Road Safety Audits: Case Studies

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16. Abstract 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. To demonstrate the effectiveness of RSAs, the Federal Highway Administration (FHWA) Office of Safety sponsored a series of ten RSAs. The aim of these case studies was to demonstrate the usefulness and effectiveness of RSAs for a variety of projects and project stages, and in a variety of agencies throughout the United States. 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 state and local agencies and Tribal governments with examples and advice that can assist them in implementing RSAs in their own jurisdictions.			
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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 on RSAs is 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 ten RSAs conducted throughout the United States during 2004-2006, involving transportation agencies at the city, county, state, federal, and tribal levels, and examining roadway projects at all stages of design and operation. FHWA and the authors greatly appreciate the cooperation of the following agencies for their willing and enthusiastic participation in the FHWA-sponsored RSA series: Illinois DOT, Oklahoma DOT, Oregon DOT, Wisconsin DOT, the Standing Rock Sioux Tribe, the City of Cincinnati, the City of Tucson, Clark County (WA), Collier County (FL), and the National Park Service.

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INTRODUCTION

Background

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.

To demonstrate the effectiveness of RSAs, in December 2003 the Federal Highway Administration (FHWA) Office of Safety sponsored a RSA of the Marquette Interchange in Milwaukee, WI. The RSA team reviewed the detailed design for an $800 million interchange reconstruction project. Subsequently, in the summer of 2004, the FHWA Office of Safety commissioned a series of nine additional RSAs. The aim of these case studies was to demonstrate the usefulness and effectiveness of RSAs for a variety of projects and project stages, and in a variety of agencies throughout the United States.

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 state and local agencies and Tribal governments with examples and advice that can assist them in implementing RSAs in their own jurisdictions.

What is an RSA?

A road safety audit (RSA) is a formal safety performance examination of an existing or future road or intersection by an independent, multidisciplinary team.

Compromises and constraints among the competing interests that typically drive a road project (such as cost, right of way, environment, topographic and geotechnical conditions, socioeconomic issues, and capacity/efficiency) are a normal part of the planning and design process. The design team has the responsibility of integrating these competing interests to arrive at a design that accommodates these interests in as balanced and effective a manner as possible. RSAs, conducted by a team that is independent of the design, enhance safety by explicitly and exclusively identifying the safety implications of project decisions. 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 having a background 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 audited. 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 done at any stage in a project’s life:

- A *pre-construction RSA (planning and design stages)* examines a road before it is 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 FHWA RSA Case Study Program

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

TABLE 1 - CASE STUDY RSAs		
FACILITY OWNER	**PROJECT**	**RSA STAGE**
State Departments of Transportation		
Illinois DOT	improvement to four-lane arterial road	preliminary design stage and existing roads
Oklahoma DOT	widening and resurfacing of two-lane rural highway	detailed design stage
Oregon DOT	improvements to two-lane rural highway	conceptual design stage
Wisconsin DOT	replacement of major interstate interchange	detailed design stage
Counties		
Clark County, WA	road alignment and intersection improvements to two-lane rural road	detailed design stage
Collier County, FL	widening of four-lane arterial road	planning stage
Cities		
Cincinnati, OH	improvements to commuter arterial, including bridge widening and intersection improvements	planning stage and existing roads
Tucson, AZ	six pedestrian crossings with HAWK signals	detailed design stage
Tribal		
Standing Rock Sioux Tribe, ND/SD	existing two-lane rural tribal roads	existing roads
Federal Lands		
Yellowstone National Park, WY	replacement of existing interchange with new access	planning stage and existing roads

All participating transportation agencies volunteered to be involved in this RSA program. Involvement in the case study program required the agency to nominate the project for the RSA; provide the RSA team with the materials (such as design drawings) on which the RSA would be based, or that provided useful background information, such as justification reports, traffic counts, collision data, or the results of public hearings; participate at a senior level in the RSA start-up and closing meetings; and contribute at least one engineer from their staff, not previously involved in the project, 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 reference to the case studies.

