PB99-115255

A Center of Excellence for Rural and Intermodal Transportation

MPC REPORT NO. 98-96B

Adapting Road Safety Audits to Local Rural Roads

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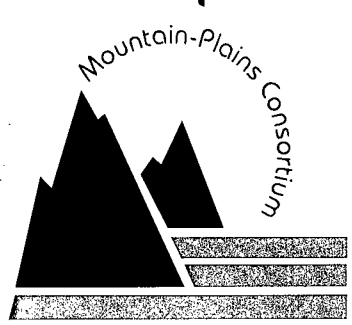
October 1998



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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	PB99-115255
4. Title and Subtitle Adapting Safety Audits to Local Rural Roads		5. Report Date October 1998 6. Performing Organization Code
7. Author(s) Joseph Tate III and Eugene M. Wilson, Univ. of Wyoming		8. Performing Organization Report No. MPC 98-96B
9. Performing Organization Name and Address Mountain-Plains Consortium North Dakota State University Fargo, ND 58105		10. Work Unit No. (TRAIS) 11. Contract or Grant No.
12. Sponsoring Agency Name and Address U.S. Department of Transportation Research and Special Programs Administration 400 7th Street SW Washington, DC 20590-0001		13. Type of Report and Period Covered Project Technical Report 14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

Many rural governments do not have an effective safety improvement program for their roads, yet crash rates are significantly higher on rural roads than on urban, state and federal roads. Smaller agencies seldom have the financial resources or expertise to provide a comprehensive roadway safety improvement program and usually rely on input from the public, governing bodies, employees, and analysis of accident records. The result is a reactive program that leaves many road safety issues unnoticed and unimproved. A road safety audit is a proactive and comprehensive approach to identifying roadway safety deficiencies. This paper provides a practical means of identifying roadway safety deficiencies by developing and testing a road safety audit program for existing rural local roads.

17. Key Words rural, roads, safety, traffic, audit,	18. Distribution Statement		
19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages 95	22. Price

ADAPTING ROAD SAFETY AUDITS TO LOCAL RURAL ROADS

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October 1998

Acknowledgments

Funding for this research project was provided by the Mountain Plains Consortium of the USDOT University Centers Program and the University of Wyoming. Many local county employees provided useful input to further this project. With this help in funding and expertise, the road safety audit will continue to become more and more useful as a management tool for making roads safer.

Disclaimer

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ABSTRACT

Many rural governments do not have an effective safety improvement program for their roads, yet crash rates are significantly higher on rural roads than on urban, state, and federal roads. Smaller agencies seldom have the financial resources or expertise to provide comprehensive roadway safety improvement programs and usually rely on input from the public, governing bodies, employees, and analysis of accident records. The result is a reactive program that leaves many road safety issues unnoticed and unimproved. A road safety audit is a proactive and comprehensive approach to identifying roadway safety deficiencies. This paper provides a practical means of identifying roadway safety deficiencies by developing and testing a road safety audit program for existing rural local roads.

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EXECUTIVE SUMMARY

Introduction

Simple cost effective techniques are needed to improve safety on local rural roads. Systematically improving safety is difficult due to the limited resources of most local jurisdictions, which also have insufficient or limited methods of identifying safety improvement needs. Local jurisdictions need a practical method to identify safety deficiencies on existing roadways.

Road safety audits originated in the United Kingdom and are used commonly in New Zealand and Australia. A road safety audit (RSA) evaluates accident potential and safety performance of a road section or project. A road safety audit identifies existing or potential safety deficiencies.

The purpose of this project was to develop a road safety audit program that would increase safety on rural local road systems. This project had four goals.

- Create a functional classification system for rural local roads to structure road safety audits.
- Determine the current safety improvement practices used in Federal Highway Administration (FHWA) Region VIII (Wyoming, Colorado, Utah, Montana, North Dakota, and South Dakota) on rural local roads.
- Develop a feasible road safety audit program including audit checklists to help identify road safety deficiencies on local rural roads.
- Evaluate the proposed RSA procedures through a pilot study.

Literature Review

State-of-the-art safety programs for roads were reviewed. Risk management, conventional Highway Safety Improvement Programs (HSIP), and Safety Management Systems (SMS) all require a substantial amount of funding, personnel, and expertise. They generally are not used by smaller local governments. No road safety audit programs reviewed in the literature were tailored for use on rural local roads, however the

audit procedures successfully used in Australia and New Zealand provided a good resource for developing a local road audit.

Methodology

A regional focus group was established to provide input toward development of a functional classification system for road safety audits. The rural local road classification encompasses a variety of roads. This project used three criteria for classifying rural local roads, including average daily traffic (ADT), user type, and surface type. Input from a modified Delphi survey procedure was used to create a classification system. The modified Delphi is a survey technique that uses an iterative process of multiple rounds of questionnaires with feedback from a group with expert knowledge and opinion. This procedure provides a distillation of views to build a rational basis for determining priorities and recommendations for action. A random sample of county road superintendents and county engineers in FHWA Region VIII was conducted to determine current practice used to identify safety improvement needs and how a road safety audit program might be structured to suit their needs.

Analysis and Results

The initial Delphi survey of the regional focus group determines if classification of rural local roads is warranted and if so, how classifications should be structured and used. Findings from the survey were:

- Classification for rural local roads is warranted.
- Classifications for rural local roads should be based on average daily traffic (ADT), user type, and surface type.
- Three to four classifications are most appropriate for all three criteria (ADT, user type, and surface type).

Table 1 lists functional classifications of local rural roads developed from results of the second Delphi survey. The rural primary classification serves larger towns and other traffic generators not served by the other systems, links these places with nearby cities and larger towns or with higher systems, and serves more important intra-county travel corridors. Rural secondary classification accumulates traffic from local roads, brings all developed areas within reasonable distance of collector roads, provides service to the remaining smaller communities, and links the locally important traffic generators with the rural region. Rural local and rural low-volume local classifications provide access to land adjacent to the collector network and serve travel over relatively short distances.

Road characteristics and current safety improvement practices used by counties in FHWA Region VIII were identified. Important findings from the survey follow:

- The average road mileage of each responding county was 839 miles.
- Mileage in each road classification for the responding counties ranged from 19 percent to 28 percent.
- Only 39 percent of the responding counties identified safety needs uniformly for all road classifications. Rural Primary and Rural Secondary classifications received more attention than the other two classifications.
- Input from the public, the governing body, employees, inspections, and crash data were used to identify locations for safety improvements

Table 1. Classification System for Local Rural Roads

	ROAD CLASSIFICATION	
	A	B
	Rural Primary	**Rural Secondary**
FUNCTIONAL SYSTEM	Serves larger towns and other traffic generators not served by higher systems, links these places with nearby cities and larger towns or with higher systems, and serves more important intracounty travel corridors	Accumulates traffic from local roads, brings all developed areas within reasonable distance of collector roads, provides service to the remaining smaller communities, and links the locally important traffic generators with their rural region
	Typically paved surfaces, traffic volumes are generally 400 vehicles per day and above	Typically unpaved surface but may be paved, traffic volumes generally range from 250 to 400 vehicles per day

	ROAD CLASSIFICATION	
	C	D
	Rural Local	**Rural Low-volume Local**
FUNCTIONAL SYSTEM	Provides access to land adjacent to the collector network and serves travel over relatively short distances	Provides access to land adjacent to the collector network and serves travel over relatively short distances
	Typically unpaved surfaces, traffic volumes generally range from 100 to 250 vehicles per day	Typically graded surface, traffic volumes generally range from 0 to 100 vehicles per day

The primary purpose of the second part of the Delphi survey determines local rural interest in an RSA program. The findings follow:

- 59 percent indicated that an RSA program for rural local roads was necessary, 84 percent indicated that it would be useful, and 63 percent indicated that it would be cost-effective.
- 67 percent indicated that RSA program training was necessary for counties to implement the program.
- 77 percent indicated that the RSA procedures (checklists) should vary for different local rural functional classifications.

Development of a Rural Local RSA Program

To keep an audit program concise and cost-effective, only major safety issues were selected from results of Delphi surveys for use on the checklist. Other safety issues not on the checklist can and should be noted. Careful thought should be given to the selection of the audit team. Independent qualified examiners, county personnel, and associate county personnel all were considered in this report.

In the regional local rural road safety survey, respondents indicated that limited funding and manpower restrict the local agency's abilities to develop and implement a safety improvement program. Therefore, using a team of county road superintendents for auditing existing roads may be less expensive as major safety issues are identified. To reduce potential bias of county personnel looking at their own county and to add additional resources to an audit, county personnel from a neighboring county may be an effective audit team.

The proposed RSA program for rural local jurisdictions was structured to be beneficial, efficient, and easily implemented. Processes from the AUSTROADS program were tailored for use by U.S. rural local jurisdictions. The RSA process in this report was designed to be used by road superintendents as auditors.

The first step in the proposed RSA process is the brief office review. Road superintendents gather and review only necessary background information. This includes information such as existing and expected future traffic volumes, any known unresolved safety issues, and other information pertinent to the audit. A brief review of crash records is recommended.

The next step is the field review or actual examination of the existing road section. Ideally, field reviews should occur during daylight and nighttime hours. The recommended procedure is to drive the length of the road section in both directions at a safe operating speed or the speed limit, and then again at a slow speed (approximately 10 mph) stopping, if needed, to take a closer look at potential deficiencies. Taking pictures of major safety deficiencies is recommended. Next, inspect the road section for key existing and potential safety deficiencies. Audit checklists, such as the one at the back of this section, can be used as

a tool to aid in the audit process and guide the investigation. The auditors fill out checklists as they complete the inspection for each specified safety deficiency.

During the final step, the auditors fill out a report form, which also is included at the back of this section. The main focus of the report form is the statement and description of safety deficiencies discovered during the audit process. Possible recommendations and discussion for safety improvements should be included when appropriate.

High frequency problems and primary checklist items or safety issues contained in the AUSTROADS approach were considered while structuring the RSA checklists. To encourage local rural agencies to initiate an RSA, a tailored approach is recommended and is included in this report. Only major items applicable to local rural roads and their intersections were included. Major safety issues in the checklist were classified as special users, intersections, road surface issues, traffic control devices, roadside features/physical objects, and consistency.

The final goal of this research project was to test proposed safety deficiency identification and reporting procedures. Two five-mile sections of a local county road in Albany County Wyoming were used for this purpose. Pilot studies validated the checklist process as simple and quick, yet beneficial. The RSA checklists were quite helpful in guiding audit of the road section and ensuring that key safety issues were addressed. The reporting form also proved to be simple and efficient for recording pertinent safety audit information.

Summary

This research addressed the need for a road safety audit (RSA) program designed specifically for existing rural local roads. With limited resources at the local level, many local agencies do not have an effective safety improvement program. Significantly higher crash rates on rural local roads indicate the need for a program specifically designed to increase safety on these roadways.

The primary objective of this research was to develop and test a suitable RSA program for rural local roads. A literature review of current RSA programs discovered fairly skill-intensive models focusing primarily on high volume, high priority road sections in Australia and New Zealand. The feasibility and development of an RSA program was studied for existing roads tailored to resources as well as needs of rural local jurisdictions in the United States. A survey of county road superintendents and engineers in FHWA Region VIII was completed to help structure the proposed RSA program for rural local roads. Three steps are proposed: office review, field review, and report. The recommended program is simple to use and likely will be cost effective for most rural local jurisdictions.

This project also developed a functional classification system for rural local roads to aid in the road safety audit. A regional focus group of professionals (FHWA Region VIII) with knowledge and previous work experience dealing with transportation safety on rural roads was formed. Input from the focus group was acquired through use of a modified Delphi procedure. Four classifications were developed to categorize rural local roads: rural primary, rural secondary, rural local, and rural low-volume local (see Table 1).

Conclusions

Listed, are this project's conclusions.

- The functional classification of rural local roads must be established to structure the safety needs identification process and incremental improvements.
- Most local jurisdictions do not have an adequate safety needs identification process.
- The local rural road safety survey indicated a region-wide belief that an RSA program is justified and useful for local rural jurisdictions as a safety needs identification process.
- Pilot studies demonstrated that RSAs are a simple yet beneficial method for evaluating safety needs.

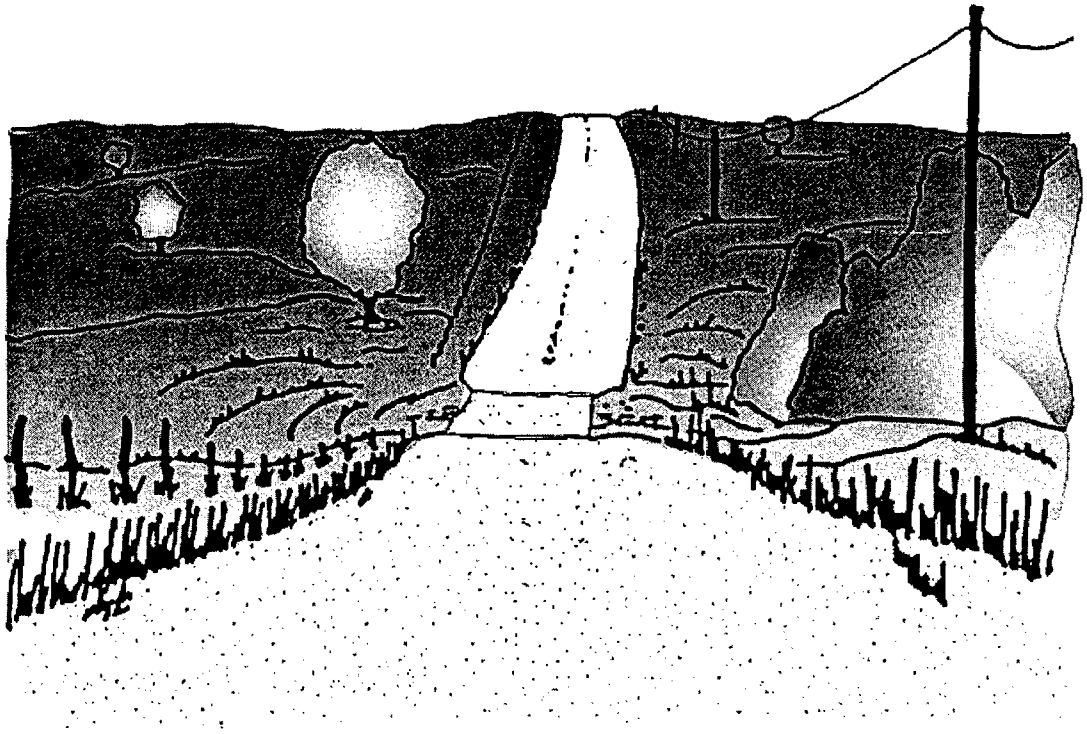
Recommendations

Additional recommendations for research concerning safety on rural local roads follow.

- Determine appropriate differences in the RSA procedures/checklists for different local rural road classifications.
- Integrate use of a Global Positioning System into the RSA process.
- Develop an appropriate RSA training program to properly train prospective auditors.
- Develop an RSA manual/field guide for training and in conjunction with the checklists during the audit process.

Note: References made, but not noted, in the executive summary can be found in the reference section of the full report.

