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Feasibility of a Quantitative Rural Safety Policy Improvement Index (RSPII): Phase I

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Many factors that contribute to fatal crashes are related to human behavior. One method of adjusting these behaviors is through the enactment and enforcement of legislatively-based safety improvement measures (LSIMs). The objective of this research was to investigate the feasibility of a research-based rural safety policy improvement index (RSPII) to quantify the state-by-state impacts of LSIMs. Recently completed LSIM summaries categorized the direct safety impacts of 23 behavioral highway safety countermeasures as “proven” with “high-quality” research. It was concluded that a RSPII was feasible and six LSIMs were selected for consideration with a RSPII framework. The LSIMs selected include the implementation of a comprehensive graduated driver licensing program, primary seat belt law, motorcycle helmet use law, sobriety checkpoints, ignition interlocks, and automated speed enforcement. A six-step RSPII framework and a pilot application are documented in this report. Two estimation methods were used to quantify the rural roadway safety impacts of primary seat belt law implementation. It was estimated that 488 fatalities or 248 unbelted front seat passenger vehicle occupant (≥ 13 years old) deaths could be avoided if this were to occur. More detailed applications for all six LSIMs selected will be completed in Phase II of this project.

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Feasibility of a Quantitative Rural Safety Policy Improvement Index (RSPII): Phase I

Final Report

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Executive Summary

The majority of fatal rural roadway crashes have at least one contributing factor related to human behavior or choices. One method of adjusting these behaviors is through the enactment and enforcement of legislatively-based safety improvement measures (LSIMs). Examples of LSIMs include primary seat belt laws, graduated driver licensing programs, and automated speed enforcement. The objective of this research was to investigate the feasibility (Phase I) and possible implementation (Phase II) of a research-based rural safety policy improvement index (RSPII) to quantify the state-by-state impacts of LSIMs. This report summarizes the activities completed during Phase I of the project.

Chapter 2 of this report describes two recently completed LSIM-related summaries, three LSIM indices, and the reference locations to determine the state-by-state status of LSIMs. Both LSIM-related summaries were completed by a team of researchers with specialized expertise in safety improvement measures designed to influence human behavior. They reviewed the literature related to more than 100 behavioral highway safety countermeasure and categorized 23 of them (some of which were LSIMs) as "proven" with "high-quality" research that showed their direct safety impacts (e.g., crash, injury, and/or fatality reductions). Some of these countermeasures met three of the four criteria that were defined to evaluate their relevance to this project and possible application within a RSPII framework. They were legislatively-based, related to human behavior or choices, and had their safety impact quantified in an acceptable (i.e., "high-quality") manner. The fourth selection criterion is that each countermeasure applied in the RSPII framework has the potential for an impact on rural roadway safety impact.

Three existing LSIM-related indices and status summaries were also described in Chapter 2. Each of these indices evaluates and rates the current status of various transportation safety laws within each state. There is some overlap in the LSIMs considered (e.g., primary seat belt laws), but they also each evaluate laws that are not considered by the others. All of the indices are either partially or fully based on a point assignment process, but none are directly based on the quantitative safety impacts of the LSIMs evaluated. In addition, none focus on the LSIM safety impacts along rural roadways. The RSPII developed and applied in this project, if completed, will consider a response to these two research gaps. LSIM status information is provided along with the existing index results, but it also available at several other Web page locations identified in this report. This information will be critical to the application of the RSPII.

The information described in Chapter 2 led the research team to conclude that a RSPII, in some form, was feasible. The 23 behavioral highway safety improvement countermeasures categorized as "proven" with "high-quality" safety impact research were then evaluated with respect to the four selection criteria noted above. This initial selection process resulted in the "acceptance" or "tentative acceptance" of 11 LSIMs. Each of these LSIMs was more closely considered during a final candidate selection process. The research related to their safety impacts was summarized and, if available, any differences in their urban and rural influence noted. In addition, any challenges that might need to be overcome during their application within a RSPII framework were identified.

The input and results of the initial and final LSIM selection process are described in Chapter 3. Overall, six LSIMs were selected for quantification within a RSPII framework during Phase II of this project. These six LSIMs included the following:

- Comprehensive Graduated Driver Licensing Program
- Primary Seat Belt Laws
- Motorcycle Helmet Use Laws
- Sobriety Checkpoints
- Ignition Interlock Implementation
- Automated Speed Enforcement

During the final selection process it was also decided that LSIMs with research focused on fatality reduction were desirable and that at least one LSIM related to seat belt use, speeding, and alcohol impairment (due to their over-representation in rural roadway crash fatalities) should be chosen for application within a RSPII framework.

The proposed RSPII framework and its pilot application are described in Chapter 4. The RSPII framework developed has six steps. First, the potential safety impacts of each LSIM must be identified through the review of relevant research results. Then, the fatality target group must be defined and the states that might benefit from the implementation of the LSIM identified. These are the applicable "before" states. Finally, the rural portion of the target group should be defined and the safety impacts on this target group due to the implementation of the LSIM calculated and presented. A number of challenges were also identified that will need to be overcome, if possible, to properly apply the RSPII framework. The majority of these challenges are directly related to the application of the research results to the target group and "before" states. The wide variety of LSIMs evaluated in the research and that exist throughout the United States will likely require one or more generalizations to complete the steps within the RSPII framework. The impact of these generalizations and any other challenges on the robustness of the RSPII results will need to be documented.

The pilot application of the RSPII framework quantified the rural roadway safety impact of implementing a primary seat belt law. Two estimation methods were used to complete this task. First, the National Highway Traffic Safety Administration BELTUSE software was applied and it estimated that 488 rural fatalities would be avoided if primary seat belt laws were implemented in the 24 applicable "before" states identified. Then, the potential safety impact and target group identified in National Cooperative Highway Research Program Report 622 for primary seat belt law implementation were applied (See Chapter 3). In this case it was estimated that the number of rural fatalities related to unbelted front seat passenger vehicle occupants ($\geq$ 13 years old) could have been reduced by 248 if primary seat belt laws were implemented in the 24 applicable "before" states identified. One of the primary reasons these results are different is because the target group of each approach is different. The difference in the results also shows how critical the identification of safety impacts and target groups are in the application of the proposed RSPII framework. All six of the LSIMs selected will be applied within the RSPII framework during Phase II of this project.

Chapter 1
Introduction

Rural roadway safety is a concern throughout the United States. There have been more than 41,000 fatalities annually for more than 10 years. Unfortunately, the majority of these fatalities occur along rural roadways that have about half the number of vehicle-miles-traveled of urban roadways. In fact, the fatality crash rate along rural roadways in the United States is more than twice that of urban roadways (*1*).

The greater than expected number of fatalities that occur along rural roadways is not a new problem. From 1997 to 2006 approximately 55 to 61 percent of the motor vehicle crash fatalities in the United States occurred along these roadways (*1*). In 2006, for example, approximately 55 percent of the motor vehicle crash fatalities in the United States occurred along rural roadways, but only about 23 percent of the population was rural (*1*). Clearly, the fatalities that occur along rural roadways also involve urban residents and improvements to these facilities will benefit the safety of all travelers.

Crash summaries show that about 90 percent of motor vehicle incidents have at least one contributing factor related to driver decisions, errors, or choices (*2*). Rural roadway crash fatalities are also typically over-represented among incidents that involve many of these types of contributing factors (e.g., non-use of seat belts, alcohol involvement, and speeding) (*1*). Changes to these driver and/or vehicle occupant behaviors are often required through the enforcement of safety legislation/policy or encouraged through education.

The research documented in this Phase I report focuses on the background/literature review and methodological development activities needed to determine the feasibility and potential application of a rural safety policy improvement index (RSPII). The RSPII is envisioned as a tool that could be used to quantify the potential rural roadway safety impacts of the enactment or application of legislation- or policy-based safety improvement measures (LSIMs). Phase II of this project, if completed, would apply the RSPII implementation framework on a state-by-state basis for the LSIMs of interest.

PROBLEM ADDRESSED

It is generally accepted that a number of LSIMs (when enforced) can have a positive impact on safety-related driver and/or passenger behaviors/choices. The objective, of course, is that these changes in behavior will lead to reductions in motor vehicle crashes, injuries, and/or fatalities. In fact, because of their significant potential for roadway safety improvement, the enactment or implementation of many LSIMs are included as a goal within state Department of Transportation (DOT) Strategic Highway Safety Plans (SHSPs). The SHSP and the State Highway Safety Plan generally guide the safety improvement strategy within a state. Unfortunately, the Advocates for Highway and Auto Safety have concluded that only minimal progress has been made toward the enactment or update of many critical LSIMs throughout the United States (*3*).

The enactment or update to an LSIM, however, can only be encouraged by state agencies. However, one the objectives of a DOT or Department of Public Safety (DPS) is to reduce roadway crashes, and it is generally accepted that the lack of progress related to LSIMs continues to result in motor vehicle crashes, injuries, and/or fatalities that could potentially have been avoided. In addition, because of the overrepresentation of certain crash characteristics along rural roadways (e.g., lack of seat belt use, alcohol use, and speeding) it is also expected that the impact of some LSIMs related to human-behavior may actually be greater in rural areas than urban areas.

A tool or methodology is needed that allows those who encourage, enact, or update LSIMs to quantify the positive rural roadway safety impacts these activities have. Desirably, this tool or methodology (referred to as the RSPII in this report) should allow the user to quantitatively determine and/or compare the potential rural roadway safety impacts of changes to one or more LSIMs on a state-by-state basis. The existing indices that currently rate and/or rank the status of various LSIMs (See Chapter 2 for a description of these) are only partially based on the current understanding of the research-based quantitative impacts of LSIMs or focused on rural roadway safety. This report discusses the feasibility and, if appropriate, the development and application of a RSPII.

PROJECT SCOPE AND OBJECTIVES

The scope of the research described in this document is limited to an investigation of the feasibility and potential development of a pilot application of a RSPII that attempts to quantify the rural roadway safety impacts of various behavior-related LSIMs on a state-by-state basis. The RSPII should be based on the current state-of-the-knowledge related to research that quantifies direct safety impacts of the LSIMs selected. It is expected, however, that most (if not all) LSIM research will not focus on or differentiate between their rural and urban roadway safety impacts. The assumptions that may be necessary to apply the research results within a RSPII and present its potential results will be documented. The safety improvement measures that are the focus of this research will need to meet the following criteria:

- Legislatively-based
- Related to human behavior or choices
- Direct safety impact quantified in an acceptable manner
- Potential for a rural roadway safety impact.

In fact, the ability to find one or more of these types of measures within the research literature is critical to the feasibility of a RSPII and its potential implementation.

The primary objectives of this research are to investigate and develop, if feasible, a tool or methodology (i.e., a RSPII) to quantify the potential rural roadway safety impacts expected due to changes in one or more LSIMs on a state-by-state basis. The specific tasks proposed to meet these objectives are noted below:

1. Review and describe relevant literature that summarizes, evaluates and quantifies the research and/or crash, injury, and/or fatality reduction capabilities of behavior-related LSIMs (e.g., primary seat belt laws)
2. Identify and summarize the results of existing LSIM-related (and possibly other) indices and/or processes
3. Identify those LSIMs that have supporting safety impact research results and/or the potential to influence rural roadway safety
4. Evaluate and determine the feasibility of a RSPII that might be applied throughout the United States and if appropriate complete the following:
   a. Develop a general framework for its application
   b. Discuss the challenges related to its implementation
   c. Complete a pilot application of the proposed implementation framework for one LSIM
5. Phase II of the project, if completed, should determine the rural roadway safety impacts of multiple LSIMs within the application framework developed (the challenges related to their individual application should be identified and the response documented)
6. Document the results of all the tasks above in a manner that is useful to the general public, transportation safety personnel, non-governmental organizations, and legislative decision-makers and their staff

This Phase 1 report summarizes the results from the first four tasks listed above. The results of the research and index review, identification of potential LSIMs, feasibility determination, general framework development, and pilot application are described. The organization of this Phase 1 report is noted below.