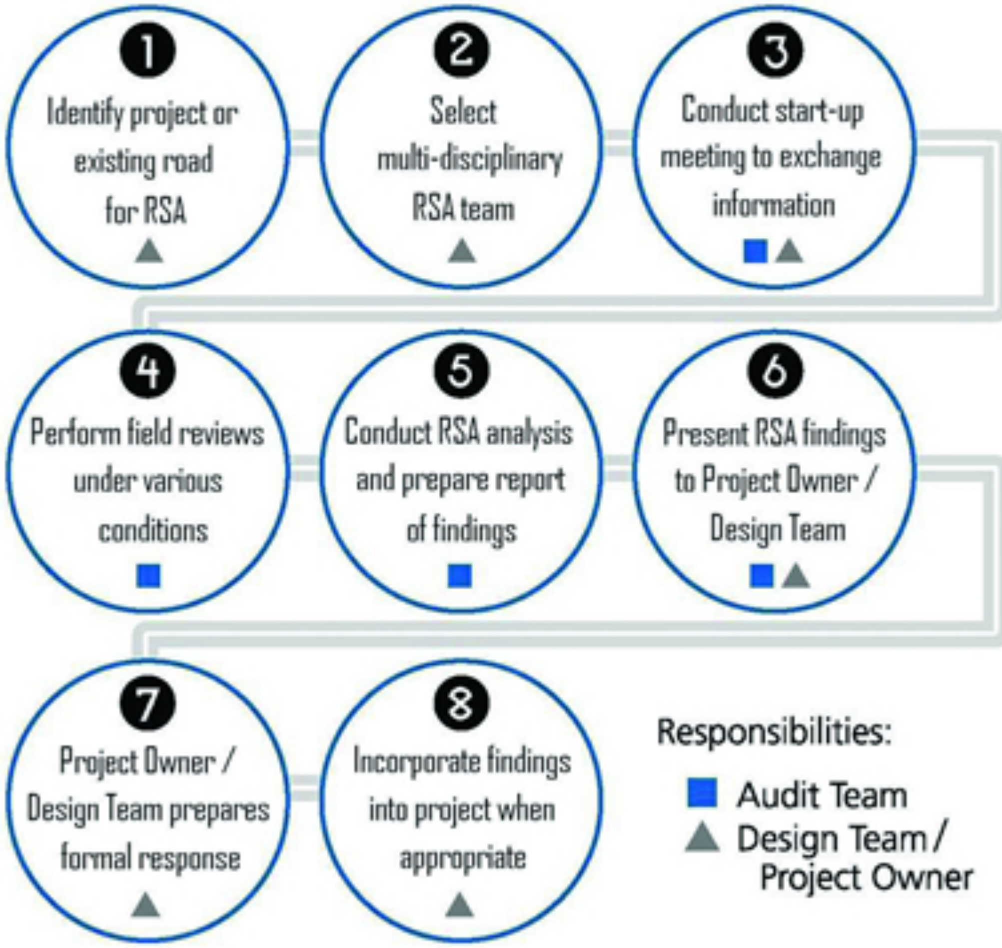

FIGURE 1 RSA PROCESS

RSA projects and the RSA team (Steps 1 and 2) were pre-selected in this FHWA case studies project. All meetings and site visits for the RSAs in the case studies project were conducted over two to four days, depending on the size and complexity of the project. The RSAs typically began with a start-up meeting (Step 3) attended by the Project Owner (hereafter referred to as the Owner), the Design Team, and the RSA team:

- The Owner described the objectives of the road project, including why it was being pursued and the improvements it was expected to accomplish. The Owner also explained why this project had been chosen for an RSA.

- The Design Team then described the road design (if the RSA was being conducted on a design), including a description of its individual elements; the current design stage and anticipated design/construction schedule; and the constraints and challenges involved in the design.

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.

Illinois DOT

FIGURE 2
START-UP MEETING

Standing Rock Sioux Reservation

FIGURE 3
FIELD REVIEW

Following the start-up meeting and a preliminary review of the design or site documentation provided by the Owner and Design Team, 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 design-stage RSAs), or to observe geometric and operating conditions (for RSAs of existing roads). The RSA team observed road user characteristics (such as typical speeds and traffic mix), surrounding land uses (including traffic and pedestrian generators), and link points to the adjacent transportation network. 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 non-peak times).

The team conducted the **RSA analysis** (Step 5) in a setting in which all team members reviewed available background information (such as design criteria, project/justification reports, traffic volumes, and any relevant collision data) and drawings. The RSA analysis methodology involved a systematic review of design drawings, examining features such as road geometry, sight distances, clear zones, drainage, signing, lighting, and barriers. Human factors issues were also considered by the RSA team, including road and intersection “readability”, sign location and sequencing, older-driver limitations, and driver perception of geometric features constructed to minimum standards. On the basis of this review of drawings, reports, and information obtained during the field review, the RSA team identified and prioritized safety issues, project 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 ways to mitigate the crash potential.

