable.
Cross Street	Name of cross street from which location is referenced.
Direction	Direction from which the cross street location is referenced.
Distance in Ft.	Distance in feet from the referenced cross street.
GPS Coordinates	If known.
Request Description	Enter the information provided by the named person. Take as much detailed information as possible. Avoid including any conclusions or pre-suppositions. Take only the information provided by the person.
Request Referred to	The name and office of the individual to whom the request was forwarded for appropriate action.
Date referred	The day the information was forwarded to the appropriate individual for action.
Time referred	The time of day the information was forwarded to the appropriate individual (presumed to be on the same date as received; if not, include the actual date of referral).

Service Findings and Actions

Request Type	Select the appropriate code for the request type from the list at the bottom of the page. You can use a simple, high level identification method by using the single letter codes such as G, T, D, or I. Or you can select a more detailed identification method that incorporates two-digit coding. Whichever method is chosen, your agency should establish a standard policy and use it consistently.
Initial investigation by	The name of the person conducting the initial investigation.
Date Received	The date that the investigator received the request/assignment.
Time Received	The time that the investigator received the request/assignment.
Initial Investigation By	Investigator’s name.

Investigation Date	The date that the investigator began the investigation.
Investigation Time	The time that the investigator began the investigation.
Findings/Action Taken	Investigator should record findings, observations and actions taken, if any. If no action is taken, report, "Concluded no further action required."
Date completed or referred	Enter the date action was taken or the matter was referred to further appropriate authority.

Contact Log

Information as indicated about each contact, investigation, or action taken on this request.

Mode	Whether the contact was by phone (P), in person (I), note (N), or unable to contact (U).
Date	The date of contact or attempted contact.
Time	The time of the contact or attempted contact.
Comments and by whom	Appropriate comments pertaining to the contact, by additional information revealed, or other appropriate information.

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Safety Management System
Safety Action Request

Caller Information

Taken Via ☐ Phone ☐ Letter ☐ On-Site ☐ Radio ☐ Fax ☐ Other	Request Date	Request Time	**Request Number**
Caller Type ☐ Citizen ☐ School District ☐ Other Dept. ☐ Council/Mgmt. ☐ Public Works ☐ Other		Received By	
Name (Last, First)	Address		
City	State	Zip Code	Home Phone	Work Phone

Service Request Information

Street Address	Name or Number	Milepost	Cross Street
Direction From	Distance in Ft.	Other Location Data	GPS Coordinates N W
Request Description			**Diagram**
Request Referred To	Date Referred	Time Referred	

Service Findings and Action

Request Type	Date Received	Time Received
Initial Investigation By	Investigation Date	Investigation Time
Findings/Action Taken		

Contact Log

Mode	Date	Time	Comments and by Whom

Mode: **P** = Phone **I** = In Person **N** = Note **U** = Unable to Contact

Request Type Codes

G - General
- **GA** - Abandonded Vehicle
- **GC** - Spill Cleanup
- **GD** - Drainage
- **GL** - Landscape Related
- **GP** - Sidewalk/Path
- **GS** - Snow/Ice
- **GU** - Utility Related
- **GV** - Illegal Use of R/W

T - Traffic
- **TD** - Debris on Roadway
- **TF** - Speed Limit
- **TI** - Dangerous Intersection
- **TL** - Signals
- **TP** - Pavement Markings
- **TS** - Sight Distance
- **TT** - Traffic Sign

D - Damage/Condition
- **DA** - Spray Application
- **DF** - Flooding
- **DG** - Guardrail Damage
- **DH** - Pothole
- **DM** - Shoulder Maintenance
- **DR** - Pavement Condition
- **DS** - Washout/ Slide
- **DW** - Lid Missing (CB, MH)

I - Information
- **IC** - Construction Inquiry
- **ID** - Roadside Object
- **IM** - Mainenance Inquiry
- **IN** - Request for Information
- **IT** - Trash/Litter on Rdwy
- **IX** - Misc. Requests

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General Information

The top three lines contain general information. All information on each sheet should be completed. Above the top line is a sheet number. This should be used only if a roadway segment needs more than one sheet to gather the data.

Date	The date of the collection effort.
Roadway name or number	Enter the name or number including suffix or prefix indicators such as NE 195th St., or, 195th Ave. NE.
Beg. M.P.	Beginning milepost if applicable.
End M.P.	Ending milepost if applicable.
Cross road/ starting point	Enter the name or number of the cross street starting point.
Length	Enter the roadway section length.
Travel direction	Enter the direction of general travel at beginning.
Data collector	Enter the initials or name of the person collecting the data.
Posted speed limit	Enter the posted speed limit in mph.
No. of Lanes	Number of traffic lanes.
Rdwy. Width	Roadway width.
Shoulder Width	Enter the width of the shoulder.
Curve Length	Enter the length of the curve.
Curve Radius	Enter the curve radius.
Tangent Length	Enter the tangent length between curves.

Roadway Characteristics

Roadway characteristics generally describe the roadway being inventoried. This information needs to be entered only for the first sheet of a segment if multiple sheets are necessary. Some segments will have more than one characteristic — hard surfaced shoulder for a short distance, for example. Where this occurs, choose the predominant characteristic to describe the segment. Indicate this type of condition change in the data entry area.

Classification The functional classification of the roadway. This information is available from the TransAid Division of WSDOT, who have roadway functional classifications for each agency in the State of Washington. If not certain of the classification while in the field, mark the sheet(s) and research the data in the office.

Number of lanes Enter the predominant number of lanes for the roadway segment. Do not include turn lanes unless they are continuous through the segment. Choose the number that best describes the section of roadway.

Curb and gutter Enter the type of curb, if present, within the segment. Leave blank if no curb is present. If curb is present, check the applicable box for the predominant type. Also, check whether the curb is mountable (curb height less than 6 inches) or if a traffic barrier is present.

Roadway width Enter the predominant width of the roadway segment. Do not include turn lanes unless they are continuous.

Shoulder width Enter shoulder type and width.

Drainage Enter the predominant type of drainage present on the segment. If no drainage is present, choose “none.”

Non-Motorized Facility Enter the predominant type of sidewalk if present. If not, choose none.

Pavement Markings Select the type of pavement markings present within the segment. Check all applicable boxes.

Data Entry Area

All roadside object data is entered in this area. The purpose of this collection effort is to locate all roadside objects, referencing their locations in one of several ways: GPS coordinates, log number and milepoint, distance from point of beginning, lateral distance from the centerline, or where applicable, from a known object such as an outer curb, or the edge of a shoulder or pavement.

Roadside objects located within the right-of-way come in many shapes and sizes. Common fixed objects are utility poles, trees, boulders and fire hydrants. Additionally, there are many features which are part of the roadway system itself: sign posts, bridge rail, guardrail, bridge piers, abutments, luminaire poles, buildings and other immovable or non-breakaway objects are considered fixed roadside objects.

Certain features of the terrain can also be considered roadside features and are included in the inventory. For example embankment slopes steeper than 3:1 are inventoried.

The last entry should be the inventory ending point — at the centerline of the cross street at the end of the segment or at another location as applicable.

Roadside feature codes This box contains all desired features to be inventoried and their applicable one-, two- or three-letter code references.

Location This entry should be a GPS coordinate, a mile point or distance from the point of beginning in feet or miles, measured to three decimals.

Code This entry is the one-, two-, or three-letter code from the Roadside Feature Code box on the left side of the sheet.

Distance CL, L, or R This entry is for the distance in feet from the centerline of the roadway to the feature object, and indication of left or right from direction of inventory survey.

Offset This entry is for the distance in feet behind or outside of a known object such as the back of a curb, the edge of the pavement, the back of the sidewalk, or other roadway feature of absolute nature not likely to change with time.

From This entry is the identification of the known object from which the offset is measured.

Notes

All notes pertaining to an object and field observations should be entered here. These will include notes described in the obstacle codes section. More than one line may be used for long notes.

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Safety Management System Roadway Inventory

	Date	Data Collected By:

Roadway Name or Number	Beg. M.P.	Sheet ____ of ____	
Cross Road or Starting Point	End M.P.	Length	Travel Dir.

