Federal and Tribal Lands Road Safety Audits:
CASE STUDIES



U.S.Department of Transportation
Federal Highway Administration

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FHWA-FLH-10-05

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The Federal Highway Administration (Office of Safety and Office of Federal Lands Highway) sponsored six of the RSAs reported in this document. The FHWA Office of Federal Lands Task Order Manager was Chimai Ngo. The Office of Safety Task Order Manager was Rebecca Crowe. Documentation of the other two RSAs included in this document were provided by Victoria Brinkly and Scott Whittemore. Production was performed by Kylie Morris and Michelle Scism from VHB.</td></tr>
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The results of the RSAs have been compiled in this case studies document. Each case study includes photographs, a project description, a summary of key findings, and the lessons learned. The aim of this document is to provide Federal Land Management Agencies (FLMAs) and tribal transportation agencies with examples and advice that can assist them in implementing RSAs in their own jurisdictions.</td></tr>
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PREFACE

Road Safety Audits (RSAs) are an effective tool for proactively improving the future safety performance of a road project during the planning and design stages, and for identifying safety issues in existing transportation facilities. Additional information and resources on RSAs are available on the web at http://safety.fhwa.dot.gov/rsa.

Information for the case studies reported in this document was gathered during a series of eight RSAs conducted throughout the United States between 2007 and 2009, involving Federal Land Management Agencies (FLMAs) (Pinckney Island and Savannah National Wildlife Refuges, Patuxent Research Refuge, Siskiyou National Forest, Cumberland Gap National Historical Park, and Gifford Pinchot National Forest) and tribal transportation agencies (Red Cliff Band of Lake Superior Chippewa, Navajo Nation, and Eastern Band of Cherokee Indians). The Federal Highway Administration (FHWA) and the authors greatly appreciate the cooperation of these FLMAs and Tribes, as well as other participating agencies such as the Bureau of Indian Affairs (BIA) and state departments of transportation (DOTs), for their willing and enthusiastic participation in this FHWA-sponsored RSA series.

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INTRODUCTION

Background

Road Safety Audits/Assessments (RSAs) are an effective tool for proactively improving the future safety performance of a road project during the planning and design stages, and for identifying safety issues in existing transportation facilities.

The Federal Highway Administration (FHWA) Office of Safety and Office of Federal Lands Highway commissioned a series of six Federal and tribal lands RSAs as part of a Task Order under FHWA Contract DTFH61-05-D-00024. The RSAs were conducted by Vanasse Hangen Brustlin, Inc. and Opus International. Two additional RSAs on Federal Lands were conducted by Western and Eastern Federal Lands Division Offices.

The results of the RSAs have been compiled in this case studies document. Each case study includes photographs, a project description, a summary of key findings, and the lessons learned. The aim of this document is to provide Federal Land Management Agencies (FLMAs) and tribal transportation agencies with examples and advice that can assist them in implementing RSAs in their own jurisdictions.

What is an RSA?

A Road Safety Audit/Assessment (RSA) is a formal safety performance examination of an existing or future road or intersection by an independent, multidisciplinary team.

Changes in roadway ownership, traffic patterns (which may be seasonal), and development around roadways often create conditions unanticipated in the original roadway design. RSAs, conducted by a team that is independent of the facility Owner and design team, address safety by a thorough review of roadway, traffic, environmental, and human factors conditions. By focusing on safety, RSAs make sure that safety does not “fall through the cracks.”

The RSAs followed the procedures outlined in the FHWA Road Safety Audit Guidelines document (Publication Number FHWA-SA-06-06). The procedures involve an eight-step RSA process discussed later in this case study document.

The multidisciplinary RSA Team is typically composed of at least three members, representing backgrounds in road safety, traffic operations, and/or road design, and members from other areas such as maintenance, human factors, enforcement, and first

responders. Members of the RSA Team are independent of the operations of the road or the design of the project being assessed. The RSA team's independence assures two things: that there is no potential conflict of interest or defensiveness, and the project is reviewed with "fresh eyes."

RSAs can be conducted at any stage in a project's life:

- A *pre-construction RSA (planning and design stages)* examines a road before it is modified or built, at the planning/feasibility stage or the design (preliminary or detailed design) stage. An RSA at this stage identifies potential safety issues before crashes occur. The earlier a pre-construction RSA is conducted, the more potential it has to efficiently remedy possible safety concerns.
- *Construction RSAs (work zone, changes in design during construction, and pre opening)* examine temporary traffic management plans associated with construction or other roadwork, and changes in design during construction. RSAs at this stage can also be conducted when construction is completed but before the roadway is opened to traffic.
- A *post-construction or operational RSA (existing road)* examines a road that is operating, and is usually conducted to address a demonstrated crash problem.

The Federal and Tribal Lands RSA Case Study Program

The eight RSAs conducted in this case study program are summarized in Table 1.

TABLE 1 CASE STUDY RSAS

FACILITY OWNERS AND OTHER RESPONSIBLE AGENCIES	RSA SITES	RSA STAGE
Maryland State Highway Administration (SHA), United States Department of Agriculture, Patuxent Research Refuge	• paved two-lane rural roads • signalized intersection	existing roads and proposed design
Red Cliff Band of Lake Superior Chippewa, Wisconsin Department of Transportation	• paved two-lane rural roads • unsignalized intersections	existing roads and planned improvements
Navajo Nation, Bureau of Indian Affairs, Phillips Oil Company, San Juan County, Utah	• paved two-lane rural roads • unsignalized intersections	existing roads
Pinckney Island and Savannah National Wildlife Refuges, South Carolina Department of Transportation	• existing entrances to wildlife refuges • proposed entrance to wildlife visitor center	existing roads
US Forest Service and Bureau of Land Management, Bear Camp Coastal Route	• paved one- and two-lane rural road	existing roads
Eastern Band of Cherokee Indians	• rural and urbanized unsignalized intersections	existing roads
Cumberland Gap Tunnel Authority, Kentucky Transportation Cabinet, Tennessee Department of Transportation, and National Park Service	• four-lane rural highway • interchange • tunnel approach	existing roads
US Forest Service, Skamania County, Washington	• paved two-lane rural roads • unsignalized intersections	existing roads

All participating FLMAs and tribal transportation agencies volunteered to be involved in this RSA program. Involvement in the case study program required the agencies to nominate the sites for the RSA project; provide the RSA Team with the materials (such as traffic volume and crash data) on which the RSA would be based; participate in the

start-up and preliminary findings meetings; and contribute at least one Federal/tribal staff member to participate on the RSA team. The RSA teams were led by two experienced and independent consultants.

Information on each of these RSAs, including background, a summary of RSA issues, and a list of suggested improvements, is included in the Appendix.

THE RSA PROCESS

Eight Steps of an RSA

The eight steps of an RSA are shown in Figure 1, and are discussed below with some reference to the case studies.

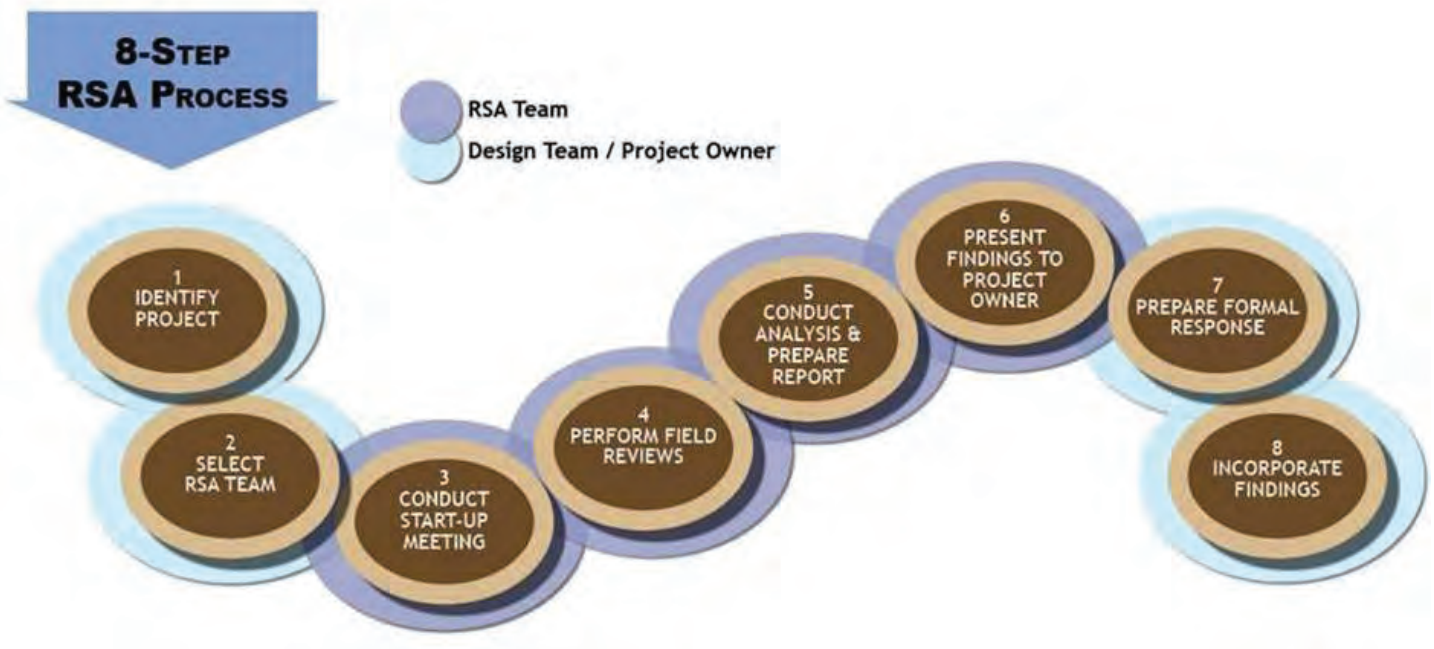


FIGURE 1 RSA PROCESS

RSA projects and the **RSA team** (Steps 1 and 2) were pre-selected in this FHWA case studies project. RSA teams were interdisciplinary, typically including engineering and enforcement staff. Some RSA teams included non-traditional disciplines that were beneficial to the team, such as the public health specialist from Indian Health Services (IHS) who played a critical role in the Red Mesa RSA for the Navajo Nation.

All meetings and site visits for the RSAs in the case studies project were conducted over two or three day periods. The RSAs typically began with a **start-up meeting** (Step 3) attended by the Project Owner and/or Design Team (hereafter referred to as the Owner), and the RSA team:

- The Owner described concerns regarding the roads and intersections to be assessed, why the sites had been chosen for an RSA, and any constraints or limitations. Typically, the reasons for the RSA site selection centered on high-profile crashes or public safety concerns.
- The multidisciplinary RSA Team then described the RSA process. This included an overview of the RSA process with examples of safety issues that are typically encountered and mitigation measures to address them.
- Additional issues can be discussed during this step. For example, at the Red Cliff RSA, which included a review of planned improvements, the Design Team representative described the proposed future road design, including its constraints and challenges.

FIGURE 2
START-UP MEETING

FIGURE 3
FIELD REVIEW

Following the start-up meeting and a preliminary review of the design or site documentation, the RSA Team conducted a **field review** (Step 4). The purpose of the field review was to observe the ambient conditions in which the proposed design would operate (for the planning-stage RSA), or to observe geometric and operating conditions (for the RSAs of existing roads). The RSA Team observed site characteristics (such as road geometry, sight distances, clear zones, drainage, signing, lighting, and barriers), traffic characteristics (such as typical speeds and traffic mix), surrounding land uses (including traffic and pedestrian generators), and link points to the adjacent transportation network. Human factors issues were also considered by the RSA team, including road and intersection

"readability," sign location and sequencing, and older-driver limitations. Field reviews were conducted by the RSA Team under a variety of environmental conditions (such as daytime and night-time) and operational conditions (such as peak and off-peak times).

The team conducted the **RSA analysis** (Step 5) in a setting in which all team members reviewed available background information (such as traffic volumes and collision data) in light of the observations made in the field. On the basis of this review, the RSA Team identified and prioritized safety issues, including features that could contribute to a higher frequency and/or severity of crashes. For each safety issue, the RSA Team generated a list of possible measures to mitigate the crash potential and/or severity of a potential crash.

At the end of the analysis session, the Owner and RSA Team reconvened for a **preliminary findings meeting** (Step 6). Presenting the preliminary findings verbally in a meeting gave the Owner the opportunity to ask questions and seek clarification on the RSA findings, and also provided a useful forum for the Owner to suggest additional or alternative mitigation measures in conjunction with the RSA team. The discussion provided practical information that was subsequently used to write the RSA report.

FIGURE 4
RSA ANALYSIS SESSION

FIGURE 5
PRELIMINARY FINDINGS MEETING

In the weeks following the on-site portion of the RSA, the RSA Team wrote and issued the **RSA report** (also part of Step 6) to the Owner documenting the results of the RSA. The main content of the RSA report was a prioritized listing and description of the safety issues identified (illustrated using photographs taken during the site visit), with suggestions for improvements.

The Owner was encouraged to write a brief **response letter** (Step 7) containing a point-by-point response to each of the safety issues identified in the RSA report. The response letter identifies the action(s) to be taken, or explains why no action would be taken. The formal response letter is an important "closure" document for the RSA. As a final step, the Owner was encouraged to use the RSA findings to identify and implement safety improvements when policy, manpower, and funding permit (Step 8).

Prioritization of Issues

For many of the RSAs conducted on FLMAs and tribal lands, reliable crash data were not available. Anecdotal information on run off the road crashes and evidence of fence strikes along the roadway helped create a more complete picture of the potential hazards, but could not be quantified with any certainty. Therefore a prioritization framework was applied in both the RSA analysis and presentation of findings. The likely *frequency* and *severity* of crashes associated with each safety issue were qualitatively estimated, based on team members' experience and expectations. Expected crash *frequency* was qualitatively estimated on the basis of expected crashes, exposure (how many road users would likely be exposed to the identified safety issue?) and probability (how likely was it that a collision would result from the identified issue?). Expected crash *severity* was qualitatively estimated on the basis of factors such as anticipated speeds, expected collision types, and the likelihood that vulnerable road users would be exposed. These two risk elements (frequency and severity) were considered during the qualitative risk assessment of each safety issue on the basis of the matrix shown in Table 2.

Consequently, the RSA Team prioritized each safety issue. It should be stressed that this prioritization method was qualitative, based on the expectations and judgment of the RSA Team members, and was employed to help the Owner prioritize the multiple issues identified in the RSA. For each safety issue identified, possible mitigation measures were suggested for short-term, intermediate, and long-term implementation timeframes. The suggestions focused on short-term and intermediate measures that could be cost-effectively implemented within likely budget constraints. Ultimately, implementation of the measures suggested in the RSA is dependent on project costs and financial constraints of the Owner.

TABLE 2 CRASH RISK ASSESSMENT

FREQUENCY RATING	SEVERITY RATING			
	Minor	*Moderate*	*Serious*	*Fatal*
Frequent	Moderate-High	High	Highest	Highest
Occasional	Moderate	Moderate-High	High	Highest
Infrequent	Low	Moderate	Moderate-High	High
Rare	Lowest	Low	Moderate	Moderate-High

RSAs: COSTS AND BENEFITS

RSA Costs

Three main factors contribute to the cost of an RSA:

- RSA Team costs.
- Design team and Owner costs.
- Costs of design changes or enhancements.