At the end of the analysis session, the Owner, Design Team, and RSA team reconvened for a **preliminary findings meeting** (Step 6). Presenting the preliminary findings verbally in a meeting gave the Owner and Design Team the opportunity to ask questions and seek clarification on the RSA findings, and also provided a useful forum for the Owner and Design Team 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.

Illinois DOT

FIGURE 4
RSA ANALYSIS SESSION

Standing Rock Sioux Reservation

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 and Design Team documenting the results of the RSA. The main contents of the RSA report were a prioritized listing and description of the safety issues identified (illustrated using photographs taken during the site visit), with suggestions for improvements.

The Owner and Design Team were then 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 and Design Team use the RSA findings to identify and implement safety improvements as and when policy, manpower, and funding permit (Step 8).

Prioritization of Issues for Design-Stage RSAs

For design-stage RSAs, 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* (Table 2) was qualitatively estimated on the basis of expected 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* (Table 3) 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 then combined to obtain a qualitative risk assessment on the basis of the matrix shown in Table 4. Consequently, each safety issue was prioritized on the basis of a ranking between A (lowest risk and lowest priority) and F (highest risk and highest priority). 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 and Design Team prioritize the multiple issues identified in the RSA.

For each safety issue identified, possible mitigation measures were suggested. The suggestions focused on measures that could be cost-effectively implemented at the current design stage.

TABLE 2 FREQUENCY RATING

ESTIMATED		

EXPOSURE	PROBABILITY	EXPECTED CRASH FREQUENCY (per RSA item)	FREQUENCY RATING
high	high	10 or more crashes per year	*Frequent*
medium	high		
high	medium	1 to 9 crashes per year	*Occasional*
medium	medium		
low	high		
high	low	less than 1 crash per year, but more than 1 crash every 5 years	*Infrequent*
low	medium		
medium	low	less than 1 crash every 5 years	*Rare*
low	low		

TABLE 3 SEVERITY RATING

TYPICAL CRASHES EXPECTED (per RSA item)	EXPECTED CRASH SEVERITY	SEVERITY RATING
crashes involving high speeds or heavy vehicles, pedestrians, or bicycles	probable fatality or incapacitating injury	*Extreme*
crashes involving medium to high speed; head-on, crossing, or off-road crashes	moderate to severe injury	*High*
crashes involving medium to low speeds; left-turn and right-turn crashes	minor to moderate injury	*Moderate*
crashes involving low to medium speeds; rear-end or sideswipe crashes	property damage only or minor injury	*Low*

TABLE 4 CRASH RISK ASSESSMENT

FREQUENCY RATING	SEVERITY RATING			
	Low	***Moderate***	***High***	***Extreme***
Frequent	**C**	**D**	**E**	**F**
Occasional	**B**	**C**	**D**	**E**
Infrequent	**A**	**B**	**C**	**D**
Rare	**A**	**A**	**B**	**C**

Crash Risk Ratings: *A: lowest risk level* *C: moderate-low risk level* *E: high risk level*
B: low risk level *D: moderate-high risk level* *F: highest risk level*

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 were composed of between four and ten persons in this case studies project, but these teams were large since the RSAs served as training exercises for local engineering staff. Without the need for training, the RSA teams would more typically have been composed of three or four persons.

- Opening and closing meetings, site visits, and RSA analysis sessions were conducted in a 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 ranged between 20 and 55 man-hours, with 30 to 40 man-hours being typical. The wide range primarily reflected the number and complexity of the issues identified during the RSA.

For this case studies project, additional RSA team costs were incurred in travel for experienced RSA team leaders. 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 design drawings and other 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.12) 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 four RSAs of existing roads focused mainly on improved signing, signal enhancements, parking and access management.
- Suggested improvements for the four detailed-design RSAs focused on improved signing and pavement markings, minor or moderate geometric changes (such as added auxiliary lanes at intersections), and barrier improvements. It should be noted, however, that one project owner initiated a fundamental reconsideration of its entire project on the basis of the RSA findings, which identified fundamental concerns regarding the net safety benefits of the improvement project.
- Suggestions for the preliminary and planning stage RSAs ranged from minor improvements such as signing, through moderate geometric improvements such as median and gateway treatments, to suggestions related to fundamental issues such as design vehicles, design volumes, and access restrictions.