Post.Spd Lmt mph	No. of Lanes	Rdwy Width	Shoulder Width	Curve Length	Curve Radius	Tangent Length

Roadway Characteristics

- Classification
  - ☐ Urban
  - ☐ Rural
  - ☐ Principal Arterial
  - ☐ Minor Arterial
  - ☐ Collector
  - ☐ Local Access
- Curb and Gutter
  - ☐ Cast in Place
  - ☐ Extruded
  - ☐ Barrier
  - ☐ Mountable
- Shoulder
  - ☐ Hard Surface
  - ☐ Gravel
- Drainage
  - ☐ Ditch
  - ☐ Buried
  - ☐ None
- Non-Motorized Fac.
  - ☐ Concrete
  - ☐ Asphalt
  - ☐ Gravel
  - ☐ Other
  - ☐ None
- Pave. Markings
  - ☐ Centerline
  - ☐ Edgeline
  - ☐ RPMs

Location	Code	Dist. ℄ (L or R)	Offset From...	Notes

Roadside Feature Codes

P - Poles
- **PLB** - Luminaire Pole-Breakaway
- **PLR** - Luminaire Pole-Rigid Base
- **PS** - Signal Pole
- **PU** - Utility Pole
- **PF** - Fence Pole
- **PUG** - Ut. Pole Guy Wire
- **PMB** - Mailbox (Non Breakway)

G - Guardrail
- **GWB** - Wood Beam
- **GTB** - Thrie Beam
- **GS** - Beam (Std)
- **GC** - Cable
- **GB** - Barrier

B - Bridge
- **BA** - Apron Rail
- **BP** - Piers/Abuts/Columns
- **BW** - Wing Walls
- **BO** - Other Elements

ST - Structure
- **RW** - Retaining Wall
- **MUS** - Misc. Utility Structure
- **BLG** - Building
- **F4** - Foundation 4”-10” high
- **F10** - Foundation >10” high
- **CS** - Square Culvert Ends
- **IS** - Irrigation Structure
- **HYD** - Hydrant
- **CC** - Signal Control Cabinet

S - Signs
- **SR** - Regulatory
  - **SRB** - Breakaway Pole
  - **SRN** - Non Breakaway
- **SW** - Warning
  - **SWB** - Breakaway Pole
  - **SWN** - Non Breakaway
- **SG** - Guide
  - **SGB** - Breakaway Pole
  - **SGN** - Non Breakaway
- **SN** - Non Motoring
  - **SNB** - Breakaway Pole
  - **SNN** - Non Breakaway
- **SRR** - Railroad Crossbuck

C - Curbs/Slope/Ditches
- **C6** - (Curb 6”-10” high)
- **C10** - (Curb >10” high)
- **D4** - Drop-off 4”-10”
- **D10** - Drop-off >10”
- **SSC** - Side Slope - Cut
- **SSF** - Side Slope - Fill
- **DPOB** - Ditch (Point of Begin)
- **DPOE** - Ditch (Point of End)

T - Trees (all above 4”)
- **T4** - d=>4”<10”
- **T10** - d=>10”

RB - Rock/Boulder/Rip Rap

WF - Water Feature
- **LSR** - Lake/Stream/River
- **PND** - Pond
- **WTLD** - Wetland

OTH - Other

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Washington State Department of Transportation

Sheet ______ of ______

Location	Code	Dist. ℄ L or R	Offset From	Notes

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Appendix E — Collision Work Sheet

The Collision Work Sheet is divided into four sections:

1. **Study Identification Information**
2. **Collision Count Data**
3. **Collision Type Summary Information**
4. **Traffic Exposure and Collision Rate Calculations**

Study Identification Information

- Fill in:

Agency (unlabeled):	The agency name.
Prepared by:	Name of the person preparing this data sheet.
Date:	Date the data sheet is prepared.
Study Location:	Intersection or location identifier name
Beg. M.P.	Beginning milepost location of study site (Road Log milepost if applicable)
End M.P.	Ending milepost location of study site (Road Log milepost if applicable)
Study period	Time in years that collision data covers.

Location Data

- Check if:

Urban	the location is in a federally designated Urban area.
Rural	the location is NOT in a federally designated Urban area.
Principal Arterial	the street or roadway is federally functionally classified as an principal arterial, based on the official maps published by WSDOT.
Minor Arterial	the street or roadway is federally functionally classified as a minor arterial based on the officials mpas published by WSDOT.

Collector	the street or roadway is federally functionally classified as a Collector, based on the official maps published by WSDOT.
Local Access	the street or roadway is federally functionally classified as a Collector, based on the official maps published by WSDOT.
One-Way	the street or roadway is marked one-way and traffic is required to operate in only one direction.
Two-Way	the street or roadway operates in two directions.
Lt-Turns OK	left turns are permitted.
Lt-Turn Lne	there is a designated and marked left turn lane.
1-Lane	the street or roadway has only one usable and/or striped lane.
2-Lane	the street or roadway has two usable and/or striped lanes.
4-Lane	the street or roadway has four usable and/or striped lanes.
Multi-Lane	the street or roadway has more than four usable and/or striped lanes.
Park 1 Side	parking is permitted on one side only.
Park 2 Side	parking is permitted both sides.
Non-I/S	the location is NOT at an Intersection.
I/S	the location is at an Intersection.
I/S Stop Sign	the location is a Stop Sign controlled intersection.
I/S Signal	the location is a Traffic Signal controlled intersection.

Collision Count Data

The Collision Count data must be summarized into the categories noted for each year of the study, the total for one year before, and the total for two years before. The years may be calendar years or selected years. For example, if the current date is July 15, 1996, the years may run July 16, 1995 to July 15, 1996 for the current year, July 16, 1994 to July 15, 1995 for one year before, etc. The three categories, as noted on the collision records, are:

1. Number of Fatal Collisions (where a fatality occurred)
2. Number of Injury Collisions (where an injury of any type, excluding fatalities occurred)
3. Number of Property Damage Only Collisions (where the only damage was to the vehicle or other property)

Collision Types Summary

The collisions in the study area for the entire study period must also be summarized by Collision Type, as noted on the collision records. The Collision Type is the one most predominant in the collision. The nine basic categories are:

1.	Right Angle	Vehicles collided at Right Angles (typically at an intersection or driveway).
2.	Side Swipe-opp	Vehicles side swiped — opposite directions
3.	Side Swipe-same	Vehicles side swiped — same direction
4.	Rear End	Vehicle collided with Rear End of another vehicle
5.	Head On	Vehicles collided Head On
6.	Approach Turn	Vehicles collided where one vehicle was turning into mainline traffic from a side approach.
7.	Fixed Object	Vehicle(s) collided with a Fixed Object
8.	Backing	Collision occurred while vehicle(s) were Backing
9.	Bike/Ped	Collision involved a Bicycle or Pedestrian
10.	Other	All Other Collisions

Observation Notes

This section provides an opportunity to make specific notes about causal factors in the collision.

Calculate Traffic Exposure, M

- Select the type of collision site (e.g., Intersection, Spot location, or Roadway section), by checking the appropriate box.
- Fill in the ADT data and calculate the total traffic entering the study location. Place the total in the box labeled “Total ADT.”
- Fill in the box labeled "Study Period" from the area at the top right corner of the page.
- Multiply total ADT X Section Length X 0.000365 X Study Period, and place the value in the box labeled “Traffic Exp., M.”

Note:

Intersection	at an Intersection location
Spot Location	a Spot Location if less than 0.10 miles in length
Roadway Section	a Section Location if it exceeds 0.10 miles in length
ADT	Average Daily Traffic at the location, based on standard traffic count data, or estimate
Major Road ADT	ADT on the primary or ‘Major’ street or road at an intersection location, based on standard traffic count data, or estimate
Minor Road ADT	ADT on the cross or ‘Minor’ street or road at an intersection location, based on standard traffic count date, or estimate. (This is zero for spot locations and roadway sections.)
Section Length	Length in miles and tenths of miles in a section location. (This is assumed to be one (1) unit in the general expression for intersections and spot locations.)
Traffic Exposure, M	Millions of vehicles entering an intersection or a spot location Millions of vehicle miles on a roadway section

Calculate the Collision Rate, R

- Calculate 1/M and fill in the box located below the Traffic Exposure Box.
- Plug in the Total Collisions previously calculated in the Collision Count Data Section.
- Then multiply the Box 1/M X the Total Collisions Box and write the value in the box labeled “Collision Rate, R”

Note:

Total Collisions	The Total number of collisions of all types at the identified location
Collision Rate	Collisions per million of vehicles entering an intersection or a spot location Collisions per millions of vehicle miles on a roadway section

Calculate the Critical Collision Rate

- Using the equation at the bottom of the section, write in the System wide Collision Rate for your agency in the two boxes labeled R_a.
- Copy the figure 1/M from the Collision Rate Calculation into the two boxes labeled in the equation
- Carry out the calculation and write the value in the box labeled “Critical Coll. Rate, R_c”

Determine if the Study Location Collision Rate is Above the Critical Collision Rate

- Simply compare the Collision Rate to the Critical Rate calculated
- Check the appropriate response to the question at the bottom of the page.