The *RSA Team costs* reflect the size of the team and the time required for the RSA, which in turn are dependent on the complexity of the RSA project. For the RSAs in this case studies project, the following cost components are noted:

RSA teams consisted of groups between five and fourteen persons, but these teams were large since the RSAs served as training exercises for Federal, tribal, and state engineering staff, and also because there are multiple owners in some cases. Without the need for training, the RSA teams would more typically have been composed of three to four persons.

Opening and closing meetings, site visits, and RSA analysis sessions were conducted in a two- or three-day period for each RSA.

Prior to and following the on-site portion of the RSA, the time required for analysis (such as analysis of collision records, and research on applicable design standards or mitigation measures) and writing the RSA report averaged about 40 man-hours.

For this case studies project, additional RSA Team costs were incurred in travel and time for RSA Team leaders, who are consultants traveling from out of town. However, typical RSAs would employ local team members, and consequently entail only minor travel costs.

The *design team and owner costs* reflect the time required for staff to attend the start-up and preliminary findings meetings, and to subsequently read the RSA report and respond to its findings. In addition, staff time is required to compile project or site materials for the RSA team.

The final cost component is that resulting from *design changes or enhancements,* which reflect the number and complexity of the issues identified during the RSA. Suggested design changes and enhancements, listed in the Appendix (Tables A.1 through A.8) for each of the RSAs conducted for this case studies project, have focused on low-cost improvements or countermeasures where possible. Suggested improvements for the RSAs focused on improved signing and pavement markings, minor or moderate geometric changes (such as added auxiliary lanes at intersections), gateway treatments, and barrier improvements.

RSA Benefits

The primary benefits of RSAs are to be found in reduced crash costs as road safety is improved. The costs of automotive crashes are estimated by the US Department of Transportation[1] as:

- $3,000,000 for a traffic fatality.
- $2,290,000 for a critical injury.
- $565,000 for a severe injury.
- $175,000 for a serious injury.
- $45,000 for a moderate injury.
- $6,000 for a minor injury.

Other benefits of RSAs include reduced life-cycle project costs as crashes are reduced, and the development of good safety engineering and design practices, including consideration of potential multimodal safety issues and integrating human factors issues in the design, operations, and maintenance of roads.

[1] *Intersection Safety Issue Brief No. 15 ("Road Safety Audits: An Emerging and Effective Tool for Improved Safety"), issued April 2004 by Federal Highway Administration and Institute of Transportation Engineers.*

It is difficult to quantify the benefits of design-stage RSAs, since they aim to prevent crashes from occurring on new or improved facilities that have no crash record. However, when compared with the high cost of motor-vehicle injuries discussed above, the moderate cost of a design-stage RSA suggests that changes implemented from an RSA only need to prevent a few low- or moderate-severity crashes for an RSA to be cost effective.

The benefits of RSAs on existing roads can be more easily quantified, since pre-and post-improvement collision histories are available. As an example, the Road Improvement Demonstration Project conducted by AAA Michigan in Detroit and Grand Rapids (MI), which is based on RSAs of existing high-crash urban intersections and implementation of low-cost safety measures, has demonstrated a benefit-cost ratio of 16:1. Another example of data on the quantitative safety benefit of RSAs conducted on existing roads comes from the New York DOT, which reports a 20 to 40 percent reduction in crashes at more than 300 high-crash locations that had received surface improvements and had been treated with other low-cost safety improvements suggested by RSAs.

The South Carolina DOT RSA program has reported a positive impact on safety. Early results from four separate RSAs, following one year of results, are promising. One site, implementing four of eight suggested improvements, saw total crashes decrease 12.5 percent, resulting in an economic savings of $40,000. A second site had a 15.8 percent increase in crashes after only two of the thirteen suggestions for improvements were incorporated. A third site, implementing all nine suggested improvements, saw a reduction of 60 percent in fatalities, resulting in an economic savings of $3,660,000. Finally, a fourth location, implementing 25 of the 37 suggested safety improvements, had a 23.4 percent reduction in crashes, resulting in an economic savings of $147,000.

The most objective and most often-cited study of the benefits of RSAs, conducted in Surrey County, United Kingdom, compared fatal and injury crash reductions at 19 assessed highway projects to those at 19 highway projects for which RSAs were not conducted. It found that, while the average yearly fatal and injury crash frequency at the RSA sites had dropped by 1.25 crashes per year (an average reduction from 2.08 to 0.83 crashes per year), the average yearly fatal and injury crash frequency at the sites that were not assessed had dropped by only 0.26 crashes per year (an average reduction from 2.6 to 2.34 crashes per year). This suggests that RSAs of highway projects make them almost five times more effective in reducing fatal and injury crashes.

Other major studies from the United Kingdom, Denmark, New Zealand, and Jordan quantify the benefits of RSAs in different ways. However, all report that RSAs are relatively inexpensive to conduct and are highly cost effective in identifying safety enhancements.

THE FHWA CASE STUDIES: PROMOTING THE ACCEPTANCE OF RSAs

The RSAs in this case studies project have been well received by all participating agencies. There are several key factors that contribute to a successful RSA, the most obvious of which is working together to identify and solve road safety issues. Through a cooperative and coordinated effort, Federal, tribal, state, and local agencies can partner to enhance safety on our nation's roads. There are also many unique conditions associated with RSAs conducted on or near Federal or tribal lands. Several key factors and lessons learned from the RSA case studies are discussed in the following sections.

Key Factors for Success

The key factors described in this section are basic principles that should be considered on all RSAs of all facilities.

1. *RSA teams should be composed of a multidisciplinary group of experienced professionals willing and able to identify deficiencies and solutions to ensure safety problems on roads are addressed in a proactive manner.*

The core disciplines on an RSA Team are traffic operations, geometric design, and road safety. Beyond these disciplines, all of the RSA teams in this case studies project included members who brought a range of backgrounds and specialties to the RSA, including:

- *Specialist expertise:* The RSA of tribal roads on the Navajo Nation included a representative from Indian Health Services to provide advice from a public health perspective. The public health representative was able to provide valuable information regarding road user demographics in the area as well as opportunities for educational improvements such as road safety campaigns. The RSA conducted for Patuxent Research Refuge included a Community Traffic Safety Team Coordinator. These representatives of the community are trained and experienced in conducting RSAs and bring a unique viewpoint to the team, very often centered on human factors principles.
- *Enforcement:* The RSA teams included traffic enforcement officers where possible, and consulted with enforcement staff where their full-time participation on the RSA Team was not feasible. Enforcement staff contribute knowledge regarding local driver

behavior and road safety history, and can provide advice concerning the expected effectiveness of suggested improvements that rely on driver behavior to be effective. For example the RSA for the Red Cliff Band of the Lake Superior Chippewa included the police chief who was able to provide details on crashes and discuss enforcement challenges faced by the community.

- *Road agency staff:* RSA teams included members from the Federal or tribal road agency, state DOTs, local (e.g., county) transportation agencies, and FHWA field safety staff. These team members provided first-hand knowledge of local policies, practices, constraints, and resources.

In this series of pilot RSAs, RSA Team members were recruited from the Federal or tribal agency, state DOTs, local agency, local enforcement, and FHWA. Federal or tribal agencies considering their own RSAs may consider these agencies, as well as staff from other Federal agencies or Tribes with whom they establish a reciprocal relationship, when looking to staff RSA teams. When staffing a team, the RSA Team leader should remember that the RSA Team should be independent of the project or site being assessed, as far as possible. While consultation with local involved staff is necessary to gain an adequate understanding of the project or site, the RSA Team should be made up of members who have little or no prior involvement with the specific project or site.

2. *The safety benefits of proposed or existing facilities already in place are identified as part of the RSA process and report.*

As part of the RSA process, the team identified proposed improvements or measures already in place (prior to the RSA) that improve the safety of road users, such as paved shoulders, designated pedestrian/bicycle facilities, targeted traffic enforcement, educational campaigns, and institutional measures that provide ongoing support for transportation safety initiatives. Acknowledging proposed improvements and safety measures that have been implemented puts the RSA findings in an appropriate context, and acknowledges the efforts already done by the road agency to improve the safety of road users.

3. *All RSA Team members need to be heard.*

RSAs are conducted by an independent and multidisciplinary team. Each team member brings individual expertise and perspective to the RSA that they can pass along to their teammates. It is important to fully engage every team member to facilitate a free and open discussion of issues and suggested improvements, which will help ensure the success of the RSA.

The RSA for the Navajo Nation in Red Mesa included team members from the Navajo DOT, Navajo police, Utah DOT, BIA, Indian Health Services, FHWA, and San Juan County. All members provided useful insights during the RSA process and several team members commented on the benefit of listening to and learning from their teammates who were able to provide a different perspective of the safety issues and potential improvements. For example, the member from Indian Health Services learned about road safety issues from a highway design perspective, and in return, was able to educate the team on road safety concerns from a public health perspective.

4. Candidate funding sources for suggested improvements are identified.

All of the Federal and tribal RSAs included suggestions for improvements to address safety issues. An important consideration in identifying and implementing road safety improvements is funding. The federal government provides funding assistance for eligible activities through legislative formulas and discretionary authority, including some 100% federal aid programs and programs based on 90/10 or 80/20 (federal/local) matches. The RSA Team can obtain up-to-date information on funding opportunities by referring to the following resources and visiting the following websites:

- *Tribal Highway Safety Improvement Implementation Guide (http://www.fhwa.dot.gov/hep/tribaltrans/saf_guide.htm*).
- *Tribal Transportation Funding Resources (http://www.fhwa.dot.gov/hep/tribaltrans/ttfundresource.pdf).*
- FHWA Discretionary Programs website *(http://www.fhwa.dot.gov/discretionary/proginfo.cfm)*.

The *Tribal Highway Safety Improvement Implementation Guide* advises that the implementation plan for a tribal highway safety improvement project (THSIP) or highway safety project will depend greatly on which funding sources the Tribes pursue, since each source has different program eligibility requirements. Some of the important government traffic safety-funding sources include:

- *The Highway Safety Improvement Program (HSIP) and Surface Transportation Program (STP)* federal-aid highway programs, administered by the state highway agency for projects that improve safety.
- *Transportation enhancement funds* administered by the state highway agency for projects involving pedestrian facilities and scenic highways.

- *Safe Routes to School (SRTS) Program funds* administered by the state highway agency to enable and encourage children to walk and bike to school.
- *National Scenic Byway Program* administered by the state highway agency which provides funding for roads designated either locally or nationally as having outstanding scenic, historic, cultural, natural, recreational, and archaeological qualities. Funds can be used for pedestrian and bicycle facilities along scenic byways.
- *Indian Reservation Roads (IRR) Program* jointly administered by BIA Division of Transportation and the FHWA Federal Lands Highway Office.
- *Public Lands Highways Discretionary (PLHD) Program funds* administered by the Office of Federal Lands Highway. PLHD funds are intended to improve access to and within Federal lands and are available for transportation planning, research, engineering, and construction of highways, roads, parkways, and transit facilities within Federal public lands.
- *National Highway Traffic Safety Administration (NHTSA) funds* administered by the state Highway Safety Office and the BIA Indian Highway Safety Program Office, including the *State and Community Highway Safety Grants Program (Section 402), Occupant Protection Incentive Grants (Section 405), Safety Incentive Grants for Safety Belt Use (Section 406), State Traffic Safety Information System Improvement Grants (Section 408), and Alcohol-Impaired Driving Countermeasures Incentive Grants (Section 410).*
- *Indian Health Service Injury Prevention Program* for basic and advanced injury prevention projects, and for building tribal capacity for preventing any type of injury problem facing a tribal government.

Additional sources specific to each state may be available from the state department of transportation.

Lessons Learned

Over the course of the Federal and tribal lands RSA case studies project, the RSA teams identified eleven key elements that must be considered as agencies move forward with an RSA program.

1. *The RSA Team must acquire a clear understanding of the project background and constraints.*

At the RSA start-up meeting, a frank discussion of the constraints and challenges encountered in the design of the project, or operation of existing road, is critical to the success of the RSA. It is crucial that the RSA Team understand the trade-offs and compromises that were a part of the design process or the form of the present road. Knowledge of these constraints helps the RSA Team to identify mitigation measures that are practical and reasonable.

The RSA for the Red Cliff Band of Lake Superior Chippewa included team members from the Red Cliff transportation agency and the Wisconsin DOT. The RSA was conducted on a section of WIS-13 (a state route) through the Red Cliff community. The state built the roadway and is responsible for major improvements such as resurfacing, while the Tribe is responsible for maintenance activities such as signing and pavement markings. Prior to the RSA, both agencies had identified improvements for this section of road, but the improvements did not coincide. There were also several mid- to long-range improvements planned for the area (e.g., relocating existing casino and new housing developments). The RSA provided an opportunity to combine aspects of the plans from both agencies to address the identified safety issues and assign responsibility to the respective parties. The RSA Team obtained a clear understanding of the desires and responsibilities of both parties as well as the planned developments in the area.

2. *The involvement of multiple road agencies in the design, operation, and maintenance of roads on Federal and tribal lands can present a challenge, but can also help promote a successful RSA outcome.*

There is a need for a high degree of coordination among the RSA Team on Federal and tribal lands because of the many agencies involved. Most of the roads assessed in this series of RSAs were under the joint jurisdiction of two or more road agencies at different levels, including:

- The Federal Lands Management Agency or Tribal transportation agency.
- One or more state Departments of Transportation.
- Local (county) transportation agency.

When a road is under multiple jurisdictions, there are multiple interests involved. For example, FLMAs may have partial control over improvements (due to environmental and right-of-way constraints) even though they may not own or be responsible for maintaining the roadway. As such, it is important to identify ownership and jurisdiction, as well as the responsibilities of each agency on the team.

Although relations between the representatives from these agencies ranged from civil to friendly on all RSAs conducted in this series, these multiple layers can result in a large and unwieldy RSA team, and may result in conflict between members of the team. At the same time, the involvement of multiple agencies was a distinct advantage in some Federal and tribal lands RSAs where participants were able to call upon resources within multiple agencies to make the RSA outcome as successful as possible.

The RSAs on Savannah Wildlife and Patuxent Research Refuges included state-owned roadways that travel through Federal lands owned by the Fish and Wildlife Service (FWS). In these situations, the wildlife refuges do not own the roadways, but there are multiple voices of concern regarding any improvements to the roads. Environmental impacts are often a concern of the FLMAs, but there is also a concern for the safety of their visitors. In the case of the Savannah RSA, the Federal lands agency recognized the safety issues along the roadways within the refuge and helped to identify suggestions to improve facilities with minimal impact to the environment. The Patuxent Research Refuge has established an agreement with the state for certain maintenance responsibilities.