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 and the need for retrofitted safety improvements are reduced, and the development of good safety engineering and design practices, including integration of multimodal safety concerns and consideration of human factors in the design.

As mentioned in the recent FHWA/ITE Intersection Safety Issue Brief on RSAs, 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 moderate- or high-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 at them, has demonstrated a benefit-cost ratio of 16:1.

Another example of U.S. 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 had 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 audited 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 audited had dropped by only 0.26 crashes per hear (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.

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[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.*

THE FHWA CASE STUDIES: PROMOTING THE ACCEPTANCE OF RSAs

The RSAs in this case studies project have been well received by all participating agencies. Characteristics of the FHWA RSAs that have promoted their acceptance by the participating agencies are generally those that are aimed at making the RSA as useful and "user-friendly" as possible:

Key Factors for Success

1. The RSA suggestions have been consistent with the project's design stage.

When a safety issue is identified by the RSA team, one or more possible mitigation measures are suggested for consideration by the Design Team and Owner. Suggested mitigation measures must be consistent with the design stage at which the RSA is being conducted.

For example, an RSA was conducted on the detailed design of improvements to US 60 in Oklahoma within 12 weeks of the date on which the final design was due for submission. In the course of the RSA, the team identified a vertical crest curve that limited sight distance to an intersection and driveways. Both the RSA team and Design Team agreed that redesign of the road profile would improve sight distance, but was infeasible financially and at such an advanced project stage, when the land acquisition process had already been completed and utility relocation was underway. The Design Team had already incorporated geometric features to address the limited sight distance in the design, and the RSA team put forward further mitigation measures that could feasibly be implemented at the advanced design stage, such as signing and driveway relocation. Conversely, for the RSA conducted at an early (planning) stage for widening an arterial roadway in Collier County, FL, the RSA team could consider a wider range of safety improvements that could feasibly be included in subsequent design stages. Suggested measures included improved pedestrian and cycling facilities (since the arterial was adjacent to newly constructed schools) and a comprehensive access management program.

2. Preliminary RSA results (findings and suggestions) have been presented to the Owner twice, verbally and in a draft written form, to provide the Owner and Design Team with the opportunity for input and review before the results are documented in the final report.

Since RSA reports may become public documents, transportation agencies may be sensitive to their contents and the way in which the RSA results are presented. To address an agency's concerns and provide it with an opportunity for input, the RSA team first discusses the RSA results in the preliminary findings meeting. In this discussion, the design team and the Owner have the opportunity to identify potentially sensitive safety issues or alternative suggestions to those that have been identified by the RSA team. In practice, the safety issues identified by the RSA team in this case studies project have been consistently accepted as valid, and no agency has attempted to discourage their inclusion in the RSA report. In contrast, the RSA team's suggestions for improvements were discussed at some length.

After discussion in the preliminary findings meeting, a final set of suggestions can be identified and incorporated in the RSA report. A draft version of the RSA report is provided to the Owner for review. The Owner or Design Team can suggest clarifications or provide additional information that can be incorporated in the final RSA report. In practice, of the ten RSA reports completed to date in this case studies project, changes to the draft have been requested in only three reports. These changes were minor in nature, dealing with details such as terminology and clarification of some transportation agency policies.

By discussing RSA findings in the preliminary findings meeting and issuing a draft version of the report, the RSA team, Design Team, and Owner can work together to ensure that potentially sensitive issues are appropriately presented. It remains the responsibility of the RSA team to ensure that, while the Owner's concerns are adequately addressed, the final RSA report is an objective and accurate reflection of its findings, and that the integrity and independence of the RSA process are maintained.

3. For RSAs at an early design stage, the RSA team has provided guidance on possible low-cost improvements that could be implemented as interim measures to decrease interim crash risks.

Two of the RSAs in this pilot series were conducted in the planning or preliminary design stage, when construction was expected to start two or more years in the future. In the interim, while waiting for the public consultation, design and funding processes to proceed, the RSA team and Owner agreed that the safety issues that had partly motivated the projects should be addressed. Accordingly, during field reviews, the RSA team conducted an RSA of the existing facilities aimed at identifying safety issues and low-cost countermeasures that could be implemented as stopgap measures to improve safety as much as possible while waiting for the redesign to be implemented. Representative stopgap improvements included improved signing, improved pedestrian facilities (crosswalks and signal heads), and a suggestion to review signal operations to determine if left-turn phasing should be changed.