Safety Management System
Collision Work Sheet

	Prepared By	Date

Study Location	Beg. MP	Ending MP	Study Period T = Yrs.

Location Data (Check all appropriate boxes.)

☐ Urban	☐ Principal Arterial	☐ One-Way	☐ 1-Lane	☐ Multi-Lane	☐ Non-I/S
☐ Rural	☐ Minor Arterial	☐ Two Way	☐ 2-Lane	☐ Park 1 Side	☐ I/S
	☐ Collector	☐ Lt-Turns Okay	☐ 4-Lane	☐ Park 2 Side	☐ I/S Stop Sign
	☐ Local Access	☐ Lt-Turn Lane			☐ I/S Signal

Collision Count Data

	No. of Fatal Accidents		No. of Injury Accidents		No. Fatal and Injury Accidents		No. PDO Accidents		
Current Year		+		=					
1-Year Fatal		+		=					
2-Year Fatal		+		=					
3-Year Fatal		+		=					
4-Year Fatal		+		=					
5-Year Fatal		+		=					
					Total F&I	+	**Total PDO**	=	**Total Collisions**
					Avg. Annual F&I	+	**Avg. Annual PDO**	=	**Tot. Annual Collisions**

Collision Types Summary *(No. in each category)*

		Observation Notes
Rt Angle	______	
Side Swipe - Opp.	______	
Side Swipe - Same	______	
Rear End	______	
Head On	______	
Approach Turn	______	
Fixed Object	______	
Backing	______	
Bike/Ped	______	
Other ______	______	

Traffic Exposure and Collision Rate

Choose One	Major Rdwy, ADT V1		Minor Rdwy, ADT V2		Total ADT * V		Section Length			Study Period		**Traffic Exp., M**
☐ Intersection							1					
☐ Spot Location		+	0	=		x	1	x 0.000365	x		=	
☐ Section			0									1/M

1/M [ ] x Total Collisions [ ] = **Collision Rate, R** [ ]

***Note:** ADT is the average traffic entering the study location. This can be assumed to be the sum of the ADT on each leg divided by 2.

Systemwide Coll. Rate, R_a [ ] + 2.0 x $\sqrt{(R_a \times 1/M)}$ - (0.5 x 1/M) = **Critical Coll. Rate, Rc** [ ]

Does this location exceed the Critical Factor? ☐ **No** ☐ **Yes**

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Like the Collision Work Sheet, the Safety Benefit Work Sheet is divided into four sections:

1. **Study Identification Information**
2. **Summary Information**
3. **Benefit Calculations**
4. **Cost Calculations**

Study Location Information

Fill in:

Agency	The agency name.
Study Location	Intersection or Location Identifier Name
Beginning M.P.	Beginning milepost location of Study Site
Ending M.P.	Ending milepost location of Study Site.
Scenario	Number identifying this particular trial.
Comments	Any notes you want to attach to the calculations
Prepared by	Name of the person preparing this data sheet.
Date	Date the data sheet is prepared.

Summary Information

First, fill in:

Collision Type	Type of collision countermeasure will address
Countermeasure	Countermeasure(s) being analyzed
E_k	Service Life Factor from Table A
G	Growth Rate from Table B
Reduction Factor, R	Reduction Factor for F&I from Table A (if more than one countermeasure, see below)
Reduction Factor, R_p	Reduction Factor for PDO from Table A

R/W Cost — Total estimated cost of right of way need to implement the countermeasure ($ in thousands)

Initial Cost — Total estimated capital cost to construct/ implement the countermeasure ($ in thousands)

O&M Cost — Estimated annual cost to operate and maintain the countermeasure ($ in thousands)

Next, ***if more than one countermeasure is evaluated***, calculate the following for each of the proposed countermeasures:

Reduction Factor, r — Modified F&I Reduction Factor for multiple countermeasures; (r = 1 - 0.01 R)

Reduction Factor, rp — Modified PDO Reduction Factor for multiple countermeasures; (r = 1 - 0.01 R_p)

Calculate the Total Initial Cost in Box I

Calculate the Total O&M Cost in Box O

Benefit Calculations

The first step is to calculate the total reduction factors for Fatalities and Injuries (F&I) and Property Damage Only (PDO) for the countermeasure(s). For a single countermeasure, they are R and R_p. Simply transfer the appropriate values from the Summary Information Section to the lines labeled "Total R" and "Total R_p" in the calculation expression just below the matrices. For multiple countermeasures, use the F&I and PDO Calculations matrices.

Using the F&I Calculations Matrix for Multiple Countermeasures

- Transfer the three greatest R values from the Summary Information Section to the left column of the matrix. Start with the greatest R value and work down the column. That is, place the largest R in R_1, the second largest in R_2, and the third largest in R_3. Likewise, transfer the corresponding r values to the labeled locations.
- Multiply across the rows and put the value on the line at the right of the matrix.
- Add the values in the right column and place the sum in the box Total R at the bottom of the matrix.

In the mathematical expression just below the matrix:

1. Fill in the Annualized weighted cost for fatal and injury collisions, Q, for the roadway (in thousands of $).

2. Fill in the average annual F&I from the Collision Count Data Section of the Collision Work Sheet.
3. Multiply Q x Average Annual F&I × Total R and place the value in Box A1

Using the PDO Calculations Matrix for Multiple Countermeasures

The process for calculating the total PDO Reduction Factor using the PDO Calculation Matrix is identical to that used for the F&I Total Reduction Factor.

For the PDO Calculations, transfer the three greatest Rp values form the Summary Information Section to the left column of the matrix. Start with the greatest R_p value and work down the column. That is, place the largest Rp in R_{p1}, the second largest in R_{p2}, and the third largest in R_{p3}. Likewise transfer the r_p values to the labeled locations.

Multiply across the rows and put the value on the line at the right of the matrix.

Add the values in the right column and place the sum in the box Total R_p at the bottom of the matrix.

In the mathematical expression just below the matrix:

1. Fill in the P_c value (in thousands of $)

2. Fill in the Average Annual PDO from the Collision Count Data Section of the Collision Work Sheet.

3. Multiply $P_c \times$ Average Annual PDO × Total R and place the value in Box A2

Add Boxes A_1 and A_2. Place the value in Box $A_1 + A_2$. From Table B, place the Growth Factor in the box labeled “Growth Factor.” Multiply Box $A_1 + A_2$ × the Growth Factor and place in Box B, Adjusted Benefit.

Cost Calculations

In the mathematical expression:

1. Fill in the box labeled E_k from Table A

Note: Selected by either the most predominent E_k, a weighted average, or another method derived by the agency. Whatever method is used it should be used consistently to ensure a proper relative ranking.

2. Transfer the value from Box I to the box labeled “Initial Cost”

3. Multiply $E_k \times$ Initial cost and place the value in the box next to the = sign.

4. Transfer the value from Box O to the box labeled O&M Cost.

5. Multiply the previous product times the O&M Cost and place the value in Box C labeled "Total Cost."

B/C Calculation

Simply divide Box B by Box C and place the value in the Box labeled "B/C Ratio."

Safety Benefit Index

Divide the B/C Ratio by Q, multiply by 100 and place in the box labeled "Safety Benefit Index."