The RSA for the Navajo Nation in Red Mesa was conducted along N-35. The entire N-35 corridor north of US-160 is a Federal Aid Highway. The portion of the roadway from milepost 0 to milepost 18 is owned by the Bureau of Indian Affairs (BIA). The Phillips Oil Company paved the section of N-35 from milepost 18 to milepost 23, but road ownership remains the Navajo Nation's. Funding for reconstruction and maintenance of N-35 comes from several sources, including the Indian Reservation Roads Program (IRR), Congressional earmarks, and the BIA road maintenance program. The funding for road improvements is administered by the Navajo Region Division of Transportation (NRDOT) through the IRR Program within the Federal Lands Highway Program. Funding for road maintenance comes from the Department of the Interior (DOI) and is also administered by the NRDOT. They have contracted San Juan County to maintain much of the roads in the county, including N-35. San Juan County is responsible for signing, pavement markings, and roadside mowing. While the ownership of the roadway is very complex and can present challenges, there are also benefits of multi-agency involvement. For example, funding for reconstruction and maintenance are limited for an individual agency, but the agencies identified options for pooling resources to implement the suggested RSA improvements.

3. *The RSA Team and Owner need to work in a cooperative fashion to achieve a successful RSA result. It is important to maintain an atmosphere of cooperation among all participants in the RSA process.*

The RSA Team should be consistently positive and constructive when dealing with the facility Owner. Many problems can be avoided if the RSA Team maintains effective communication with the Owner during the entire RSA process (including the opportunities presented in the start-up and preliminary findings meetings) to understand why roadway elements were designed as they were, and whether mitigation measures identified by the RSA Team are feasible and practical. This consultation also gives the Owner a "heads-up" regarding the issues identified during the RSA, as well as some input into possible solutions, both of which can reduce apprehension (and therefore defensiveness) concerning the RSA findings.

The cooperation of the Owner is vital to the success of the RSA. An RSA is not a critical review of the Owner's work, but rather a supportive review of the facility with a focus on how safety can be further incorporated into the existing facility or design. Cooperation between the RSA Team and Owner usually results in a productive RSA, since the RSA Team will fully understand the design issues and challenges (as explained by the Owner), and suggested mitigation measures (as discussed in advance with the Owner) will be practical and reasonable.

Support from the Owner is vital to the success of individual RSAs and the RSA program as a whole. It is essential that the Owner commit the necessary time within the project schedule for conducting the RSA and incorporating any improvements resulting from it, as well as the staff to represent the Owner in the RSA process (primarily the start-up and preliminary findings meetings).

The Cumberland Gap National Historic Park RSA included an examination of the Tennessee side approach to the Cumberland Gap Tunnel. This section is jointly owned by the Tennessee DOT and Kentucky DOT. The RSA process was enhanced by cooperation from the project owners. Specifically, the Tennessee DOT offered to conduct a speed study at a high crash location to evaluate if speeding was a factor in the crashes. In addition, the Tennessee DOT provided assistance by outlining their state process for performing RSAs and implementing improvements in their High Risk Rural Roads Program. The established RSA process allowed the RSA Team to better focus on other key elements of the RSA workshop such as the field investigation, crash data analysis, and safety measure selection.

Similarly, on the Patuxent RSA, Maryland State Highway Administration, the facility Owner, provided information on established RSA policies, procedures, and RSA report formats. This enabled the RSA Team to more effectively use their time to discuss issues and opportunities for improvement.

4. A "local champion" can greatly help to facilitate the establishment of RSAs.

Wilson and Lipinski[2] noted in their synthesis of RSA practices in the United States that the introduction of RSAs or an RSA program can face opposition based on liability concerns, the anticipated costs of the RSA or of implementing suggested changes, and commitment of staff resources. To help overcome this resistance, a "local champion" who understands the purposes and procedures of an RSA, and who is willing and able to promote RSAs on at least a trial basis, is desirable. Thus, measures to introduce RSAs to a core of senior transportation professionals can help to promote their wider acceptance. "Local champions" have been found within Federal and tribal road agencies, state DOTs, and FHWA field offices.

However, sometimes a local champion can emerge from a discipline other than the transportation field. For example, Indian Health Services (IHS) worked tirelessly to ensure an RSA was conducted for the Navajo Nation. Having detailed knowledge of the issues affecting the health and safety of people within their jurisdiction, IHS staff helped to identify potential RSA projects and RSA Team members to ensure maximum impact of the RSA.

5. The RSA field review should be scheduled during regular recurring traffic conditions.

Where possible, the RSA Team should visit the project site when traffic conditions are typical or representative. For example, the RSA for the Red Cliff community included the primary road through their community as well as a local road that provides access to residential areas. Pedestrian safety, particularly for school children, was identified as an issue along these roads. Therefore, the RSA Team scheduled site visits during the school year and observed conditions during the morning and afternoon, coinciding with the start and end of the school day. As such, the team was able to observe pedestrian, bicycle, and bus activity along the routes and identify suggestions to enhance safety for all road users.

In contrast, the RSA on the Navajo Nation was conducted in late August, nearing the end of the tourist season, but prior to the annual Shiprock Fair in October. The review of the crash data identified a substantial increase in crashes in October, coinciding with the Shiprock Fair. Consequently, the RSA Team was not able to observe traffic conditions

[2] Eugene Wilson and Martin Lipinski. *NCHRP Synthesis 336: Road Safety Audits, A Synthesis of Highway Practice* (National Cooperative Highway Research Program, TRB, 2004)

and driver behavior associated with the annual event. Although this did not significantly affect the RSA findings, scheduling the field review to observe recurring traffic conditions is preferable as it allows the RSA Team to see how these traffic conditions and road user behavior may affect safety.

6. *The RSA field review should be conducted under various light and weather conditions when possible.*

The RSAs conducted as part of this series all included field visits during various conditions (i.e., day/night and AM/PM peak periods). When possible it is also important to conduct field visits during various weather conditions. Conducting field visits under various roadway and traffic conditions allows the RSA Team to observe road user behaviors under each scenario and identify potential safety issues.

The Patuxent RSA was conducted during various conditions, including daytime, night-time, and wet weather conditions. Drainage issues, including standing water near inlets and ponding in wheel ruts, were apparent based on the field review during wet weather conditions. The RSA Team also reviewed the study area during night-time conditions, which helped to identify the lack of visual guidance as a major safety issue. These issues would not have been easily detected if the field review was conducted during daylight and dry weather conditions only. As a result of the field review under various conditions, the RSA Team was able to conduct a more comprehensive review and incorporate this information in their suggestions for improvements.

The Red Mesa RSA Team also identified safety issues during day and night conditions. During the day, the team noted several signs that were dirty. Under further review during nighttime conditions, the RSA Team noted that the same signs were nearly illegible. The nighttime review helped to identify the severity of the issue related to sign maintenance.

7. *RSAs establish relationships among agencies who don't typically communicate with each other.*

Tribal agencies are responsible for the roadways within their jurisdiction, but there is often a shared responsibility with the state DOT because state roads often border or pass through tribal lands. The state may be responsible for construction of the roadway, but the Tribe is often responsible for maintaining the roadway. This requires an effective line of communication between the involved parties. The RSA process involves a formal safety evaluation by a multidisciplinary team, and for RSAs on tribal lands, the team often

includes representation from the local Tribe and state DOT, among others. This provides an opportunity for the Tribe to discuss their issues and long-term visions with the state DOT and vice versa. As such, RSAs not only have the potential to enhance road safety, they have the potential to help establish better lines of communication and cooperation between the state DOT and the Tribe.

The Red Cliff Band of Lake Superior Chippewa is responsible for maintaining the signs and pavement markings on WIS-13 (a state route) through their community. During the RSA, it was discovered that the Wisconsin DOT and the Red Cliff Tribe had each identified improvements for WIS-13, but the two agencies' plans did not coincide. The RSA process provided an opportunity for the agencies to establish a common vision for WIS-13 within the Red Cliff community and develop short-term, intermediate, and long-term goals. The RSA Team also identified safety issues on the existing facility and developed a list of additional improvements to include as part of the short-term, intermediate, and long-term goals. Overall, the RSA process provided an opportunity to enhance communication between the agencies and integrate planned improvements into a single vision. Throughout the course of the RSA process, the Red Cliff community, WisDOT, and BIA provided support and were open to suggestions for improvements. This attitude will help to maintain long-term communications and a commitment to improving safety for the Red Cliff community.

8. *There may be opportunities to implement improvements by incorporating them with long-range plans.*

As part of the RSA opening meeting, the Team reviews data available for the study location such as traffic volumes and crashes. The RSA Team may also review long-range improvement plans. It is important for the RSA Team to understand the extent of the long-range plans so that they can identify how and when existing safety issues may be addressed. This also provides an opportunity for the RSA Team to identify additional improvements that were not previously identified in the long-range plans.

During the RSA for the Navajo Nation in Red Mesa, the RSA Team identified several safety issues related to the narrow roadway width and lack of shoulders. Due to the limited annual funding for maintenance and roadway improvements, it was not practical to identify pavement widening as a short-term or intermediate improvement. However, there is a long-term resurfacing project along the corridor and the RSA Team identified opportunities to incorporate RSA suggestions as part of this long-range project.

9. The geometric design of roadways on Federal and tribal lands are often not intended for the current traffic types and volumes.

Current use of roadways on Federal and tribal lands often exceed the intended use for which they were designed. Several of the RSAs conducted as part of this case studies series included roads that were designed for low-volume, passenger car use. As such, the lane and shoulder widths are relatively narrow and roadsides are often unforgiving. Due to local attractions (e.g., National parks) that are served by these roadways or the location of these roads in relation to commuter routes, there are increasing traffic volumes along these routes.

The original purpose of Bear Camp Road in Oregon was for timber haul and for administration of Forest Service and Bureau of Land Management lands. However, the use and function of the road has evolved over time. At the time of the RSA, the road was being used by the public as a link between the interior of Oregon and the coast, and for commercial and recreational uses. Although the use and function of the road has evolved, its design, maintenance, and management has not. Consequently, the public was using a facility that was not designed for public use, and that did not incorporate safety features that the public generally expects or assumes.

The RSA for the Savannah National Wildlife Refuge in South Carolina included the review of a two-lane, rural road with limited lane widths and no paved shoulders. Pedestrian and bicycle activity along this route is generated by the refuge wildlife trails. The refuge would like to encourage further pedestrian and bicycle activity, but there are currently inadequate facilities along the roadway (i.e., no paved shoulders). This road also serves local traffic as well as large truck volumes from nearby factories, mills, and the Savannah Port. The truck volumes are expected to increase substantially when the Jasper Port opens. The mix of heavy truck traffic with pedestrians and bicyclists, coupled with limited geometrics, creates a significant safety concern.

The RSA in Red Cliff, Wisconsin included a section of WIS-13 through the Red Cliff community. While this road is a rural state trunk highway, it is a two-lane road with narrow shoulders and relatively high speeds. The route serves commuters between the communities of Bayfield and Red Cliff and also accommodates tourist traffic visiting local attractions such as the Isle Vista Casino, Town of Bayfield, and the Apostle Islands National Lakeshore (National Park). While pedestrian, bicycle, and ATV activity are generated by several nearby attractions, there are limited facilities to accommodate these user groups. The RSA Team identified options to create more of a community feel to the section of road

through the Red Cliff community to help increase driver expectancy of pedestrians and bicyclists and potentially reduce vehicle speeds. The Team also identified opportunities to construct shared-use paths for pedestrians and bicyclists along the route.

The RSA for the Patuxent Research Refuge included a portion of Laurel Bowie Road. The road was constructed as a two-lane rural road, serving the Patuxent Research Refuge with several access points to the Refuge in the study area. The roadway has since become a heavily traveled commuter route between Laurel and Bowie. The roadway and roadside were not designed to accommodate the current use of the facility, which has manifested in a safety problem, including several fatal crashes.

10. There is a need and opportunity to incorporate pedestrian and bicycle improvements on Federal and tribal lands.

There are multiple pedestrian and bicycle generators on Federal and tribal lands, but often a lack of adequate pedestrian and bicycle facilities. WIS-13 in Red Cliff, Wisconsin not only serves local pedestrian, bicycle, and vehicle traffic, but also accommodates tourist traffic generated by the Isle Vista Casino and Apostle Islands National Lakeshore (National Park). There are limited shoulders and no sidewalks for pedestrians and bicyclists along WIS-13. Coupled with relatively high vehicle speeds, this creates a significant safety issue for pedestrians and bicyclists.

The Savannah Wildlife Refuge generates significant pedestrian and bicycle activity, particularly along SC-170, which provides access to a wildlife viewing trail. Many visitors currently drive to the beginning of the Laurel Hill Wildlife Drive, park their vehicle, and continue by bike along the 4.5 mile drive. At the end of the drive, the bicyclists must either ride along SC-170 to return to their vehicle or backtrack the 4.5 miles against traffic on the one-way wildlife drive. The lane widths are narrow and there are no paved shoulders on SC-170. Coupled with the increasing volumes of heavy trucks, this creates an unsafe situation for pedestrians and bicyclists. The RSA Team identified several options for improving pedestrian and bicycle facilities within the refuge.

11. Animal control is an issue along many Federal and tribal land roads.

Animal-vehicle crashes vary by state and region. Deer are a primary concern in many states, but moose, elk, cows, and horses are a significant safety concern in Federal and tribal lands. There is a significant safety concern for motorists when the animals are large because crashes are often more severe. Animal-related crashes can be classified as wildlife or as domestic/livestock. The safety concerns may be similar among the two

groups (i.e., large animals create a significant risk); however, the countermeasures to address the two categories can differ.

There are no assigned "keepers" of non-domestic animals (i.e., wildlife). Wildlife may travel long distances for food, mating, and migration. These animals often cross many roads in their travels. While animal fencing is an effective method for reducing animal crossings, it interferes with the animals' desired route and disrupts their feeding, mating, and migration. The Deer-Vehicle Crash Information Clearinghouse identifies several countermeasures to address deer-vehicle collisions (http://deercrash.com/toolbox/index.htm). Many of these strategies can also be applied to address other types of animal crashes. For example, wildlife crossings (i.e., overpasses and underpasses) are identified as a strategy to address deer collisions, but have been constructed in many states to provide safe crossing routes for several other species ranging from frogs to bear. FHWA has developed a document and a website specifically focused on wildlife crossings or "critter crossings" as they are also known (http://www.fhwa.dot.gov/environment/wildlifecrossings/index.htm).

Domestic animals and livestock are also a safety concern, but someone is responsible for these animals. The risk of animal-vehicle collisions increases when domestic animals and livestock are allowed to roam free along the roadway. Installing and maintaining fencing along the road can help to reduce the number of animal-related crashes. However, it may be too costly for some agencies to install and maintain animal fencing. While enforcement and education efforts are not particularly useful to address wildlife crashes, they can help to address crashes related to domestic animals and livestock. Specifically, laws can be enacted and enforced to prohibit grazing within the right-of-way. Education campaigns can be employed to provide information related to animal control laws and stress the importance of keeping animals and drivers safe by minimizing potential conflicts.

Open grazing is allowed along N-35 on the Navajo Nation in Red Mesa, Utah. Coupled with a lack of animal fencing, animal crashes represent approximately 25 percent of crashes annually along the corridor. The Patuxent Research Refuge has animal fencing along the road to control animals and, as such, animal crashes are not a significant issue. The animal fence on the Patuxent Research Refuge is often struck, but these crashes are often much less severe than animal crashes and the fence is easily repaired. The fence collisions are partially attributed to roads that are not designed for current traffic use and non-recoverable slopes that lead to the fence.