REPORT ORGANIZATION

There are five chapters to this Phase I report. Chapter 1 describes the problem addressed, scope, and objectives of the research project. The tasks for the project are also listed. Chapter 2 is a description of two recent, but significant, summaries of behavior-related LSIMs and the research that describes their potential safety impacts. The approach used and results of three existing LSIM indices (produced by three separate organizations) are also summarized. Several sources that can be used to determine the current status of various LSIMs on a state-by-state basis are also provided. Chapter 3 identifies and describes the LSIMs that might be applied in a RSPII implementation framework. The four selection criteria listed above will be used and a target application group of fatalities for each LSIM identified. Some of the challenges involved in the application of the LSIMs selected for use within a RSPII framework are described. These LSIMs would be applied within a RSPII implementation framework during Phase II of this project. If appropriate, a RSPII implementation framework will be described in Chapter 4 and the results of a pilot application summarized. Chapter 5 includes the research team conclusions based on the results of the Phase I activities for this project and a description of the next steps proposed for completion during Phase II.

Chapter 2
LSIM-Related Summaries, Indices, and Status

The primary objective of this phase of the research project was to determine the feasibility of a RSPII that could be used to quantify the expected rural roadway safety impacts of the LSIMs selected. Meeting this objective will require a comprehensive understanding of the following:

- Behavior-related LSIMs that have had direct safety impacts (e.g., fatality, injury, and/or crash reduction) quantified by what the experts consider a relatively robust research approach;
- The methods used to develop existing LSIM indices and their results; and
- The availability and accessibility (e.g., Web site, reports, etc.) of the existing status of various LSIMs within each state.

Two significant LSIM-related summaries were completed and published in 2008 that were of great value to this phase of the project (*4*, *5*). The results and recommendations of these two documents, which were supported and/or supplemented by a literature review and summary completed by this project team, are presented in this chapter. These reports were completed by experts in the specialized field of human-behavior safety improvement measures. A more focused information about the research results related to the safety impacts of particular LSIMs are provided in Chapter 3. This chapter, however, also includes a description of the development methodologies and results from three existing LSIM indices. In addition, several documents and Web sites are identified that describe the status of a wide range of LSIMs. All of this information was used to a) assist with the initial and final selection of the LSIMs that might be used in a RSPII; b) determine the feasibility of this type of tool and challenges to its implementation; and, c) if appropriate, develop the general application framework of a RSPII. The results of these activities are described in Chapters 3 and 4.

THE “COUNTERMEASURES THAT WORK” GUIDE

In 2008 the National Highway Traffic Safety Administration (NHTSA) published a 270-page summary of research references that focused on 108 roadway safety improvement measures related to human behavior (*4*). Some of the measures described were LSIMs. The team that authored “Countermeasures that Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices” (the Guide) summarized what it believed the research indicated about the use, effectiveness, costs, and implementation time of these 108 countermeasures (*4*). The document also provides references to the “most important” countermeasure research (*4*). The measures reviewed in the Guide are those the authors believed had the most “evidence of effectiveness” and were used on a regular basis (*4*). The 108 safety improvement measures included are divided into nine categories. [It should be noted by the reader that the Guide authors indicate that their summary includes 104 countermeasures but our review of the document appeared to identify 108 (*4*).] The categories used, and the number of countermeasures (in parentheses) within each, are listed below:

- Alcohol-Impaired Driving (28)
- Seat Belt Use (11)
- Aggressive Driving and Speeding (8)
- Distracted and Fatigued Driving (7)
- Motorcycle Safety (9)
- Young Drivers (11)
- Older Drivers (8)
- Pedestrians (15)
- Bicyclists (11)

The largest number of countermeasures evaluated in the Guide focused on the reduction of alcohol-impaired driving. The second largest number of countermeasures was related to pedestrian crash reduction.

Countermeasure Effectiveness

The effectiveness of each countermeasure in the nine categories listed above was evaluated by the authors of the Guide. These evaluations were primarily based on their opinion about the robustness of the research results available. The effectiveness of each countermeasure was defined as one of the following:

- Proven - Demonstrated by several high-quality evaluations with consistent results
- Likely - Based on the balance of evidence from high-quality evaluations or other sources
- Uncertain - Limited and perhaps ambiguous evidence
- Unknown - No high-quality evaluation evidence
- Varies - Different methods of implementing the countermeasure appear to produce different results

The number of countermeasures in each of these five groups of effectiveness is noted in Table 2.1. As indicated by the definitions above, the effectiveness of each countermeasure was generally gauged by the quality of its related research and what the results indicated about its impact on safety (e.g., reductions in crashes, injuries, and/or fatalities). However, the focus of this research project is the safety improvement measures that were identified as "proven" (specifically those with research indicating their direct impact on crashes, injuries, or fatalities). The "proven" countermeasures that meet this definition are listed in Table 2.1. The category and number of countermeasures that were "proven" with a surrogate safety measure is also noted in Table 2.1 and are identified in the Guide (*4*).

Overall, only about 30 percent (n = 32) of the 108 measures reviewed in the Guide were defined as "proven" (*4*). A total of 25 countermeasures, about 23 percent, were defined as "proven" with research using crash, injury, and/or fatality reduction as the safety measure (*4*). The largest number of "proven" countermeasures were related to the reduction of alcohol-impaired driving (n = 13) but the effectiveness of less than half (n = 6) of these were "proven" based on research showing their relationship to reductions in crashes, injuries, and/or fatalities (*4*). The effectiveness of the seven others was based on a surrogate safety measure.

Table 2.1. Number of Countermeasures by Effectiveness Category (Adapted from *4*)

Countermeasure Category	**Effectiveness Rating**[1]					
	Varies	Unknown	Uncertain	Likely	Proven[2]	
						Countermeasure
Alcohol-Impaired Driving (28)	3	2	5	5	6 (plus 7 Proven with Surrogate Safety Measures)	• Administrative license revocation or suspension • Sobriety Checkpoints • Alcohol Problem Assessment • Alcohol Interlocks • Alcohol Screening & Brief Interventions • Supporting Mass Media Campaigns
Seat Belt Use (11)	0	1	1	4	5	• State Primary Enforcement Seat Belt Laws • Short High-Visibility Belt Law Enforcement • Supporting Enforcement • Employer and School Programs[3] • Incentive Programs[3]
Aggressive Driving and Speeding (8)	1	2	2	1	2	• Speed Limits when Enforced and Obeyed • Automated Enforcement
Distracted and Fatigued Driving (7)	0	5	1	0	1	• Graduated Licensing Requirements for Beginning Drivers
Motorcycle Safety (9)	0	6	2	0	1	• State Motorcycle Helmet Use Laws
Young Drivers (11)	0	4	2	1	4	• Graduate Driver Licensing • Learner's Permit Length, Supervised Hours • Intermediate – Nighttime Restrictions • Intermediate – Passenger Restrictions
Older Drivers (8)	0	2	2	2	2	• Referring Older Drivers to Department of Motor Vehicles • License Screening and Testing[4]
Pedestrians (15)	1	3	3	5	3	• Elementary School Pedestrian Training • Pedestrian Safety Zones • Reduced Speed Limits
Bicyclists (11)	0	6	0	4	1	• Bicycle Helmet Laws for Children

[1]Effectiveness rating defined in report text.
[2]Proven with crash, injury, and/or fatality reduction as a basis.
[3]Proven when used in low belt use settings with no belt use law.
[4]High level of use but quality varies considerably.

The second and third largest number of "proven" countermeasures were focused on seat-belt use (n = 5) and younger driver safety (n = 4) (*4*). The number of "proven" countermeasures (based on direct crash, injury, and/or fatality reductions) in any of the categories, however, only ranged from one to six (*4*). The Guide also includes a description and references, along with an effectiveness evaluation, for each of the 108 countermeasures it identifies (*4*). The level of use for each countermeasure (high, medium, low, and unknown), cost (high, medium, and low), and the time to implementation (long, medium, and short) are also noted (*4*).

The list of countermeasures in Table 2.1, when combined with the information that follows in this report, was considered a starting point by this project team in their selection of LSIMs that might be used in a RSPII. The Guide content also appears to have been used as a basis for the recently completed National Cooperative Highway Research Project (NCHRP) 622 report "Effectiveness of Behavioral Highway Safety Countermeasures" (*5*). This report proposes a methodology that could be used to apply the safety impact of implementing countermeasures related to human behavior on the roadway and its relevant content is described below (*5*).

THE "EFFECTIVENESS OF BEHAVIORAL HIGHWAY SAFETY COUNTERMEASURES" REPORT

In 2005, NCHRP Project 17-33 was started. One of the objectives of this project was to create a methodology to assist with the implementation (based on their potential benefits and costs) of behavior-related highway safety countermeasures (*5*). The final report for NCHRP Project 17-33 was Report 622 – "Effectiveness of Behavioral Highway Safety Countermeasures" (*5*). This document was released in November 2008 and its basis, as indicated previously, was the content of the Guide (see above) (*4*, *5*). Its content was also supplemented with new information, however, and some "…adjustments and updates…" were made by the authors to the countermeasures ultimately considered (although the vast majority of those discussed as the same as the Guide) (*5*). The sections of NCHRP Report 622 that were relevant to this research project are described below (*5*). The countermeasure classifications and categories used in the report are identified and the application methodology it proposed is presented (*5*).

The classification or groupings of the countermeasures within the Guide (see above) and NCHRP Report 622 are different (*4*, *5*). The nine categories used in the Guide were combined into four classifications by the NCHRP Report 622 authors (*4*, *5*). Fortunately, these classifications were more useful to this research project because at least two of them two of them were specifically defined by their relationship to legislative policy (i.e., almost all of the countermeasures within these classifications are LSIMs). The countermeasure classifications used in NCHRP Report 622 included:

- Voluntary Activities - Countermeasures that focus on training, educating, or requesting a change in behavior
- Laws, Regulations, or Policies - Countermeasures that require changes in behavior through legislation or regulation
- Laws plus Enhancements - Countermeasures that support legislation with additional actions (e.g., high visibility enforcement)

- Sanctions and Treatments - Countermeasures that include the sanctioning or treatment of unacceptable behavior of people

The classification scheme used in NCHRP Report 622 generally groups the countermeasures evaluated by the means through which they attempt to change driver, vehicle occupant, and/or other user behavior within the roadway environment. However, the effectiveness of the countermeasures included within each classification was also categorized as "proven", "likely" or "unknown/uncertain/unlikely" (*5*). The definitions for each of these categories are described in the next section of this report along with the number of countermeasures they include. The "proven" countermeasures (especially those with research showing their expected impact on crashes, injuries, and/or fatalities) are the most relevant to this research.

Countermeasure Effectiveness

The authors of NCHRP Report 622 completed an extensive review of the literature focused on the roadway safety improvement effectiveness of human-behavior safety countermeasures (*5*). The countermeasure effectiveness categories used within NCHRP Report 622 are similar to those used in the Guide and are defined below (*4*, *5*):

- Proven - High-quality research or evaluations have consistently indicated that these countermeasures have an impact (*4*, *5*). NCHRP Report 622 included 41 measures (about 38 percent of the total reviewed) in this category:

    - 23 countermeasures were defined as "proven" with research results that show they reduce crashes, injuries, and/or fatalities
    - 3 countermeasures were defined as "proven" with research results that show they increase crashes, injuries, and/or fatalities
    - 15 countermeasures defined as "proven" with a different type of data or surrogate safety measure

    The authors of NCHRP Report 622 propose that the safety improvement measures with research that shows they reduce crashes, injures, and/or fatalities "…should be considered first for inclusion in a state's highway safety plan (*5*)."