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Safety Management System
Safety Benefit Work Sheet

Agency	Study Location	Beginning MP Ending MP	Scenario
Comments		Prepared By	Date

Summary Information

Collision Type	Countermeasure	R_i*	Individual Reduction Factor				Annual Costs (in thousands)		
			R_i*	r	R_i*	rp	R/W + Improv. =	Initial	O&M

* From Table A

Box I Box C

Benefit Calculations

FSI Reduction Factor Calculations - *From Summary Above*

List Greatest 3 - Largest to Smallest

R_1 ______ =

R_2 ______ x r_1 ______ = ______

R_3 ______ x r_2 ______ x r_1 ______ =

PDO Reduction Factor Calculations - *From Summary Above*

List Greatest 3 - Largest to Smallest

R_{p1} ______ =

R_{p2} ______ x r_{p1} ______ = ______

R_{p3} ______ x r_{p2} ______ x r_{p1} ______ = ______

[ ] x [ ] x Total R = Box A_1

C (in thousands) x Avg Annual FSI (From Collision Worksheet) x Total R = Box A_1

PC (in thousands) x Avg Annual Total PDO (From Collision Worksheet) x Total Rp = Box A_2

Growth Factor (From Table B) x Total Benefit (Box A_1 + A_2) = Adjusted Benefit (Box B)

Cost Calculations

S_r (From Table A) x Total Initial Cost (From Box I) - [ ] - Total O&M Cost (From Box C) = Total Cost (Box D)

Safety Benefit Index Calculation

Adj. Benefit (Box B) / Total Cost (in thousands) x 100 = **Safety Benefit Index**

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Table A

Urban or Rural	Number of Lanes	Type of Improvement	Capital Recovery Factor	Fatality & Injury Reduction Percent		PDO Accident Reduction Percent	
			E_k	R	r	R_p	r_p
		INTERSECTIONS					
R	2	Add Stop Signs on Minor Leg	0.237	0.80	0.20	0.65	0.35
U	2	Add Stop Signs on Minor Leg	0.237	0.70	0.30	0.50	0.50
U	Multi	Add Stop Signs on Minor Leg	0.237	0.20	0.80	0.40	0.60
U	2	Add Stop Signs of All Legs	0.237	0.65	0.35	0.70	0.30
R	Multi	Add Right Turn Lane	0.135	0.40	0.60	0.10	0.90
U	Multi	Add Right Turn Lane	0.135	0.40	0.60	0.10	0.90
R	2	Add Left Turn Lane	0.135	0.80	0.20	0.20	0.80
U	2	Add Left Turn Lane	0.135	0.80	0.20	0.20	0.80
U	Multi	Add Left Turn Lane	0.135	0.55	0.45	0.05	0.95
U	Multi	Add Left Turn Lane (T Intersection)	0.135	0.60	0.40	0.50	0.50
U	2	Add Left Turn Lane (T Intersection)	0.135	0.80	0.20	0.80	0.20
R	2	Add Left Turn Lane (Y Intersection)	0.135	0.05	0.95	0.35	0.65
R&U	All	Increase Radii at Intersection	0.135	0.25	0.75	0.25	0.75
R&U	All	Add Traffic Signals	0.102	0.50	0.50	0.30	0.70
U	Multi	Add Left Turn Signals (No Left Turn Lane)	0.102	0.55	0.45	0.40	0.60
R&U	All	Modify Traffic Signals	0.102	0.30	0.70	0.30	0.70
R&U	All	Interconnect Traffic Signals	0.102	0.30	0.70	0.30	0.70
U	2	Add Pedestrian Signals	0.102	0.55	0.45	0.15	0.85
U	Multi	Add Pedestrian Signals	0.102	0.40	0.60	0.05	0.95
R	Multi	Ramp Metering	0.102	0.45	0.55	0.45	0.55
U	Multi	Ramp Metering	0.102	0.45	0.55	0.45	0.55
U	Multi	Install Flashing Warning Signals	0.135	0.30	0.70	0.50	0.50
R	2	Install Flashing Warning Signals	0.135	0.30	0.70	0.50	0.50
R	Multi	Install Flashing Warning Signals	0.135	0.15	0.85	0.20	0.80
R	Multi	Add Flashing Beacons at RR Crossing	0.135	0.50	0.50	0.80	0.20
U	Multi	Add Flashing Beacons at RR Crossing	0.135	0.50	0.50	0.80	0.20
U	All	Illuminate Intersection or RR Crossing	0.135	0.15	0.85	0.20	0.80
		MEDIAN					
U	Multi	Painted or Raised	0.135	0.10	0.90	0.10	0.90
U	Multi	Concrete Median Barrier	0.087	0.60	0.40	0.60	0.40
		SIGNING					
R	2	Install Advance Warning Signs	0.135	0.30	0.70	0.35	0.65
R	Multi	Install Advance Warning Signs	0.135	0.05	0.95	0.20	0.80
U	2	Install Advance Warning Signs	0.135	0.15	0.85	0.15	0.58
U	Multi	Install Advance Warning Signs	0.135	0.20	0.80	0.20	0.80
R	2	Install Stop Ahead Sign	0.237	0.80	0.20	0.45	0.55
U	2	Install Yield Sign	0.237	0.80	0.20	0.60	0.40
		DELINEATION					
U	Multi	Double Yellow Line	0.545	0.05	0.95	0.05	0.95
R	Multi	Reflectorized Raise Pavement Marking	0.237	0.05	0.95	0.05	0.95
U	Multi	Reflectorized Raise Pavement Marking	0.237	0.05	0.95	0.05	0.95
R	2	Edge Marking	0.545	0.15	0.85	0.15	0.85

Table A (Continued)

Urban or Rural	Number of Lanes	Type of Improvement	Capital Recovery Factor	Fatality & Injury Reduction Percent		PDO Accident Reduction Percent	
			E_k	R	r	R_p	r_p
R&U	All	Guide Posts on Curve	0.237	0.25	0.75	0.25	0.75
		ROADWAY					
R	2	Widen Traveled Way	0.087	0.30	0.70	0.40	0.60
R	2	Widen Shoulders	0.087	0.05	0.95	0.00	1.00
U	Multi	Eliminate Parking (Signing Necessary)	0.087	0.05	0.95	0.30	0.70
R&U	All	Construct Grade Separation	0.087	0.60	0.40	0.60	0.40
R	All	Add Two Way Left Turn Lane	0.087	0.50	0.50	0.50	0.50
U	All	Add Two Way Left Turn Lane	0.087	0.50	0.50	0.50	0.50
R&U	All	Widen Bridge (Minimum Six Feet)	0.087	0.60	0.40	0.60	0.40
R&U	All	Reconstruct Road and Shoulders	0.087	0.35	0.65	0.35	0.65
R	2	Reconstruct Curve	0.087	0.80	0.20	0.80	0.20
R	Multi	Construct Interchange	0.087	0.30	0.70	0.30	0.70
U	Multi	Construct Interchange	0.087	0.30	0.70	0.30	0.70
R	Multi	Pavement Grooving	0.237	0.15	0.85	0.25	0.75
U	Multi	Pavement Grooving	0.237	0.15	0.85	0.25	0.75
R	2	Install Rumble Strips	0.087	0.25	0.75	0.25	0.75
R	Multi	Lengthen Acceleration Lane	0.087	0.50	0.50	0.50	0.50
U	Multi	Lengthen Acceleration Lane	0.087	0.50	0.50	0.50	0.50
R	Multi	Extend Drop Lane (Beyond Exit)	0.087	0.40	0.60	0.40	0.60
U	Multi	Extend Drop Lane (Beyond Exit)	0.087	0.40	0.60	0.40	0.60
		MISCELLANEOUS					
R&U	All	Illuminated Terminal Nosing	0.102	0.25	0.75	0.25	0.75
R&U	All	Guard Rail at Embankments	0.135	0.20	0.80	0.20	0.80
R&U	All	Guard Rail at Bridge Ends, Abutements, Piers, Steel Sign Posts	0.135	0.50	0.50	0.35	0.65
R	2	Flatten Side Slopes	0.087	0.20	0.80	0.20	0.80
U	2	Flatten Side Slopes	0.087	0.20	0.80	0.20	0.80
R&U	All	Energy Absorption Devices	0.135	0.50	0.50	0.20	0.80
R&U	All	Breakaway Sign Posts and Illumination Poles	0.135	0.50	0.50	0.00	1.00

Table B

(1+G)