CONCLUSION

The Federal and tribal lands RSA case studies project sponsored by the FHWA Office of Federal Lands Highway and the Office of Safety has been well received by the participating FLMAs and tribal transportation agencies. The case studies project has exposed FLMAs and tribal governments to the concepts and practices of an RSA, and provided the opportunity for these agencies' staff members to participate on the RSA Team as part of the process. This case studies document has summarized the results of each RSA, with the intent of providing FLMAs and tribal governments with examples and advice to assist them in implementing RSAs in their own jurisdictions. While safety issues vary from one transportation facility to another, these case studies provide a wide range of examples that demonstrate the usefulness of RSAs in solving safety problems on Federal and tribal lands.

APPENDIX A
CASE STUDY RSAs

RSA NUMBER 1

PINCKNEY ISLAND AND SAVANNAH NATIONAL WILDLIFE REFUGES: RSA OF ENTRANCES TO CURRENT AND PLANNED REFUGE FACILITIES SOUTH CAROLINA

Roads: existing two-lane and four-lane rural principal arterial roadways	
RSA Sites:	*Pinckney Island National Wildlife Refuge* • existing entrance to wildlife refuge *Savannah National Wildlife Refuge* • existing entrance to wildlife refuge maintenance facility • existing entrance and exit for Laurel Hill Wildlife Drive • proposed entrance to wildlife refuge visitor center
Environment:	☐ urban/urbanized ☑ **suburban** ☑ **rural**
Owners:	Savannah Coastal Refuges, South Carolina Department of Transportation (SCDOT)
Road Safety Audit	
Date of RSAs:	5 to 6 March 2008
RSA Stage(s):	☐ planning/design stage ☑ **RSA of existing roads**
RSA team:	Savannah National Wildlife Refuge, Federal Highway Administration Eastern Federal Lands Highway Division (EFLHD), South Carolina Department of Transportation (SCDOT), US Fish and Wildlife Service (USFWS), and Vanasse Hangen Brustlin, Inc.

BACKGROUND:

The US Fish and Wildlife Service (USFWS) identified locations of concern on the two refuges. The purpose of this RSA was to identify safety issues at the locations and develop suggestions.

Pinckney Island National Wildlife Refuge

The Pinckney Island National Wildlife Refuge is operated by the USFWS. The area of interest for the RSA was the entrance to Pinckney Island as shown in Figure A.1. The roadway that accesses the refuge is US-278 in Beaufort County, South Carolina. US-278 is a four-lane principle arterial roadway owned by South Carolina DOT (SCDOT). This road serves as a commuter route and provides the only land access to Hilton Head Island. There is a relatively large amount of pedestrian and bicycle activity in this area due to the refuge. Currently, the level of service along US-278 is F (i.e., exceeding capacity), beginning just west of Pinckney Island due to the large traffic volumes accessing Hilton Head Island. The Beaufort County Comprehensive Transportation Plan describes plans to upgrade this section of US-278 from a 4-lane to a 6-lane section as part of the planned improvements to address 2025 needs.

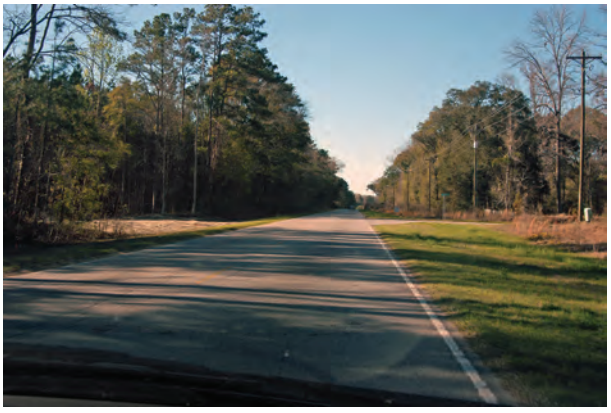
Savannah National Wildlife Refuge

The Savannah National Wildlife Refuge is also operated by the USFWS. The RSA study area was located near the junction of US-17 and SC-170 in Jasper County, South Carolina. More specifically, the Savannah National Wildlife Refuge study area included three locations, 1) the entrance to the Savannah National Wildlife Refuge maintenance facility, 2) the access points to the Laurel Hill Wildlife Drive, and 3) the entrance to the proposed visitor center. US-17 and SC-170 are two-lane principle arterial roadways owned by SCDOT. These roads serve local traffic as well as large trucks from the nearby factories, mills, and the Savannah Port. The level of service along US-17 and SC-170 is currently very good; however, the truck volumes are expected to increase substantially when the Jasper Port opens. The refuge generates pedestrian and bicycle traffic and refuge staff would like to encourage further pedestrian and bicycle activity.

ENTRANCE TO PINCKNEY ISLAND NATIONAL WILDLIFE REFUGE, SC

ENTRANCE TO SAVANNAH NATIONAL WILDLIFE REFUGE MAINTENANCE FACILITY, SC

ACCESS POINT TO LAUREL HILL WILDLIFE DRIVE AT SAVANNAH NATIONAL WILDLIFE REFUGE, SC



PROPOSED ENTRANCE TO SAVANNAH NATIONAL WILDLIFE REFUGE VISITOR CENTER, SC

FIGURE A.1 VIEWS OF RSA SITES (PICKNEY ISLAND AND SAVANNAH COASTAL WILDLIFE REFUGES RSA)

KEY RSA FINDINGS AND SUGGESTIONS:

The key findings and suggestions of the RSA are summarized in TABLE A.1.

TABLE A.1 SUMMARY OF SELECTED SAFETY ISSUES AND SUGGESTIONS: PICKNEY ISLAND AND SAVANNAH NATIONAL WILDLIFE REFUGE RSA

SELECTED SAFETY ISSUE (Number and Description)		SUGGESTIONS
1	*Roadway Geometry:* • The lack of turn-lanes along SC-170 and US-17 at the access points increases the chance of conflict. • Turn and acceleration lanes at the entrance along US-278 are relatively short. This issue is confounded by horizontal and vertical curves, which limit sight distance to and from the entrance.	• construct right- and left-turn lanes at entrances • install shoulder bypass lanes as alternative • lengthen existing turn and acceleration lanes • consider potential underpass to eliminate left-turns and crossing movements at Pinckney Island • trim vegetation • install intersection warning signs • install advance guide signs or advance street name signs
2	*Signage and Pavement Markings:* • Lack of guidance within the median opening at Pinckney Island. • Faded pavement markings and missing raised pavement markers reduce visibility at night. • Lack of signing at access points. • Centerline is marked as a passing zone on US-17 at the entrance to the proposed visitor center. • Inconsistent color of SCDOT guide sign for Savannah National Wildlife Refuge.	• delineate nose of median openings • install STOP bars and double yellow centerlines in median openings • install retroreflective signs and pavement markings • replace missing raised pavement markers • install post-mounted delineators along corridor • install signs to warn motorists of turning and entering vehicles • restripe US-17 as ‘no passing’ • replace green SCDOT sign for Savannah NWR, use brown background with white text
3	*Traffic Congestion:* • Level of service F along section of US-278 creates safety-related congestion issues. • Parking facilities are over capacity at Pinckney Island. • Nighttime events at Savannah NWR maintenance facility or Laurel Hill Wildlife Drive create safety issues.	• install traffic warning system to warn motorists of slow or stopped traffic • increase capacity of parking lot • continue policy of ‘no nighttime events’ at maintenance facility or Laurel Hill Wildlife Drive

SELECTED SAFETY ISSUE (Number and Description)		SUGGESTIONS
4	*Roadside Design:* • Lack of paved shoulders along US-278, US-17, and SC-170. • Rough transition from wildlife drive exit to SC-170. • Pavement edge drop-offs. • Damaged guardrail on southeast corner of entrance at Pinckney Island. • Drop-offs on levees. • Narrow bridge widths along SC-170.	• improve shoulder width, particularly on horizontal curves and at access points • improve transition from wildlife drive exit • improve maintenance practices to eliminate pavement edge drop-offs and stabilize shoulders; beveled “safety edge” • replace damaged guardrail • install guardrail along sections of SC-170 • widen shoulders when bridges are replaced
5	*Nighttime and Poor Visibility:* • Lack of nighttime guidance. • Fog along US-278 and SC-170.	• install or replace raised pavement markers • install high-visibility pavement markings • install high-intensity signs • delineate nose of median openings • install double yellow centerline and STOP bar in median openings • install fog-warning system
6	*Bicyclists:* • No safe bicycle access between refuge and boat access area at Pinckney Island. • Narrow bridge widths are safety hazard for bicyclists.	• provide better bike access • consider underpass between Pinckney Island Refuge and boat access • widen shoulders when bridges are replaced

KEY LESSONS LEARNED:

The RSA field review and team members can help to identify issues not apparent in crash and traffic data. This RSA was conducted during various conditions, including AM and PM peak periods. Based on the field reviews during peak periods, it was apparent that congestion along US-278 was contributing to several of the crashes at and near the entrance to Pinckney Island. The RSA team actually observed a crash that had occurred moments before the team arrived at the site. From the field visit, it was also identified that left-turns to and from the entrance to the Pinckney Island Wildlife Refuge may be difficult and dangerous. The RSA team was able to incorporate this valuable information in their suggestions for improvements.

Many crashes in the Savannah National Wildlife Refuge study area were not reported as a result of the location of the vehicle. Run-off road crashes were noted as a particular concern by the staff at the refuge. Vehicles involved in run-off-road crashes along SC-170 were not represented in the crash reports because once the vehicle leaves the roadway it

enters Federal refuge property. The motorist is responsible for removing the vehicle and it is not reported by the police.

Furthermore, traffic volumes and truck volumes in particular are higher than originally intended for this type of roadway; therefore the RSA team suggested measures to provide more positive guidance to motorists on the roadway and provide a more forgiving roadside.

See also the discussion of “Key Factors for Success” and “Lessons Learned” in the main text.

RSA NUMBER 2

PATUXENT RESEARCH REFUGE: RSA OF LAUREL BOWIE ROAD (MD 197) AND POWDER MILL ROAD

Roads: existing two-lane rural roadways	
RSA Sites:	• paved, rural, two-lane roads • signalized intersection
Environment:	☐ urban/urbanized ☑ suburban ☑ **rural**
Owners:	Maryland State Highway Administration (MD SHA), United States Department of Agriculture, Patuxent Research Refuge
Road Safety Audit	
Date of RSA:	5 to 6 December 2007
RSA Stage(s):	☐ planning/design stage ☑ **RSA of existing roads**
RSA team:	staff from the Patuxent Research Refuge, Federal Highway Administration, Maryland State Highway Administration (MD SHA), VHB, and a Community Traffic Safety Team Coordinator

BACKGROUND:

The US Fish and Wildlife Service (USFWS) identified locations of concern on the refuge. They voiced safety concerns on these roadways and requested this RSA through FHWA. There were four fatal crashes on this section of MD 197 between 2002 and 2006.The purpose of this RSA was to identify safety issues at the locations of concern and develop suggestions to address the identified safety issues.

The RSA included two roadways. The Laurel Bowie Road (MD 197) study area is over 3 miles in length, located between Snowden Pond Road/Basswood Drive and Lemons Bridge Road in Prince George's County, Maryland. Laurel Bowie Road (MD 197) is a two-lane east-west highway serving as a commuter route between Laurel and Bowie. The road is a State-owned facility that serves the Patuxent Research Refuge with several access points within the study area.

The Powder Mill Road study area is over 2 miles in length, located between Springfield Road and Laurel Bowie Road (MD 197) in Prince George's County, Maryland. Powder Mill Road is a two-lane north-south rural roadway. A portion of Powder Mill Road in the southern part of the study area is maintained by the United States Department of Agriculture while the northern part of the roadway is maintained by the Patuxent Research Refuge, a facility of the USFWS. Views of the study area are shown in Figure A.2.

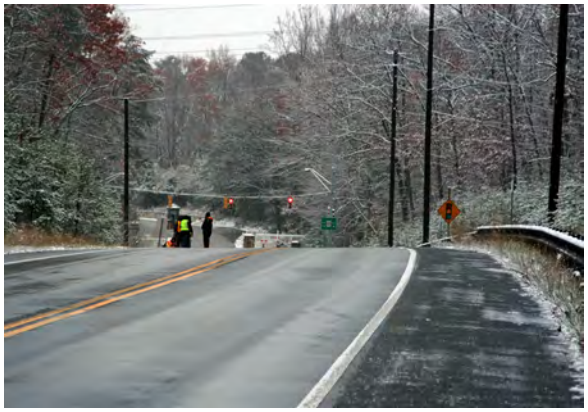
The intersection of Laurel Bowie Road (MD 197) and Powder Mill Road is the only signalized intersection in the study area. MD SHA developed plans to upgrade this intersection which were reviewed by the RSA team as part of this RSA. The scope of the

planned improvements included the construction of turn lanes, drainage improvements, and an upgrade in traffic signal equipment.

OLD LAUREL BOWIE ROAD AT MD 197, MD

TYPICAL SECTION ALONG MD 197, MD

VIEW OF OLD LAUREL BOWIE ROAD, MD



SIGNALIZED INTERSECTION OF POWDER MILL ROAD AT MD 197, MD

FIGURE A.2 VIEWS OF RSA SITES (PATUXENT WILDLIFE REFUGE RSA)

KEY RSA FINDINGS AND SUGGESTIONS:

The key findings and suggestions of the RSA are summarized in Table A.2. The issues are listed in order of priority as identified by the RSA team.