- Likely: Observations of similar countermeasures have indicated that these activities should be effective if implemented. NCHRP Report 622 included 13 countermeasures (about 12 percent of the total reviewed) within this category (*5*). It was determined that the application of these countermeasures was "likely" to be effective but there is no research available to prove their impact (*5*). This category also included human-behavior safety improvement measures that were "…emerging and developing…" (*5*).

- Unknown/Uncertain/Unlikely: The countermeasures included in this category were those with either non-existent or "…limited and ambiguous…" information available about their effectiveness (*4*, *5*). NCHRP Report 622 included 54 countermeasures (50 percent of the total reviewed) within this category (*5*). These safety improvement measures were also grouped into sub-categories as those that had "…some basis for thinking it might work…", those that had "…some basis for thinking that the countermeasure will not work", and those that had impacts that were "…unknown or no opinion…" was available (*5*).

The reader should note that the lists of "proven" countermeasures in Chapter 3, Chapter 7, Appendix B, and Appendix D of NCHRP Report 622 are somewhat inconsistent (*5*). The summaries in this report are an interpretation of their content.

As indicated previously, the countermeasures of most interest to this project are those that the authors of NCHRP Report 622, based on their extensive literature review and expertise, defined as "proven" (*5*). Only some of these countermeasures, however, were "proven" with research that showed their direct safety improvement impacts (e.g., crash, injury and/or fatality reductions) and the authors of NCHRP Report 622 believed were "high-quality" (*5*). Other countermeasures were categorized as "proven" based on their impact on various surrogate safety measures. Table 2.2 lists all of the "proven" countermeasures from NCHRP Report 622 and identifies the method that was used to support their inclusion within this category (either from their impact on a direct quantitative safety measure or a surrogate). They are summarized in the following section of this report and the number of countermeasures within the other categories (i.e., likely and unknown/uncertain/unlikely) are also presented.

The "Proven" Countermeasures

Overall, 41 of the 108 (about 38 percent) safety improvement measures reviewed by the authors of NCHRP Report 622 were categorized as "proven" (*5*). In addition, these 41 countermeasures were classified in the following manner:

- 7 (about 17 percent) voluntary activities;
- 11 (about 27 percent) laws, regulations, or policies;
- 10 (about 24 percent) laws with enhancements; and
- 13 (about 32 percent) sanctions and treatments.

The NCHRP Report 622 classification of these measures (including the three that were "proven to have a negative impact on safety) are shown in Table 2.2 and discussed below. Only about 56 percent (n = 23) of the 41 safety improvement countermeasures included in the "proven" category had research that the NCHRP Report 622 authors felt supported was both acceptable and showed the direct crash, injury, and/or fatality reduction impact(s) of the activity being evaluated. The overall lack of high-quality and quantitative crash, injury, and/or fatality reduction information about behavioral highway safety countermeasures is a significant research gap and was also a critical influencing factor in determining the current feasibility of a RSPII.

Table 2.2. "Proven" Behavioral Highway Safety Countermeasures (Adapted from *5*)

Countermeasure	"Proven" with Positive Direct Safety Measures	"Proven to Decrease Safety"	"Proven" with Positive Surrogate Safety Measures
Voluntary Activities			
School pedestrian training for children	X		
Programs to get parents to put children in rear seats			X[2]
Booster seat promotions	X		
Child bicycle helmet promotions			X
High school driver education (leading to early learning/licensing)		X	
Advanced driver education skid training		X	
Traffic violator school in lieu of penalties		X	
Laws, Regulations, or Policies			
Bike helmet laws for children	X		
Comprehensive graduated driver licensing program (see three components below):	X		
a) Extended learner's permit	X		
b) Night restrictions	X		
c) Passenger restrictions	X		
Administrative license revocation	X		
Blood alcohol content (BAC) test refusal penalties			X
Primary seat belt laws	X		
Speed limits			X
Motorcycle helmet use laws	X		
Reduced speed limit for pedestrians (proven in Europe)	X		
Laws Plus Enhancements			
Sobriety checkpoints	X		
Saturation patrols for alcohol-impaired driving			X
Preliminary breath test devices			X
Passive alcohol sensors			X
Short term and high visibility belt law enforcement	X		
Automated speed enforcement	X[1]		
Automated red-light running enforcement			

	X[1]		
Mass media to support alcohol program enforcement or other programs (top-line programs)	X		
Public information and education (PI & E) supporting enforcement of seat belt laws			X
Community programs including age 21 enforcement of underage driving while under the influence	X		
Sanctions and Treatments			
Aggressive driving, speeding penalties (See four measures below):			
a) License suspension	X		
b) Individual meetings	X		
c) Group meetings	X		
d) Warning letters	X		
Restrictions on plea bargains			X
Court monitoring			X
Mandatory attendance at alcohol treatment	X		
Close monitoring of driving while under the influence violators			X
Ignition interlock implementation	X		
Brief interventions –alcohol			X
License plate impoundment			X
Vehicle immobilization			X
Vehicle impoundment			X

[1]Automated speed and red-light running enforcement countermeasures are sometimes combined and sometimes separate in NCHRP Report 622 (*5*).
[2]The basis for identifying this countermeasure as "proven" was not included within NCHRP Report 622, but was assumed by the authors.

Voluntary Activities

Many safety improvement measures encourage vehicle drivers/occupants and other road users to voluntarily make different choices through educational material and programs. Some of these measures are described within a research results digest (also produced by the NCHRP Report 622 project team) entitled "Public Information and Education in the Promotion of Highway Safety" (*6*). The seven voluntary behavioral highway safety countermeasures categorized as "proven" in NCHRP Report 622 included:

- School pedestrian training for children
- Programs to get parents to put children in rear seats
- Booster seat promotions

- Child bicycle helmet promotions
- High school driver education (leading to early learning/licensing) ("proven" to have a negative impact on safety)
- Advanced driver education skid training ("proven" to have a negative impact on safety)
- Traffic violator school in lieu of penalties ("proven" to have a negative impact on safety) (*5*)

Only 2 of the countermeasures listed above (i.e., school pedestrian training for children, and booster seat promotions) were categorized as "proven" with quantitative research showing direct crash, injury, and/or fatality reductions. Three (i.e., high school driver education driver education skid training, and traffic violator school in lieu of penalties) were also "proven" to have a negative impact on safety. The remaining countermeasures in the list above were "proven" by research that focused on their impacts to various surrogate safety measures (*5*).

Overall, there were 38 safety improvement measures classified as voluntary activities in NCHRP Report 622 (*5*). This classification included more measures than any other in the report (*5*). Seven of these voluntary countermeasures were defined as "proven" and 31 were categorized as "likely" (n = 2) or "unknown/uncertain/unlikely" (n = 29).

Laws, Regulation, or Policies

The implementation of laws and regulations can result in roadway safety improvements. They are typically more successful, however, when the law is well-known and can also be objectively enforced through direct observation (e.g., a helmet law that applies to all riders). The authors of NCHRP Report 622 also conclude that laws enforced by parents can be effective (e.g., graduate driver licensing requirements). The following safety improvement laws, regulations, or policies were categorized as "proven" in NCHRP Report 622:

- Bike helmet laws for children
- Comprehensive graduated driver licensing programs (see three components below)
  - Extended learner's permit
  - Night restrictions
  - Passenger restrictions
- Administrative license revocation
- Blood alcohol content (BAC) test refusal penalties
- Primary seat belt laws
- Speed limits
- Motorcycle helmet use laws
- Reduced speed limit for pedestrians (proven in Europe)

Nine of the 11 countermeasures listed above were categorized as "proven" with quantitative research showing direct crash, injury, and/or fatality reductions. The only two categorized as "proven" with surrogate safety measures were BAC test refusal penalties and speed limits (*5*).

Overall, there were 30 safety improvement measures classified as laws, regulations, or policies in NCHRP Report 622 (*5*). Eleven of these laws, regulations, or polices were defined as "proven" (see above), five were categorized as "likely", and 14 had "unknown/uncertain/unlikely" effectiveness.

Laws plus Enhancements

The roadway safety impact of laws that are well known to the public and/or vigorously enforced are generally believed to be greater than legislation that does not have these characteristics. In some cases even the perception that a law is well enforced may be enough to increase its impact. The safety improvement measures defined as laws with enhancements in NCHRP Report 622 are generally those that have their impact enhanced through additional publicity about their existence and/or enforcement. The following safety improvement laws plus enhancements were categorized as "proven" in NCHRP Report 622:

- Sobriety checkpoints
- Saturation patrols for alcohol-impaired driving
- Preliminary breath test devices
- Passive alcohol sensors
- Short term and high visibility belt law enforcement
- Automated speed enforcement (sometimes combined with automated red-light running enforcement within NCHRP Report 622, see below)
- Automated red-light running enforcement (sometimes combined with automated speed enforcement within NCHRP Report 622, see above)
- Mass media to support alcohol program enforcement or other programs
- Public information and education (PI & E) supporting enforcement of seat belt laws
- Community programs including age 21 enforcement of underage driving while under the influence

Six of the 10 countermeasures listed above were categorized as "proven" with quantitative research showing direct crash, injury, and/or fatality reductions. The countermeasures categorized as "proven" with surrogate safety measures included saturation patrols, preliminary breath test devices, passive alcohol sensors, and PI & E programs supporting seat belt law enforcement.

Overall, there were 19 safety improvement measures classified as laws plus enhancements within NCHRP Report 622 (*5*). Ten of the laws plus enhancements were defined as "proven" (see above), four were categorized as "likely", and five had "unknown/uncertain/unlikely" effectiveness.

Sanctions and Treatments

The safety improvement measures and activities in this classification encompass the sanctions and treatments that may be connected to transportation safety legislation, regulation, or policy applications. In general, sanctions have a better chance of success (i.e., an impact on roadway safety) if they are well-publicized (i.e., well-known to potential violators), more likely to be imposed, and "highly intrusive" with respect to time and/or money (*5*). It is also apparent, however, that treatment program and their safety effectiveness can be highly variable. In addition, the treatment programs that are successful and well-designed are typically those that have their impacts documented (i.e., it is rare that a treatment program that fails will have its lack of impact published). The following safety improvement sanctions and treatments countermeasures were categorized as "proven" in NCHRP Report 622:

- Aggressive driving, speeding penalties (see four measures below)
  - License suspension
  - Individual meetings
  - Group meetings
  - Warning letters
- Restrictions on plea bargains
- Court monitoring
- Mandatory attendance at alcohol treatment
- Close monitoring of driving while under the influence (DUI) violators
- Ignition interlock implementation
- Brief interventions –alcohol
- License plate impoundment
- Vehicle immobilization
- Vehicle impoundment

Six of the 13 countermeasures listed above were categorized as "proven" with quantitative research showing direct crash, injury, and/or fatality reductions. The countermeasures categorized as "proven" with surrogate safety measures included plea bargain restrictions and court monitoring. In addition, close monitoring of DUI violators, brief interventions, license place impoundment, and vehicle immobilization and/or impoundment were included in the list above for similar reasons.

Overall, there were 21 safety improvement measures classified as sanctions and treatments within NCHRP Report 622 (*5*). Thirteen of the sanctions and treatments were defined as "proven" (see above), two were categorized as "likely", and six had "unknown/uncertain/unlikely" effectiveness.