Calculation Chart

TGR	LIFE (in years)					
	5	**10**	**15**	**20**	**25**	**30**
1.01	1.0255	1.0523	1.0805	1.1101	1.1412	1.1739
1.02	1.0520	1.1095	1.1729	1.2430	1.3203	1.4057
1.03	1.0796	1.1720	1.2790	1.4031	1.5469	1.7136
1.04	1.1083	1.2401	1.4005	1.5956	1.8329	2.1217
1.05	1.1381	1.3144	1.5395	1.8266	2.1932	2.6610
1.06	1.1691	1.3954	1.6983	2.1036	2.6459	3.3717
1.07	1.2013	1.4836	1.8795	2.4348	3.2137	4.3061
1.08	1.2347	1.5795	2.0861	2.8305	3.9242	5.5313
1.09	1.2693	1.6837	2.3212	3.3022	4.8115	7.1338
1.10	1.3053	1.7969	2.5886	3.8637	5.9174	9.2247
1.11	1.3425	1.9197	2.8923	4.5312	7.2927	11.9461
1.12	1.3812	2.0529	3.2368	5.3231	9.0000	15.4800
1.13	1.4212	2.1973	3.6271	6.2615	11.1153	20.0579
1.14	1.4627	2.3536	4.0690	7.3717	13.7310	25.9751
1.15	1.5057	2.5228	4.5685	8.6833	16.9595	33.6059
1.16	1.5502	2.7057	5.1328	10.2304	20.9371	43.4249
1.17	1.5962	2.9034	5.7694	12.0528	25.8289	56.0323
1.18	1.6439	3.1169	6.4869	14.1965	31.8343	72.1853
1.19	1.6932	3.3473	7.2948	16.7147	39.1940	92.8377
1.20	1.7442	3.5959	8.2035	19.6688	48.1981	119.1882
1.21	1.7969	3.8637	9.2247	23.1296	59.1954	152.7408
1.22	1.8514	4.1523	10.3711	27.1788	72.6051	195.3789
1.23	1.9077	4.4630	11.6570	31.9103	88.9296	249.4564
1.24	1.9658	4.7972	13.0978	37.4321	108.7710	317.9100
1.25	2.0259	5.1566	14.7109	43.8681	132.8489	404.3968

If TGR > 1.25, use the following equation:

$$(1 + G) = \frac{(TGR)^{LIFE} - 1}{2} + 1$$

The information below and on the following pages was taken from the 1978 edition of the *Informational Guide for Highway Safety Improvements* by the Washington Traffic Safety Commission. Reprinted with permission.

Data Requirements

One of the most important parts of any management system is the evaluation of its performance. How well did the solutions work and how effective were the decisions the system supported? For the SMS, emphasis should be placed on the need for good documentation of all the steps taken for identifying high collision locations; selecting and evaluating alternative improvements; prescribing and implementing a particular improvement; and predicting results. This information will be needed when evaluating after-implementation results.

Specifically, the evaluation should reflect:

What type of improvement or program was installed or implemented?

Where was it installed?

When was it installed/implemented?

Which agency installed the improvement or administered the safety program?

What was the implementation cost?

What was the prior collision data?

What was the prior ADT?

How was the problem diagnosed?

Why was this improvement selected?

What results were predicted?

What is the after collision data?

What is the after ADT?

Figure 8-3 is an example of the kind of safety improvement evaluation report that can be used by local agencies. These evaluation reports can then be used by the agency to produce summaries and statistics on before and after collision data. Local agencies should consider maintaining a copy of this report to periodically evaluate benefits.

Safety Management System
Countermeasure Evaluation Worksheet

F.A. Project Number	Contract Number

Road Name or Number	Beginning MP	Ending MP
Cross Road or Starting Point	Const. Start Date	Full Operational Date

Location Data (Check all appropriate boxes.)

- ☐ Urban
- ☐ Rural
- ☐ Principal Arterial
- ☐ Minor Arterial
- ☐ Collector
- ☐ Local Access
- ☐ One-Way
- ☐ Two-Way
- ☐ L-Turns Daily
- ☐ L-Turn Lane
- ☐ 1-Lane
- ☐ 2-Lane
- ☐ 4-Lane
- ☐ Multi-Lane
- ☐ Park 1 Side
- ☐ Park 2 Side
- ☐ Non-I/S
- ☐ I/S
- ☐ I/S Stop Sign
- ☐ I/S Signal

Loc. Type
- ☐ Intersection
- ☐ Spot
- ☐ Section

Evaluation
- ☐ Prelim.
- ☐ Final

Analysis Period
- ☐ 1 Year
- ☐ 2 Year
- ☐ Other ____________

Countermeasure(s)

Before Information From (M/Y) ________ To (M/Y) ________ | Prepared By

After Information From (M/Y) ________ To (M/Y) ________ | Prepared By

Collision Summary

	Before	After	Difference
Right Angle	______	______	______
Sideswipe - Opposite	______	______	______
Sideswipe - Same	______	______	______
Rear-End	______	______	______
Head-On	______	______	______
Approach Turn	______	______	______
Hit Fixed Object	______	______	______
Backing			
Bike/Pedestrian			
Other			

	Average Before Data	Expected After Data W/O Improv.	Average After Data	Difference From Expected	Significance 95% Conf. Level
Property Damage Collisions	______	______	______	______	______
Injury Collisions	______	______	______	______	______
Fatal Collisions	______	______	______	______	______
Total Collisions	______	______	______	______	______
Persons Injured	______	______	______	______	______
Number of Fatalities	______	______	______	______	______
Amount Property Damage	______	______	______	______	
Property Damage per Collision					
Total Economic Loss					
AADT (Avg. Ann. Daily Traffic)					
Fatality Rate*	______	______	______	______	
Collision Rate**	______	______	______	______	
Special Collision***	______	______	______	______	

Note: -- = Decrease or less than expected
+ = Increase or more than expected
* Fatality Rate is Fatalities per 100 million vehicle miles
** Collision Rate is Collisions per million vehicle miles
*** Special Collision of irregular nature or special interest

LAG Form [illegible]
7/97

Basis for Comparison

The most common method of evaluating improvement effectiveness is the before-after study. Before-after studies compare the collision experience of a location before and after an improvement is installed. These comparisons are normally made in terms of total collisions and collision types. The basis for measurement is the change between the before-and-after improvement collision data. Comparisons can also be made in terms of percentage changes. For meaningful results in both methods, adjustments should be made for both time periods and changes in traffic volumes.

A before-and-after study may be run for each safety improvement project submitted when one year of collision experience is available for the “after” period. “Before” collision data is obtained from the collision data system. An annual average of 2 years” collision data is used for the one year before data. This is compared to one year after data. The second year after completion, another comparison may be made using an annual average of 2 years of “after” data.

If the ADT's of the before and after periods are different, determine the ADT ratio by dividing the average “after” ADT by the average “before” ADT. Adjust all “before” collision numbers by multiplying them by the ADT ratio. The adjusted “before” collision data becomes the normal expected “after” data without considering changes due to a safety project. The expected “after” data is compared with the actual “after” data for a meaningful comparison.

Significance of Results

Assuming that the “before” and “after” data are comparable, the decision as to whether or not there was any improvement or change in traffic characteristics is usually based upon comparing averages, totals, or percentages in the two studies. When the two comparative figures differ markedly, there is not much of a problem deciding whether or not there was a change. But where the difference is small, there is always a question of whether or not the change is due to the chance variation in data and, therefore, not significant.

Tests may be employed to determine whether the results at a particular location (or group of locations) are truly statistically significant. One test assumes that the distribution of collisions at a location has the general characteristics of a Poisson distribution. The second accepted test for this type of data is the chi-square method. These tests are illustrated graphically by the curves in Figures 8-1 and 8-2. The chi-square curves relate the expected “after” data without improvement to the actual “after” data. The Poisson curves relate the expected “after” data without improvement to the percent reduction in the actual after improvement data.

The Poisson curves in Figure 8-1 are designed to assure a 95 percent level of confidence that the collision reduction was significant. This means there is only a 5 percent probability that the reduction occurred merely by chance. A 95 percent level of confidence is considered generally acceptable for the Poisson test. The lower of the two curves reflects a liberal test of significance — the upper curve, a more conservative test.

The chi-square curves in Figure 8-2 are more conservative than the curves shown in Figure 8-1. The 80 percent level of confidence approximates a 95 percent Poisson distribution test and the 90 percent level of confidence (or the chi-square approximates a 95 percent Poisson comparison of the mean.) An 85 percent level of confidence is considered generally acceptable for the chi-square test.

The test for statistical significance of collision data using the Poisson test in Figure 8-1, requires computing the percentage change between the actual "before" data (or the "before" data adjusted by the expected "after" Average Annual Daily Traffic) and the actual "after" data. Using the computed percentage and the "before" collisions, find the intercept of the two values on the chart. The location of this point above or below the selected curve will determine the significance of the data. In the chi-square test, the expected "after" data and the actual "after" data values are used.

The last part of Figure 8-3 is a suggested format for comparing the "before" and "after" collision data at the locations that the countermeasure(s) were placed. Figures 8-1 and 8-2 are provided to assist in verifying that the change is due to the effects of the countermeasure taken than by chance. Extra spaces are provided for comparing special collision types or conditions if they provide a better measurement of the improvement.