TABLE A.2 SUMMARY OF SELECTED SAFETY ISSUES AND SUGGESTIONS: PATUXENT WILDLIFE REFUGE RSA

SELECTED SAFETY ISSUE (Number and Description)		SUGGESTIONS
1	*Signage and Pavement Markings:* • Intersection conspicuity. • Sign conspicuity on curves. • Passing zones are not clearly defined. • Sign and pavement marking visibility. • Vegetation obstructions.	• relocate advance intersection warning signs • install stop bar • install supplemental stop signs • reinstall chevron alignment signs • consider eliminating passing zones • define passing zones with appropriate signs • upgrade signs and pavement markings • trim vegetation
2	*Nighttime Visibility:* • Little visual guidance at night.	• install post mounted delineators • install raised pavement markers • install high visibility pavement markings
3	*Roadside Design:* • Pavement edge drop-offs. • Height of existing guardrail. • Unshielded slopes. • Inconsistent shoulder width. • Utility poles/fixed objects in clear zone. • Sight distance restrictions.	*Short-term:* • install object markers or reflective tape on objects closest to roadway • review guardrail height • install guardrail to shield objects/slopes • trim vegetation *Long-term:* • use beveled “safety edge” • consider shoulder stabilizing maintenance programs • widen shoulders to 5 feet • relocate utility poles • move fence • conduct sight distance analysis using IHSDM

SELECTED SAFETY ISSUE (Number and Description)		SUGGESTIONS
4	*Drainage:* • Poor drainage – standing water. • Ponding water in wheel ruts.	*Short-term:* • clean/repair clogged inlets • install 'Slippery When Wet' signs (W8-5) *Long-term:* • ensure adequate inlets • eliminate curb • increase capacity of culvert • resurface roadway to eliminate ruts
5	*Access to/from Side Streets:* • Sight distance limitations. • Few available gaps in traffic for left-turning vehicles.	*Short-term*: • install advance warning signs • consider transverse rumble strips or pavement markings • relocate traffic sign *Intermediate/Long-term:* • build bypass lanes at high-use gates • consider two-stage crossings at unsignalized intersections • consider intersection control beacon • consider automated real-time detection
6	*Effects of Roadway Curvature on Motorists:* • Potential difficulty staying within the lane. • Off-peak speeding.	• install centerline rumble strips • widen lane/ shoulder on curves • conduct formal speed study • increase enforcement and variable message sign speed trailer • consider optical speed bars, PennDOT advance curve warning pavement marking and supplementary advisory speed markings at curves • consider dynamic curve warning sign
Review of Planned Improvements		
7	*Intersection of Powder Mill Road and Laurel Bowie Road (MD 197):* • Driver expectation of traffic control and right-of-way assignment. • Sight distance from Powder Mill Road for right-turning vehicles. • Unsafe driver behavior including passing left-turning cars on the shoulder.	*Short-term:* • relocate traffic sign that obstructs sight distance • trim vegetation • relocate right-turn lane stop bar • implement signal timing changes • change to full color operation on weekdays and weekends *Long-term:* • implement intersection improvement plan

KEY LESSONS LEARNED:

The RSA field review should be conducted under various light and weather conditions when possible. This RSA was conducted during various conditions, including daytime, night-time, and wet weather conditions. Drainage issues, including standing water near inlets and ponding in wheel ruts, were apparent based on the field review during wet weather conditions. The RSA team also reviewed the study area during night-time conditions, which helped to identify the lack of visual guidance as a major safety issue. These issues would not have been easily detected if the field review was conducted during daylight and dry weather conditions only. As a result of the field review under various conditions, the RSA team was able to conduct a more comprehensive review and incorporate this information in their recommendations for improvements.

The benefit of an RSA on existing roads can be increased by reviewing planned improvements or designs. RSAs of existing roadways are common on roads administered by FLMAs and tribal agencies since these roads tend to be in rural areas where funding may be scarce for maintenance or other upgrades. Improvement plans may have been developed that have a long construction cycle. The RSA provides an opportunity for a multidisciplinary team to examine the site and the proposed or planned improvements to ensure safety issues are addressed or incorporated into the future design.

See also the discussion of “Key Factors for Success” and “Lessons Learned” in the main text.

RSA NUMBER 3

RED CLIFF BAND OF LAKE SUPERIOR CHIPPEWA: RSA OF HIGHWAY 13 AND BLUEBERRY ROAD THROUGH RED CLIFF COMMUNITY WISCONSIN

Roads: existing two-lane rural state trunk highway	
RSA Sites:	• paved, rural, two-lane roads • unsignalized intersections
Environment:	☐ urban/urbanized ☐ suburban ☑ **rural**
Owners:	Red Cliff Band of Lake Superior Chippewa, Wisconsin Department of Transportation (WisDOT)
Road Safety Audit	
Date of RSA:	20 to 21 May 2009
RSA Stage(s):	☑ **planning/design stage** ☑ **RSA of existing roads**
RSA team:	Red Cliff Transportation Agency, Wisconsin Department of Transportation (WisDOT), Bureau of Indian Affairs, Red Cliff Police Department, Michigan Tribal Technical Assistance Program, and Vanasse Hangen Brustlin, Inc.

BACKGROUND:

The Red Cliff Tribe identified locations of concern within the Red Cliff community. The purpose of this RSA was to identify safety issues at the locations of concern and develop suggestions to address or mitigate the identified safety issues.

The study area is located on tribal lands of the Red Cliff Band of Lake Superior Chippewa. The study limits along Highway 13 include the area from Bresette Hill Road to the Buffalo Bay store, approximately 0.25 miles north of Blueberry Road as shown in Figure A.3. Highway 13 is a two-lane, rural State trunk highway, providing a north-south connection between the communities of Wisconsin Dells, Wisconsin Rapids, Marshfield, and Ashland. Locally, this road serves as a commuter route between the communities of Bayfield and Red Cliff and also accommodates tourist traffic visiting local attractions such as the Isle Vista Casino, Town of Bayfield, and the Apostle Islands National Lakeshore (National Park). Pedestrian, bicycle, and ATV activity in the study area is generated by the Isle Vista Casino, school bus stops, commercial developments, and residential areas.

The study also included Blueberry Road from Highway 13 to Daley Road. Blueberry Road is a two-lane, rural local road, primarily serving residents of the Red Cliff community. Blueberry Road intersects Highway 13 near the Isle Vista Casino and continues north to Lake Superior. An additional 100 housing units are planned off of Blueberry Road (on Daley Road), which is expected to increase the population in Red Cliff to approximately 2,000 by 2015, nearly a 50 percent increase. Other planned redevelopments in the area

include a new medical clinic on the west side of Highway 13 at Pike Road and a new Casino facility to be located on the west side of Highway 13 near the existing facility. These new developments will increase traffic volumes within the study area and likely increase pedestrian activity. As such, it is necessary to anticipate the increased potential for conflicts between pedestrians and vehicles and develop short-, intermediate-, and long-term strategies to provide safe and efficient facilities for both pedestrians and vehicles.

In 2004, a separate safety evaluation was performed along Highway 13 in a joint effort between the WisDOT and the Red Cliff community. The goal of the study was to improve safety for pedestrians and motorists on and along Highway 13 from Bresette Hill Road to Aiken Road from an uncomfortable level of safety to a comfortable level by October 2005. Several safety issues were identified, including a lack of safety education for youths, speeding, lack of sidewalks, lack of signing, and a general lack of the 3 E's (engineering, enforcement, and education). As part of this effort, recommendations were developed and strides have been made to enhance signing and markings and provide education at the Early Childhood Center (ECC) and community meetings.

There are also several planned improvements for Highway 13 at various stages in the planning and design process. WisDOT has developed preliminary design plans for a pavement replacement project, including the portion of Highway 13 through the Red Cliff reservation. Improvements identified on the preliminary plans included pavement replacement, a right-turn lane for northbound Highway 13 at Blueberry Rd., and the provision of a sidewalk or walkable shoulder along portions of Highway 13. The Red Cliff community has also signed a memorandum of understanding (MOU) with WisDOT to incorporate sidewalks and lighting along Highway 13 within the study area. Prior to the RSA, the Red Cliff community completed a Transportation Enhancement Application (TEA) to apply for American Recovery and Reinvestment Act (ARRA) funding. The TEA included conceptual drawings to incorporate additional safety improvements and enhance continuity and connectivity for pedestrians and bicyclists throughout the area. Specifically, the TEA illustrated a trail, pedestrian lighting, pedestrian plazas, and streetscaping along Highway 13. The concept drawings also illustrated median islands and designated pedestrian crossings at the intersections of Highway 13 with Blueberry Rd. and Pike Rd. The TEA has since been approved and will move forward to design. With the approval of the TEA, the WisDOT project will now focus on the pavement replacement, and the ARRA-funded project will focus on the intersection, median, lighting, and pedestrian enhancements.

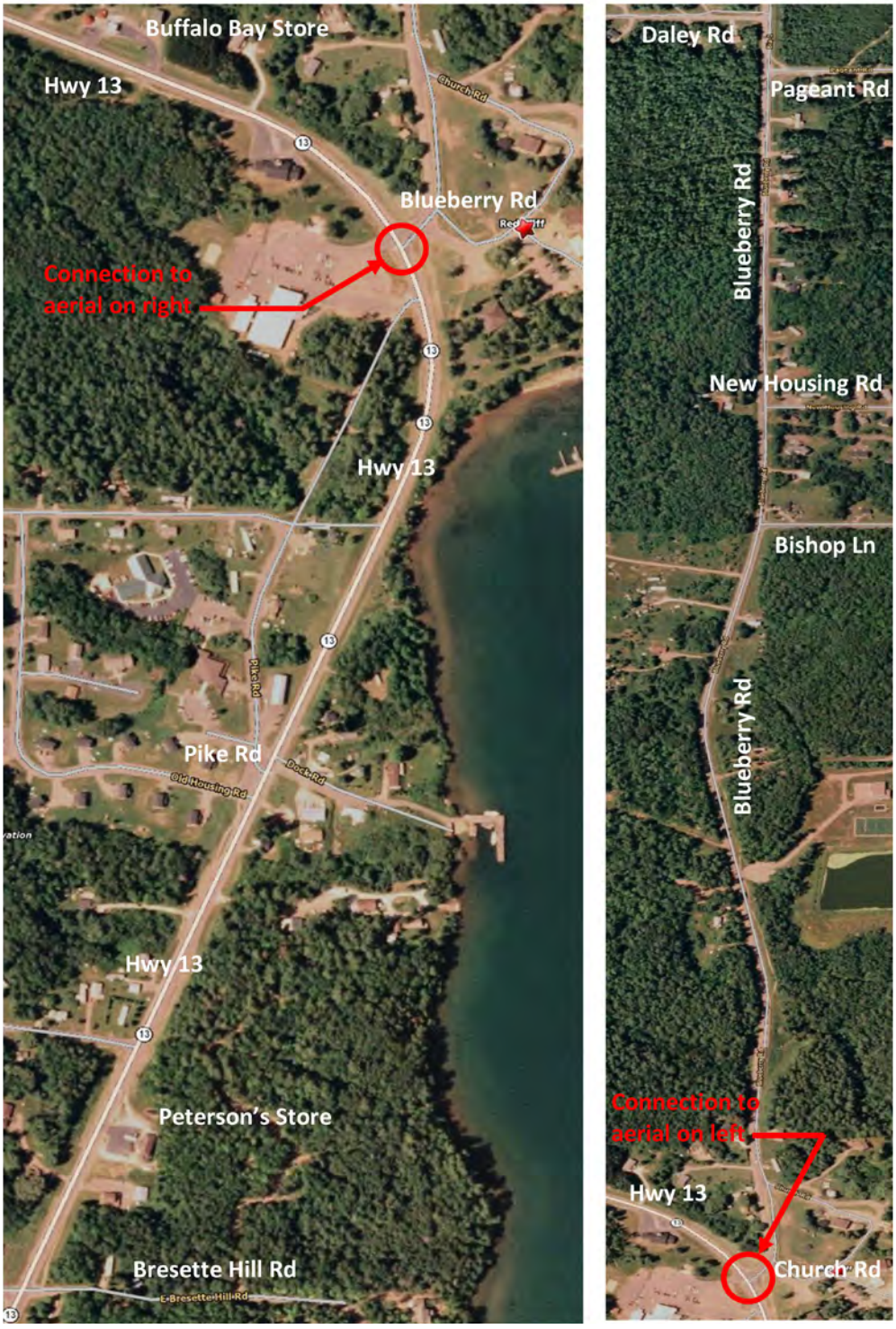


FIGURE A.3 AERIAL VIEWS OF RED CLIFF RSA SITES

KEY RSA FINDINGS AND SUGGESTIONS:

The key findings and suggestions of the RSA are summarized in Table A.3.

TABLE A.3 SUMMARY OF SELECTED SAFETY ISSUES AND SUGGESTIONS: RED CLIFF RSA

SELECTED SAFETY ISSUE (Number and Description)		SUGGESTIONS
1	*Overarching Safety Issues:* • Pavement on Highway 13 is deteriorating, creating large cracks, pot holes, and unstable shoulders. • Pavement markings are faded on Highway 13 and Blueberry Road, limiting conspicuity. • Inconsistent cross-section on Highway 13 through study area. • Lack of continuity and connectivity for pedestrians, bicyclists, and ATVs. • Faded crosswalk pavement markings. • Multiple access points for Isle Vista Casino create several conflict points. • Multiple intersections in close proximity at Blueberry Road and Highway 13 create wide pavement surface with limited delineation. • Drivers traveling northbound on Highway 13 use shoulder as deceleration/turn lane. • Run-off into the roadway and washout from the Isle Vista Casino parking lot into the ditch.	• determine schedule for DOT pavement replacement project • restripe Blueberry Road and coordinate restriping of Highway 13 with the mill and fill or pavement replacement project • identify desired cross-section and coordinate vision with DOT pavement replacement project • develop an overall ped/bike/ATV plan • restripe crosswalks to increase conspicuity • consolidate access at Isle Vista Casino • provide better channelization through intersections of 1) Blueberry Road and Church Road and 2) Highway 13 and Blueberry Road • provide better delineation of the edge of roadway and designate refuge areas for pedestrians at waiting areas • mitigate run-off issues by consolidating access points at Isle Vista Casino • install median along Highway 13 or a raised median throughout community with painted two-way left-turn lane and raised median at critical pedestrian crossings

SELECTED SAFETY ISSUE (Number and Description)		SUGGESTIONS
2	*Intersection of Highway 13 and Pike Road:* • Crosswalk located in a passing zone, which creates major safety issue for pedestrians. • Multiple access points, turning vehicles, bus stop, and pedestrian crossing increases driver workload and creates several conflict points. • Multiple intersections in close proximity and few pavement markings create wide pavement surface and several conflicting movements. • Lack of pavement markings through intersection, incorrect placement of STOP sign, and inconsistent pedestrian crossing sign. • Inconsistent bus activity.	• restripe centerline, changing markings from passing zone to no passing zone and restripe crosswalk to increase conspicuity • install advance pedestrian warning sign and consolidate access points • consolidate access points and provide better channelization through use of stop bars, centerlines, and edgelines • provide channelization (STOP bars, centerlines, edge lines), relocate STOP sign to right side of road, and replace pedestrian crossing sign to be consistent with other signs in the study area • work with schools to better coordinate bus activity and install sidewalks or trails to connect bus stop locations
3	*Blueberry Road Segment:* • Lack of paved shoulder along west side of Blueberry Road. • Horizontal curve to the left (south of Bishop Lane) with limited unpaved shoulder, steep embankment, and trees at bottom of slope.	• install 4' paved shoulder along west side of Blueberry Road and provide separate mixed-use trail parallel to Blueberry Road • install post-mounted delineators along outside of curve
4	*Highway 13 from Peterson's Store to Pike Road:* • Location and condition of midblock crosswalk north of entrance to Peterson's store. • Crossing located in a passing zone. • ATVs riding along Highway 13.	• relocate crosswalk to better align with store and upgrade signs and pavement markings to increase visibility and conspicuity of crossing • restripe centerline to make area a no passing zone • increase enforcement to limit ATV traffic on Highway 13 and consider opportunities for ATV parking so riders can park and walk to Peterson's store
5	*Highway 13 from Pike Road to Blueberry Road:* • ATVs crossing Highway 13.	• create ATV parking areas so riders may park and walk to destinations and create curbed cross-section to deter midblock ATV crossings
6	*Highway 13 from Blueberry Road to Buffalo Bay Store:* • Location and width of access point to fire station.	• designate parking area at fire station to prohibit vehicles from parking close to Highway 13 where they obstruct sight distance

KEY LESSONS LEARNED:

RSAs establish relationships among agencies who don't typically communicate with each other. The Red Cliff Band of Lake Superior Chippewa is responsible for maintaining the signs and pavement markings on WIS-13 (a State route) through their community. During the RSA, it was discovered that the Wisconsin DOT and the Red Cliff Tribe had each identified improvements for WIS-13, but the two agencies' plans did not coincide. The RSA process provided an opportunity for the agencies to establish a common vision for WIS-13 within the Red Cliff community and develop short-term, intermediate, and long-term goals. The RSA team also identified safety issues on the existing facility and developed a list of additional improvements to include as part of the short-term, intermediate, and long-term goals. Overall, the RSA process provided an opportunity to enhance communication between the agencies and integrate planned improvements into a single vision. Throughout the course of the RSA process, the Red Cliff community, WisDOT, and BIA provided support and were open to suggestions for improvements. This attitude will help to maintain long-term communications and a commitment to improving safety for the Red Cliff community.