RURAL ROAD
SAFETY AUDIT



Project: _____

Date/Time: _____

Location: _____

Auditor(s): _____

Weather: _____

Page #: 1 of ___

When completing the audit using the attached checklist, check the appropriate box for each question.

	Yes	No	N/A	COMMENTS
RURAL ROAD SAFETY AUDIT – GENERAL ISSUES (1 of 2)				
INTERSECTIONS				
Are intersections free of sight restrictions which could result in safety problems?				
Are intersections free of abrupt changes in elevation or surface condition?				
Are advance warning signs installed when intersection traffic control cannot be seen a safe distance ahead of the intersection?				
SIGNING & DELINEATION				
Signing				
Is the road free of locations where signing is needed to improve safety?				
Are the regulatory, warning, and directory signs in place conspicuous?				
Is the road free of locations with improper signing which may cause safety problems?				
Is the road free of unnecessary signing which may cause safety problems?				
Are signs effective for likely conditions?				
Can signs be read at a safe distance?				
Is the road free of signing that impairs safe sight distances?				
Delineation				
Is the road free of locations with improper or unsuitable delineation (post delineators, chevrons, object markers)?				

	Yes	No	N/A	COMMENTS
RURAL ROAD SAFETY AUDIT – GENERAL ISSUES (2 of 2)				
ROADSIDE FEATURES / PHYSICAL OBJECTS				
Are clear zones free of hazardous, non-traversable side slopes with no safety barriers?				
Are the clear zones free of nonconforming and/or dangerous obstructions that are not properly attenuated?				
SPECIAL ROAD USERS				
Are travel paths and crossing points for pedestrians and cyclists properly signed and/or marked?				
Are bus stops safely located with adequate clearance and visibility from the traffic lane?				
Is appropriate advance signing provided for bus stops and refuge areas?				
RAILROAD CROSSINGS				
Are railroad crossing (crossbucks) signs used on each approach at railroad crossings?				
Are railroad advance warning signs used at railroad crossing approaches?				
Are railroad crossings free of vegetation and other obstructions which have the potential to restrict sight distance?				
Are roadway approach grades to railroad crossings flat enough to prevent vehicle snagging?				
CONSISTENCY				
Is the road section free of inconsistencies that could result in safety problems?				

	Yes	No	N/A	COMMENTS
RURAL ROAD SAFETY AUDIT – PAVED ROAD ISSUES (1 of 1) **PAVEMENT MARKINGS** Is the road free of locations with pavement marking safety deficiencies? Is the road free of pavement markings that are not effective for likely conditions? Is the road free of old pavement markings that affect the safety of the roadway? **PAVEMENT CONDITION** Is the pavement free of defects which could result in safety problems (e.g. loss of steering control)? Are changes in surface type (e.g. pavement ends) free of drop-offs / poor transitions? Is the pavement free of locations that appear to have inadequate skid resistance which could result in safety problems, particularly on curves, steep grades and approaches to intersections? Is the pavement free of areas where ponding or sheet flow of water occur resulting in safety problems? Is the pavement free of loose aggregate/gravel which may cause safety problems?				

	Yes	No	N/A	COMMENTS
RURAL ROAD SAFETY AUDIT – UNPAVED ROAD ISSUES (1 of 1) **ROADWAY SURFACE** Is the road surface free of defects which could result in safety problems (e.g. loss of steering control)? Is the road surface free of areas where ponding or sheet flow of water occur resulting in safety problems? Is the road surface free of loose gravel/fines which may cause safety problems (control, visibility, etc.)? Are changes in surface type (e.g. pavement ends) free of drop-offs / poor transitions?				

Road Safety Audit – Report Form (1 of __)

Deficiency #: _____

Location of Safety Deficiency: _____

_____

_____

Description: _____

_____

_____

Recommendation: _____

_____

_____

Deficiency #: _____

Location of Safety Deficiency: _____

_____

_____

Description: _____

_____

_____

Recommendation: _____

_____

_____

CHAPTER 1

INTRODUCTION

Background

Simple cost effective techniques are needed to improve safety on local rural roads. Systematically improving safety on local roads is difficult due to limited resources of most local jurisdictions. Most rural local jurisdictions also have insufficient or limited methods of identifying safety improvement needs and need a practical method, such as road safety audit programs to identify safety deficiencies on existing roadways.

Road safety audits originated in the United Kingdom and commonly are used in New Zealand and Australia. A road safety audit (RSA) evaluates accident potential and safety performance of a road section or project. A road safety audit identifies existing or potential safety deficiencies.

Objectives

The purpose of this project was to develop a road safety audit program to increase safety on rural local road systems. This project had four goals.

- Create a functional classification system for rural local roads to structure road safety audits.
- Determine current safety improvement practices used in Federal Highway Administration (FHWA) Region VIII (Wyoming, Colorado, Utah, Montana, North Dakota, and South Dakota) on rural local roads.
- Develop a feasible road safety audit program, including audit checklists, to help identify road safety deficiencies on local rural roads.
- Evaluate the proposed RSA procedures through a pilot study.

Report Organization

Chapter 2 is a literature review of road safety programs, functional classifications, incremental improvements, and tort liability relating to rural local roads. Chapter 3 presents the procedures and methodology used in this project. Chapter 4 contains analysis and results of the project. Chapter 5 includes summary, conclusions, and recommendations of this research project.

CHAPTER 2

LITERATURE REVIEW

Introduction

Local government agencies are responsible for maintaining approximately 75 percent of the more than 3.9 million miles of public roads in the United States. Local rural agencies typically are responsible for the lower volume local roads that constitute 54 percent of the U.S. road mileage. However, funds available for maintaining these local roads are on average only $11,080 per mile. State maintained highways receive approximately six times as much funding [1].

Significantly higher crash rates experienced on rural local roads indicate the need for a program specifically designed to increase safety on these roadways. According to the U.S. Bureau of Transportation Statistics, the fatal crash rate on rural local roads for 1992 (3.64 deaths per million vehicle miles) was approximately twice that for the entire U.S. highway system. The non-fatal crash rate (176 accidents per million vehicle miles) on rural local roads for 1992 was approximately 2.4 times that for all rural highways [1].

Functional Classification Systems

Functional classification is an administrative tool for planning, designing, and developing practical improvement guidelines [2]. Functional classification systems often are used in conjunction with various safety improvement programs to structure operations. Classification systems also are used to structure the differing minimum geometric and cross sectional design parameters for each classification. The American Association of State Highway and Transportation Officials (AASHTO) "Green Book" states:

> ***The first step in the design process is to define the function that the facility is to serve. The level of service required to fulfill this function for the anticipated volume and composition of traffic provides a rational and cost-effective basis for the selection of design speed and geometric criteria within the range of values available to the designer (for the specified functional classification). The use of functional classification as a design type should appropriately integrate the highway planning and design process [3, 4].***

The Federal Highway Administration (FHWA) categorizes public roads into 12 functional classifications according to movement and land access (see Table 2.1). The Rural Local Road classification represents more than half of the existing public road mileage in the United State (54.2 percent or 2,119,048 miles) [5, 6]. Relatively speaking, this is a large percentage of road mileage categorized under the same functional classification. This classification does not distinguish variances and discrepancies that exist among roads under this classification.

Rural local roads include both paved and unpaved surfaces as well as varying levels of traffic volumes and operational characteristics [6]. Rural local road surfaces are of all types including concrete, paved, low bituminous (oil and chip), high bituminous (hot mix), earth, or gravel (loose aggregate) [7]. Traffic volumes and travel demands influence a roadway's surface type. Roads serving higher traffic volumes tend to have a better quality surface that provides improved service and increased safety.

Table 2.1 United States Public Road and Street Functional System -1995 [5, 6]

Functional Classification	Miles	Percent
Rural: Interstate	32,580	0.8
Other Principal Arterial	97,948	2.5
Minor Arterial	137,151	3.5
Major Collector	431,712	11.0
Minor Collector	274,081	7.0
Local	2,119,048	54.2
Subtotal	3,092,520	79.0
Urban: Interstate	13,164	0.3
Other Principal Arterial	8,970	0.2
Minor Arterial	52,796	1.4
Major Collector	88,510	2.3
Minor Collector	87,331	2.2
Local	568,935	14.6
Subtotal	819,706	21.0
Total	3,912,226	100.0

Due to the wide range of rural local road characteristics, safety considerations also vary greatly. The AASHTO "Green Book" presents general considerations and design guidelines for local roads and streets, recreational roads, resource development roads, and local service roads. AASHTO rural local road

classifications by traffic volume are average daily traffic (ADT) of less than 400 vehicles per day (vpd), ADT of 400 - 1,500 vpd, ADT of 1,500 - 2,000 vpd, and ADT of more than 2,000 vpd [3]. Although FHWA only has one classification for traffic volumes of less than 400 vpd, various states and organizations have further refined this classification with sub-classifications (see Table 2.2). Functional classification and respective minimum design guidelines on roadways with traffic volumes less than 400 vpd currently are being reviewed. The National Research Council of the Transportation Research Board (TRB) is conducting research to devise an appropriate set of classifications and guidelines to categorize low-volume roads. The project is being completed under the National Cooperative Highway Research Program (NCHRP) 20-7, Task 75 [6].

Table 2.2 Sub-Classifications for Local Roads with ADT Less Than 400 [6]

	Use Categories	ADT	Minimum Design Speed (mph)	Roadway Width (minimum)
AASHTO	Local	0 - 400	40	22
BLM	Collector	50 - 150	30	20
		> 100	40	20
	Local	0 - 100	30	20
		> 75	40	20
	Resource	0 - 20	30*	14*
Nebraska	Local	0 - 50	30	26
		50 - 250	50	28
		250 - 400	50	30
	Scenic -	0 - 250	30	26
	Recreational	250 - 400	50	28
Oklahoma	Local	0 - 250	30	22
		250 - 400	30	24
Vermont	Local	0 -25	25	14
		25 - 50	25	16
		50 - 100	25	18
		100 - 400	25	22
Washington	Access	0 -150	30	18
		150 - 400	30	24
	Collector	0 - 150	30	20
		150 - 400	30	24
Wyoming	Local	0 - 250	30	22
		250 - 400	40	24

*No minimum determined, values are preferred

One goal of this research, through the use of a regional focus group, was to create a functional classification system for categorizing rural local roads. This research resulted in the formation of rural primary, rural secondary, rural local, and rural low-volume local sub-classifications. Typical surface type and typical traffic volumes also were incorporated into the classification system. The classification system is presented and discussed in Chapter 4. The primary intent of this classification system is to allow appropriate structuring of the road safety audit of rural local roads discussed in Chapter 4.

Tort Liability

Tort liability claims have increased increased steadily over the past few decades. This is partially because design immunity is no longer a viable defense [4, 6, 10]. For this reason, tort liability has become a serious concern for local agencies involved in roadway design, construction, maintenance, and operation. Tort claims allege that the agency is responsible for the unsuitable or negligent design, maintenance, or operation of a road section that resulted in an accident or crash. Negligence on account of the highway agency is either misfeasance (improperly performed duties) or nonfeasance (failed to perform duties) [10].

One central issue in tort cases is failure to use due care in maintaining the road section in a condition reasonably safe for public travel. Litigation usually involves proving failure to act the way a "reasonable man" would have acted. Federal and state regulations and guidelines, the AASHTO "Green Book," other guidelines and research publications, and expert witnesses are used in tort cases to inform the jury of the standard level of practice [4].

Safety Programs

Many highway safety programs have been developed to date. The FHWA encourages states to develop various safety-related programs through federal funding incentives and distribute useful information as guides for transportation agencies. However, the majority of safety programs developed to date require resources and expertise that make them difficult to be established and maintained by local road agencies.

Highway Safety Improvement Programs

In 1979, the FHWA required that each state develop and implement a comprehensive highway safety improvement program (HSIP) [1, 11]. The three basic components of the HSIP are planning, implementation, and evaluation. Overall, the recommended improvement program structure is complex, consisting of three components, six processes, 14 sub-processes, and 64 recommended procedures (Table 2.3). Unfortunately, the HSIP requires personnel, expertise, and funding not available under most local agencies. For this reason, many local agencies have not adopted a comprehensive highway safety improvement program.

Some research has been completed to adapt a Safety Improvement Program (SIP) to local rural agencies [1, Caldwell, Wilson]. Caldwell and Wilson propose a SIP containing five steps for addressing unpaved rural roads:

- System-wide prioritization of roads
- Identification of safety improvement needs on individual road sections
- Prioritization of safety improvements
- Scheduling and implementing safety improvements
- Program evaluation and update process [1]

Safety Management Systems

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) initially required that states develop, establish, and implement a safety management system (SMS) to direct and manage functions and programs that impact highway safety. The goal of an SMS is to reduce total accident frequency and severity by reducing or eliminating the underlying causes associated with crashes. The SMS focuses on the following four processes:

- Identifying hazards, setting priorities, and developing a program to correct hazardous highway locations and features
- Maintaining and upgrading the safety of highways, highway features, and highway hardware

- Ensuring routine and timely inclusion of safety concerns in the development of all highway projects
- Identifying special safety needs of commercial motor vehicles in the planning, design, construction, and operation of the highway system [1, 8]

Table 2.3 Outline of HSIP Structure

I. PLANNING COMPONENT
Process 1: Collect and Maintain Data
Sub-process 1: Define the Highway Location Reference System (5)
Sub-process 2: Collect and Maintain Crash Data (3)
Sub-process 3: Collect and Maintain Traffic Data (3)
Sub-process 4: Collect and Maintain Highway Data (3)
Process 2: Identify Hazardous Locations and Elements (7)
Process 3: Conduct Engineering Studies
Sub-process 1: Collect & Analyze Data at Identified Hazardous Locations (24)
Sub-process 2: Develop Candidate Countermeasures (3)
Sub-process 3: Develop Projects (5)
Process 4: Establish Project Priorities (4)
II. IMPLEMENTATION COMPONENT
Process 1: Schedule and Implement Safety Improvement Projects
Sub-process 1: Schedule Projects (4)
Sub-process 2: Design and Construct Projects
Sub-process 3: Conduct Operational Review
III. EVALUATION COMPONENT
Process 1: Determine the Effect of Highway Safety Improvements
Sub-process 1: Perform Non-Crash-Based Project Evaluation
Sub-process 2: Perform Crash-Based Project Evaluation
Sub-process 3: Perform Program Evaluation
Sub-process 4: Perform Administrative Evaluation

The number in parenthesis following each sub-process refers to the number of individual procedures recommended for that sub-process.

A coalition of organizations that have an impact on highway safety should participate in the development and implementation of the SMS. The agencies and organizations operate independently, but cooperatively, in enhancing highway safety from their specific areas of responsibility [12].

Unfortunately, the requirements of a SMS also make it infeasible for many local government agencies because they lack the personnel, expertise, and funding needed to establish and maintain a comprehensive safety management system.