4. The RSA process has been applied to enhance the implementation of innovative road safety measures, with the aim of promoting their success.

Transportation agencies may develop or adopt technologies or measures that are innovative (locally or nationally) with the aim of promoting road safety. A common example of such a measure is the modern roundabout. Since these measures may be new to both the transportation agency and the wider community of road users, they may involve unforeseen consequences that ultimately compromise, rather than promote, safety. An RSA can be beneficial as a means of reviewing the innovative improvement in its intended environment, identifying possible factors that may compromise its successful implementation, and suggesting measures to address them.

For example, the City of Tucson has developed an innovative pedestrian crossing device, the HAWK signal (**H**igh Intensity **A**ctivated Cross**W**al**K**, a type of flashing beacon), and is implementing it at intersections where pedestrian safety is a concern. The City of Tucson received approval from FHWA to experiment with this device; it is not yet adopted in the *Manual of Uniform Traffic Control Devices*. One of the outcomes of the RSA conducted for six implementation sites in Tucson was a set of suggestions to enhance the HAWK system with a view to its wider (statewide or nationwide) application. Another outcome was a set of suggestions for site-specific low-cost improvements that could be "piggybacked" onto the signal implementation works to further enhance pedestrian and traffic safety.

5. The safety benefits of a project have been identified as part of the RSA process and report.

In this RSA case studies project, all of the road improvement projects on which RSAs were conducted during the planning or design stages were initially motivated, wholly or in part, by a desire to address safety issues. Part of the RSA process developed in this case studies project has been to identify safety issues that were observed on-site or through collision data, and to clearly state how the elements of the Design Team's proposed improvements or design can be expected to positively address these issues. Acknowledging the safety benefits of the original design puts the RSA findings in an appropriate context.

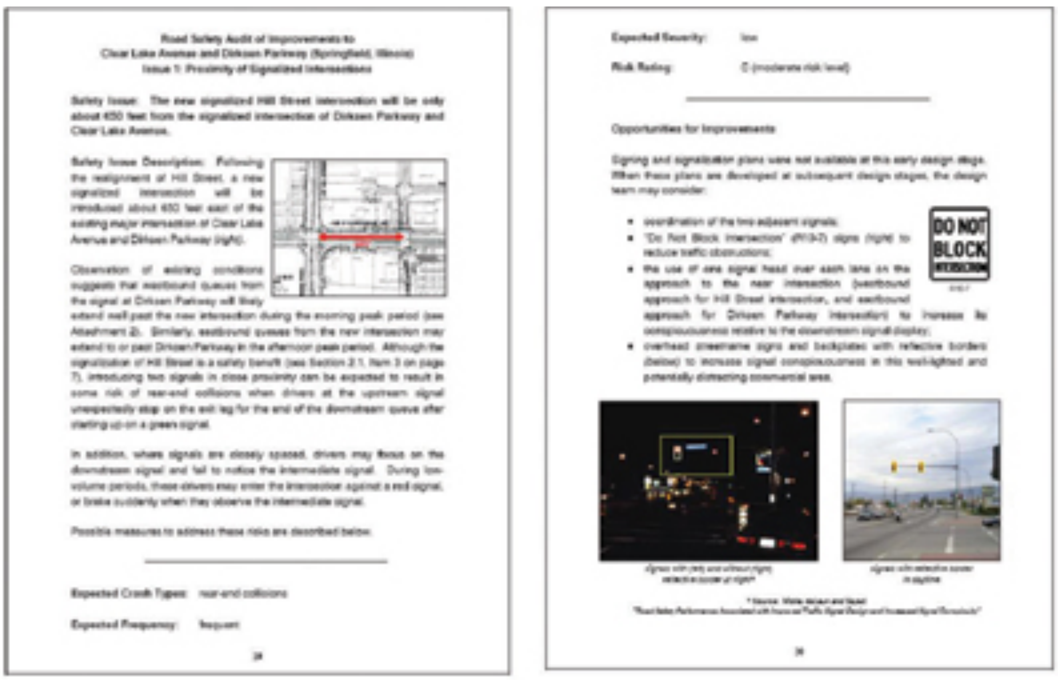
6. RSA teams have been composed of a multidisciplinary group of experienced professionals.