See also the discussion of "Key Factors for Success" and "Lessons Learned" in the main text.

RSA NUMBER 4
RED MESA:
RSA OF N-35 THROUGH THE NAVAJO NATION
UTAH

Roads: existing two-lane rural highway	
RSA Sites:	• paved, rural, two-lane road • unsignalized intersections
Environment:	☐ urban/urbanized ☐ suburban ☑ **rural**
Owners:	Bureau of Indian Affairs, Mobile Oil Company, San Juan County, Utah
Road Safety Audit	
Date of RSA:	25 to 26 August 2009
RSA Stage(s):	☐ planning/design stage ☑ **RSA of existing roads**
RSA team:	Navajo DOT, Utah Department of Transportation (UDOT), Navajo Nation Police Department, Indian Health Services (IHS), Federal Highway Administration (FHWA) Utah Division Office, FHWA Central Federal Lands Highway Division (CFLHD), San Juan County Roads, Bureau of Indian Affairs, San Juan County Sheriff Office, and Vanasse Hangen Brustlin, Inc.

BACKGROUND:

The Navajo Nation and Indian Health Services identified the location of concern. The purpose of this RSA was to identify safety issues at the location of concern and develop suggestions.

The study area is located on tribal lands on the Navajo Nation in Red Mesa, Utah. The study limits include N-35 from milepost 18 to milepost 23 as shown in Figure A.4. N-35 is a two-lane rural road, providing a connection between Highway 163 (Town of Montezuma) in the north and Highway 160 in the south. This road serves as a commuter route from the northern towns of Bluff, Montezuma, and Aneth to communities and amenities in the south, including the town of Shiprock and the Red Mesa hospital. The Red Mesa Chapter House and several residential housing units are located along N-35. This route also accommodates tourist traffic visiting national parks and local attractions such as the Shiprock Fair.

There are several planned improvements for N-35 at various stages in the planning and implementation process. UDOT conducted a sign study along the N-35 corridor as part of the High Risk Rural Roads (HRRR) program, identifying several sign improvements. There is an ongoing effort to resurface N-35 from the Arizona state line to Highway 163 through Federal earmarks; approximately six miles of the road have been resurfaced in Phase I and it is anticipated that six to seven additional miles will be resurfaced in each subsequent phase until the roadway is completed.

The entire N-35 corridor is a Federal Aid Highway. The portion of the roadway from milepost 0 to milepost 18 is owned by the Bureau of Indian Affairs (BIA). The Mobile Oil Company built and owns the section of N-35 from milepost 18 to milepost 23. San Juan County is responsible for maintaining the roadway, including signing, pavement markings, and roadside mowing. Funding for reconstruction and maintenance of N-35 comes from several sources, including the State gas tax, the Shiprock Transportation Agency, and Congressional earmarks.

N-35 IN RED MESA, UTAH. PHOTO SHOWS LIMITED PAVEMENT WIDTH, LACK OF DELINEATION, AND CLOSE PROXIMITY OF ROADSIDE HAZARDS.

N-35 IN RED MESA, UTAH. PHOTO SHOWS THE ISSUE WITH OPEN GRAZING ALONG THIS ROADWAY.

FIGURE A.4 VIEWS OF RED MESA RSA SITE

KEY RSA FINDINGS AND SUGGESTIONS:

The key findings and suggestions of the RSA are summarized in Table A.4.

TABLE A.4 SUMMARY OF SELECTED SAFETY ISSUES AND SUGGESTIONS: RED MESA RSA

SELECTED SAFETY ISSUE (Number and Description)		SUGGESTIONS
1	*Nighttime Visibility/Lack of Delineation:* • Faded pavement markings limit conspicuity during nighttime and wet weather conditions. • Limited guidance for drivers at night and within horizontal curves.	• refresh centerline with high-visibility pavement markings and install edgelines • delineate curves and roadside hazards (e.g., embankments) with appropriate object markers or chevrons

	SELECTED SAFETY ISSUE (Number and Description)	SUGGESTIONS
2	*Maintenance Issues:* • Pavement edge drops create a “lip” along the edge of the pavement. • Dirty/faded/illegible signs limit visibility and legibility of signs at night. • Deterioration of pavement edge and erosion near culverts.	• improve maintenance and resurfacing practices to eliminate edge drops and create a beveled “safety edge” • clean or replace damaged/dirty signs and employ educational campaigns targeting young drivers and their peers • pave aprons at intersections and access points and stabilize slopes between intersections to prevent erosion
3	*Animals on the Roadway:* • Horses, cows, and sheep were observed crossing and grazing along the roadway during daytime and nighttime conditions.	• utilize reflective ear tags, branding, or other strategies to increase conspicuity of animals at night • install animal fence • engage animal owners regarding economic loss and control of animals • prohibit open range grazing with local enforcement
4	*Inconsistent Roadway Width:* • Inconsistent pavement width through the study area creates a lack of driver expectancy and limits recovery room for errant vehicles. • No paved shoulders and limited unpaved shoulders provide limited recovery room for errant vehicles.	• identify desired pavement width and coordinate vision with future resurfacing projects • increase pavement width and delineate edge of lanes with edge line markings
5	*Driver Behavior Issues:* • Speeding, seatbelt use, and alcohol were identified as factors contributing to crashes and crash severity.	• increase enforcement by building an additional substation and cross-commissioning officers • develop and deliver high school driver education for road safety • offer media literacy for alcohol advertising in high schools • develop and deliver community education targeting speeding and seatbelt use • legalize sale of alcohol on Navaho Nation to reduce drinking and driving from store
6	*Intersection Issues:* • Significant intersection skew creates sight issues for drivers on the cross road. • Lack of intersection warning and delineation for cross roads. • Lack of STOP signs on minor roads.	• pave aprons to eliminate intersection skew and create a cross-type intersection • install delineators and intersection warning signs to better define access points • install lighting at intersections

SELECTED SAFETY ISSUE (Number and Description)		SUGGESTIONS
7	*Use of Traffic Control Devices:* • Type and placement of signs are inconsistent and inappropriate along the corridor. • Horizontal and vertical curves limit sight distance through passing zones.	• incorporate sign improvements from the UDOT sign review • review passing zones and change to "no passing zones" as appropriate
8	*Roadside Hazards:* • Slopes adjacent to edge of roadway are unrecoverable or non-traversable.	• install warning signs or object markers as appropriate to delineate roadside hazards • stabilize existing slopes to reduce erosion and prevent slopes from becoming steeper • install guardrail at non-traversable slopes and at non-recoverable slopes that lead to non-traversable slopes • reconstruct roadside to provide more forgiving slopes and increase pavement width to provide more recovery room
9	*Limited Sight Distance:* • Limited sight distance through horizontal and vertical curves. • Horizontal and vertical curves limit sight distance through passing zones.	• install edgelines and/or post-mounted delineators to enhance guidance through horizontal and vertical curves • re-stripe passing zones as appropriate • consider redesign options to provide less severe horizontal and vertical curvature

KEY LESSONS LEARNED:

There may be opportunities to implement improvements by incorporating them with long-range plans. During the RSA for the Navajo Nation in Red Mesa, the RSA Team identified several safety issues related to the narrow roadway width and lack of shoulders. Due to the limited annual funding for maintenance and roadway improvements, it was not practical to identify pavement widening as a short-term or intermediate improvement. However, there is a long-range resurfacing project along the corridor and the RSA Team identified opportunities to incorporate RSA suggestions as part of this long-range project.

Animal control is an issue along many federal and tribal lands. Open grazing is allowed along N-35 on the Navajo Nation in Red Mesa, Utah. Coupled with a lack of animal fencing, animal crashes represent approximately 25 percent of crashes along the corridor. Open grazing presents a significant safety concern for motorists, particularly when the animals are large, such as cows and horses. Animal-vehicle collisions are also a financial and liability concern to ranchers.

See also the discussion of "Key Factors for Success" and "Lessons Learned" in the main text.

RSA NUMBER 5

ROGUE RIVER - SISKIYOU NATIONAL FOREST: RSA OF BEAR CAMP COASTAL ROUTE OREGON

Road: existing one- and two-lane forestry road

RSA Site	65-mile Bear Camp Coastal Route (Josephine and Curry Counties, Oregon)
Project Environment:	☐ urban ☐ suburban ☑ **rural**
Project Owners:	US Forest Service and Bureau of Land Management

Road Safety Audit

Date of RSA:	19 to 21 August 2008
RSA Stage(s):	☑ design stage ☑ **RSA of existing road**
RSA team:	Federal Highway Administration Oregon Division Office, US Forest Service, Bureau of Land Management, and Opus International Consultants

BACKGROUND:

Bear Camp Coastal Route (shown in Figure A.5), partly in the Rogue River – Siskiyou National Forest, is under the jurisdiction of two federal agencies. The Bureau of Land Management (BLM) administers the eastern part of the roadway as BLM Road 34-8-36, extending from Galice, Oregon to the 12 mile point. The Forest Service (FS) administers the western part as FS Road 23, extending from the 12 mile point to Agness, Oregon. This RSA was conducted on both the BLM and FS segments of the road, covering a total distance of about 65 miles.

As a forest road, Bear Camp Coastal Route is intended primarily for timber haul and to administer FS and BLM lands. In practice, however, the road is open to the public for most of the year, and accommodates a range of users and vehicles. Enforcement is present on the road primarily for resource issues such as timber theft or drug activity.

The geometric design of Bear Camp Coastal Route is characterized by a varying width (two narrow lanes on the BLM segment, one lane on the FS segment), very narrow or no shoulders, small-radius curves, steep grades, and limited sight distances. The road was built in the late 1950s by the Bureau of Public Roads (former name of Federal Highway Administration) to a contemporary standard for a forest road, but for not public use. Consequently, the road geometry generally does not meet current federal, state, or county standards for roads built for public use. However, road users, who usually drive on public roads designed to standard, typically expect any paved road open to the public to meet these standards. Public users may therefore be unprepared for the tight and relatively unforgiving geometry of the Bear Camp Coastal Route. This lack of driver expectancy may result in drivers “overdriving” the road, and consequently being unprepared for some of the hazardous conditions that they encounter. Some factors that may aggravate the issues associated with constrained geometry include limited signing and delineation,

limited maintenance (including winter snow removal), an absence of night-time lighting, and the presence of large or long vehicles (including recreational vehicles and tractor trailers) driven by unfamiliar drivers.

This in-service RSA focused on general issues associated with road safety along the route, rather than specific issues associated with specific sites.

FIGURE A.5-1 BEAR CAMP COASTAL ROUTE RSA SITE

FS SEGMENT (FS ROAD 23), SHOWING A SINGLE-LANE WITH NO TURNOUTS. FOG LINES ARE VISIBLE ON BOTH SIDES OF THE PAVEMENT, ALONG WITH REFLECTIVE DELINEATORS AT RIGHT.

BLM SEGMENT (BLM ROAD 34-8-36), NEAR THE INTERSECTION WITH PEAVINE/SERPENTINE SPRINGS ROAD. A SPEED LIMIT SIGN (25 MPH) IS POSTED AT RIGHT. THE UNMARKED PAVEMENT CAN ACCOMMODATE TWO LANES OF TRAFFIC.

FIGURE A.5-2 BEAR CAMP COASTAL ROUTE

KEY RSA FINDINGS AND SUGGESTIONS:

The key findings and suggestions of the RSA are summarized in Table A.5.

TABLE A.5 SUMMARY OF SELECTED SAFETY ISSUES AND SUGGESTIONS: RSA OF BEAR CAMP COASTAL ROUTE

SELECTED SAFETY ISSUE (Number and Description)		SUGGESTIONS
1	*Winter Road Conditions*: Bear Camp Coastal Route is not maintained for winter travel. Since the road remains physically open to traffic year-round, drivers may attempt to drive it during the times when travel is not advised. Three fatalities have resulted in 13 years when the road became impassable due to snow, stranding drivers who subsequently died of exposure or starvation.	• barricades or gates • winter closure warnings for in-vehicle navigation systems and maps • liaison with Oregon DOT for inclusion in on-line and 511 advisory report • cell phone coverage
2	*Roadside Hazards:* Steep drop-offs and fixed objects (including trees and rock faces) are present close to the roadway along much of Bear Camp Coastal Route. The risks associated with off-road crashes are aggravated by narrow pavement width, an absence of shoulders, frequent horizontal curves and substantial gradients, poor visibility, winter road conditions, frequent rock falls, and pavement subsidence.	• post-mounted delineators, chevron signs, guardrail (including a stepped-assessment of and response to potentially hazardous locations to address the most critical sections first) • fog lines • safety edge • shoulder reconstruction • rockfall mitigation • regular roadside brushing

SELECTED SAFETY ISSUE (Number and Description)		SUGGESTIONS
3	*Signing:* • Some warning signs appear to be in poor condition or are obstructed. • Additional warning, regulatory, and/or guide signs may be beneficial. • Some signing appears to be obsolete.	• sign survey • signing upgrade plan (including sign consistency over entire route, uniform use of side street STOP signs, uniform use of dead-end signs or similar on side roads, and relocating signs to ensure proper visibility) • daytime/night-time "lights on for safety" signs
4	*Pavement Markings and Delineation:* Delineation is absent or inconsistent, limiting driver guidance.	• fog lines • review of delineation (included in sign survey)
5	*Consistency between BLM and FS Segments:* Bear Camp Coastal Route is under the jurisdiction of separate agencies, resulting in inconsistencies in the design, operations, and maintenance practices different between the two segments. These inconsistencies can, for example, affect the way that road conditions and hazards are identified and marked, contributing to issues with driver expectancy.	• road management plan shared by both agencies

KEY LESSONS LEARNED:

Most, if not all, of the safety issues identified in this in-service RSA resulted from a disconnection between the original purpose for Bear Camp Coastal Route and its eventual use. Resolving this disconnection was deemed crucial to addressing the safety issues in a coherent and effective way. The original purpose of Bear Camp Road was for timber haul and for administration of FS and BLM lands. However, the use and function of the road had evolved over time. At the time of the RSA, the road was being used by the public as a link between the interior of Oregon and the coast, and for commercial/recreational uses. However, although the use and function of the road had evolved, its design, maintenance, and management had not. Consequently, the public was using a facility that was not designed for public use, and that did not incorporate safety features that the public generally expects or assumes. Further, within the controlling agencies, the disconnection between the original purpose of the road and its eventual use generated further inconsistencies. For example, FS policy directed that the road should be snowplowed only for resource administration, not for public use. In practice, however, spring plowing was conducted in response to pressure for public access. These types of inconsistencies further distorted users' expectations concerning the purpose, and therefore the design and maintenance standards, of Bear Camp Coastal Route.