Risk Management Programs

Due to the increasing number of tort liability cases facing public agencies, transportation and law experts highly recommend the adoption of a risk management program. Risk management aims to identify, quantify, and control exposure to tort liability claims. Generally, a risk management program includes the following activities:

- Recognize and anticipate the degree of legal risk inherent in all of an agency's system responsibilities and programs, procedures, or actions
- Ensure that available resources are used in a manner to achieve maximum reduction of risk and prevention of loss while accomplishing the mission of the agency
- Prepare a timely, defensive response for actual or threatened legal actions
- Manage claims to result in proper resolution while achieving economy and fairness to the agency and therefore the public [12]

Risk management programs focus on roadway safety improvement in relation to the reduction of traffic crashes. This program in turn reduces an agency's risk of incurring liability claims. A risk management program systematically addresses high risk issues through preventative maintenance. The National Association of County Engineers (NACE) lists the following issues as most frequent causes of lawsuits against county road agencies: malfunctioning traffic signals, sign defects, roadside hazards, guidance, guardrail, shoulder maintenance, road surface maintenance, geometric elements of the road and

intersections, snow and ice control, and removal of highway debris. By addressing these and other important issues, a risk management program minimizes crash potential.

Employee training and education, good record keeping, and proper insurance coverage are essential to an effective risk management program. Routine inspections, provisions for emergency maintenance, design and operational reviews, and crash record reviews also are essential [1, 9, 13].

Like the highway safety improvement program and the safety management system, risk management programs require resources that often are not available to local government agencies. Some procedures are within the means of local agencies, yet many are too complex. Due to the lack of resources, most local government agencies have not adopted comprehensive risk management systems [1].

Road Safety Audits

The Road Safety Audit approach was established in the United Kingdom in the 1980s and is widely used in New Zealand and Australia. A road safety audit (RSA) evaluates accident potential and safety performance of a road section. Benefits of conducting aN RSA include:

- Reduction in accident likelihood
- Reduction in accident severity
- Elevation of road safety in priorities of road designers and traffic engineers
- Reduction in the need for costly remedial work
- Reduction in the total cost of a project to the community, including accidents, disruption, and trauma [14, 15, 16].

The current RSA program stresses the need for examiners to be independent trained professionals. The program also recommends that a team of professionals conduct audits when feasible. This improves the quality of the RSA due to diverse backgrounds and different approaches that will be consolidated in the team. RSAs are conducted during the feasibility, draft design, detailed design, and/or pre-opening stage of a roadway project or on an existing road [14, 15, 16, 17].

RSA's have proven extremely effective in New Zealand and Australia. RSA programs have been developed for several stages of design, construction and existing facilities. Practice shows that the earlier in the design and development process a road is audited the better. Auditing is most effective and feasible at the beginning of the design and development process because it is much simpler and substantially more economical to make changes to plans (redrawing) than it is to change the project after construction (costly reconstruction). Hence, audits in the early phases of a project tend to have the greatest effect on road safety because of higher versatility to major safety improvements or changes. Proper early auditing also reduces need for costly remedial work and reduces a project's total cost to the community, including disruption, trauma, and accidents [14, 15, 16].

AUSTROADS, the National Association of Road Transport and Traffic Authorities in Australia, emphasizes the extreme importance and utility of road safety audits within the design and development process. Nevertheless, AUSTROADS recognizes that road safety audits of existing road sections also are vital to enhancing roadway safety. Routine audits of existing roads are necessary to identify existing and potential road safety deficiencies even if a road was audited during design and development. Reasons for conducting a road safety audit on existing road sections include:

- Changing road uses over time
- Changing uses next to the road over time
- Attending to changes before they lead to crashes
- Growing landscapes
- Changing accepted practices with experience
- Checking consistency of road features
- Decreasing visibility and reflectivity of aging devices
- Maintaining devices may not result in safety because they become damaged or dangerous
- Addressing safety specifically rather than relying on routine or poor maintenance [14, 15, 16]

AUSTROADS developed a comprehensive RSA program including thorough audit checklists for each of the five phases. An important feature of an RSA program is the person who completes the audits.

AUSTROADS declares that a road safety audit should be executed by an individual or team of individuals who possess sufficient knowledge and expertise in traffic engineering, accident investigation and prevention, roadway safety engineering, and roadway design [14, 15, 16]. An understanding of road-user behavior and human perception also is beneficial because of the high interaction between road-user behavior and the roadway environment. A team of individuals is recommended over a single individual auditor. A team approach contributes diversity and cross-fertilization of ideas and approaches that allow for a more efficient audit.

Road safety auditors use an RSA checklist to aid in the audit process. The checklist provides questions regarding key safety issues considered during the audit process. Auditors assess the projects or road sections for any safety deficiencies with aid of the checklist and prepare reports that identify existing and/or potential safety problems. Road Engineers or project managers use the information to determine what appropriate actions should be taken.

This covers the basic principles behind an RSA, however the actual RSA process is more complex (see Table 2.4). The size of the audit task often determines appropriate size of the audit team. A specialist is sometimes used when specialized skills are required for a small portion of the audit task.

Table 2.4 Steps in a Road Safety Audit [16]

	STEP	RESPONSIBLE ENTITY
1	Select Auditor	Client or Designer
2	Provide background information	Designer
3	Hold commencement meeting	Client/Designer and Auditor
4	Assess Documents and Inspect Site	Auditor
5	Write Report	Auditor
6	Hold Completion Meeting	Client/Designer and Auditor
7	Follow Up	Client and Designer

After auditors have been selected, clients should provide all pertinent information such as the intent of the project, relevant site data, and plans and drawings (when audit is in the design phases). The project intent describes project goals and how they are to be achieved. Site data include all pertinent information

such as accident history, traffic volumes, any known safety issues, which remain unresolved from earlier audits, design standards that were used when the road section was constructed, and any environmental effects [14, 15, 16]. A commencement meeting to aquaint the road safety auditor with background of the project and to turn over necessary information is conducted, and auditors familiarize the client with the audit process.

Auditors are responsible for reviewing all the provided documents before completing the site inspection. A thorough inspection of the existing road (including a nighttime inspection) is conducted to identify existing and potential safety deficiencies. Auditors write an audit report with their findings. It is essential that the report be clear, concise, and formally written. The report includes the names of the auditors and a declaration signed and dated by the auditors confirming the audit's completion. The auditors also should include a list of the background information that was provided and used in the audit process. The main focus of the report is the statement and description of safety deficiencies discovered during the audit process. Recommendations for remedial action also are included when appropriate. However, these recommendations are not specific resolutions to the noted deficiencies, but the general nature or direction of a solution. It is important to note that the auditors' primary purpose is to identify existing and potential safety deficiencies and not specifically to determine solutions or recommendations.

After writing the report, auditors hold a completion meeting with the client to hand over the report and discuss findings. It is the client's responsibility to review the safety audit's findings to determine the appropriate actions to take. It also is important that the client carefully document the final decisions [14,15,16].

Incremental Improvements

Improvements to rural local roads are needed to increase roadway safety and should be in conformance with acceptable guidelines. However, due to funding constraints and other factors, full compliance with current guidelines is not always possible nor is it always in the best interest of a road manager's overall improvement program. There is a recognized need for alternatives to improve safety on existing rural local roadways. Many less expensive incremental improvements to safety deficiencies

throughout the rural local road network will result in greater reduction of injuries and fatalities than a few, "up-to standard" improvements [18]. Ideally, incremental improvements are staged to maximize safety, given limited resources.

There is a recognized desire for the use of incremental improvements on existing roadways by local agencies. However, it currently is difficult to secure funding for an incremental improvement. This is primarily due to liability issues that result from the rise in tort liability cases [1]. Funding agencies frequently are not willing to approve projects that do not completely upgrade a road section to current guidelines.

Summary of Literature Review

The risk management, conventional HSIP, and SMS programs examined in this chapter all require a substantial amount of funding, personnel, and expertise. Due to the lack of resources, many local government agencies do not implement these programs. Local agencies tend to rely on input from law enforcement, analysis of accident records, routine maintenance inspections, and/or input from the public and public officials and employees for identifying safety improvement needs. The methods are beneficial, but current high crash rates on rural local roads indicate a need to further address safety issues on these roads. There also is a need to elevate rural local road safety considerations on new planned roads and projects.

The road safety audit program examined represents a comprehensive outline of audit procedures successfully used in Australia and New Zealand. However, tailoring the recommended procedures for a successful road safety audit program is needed by rural local agencies in the United States. The present RSA process requires substantial resources that generally are not available to local agencies. A tailored RSA program to identify existing road safety deficiencies is proposed.

CHAPTER 3

METHODOLOGY

Introduction

As identified in the literature review, the rural local road classification represents more than half of the existing public road mileage in the United States [5,6]. Limited literature was found on safety practices and programs on rural local roads [4]. This project focused on developing safety practices based on expanding the rural local road classification. Surveys were designed to determine what further sub-classifications are appropriate for rural local roads, and what common safety programs' practices must be implemented by local road jurisdictions to address safety issues. In determining the sub-classifications of rural local roads, two rounds of the modified Delphi procedure were conducted. The results of the first round Delphi survey provided the basis for structuring the second round Delphi survey. The second round Delphi survey condensed responses for road classifications from the first round. A two-sample T-test was used in the first round and a chi-square test on the second round to help distinguish differences in the responses.

To identify common safety program practices in local road jurisdictions and to develop a road safety audit, a random sample test was conducted with county road superintendents and county engineers in FHWA Region VIII (Wyoming, Colorado, Utah, Montana, North Dakota, and South Dakota). The focus group (expert panel) and modified Delphi procedure are discussed in detail in this chapter.

Functional Classification System Surveys

Delphi Procedure

Quantitative or experimental methods don't easily determine appropriate sub-classifications for rural local roadways. Engineering judgement based on experience and a broad understanding of the situation is important. The modified Delphi surveys used in this project prompted specific input from the focus group, based on professional knowledge and personal judgement. This procedure provides a distillation of views from a wide range of experts used to build a rational basis for determining priorities and recommendations

for action on specific issues. The Delphi process often is used when results are not generally quantitative in nature and when limited facts are available [6, 19, 20, 21].

The Delphi survey procedure requires a relatively small group size. Research by Norman C. Dalkey demonstrated 20-30 professionals is an effective group size for obtaining group opinion [6,19]. The modified Delphi technique uses an iterative process of multiple rounds of questionnaires with feedback provided for the respondents. Responses to the first round of questions are incorporated into the next round of surveys. This provides panelists the opportunity to reevaluate and refine responses in hopes that the focus group reaches or approaches an agreement. However, the Delphi results seldom are a finalized resolution. Delphi results yield expert knowledge and an opinion used in resolving an issue or problem.

Focus Group

The focus group consisted of individuals from the six states in FHWA Region VIII — Colorado, North Dakota, Montana, South Dakota, Utah, and Wyoming. Thirty-nine individuals from diverse organizations including the Federal Highway Administration (FHWA), Bureau of Land Management (BLM), Department of Transportation (DOT), Local Technical Assistance Programs (LTAP), and selected counties responded to the surveys (see Table 3.1). The organizations are affiliated with rural roads on a local or regional basis and were selected because of knowledge and previous work experience with transportation safety. The organization and demographics for each of the Delphi survey respondents are contained in Table 3.2.

Table 3.1 Focus Group Organization Classification

Organization Classification	Number
State DOT	7
Federal	3
County	24
University/LTAP	5

Delphi Survey Questionnaires

During the first round of the Delphi surveys for this project, a questionnaire was sent with a detailed cover letter that explained the background, nature, and importance of the study. Information pertaining to the extent of involvement required from the focus group also was discussed. During the second round of the Delphi survey, the focus group members were informed of the first round survey results and were asked to complete the second and final survey questionnaire. As in the first round, focus group members were mailed a reminder/thank you postcard. The Delphi surveys for this project dealt with creation of the proposed functional classification system for rural local roads (see Appendix A). In the first round Delphi survey, respondents were asked if sub-classifications for low volume rural roads were warranted. Respondents also were asked what criteria sub-classifications should be based on for rural local roads. Respondents were asked to list the most appropriate sub-classifications for each of the criteria.

Results from the first round Delphi survey were used to structure the second round survey questionnaire. In the second round Delphi survey, respondents were provided with different sub-classifications for the average daily traffic (ADT), user type, and surface type criteria and asked to identify the sub-classifications for each criteria that they thought were most appropriate for sub-classifying existing rural local roads (see Appendix B). Each survey also provided respondents the opportunity to provide comments. Analysis of the Delphi surveys is contained in Chapter 4.

Table 3.2 Demographic and Organization Information of Delphi Respondents

Organization	State
Bureau of Land Management	Wyoming
Federal Highway Administration	Wyoming
Department of Transportation	Wyoming
Department of Transportation - District 1	Wyoming
Department of Transportation - District 3	Wyoming
Sublette County	Wyoming
Albany County	Wyoming
Park County	Wyoming
Federal Highway Administration	Colorado
Department of Transportation	Colorado
Boulder County	Colorado
Mesa County	Colorado
Weld County	Colorado
ND Technology Transfer Center	North Dakota
Upper Great Plains Transportation Institute	North Dakota
Department of Transportation	North Dakota
Burleigh County	North Dakota
Cass County	North Dakota
Golden Valley County	North Dakota
LaMoure County	North Dakota
Mercer County	North Dakota
SD Transportation Technology Transfer Center	South Dakota
Department of Transportation	South Dakota
Grant County	South Dakota
Harding County	South Dakota
Pennington County	South Dakota
Turner County	South Dakota
Utah Transportation Technology Transfer Center	Utah
Orem County	Utah
Garfield County	Utah
Summit County	Utah
San Juan County	Utah
Utah County	Utah
Department of Transportation	Montana
Montana Local Technical Assistance Program	Montana
Richland County	Montana
Gallatin County	Montana
Hill County	Montana
Missoula County	Montana

Local Rural Road Safety Survey

The next step of this research project involved a survey of county road superintendents and engineers in FHWA Region VIII (see Appendix D). The survey identified current situations facing counties in FHWA Region VIII, methods used to identify safety improvement needs, and factors that limit a county's ability to develop and implement a safety improvement program. The primary purpose of this survey was to gather input regarding feasibility and proper structuring of a road safety audit program for rural local roads. Feedback was used to help structure the proposed road safety audit program.

This survey was a random sample survey rather than a Delphi survey. The required sample size, n, for an infinite population was determined from the following equation [22]:

$$n = \frac{pqz^2}{T^2}$$

where p = preliminary estimate of the percentage,

q = 1 - p,

z = the number of standard error units (from a normal probability table), and

T = the required precision or tolerance.

P and q were assumed to be 0.5 because it produces the largest value of n. The value of z was 1.96 (95 percent confidence), and T equaled 7 percent error (0.07) since it produced a reasonable sample size and was within 10 percent, which T is generally limited. The required sample size was reduced due to effect of the finite population. This reduction was appropriate because the computed value of n (196) was greater than 10 percent of the population (30). The following equation was used to determine the required sample size, n′, for the survey (finite population) [23]:

$$n' = n/(1 + \phi)$$

where:

n = required sample size for infinite population, and

ϕ = n/N, where N = population size.

One hundred and nineteen responses were required from the random sample survey. It was assumed that approximately 40 to 50 percent of individuals involved in the regional study would actually respond to the survey. The required sample size or quantity of returned questionnaires was 41 percent of the population size. Therefore, it was determined necessary to include every county in FHWA Region VIII in the study instead of using random sampling. Surveys were addressed to the county road superintendents and county engineers.

A variety of techniques were used to maximize percentage of counties replying to the survey. A detailed cover letter that explained the background, nature, and importance of the study accompanied each questionnaire. Participants were provided business reply envelopes to minimize difficulty in returning questionnaires. Individuals also were given the option to fax questionnaires back, if preferred. A postcard was mailed to each of the participants approximately one week after the survey questionnaires were sent out reminding each member to respond to the survey and thanking those that had already responded. To obtain the required number of returned questionnaires, another questionnaire was sent to each of the counties that had not yet responded to the study after three weeks.