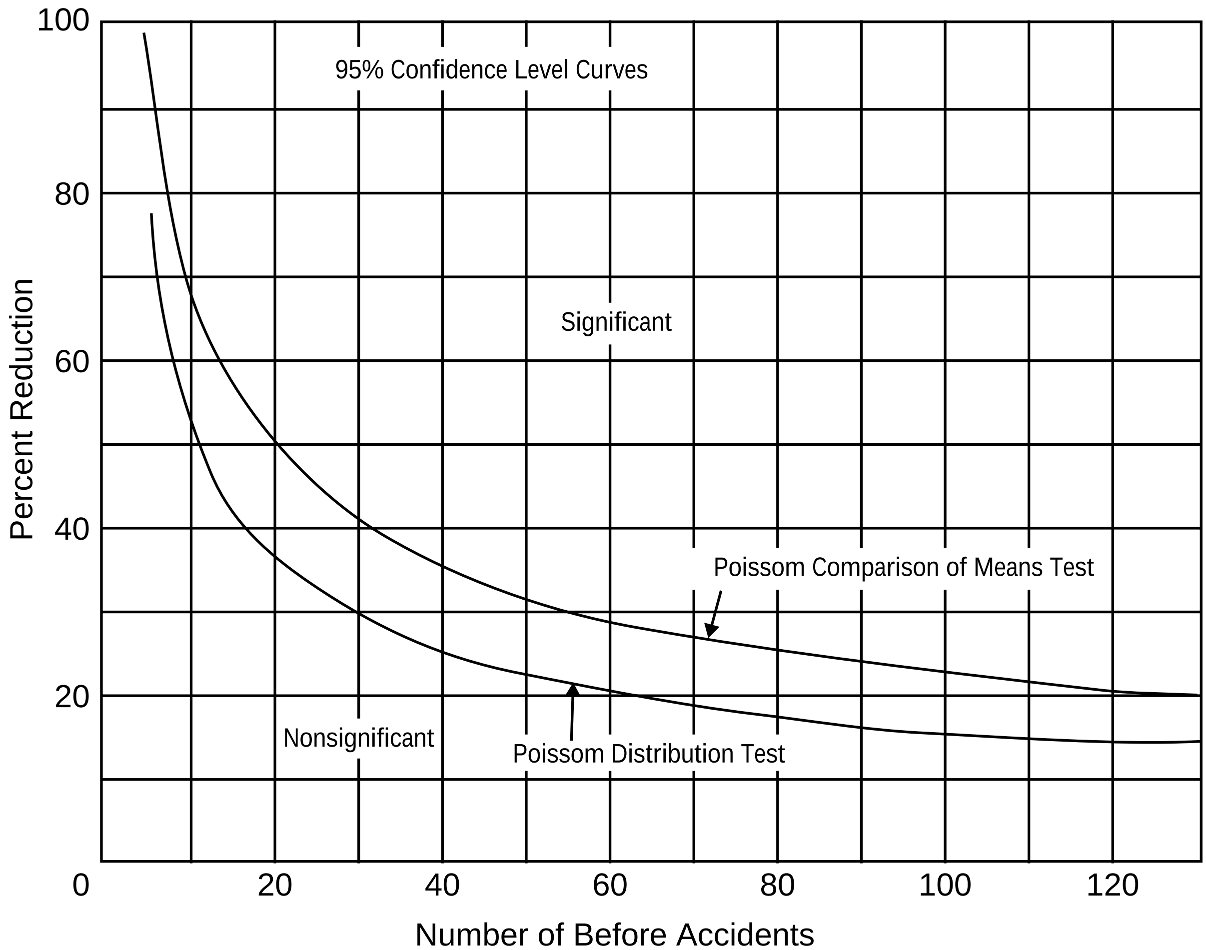


Figure 8-1
Poisson Tests for Significance

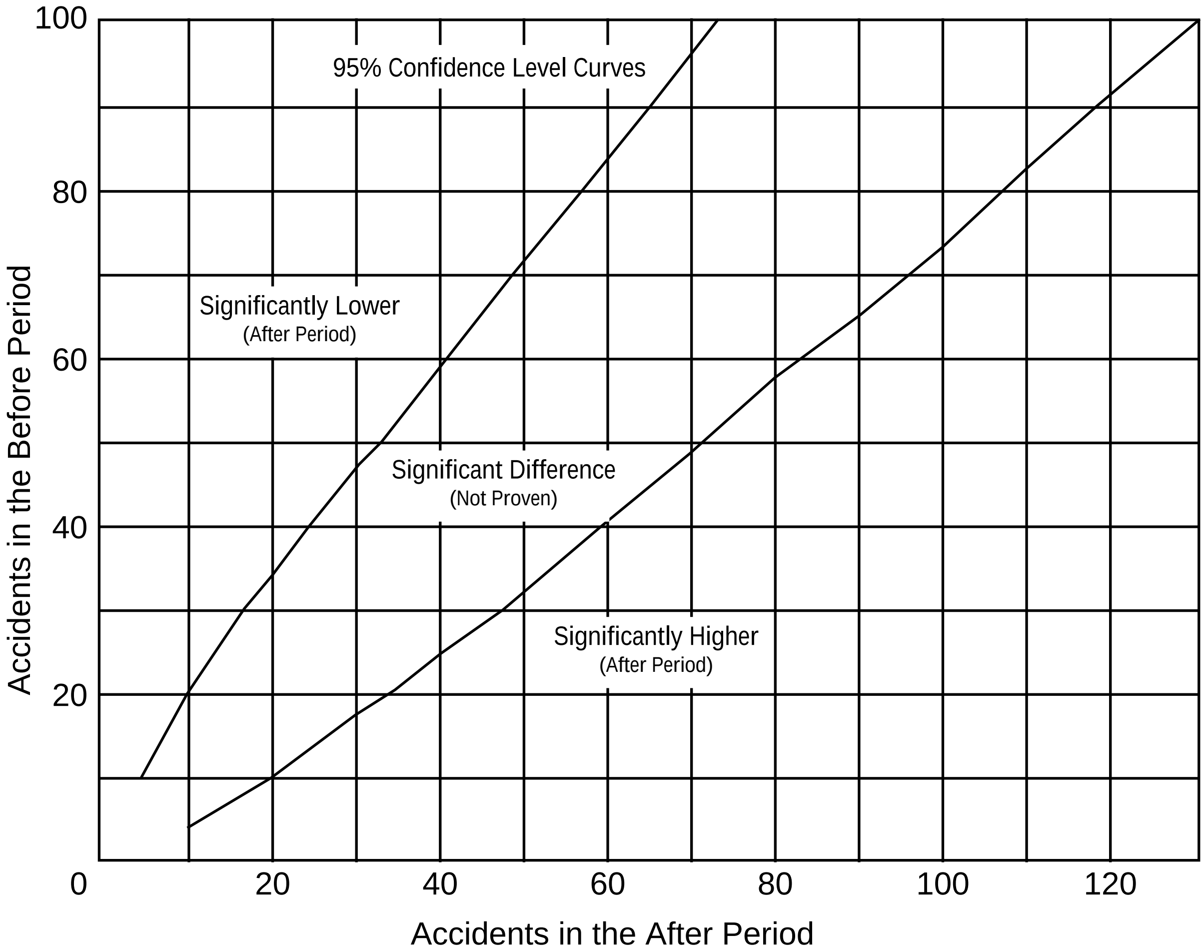
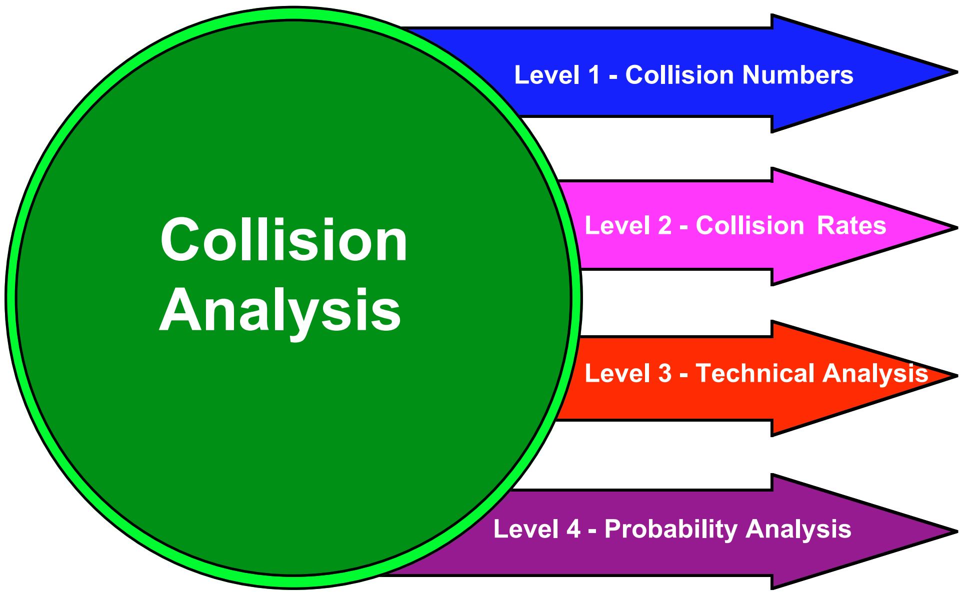