"Proven" Countermeasures Summary

Three types of "proven" behavioral highway safety countermeasures were defined in NCHRP Report 622 and summarized in this report. The "proven" countermeasures that are more relevant to this research project are those supported by well-designed research results that show the reductions in crash, injuries, and/or fatalities expected when they are implemented. Overall, only 23 of the 41 (about 56 percent) safety improvement measures in the NCHRP Report 622 "proven" category actually meet this criterion. In addition, only 5, 22, 15, and 15 percent of the "proven" countermeasures were classified as voluntary, law; regulation or policy; laws plus enhancements; and sanctions and treatments, respectively. Another 15 countermeasures were defined as having a "proven" positive impact on safety through surrogate measures. The last three safety-related measures were "proven" to increase crashes, injuries, and/or fatalities. All 41 of these countermeasures are shown in Table 2.2. The next chapter includes an identification of the expected crash, injury, and/or fatality reductions related to each of 23 countermeasures "proven" with direct safety impact research. They meet at least two of the criterion listed in chapter one that are required for a countermeasure to be selected for further consideration during Phase II of this research. The existence of these types of countermeasures also makes the feasibility of a RSPII much more likely.

Proposed Application Methodology

NCHRP research projects are developed and funded by practitioners. The ability to implement the results of all the projects funded through this program is one of its primary objectives. The NCHRP Report 622 team developed a methodology that could be used to efficiently and effectively implement the 23 "proven" safety improvement measures (supported by crash, injury, and/or fatality reduction research results) previously defined (See Table 2.2). The methodology proposed in NCHRP Report 622 is described below (*5*).

The decision-making methodology proposed in NCHRP Report 622 applies the research-based expected safety impacts of the 23 "proven" countermeasures (see Table 3.1 in Chapter 3) to a "target group" of what is considered to be the appropriate fatal crashes (*5*). An estimate of the major injury reduction impacts of these countermeasures and a highway loss-savings analysis is also completed. The estimated safety impacts (or measures of effectiveness), target group, and highway loss-savings term were generally defined within NCHRP Report 622 in the following manner

- Estimated Measure of Effectiveness: The research based safety improvement expected to be produced by the implementation of a safety improvement measure
- Target Group: Number of crash fatalities and/or major injuries that could be addressed by the safety improvement measure being considered
- Highway Loss-Savings: Estimated dollar value of the total fatalities and/or major injuries in the target group and the reduction expected by the implementation of the safety improvement measure

The application methodology proposed primarily focuses on the estimated benefits (e.g., fatality and/or major injury crash reduction) and costs related to the implementation of the 23 "proven" countermeasures defined in NCHRP Report 622 (*5*). It generally includes three steps. First, the direct safety impact (based on research results) of the behavioral highway safety countermeasure is identified. The research results that are proposed for use in this process (and within this project) are contained in NCHRP Report 622 and also provided in the next chapter (See Table 3.1). The type of impacts that are quantified in the research varies (e.g., crash, injury, and/or fatality reduction). Second, the target group of motor vehicle crash fatalities that would potentially be impacted by the implementation of the countermeasure needs to be determined. The method used in NCHRP Report 622 to estimate the size of the target groups it specifically proposes for the 23 "proven" countermeasures is described in the next section of this report. The third step in the proposed methodology includes the estimation of highway loss and savings (i.e., benefits) related to the countermeasure implementation. The total potential highway loss connected to a particular countermeasure was defined as the estimated "value" of the fatalities and major injuries in its target group. The savings impact calculated for each countermeasure is the expected value of the potential reduction in its target group highway losses (i.e., fatalities and/or major injuries) after its application.

Fatality Target Group and Major Injury Estimates

The target groups in NCHRP Report 622 were defined as the motor vehicle crash fatalities that resulted from an incident with characteristics that might altered by the countermeasure being considered (*5*). The number and percentage of fatalities within some general target groups are shown in Table 2.3. The database and process used to calculate the fatalities and injuries related to a target group are described below. The potential impact of the countermeasures on property damage crashes was ignored.

In the United States there is only one national database of fatal crash characteristics but there are at least two databases with a statistical sample of major injury crash information. In NCHRP Report 622 the research team used 2006 data from the Fatality Analysis Reporting System (FARS) to calculate the number and percentage of fatalities for some general fatal crash target groups (See Table 2.3). They correctly note, however, that the crash fatalities within these target groups are not mutually exclusive (i.e., the percentages don't sum to 100). In other words, one fatal crash might involve various characteristics (e.g., pedestrian, motorcyclist, and alcohol and speeding). The NCHRP Report 622 researchers also used the FARS data with sampled injury information from the General Estimates System (GES) database and the crash cost and major injury research results by Blincoe, et al. to estimate the value of the highway losses and savings for each target group (*7*).

Table 2.3. Number and Percent Fatalities by General Target Group (2006, Total Fatalities = 42,642) (Adapted from *5*)

General Target Group Characteristic	Number of Fatalities	Percentage of Fatalities
Pedestrians	4,784	11.22
Distracted Drivers (Excluding Drowsy Drivers)	4,246	9.96
Drowsy Drivers	1,344	3.15
Speed-Related, Speed Violation, or Excessive Speed	11,518	27.01
Aggressive Driving, Speeding, Reckless Driving, and Road Rage	11,684	27.40
Alcohol-Related (Drivers with Blood Alcohol Content $\geq$ 0.01)	17,602	41.28
16- and 17-Year Old Teen Drivers in Passenger Vehicles	2,291	5.37
16-Year Old Drivers in Passenger Vehicles	880	2.06
Older Drivers 75 Years Old or More in Passenger Vehicles	3,135	7.35
Motorcyclist	4,654	10.91
Nighttime between 9 PM and 6 AM	15,194	35.63
Child in Passenger Vehicle 12 Years Old and Younger	993	2.33
Outboard Front Seat Occupants in Passenger Vehicles that are 13 Years Old or Greater	26,715	62.65
Bicyclist	770	1.81

The number of crash major injuries potentially related to the fatality target group of a countermeasure was also estimated in NCHRP Report 622 (*5*). The GES ratio of injuries to fatalities for the general target groups in Table 2.3 are shown in Table 2.4. This type of ratio was calculated by the NCHRP Report 622 research team for each "proven" countermeasure and then adjusted in the following manner (the adjusted ratios are also shown in Table 2.4). First, the Blincoe, et al. research was used to estimate that there were approximately 126 injuries (of all severities) for every fatality (*7*). Second, 2004 to 2006 data from the General Estimating System (GES) database were used to calculate an initial injury to fatality ratio for the target groups (See Table 2.4). Then, the NCHRP Report 622 project team used the Blincoe, et al. research results to proportion or adjust the target group ratios from the 85:1 "all injury to fatality" GES-based ratio to the 126:1 "all injury to fatality" ratio calculated by Blincoe, et al (*7*). Table 2.4 shows the adjusted ratios for a series of general target groups (*5*).

Table 2.4. General Estimating System (GES) and Adjusted Fatality to Injury Ratios for General Target Groups (Adapted from *5*)

General Target Group Characteristic	GES Injury to Fatality Ratio[1]	Adjusted Injury to Fatality Ratio[1]
Pedestrians	21	31.43
Distracted Drivers (Excluding Drowsy Drivers)	158	234.28
Drowsy Drivers	51	74.68
Speed-Related, Speed Violation, or Excessive Speed	59	87.48
Aggressive Driving, Speeding, Reckless Driving, and Road Rage	61	89.84
Alcohol-Related (Drivers with Blood Alcohol Content ≥ 0.01)	32	46.70
16- and 17-Year Old Teen Drivers in Passenger Vehicles	161	238.28
16-Year Old Drivers in Passenger Vehicles	181	267.96
Older Drivers 75 Years Old or More in Passenger Vehicles	65	95.95
Motorcyclist	23	34.53
Nighttime between 9 PM and 6 AM	45	65.99
Child in Passenger Vehicle 12 Years Old and Younger	444	656.15
Outboard Front Seat Occupants in Passenger Vehicles that are 13 Years Old or More	106	156.21
Bicyclist	72	106.41

[1]Adjusted ratios are the individual GES ratios proportioned from the GES "all injury to all fatality" ratio and to a similar ratio calculated by Blincoe, et al. (*7*).

The 2006 percentage of fatalities and the adjusted injury to fatality ratios for the specific target groups for 23 "proven" (with direct safety measure impacts) countermeasures in Table 2.2 are listed in Table 2.5. The specific target groups in Table 2.5 were proposed in NCHRP Report 622. Overall, there appear to be three fatality target groups with particular characteristics that represent a large percentage of the incidents in the United States (*5*). Unbelted outboard front seat occupants in passenger vehicles were involved in 31 percent of the fatalities in 2006 within the United States, 35 percent of fatalities involved alcohol-impaired drives in some manner, and speed was a crash characteristic in 27 percent of fatalities. It is noted that the size of the target groups for some of these specific countermeasures is very small. In addition, the target group of some of the countermeasures is the same because they have similar objectives (e.g., reduction in drivers operating a motor vehicle under the influence of alcohol). This overlap also emphasizes the fact that these target groups are not mutually exclusive. The information in Table 2.5 is also a strong indication that a RSPII is feasible. Its application in the calculation of highway loss and savings is described below.

Table 2.5. "Proven" Countermeasure Target Group, Percent Fatalities, and Adjusted Injury to Fatality Ratios (Adapted from 5)

"Proven" Countermeasure	Specific Target Group Characteristic	Percentage of Fatalities (2006)	Adjusted Injury to Fatality Ratio[5]
School pedestrian training for children	Child Pedestrians: 6 to 12 Year Olds	0.303	31.43
Booster seat promotions	4 to 8 Year Olds not Traveling in Booster Seats	0.643	656.15
Bike helmet laws for children	Child Bicyclists Under the Age of 12	0.143	106.41
Comprehensive graduated driver licensing programs (see three components below):	16-Year Old Drivers	2.064	267.96
a) Extended learner's permit	16-Year Old Drivers	2.064	267.96
b) Night restrictions	16-Year Old Drivers at Night	0.593	267.96
c) Passenger restrictions	16-Year Old Drivers with Teen Passengers	1.182	267.96
Administrative license revocation	Alcohol-Impaired Drivers (BAC $\geq$ 0.08)	35.46[1]	46.7[1]
Primary seat belt laws	Unbelted Outboard Front Seat Occupants in Passenger Vehicles (Age 13 and More)	30.892[2]	156.21[2]
Motorcycle helmet use laws	Motorcyclists	10.914	34.53
Reduced speed limit for pedestrians (proven in Europe)	All Pedestrians in Urban Areas with 60 kph (Approx. 35 mph) Roadway Speed	2.594	31.43
Sobriety checkpoints	Alcohol-Impaired Drivers (BAC $\geq$ 0.08)	35.46[1]	46.7[1]
Short term and high visibility belt law enforcement	Unbelted Outboard Front Seat Occupants in Passenger Vehicles (Age 13 and More)	30.892[2]	156.21
Automated speed enforcement	Speed-related crashes	27.011	87.48
Automated red-light-running enforcement	Red-Light Running Crashes	NA[3]	NA[3]
Mass media to support alcohol program enforcement or other programs (top-line programs)	Alcohol-Impaired Drivers (BAC $\geq$ 0.08)	35.46[1]	46.7[1]

Community programs including age 21 enforcement of underage driving while under the influence	Drivers Under 21 Years Old with BAC ≥ 0.01	6.531[4]	46.7[4]
Aggressive driving, speeding penalties (See four measures below):			
a) License suspension	Drivers with Previous Speed Convictions Involved in Aggressive Driving-Related Crashes	7.884	89.84
b) Individual meetings	Drivers with Previous Speed Convictions Involved in Aggressive Driving-Related Crashes	7.884	89.84
c) Group meetings	Drivers with Previous Speed Convictions Involved in Aggressive Driving-Related Crashes	7.884	89.84
d) Warning letters	Drivers with Previous Speed Convictions Involved in Aggressive Driving-Related Crashes	7.884	89.84
Mandatory attendance at alcohol treatment	Drivers with Previous DUI Convictions Involved in Alcohol-Related Crashes (BAC ≥ 0.01)	2.737	46.7
Alcohol Interlock Implementation	Drivers with Previous DWI Convictions Involved in Alcohol-Related Crashes (BAC ≥ 0.01)	2.737	46.7

[1]Alcohol-related injury to fatality ratio applied to alcohol-impaired target group in NCHRP Report 622.
[2]May be the injury to fatality ratio for all front seat occupants applied to a subset of this group (i.e., outboard occupants 13 years old or older).
[3]NA = Not available from NCHRP Report 622.
[4]Alcohol-related injury to fatality ratio applied to a subset of this group (i.e., drivers less than 21 years old).
[5]Adjusted ratios are the individual GES ratios proportioned from the GES "all injury to all fatality" ratio and to a similar ratio calculated by Blincoe, et al. (*7*).