Analysis of the local rural road safety survey is contained in Chapter 4. Results of the analysis provided a foundation for conclusions and recommendations of this project.

Statistical Analysis

Statistical tests ranging from simple calculations, such as averages and percentages, to more complicated tests, such as two sample t-tests and chi-square tests, were used to analyze data during this project. The computer program Minitab was used to complete the statistical analyses for this project.

Two Sample T-Test

In analyzing the ADT sub-classifications survey data, statistical tests between two rankings were conducted. The testing determined if two different average rankings were statistically equal. The hypothesis for these tests is:

H_o: $\mu_1 = \mu_2$ (ranking 1 = ranking 2)

H_1: $\mu_1 \neq \mu_2$ (ranking 1 ≠ ranking 2)

The two samples were assumed independent. The two populations were not assumed to have equal variances (non-pooled procedure). The test is based on the statistic

$t = (\bar{x}_1 - \bar{x}_2)/s$

Where s is the standard deviation of $\bar{x}_1 - \bar{x}_2$ $\quad s = [s_1^2/n_1 + s_2^2/n_2]^{1/2}$

and s_1 and s_2 are the standard deviations of the two samples.

The statistic has approximately a t-distribution with degrees of freedom given by:

$$Df = \frac{(Var_1 + Var_2)^2}{[(Var_1)^2/(n_1 - 1)] + [(Var_2)^2/(n_2 - 1)]}$$

where:

$Var_1 = s_1^2/n_1$, and $Var_2 = s_2^2/n_2$.

The decision rule is:

If $t^* \leq t(1 - \alpha/2; df)$, conclude H_o

If $t^* > t(1 - \alpha/2; df)$, conclude H_1

The confidence interval is from:

$$(\bar{x}_1 - \bar{x}_2) - ts \text{ to } (\bar{x}_1 - \bar{x}_2) + ts$$

where t is the t-table value corresponding to the same degrees of freedom and percent confidence used in the test. The non-pooled procedure at the $\alpha = 0.05$ level of significance was used [24]. Results of the two sample t-tests relative to the ADT sub-classification data are contained in Appendix B.

Chi-square Test

In analyzing survey data for the second round Delphi survey, chi-square tests were performed to determine if associations exist within the data sets. Testing determined if an association exists between various responses (i.e. an association between how the focus group responded to the use of local access as a

sub-classification and how they responded to the use of collector as a sub-classification). The hypothesis for the test is stated as:

H_o: no association (or statistical significance) between sets

H_a: association (or statistical significance) between sets

The test statistic, X^2, is calculated by [24]:

$$\Sigma_i \Sigma_j (O_{ij} - E_{ij})^2/E_{ij}$$

where O_{ij} is the observed frequency in cell (i, j) and E_{ij} is the expected frequency for cell (i, j). The expected frequency for cell (i,j) is equal to $(n_1 * n_2)/n$ which equals:

$$\frac{\text{(total of row i) x (total of column j)}}{\text{total number of observations}}$$

Table 3.3 contains the representation for 2 x 2 comparisons. The test statistic for the matched pair data from the survey is:

$$Q_M = \frac{(n_{1\text{-}2} - n_{2\text{-}1})^2}{(n_{1\text{-}2} + n_{2\text{-}1})}$$

Table 3.3 Matched Pairs Data (2 x 2 Table)

	Arterial	
Collector	Acceptable	Unacceptable
Acceptable	$n_{1\text{-}1}$	$n_{1\text{-}2}$
Unacceptable	$n_{2\text{-}1}$	$n_{2\text{-}2}$

X^2 follows approximately a chi-square (χ^2) distribution. The decision rule is:

If $X^2 \leq \chi^2 (1 - \alpha; (r - 1)(c\text{-}1))$, conclude H_o

If $X^2 > \chi^2 (1 - \alpha; (r - 1)(c\text{-}1))$, conclude H_a

The appropriate alpha level was determined by calculating the Bonferroni family confidence coefficient: $\alpha/(2g)$, where g = # of tests or comparisons. Results of the chi-square tests completed in this project are contained in Appendix B.

The results of the surveys and the statistical analysis are contained in Chapter 4 . Functional classification expansion for rural local roads begins the chapter. Concluding the chapter is the result of applying road safety audit to a rural secondary sub-classification.

CHAPTER 4

ANALYSIS & RESULTS

Introduction

The road safety audit (RSA) program proposed for use by local agencies was developed in two stages. First, a classification system for rural local roads was created to help structure road safety audits using input from the regional focus group. Second, an RSA program was developed with input from the county road superintendents and engineers in FHWA Region VIII. This chapter presents the results of the Delphi surveys and the random sample survey, the classification system, the road safety audit program, and the results from the pilot study.

Evaluation of Functional Classification System Survey Data

The primary purpose of the initial Delphi survey of the regional focus group was to determine if sub-classification of rural local roads was warranted. Issues for the creation of an appropriate sub-classification system for the roads also was examined. Thirty-six surveys were returned — a 59 percent return rate. The survey questionnaire and summary results for the first round are included as Appendix A. Important findings from the survey follow.

- Sub-classification for rural local roads is warranted
- Sub-classification for rural local roads should be based on average daily traffic (ADT), user type, and surface type
- Three to four sub-classifications using ADT, user type, and surface type were most appropriate

Respondents offered supportive comments for sub-classification of rural local roads. Several typical comments follow.

- "In South Dakota, we recommend surfacing based on ADT. Therefore a separate classification for surface type would be redundant."

- "ADT and user type should be used in conjunction to sub-classify low volume rural roads. This will be in keeping with the concept of functional classification, with ADT being a modifying element for assessing need for various safety and traffic operation standards."
- "While surface types don't create the sub-classifications, the ADT sub-classifications begin to suggest or demand a surface type."

Results of the first round Delphi survey also provided the basis for structuring the second round Delphi survey. The purpose of the second round Delphi survey was to gather input to condense responses for sub-classifications from the first round. Thirty-nine surveys were returned during the second round, a 64 percent return rate. The survey questionnaire and summary results for the second round are included as Appendix B. Analysis of survey data received from the respondents for the second round of the Delphi survey consisted of basic statistics, two-sample t-tests, and chi-square tests.

In analyzing the ADT sub-classification data, average rank for each of the nine possible ADT sub-classification systems was determined. The rankings provided were averaged by all the focus group members for each sub-classification (sub-classifications were ranked 1-9 with 1 being the most appropriate and 9 being the least appropriate). The average ranking results for the nine ADT sub-classification systems are presented in Table 4.1. Two sample t-tests were completed for systems with the three best (lowest) average

Table 4.1 Average Rankings for ADT Sub-classification Systems

ADT Sub-classification System	Avg. Rank
(A) 0-25, 25-50, 50-100, 100-400, 400-1500	5.7
(B) 0-25, 25-250, 250-400, 400-1500	5.1
(C) 0-25, 25-250, 250-1500	5.6
(D) 0-50, 50-200, 200-400, 400-1500	**4.0**
(E) 0-50, 50-250, 250-400, 400-1500	**3.7**
(F) 0-50, 50-250, 250-1500	5.1
(G) 0-100, 100-250, 250-400, 400-1500	**4.3**
(H) 0-100, 100-250, 250-1500	5.7
(I) 0-250, 250-400, 400-1500	6.1

rankings. Average ranks for the groups were distinctively better than the next highest ranked ADT groupings. This statistical analysis determined that no significant difference in respondent approval existed between any of the top three ranked ADT sub-classification systems.

Table 4.2 shows the two sample t-test results. In analyzing the user type sub-classification data, the percent of respondents who selected each user type sub-classification was calculated (see Table 4.3). The majority of respondents selected passenger car, emergency route, and trucking as a user type sub-classification. Respondents also often selected arterial, collector, recreational, bus route, and residential. Chi-square (McNemar's) tests were completed between each of the sub- classifications to determine if a statistical significance existed between pairs of sub-classifications. Results of the chi-square tests are included in Appendix B. Collector, arterial, local access, and low-volume local were selected for sub-classifying rural local roadways. The four sub-classifications were preferred by the focus group. These sub-classifications categorize roadways according to their traffic service characteristics. The other user type sub-classifications studied refer to specific vehicle types (passenger car, trucking) or specific routes (bus route, mail route, emergency route) not unique to a type of rural local road; therefore arterial, collector, local access, and low-volume local were the primary considerations.

Table 4.2 Two-Sample T-Test Results

Class	Difference in Avg. Ranks	T value	P value	95% C.I.	DF	Decision
E vs. D	3.7 – 4.0 = -0.3	-0.86	0.39	(-1.28, 0.51)	75	Cannot Reject H_o: Not significantly different
D vs. G	4.0 – 4.3 = -0.3	-0.49	0.62	(-1.29, 0.78)	73	Cannot Reject H_o: Not significantly different
E vs. G	3.7 – 4.3 = -0.6	-1.27	0.21	(-1.65, 0.37)	71	Cannot Reject H_o: Not significantly different

Table 4.3 User Type Results

User Type Sub-classification	Percentage*
Passenger Car	59
Emergency Route	51
Trucking	51
Collector	49
Bus Route	49
Residential	44
Arterial	44
Recreational	41
Agricultural	36
Local Access	26
Low Volume Local	21
Mail Route	10
Commercial/Industrial	3

* Percentage selected by responding counties

Percent of respondents who selected each surface type sub-classification was determined by analyzing the surface type sub-classification data (see Table 4.4). The majority of respondents selected paved as a surface type sub-classification. Respondents also frequently chose gravel, graded all-weather gravel, and dirt (graded surface). Chi-square tests were completed between each of the sub-classifications to determine if a statistical significance existed between pairs of sub-classifications. Results of the chi-square tests are included in Appendix B. Paved, gravel, and dirt were considered to be the most appropriate surface type sub-classifications by the focus group.

Table 4.4 Surface Type Results

Surface Type Sub-classification	Percentage*
Paved	92
Gravel	67
Dirt	46
Graded All-weather Gravel	46
Unpaved - Treated	36
Unimproved Dirt	31
Graded Dirt	28
Unpaved - Untreated	21
Native Gravel	13
Double Shot	10

* Percentage selected by responding counties

Development of the Rural Local Road Functional Classification System

The proposed rural local road sub-classification system is included in Table 4.5. Input from the first round Delphi survey determined four sub-classifications. The rural primary classification serves larger towns. Other traffic generators not served by higher systems, links these places with nearby cities and larger towns or with higher systems, and serves the more important intra-county travel corridors. The rural secondary classification accumulates traffic from local roads, brings all developed areas within reasonable distance of collector roads, provides service to the remaining smaller communities, and links the locally important traffic generators with their rural region. The rural local and rural low-volume local classifications provide access to land adjacent to the collector network and serve travel over a relatively short distance [3].

Traffic volumes (ADT) and surface types generally are not independent road characteristics. For this reason the four functional sub-classifications were used to structure the classification system and typical traffic volumes and surface types were included under each sub-classification. ADT sub-classifications of 0-100, 100-250, 250-400, 400-1500, were selected for the typical traffic volumes. The study took into account that many rural local jurisdictions do not maintain current and accurate records of roadway traffic volumes. For this reason, a larger range of traffic volumes was selected as more appropriate. Paved, unpaved, and dirt (graded surface) were used as typical surface types for the sub-classification system.

Evaluation of the Local Rural Road Safety Survey

The local rural road safety survey gathered input into structuring the road safety audit program for rural local roads. One hundred and fifty-eight (158) surveys were returned, a 55 percent return rate. The survey questionnaire and summary results are included as Appendix C.

Table 4.5 Classification System for Local Rural Roads

	ROAD CLASSIFICATION	
	A	**B**
FUNCTIONAL SYSTEM	**Rural Primary**	**Rural Secondary**
	Serves larger towns and other traffic generators not served by higher systems, links these places with nearby cities and larger towns or with higher systems, and serves the more important intracounty travel corridors Typically paved surface, traffic volumes are generally 400 vehicles per day and above	Accumulates traffic from local roads, brings all developed areas within reasonable distance of collector roads, provides service to the remaining smaller communities, and links the locally important traffic generators with their rural region Typically unpaved surface but may be paved, traffic volumes generally range from 250 to 400 vehicles per day
	ROAD CLASSIFICATION	
	C	**D**
FUNCTIONAL SYSTEM	**Rural Local**	**Rural Low-volume Local**
	Provides access to land adjacent to the collector network and serves travel over relatively short distances Typically unpaved surface, traffic volumes generally range from 100 to 250 vehicles per day	Provides access to land adjacent to the collector network and serves travel over relatively short distances Typically graded surface, traffic volumes generally range from 0 to 100 vehicles per day

Road characteristics and current safety improvement practices used by counties in FHWA Region VIII were identified. Important findings from the survey follow.

- The average road mileage under each responding county's jurisdiction was 839 miles.
- The average percentage of county road mileage under each road classification in for the responding counties (listed in Table 4.6) ranged from 19 to 28 percent.
- Only 39 percent of the responding counties stated that individual safety improvement needs are identified uniformly for all road classifications. The majority of counties stated that road classifications A: Rural Primary and B: Rural Secondary receive more attention than the other two classifications.
- Input from the public, public officials and employees, and law enforcement was the most used method for identifying locations for safety improvements (see Table 4.7). Routine inspections and rating activities, operational problems, and analysis of accident records also were used by a majority of the responding counties. Routine inspections and rating activities primarily focus on maintenance issues.
- Manpower and funding were cited as major factors limiting the responding counties' abilities to develop and maintain safety improvement programs (see Figure 4.1).

Table 4.6 Average Percentage of County Road Mileage by Classification

Roadway Classification	Percentage*
A: Rural Primary	19
B: Rural Secondary	27
C: Rural Local	26
D: Rural Low-Volume Local	28

* Average percentage of county road mileage for the responding counties (total = 100%)

Table 4.7 Methods Used by Counties in FHWA Region VIII for Identifying Locations for Safety Improvements

Methods for Identifying Locations for Safety Improvements	Percentage*
Input/Comments from the Public	91
Input from Public Officials/Employees	84
Input from Law Enforcement	70
Routine Inspections and Rating Activities	60
Analysis of Accident Records	59
Operational Problems	59
Safety Studies (on rural roads)	15
Comprehensive Safety Improvement Program	9
Accident Pin Map	7
Other	2
None	1

* Percentage of responding counties that use the specified methods to identify locations for safety improvements

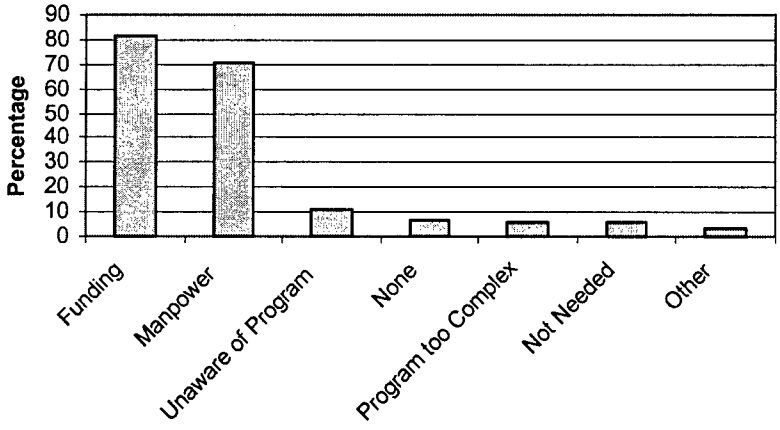


Figure 4.1 Factors Limiting Abilities to Develop and Maintain SIPs

The primary purpose of the survey's second part was to determine local rural interest in an RSA program. Input also was gathered to help structure the RSA program for existing rural local roads. Important findings on these issues from the responding counties follow.