Figure 8-2
Chi-Square Tests for Significant

15:F:DP/SMS

Collision analysis is a tool to help classify the locations, types, and causes of collisions. At its most sophisticated, it provides effective counter measures. Collision analysis may be accomplished at four primary levels shown below:



Level One — Collision Numbers

The first is a relatively simple analysis of the locations, combined with the number of collisions. The collisions are classified as three types: property damage only, injury, or fatal. This level of analysis provides an indicator of where, how many, and how severe the collisions are. It does not, however, identify the cause(s) of the collisions. This is a beginning level of analysis and provides minimal indication of a problem area. It provides no identification of causes, nor any comparison of different roadways. It only provides an approximation of differing traffic conditions.

Level Two — Collision Rates

The next level of analysis provides a better overview of problem areas. This analysis level takes the amount of traffic into account by comparing the number of collisions to the average daily traffic entering the location. Collision Rates can be developed for road types and classifications as well as for different areas.

Level Three — Technical Analysis

This highest level of analysis is broken into two parts. The first is a technical analysis of the traffic volumes, roadway features, collision patterns and potential appurtenant causes. It involves significantly more data collection to ascertain accurate traffic volumes and collision dynamics. With the traffic volume information, the 'exposure' or level of risk can be calculated. With more in-depth information, roadway features and collisions may be diagrammed and patterns can be identified.

Pattern identification is a key element in determining appropriate countermeasures. Collisions must be grouped into types, such as 'rear end' or 'right angle,' as there are specific countermeasures to address these particular types. Information on collision types is available in the Washington State Patrol Accident Data publication.

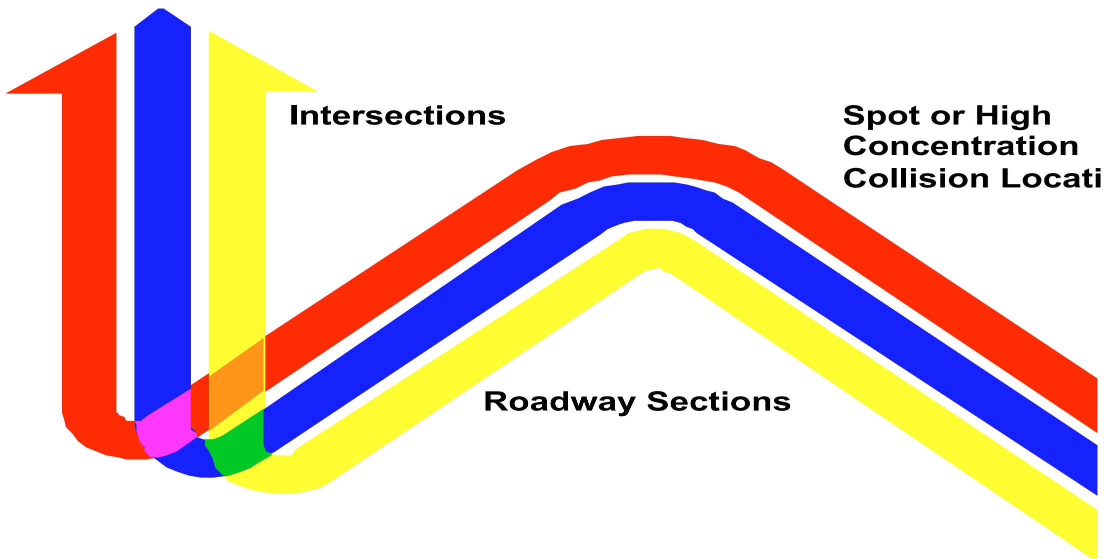
Collision causes are seldom clear cut and there is often more than one cause. This is the most accurate level of analysis, and finding collision causes requires professional level knowledge of roadway design and collision dynamics. When collision causes can be determined with greater precision, the most appropriate countermeasures can be identified and selected.

Level Four — Probability Analysis

The second part of this highest analysis level involves identification of the "best" countermeasure, and its corresponding probability of reducing the number of collisions. Since actual historical statistics have not been available, probability information is currently based on experience combined with professional evaluation. This is, however, the best information available and has generated countermeasures with results. As actual data is collected and analyzed over time, probability information will be refined and become more accurate.

Collision Locations

Collisions occur at three different types of locations; therefore, it is necessary to analyze collision information within each of these location types. They are:



Each location type has unique characteristics and commonly requires different counter measures. The factors used for calculating collision rates are similar for all types of collisions but there are some significant differences in how they are applied to these three location types.

Intersection Rate Calculation

Intersections present a unique situation in that turning movements, along with stop and start movements, are often predominant in collision causes. Intersections require different countermeasure considerations than other roadway locations.

Since the location is essentially a point, the length of the roadway section is considered to be one (1). The Average Daily Traffic is the total average traffic entering the intersection during the study period. This is the sum of the approach daily traffic volumes. If this number is not available, it can be taken as the sum of the ADT on each leg divided by 2.

Spot Location Calculations

Spot locations are places along the roadway other than intersections, where collisions are occurring within a relatively small area. These may be associated with some roadway feature unique to that particular location, such as a sharp curve.

Similar to the intersection calculation, since the location is essentially a point, the length of the roadway section is considered one (1) in the calculation formula for the traffic exposure and collision rate calculations discussed in the following paragraphs. Since there is only one roadway involved, only the volume of the primary roadway is involved in the calculations. In this case, then, the volume for a minor roadway (V_2) of the general collision rate formula, equals zero.

Roadway Section Calculations

Roadway sections are defined as lengths in excess of one mile where a number of collisions are occurring.

Similar to the spot location, there is only one roadway involved, so in the traffic exposure and collision rate calculations, only the volume of the primary roadway is involved in the calculations. Thus, the volume for a minor roadway (V_2) in the general collision rate formula, equals zero.

Traffic Exposure

To get an understanding of the relative severity of a collision location relative to other locations on the roadway network and to the network as a whole, the collision rate at the location is compared to an "average" rate for the entire network. The following calculations provide an exposure rate expressed in millions of vehicles or million vehicle miles, depending on the type of location. Once the traffic exposure is determined, it can be further analyzed to determine the Collision Rate. The rate can then be compared to a system-wide rate to determine the most critical collision locations.

Traffic Exposure, M, in million vehicle miles, can be expressed by the general mathematical expression:

$M = 0.000365\ T\ L\ (V1+V2)$; Where

T = period of study in years or fractions thereof

L = length of roadway section to be studied. Lengths less than one mile should not be used in the equation due to a ballooning effect.

Note: L equals one (1) for Intersections and Spot Locations

V_1 = ADT on major road or street at intersection

V_2 = ADT on minor road or street at intersection

Note: V_2 equals zero (0) for Spot Locations and Roadway Sections

Caution: Exercise care to use only the traffic entering the intersection during the study period. This equals the approach volume. If the approach volume is not available, use the sum of the ADT on each leg divided by 2.

Collision Analysis Calculations

These calculations are divided into the four levels described earlier: Collision Numbers, Collision Rates, Technical, and Probability Analysis. They are progressive in accuracy and sophistication and each level builds upon and is dependent upon the previous level.

Collision Numbers

This level is simply a count of the number of collisions at a given location. It may be taken easily from collision records, which, as required by state law, are filed with the Washington State Patrol. Calculation is commonly done with a map noting the locations and numbers counted at defined locations. When viewed over a typical three-year period, these numbers will provide a picture of accident frequency.