Highway Loss and Savings Calculation

NCHRP Report 622 provides guidance about how the information described above might be used to compare the potential benefits and costs related to the implementation of various behavioral highway safety countermeasures (*5*). The focus of the guidance is the difference between the assumed implementation/operating costs and the value of the fatality and/or injury reduction savings expected from the implementation of a countermeasure. The costs related to the implementation of these types of measures can vary widely, however, and need to be estimated on a case-by-case basis. The discussion below, therefore, focuses on the calculation of countermeasure savings.

The highway loss and savings calculated for the "proven" countermeasures in Table 2.5 is based on the expected fatality and major injury reduction impacts they may have on their specific target group. The highway losses related to a countermeasure were assumed to be equal to the fatalities and estimated major injuries related to the countermeasure target group. Table 2.5 shows the percentage of fatalities in 2006 and the "injury to fatality" ratio for 23 "proven" countermeasures (*5*). This information can be used to estimate the number of fatalities and major injuries that might be impacted (i.e., the target group size) within a particular jurisdiction due to the countermeasure indicated. NCHRP Report 622 includes calculations of the fatality and major injury highway losses related to all 23 of the "proven" countermeasures shown in Table 2.5 for a "median state" that has 600 fatalities. Similar statistics can be calculated for states with a different number of fatalities by proportioning the NCHRP Report 622 results.

The potential savings expected from the implementation of a countermeasure (See Table 2.5) can be calculated by applying the safety improvements (e.g., crash, injury, and/or fatality reduction) noted in the research to the fatalities and major injuries in its target group. A monetary or savings value can then be placed on the safety improvements expected. The NCHRP Report 622 project team extrapolated past cost estimates by Nichols and Ledingham and Blincoe, et al. for the average fatality and Maximum Abbreviated Injury Scale (MAIS) 1 to 5 injuries (*7*, *8*). Their estimated cost for a fatality in 2007 was $1,115,820, and the average unit cost of MAIS 1 to 5 injuries was $30,238. These costs, when applied to the number of fatalities and major injuries eliminated due to the implementation of a countermeasure, are equivalent to the estimated savings it may produce. NCHRP Report 622 includes the expected savings for all 23 "proven" countermeasures (See Table 2.5) in a "median state" with a total of 600 fatalities (*5*). It also estimates that the addition of pain, grief, and suffering costs to these saving estimates could increase their size by as much as 300 percent (*5*).

EXISTING LSIM-RELATED INDICES

There are at least three organizations that regularly release indices or rankings related to various LSIMs (*3*, *9*, *10*). The approaches used to create these indices are described below and the LSIMs they consider are identified. Their results or findings are also noted. References are provided for the reader because the index documents and/or Web pages summarized in this report are regularly updated to take into account changes in legislation and policy (*3*, *9*, *10*). These documents and/or Web sites are also a good resource for more detailed information about the indices discussed and the current state-by-state status of various LSIMs. The indices described below include those completed by the Insurance Institute for Highway Safety (IIHS), the Emergency Nurses Association (ENA), and Advocates for Highway and Auto Safety (AHAS) (*3*, *9*, *10*). The LSIMs reviewed by each group are not the same.

Insurance Institute of Highway Safety State Traffic Laws Index

The IIHS has developed a state traffic laws index that is updated on a monthly basis (*9*). This index, and its supporting documentation, can be found at www.iihs.org. The LSIMs that are rated by the IIHS include the following:

- Driving while under the influence (DUI or DWI)

- Young driver licensing
- Seat belt use
- Child restraint use
- Motorcycle helmet use
- Red-light-running camera enforcement

The set of laws in each state that are related to the LSIMs above are rated or labeled by IIHS as "good", "fair", "marginal" and/or "poor" (*9*). The approaches taken to rate the traffic law status within each subject area varies somewhat and are summarized below. The general results are also noted (*9*). More detail and the current status (updated monthly) of the laws reviewed for each state can be found at the IIHS Web site (See www.iihs.org) (*9*). An overall or "total" rating and/or ranking of a combination of all the state traffic laws considered within each state is not done by the IIHS.

Driving While Under the Influence (DUI or DWI)

The status of four alcohol-related laws in each state was reviewed by the IIHS. The legislation considered was administrative license revocation, blood-alcohol-content (BAC) 0.08 per se, readily enforceable "no measurable" BAC for drivers younger than 21 years old, and sobriety checkpoints. The laws in each state were rated in the following manner:

- "Good" when the state had all four of the measures above
- "Fair" when either an administrative license revocation law or a BAC 0.08 per se law were in place and at least one of the other measures
- "Marginal" for laws against measureable BAC if an underage driver and sobriety checkpoints
- "Poor" if only one or less of the four measures have been enacted

The November 2008 status summary by the IIHS also showed that all 50 states and the District of Columbia had a 0.08 BAC per se law (*9*). In addition, 41 of the states and the District of Columbia allowed an administrative license revocation (after the first DUI offense). However, no information is provided on the IIHS Web site about the state status of the "no measurable" BAC for drivers 21 years old and younger, and the Web site sobriety checkpoint discussion focuses only on court decisions (*9*). There appears to be some form of sobriety checkpoint implementation possible in 38 states and the District of Columbia (*9*). Overall, the DUI/DWI legislation in 19 states were rated as "good", 31 (including Washington, D.C.) were rated as "fair", none were "marginal", and one was "poor" (*9*). In addition, although these laws were not rated, the IIHS Web site indicates that 32 states sometimes require multiple offenders to forfeit their vehicles, and 47 states and the District of Columbia also allow the use of an ignition interlock as a possible penalty for some DUI offenses (*9*).

Young Driver Licensing

The young driver licensing legislation reviewed by the IIHS focused on the key components of graduated driver licensing (GDL) programs. A point system used by the IIHS was based on the "strength and likely effectiveness" of the existing GDL-related laws within a state (*9*). The point-based rating system that was used included the following:

- “Good”: ≥ 6 points
- “Fair”: 4 or 5 points
- “Marginal”: 2 or 3 points
- “Poor”: 0 or 1 points.

More specifically, graduated driver licensing (GDL) points were assigned to each state based on the criteria noted in Table 2.6. More points were given to a state with a strong initial or learner’s entry GDL stage and for the time the licensing restrictions remained past the 16th birthday of the driver. In addition, no state was ranked above “marginal” if it allowed an intermediate license to be issued to those younger than 16 years old or unrestricted driving before they were 16.5 years old (*9*). Overall, no state had the optimal GDL program legislation defined by the IIHS (*9*). This type of program would match the point assignment criteria in Table 2.6 and require the following: a) a minimum age of 16 years old for a learner’s permit; b) a learner’s permit stage of at least 6 months (during which 30 to 50 hours of supervised driving must occur); and c) an intermediate stage that lasts until the driver is 18 years old (including night driving restrictions starting at 9 or 10 PM and a one or fewer teenage passenger restriction).

Overall, 47 states and Washington D.C. have a three-stage GDL program. However, no jurisdiction has an optimal GDL program as defined by the IIHS. The components of the GDL programs that exist also vary from state to state. A rating for each of the three GDL program stages, along with a status description, is provided at www.iihs.org for each state. In summary 30 states (including Washington, D.C.) had GDL legislation rated as “good”, 12 were rated as “fair”, 9 were “marginal”, and none were rated as “poor”.

Seat Belt Use

The IIHS rating of seat belt legislation in each state focused on whether the existing laws included primary or secondary enforcement and whether they applied to all vehicle occupants or just front seat passengers. Primary seat belt legislation allows law enforcement to issue tickets when a seat belt violation is observed. Secondary seat belt legislation only allows ticketing for seat belt violations if a different infraction is first observed. The seat belt legislation in each state was rated by the IIHS in the following manner:

- “Good” if primary enforcement was allowed, fines and/or license points were applied for violations, and the law also applies to rear seat occupants
- “Fair” if there was primary enforcement but the law doesn’t require belt use in rear seats
- “Marginal” if secondary enforcement was allowed
- “Poor” if the state had no seat belt law or did not impose fine or license points for violations

The November 2008 status summary by the IIHS indicated that either primary or secondary enforcement seat belt laws exist in every state except New Hampshire (*9*). The seat belt legislation in only 11 states (including Washington, D.C.) was rated as “good”. However, a total of 19 states have seat belt laws that apply to front and rear seat passengers and 26 states have primary enforcement seat belt legislation. In some cases, the primary enforcement may only apply to passengers of a particular age range (e.g., less than 16 or 19 years old). A total of 16 states had seat belt legislation rated as "fair", 23 as "marginal", and one as "poor".

Table 2.6. Graduate Licensing Program Point Assignment Criteria (*9*)

Graduate Licensing Program Component	Point Assignment Criteria
Learner's entry age	1 point for learner's entry age of 16
Learner's holding period	2 points for ≥ 6 months; 1 point for 3 to 5 months; or none for <3 months
Practice driving certification	1 point for ≥ 30 hours; or none for less than 30 hours
Night driving restriction	2 points for 9 or 10 PM; or 1 point for after 10 PM
Passenger restriction	2 points for ≤ 1 underage passenger; 1 point for two passengers; no points for 3 passengers (where supervising driver may be < 21, point values were determined including the supervising driver as a passenger)
Driver education	Where completion of driver education changed a requirement, point values were determined for the driver education track
Duration of restrictions	1 point if difference between minimum unrestricted license age and minimum intermediate license age is 12 or more months (night driving and passenger restrictions were valued independently)

Child Restraint Use

The IIHS rating for child restraint legislation focuses on the requirements state laws placed on motor vehicle occupants younger than 13 years old. The child restraint laws in each state were rated in the following manner:

- "Good" if primary enforcement (see definition above) is allowed for existing laws that require all children younger than 13 years old to be restrained in some manner (e.g., infant restraints, child seats, booster seats, or seat belts)
- "Marginal" if all children younger than 13 years old are required to be restrained in some manner (e.g., infant restraints, child seats, booster seats, or seat belts), but only secondary enforcement is allowed
- "Poor" if laws don't require all children younger than 13 years old to be restrained

The November 2008 status summary by the IIHS indicated that all 50 states and Washington D.C. have child restraint use laws (*9*). The specific provisions of these laws, however, vary widely. All but four states have a primary enforcement law for child restraint use. The remaining four states have a secondary enforcement child restraint law except for a small age group of children that must use booster seats. Several states also have gaps in their laws that have produced an unfortunate situation in which children in a particular age range are not addressed by either a child restraint use or an adult seat belt law. All children younger than 16 years old, however, are addressed by at least one restraint law within 41 states and Washington D.C. Eleven states also require the use of booster seats for children who have outgrown child seats. Overall, the child restraint use legislation in 35 states (including Washington, D.C.) was rated as "good", 11 were rated as "marginal", and 5 were rated as "poor".