- 59 percent indicated that a RSA program for rural local roads was necessary, 84 percent indicated that it would be useful, and 63 percent indicated that it would be cost-effective.
- 67 percent indicated that RSA program training was necessary for counties to be able to implement the program.
- 77 percent indicated that RSA procedures (checklists) should vary for different local rural functional classifications (a more comprehensive RSA should be completed on higher road classifications).
- Some respondents indicated that their agency was skeptical about conducting road safety audits, noting that identifying safety deficiencies and not repairing them would increase the possibility of lawsuits.

Development of the Rural Local RSA Program

Based on the previously stated findings, the proposed RSA of existing rural local roads focuses on identifying major safety issues. The purpose is to keep the program concise and cost-effective.

Audit Team

Auditors are a vital part of an RSA program. For this reason, significant thought was given to who should complete audits on rural local roads. Several possibilities for structuring an audit team were considered, including independent qualified examiners, county personnel, and associate county personnel.

An ideal team of independent examiners would be comprised of experienced individuals with diverse backgrounds in traffic engineering, crash investigation and prevention, roadway safety engineering, and other related areas. Based on AUSTROADS, this approach greatly benefits the road safety audit process. The cross-fertilization of ideas and approaches and the many "fresh" sets of eyes adds to the benefit of an audit.

This vast knowledge and expertise of the audit team also allows for a highly comprehensive road safety audit. However, is a team of independent professionals feasible for auditing existing rural local roads? Engineering expertise is important in auditing existing roads, although a large diverse team of professionals is also not as essential as it is in auditing the early design phases. Knowledge of environmental factors and their potential impact is an important consideration to low volume rural roads. The under reporting of crashes is a characteristic of these roads. The cost of such a professional audit team also is a factor. In the regional local rural road safety survey, respondents indicated that limited funding restricts the local agency's ability to develop and implement a safety improvement program. With limited resources, this type of audit team structure is not likely for most local agencies.

The use of road superintendents to conduct road safety audits for their own county and/or for a nearby county also was considered due to the fact that a large majority of counties in region VIII have road superintendents and no county engineers. Road superintendents may not have the expertise and experience of independent qualified safety examiners. Training on key safety issues is needed. If a road superintendent conducted audits on roads under his/her own jurisdiction, it does not provide "fresh eyes" or provide a fresh perspective in auditing road sections. However, it provides familiarity with roadway environment and road users, and possibly knowledge of unofficially reported crashes.

Arrangements between counties to exchange road superintendents for the audit process also is a possibility. A road superintendent from a neighboring county brings a fresh perspective by not being familiar with the roads. Assembling a team using a combination of methods also is possible.

Road Safety Audit Process

The proposed RSA program for rural local jurisdictions was structured to be beneficial, efficient, and easily implemented. Processes from the AUSTROADS program were tailored for use by U.S. rural local jurisdictions. The RSA process for existing roads was designed for use by road superintendents as auditors.

The first step in the proposed RSA process is an office review. The road superintendents gather and review only necessary background information. This includes information such as existing and expected

future traffic volumes if known, any known unresolved safety issues, and other information pertinent to the audit. If easily obtained, a brief review of crash records is recommended, however, the audit should not focus on these specific sites. In the regional local road safety survey, a majority of the respondents indicated that their agency already completes analyses of crash records.

The next step is a field review or actual examination of the existing road section. Ideally, field reviews should occur during daylight and nighttime hours. The recommended procedure is to drive the length of the road section in both directions at a safe operating speed or at the speed limit and then again at a slow speed (approximately 10 mph) stopping to take a closer look at potential deficiencies. Taking pictures of the major safety deficiencies is recommended for use at a later date when the problems will be presented to local elected officials. Audit checklists are used as a tool to aid in the audit process (see Appendix D). They help guide the auditors through the examination and help structure the investigation. The auditors may want to fill out checklists as they complete the inspection for each specified safety deficiency, including relevant comments, or to use the checklist only to ensure consideration of major issues.

During the final step, auditors fill out a simple report form (see Appendix E). The main focus of the report form is the statement and description of the safety deficiencies discovered during the audit process. Possible recommendations for safety improvements should be included when appropriate. It is important to note that the auditors' primary purpose is to identify existing and potential safety deficiencies and not specifically to determine solutions or recommendations. When general recommendations are included, they should be feasible improvements for rural local jurisdictions. Finally, a brief discussion of the major findings with the local political jurisdictions is key to the audit's effectiveness.

Adapting RSA Field Review to Rural Local Roads

Many factors must be taken into account in the planning, design, and operation of a road system. Although safety is a major goal, other objectives that influence the possible level of safety include convenience and ease of travel, increased mobility, protection of the environment, and cost.

Road jurisdictions are responsible for roadways with a wide range of road characteristics. Rural local roads include paved and unpaved roads in various conditions. Traffic volumes on the roads also vary significantly. Some roads carry traffic volumes of more than 1,500 vehicles per day; others carry traffic volumes of less than 50 vehicles per day. Alignments and cross sections on rural local roads typically do not provide the same level of safety as on main highways.

Limited funds and/or technical constraints make some state-of-the-art safety treatments impractical for local roads. The National Association of County Engineers notes that high frequency problems on county roads include malfunctioning traffic signals, sign defects, roadside hazards, deficient guide/guardrail, shoulder maintenance, road surface maintenance, geometrics of the road and intersection, snow/ice control, and removal of highway debris [9]. These high frequency problems were considered while structuring RSA checklists. The primary checklist items or safety issues contained in the AUSTROADS approach for existing roads also were considered. However, to encourage local rural agencies to initiate a process of RSAs, a tailored approach is recommended. Only major safety issues for rural local roads and their intersections were included in the checklist. In the following sections these key safety issues are discussed.

Special Users

Pedestrians and cyclists are a vulnerable roadway user group and subsequently have special needs regarding safety. However, rural local roads generally do not have a high volume of these road users. Also, limited resources at the local level unfortunately make it difficult to maximize safety for them. Auditors should focus primarily on appropriate signing and/or marking for areas where a substantial volume of the road users exists. However, the auditor should look for areas where special safety problems potentially exist for them.

Intersections

Demands on all road users increase at intersections due to the wide variety of potential conflicts [17]. Visibility while approaching intersections and visibility at intersections must be addressed in the audit

process. Readability by motorists and intersection traffic control devices, railroad crossing sight distances, the approach grades, and proper use of signing also need to be addressed. [25] Potentially limited sight distances should be checked against practice guidelines.

Road Surface Issues

The safety audit should address major road surface features for potential safety deficiencies. Major issues include surface defects, edge drop-offs, and other areas where loss of steering control or impaired visibility has a high potential. Particular focus should consider washboard or corrugations in advance of major structures and on horizontal and vertical curves.

Traffic Control Devices

The auditors must analyze traffic signs, pavement markings, and delineators for compliance with present *Manual on Uniform Traffic Control Devices* (MUTCD) practice. Adequacy, visibility, and location of the devices should be addressed.

Roadside Features/Physical Objects

The clear zone, crash barriers, bridges, culverts, fencing, poles, and other objects or features should be evaluated. Minimum clear zone widths of 10 feet are desirable. Initial efforts to improve clear zones while focusing on the outside of horizontal curves has the highest potential for improving road safety. Removal, relocation, retrofitting, shielding, and delineation of fixed objects are alternatives for improving roadside safety.

Consistency

A safety audit addresses consistency throughout the length of the road section being audited and consistency to adjacent sections. Inconsistencies in roadway cross section, approach treatments, signing, pavement markings, and delineation have potential to lead to safety problems by violating driver expectancy.

These issues are included in RSA checklists (see Appendix D). Different checklists were developed for paved roads (Class A and some Class B roads), and unpaved roads (Class B, C, and D).

Evaluation of RSA Field Review Process

The final part of this research project tested RSA checklists. Two pilot RSA field reviews were completed to test proposed safety deficiency identification and reporting procedures. Both RSA pilot studies were completed during daylight hours and good weather conditions. The following two sections discuss the studies.

Rogers Canyon Road (Pavement)

A five-mile section of Albany County Road No. 17 carries through traffic to a few new subdivisions, the Laramie rifle range, and several ranches. Rogers Canyon Road provides a direct route between Laramie and Horse Creek (see Figure 4.2). Alignment varies from straight and level to curved and rolling. There are several cattle guards on the section. Characteristics of the road section included average traffic volume (320 vehicles per day), local and recreational users, and an extremely low number of heavy vehicles.

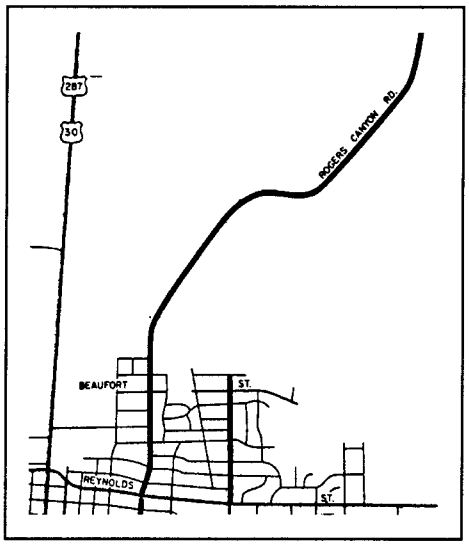


Figure 4.2 Rogers Canyon Road, No. 17 [26]

The pilot study of this five-mile paved section of Rogers Canyon Road validated the checklist process as simple and quick, yet beneficial. The RSA checklists helped to guide the audit of the road section and ensured that key safety issues were addressed. The reporting form also proved to be simple and efficient for recording pertinent safety audit information.

Safety deficiencies identified for this section of Rogers Canyon Road and the respective recommendations for improvement follow. See Appendix F and G for the checklists and reporting forms respectively for this audit.

- Deficiency: Missing and damaged post delineators on curves

  Recommendation: Replace the missing and damaged post delineators;
- Deficiency: Physical object in clear zone(square post signing private property)

  Recommendation: Relocate post to outside of clear zone;
- Deficiency: Missing object marker at southbound approach to cattle guard

  Recommendation: Replace missing object marker
- Deficiency: Dangerous drop-off at edge of pavement over a culvert (3-ft. nearly vertical slope down to a 2-ft. diameter culvert, which has not been day-lighted),

  Recommendation: Add material to flatten the slope

Rogers Canyon Road (Unpaved)

A five-mile, unpaved section of Albany County road No. 17a continues access to several county residences. Alignment varies from straight and level to curved and rolling. There also are several cattle guards on this section. Characteristics of the road section were similar to that for the paved section.

The pilot study of this five-mile unpaved section of Rogers Canyon Road also validated the checklist to be practical and useful in ensuring that key safety issues were addressed. The reporting form proved to be simple and efficient for recording the pertinent safety audit information for this road section.

Safety deficiencies identified for this unpaved section of Rogers Canyon Road and the respective recommendations for improvement consisted of (see Appendix F and G for the checklists and reporting forms respectively for this audit):

- Deficiency: Several cattle guards without any delineation

  Recommendation: Install post delineators or object markers at cattleguards;
- Deficiency: No warning of end of pavement is provided

  Recommendation: Install a Pavement Ends sign at approach to the end of the pavement
- Deficiency: Abrupt drop-off at transition from paved to unpaved surface

  Recommendation: Improve transition by smoothing surface and adding gravel as needed to eliminate drop-off
- Deficiency: Physical object in clear zone (large fallen tree)

  Recommendation: Remove fallen tree from clear zone
- Deficiency: Intermittent rutting and potholes

  Recommendation: Remove surface irregularities by smoothing or reshaping.

The purpose of this brief reporting of results indicates the value of a proactive approach to safety. A systematic RSA incorporated into a safety improvement process is proposed. This has been presented in the following sections.

The Safety Improvement Process

RSAs must be incorporated into a simple yet effective safety improvement program (SIP). A previously proposed five-step SIP by Caldwell and Wilson follows.

- System-wide prioritization of roads
- Identification of safety improvement needs on individual road sections
- Prioritization of safety improvements
- Scheduling and implementing safety improvements
- Program evaluation and update process [1]

The first step in the SIP process is prioritization of the roads to be audited. It is not feasible for a local road agency to audit all of its roads yearly. Local agencies must determine what portion of their roads to audit each year. It is suggested that local agencies audit at least 20 percent to 25 percent of their roads each year with repeat or continual audits of the same road sections conducted over time.

Functional classification is one way to help local jurisdictions structure their audits. For example, one proposed system is to schedule audits of class A roads first, than class B roads, than class C roads, and class D roads last. The goal of the prioritization process is to identify road sections with the largest potential safety benefit. Professional judgement is necessary to avoid in-depth, unnecessary procedures that will make prioritizing road sections complex, timely, and ultimately infeasible for a local agency [1]. Initially, completing RSAs on these high priority road sections is proposed.

The proposed RSA program is intended to be used to identify safety improvement needs on individual road sections. If key safety improvement needs are not adequately identified, the other SIP procedures are of little benefit. The proposed RSA program was designed as a more practical yet cost-effective procedure for this purpose.

After the RSA process has been completed, it is the local agency's responsibility to consider each safety deficiency. In this third step, the local agency should consider possible approaches and alternatives for remedying or reducing deficiencies and determine the appropriate courses of action. It is important that the local agency document reasons for decisions. Careful documentation especially is important when no improvement is made on a given deficiency. References are available that discuss prioritization of safety improvements, which will help local agencies determine how to structure improvements [2, 27]. A standardized procedure for prioritizing improvements is strongly recommended. Nonetheless, some flexibility in the system is needed due to unique conditions facing local jurisdictions.

Scheduling safety improvements according to priority and to maximize safety benefit per cost ratio is a possible procedure. After safety improvements have been implemented, the local agency must evaluate their effectiveness. Evaluations enable the SIP process to be the dynamic safety program necessary to accommodate changes that occur in rural local road networks.

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

This research addressed the need for a road safety audit (RSA) program designed specifically for existing rural local roads. With limited resources at the local level, the majority of local agencies currently do not have an effective safety improvement program. Significantly higher crash rates experienced on rural local roads indicate the need for a program specifically designed to increase safety on these roadways. The safety practices used by most local agencies rely mainly on input from the public, public officials and employees, and law enforcement and from the analysis of crash records.

An RSA program increases road safety by specifically addressing safety deficiencies before they result in crashes. Unfortunately, some responding local road agencies are skeptical about identifying safety deficiencies that exist on roads in their jurisdiction while not being capable of completely remedying all deficiencies at once. They believe an audit will increase exposure to tort liability. Ignorance of existing safety deficiencies is not a defense of tort liability, therefore it is essential that local agencies incorporate a program to help identify safety deficiencies.