Collision Rates

The collision rate (R) is Total Collisions (A) divided by the Traffic Exposure (M), or:

$$R = \frac{A}{M}$$

This level takes the number of collisions and compares them to the amount of traffic at a given location. Both collision numbers and traffic volumes must be determined. While the collision numbers may be collected easily, they should be validated. It is desirable to review these reports to confirm the proper location and determine the level of accuracy. In addition, traffic volumes require automatic and/or manual traffic counts that must be reviewed and correlated for accuracy.

Critical Collision Rate

The critical collision rate is a statistically derived value. Using this rate provides a comparison basis for the collision rates of specific sites on the system.

"System wide" may refer to a single geographical area, a city, a county, a state or the whole country. For the best results, both a city or county area and a statewide area can be used for these comparisons. The city or county area provides relativity to local conditions, while the statewide rate comparison provides a broader statistical basis.

The critical collision rate is calculated by:

$$R_c = R_a + k\sqrt{\frac{R_a}{M}} + \frac{1}{2M}\text{; Where:}$$

R_c = Critical collision rate for the area being analyzed. The result will be in collisions per million miles or collisions per million miles, depending on the type of location being analyzed.

R_a = System wide average network level collision rate classified by type of location and roadway functional class for comparisons, analysis, and programming of safety improvements.

K = A statistical constant used to establish the desired level of confidence, assurance and probability that the critical collision rate at the location under analysis has a higher than average collision rate, and is due to something other than chance. A 98 percent confidence level constant may be used which places the "K" value at 2.0.

M = Vehicle exposure for the study period (as derived previously) for spots, intersections and high concentrations. The vehicle exposure for roadway sections of equal analysis units is expressed in million vehicle miles. The vehicle exposure (M) is always for the specific location under study.

If the local system-wide collision rates (R_a) are determined to be statistically insignificant due to a small sample size, use a rate for a larger area like a county or the state, for the location and roadway classifications. If it is necessary to use a larger area rate for one classification, it is recommended that the same area be used for all comparable rates to assure consistency of comparison between classifications.

The Critical Collision Rate formula illustrated on the previous page is a statistical calculation to assure a 98 percent level of confidence in the comparisons of collision rates at specific sites on the system.

After calculating the study location critical collision rate (R), compare the rate with the critical rate (R_c). If the location collision rate is greater than the system-wide critical rate for the functional class, the location is considered significant and warrants further study.

We have developed a simple Collision Work Sheet to assist you in determining if a collision location exceeds the critical rate. See **Appendix F**.

16:F:DP/SMS

Appendix I — Selected Bibliography

Authors, Private Firms, Associations, Boards, Studies

Traffic Engineering, William R. McShane, Roger P. Roess, 1990.

A Policy on Geometric Design of Highways and Streets 1994, American Association of State Highway and Transportation Officials, 1995.

Standard Plans for Road, Bridge and Municipal Contruction M 21-01, American Public Works Association, Washington State Department of Transportation.

Local Low Volume Roads and Streets, American Society of Civil Engineers, 1992.

Fundamentals of Traffic Engineering 11th Edition, Institute of Transportation Studies, Wolfgang S. Homburger, James H. Kell, 1984.

A Guidebook for Student Pedestrian Safety Final Report, KJS Associates, Inc., MacLeod Reckord, Education Management Consultants, 1996.

Maintenance Management of Street and Highway Signs, Transportation Research Board, Richard A. Cunard, 1990.

U.S. Department of Transportation, Federal Highway Administration

Manual on Uniform Traffic Control Devices for Streets and Highways, U.S. Department of Transportation, Federal Highway Administration, 1988.

Traffic Control Devices Handbook, U.S. Department of Transportation, Federal Highway Administration, 1983.

Highway Safety Improvement Program (HSIP), U.S. Department of Transportation, Federal Highway Administration.

Local Highway Safety Studies User's guide, U.S. Department of Transportation, Federal Highway Administration, National Highway Institute, 1986.

Handbook on Planning, design, and Maintenance of Pedestrian Facilities, Brian L. Bowman, John J. Fruin and Charles V. Zegeer, Goodell-Grivas, Inc., Federal Highway Adminitration, Office of Implementation, 1989.

Railroad-Highway Grade Crossing Handbook - 2nd Edition, B.H. Tustin, H. Richards, R. Patterson, Tustin Enterprises, Federal Highway Administration, Office of Implementation, 1986.

Low Cost Methods for Improving Traffic Operations on Two Lane Roads Informational Guide, D. W. Harwood and C.J. Hoban, Midwest Research Institute, Federal Highway Administration, Office of Implementation, 1987.

Countermeasures for Sign Vandalism, D. Perkins, Goodell-Grivas, Inc., Federal Highway Administration, Office of Implementation, 1986.

Improving the Residential Street Environment, Final Report. Daniel T. Smith, Jr., Donald Appleyard, Deleuw, Cather & Company, Federal Highway Administration, Office of Research, 1981.

Institute of Transportation Engineers

Traffic Engineering Handbook Fourth Edition, Institute of Transportation Engineers, James L. Pine, Editor, 1992.

Residential Street Design and Traffic Control, Institute of Transportation Engineers, Wolfgang S. Homberger, et al, 1989.

The Traffic Safety Toolbox: A primer on Traffic Safety, Institute of Transportation Engineers, 1993.

Manual of Traffic Signal Design, Institute of Transportation Engineers, James H. Kell, Iris J. Fullerton, 1982.

Manual of Transportation Engineering Studies, Institute of Transportation Engineers, H. Douglas Robertson, Ph.D., Joseph E. Hummer, Ph.D, Donna C. Nelson, Ph.D, 1994.

Transportation Planning Handbook, Institute of Transportation Engineers, John D. Edwards, Jr., P.E., 1992.

Washington State Department of Transportation

Design Manual M 22-01, Washington State Department of Transportation

Sign Fabrication Manual M 55-05, Washington State Department of Transportation

Standard Plans for Road, Bridge and Municipal Contruction M 21-01, Washington State Department of Transportation, American Public Works Association

Traffic Manual M 51-02, Washington State Department of Transportation

17:F:DP/SMS

August 29, 1997

Mr. Joe Smith, Mayor
City of Anytown
115 Main Street
Anytown, WA 98000

Dear Mr. Smith:

At your request I evaluated the two way stop control at the intersection of Oak Avenue and Third Street. My study concludes that the intersection is operating efficiently and correctly with the existing two way stop control. I recommend no change in the intersection traffic control.

Findings

The intersection is currently two-way stop controlled with the stop signs on Third Street. The speed limits on both streets is 25 mph. The crosswalks on the west (Oak Avenue) and south (Third Street) legs of the intersection are marked. The crosswalk on the west leg of the intersection across Oak Avenue is signed as a school crossing. Sight distance on all approaches is adequate.

The intersection traffic volumes were counted by the city traffic crew in June of 1997. These count volumes were compared to the volume warrants in the Manual on Uniform Traffic Control Devices (MUTCD) for both a four way stop and a traffic signal. The intersection volumes did not meet the volume criteria for even one hour of either form of traffic control. The volumes on Oak Avenue approach the volume levels to warrant either the four way stop or traffic signal. The traffic volume on Third Street is far below the requirement for either form of traffic control.

The MUTCD also contains an accident warrant for both a four way stop and a traffic signal. The accident warrant for either form of traffic control requires five or more accidents correctable by the proposed form of traffic control. Accident records for this intersection show only two recorded accidents in the years 1991 through 1995. Neither accident was correctable by the installation of a four way stop. The intersection does not meet the accident warrant for the four way stop.

Operational Problems

During my site visit on August 18th, I observed the intersection during the evening peak from 4:15 pm to 5:40 pm. Very little delay was observed for vehicles on Third Street stopped at Oak Avenue. The south leg of Third Street (higher volume approach) is wide enough for two lanes enabling right turning vehicles to make their turns with little delay. The traffic signal at Oak Avenue and First Street serves to platoon the westbound vehicles on Oak Avenue providing adequate gaps for vehicles turning left onto or crossing Oak Avenue. Several pedestrians crossed Oak Street during the observation period. While they were crossing, the queue of westbound cars on Oak Street backed up almost to First Street. I believe if a four way stop were implemented at Oak Avenue and Third Street the backup could impact the signal operation at First Street on occasion.

Recommendations

In summary, my study concludes that the intersection is operating safely and efficiently.
I recommend no change in the intersection traffic control.

If you have any questions concerning this letter please contact me at 360-123-4567.

Sincerely,

WILLIAM JONES, P.E.
Traffic Engineer

Attachment: Warrant analysis spreadsheet
Study data

18:F:DP/SMS