Motorcycle Helmet Use

The IIHS rating of motorcycle helmet use laws in each state was relatively straightforward. The rating focused on whether state helmet use law in each state applied to all motorcycle riders, part of the motorcycle user population, or no riders. One of two ratings was assigned to each state and Washington, D.C. These ratings were defined in the following manner:

- "Good" requires helmet use by all motorcycle riders
- "Poor" indicates that no motorcycle law or a partial law (e.g., it applies to drivers and/or riders 18 years old or younger) exists

.

Universal motorcycle helmet laws that require helmet use by all motorcycle riders exist in 20 states and Washington, D.C. (*9*). The motorcycle helmet use laws in these states, therefore, were rated as "good." Partial helmet use laws, mostly covering young motorcycle riders (e.g., 18 years old or younger), are in place in 27 states. Eight states also mandate helmet use for motorcycle riders with instructional licenses or who are defined as a "novice". Three states require helmet use for motorcyclists who lack sufficient insurance and three others (i.e., Illinois, Iowa, and New Hampshire) have no motorcycle helmet use law. Overall, the 30 states with partial or no motorcycle helmet use laws were rated as "poor" by the IIHS.

Red-Light-Running Camera Enforcement

Automated or camera enforcement of red-light-running has been used throughout the world and also at several locations within the United States. The safety benefits of this type of enforcement have been accepted by most transportation professionals. The ability to implement red-light-running cameras, however, is limited in many jurisdictions and requires new legislation. The IIHS rating of automated red-light-running enforcement legislation, therefore, focuses on how much authority is available in each state to implement this type of equipment. The IIHS ratings were defined in the following manner:

- "Good" includes statewide authority for camera enforcement
- "Fair" includes situations where camera enforcement occurs without specific legal authority
- "Marginal" includes camera enforcement within specific communities
- "Poor" indicates that there is no law granting authority for camera enforcement and no installations have been implemented

The November 2008 IIHS status summary of automated red-light-running enforcement indicated that cameras are used for this purpose in 372 communities within 24 states and

Washington, D.C. (*9*). A factor that is a point of discussion with respect to laws focused on automated enforcement, however, is whether the driver or owner of the vehicle is responsible for an offense observed by a camera. Overall, the IIHS rated red-light-running camera enforcement legislation in 13 states (including Washington, D.C.) as "good", 11 were rated as "fair", 5 were "marginal", and 22 were rated as "poor".

Emergency Nurses Association National Scorecard on State Highway Laws

In November 2008 the Emergency Nurses Association (ENA) released its second scorecard of state highway safety laws (*10*). The overall purpose of this scorecard is to educate legislators and the public about the quality of their state highway safety laws. One unique aspect of this scorecard is that it also considers the status of enabling legislation that may or may not exist in each state authorizing the development, maintenance, and evaluation of a statewide trauma system. Laws related to the following safety factors were rated by the ENA:

- Seat belt use
- Booster seat use
- Child passenger safety
- Motorcycle helmet use
- Graduated driver licensing
- Ignition interlocks for hard-core drinking drivers
- Statewide trauma systems

Some of the laws the ENA considered overlap with those rated by the IIHS. However, the approach followed by the ENA to complete its ratings was different than the one used by the IIHS. In fact, all the ENA ratings were based on a point system. If the law(s) related to the subject areas listed above had the provisions described below one or more points were awarded. The points were awarded in the following manner (*10*):

- Primary enforcement seat belt law (1 point)
- Primary enforcement seat belt law applies to all seating positions (1 point)
- Existence of booster seat law (1 point)
- Booster seat law that applies to children up to 8 years old (1 point)
- Child passenger safety law applies to children under 16 years old in all seating positions (1 point)
- Universal helmet use law applies to all motorcycle riders (1 point)
- Requirement that all helmets meet federal protection standards (1 point)
- Graduated driver licensing
    - 6-month learner's stage holding period (1 point)
    - 30 to 50 hours of supervised driving during learner's stage (1 point)
    - Nighttime driving restriction during intermediate stage (1 point)
    - Maximum of one passenger under 20 years old in intermediate stage (1 point)
- Mandated installation of an ignition interlock device to restrict or separate "hard-core" drinking drivers from their vehicles (1 point)
- Existence of enabling legislation that provides the "…authority to develop, maintain, and evaluate a state trauma system and its components. (*10*)" (1 point)

A maximum of 13 points could be awarded to an individual state. Points were not awarded for partially meeting the provisions described above. In addition, the existence of proper graduated driver licensing, booster seat, motorcycle helmet use, and primary seat belt laws represent 10 of the 13 points possible. Laws in these four subject areas, therefore, have a greater influence on the overall number of points awarded than the other three considered. The overall points values awarded to each state are shown in Table 2.7. The status of the individual laws (and/or their components) in each state, as of October 20, 2008, can also be found on the ENA Web site (www.ena.org) and its scorecard document (*10*).

Overall, only two states (Oregon and Washington) received all 13 of the points awarded by the ENS for their highway safety laws. Another four states earned 11 points and seven states had an overall score of 10. A total of 14 states earned less than half the points possible (i.e., 6 points or less).

Advocates for Highway and Auto Safety Roadmap to State Highway Safety Laws

The Advocates for Highway and Auto Safety (AHAS) releases an annual *Roadmap to State Highway Safety Laws* document (*3*). The primary goal of the AHAS is to make roadways in the United States safer through advocacy for improvements to laws that it believes will save lives and reduce injuries. The intent of the roadmap document is to increase awareness of the current status of highway safety laws. The status of the state highway safety laws in the following subject areas are evaluated by the AHAS:

- Seat belt use
- Motorcycle helmet use
- Booster seat use
- Graduated driver licensing
- Driving while under the influence (DUI/DWI)

The AHAS annually rates a relatively long list of individual highway safety laws in each state. Some of these laws overlap with those rated in the previous two indices, but others do not. For example, the AHAS index considers the status of cell phone restriction laws related to young drivers and also investigates a significant number of alcohol-impaired or alcohol-related driving laws (e.g., open container, child endangerment, etc.). Only two of the latter laws were considered by the IIHS or the ENA.

Table 2.7. 2008 National Scorecard on State Roadway Laws – State Rankings (As of October 20, 2008) (Adapted from *10*)

State	Score
Oregon	13
Washington	13
California	11
Washington, D.C.	11
Maine	11
Tennessee	11
Delaware	10
Georgia	10
Illinois	10
Maryland	10
Massachusetts	10
New Jersey	10
New Mexico	10
Alaska	9
Connecticut	9
Kentucky	9
Michigan	9
Missouri	9
Nebraska	9
New York	9
North Carolina	9
Utah	9
Virginia	9
West Virginia	9
Colorado	8
Hawaii	8
Louisiana	8
Oklahoma	8
Pennsylvania	8
South Carolina	8
Vermont	8
Wisconsin	8
Arizona	7
Indiana	7
Kansas	7
Nevada	7
Texas	7
Alabama	6
Florida	6
Iowa	6
Mississippi	6
Montana	6
New Hampshire	6
Rhode Island	6
Wyoming	6
Idaho	5
Minnesota	5
Ohio	5
North Dakota	4
South Dakota	4
Arkansas	3

The approach followed by the AHAS to rate and/or rank the status of the highway safety laws they considered was also different than that used by the IIHS and the ENA. The primary focus of the AHAS approach was whether or not an individual law in a state met the AHAS definition of "optimal". One credit point was given to a state for a law that met the "optimal" definition and a ½-credit point for booster seat, graduated driver licensing, mandatory BAC testing, and ignition interlock laws that met a portion of the "optimal" law requirements. The 15 laws investigated, the AHAS definition of the "optimal" law, and the specifics about how the credits were assigned are described below (*3*):

- Primary seat belt enforcement law (1 credit)
- Motorcycle helmet use law requiring all riders to wear a helmet that meets all United States Department of Transportation standards (1 credit)
- Booster seat use law that is a requirement for children from 4 to 7 years old (1 credit). Laws that apply to fewer children than 4 to 7 year olds (1/2 credit). No credit provided if booster seat use law is secondary enforcement.
- Graduated driver licensing
  - 6-month (minimum) learner's stage holding period without reduction allowance for driver's education course completion (1 credit)
  - 30 (minimum) to 50 hours of adult supervised driving during learner's stage without reduction allowance for driver's education completion (1 credit)
  - Nighttime unsupervised driving restriction during intermediate stage from at least 10 PM to 5 AM (1 credit). Nighttime restrictions that don't meet these optimal requirements (1/2 credit). No credit is given for secondary enforcement.
  - Maximum of one non-familial teenage passenger with teenage driver without adult supervision in intermediate stage (1 credit). Passenger restrictions that don't meet these optimal requirements (1/2 credit). No credit is given for secondary enforcement.
  - Total cell phone use restriction (except during emergency) for teenage drivers during the entire duration of learner's and intermediate stages (1 credit). If law does not include a ban on text messaging (1/2 credit). No credit is given for secondary enforcement.
- Driving while under the influence
  - Separate offense or enhancement of existing penalty if a minor is endangered (1 credit). No credit is given if law is age specific (e.g., it applies only to drivers under 18 or 21 years of age).
  - Separate more severe offense or enhancement of existing penalty for drivers with BAC of 0.15 or more (1 credit).
  - Mandatory BAC testing for drivers killed and surviving drivers involved in a fatal crash (1 credit). If law only applies to one of these driver groups (1/2 credit).
  - Prohibit possession and consumption of any open alcoholic beverage container in the entire passenger area of a motor vehicle. Law must apply to all vehicle occupants in all vehicles (except passengers of buses, taxi cabs, limousines, or persons in the living quarters of motor homes) on the roadway or the roadway shoulder and allow primary enforcement (1 credit).
  - Repeat offenders (those with previous impaired driving convictions) are required to have a minimum one-year license suspension, vehicle impoundment or

installation of an ignition interlock system, alcohol assessment, and an increasing mandatory minimum sentence based on the number of subsequent offenses (1 credit).
  - A state statute authorizes sobriety checkpoints and a sobriety checkpoint program is implemented to evaluate driver impairment – alcohol and drugs (1 credit).
  - Ignition interlock devices are required for all impaired driving offenders (1 credit). All other ignition interlock laws not meeting this requirement (1/2 credit).

The total number of credits assigned to each state by the AHAS in their 2009 index report is shown in Table 2.8 (*3*). This document and the credits assigned to each state for each of the 15 laws considered can be found on the AHAS Web site (See www.saferoads.org). The laws needed in each state, according to the AHAS, are also noted in their roadmap document (*3*).