The primary objective of this research was to develop and test a suitable RSA program for rural local roads. A literature review of current RSA programs discovered fairly skill-intensive models focusing primarily on high volume, high priority road sections in Australia and New Zealand. The feasibility and development of an RSA program for existing roads tailored to resources as well as to needs of rural local jurisdictions in the United States was studied. A survey of county road superintendents and engineers in FHWA Region VIII was completed for this purpose. Input from the road superintendents and county engineers was used to help structure the proposed RSA program using the following three steps: (1) office review, (2) field review, and (3) report. The recommended program is simple to use and likely cost effective for most rural local jurisdictions.

Another objective of this research was to develop a functional classification system for rural local

roads to help structure RSAs. A regional focus group (FHWA Region VIII) of professionals with knowledge and previous work experience dealing with transportation safety on rural roads was formed to gather input for this objective. Focus group members represented the Federal Highway Administration, Bureau of Land Management, Departments of Transportation, Local Technical Assistance Programs, and selected counties. Input from the focus group was acquired through use of a modified Delphi procedure. Using this input, four sub-classifications were developed to categorize rural local roads: rural primary, rural secondary, rural local, and rural low-volume local.

Conclusions

This research project reached the following conclusions:

- The functional classification of rural local roads must be established to structure the safety needs identification process and incremental improvements.
- Most local jurisdictions do not have an adequate safety needs identification process.
- Development of a safety needs identification process for rural roads must recognize limited local resources.
- The local rural road safety survey indicated region-wide belief that an RSA program is justified and useful for local rural jurisdictions as a safety needs identification process.
- Pilot studies demonstrated that RSAs are a simple yet beneficial method for evaluating safety needs.

Recommendations

Additional research concerning safety on rural local roads follow.

- Determine the appropriate differences in the RSA procedures/checklists for different local rural road classifications.
- Integrate use of a Global Positioning System into the RSA process.
- Develop an appropriate RSA training program to properly train prospective auditors.

- Develop an RSA manual/field guide to be used in training and in conjunction with the checklists during the audit process.

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Appendix A

First Round Delphi Survey Questionnaire
And
Summary Results

LOCAL RURAL ROADS SURVEY

1. Do you think sub-classifications for low volume rural roads are warranted? ___ Yes ___ No

2. Should sub-classifications for low volume rural roads be based on ADT? ___ Yes ___ No

3. Should sub-classifications for low volume rural roads be based on user type? ___ Yes ___ No

4. Should sub-classifications for low volume rural roads be based on surface type? ___ Yes ___ No

5. (A) If you answered yes to question 2, how many ADT sub-classifications would be most appropriate?
_____

(B) What would be the most appropriate ADT ranges for sub-classifications?
(Please rank through 2000 ADT, ex. 0-600, 600-1200, 1200-2000)
_____

6. (A) If you answered yes to question 3, how many user type sub-classifications would be most appropriate?
_____

(B) What would be the most appropriate user type sub-classifications?

7. (A) If you answered yes to question 4, how many surface type sub-classifications would be most appropriate? _____

(B) What would be the most appropriate surface type sub-classifications?
_____

Comments: _____
_____
_____

Questions 1 – 4 Results

The overwhelming majority of the respondents indicated that sub-classifications for low volume rural roads are warranted. The majority of the respondents also indicated that sub-classifications for low volume rural roads should be based on ADT, user type, and surface type (see Table 1 for the percentage of affirmative responses for each question).

Table 1 Questions 1-4 Results

Question	Percentage*
1. Do you think sub-classifications for low volume rural roads are warranted?	97
2. Should sub-classifications for low volume rural roads be based on ADT?	78
3. Should sub-classifications for low volume rural roads be based on user type?	70
4. Should sub-classifications for low volume rural roads be based on surface type?	62

* Percentage of respondents who answered in the affirmative

Question 5A

How many ADT sub-classifications would be most appropriate?

Question 5A Results

The average of the responses for the most appropriate number of ADT sub-classifications was four.

Question 5B

What would be the most appropriate ADT ranges for sub-classifications?

Question 5B Results

The responses consisted of a wide range of ADT sub-classifications. Feedback from the literature review determined that 250-1500 vpd or 400-1500 vpd was most appropriate for the highest ADT sub-classification. Feedback from the survey was used to determine the most appropriate sub-classifications in the 0-400 range. The following ADT sub-
classification systems were the most common responses for the 0-400 range: 0-25, 0-50, 0-100, 25-50, 50-100, 50-200, 50-250, 100-250, 100-400, 200-400, and 250-400.

Question 6A

How many user type sub-classifications would be most appropriate?

Question 6A Results

The average of the responses for the most appropriate number of user type sub-classifications was three to four.

Question 6B

What would be the most appropriate user type sub-classifications?

Question 6B Results

The most recommended responses for user type sub-classifications included:

- Residential
- Trucking
- Local Access
- Mail Route
- Arterial
- Agricultural
- Passenger Car
- Low Volume Local
- Emergency Route
- Commercial/Industrial
- Recreational
- Bus Route
- Collector

Question 7A

How many surface type sub-classifications would be most appropriate?

Question 7A Results

The average of the responses for the most appropriate number of surface type sub-classifications was three to four.

Question 7B

What would be the most appropriate surface type sub-classifications?

Question 7B Results

The most recommended responses for surface type sub-classifications included:

- Paved
- Double Shot
- Unimproved Dirt
- Gravel
- Unpaved-Untreated
- Graded Dirt
- Native Gravel
- Unpaved-Treated
- Dirt
- Graded All-Weather Gravel

Typical Comments

- "In South Dakota, we recommend surfacing based on ADT. Therefore a separate sub-classification for surface type would be redundant."
- "ADT and user type should be used in conjunction to sub-classify low volume rural roads. This will be in keeping with the concept of functional classification, with ADT being a modifying element for assessing need for various safety and traffic operation standards."
- "While surface types don't create the sub-classifications, the ADT sub-classifications begin to suggest or demand a surface type."

Appendix B

Second Round Delphi Survey Questionnaire
And
Summary of Results

LOW VOLUME RURAL ROADS SURVEY

(1) ADT Sub-classifications (based on average vehicles per day)

Please rank the following sub-classifications 1-9, with 1 being the one you feel would be most appropriate and 9 being the one you feel would be the least appropriate to classify existing low volume rural roads. Please rank all options to help in the analysis process.

____ (A) 0-25, 25-50, 50-100, 100-400, 400-1500
____ (B) 0-25, 25-250, 250-400, 400-1500
____ (C) 0-25, 25-250, 250-1500
____ (D) 0-50, 50-200, 200-400, 400-1500
____ (E) 0-50, 50-250, 250-400, 400-1500
____ (F) 0-50, 50-250, 250-1500
____ (G) 0-100, 100-250, 250-400, 400-1500
____ (H) 0-100, 100-250, 250-1500
____ (I) 0-250, 250-400, 400-1500

(2) User Type Sub-classifications

There are many different categories listed below that could be used for classification purposes, but please check only the sub-classifications that you feel should be used to classify existing low volume rural roads by user type.

____ Residential
____ Agricultural
____ Commercial/Industrial
____ Trucking
____ Passenger Car
____ Recreational
____ Local Access
____ Low Volume Local

____ Bus Route
____ Mail Route
____ Emergency Route
____ Collector
____ Arterial

(3) **Surface Type Sub-classifications**

There are many different categories listed below that could be used for classification purposes, but please check only the sub-classifications that you feel should be used to classify existing low volume rural roads by surface type.

____ Paved
____ Unpaved-Untreated
____ Unpaved-Treated
____ Double Shot
____ Graded Dirt
____ Dirt
____ Unimproved Dirt
____ Graded All-Weather Gravel
____ Native Gravel
____ Gravel

Comments:

Question 1

Rank the sub-classifications 1-9, with 1 being the one you feel would be most appropriate and 9 being the one you feel would be the least appropriate to classify existing low volume rural roads.

Question 1 Results

Sub-classification systems D, E, and G had the lowest (best) average rank (see Table 1).

Table 1 Average Rankings for ADT Sub-classification Systems

Sub-classification System	Avg. Rank
(A) 0-25, 25-50, 50-100, 100-400, 400-1500	5.7
(B) 0-25, 25-250, 250-400, 400-1500	5.1
(C) 0-25, 25-250, 250-1500	5.6
(D) 0-50, 50-200, 200-400, 400-1500	**4.0**
(E) 0-50, 50-250, 250-400, 400-1500	**3.7**
(F) 0-50, 50-250, 250-1500	5.1
(G) 0-100, 100-250, 250-400, 400-1500	**4.3**
(H) 0-100, 100-250, 250-1500	5.7
(I) 0-250, 250-400, 400-1500	6.1

Two Sample T-Test Results:

H_o: $\mu_1 = \mu_2$
H_1: $\mu_1 \neq \mu_2$

Rule: Cannot Reject H_o if $T \leq T(.95, DF)$
Reject H_o if $T \geq T(.95, DF)$

$T(.95, 75) = 0.2524$, $T(.95, 73) = 0.2523$, $T(.95, 71) = 0.2523$

The analysis determined that no significant difference in respondent approval existed between the top three ranked ADT sub-classification systems (see Table 2).

Table 2 Two-Sample T-Test Results

Class	Difference in Avg. Ranks	T value	P value	95% C.I.	DF	Decision
E vs. D	3.7 – 4.0 = -0.3	-0.86	0.39	(-1.28, 0.51)	75	Cannot Reject H_o: Not significantly different
D vs. G	4.0 – 4.3 = -0.3	-0.49	0.62	(-1.29, 0.78)	73	Cannot Reject H_o: Not significantly different
E vs. G	3.7 – 4.3 = -0.6	-1.27	0.21	(-1.65, 0.37)	71	Cannot Reject H_o: Not significantly different

Question 2

Check only the sub-classifications that you feel should be used to classify existing low volume rural roads by user type.

Question 2 Results

The majority of the respondents selected passenger car, emergency route, and trucking as a user type sub-classification. Respondents also often selected arterial, collector, recreational, bus route, and residential (see Table 3).

Table 3 User Type Results

User Type Sub-classification	Percentage*
Passenger Car	59
Emergency Route	51
Trucking	51
Collector	49
Bus Route	49
Residential	44
Arterial	44
Recreational	41
Agricultural	36
Local Access	26
Low Volume Local	21
Mail Route	10
Commercial/Industrial	3

* Percentage selected by responding counties

Chi-square test results showed that there was significance at the 0.0003 level between three pairs of sub-classifications (see Table 4). The procedure has been discussed on page 30 where g = 78, the number of tests or comparisons. Only the functional sub-classifications (arterial, collector, local, etc.) were further studied. Collector and arterial were the only functional sub-classifications that were statistically significant at the

0.0003 significance level. Further analysis suggested that there was a tendency for similar responses to both sub-classifications.

Table 4 Chi-square Test Results for User Types

Collector	Arterial		Total
	Acceptable	Unacceptable	
Acceptable	18	6	24
Unacceptable	0	15	15
Total	18	21	39

Question 3

Check only the sub-classifications that you feel should be used to classify existing low volume rural roads by surface type.

Question 3 Results

The overwhelming majority of the respondents selected Paved as a surface type sub-classification. Gravel, Graded All-weather Gravel, and Dirt were also frequently selected (see Table 5).

Table 5 Surface Type Results

Surface Type Sub-classification	Percentage*
Paved	92
Gravel	67
Dirt	46
Graded All-weather Gravel	46
Unpaved - Treated	36
Unimproved Dirt	31
Graded Dirt	28
Unpaved - Untreated	21
Native Gravel	13
Double Shot	10

* Percentage selected by responding counties

Chi-square test results showed that there was no significance at the 0.0006 significance level between any pair of sub-classifications. The procedure has been discussed on page 30 where g = 45, the number of tests or comparisons.

Typical Comments

- "The surface type sub-classifications don't need to be so specific; paved, gravel, and dirt should be a sufficient number of classes."
- "Simpler is better. Most agencies don't have the resources to collect and maintain a detailed database."
- "Road classifications should be used for maintenance levels as well."
- "Most low-volume roads are mainly for agricultural use in this county. There is currently no way to finance road safety, maintenance, and improvements on damage caused by the large boxes, combines, and tractors."
- "... major expansion of classification criteria will harm more than hinder. The basic sub-classifications should be a primary characterization of information that distinguishes the road use or function ..."

Appendix C

Local Rural Road Safety Survey Questionnaire
And
Summary Results

LOCAL RURAL ROAD SAFETY SURVEY

Current Practice

1. Approximate your total county road mileage under your jurisdiction: _____

2. Using the following functional classification system, approximate the percentage of road miles for each classification (see the back of the cover letter for a description of the typical characteristics for each classification).

Classification	Percentage under your jurisdiction
A: Rural Primary	_____
B: Rural Secondary	_____
C: Rural Local	_____
D: Rural Low-Volume Local	_____
	Total = 100%

3. Are individual safety improvement needs identified uniformly for all classes of roads in your county?
   A) Yes No
   If no, which road classifications receive more attention? **Check all that apply.**
   B) A B C D
   Comments: _____
   _____

4. Which methods are used to identify locations for safety improvements? **Check all that apply.**
   (A) Analysis of Accident Records
   (B) Operational Problems
   (C) Input/Comments from the Public
   (D) Input from Public Officials/Employees
   (E) Comprehensive Safety Improvement Program
   (F) Routine Inspections and Rating Activities
   (G) Safety Studies (on rural roads)
   (H) Accident Pin Map
   (I) Input from Law Enforcement
   (J) None
   (K) Other _____

5. Do any of the following factors limit your county's ability to develop and implement a Safety Improvement Program? **Check all that apply.**
   (A) Manpower (C) Unaware of Program (E) Not Needed (G) None
   (B) Funding (D) Program too Complex (F) Other _____

Road Safety Audits for Existing Roads

It is proposed that a road safety audit (RSA) program be developed for local rural jurisdictions. Our goal is to develop a RSA checklist(s) that will be utilized to help identify road safety deficiencies on local rural roads. In order to ensure its feasibility, it is crucial that the RSA program be beneficial, efficient, cost-effective, and easily implemented.

6. Do you feel that a tailored road safety audit program (i.e. a specific checklist of safety issues for local rural roads) is justified for local rural jurisdictions?
   A. Is it necessary? Yes No
   B. Would it be useful? Yes No

Road Safety Audit Checklist Issues

Below is a list of the safety issues that are proposed to be included in a road safety audit checklist for auditing **local rural roads** to identify safety deficiencies. The roads will be audited using a checklist with questions pertaining to each of the key issues listed below.

ALIGNMENT

1. Visibility, Sight Distance
2. Operating Speed (suitability to road alignment)
3. Passing Opportunities
4. Speed Limit/Speed Zoning
5. Readability (Driver Expectancy)

CROSS SECTION

1. Widths
2. Shoulders
3. Side Slopes
4. Superelevation

INTERSECTIONS

1. Location
2. Layout
3. Controls & Delineation
4. Visibility, Sight Distance

NON-MOTORIZED TRAFFIC

1. Pedestrians
2. Cyclists
3. Public Transport

SIGNING

1. Adequacy & Redundancy
2. Sign Size & Sight Distance
3. Signs as Hazards

ROADSIDE FEATURES

1. Clear Zones
2. Safety Barriers
3. End Treatments
4. Obstructions

DELINEATION

1. Guideposts & Reflectors
2. Curve Alignment
3. Object Markers
4. Linemarkings (paved roads)

7A. If you feel that this list contains safety issues that should not be included in a RSA checklist for local rural roads, please draw a line through those issues in the above list.