These disconnections had important safety implications (identified in Table A.5 above). To address these implications, the RSA team suggested that *an updated and coherent management plan* be developed for the Bear Camp Coastal Route. The RSA team suggested that the plan should be based on a unified management policy for the Route,

and staff associated with Bear Camp Coastal Route should be supported in their efforts to adhere to it. The RSA team suggested that the management plan address the following:

- Resolve the disconnection regarding the official function and designation of Bear Camp Coastal Route.
- Ensure development of a plan for the intended long-term future use of the roadway with a minimum 20-year forecast period.
- Match the road's maintenance level to available resources by basing needed investment on agreed service levels.
- Develop short-term and long-term development plans for the road that identified which users' needs would be met, and identified and allocated the funding required to safely operate and maintain the road for these users.

See also the discussion of "Key Factors for Success" and "Lessons Learned" in the main text.

RSA NUMBER 6

EASTERN BAND OF CHEROKEE INDIANS: RSA OF THREE INTERSECTIONS NORTH CAROLINA

Roads: existing two-lane and four-lane rural principal arterial roadways

RSA Sites:	• intersection of Highway 19 and Wrights Creek Road • intersection of Highway 19 and Goose Creek Road • intersection of Big Cove Road and Acquoni Road
Project Environment:	☑ **urbanized** ☐ suburban ☑ **rural**
Project Owners:	Eastern Band of Cherokee Indians

Road Safety Audit

Date of RSA:	1 to 3 August 2007
RSA Stage(s):	☑ design stage ☑ **RSA of existing roads**
RSA team:	FHWA North Carolina Division Office, FHWA Headquarters, Eastern Band of Cherokee Indians, Bureau of Indian Affairs, and Opus International Consultants

BACKGROUND:

The Eastern Band of Cherokee Indians (EBCI) has approximately 14,000 enrolled members, many of whom live on the EBCI reservation in western North Carolina, centered around the town of Cherokee, NC. In addition to accommodating the tribe's members, the EBCI reservation is home to a number of tourist attractions, including craft shops, a tourist-oriented theatre, and a large casino/hotel.

This RSA focused on the following intersections on the EBCI reservation, shown in Figure A.6:

- State Highway 19, Wrights Creek Road, and Lucy Long Road
- State Highway 19 and Goose Creek Road
- Big Cove Road and Acquoni Road.

These intersections accommodated a range of users, including:

- local residents,
- employees who worked on the reservation, including international students employed at the casino/hotel who walked and cycled to and from work,
- visitors to the reservation's sights, shops, and casino/hotel,
- long-distance travellers who were passing through the area.

Substantial expansion of the casino/hotel was being planned at the time of the RSA, and

a traffic impact analysis was being conducted to study the impacts of the expansion. New "big box" commercial development was also being planned. This RSA was conducted to address safety issues associated with existing roads, to address the tribe's concerns regarding both existing and possible future road users.

INTERSECTION OF HIGHWAY 19 AND WRIGHTS CREEK ROAD

INTERSECTION OF BIG COVE ROAD AND ACQUONI ROAD

INTERSECTION OF HIGHWAY 19 AND GOOSE CREEK ROAD

FIGURE A.6 RSA SITES: EBCI RESERVATION

KEY RSA FINDINGS AND SUGGESTIONS:

The key findings and suggestions of the RSA are summarized in Table A.6.

TABLE A.6 SUMMARY OF SELECTED SAFETY ISSUES AND SUGGESTIONS: EBCI INTERSECTION RSA

SELECTED SAFETY ISSUE (Number and Description)		SUGGESTIONS
1	*Signing and Pavement Markings:* Worn or missing signs and pavement markings may limit driver guidance, especially at night.	• Maintenance Management Plan • sign and pavement marking upgrade • retroreflectivity assessment • lane use signs for all exclusive turning lanes • stop bars
2	*Incomplete Crash Data System:* Limited crash data may limit the tribe's ability to compete for safety funding.	• introduction of a crash data system, or participation in the NCDOT crash data system • liaison between Cherokee Engineering/ Planning and Cherokee Police Department

	SELECTED SAFETY ISSUE (Number and Description)	SUGGESTIONS
3	*Pedestrian and Bicycle Facilities on Highway 19:* Pedestrians and bicycles travel in vehicle lanes along Highway 19, which has limited pedestrian and cycling facilities.	• establishment and maintenance of a network of continuous off-road facilities for pedestrians • bike lanes • widened paved shoulder • accessibility for disabled pedestrians • increased lighting along roadway • rumble strips
4	*Absence of shoulder:* Limited paved shoulders on Highway 19 reduce the opportunity for drivers to regain control of an errant vehicle before striking roadside objects.	• shoulder stabilization • paved shoulders • safety edges
5	Intersection of Highway 19 and Wrights Creek Road: • Trees close to the intersection obstruct the sight triangle on the northeast corners. • Left-turn volumes on Highway 19 may exceed capacity of left-turn bays, resulting in vehicles slowing or stopping in the through lane. • Traffic delays for vehicles on Wrights Creek Road entering Highway 19 may cause drivers to take risks when crossing or turning.	• tree trimming on northeast corner • traffic count program to determine if a right-turn lane is warranted on Wrights Creek Road • extension of left-turn lane to accommodate peak demand
6	Intersection of Highway 19 and Goose Creek Road: • Passing zone on west leg may result in passing maneuvers close to and through the intersection. • Large left-turn volumes observed on Highway 19 turning onto Goose Creek Road may result in long delays for through and turning drivers.	• evaluation of passing zone • left-turn lane on Highway 19
7	Intersection of Big Cove Road and Acquoni Road: • The absence of a continuous pedestrian network near the intersection may contribute to vehicle conflicts with pedestrians, including tourists and students from nearby schools. • Uncontrolled access to roadside parking areas may contribute to conflicts between vehicles entering/leaving parking spaces and other road users, including pedestrians and through traffic.	• complete pedestrian network • upgraded crosswalks • request for NCDOT school evaluation • pinned curbs • diagonal parking spaces • discussion of pedestrian improvements with local commercial operators

KEY LESSONS LEARNED:

When presenting the results of the RSA, the RSA team identified positive measures that had already been implemented by the responsible road agencies (NC DOT, EBCI, and BIA) to improve safety. These measures included the tribe's recent initiative to undertake its own pavement marking program; the implementation of oversized STOP signs at selected locations to improve intersection conspicuousness; and the use of high visibility midblock crosswalk markings in commercial areas. Acknowledging positive safety measures encourages these initiatives on the part of the road agencies, and helps to put the RSA findings in perspective.

An important consideration in identifying and implementing road safety improvements is funding. To help the tribe address the safety issues identified in the RSA, the RSA report included information on possible funding sources, such as the FHWA *Tribal Highway Safety Improvement Implementation Guide*. **Funding for safety improvements could be sought from** FHWA funds administered by the state (such as the Highway Safety Improvement Program, the Surface Transportation Program, and the Safe Routes to School Program), the FHWA Indian Reservation Roads Program (jointly administered by BIA DOT and the FHWA Office of Federal Lands Highway), the Indian Health Service Injury Prevention Program, and the BIA Indian Highway Safety Program.

See also the discussion of "Key Factors for Success" and "Lessons Learned" in the main text.

RSA NUMBER 7

CUMBERLAND GAP NATIONAL HISTORICAL PARK: RSA OF US ROUTE 25E TENNESSEE

Roads: existing four-lane rural highway

RSA Sites:	• paved, rural, four-lane, divided arterial • interchange • tunnel approach
Environment:	☐ urban/urbanized ☐ suburban ☑ **rural**
Owners:	Cumberland Gap Tunnel Authority, Kentucky Transportation Cabinet, Tennessee Department of Transportation (TDOT), and National Park Service

Road Safety Audit

Date of RSA:	14 to 15 November 2006
RSA Stage(s):	☐ planning/design stage ☑ **RSA of existing roads**
RSA team:	Federal Highway Administration/Eastern Federal Lands Highway Division (EFLHD), FHWA Tennessee Division Office, Tennessee Department of Transportation (TDOT), Vaughn & Melton Consulting Engineers, Tennessee Highway Patrol

BACKGROUND:

By letter from the Southeast Region (SERO) and Cumberland Gap National Historical Park (CUGA) dated August 28, 2006, the National Park Service (NPS) requested Eastern Federal Lands Highway Division (EFLHD) to coordinate a formal safety performance examination for the Tennessee side approach to the CUGA tunnels. The EFLHD coordinated and led this RSA to identify safety issues at the location of concern and develop recommendations to correct or mitigate the identified safety issues.

The study area is located on Federal Lands within the Cumberland Gap National Historical Park in Claiborne County, Tennessee. The study limits include US Route 25E beginning just north of the Harrogate town limits towards the tunnel, including the U.S. Route 58 approach from the Wilderness Road Campground and Picnic Area entrance and the US 58 / 25E interchange ramps as shown in Figure A.7. US Route 25E provides a connection between Kentucky and Tennessee near the southwest corner of Virginia.

Approaching the CUGA tunnels, US Route 25E is a rural, four-lane, divided arterial with a 24-foot traveled way in the northbound and southbound directions. The median width of approaching the tunnels is 60-feet, with 6-foot inside shoulders (2-foot paved width) and 12-foot outside shoulders (10-foot paved width). The cross section and horizontal and vertical alignment were compared to AASHTO standards and were found to meet or exceed minimum policy criteria for a design speed of 60 mph. The 2006 annual average daily traffic (AADT) volume is 23,740 vehicles per day as provided by Tennessee Department of Transportation (TDOT).

The posted speed limit approaching the tunnels is 45 mph, excluding periods when one of the tunnels is closed due to HAZMAT vehicle escort or during cleaning of one of the tunnels. Approximately 100 HAZMAT / oversize vehicles per day (about 600 per week) are escorted separate from main traffic through the tunnels. During the HAZMAT escort operation, traffic in the direction of the escort is stopped by a traffic signal mounted to an overhead variable message sign structure. The speed limit is reduced from 45 MPH to 35 MPH when resuming normal traffic flow. During periods when one of the tunnels is closed for cleaning, both directions of traffic are diverted and maintained in the other tunnel and the speed limit is reduced to 25 MPH. A speed monitoring study was performed by TDOT on November 27 – 28, 2006. The 85th percentile speed (i.e., the operating speed) along the Tennessee approach to the tunnels is 54.4 MPH in the northbound lanes and 54.2 MPH in the southbound lanes. This indicates that the majority of motorists exceed the posted speed limit.

TDOT reviewed crash data along US Route 25E for two three-year periods, beginning one mile south of the tunnel entrance. From 2002-2004, five crashes occurred, resulting in two injuries. From 2003-2005, four crashes occurred, resulting in three injuries and one fatality. The crash rate for this segment is approximately 0.20 crashes per MVMT, which is less than the Tennessee statewide average rate of 0.80 crashes per MVMT for similar divided rural arterials.

US ROUTE 25E NORTHBOUND DIRECTION

VIEW OF US ROUTE 25E NORTHBOUND APPROACH TO TUNNEL.

FIGURE A.7 VIEWS OF US ROUTE 25E RSA SITE

KEY RSA FINDINGS AND SUGGESTIONS:

The key findings and suggestions of the RSA are summarized in Table A.7.

TABLE A.7 SUMMARY OF SELECTED SAFETY ISSUES AND SUGGESTIONS: CUMBERLAND GAP NATIONAL HISTORIC PARK

SELECTED SAFETY ISSUE (Number and Description)		SUGGESTIONS

1	*Location of recent fatal crashes:*
	• Both recent fatal crashes occurred at the crossover along the outside of a horizontal curve.
	  o Driving too fast for conditions.
	  o Pavement edge drop along the outside of curve.
		• install chevrons along the outside of curve (consider using oversized freeway panel size of 36” x 48”)
		• install rumble “stripes” along the outside of curve
		• extend paved median shoulder from 4-ft to 8-ft total width and eliminate pavement edge drop (if shoulder is widened, install shoulder rumble “strips” rather than “stripes” along outside of curve
		• install flexible cable median barrier (weathering steel W-Beam guardrail is an alternative)

2	*Merge/Weave Area from US Route 58 Interchange to US 25E Northbound:* • Two sideswipe crashes resulted in injuries at this location. • Gore area of US 58 interchange ramp to northbound 25E is located along the end of a horizontal curve. • HAZMAT and Oversize truck entrance into the storage auxiliary lane at tapered end of Ramp “D” US 58 ramp.	• install additional merge sign in median area • install centerline rumble strips along northbound US 25E between and through the two successive curves approaching the tunnel • replace 25-ft of damaged corrosion-resistant steel W-beam guardrail along Ramp D

	SELECTED SAFETY ISSUE (Number and Description)	SUGGESTIONS
3	*Interchange Area:* • Limited use of warning signs. • Vehicles not stopping at the signalized stop bar location. • Damaged and missing signs and flexible delineators. • Limited use of guardrail to shield roadside hazards and protect roadside assets. • Limited visibility of existing “Lane Ends” sign along 25E southbound approaching US 58 bridge overpass.	• replace “BE PREPARED TO STOP” signs with special warning sign “STOP AHEAD WHEN FLASHING”, including flashing beacons to increase awareness of stop condition • coordinate flashing condition to coincide with stopped condition at tunnel portal • install additional chevron sign, replace damaged chevron sign, and replace missing delineator posts along inside of curve along Ramp B • for chevron signs mounted on median concrete barrier, install mounting bracket for all chevrons on Ramp C side of barrier • along Ramp C, install new chevrons and replace missing flexible delineators along outside of curve • replace “Lane Ends” sign and replace missing flexible delineator posts along southbound US 25E • install guardrail to shield sign structure support and electrical equipment and install chevrons along the outside of the curve to improve delineation
4	*Overhead Variable Message Sign:* • Vehicles failing to stop at the overhead traffic signal. • Vehicles failing to stop at the stop bar. • Rear end crashes are the primary crash type at this location according to Park staff.	• reconfigure electronic speed limit signs to flashing mode when posted speed changes to 35 or 25 MPH • replace 8-inch signal lenses with high visibility LEDs and strobe lights for red signal • consider upgrading signal heads to black carbon with back plates and operate as steady burn solid circular green / yellow / red phasing • install a fourth signal head mounted to the left VMS structure post • use larger 12-inch signal lens for all new signal heads • install “STOP HERE ON RED” signs • turn off green lane use arrows on approaching VMS structures unless needed to advise motorists of a closure

SELECTED SAFETY ISSUE (Number and Description)		SUGGESTIONS
5	*Miscellaneous:* • Guardrail terminal does not have object marker. • It is not clear that motorists are not permitted to use crossover between HAZMAT auxiliary lane and Ramp C exit to make U-turns. • Cumberland Gap sign at entrance to South Cumberland Drive obstructs sight distance and is not crashworthy. • Missing delineator posts along US 25E and the US 58 Ramps. • "Speed Limit 45" signs along westbound 58 are not mounted at appropriate height. • Guardrail issues. o Installed too low (below 27"). o Post spacing and block-out type do not appear sufficient for high speed roadway. o Damaged guardrail terminal.	• install object marker on guardrail terminals for delineation • install an "EMERGENCY AND AUTHORIZED VEHICLES ONLY" regulatory sign at the crossover • remove Cumberland Gap median sign • install retroreflective delineator posts along mainline and Ramps B & C where curvature is sharp • mount existing speed limit signs on new posts 7-ft above pavement edge • replace guardrail with crashworthy standard W-beam guardrail • replace damaged guardrail terminal with crashworthy terminal • extend trailing end of guardrail

KEY LESSONS LEARNED:

The RSA field review and team members can help to identify issues not apparent in the crash data. In addition to evaluating crash history to focus on safety problem areas, a comprehensive review of the approaches to both tunnel portals were reviewed in the field. The diverse backgrounds of the review team, including traffic operations and safety engineers, planners, and local law enforcement, were able to observe conditions that negatively effect traffic safety. The site investigation for the fatal crashes determined that countermeasures to reduce the frequency of a crash occurring, such as installing new chevron alignment signs, edge line rumble strips, and extending the width of the paved median can fit the context of this park road. Also, new median barriers were recommended to lessen the severity of a roadway departure crash. These safety countermeasure recommendations were a successful outcome of performing the field review with the audit team. In addition to reviewing the crash locations shown in the data, the field review team observed several locations within the corridor where traffic safety may be improved, including opportunities to improve guardrail terminals, new signing and delineation, and improvements to the advance overhead variable message signs alerting traffic to changed traffic flow conditions.