The total number of credits assigned to each state, combined with the strength of their seat belt and motorcycle helmet use laws, was also used by the AHAS to assign a color code to the overall status of the highway safety laws in a state. These color codes are shown in Table 2.8 and were applied in the following manner:

- Green - A state has 11 to 15 laws with a primary seat belt enforcement law, or 9 laws with both primary seat belt enforcement law and an all rider motorcycle helmet use law. A state could not be in this category without a primary seat belt enforcement law. AHAS believes that "green" states have significantly advanced toward the adoption of all the "optimal" laws.
- Yellow - A state has 6 to 10 of the laws with a primary seat belt enforcement law or 7 to 13 of the laws without a primary seat belt enforcement law. AHAS believes that "yellow" states are progressing toward adoption of all the "optimal" laws but still have numerous others to enact.
- Red - A state has less than 7 laws without a primary seat belt enforcement law. AHAS believes that "red" states are lacking in their adoption of the "optimal" highway safety laws

Overall, 16 states (and the District of Columbia) were rated "green", 31 states were rated "yellow", and there were only four "red states (See Table 2.8). The individual laws within four highway safety subject areas (i.e., seat belt and motorcycle helmet use, booster seat use, graduated driver licensing, and driving while under the influence) were also color coded for each state. The methodology followed to accomplish this color coding and its results can be found in the 2009 AHAS roadmap document (*3*).

LSIM STATUS

The indices discussed in this chapter (and the one that may be developed as part of this research) need to be based on and appropriately applied to the current status of the transportation safety laws in each state. Each of the organizations that completed the indices described above included a summary of the status of the laws they consider within the index report and/or their Web site. The law status summaries they completed can be found on their Web sites (See www.iihs.org, www.ena.org, and www.saferoads.org). The accuracy of these status summaries, however, depends on the evaluation, conclusions, and description of the original reference completed by each group. In addition, it will also be impacted by the frequency with which these activities are completed. For example, the legislative status descriptions on the IIHS Web site are updated monthly but the other may be updated much less frequently (e.g., annually). Additional legislative status reports can also be found on the Web sites of the National Highway Traffic Safety Administration (http://www.nhtsa.gov/), Governors Highway Safety Association (http://www.ghsa.org/), American Automobile Association (www.aaapublicaffairs.com), and the National Conference of State Legislatures (http://www.ncsl.org/programs/transportation/trafsafdb.htm). The laws related to transportation safety that are summarized on each of these sites vary, however, and a combination of the information they contain should be used for the most accurate description of the enactment and/or repeal of LSIMs.

Table 2.8. 2009 Advocates for Highway and Auto Safety Highway Safety Laws State Rating and Color Coding (*3*)

State	Total Credits	Color Code
Illinois	13	Green
North Carolina	13	Green
Maine	12.5	Green
Delaware	12	Green
New Jersey	11.5	Green
District of Columbia	11	Green
Hawaii	11	Green
Massachusetts	11	Yellow
Tennessee	11	Green
Washington	11	Green
California	10.5	Green
Maryland	10.5	Green
Oregon	10.5	Green
Georgia	10	Yellow
Kentucky	10	Yellow
Louisiana	10	Green
Missouri	10	Yellow
New Mexico	10	Yellow
Oklahoma	10	Yellow
South Carolina	10	Yellow
Montana	9.5	Yellow
Nevada	9.5	Yellow
Utah	9.5	Yellow
Virginia	9.5	Yellow
Alabama	9	Green
Colorado	9	Yellow
Connecticut	9	Yellow
Florida	9	Yellow
Indiana	9	Yellow
Michigan	9	Green
New York	9	Green
Idaho	8.5	Yellow
Nebraska	8.5	Yellow
Alaska	8	Yellow
Kansas	8	Yellow
New Hampshire	8	Yellow
Minnesota	8	Yellow
Pennsylvania	8	Yellow
West Virginia	8	Yellow
Wisconsin	8	Yellow
Arizona	7.5	Yellow
Iowa	7.5	Yellow
Mississippi	7.5	Yellow
Ohio	7.5	Yellow
Rhode Island	7.5	Yellow
Texas	7.5	Yellow
Vermont	7.5	Yellow
Arkansas	6.5	Red
North Dakota	6.5	Red
South Dakota	5	Red
Wyoming	5	Red

CHAPTER SUMMARY AND RSPII FEASIBILITY

Two recently completed LSIM-related summaries were described in this chapter. Both of these documents were completed by a team of researchers with specialized expertise in safety improvement measures designed to influence human behavior. Their review of the literature related to more than 100 behavioral highway safety countermeasure allowed them to identify those they believed had been "proven" effective. Overall, 23 countermeasures (some of which were LSIMs) were categorized as "proven" with "high-quality" research that showed their direct safety impacts (e.g., crash, injury, and/or fatality reductions). Some of these countermeasures meet three of the four critical selection criteria identified in Chapter 1 for their possible inclusion within a RPSII. The information contained in this chapter, therefore, led to the conclusion that a RSPII, in some form, was feasible. The selection of the LSIMs to consider within the RSPII framework will be based on the application of the four previously defined criteria, some guiding principles, a review of their relevant research, and an evaluation of the challenges that may be encountered if they were used. This process is described in the next chapter.

Three existing LSIM-related indices and status summaries were described in this chapter. The indices were developed by the IIHS, ENA, and AHAS. Each of these organizations evaluates and rates the current status of a variety of transportation safety laws within each state. There is some overlap in the LSIMs considered (e.g., primary seat belt laws) by each group, but they each also evaluate laws that are not considered by the others. For example, the IIHS index investigated the status of automated enforcement, the ENA index evaluates a law related to statewide trauma systems, and the AHAS index considers a large number of alcohol impairment laws. All of the indices are either partially or fully based on a point assignment process, but none are directly based on the quantitative safety impacts of the LSIMs evaluated. In addition, none focus on the LSIM safety impacts along rural roadways. This project is considered a response to these two research gaps. The state-by-state ratings of the highway safety laws by two of the indices are shown in Tables 2.7 and 2.8. The content and specificity of the LSIM status information that is provided with these index results and at the other locations identified in this chapter is a critical input to the countermeasures selection process and RSPII framework development described in the next chapter proper of this report.

Chapter 3
Initial and Final Candidate LSIM Selection

Part of the previous chapter included a summary of two recently completed documents focused on the research related to the effectiveness of more than 100 behavioral highway safety countermeasures (*4*, *5*). The information contained in these two documents, combined with the other factors summarized in Chapter 2 and an independent review of the literature by this research team, led to the conclusion that a quantitative RSPII was feasible. This feasibility decision was primarily based on the fact that one or more behavioral highway safety improvement measures (some of which were LSIMs) did exist and had been "proven" effective to result in crash, injury, and/or fatality reductions with well-designed research (*4*, *5*). These are three of the four criteria (see Chapter 1 and below) used to determine if a countermeasure could be included within a RSPII implementation framework. In this chapter the 23 "proven" behavioral highway safety countermeasures previously identified (See Table 2.5 in Chapter 2) will be more closely evaluated and several selected for consideration within a RSPII application framework. The characteristics of each countermeasure will be compared to a series of initial selection criteria and those chosen for further evaluation will then be compared. The countermeasure research results (particularly anything related to rural roadway safety impacts) and any implementation challenges they may introduce will be explored in the final LSIM selection process. The results of these activities are described in this chapter.

INITIAL CANDIDATE LSIM SELECTION

Chapter 1 identified four criteria that were used to guide the literature summary (See Chapter 2) and ultimately help determine the feasibility of a RSPII. These criteria will be used in this chapter to select an initial and final candidate list of LSIMs for further consideration within a RSPII application framework (See Chapter 4) during Phase II of this project. The safety improvement measures relevant to this research project must have the following characteristics:

1. Legislatively-based
2. Related to human behavior or choices,
3. Direct safety impact quantified in an acceptable manner, and
4. Potential impact on rural roadway safety.

The safety improvement measures summarized in Chapter 2 were all focused on driver, vehicle occupant, and/or other road user behavior and/or choices (the second criteria listed above). Many of the measures were also legislatively-based (the first criteria listed above). Twenty-three safety improvement measures were also defined in NCHRP Report 622 as "proven" with "high-quality" research that quantitatively estimated their direct safety impacts (e.g., a reduction in crashes, injuries, and/or fatalities) (*5*). The countermeasures included in this group are listed in Table 3.1 along with their target group and their expected impact on crashes, injuries, and/or fatalities (*5*).

Table 3.1. Potential Safety Impacts, Target Group, and Initial Selection Decision for "Proven" Countermeasures (Adapted from *5*)

"Proven" Countermeasure	Potential Safety Impacts	Specific Target Group Characteristic	Initial Selection Decision[1]
Voluntary			
School pedestrian training for children	-12% in Child Pedestrian Injuries	Child Pedestrians: 6 to 12 Year Olds	Rejected: Not necessarily legislatively-based and small rural safety target group
Booster seat promotions	-59% Injuries for Child in Booster rather than Adult Seat Belt	4 to 8 Year Olds not Traveling in Booster Seats	Rejected: Not necessarily legislatively-based
Laws, Regulation, & Policy			
Bike helmet laws for children	-15% in Child Bicyclist Fatalities	Child Bicyclists Under the Age of 12	Rejected: Small rural safety target group
Comprehensive graduated driver licensing program (see three components below):	-20 to 40% Crashes	16-Year Old Drivers	**Accepted:** Legislatively-based and over-represented in crash fatalities throughout transportation system
a) Extended learner's permit	-22 to 33% Crashes (Minimum Permit Age of 16, and 6 Month Hold Minimum)	16-Year Old Drivers	**Tentatively Accepted:** Component of comprehensive GDL program countermeasure (see above)
b) Night restrictions	-50% Nighttime Crashes (9PM to 6AM)	16-Year Old Drivers at night	**Tentatively Accepted:** Component of comprehensive GDL program countermeasure (see above)
c) Passenger restrictions	-33% Crashes in Which a Teen Passenger Injured or Killed	16-Year Old Drivers with Teen Passengers	**Tentatively Accepted:** Component of comprehensive GDL program countermeasure (see above)
Administrative license revocation	-13 to 15% Alcohol-Related Crashes	Alcohol-Impaired Drivers (BAC $\geq$ 0.08)	**Tentatively Accepted**: Legislatively-based and large rural safety target group, but alternative LSIM with same target group and potential safety impact research focused on fatal/injury crashes (see sobriety checkpoint countermeasure)
Primary seat belt laws	-7 to 8% Fatalities	Unbelted Outboard Front Seat Occupants in Passenger Vehicles (Age 13 and Greater)	**Accepted:** Legislatively-based and large rural safety target group

Motorcycle helmet use laws	-20 to 40% Fatalities	Motorcyclists	**Accepted:** Legislatively-based and large rural safety target group
Reduced speed limit for pedestrians (proven in Europe)	-25 to 30% Pedestrian Fatalities (60 to 50 kph (Approx. 35 to 30 mph) reduction in urban areas)	All Pedestrians in Urban Areas with 60 kph (Approx. 35 mph) Roadway Speed	Rejected: Not necessarily legislatively-based in United States and small rural safety target group
Laws Plus Enhancements			
Sobriety checkpoints	-20% Alcohol-Related Fatal and Injury Crashes	Alcohol-Impaired Drivers (BAC $\geq$ 0.08)	**Tentatively Accepted:** Legislatively-based and large rural safety target group
Short term and high visibility belt law enforcement	-4 to 6% in Seat Belt Use; NHTSA +1% in Usage = 270 lives Saved = -2.52% in 2004 Fatalities (FARS)	Unbelted Outboard Front Seat Occupants in Passenger Vehicles (Age 13 and More)	Rejected: Not necessarily legislatively-based
Automated enforcement for speeding	-20 to 40% Crashes (Non-U.S. research results)	Speed-Related Crashes	**Tentatively Accepted:** Legislatively-based and large rural safety target group
Automated enforcement for red light running	-16% Injury Crashes, -24% Right-Angle Crashes, No Significant Increase in Rear-End Crashes	Red-Light Running Crashes	Rejected: Small rural safety target group
Mass media to support alcohol program enforcement or other programs (top-line programs)	-13% Alcohol-Related Crashes	Alcohol-Impaired Drivers (BAC $\geq$ 0.08)	Rejected: Not necessarily legislatively-based
Community programs including age 21 enforcement of underage driving while under the influence	-10 to 25% in Crashes; Based on -10 to 11% Single Vehicle Nighttime Crashes and -25% Fatal Crashes (Vastly Different Studies but included 21 and Under Enforcement)	Drivers Under 21 Years Old with BAC $\geq$ 0.01	Rejected: Not necessarily legislatively-based
Sanctions and Treatments			
Aggressive driving, speeding penalties (See four measures below):			
a) License suspension	-17% Crashes	Drivers with Previous Speed Convictions Involved in Aggressive Driving-Related Crashes	Rejected: Small rural safety target group and lack of widespread and accepted definition for "aggressive driving" enforcement
b) Individual meetings	-8% Crashes	Drivers with Previous Speed Convictions Involved in Aggressive Driving-Related	Rejected: Small rural safety target group