7B. Do you feel that this list, as you have modified it, includes the pertinent safety issues that should be considered? Yes No
If no, what other important safety issues do you feel should be included? _____
_____

8. Would training on the road safety audit program/procedures be necessary for your county to utilize the RSA checklist to identify safety deficiencies? Yes No

9. Do you feel that a tailored RSA program would be cost-effective for **local rural roads**? Yes No

10. Do you feel that the RSA checklists/procedures should be different for differing local rural functional classifications (i.e. should higher rural road classifications have a more comprehensive safety audit program)? Yes No

11. Please indicate your job position/title: _____

Comments:

Question 1

Approximate your total county road mileage under your jurisdiction.

Question 1 Results

The average road mileage under each county's jurisdiction in region VIII was approximately 840 miles (see Table 1). [Range: (70, 4750), 95% Confidence Interval: (732, 946)]

Table 1 Average County Road Mileage

Group	Sample Size, N	Avg. County Road Mileage	Range (miles)
South Dakota	50	530	(185, 1180)
Utah	12	1220	(220, 3000)
Wyoming	19	690	(70, 1500)
North Dakota	30	770	(200, 2090)
Colorado	24	1310	(270, 4750)
Montana	23	1040	(160, 1960)
Entire Region	**158**	**840**	**(70, 4750)**

Question 2

Approximate the percentage of road miles for each classification

Question 2 Results

The counties in region VIII on average encompass slightly more mileage of class C and class D roads than class A and class B roads (see Table 2).

Table 2 Average Percentage of County Road Mileage by Classification

Group	Class A	Class B	Class C	Class D
	Percentage*			
South Dakota	25	33	23	19
Utah	11	19	23	47
Wyoming	11	26	28	35
North Dakota	27	33	24	16
Colorado	20	23	30	27
Montana	6	12	35	47
Entire Region	**19**	**27**	**26**	**28**

* Average percentage of county road mileage for the responding counties of FHWA Region VIII

Question 3A

Are individual safety improvement needs identified uniformly for all classes of roads in your county?

Question 3A Results

Table 3 contains the percentages of responding counties that indicated that they uniformly identify safety improvement needs for all road classifications. Only 39 % of the responding counties stated that individual safety improvement needs are identified uniformly for all road classifications.

Table 3 Uniform Safety Needs Identification

Group	Percentage*
South Dakota	42
Utah	42
Wyoming	26
North Dakota	53
Colorado	29
Montana	30
Entire Region	**39**

* Percentage of responding counties that uniformly identify safety needs

Question 3B

Which road classifications receive more attention? Check all that apply.

Question 3B Results

The majority of the counties stated that road classifications A: Rural Primary and B: Rural Secondary receive more attention than the other two classifications (see Table 4 for the percentage of responding counties that give more attention to the specified sub-classifications).

Table 4 Safety Needs Identification Priorities

Group	Class A	Class B	Class C	Class D
	Percentage*			
South Dakota	40	32	8	2
Utah	42	42	17	17
Wyoming	37	58	42	11
North Dakota	40	30	10	0
Colorado	54	42	21	0
Montana	35	65	30	0
Entire Region	**41**	**42**	**18**	**3**

* Percentage of responding counties that give more attention to the specified classifications

Question 4

Which methods are used to identify locations for safety improvements? Check all that apply.

(A) Analysis of Accident Records
(B) Operational Problems
(C) Input/Comments from the Public
(D) Input from Public Officials/Employees
(E) Comprehensive Safety Improvement Program
(F) Routine Inspections and Rating Activities
(G) Safety Studies (on rural roads)
(H) Accident Pin Map
(I) Input from Law Enforcement
(J) None
(K) Other _____

Question 4 Results

Input from the public, public officials and employees, and law enforcement is the primary method for identifying locations for safety improvements in region VIII. The majority of the responding counties in region VIII also use routine inspections and rating activities, operational problems, and analysis of accident records (see Table 5 for the percentage of responding counties that use the specified methods).

Table 5 Methods Used for Identifying Locations for Safety Improvements

Group	Methods for Identifying Locations for Safety Improvements					
	A	B	C	D	E	F
	Percentage*					
South Dakota	54	50	90	84	14	66
Utah	42	67	92	92	8	58
Wyoming	79	84	84	84	0	63
North Dakota	77	67	93	80	10	57
Colorado	63	54	92	88	0	46
Montana	35	48	96	83	13	61
Entire Region	**59**	**59**	**91**	**84**	**9**	**60**

Group	Methods for Identifying Locations for Safety Improvements				
	G	H	I	J	K
	Percentage*				
South Dakota	12	6	70	0	0
Utah	17	25	75	8	0
Wyoming	168	5	58	0	5
North Dakota	7	3	77	3	3
Colorado	21	8	58	0	0
Montana	26	4	83	0	4
Entire Region	**15**	**7**	**70**	**1**	**2**

* Percentage of responding counties that use the specified methods to identify locations for safety improvements

Question 5

Do any of the following factors limit your county's ability to develop and implement a Safety Improvement Program? Check all that apply.

(A) Manpower (C) Unaware of Program (E) Not Needed (G) None
(B) Funding (D) Program too Complex (F) Other _____

Question 5 Results

Manpower and funding are the major factors limiting counties' abilities to develop and maintain SIPs (see Table 6 for the percentage of responding counties influenced by the specified factors).

Table 6 Factors Limiting Abilities to Develop and Maintain SIPs

Group	Factors Limiting Ability to Develop and Maintain a SIP						
	A	B	C	D	E	F	G
	Percentage*						
South Dakota	64	82	16	6	4	2	14
Utah	83	75	17	8	8	8	0
Wyoming	79	79	11	0	11	5	5
North Dakota	60	83	3	3	7	7	3
Colorado	71	79	13	4	8	0	4
Montana	87	87	9	13	0	0	4
Entire Region	**71**	**82**	**11**	**6**	**6**	**3**	**7**

* Percentage of responding counties that are limited by the specified factors

Question 6

Do you feel that a tailored road safety audit program (i.e. a specific checklist of safety issues for local rural roads) is justified for local rural jurisdictions?

A. Is it necessary?

B. Would it be useful?

Question 6 Results

The majority of respondents from every state in the region concluded that an RSA program for rural local roads is necessary and would be useful (see Table 7).

Table 7 Necessity and Usefulness of a RSA for Rural Local Jurisdictions

Group	Question	
	Is it necessary?	Would it be useful?
	Percentage*	
South Dakota	56	86
Utah	75	83
Wyoming	68	90
North Dakota	53	80
Colorado	58	83
Montana	57	83
Entire Region	**59**	**84**

* Percentage of responding counties that answered in the affirmative

Question 7A

If you feel that the road safety audit checklist contains safety issues that should not be included in a RSA checklist for local rural roads, please draw a line through those issues.

Question 7A Results

It is important to note that it was not significantly shown that any of the safety issues should not be included in the audit of rural local roads (see Table 8). Even the highest number of responses against including an issue (21) amounted to only 13 % of the responses.

Table 8 Checklist Issues

Issue	Sub-issue #1	Sub-issue #2	Sub-issue #3	Sub-issue #4	Sub-issue #5
	Number of Responses*				
Alignment	3	1	4	2	4
Cross Section	3	1	2	7	NA
Intersections	2	1	0	3	NA
Non-motorized traffic	19	17	21	NA	NA
Signing	3	3	4	NA	NA
Roadside Features	6	10	11	3	NA
Delineation	0	1	1	3	NA

* Number of respondents who indicated that the specified issue should not be covered in a RSA of rural local roads

Question 7B

Do you feel that the road safety audit checklist, as you have modified it, includes the pertinent safety issues that should be considered?

Question 7B Results

The majority of the respondents from every state in the region felt that the checklist as they modified it included the pertinent safety issues that should be considered. Table 9 contains the percentage of responding counties that indicated that the checklist included the pertinent safety issues. Feedback from this survey as well as a literature review were used to structure the proposed RSA procedures and checklists.

Table 9 Checklist Approval

Group	Percentage*
South Dakota	96
Utah	75
Wyoming	95
North Dakota	90
Colorado	92
Montana	87
Entire Region	**91**

* Percentage of respondents who approved the checklist issues

Question 8

Would training on the road safety audit program/procedures be necessary for your county to utilize the RSA checklist to identify safety deficiencies?

Question 8 Results

The results show that the majority of the respondents indicated that training is necessary for counties to be able to implement a RSA program (see Table 10).

Table 10 Necessity of RSA Training

Group	Percentage*
South Dakota	66
Utah	67
Wyoming	79
North Dakota	60
Colorado	71
Montana	65
Entire Region	**67**

* Percentage of respondents who indicated that RSA training is needed

Question 9

Do you feel that a tailored RSA program would be cost-effective for local rural roads?

Question 9 Results

Table 11 contains the percentage of respondents who indicated that an RSA program for rural local roads would be cost-effective. The results show that the majority of responding counties indicated that an RSA program would be cost-effective.

Table 11 Cost-effectiveness of a RSA Program

Group	Percentage*
South Dakota	50
Utah	75
Wyoming	79
North Dakota	63
Colorado	79
Montana	52
Entire Region	**63**

* Percentage of respondents who indicated that a RSA program would be cost-effective

Question 10

Do you feel that the RSA checklists/procedures should be different for differing local rural functional classifications (i.e. should higher rural road classifications have a more comprehensive safety audit program)?

Question 10 Results

The results show that the majority of the responding counties indicated that RSA checklists/procedures should be different for the differing local rural functional classifications (see Table 12). That is, they indicated that higher rural road classifications should have a more comprehensive safety audit.

Table 12 Change in RSA Checklists and Procedures by Classification

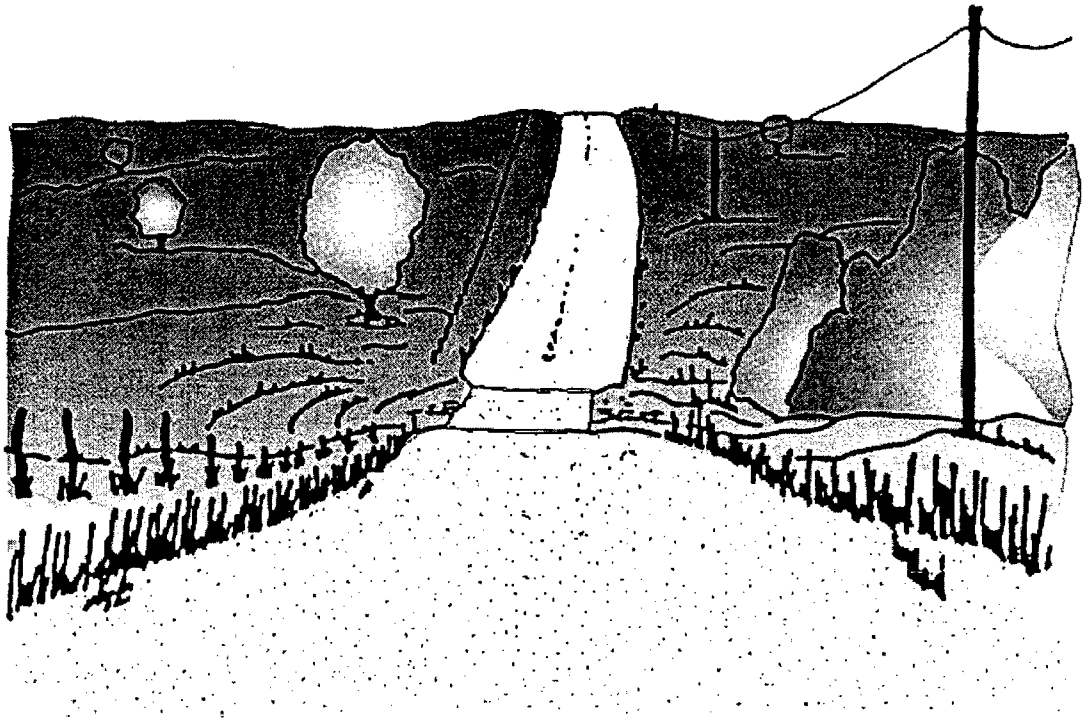
Group	Percentage*
South Dakota	76
Utah	83
Wyoming	79
North Dakota	77
Colorado	75
Montana	74
Entire Region	**77**

* Percentage of respondents who indicated that the RSA checklists/procedures should be different for differing classifications

Appendix D

RSA Checklists
For
Local Rural Roads

RURAL ROAD
SAFETY AUDIT



Project: _____

Date/Time: _____

Location: _____

Auditor(s): _____

Weather: _____

Page #: 1 of ___

When completing the audit using the attached checklist, check the appropriate box for each question.	Yes	No	N/A	COMMENTS
RURAL ROAD SAFETY AUDIT – GENERAL ISSUES (1 of 2)				
INTERSECTIONS				
Are intersections free of sight restrictions which could result in safety problems?				
Are intersections free of abrupt changes in elevation or surface condition?				
Are advance warning signs installed when intersection traffic control cannot be seen a safe distance ahead of the intersection?				
SIGNING & DELINEATION				
Signing				
Is the road free of locations where signing is needed to improve safety?				
Are the regulatory, warning, and directory signs in place conspicuous?				
Is the road free of locations with improper signing which may cause safety problems?				
Is the road free of unnecessary signing which may cause safety problems?				
Are signs effective for likely conditions?				
Can signs be read at a safe distance?				
Is the road free of signing that impairs safe sight distances?				
Delineation				
Is the road free of locations with improper or unsuitable delineation (post delineators, chevrons, object markers)?				

	Yes	No	N/A	COMMENTS
RURAL ROAD SAFETY AUDIT – GENERAL ISSUES (2 of 2)				
ROADSIDE FEATURES / PHYSICAL OBJECTS				
Are clear zones free of hazardous, non-traversable side slopes with no safety barriers?				
Are the clear zones free of nonconforming and/or dangerous obstructions that are not properly attenuated?				
SPECIAL ROAD USERS				
Are travel paths and crossing points for pedestrians and cyclists properly signed and/or marked?				
Are bus stops safely located with adequate clearance and visibility from the traffic lane?				
Is appropriate advance signing provided for bus stops and refuge areas?				
RAILROAD CROSSINGS				
Are railroad crossing (crossbucks) signs used on each approach at railroad crossings?				
Are railroad advance warning signs used at railroad crossing approaches?				
Are railroad crossings free of vegetation and other obstructions which have the potential to restrict sight distance?				
Are roadway approach grades to railroad crossings flat enough to prevent vehicle snagging?				
CONSISTENCY				
Is the road section free of inconsistencies that could result in safety problems?				

	Yes	No	N/A	COMMENTS
RURAL ROAD SAFETY AUDIT – PAVED ROAD ISSUES (1 of 1) **PAVEMENT MARKINGS** Is the road free of locations with pavement marking safety deficiencies? Is the road free of pavement markings that are not effective for likely conditions? Is the road free of old pavement markings that affect the safety of the roadway? **PAVEMENT CONDITION** Is the pavement free of defects which could result in safety problems (e.g. loss of steering control)? Are changes in surface type (e.g. pavement ends) free of drop-offs / poor transitions? Is the pavement free of locations that appear to have inadequate skid resistance which could result in safety problems, particularly on curves, steep grades and approaches to intersections? Is the pavement free of areas where ponding or sheet flow of water occur resulting in safety problems? Is the pavement free of loose aggregate/gravel which may cause safety problems?				