There may be opportunities to foster partnerships between owner agencies and implement improvements by incorporating them with long-range plans. TDOT was very cooperative in the audit process, and offered and conducted an independent speed monitoring study at the location of the fatal crashes. Also, TDOT provided assistance by outlining their state process for performing audits and implementing improvements in their High Risk Rural Roads Program. This established process allowed the audit team to better focus the field investigation and crash data evaluation on tried and proven safety mitigation countermeasures. The National Park Service was pleased with the efforts and the safety improvement recommendations and indicated they will seek ways to incorporate improvements in the long-range program of future projects.

See also the discussion of “Key Factors for Success” and “Lessons Learned” in the main text.

RSA NUMBER 8

UNITED STATES FOREST SERVICE (USFS): USFS FOREST DEVELOPMENT ROAD 90 ROAD (LEWIS RIVER ROAD) WASHINGTON

Roads: existing two-lane rural highway

RSA Sites:	• paved, rural, two-lane road • unsignalized intersections
Environment:	☐ urban/urbanized ☐ suburban ☑ **rural**
Owners:	Gifford Pinchot Forest (US Forest Service), Skamania County, Washington

Road Safety Audit

Date of RSA:	30 September to 1 October 2008
RSA Stage(s):	☐ planning/design stage ☑ **RSA of existing roads**
RSA team:	Western Federal Lands Highway Division (WFL), Gifford Pinchot Forest (US Forest Service), Skamania County, Washington

BACKGROUND:

The Gifford Pinchot Forest and Skamania County identified the location of concern as part of a call for forest highway safety projects. The purpose of this RSA was to identify safety issues at the location and develop suggestions.

The study area is located on Federal lands in the Gifford Pinchot National Forest in Washington. The study limits include Forest Development Road 90 (FDR 90, Lewis River Road) from milepost 0 to milepost 19 as shown in Figure A.8-1. Lewis River Road is a two-lane rural road, providing a connection between SR 503 in the west (near Cougar) and Curly Creek Road in the east. This road also provides access to Mount Saint Helens National Volcanic Monument sites (e.g., Ape Cave Road at MP 3.5 and Windy Ridge Road and Spirit Lake off FDR 25), boating on Swift Reservoir, fishing on Swift and the Lewis River, and other recreational activities in area. It is a primary arterial access connecting to SR 12 in Randle via FDR 25 and to SR 14 at Carson via Curly Creek Road and the Wind River Road. These access points provide numerous additional camping, hunting, fishing, hiking and wilderness access opportunities on USFS lands. There are also some PacifiCorp (Pacific Power) campgrounds and parks along Lewis River Road. Residential and year-round access has increased in recent years due to some logging lands being sold for development. The connectivity of the north and south loops to SR 12 and SR 14 also make it a favorite driving for pleasure route for motorcycles and also for some automobile clubs.

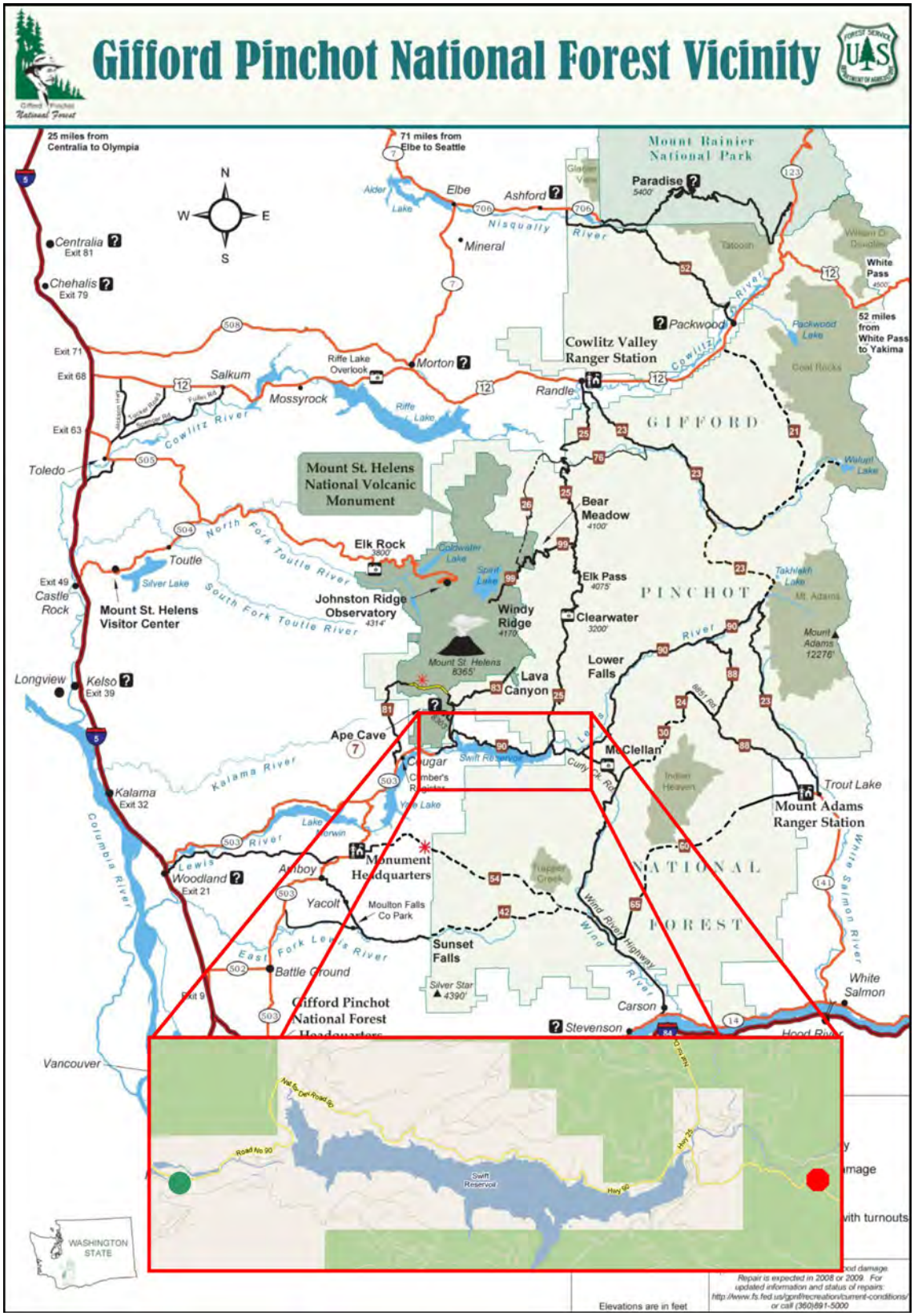


FIGURE A.8-1 LEWIS RIVER ROAD RSA SITE

The traffic volume along this route is approximately 1,300 vehicles per day with increased motorcycle usage. The traffic volume decreases toward the east end of the corridor. Local agency representatives also observed and indicated a marked increase in motorcycle traffic and year-round traffic. There were 36 documented crashes along this corridor in the six-year period from 2000 to 2005. The 36 crashes included two fatal crashes and nearly half of the crashes (17 out of 36) involved motorcycles. Many of the crashes are related to speed and negotiating curves; there were no reported intersection-related crashes. While many of the crashes are curve-related, the RSA team noted that there is good use of centerline markings, curve warning signs, chevrons, and large arrows along the entire route. The US Forest Service (USFS) also invested $150,000 in leveling pavement subsidence sections that are a significant recurring problem at numerous locations between the Canal Bridge and the FDR 25 intersection.

Despite limited funds and resources, the USFS and Skamania County have done a good job in managing and maintaining Lewis River Road. Since 2005, the road has been plowed by the County during the winter because the USFS does not receive adequate maintenance funding for a road crew during the winter for rock fall, plowing, and other needs that arise. There is a complex three-party agreement for clearing the road in winter conditions. Lewis River Road is designated as a volcanic disaster escape route. The route provides access to County, USFS, and residents/businesses for medical emergencies, forest and residential fire emergencies, and for law enforcement services. The access also provides significant economic benefits to local communities from the tourism generated by the Mount Saint Helens Volcanic National Monument and many other Gifford Pinchot National Forest recreation sites.

View of the limited recovery area and close proximity of steep rock slopes along Lewis River Road.

View of a curve along Lewis River Road with existing curve warning signs.

FIGURE A.8-2 VIEWS ALONG THE LEWIS RIVER ROAD RSA SITE

KEY RSA FINDINGS AND SUGGESTIONS:

The key findings and suggestions of the RSA are summarized in Table A.8. Figure A.8-2 provides views along the study corridor, illustrating some of the safety issues.

TABLE A.8 SUMMARY OF SELECTED SAFETY ISSUES AND SUGGESTIONS: LEWIS RIVER ROAD RSA

SELECTED SAFETY ISSUE (Number and Description)		SUGGESTIONS
1	*Signing:* • Limited visibility of signs due to fading and vegetation. • Improper placement and mounting height of signs. • Inconsistency in signing among curves and for opposite directions through the same curve.	• upgrade signs to meet current retroreflectivity requirements • combine and relocate guide signs at FDR 25 intersection • increase the size of warning signs and consider installing additional curve warning signs and arrows as appropriate • evaluate use of intersection signs for private driveways and access roads
2	*Delineation:* • While the centerline is newly painted, the edgelines are faded. • Delineators are not installed along outside of all curves.	• refresh edgeline pavement markings • install delineators along the outside of curves • delineate roadside hazards that are not protected by guardrail • evaluate use of recessed centerline pavement markings through curves and potentially along the entire route
3	*Guardrail/Barriers:* • Low mounting height and non-crashworthy terminals. • Outdated guardrail with potentially rotting wood posts. • Potential inadequate transitions at bridges.	• adjust the mounting height of guardrail to meet current standards • replace deficient terminals • evaluate old guardrail posts and replace as necessary • replace/upgrade transitions to bridge rail as necessary
4	*Bridges* • Inconsistent bridge designs along corridor. • Lack of delineation on bridge rail and approach. • Potentially inadequate transitions to bridge rail.	• upgrade transition connections at bridge rails as necessary • delineate bridge rail and approaches • install ‘no fishing from bridge’ signs on Canal Bridge • upgrade bridge rail and connections to current standards when replaced

SELECTED SAFETY ISSUE (Number and Description)		SUGGESTIONS
5	*Geometric Standards:* • Current roadway alignment and width is appropriate for the intended use and terrain. • Deteriorated pavement condition. • Pavement edge drops.	• it is unlikely that realignment will have a significant impact on crashes • provide a pavement overlay where possible and consider the use of cold in-place recycling or sub-excavation if necessary • repair pavement edge drops during resurfacing efforts
6	*Pull-outs:* • Inconsistent design and provision of paved and gravel pull-outs along the corridor. o Several pull-outs exist along the west end of the corridor (west of FDR 25). o Limited pull-outs are provided along the east end of the corridor.	• consider flattening/leveling paved and gravel pull-outs • construct additional pull-outs along the east end of the corridor • consider paving pull-outs that are currently unpaved
7	*Crashes:* • Many crashes are associated with vehicle speeds (too fast for conditions). • Many of the crashes occurred within curves. • Many of the crashes are motorcycle-related.	• improve signage and delineation • consider educational opportunities to address motorcycle safety concerns
8	*Rockfall:* • Rockfalls are an issue throughout the corridor. o Limited opportunities for fallout ditches due to terrain. o Vegetation on slopes may prelude the use of rockfall fences in certain areas. o Old concrete barrier remains where rockfall is/was an issue.	• conduct geotechnical study to determine how best to manage rockfall areas • remove unneeded barrier and repair broken sections or install new barrier • clean out areas behind concrete barrier and at base of rockfall cliffs • scale weathered rock by hand or long reach backhoe • consider installing rockfall fencing along slopes • consider rock scaling and cut-slope eyebrow work between FDR 25 and Curly Creek Road
9	*Slump Areas:* • Patched and leveled pavement subsidence / slump areas act as speed humps. • Chronic subsidence location at MP 10. • Issues at locations with guardrail. o Pavement edge drop-off. o Gap before the rail. o Rail height has been compromised by the increased depth of asphalt.	• conduct geotechnical study for the deeper, historic slumps • site-specific report assessments are needed to determine best, long-term solutions

KEY LESSONS LEARNED:

Many of the safety issues identified in this in-service RSA resulted from changes in the original purpose for Lewis River Road and its current use. The original purpose of Lewis River Road was for timber haul, for access to Mt. St Helens National Volcanic Monument, and for administration of FS lands. However, the use and function of the road has evolved over time and there are more residential activities and year-round traffic. Although the use and function of the road have evolved, its design, maintenance, and management have not. Consequently, the public is using a facility that is not designed or maintained for year-round public use or for residential purposes. These types of inconsistencies further distorted users' expectations concerning the purpose, and therefore the design and maintenance standards, of Lewis River Road.

There may be opportunities to implement improvements by incorporating them with long-range plans. During the RSA for the Lewis River Road, the RSA Team identified items related to rockfall issues and bridge improvements. The rockfall issue is being addressed through a detailed geotechnical study that will provide guidance on how to manage the rockfall areas in the long run. Due to the limited annual funding for maintenance and roadway improvements, it was not practical to identify bridge replacement as a short-term or intermediate improvement. Instead, extensive bridge improvements or complete replacement should be considered in long-range transportation plans.