The core disciplines on an RSA team are traffic operations, geometric design, and road safety. Beyond these core requirements, all of the RSA teams in this case studies project have included members who have brought a range of backgrounds and specialties to the RSA. For example, the RSA of a preliminary design for arterial road upgrades for the Illinois DOT involved a team of professionals with individual specialties in construction, maintenance, access management, and enforcement. In addition, the RSA team included members from outside the state as well as locally based members from Illinois DOT and FHWA Field Safety staff. Those team members with local experience provided first-hand knowledge of local policies, practices, and conditions (including important information on commuter routes and local land use), while those from outside the state contributed ideas gained from experience with other agencies and in other jurisdictions.

7. RSA reports have been brief.

The RSA report is concise, and focuses on describing safety issues and suggested mitigation. Graphics and photographs were used as extensively as possible. The reports included:

1. *background:* a brief summary of the road or project being audited;
2. *RSA team and process:* a listing of the RSA team members, the design or as-built drawings used, site visit dates, and a description of the prioritization method used;
3. *site observations* made during site visits, including photographs;
4. *safety benefits of the proposed improvements,* describing elements of the project that are expected to effectively address existing safety issues or otherwise enhance road safety;
5. *RSA findings:* a listing of safety issues and suggested mitigation, usually one or two pages each. A two-page example is shown in FIGURE 6. A safety issue has been identified in a single sentence at the top of the page. A description of the safety issue follows, describing the nature of the safety concern and how it may contribute to collisions. A figure has been used to illustrate the safety issue. Prioritization of the safety issue follows, using the prioritization matrix described earlier, and ways to address the safety issue are suggested.


Road Safety Audit of Improvements to
Clear Lake Avenue and Dirksen Parkway (Springfield, Illinois)
Issue 1: Proximity of Signalized Intersections

Safety Issue:

Safety Issue Description:

Expected Crash Types:

Expected Frequency:

Expected Severity:

Risk Rating:

Opportunities for Improvements

FIGURE 6 EXAMPLE DISCUSSION OF AN RSA SAFETY ISSUE

Lessons Learned

Over the course of the RSA case studies project, the RSA teams have identified several key elements that help to make an RSA successful.

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. Knowledge of these constraints helps the RSA team to identify mitigation measures that are practical and reasonable.

2. The RSA team and Design Team 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 Design Team, RSA team, and the Owner.

The RSA team should be consistently positive and constructive when dealing with the Design Team. Many problems can be avoided if the RSA team maintains effective communication with the Design Team during the RSA (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 Design Team 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 Design Team is vital to the success of the RSA. An RSA is not a critical review of the design team’s work, but rather a supportive review of the design with a focus on how safety can be further incorporated into it. Cooperation between the RSA team and Design Team usually results in a productive RSA, since the RSA team will fully understand the design issues and challenges (as explained by the Design Team), and suggested mitigation measures (as discussed in advance with the Design Team) 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).

3. A “local champion” can greatly help to facilitate the establishment of RSAs.

Wilson and Lipinski[2] noted in their recent synthesis of RSA practices in the United States *(1)* 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 state DOTs, FHWA field offices, or city, county, or Tribal transportation agencies.

4. The RSA field review should be scheduled to coincide with important site conditions.

The RSA team should visit the project site when traffic conditions are typical or representative. For example, the RSA in Yellowstone National Park was conducted at the start of the Park’s summer season when visitor volumes were increasing. Consequently, the RSA team observed parking and circulation issues that were characteristic of the Park’s high-volume summer season. In contrast, the RSA in Cincinnati was conducted in late December, after classes at a nearby university had ended. The RSA team was consequently unable to observe the impact of university traffic at the site. Although this did not significantly affect the RSA findings, scheduling the field review to observe typical or usual traffic conditions is preferable, since it allows the RSA team to see how regularly-recurring traffic conditions and road user behavior may affect safety.

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

CONCLUSION

The RSA case studies project sponsored by the FHWA Office of Safety has been well received by the participating transportation agencies. The case studies project has exposed State and local agencies and Tribal governments to the concepts and practices of an RSA, and provided the opportunity for agency staff members to participate on the RSA team as part of the process. Within a year of the first case study RSA, at least two of the participating agencies have implemented regular RSA programs for their new and upgrade transportation projects.

This case study document has summarized the results of each RSA, with the intent of providing State and local agencies and Tribal governments with examples and advice to assist them in implementing RSAs in their own jurisdictions. In the future, an evaluation of these RSAs, as well as other RSAs conducted in the United States, will be conducted and published to provide further guidance to agencies contemplating an RSA program in their jurisdictions.