	Yes	No	N/A	COMMENTS
RURAL ROAD SAFETY AUDIT – UNPAVED ROAD ISSUES (1 of 1) **<u>ROADWAY SURFACE</u>** Is the road surface free of defects which could result in safety problems (e.g. loss of steering control)? Is the road surface free of areas where ponding or sheet flow of water occur resulting in safety problems? Is the road surface free of loose gravel/fines which may cause safety problems (control, visibility, etc.)? Are changes in surface type (e.g. pavement ends) free of drop-offs / poor transitions?				

Appendix E

RSA Report Form
For
Local Rural Roads

Road Safety Audit – Report Form (1 of __)

Findings

Deficiency #: _____

Location of Safety Deficiency: _____

Description: _____

Recommendation: _____

Deficiency #: _____

Location of Safety Deficiency: _____

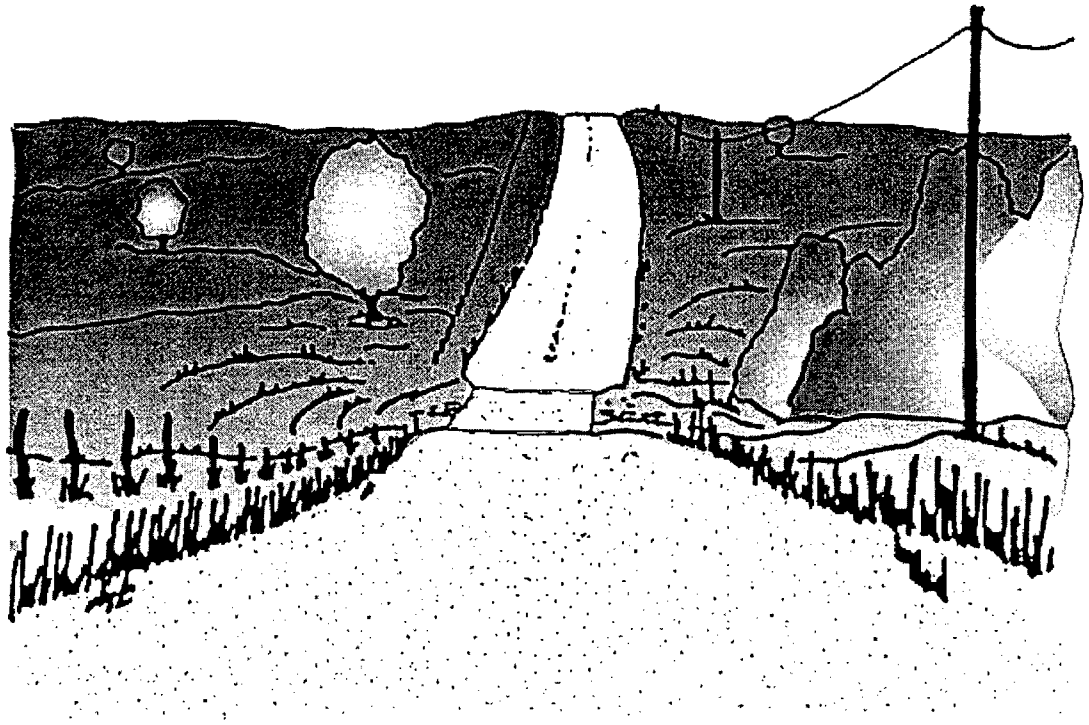
Description: _____

Recommendation: _____

Appendix F

RSA Checklists
For
Completed Audits of Pilot Study

RURAL ROAD
SAFETY AUDIT



Project: Albany County

Date/Time: June 14, 1998

Location: Rogers Canyon Road (Paved)

Auditor(s): Joe Tate III

Weather: Clear and Dry

Page #: 1 of 4

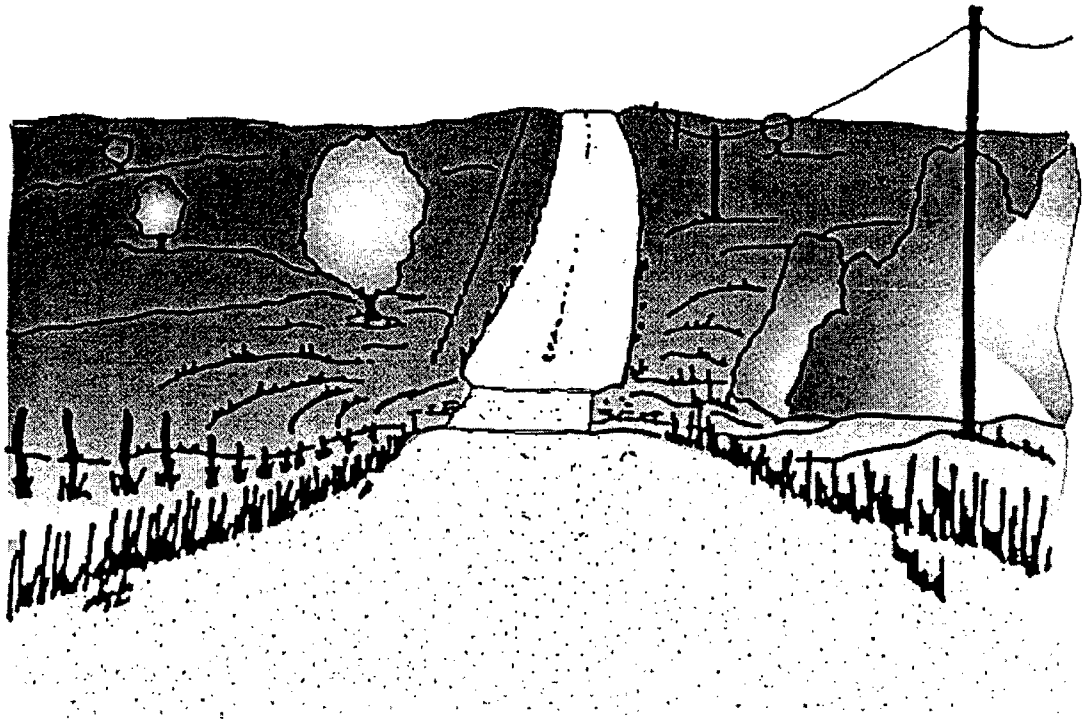
When completing the audit using the attached checklist, check the appropriate box for each question. Place additional comments on the attached comment sheet, if needed.

	Yes	No	N/A	COMMENTS
RURAL ROAD SAFETY AUDIT – GENERAL ISSUES (1 of 2)				
INTERSECTIONS				
Are intersections free of sight restrictions which could result in safety problems?	x			
Are intersections free of abrupt changes in elevation or surface condition?	x			
Are advance warning signs installed when intersection traffic control cannot be seen a safe distance ahead of the intersection?			x	
SIGNING & DELINEATION				
Signing				
Is the road free of locations where signing is needed to improve safety?	x			
Are the regulatory, warning, and directory signs in place conspicuous?	x			
Is the road free of locations with improper signing which may cause safety problems?	x			
Is the road free of unnecessary signing which may cause safety problems?	x			
Are signs effective for likely conditions?	x			
Can signs be read at a safe distance?	x			
Is the road free of signing that impairs safe sight distances?	x			
Delineation				
Is the road free of locations with improper or unsuitable delineation (post delineators, chevrons, object markers)?			x	Deficient delineation at cattlegaurds and curves

	Yes	No	N/A	COMMENTS
RURAL ROAD SAFETY AUDIT – GENERAL ISSUES (2 of 2)				
ROADSIDE FEATURES / PHYSICAL OBJECTS				
Are clear zones free of hazardous, non-traversable side slopes with no safety barriers?		x		A few bad spots exist, but adequate.
Are the clear zones free of nonconforming and/or dangerous obstructions that are not properly attenuated?		x		Sign Post
SPECIAL ROAD USERS				
Are travel paths and crossing points for pedestrians and cyclists properly signed and/or marked?			x	
Are bus stops safely located with adequate clearance and visibility from the traffic lane?			x	
Is appropriate advance signing provided for bus stops and refuge areas?			x	
RAILROAD CROSSINGS				
Are railroad crossing (crossbucks) signs used on each approach at railroad crossings?			x	
Are railroad advance warning signs used at railroad crossing approaches?			x	
Are railroad crossings free of vegetation and other obstructions which have the potential to restrict sight distance?			x	
Are roadway approach grades to railroad crossings flat enough to prevent vehicle snagging?			x	
CONSISTENCY				
Is the road section free of inconsistencies that could result in safety problems?	x			

	Yes	No	N/A	COMMENTS
RURAL ROAD SAFETY AUDIT – PAVED ROAD ISSUES (1 of 1)				
PAVEMENT MARKINGS				
Is the road free of locations with pavement marking safety deficiencies?	x			
Is the road free of pavement markings that are not effective for likely conditions?	x			
Is the road free of old pavement markings that affect the safety of the roadway?	x			
PAVEMENT CONDITION				
Is the pavement free of defects which could result in safety problems (e.g. loss of steering control)?	x			
Are changes in surface type (e.g. pavement ends) free of drop-offs / poor transitions?	x			
Is the pavement free of locations that appear to have inadequate skid resistance which could result in safety problems, particularly on curves, steep grades and approaches to intersections?	x			
Is the pavement free of areas where ponding or sheet flow of water occur resulting in safety problems?	x			
Is the pavement free of loose aggregate/gravel which may cause safety problems?	x			

RURAL ROAD
SAFETY AUDIT



Project: Albany County

Date/Time: June 24, 1998

Location: Rogers Canyon Road (Unpaved)

Auditor(s): Joe Tate III

Weather: Clear and Dry

Page #: 1 of 4

When completing the audit using the attached checklist, check the appropriate box for each question. Place additional comments on the attached comment sheet, if needed.

	Yes	No	N/A	COMMENTS
RURAL ROAD SAFETY AUDIT – GENERAL ISSUES (1 of 2)				
INTERSECTIONS				
Are intersections free of sight restrictions which could result in safety problems?	x			
Are intersections free of abrupt changes in elevation or surface condition?	x			
Are advance warning signs installed when intersection traffic control cannot be seen a safe distance ahead of the intersection?			x	
SIGNING & DELINEATION				
Signing				
Is the road free of locations where signing is needed to improve safety?		x		Need a sign to warn of end of pavement.
Are the regulatory, warning, and directory signs in place conspicuous?	x			
Is the road free of locations with improper signing which may cause safety problems?	x			
Is the road free of unnecessary signing which may cause safety problems?	x			
Are signs effective for likely conditions?	x			
Can signs be read at a safe distance?	x			
Is the road free of signing that impairs safe sight distances?	x			
Delineation				
Is the road free of locations with improper or unsuitable delineation (post delineators, chevrons, object markers)?		x		No delineation of cattleguards.

	Yes	No	N/A	COMMENTS
RURAL ROAD SAFETY AUDIT – GENERAL ISSUES (2 of 2)				
ROADSIDE FEATURES / PHYSICAL OBJECTS				
Are clear zones free of hazardous, non-traversable side slopes with no safety barriers?	x			
Are the clear zones free of nonconforming and/or dangerous obstructions that are not properly attenuated?		x		Live tree, fallen tree.
SPECIAL ROAD USERS				
Are travel paths and crossing points for pedestrians and cyclists properly signed and/or marked?			x	
Are bus stops safely located with adequate clearance and visibility from the traffic lane?			x	
Is appropriate advance signing provided for bus stops and refuge areas?			x	
RAILROAD CROSSINGS				
Are railroad crossing (crossbucks) signs used on each approach at railroad crossings?			x	
Are railroad advance warning signs used at railroad crossing approaches?			x	
Are railroad crossings free of vegetation and other obstructions which have the potential to restrict sight distance?			x	
Are roadway approach grades to railroad crossings flat enough to prevent vehicle snagging?			x	
CONSISTENCY				
Is the road section free of inconsistencies that could result in safety problems?	x			

	Yes	No	N/A	COMMENTS
RURAL ROAD SAFETY AUDIT – UNPAVED ROAD ISSUES (1 of 1)				
ROADWAY SURFACE				
Is the road surface free of defects which could result in safety problems (e.g. loss of steering control)?		x		Some rutting and potholes, but not serious safety concern.
Is the road surface free of areas where ponding or sheet flow of water occur resulting in safety problems?	x			
Is the road surface free of loose gravel/fines which may cause safety problems (control, visibility, etc.)?	x			
Are changes in surface type (e.g. pavement ends) free of drop-offs / poor transitions?		x		Edge drop-off at end of pavement.

Appendix G

RSA Report Form
For
Completed Audits of Pilot Study

Road Safety Audit – Report Form (1 of 2)

Findings

Deficiency #: One (1)

Location of Safety Deficiency: Rogers Canyon Road (Paved) – 4.7 miles past Laramie city limits.

Description: Missing and damaged post delineators.

Recommendation: Replace the missing and damaged post delineators.

Deficiency #: Two (2)

Location of Safety Deficiency: Rogers Canyon Road (Paved) – 1.5 miles past Laramie city limits.

Description: Physical object in clear zone (square post signing private property).

Recommendation: Relocate post to outside of clear zone.

Road Safety Audit – Report Form (2 of 2)

Deficiency #: Three (3)

Location of Safety Deficiency: Rogers Canyon Road (Paved) – 3.6 miles past Laramie city limits.

Description: Missing object marker at southbound approach to cattleguard.

Recommendation: Replace missing object marker.

Deficiency #: Four (4)

Location of Safety Deficiency: Rogers Canyon Road (Paved) – 2 miles past Laramie city limits.

Description: Dangerous drop-off at edge of pavement over a culvert (3 feet nearly vertical slope down to a 2 feet diameter culvert which has not been day-lighted).

Recommendation: Add "material" to flatten slope.

Road Safety Audit – Report Form (1 of 2)

Deficiency #: One (1)

Location of Safety Deficiency: Rogers Canyon Road (Unpaved) – 9.7, 10.9, 13, and 13.6 miles past Laramie city limits.

Description: Several cattleguards w/o any delineation.

Recommendation: Install post delineators or object markers at cattleguards.

Deficiency #: Two (2)

Location of Safety Deficiency: Rogers Canyon Road (Unpaved) – 8.6 miles past Laramie city limits.

Description: No warning of end of pavement is provided.

Recommendation: Install a "Pavement Ends" sign at approach to the end of the pavement.

Road Safety Audit – Report Form (2 of 2)

Findings

Deficiency #: Three (3)

Location of Safety Deficiency: Rogers Canyon Road (unpaved) – 8.6 miles past the Laramie city limits.

Description: Abrupt drop-off at transition from paved to unpaved surface.

Recommendation: Improve transition by smoothing surface and adding gravel as needed to eliminate drop-off.

Deficiency #: Four (4)

Location of Safety Deficiency: Rogers Canyon Road (unpaved) – 8.8 miles past Laramie city limits.

Description: Physical object in clear zone (large fallen tree).

Recommendation: Remove fallen tree from clear zone.