		Crashes	and lack of widespread and accepted definition for "aggressive driving" enforcement
c) Group meetings	-5% Crashes	Drivers with Previous Speed Convictions Involved in Aggressive Driving-Related Crashes	Rejected: Small rural safety target group and lack of widespread and accepted definition for "aggressive driving" enforcement
d) Warning letters	-4% Crashes	Drivers with Previous Speed Convictions Involved in Aggressive Driving-Related Crashes	Rejected: Small rural safety target group and lack of widespread and accepted definition for "aggressive driving" enforcement
Mandatory attendance at alcohol treatment	-7 to 9% Alcohol-Related Crashes	Drivers with Previous DWI Convictions Involved in Alcohol-Related Crashes (BAC $\geq$ 0.01)	**Tentatively Accepted**: Typically legislatively-based and large rural safety target group, but alternative LSIM with same target group and potential safety impact research focused on fatal/injury crashes (see sobriety checkpoint countermeasure).
Ignition interlock implementation	-37 to 90% Recidivism (Assumed 100% Effectiveness, e.g., Interlocks Result in no More Drunk Driving Crashes for Target Impact Group)	Drivers with Previous DWI Convictions Involved in Alcohol-Related Crashes (BAC $\geq$ 0.01)	**Tentatively Accepted:** Legislatively-based and large rural safety target group, but potential safety impact focused on recidivism and not direct safety measure

[1]Accepted and tentatively accepted "proven" countermeasures are discussed in more detail in the "Final Candidate LSIM Discussion and Selection" section of this chapter.

The initial LSIM selection process started with the 23 “proven” behavioral highway safety countermeasures in Table 3.1 (*4*, *5*). All of the countermeasures in this list generally meet the second and third criteria listed above. The other two criteria, therefore, need to be applied to determine which of them will be accepted for a more detailed evaluation within the final candidate selection process described later in this chapter. First, a decision was made about whether each countermeasure was legislatively-based (the first criteria listed above). Then, potential significance the implementation of each countermeasure could have on rural roadway safety was evaluated. Rural roadway safety data show that the percentage of fatalities related to unbelted vehicle occupants, speeding, and impaired driving are higher along rural roadways than urban roadways (*1*). In addition, fatal crashes related to teenage and older drivers are over-represented throughout the entire transportation system (*4*, *11*). This information was used to identify the “proven” countermeasures in Table 3.1 that might have a more substantial impact on rural roadway safety (i.e., they will have what is expected to be a large rural safety target group).

Each of the 23 “proven” behavioral highway safety countermeasures in Table 3.1 were rejected, accepted, or tentatively accepted based on an application of the criteria listed and described above. The initial selection decision is described in Table 3.1 along with the reasons for the decision. To simplify the implementation of any RSPII that might be developed it was also decided that it was preferable if only one LSIM was selected for a particular target group. In addition, it was also desirable, if alternatives existed, to select those LSIMs with research that focused on fatality or fatal crash reductions. The list of LSIMs that will be considered in more detail within a final candidate selection process (see the next few pages) potentially implemented in a RSPII framework included:

- Comprehensive Graduated Driver Licensing Program (the three components below combined or individually)
  - Extended Learner’s Permit
  - Nighttime Driving Restrictions
  - Passenger Restrictions
- Primary Seat Belt Laws
- Motorcycle Helmet Use Laws
- Alcohol Impairment Measures (one or more of the four below)
  - Sobriety Checkpoints
  - Administrative License Revocation
  - Mandatory Attendance at Alcohol Treatment
  - Alcohol Interlock Implementation
- Automated Speed Enforcement

The brief, but detailed, summary of some of the relevant research related to the potential roadway safety impacts of the accepted and tentatively accepted LSIMs in Table 3.1 is included in the next section of this report. The characteristics of the LSIMs evaluated in the research, the potential target group of their results, and any information that might be available on their potential rural roadway safety impacts are also noted if they were found in the literature by the research project team. In addition, some of the challenges to the use or application of each LSIM within a RSPII framework are also provided. Similar information will continue to be collected in the Phase II implementation stage of this project.

FINAL CANDIDATE LSIM DESCRIPTION AND SELECTION

Eleven LSIMs have been accepted or tentatively accepted for further consideration and potential application within a RSPII framework (See Table 3.1). A detailed summary of each of these LSIMs is provided below. The characteristics of each LSIM are described and the research related to their potential safety impacts (See Table 3.1) is also discussed. Any concerns or challenges that might impede their use or application within a RSPII framework are also noted. All of this information was used by the research team to select the final list of candidate LSIMs that will be included in the Phase II implementation stage of this RSPII project. This list of LSIMs is provided at the end of this chapter.

Graduated Driver Licensing Programs

Young drivers (i.e., those younger than 21 years old) are involved with vehicle crashes at a higher rate than other drivers (*4*, *11*). This increased crash risk is generally due to the inexperience of the young or novice driver. Graduated driver licensing (GDL) programs and/or their components have been established to address this issue. These programs generally establish restrictions on the driving of young or novice drivers so that more experience can be acquired before a full unrestricted driver's license is awarded (*12*, *13*).

The safety impact of a comprehensive GDL program and each of the three individual components they typically include were four of the "proven" LSIMs accepted or tentatively accepted for further consideration within a RSPII application framework (See Table 3.1). NCHRP Report 622 summarizes research that was believed to show the safety impacts of both a complete GDL program (i.e. all three stages) and several of its components (i.e., extended learning permits, night driving restrictions, and passenger restrictions) (*5*). Some of the research related to GDL programs and their components, along with rural safety impact information and implementation challenges, are discussed below.

Comprehensive Program Impacts

In September 2008 the IIHS indicated that 47 of 50 states had a three-stage or comprehensive GDL program (*9*). Based on the work of Shope and Baker, et al., NCHRP Repot 622 estimates that the implementation of these programs can be expected to reduce fatal and injury crashes involving 16-year old drivers by 20 to 40 percent (*14*, *15*). Baker, et al. completed a national review of GDL programs and found reduction impacts that were near the higher end of this range (*14*). They showed that GDL programs with 5 of the 7 program components they considered resulted in a reduction of 16- year old driver fatal crash rates by 38 percent and injury crash rates by 40 percent (*14*). However, Baker, et al., also found a reduction of only 11 percent in the population-based fatal crash involvement rate of 16-year old drivers when all three-stage GDL programs were evaluated (including those that were less successful). Shope, on the other hand, only reviewed the GDL program evaluations that have been completed since 2002 (*15*). She concluded that despite the wide range of study approaches a reduction of 20 to 40 percent in various safety measures (e.g., crashes, crash rates, fatal/injury crashes, etc.) or "crash risk" for young drivers could be expected (*15*). The results of only a few studies that were reviewed were not within this range (*15*). Overall, the impacts of GDL programs on the safety of 16-year old drivers also appear to be larger than 15- to 17-year old drivers (*14*, *15*, *16*, *17*, *18*).

In Chapter 2 the IIHS state traffic law index was summarized. This index includes a review of the GDL programs within the United States and assigns points to each state based on whether their laws include key (or "optimal") GDL program components. Overall, only 30 states (and the District of Columbia) were rated as having "good", 12 as "fair", and 9 as "marginal (*9*). The variability in the number of components and details of the 47 three-stage GDL programs that exist in the United States, therefore, would appear to impact their effectiveness. In fact, a few studies have been completed that attempt to evaluate the safety impacts on young drivers of the various combination of three-stage GDL programs that exist (*14*, *15*, *16*, *17*, *18*). Overall, these studies generally conclude that the programs with more components have greater crash reduction impacts (*14*, *15*, *16*, *17*, *18*). For example, one research study of the GDL programs rated as "good", "fair", and "marginal" by IIHS showed that they reduced 15- to 17-year old driver fatalities by 19, 5, and 1 percent, respectively (*18*).

GDL Program Component Impacts

Desirably, a comprehensive GDL program will have three stages. First, a learning stage will preferably last 6 months. During this stage all driving must be supervised (typically by a parent), and a specific amount of supervised practice may also be defined (e.g., 30 hours). The second, or intermediate, stage of a GDL program then allows unsupervised driving with some restrictions (e.g., number of passengers and driving at night). After the second stage is completed the driver is issued a license with no restrictions. The expected safety impacts of a learner's permit stage and both passenger and night driving restrictions are discussed below.

Extended Learner's Permit Stage The authors of NCHRP Report 622, based on their review of past research, indicated that the implementation of an extended learner's permit stage (with a 16-year old minimum age and 6-month holding period) should be expected to reduce crashes involving 16-year old drivers by 22 to 33 percent (*5*). Our review of the research found that Agent, et al. calculated a 32 and 33 percent reduction in 16-year old driver crash rates per 1,000 licensed drivers and total crashes using three years of data before and after the introduction of a partial GDL program in Kentucky (*19*). The number of injury and fatal crashes involving 16-year old drivers also decreased by approximately 34 and 28 percent (*19*). Agent, et al. concluded that the reduction in crash rate for the 16-year old drivers was primarily related to the very large reduction in crashes the occurred within the first six months of driving (i.e., during the learner's permit stage of the GDL program) (*19*). Ulmer, et al., found a reduction in the fatality and injury crash rate ratio (16-year old drivers to 25- through 54-year old drivers per 10,000 people in the population) of approximately 22 percent between one year before and one year after the implementation of a learner's permit requirement (*20*). In addition, in Nova Scotia, Canada Mayhew, et al. found a reduction of about 29 percent in the crash rates (per 10,000 "novice" drivers) of 16- and 17-year old drivers between two years before and after the implementation of a GDL program (*21*). It was also found that the majority of this reduction (i.e., approximately 72 percent), however, occurred during the first six months after a learner's permit was issued (*21*). The results of these three studies were generally combined in NCHRP Report 622 for its estimate of the safety impact from a learner's permit stage in a GDL program (*5*).

Nighttime and Passenger Driving Restrictions NCHRP Report 622 also references research related to the potential safety impacts of nighttime and passenger driving restrictions during the intermediate stage of a GDL program (*5*). It is concluded, based on a review of a summary completed by Williams, that a nighttime restriction can reduce crashes involving 16-year old drivers during this time period by an average of 50 percent (*5*, *22*). The Williams article included a summary of studies from Florida, Michigan, North Carolina, and Nova Scotia (Canada) (*22*). The average percentage of crash reduction shown in this research due to nighttime driving restriction was approximately 43 percent (*22*). These reductions, however, applied to 16-year old drivers in the three states considered and 16- to 17-year old drivers in Nova Scotia. Based on a review of the Williams research summary the authors of NCHRP Report 622 also concluded that a GDL passenger restriction could be expected to produce a 33 percent reduction in 16-year old driver crashes where a teenage passenger is injured or killed (*22*). However, the passenger restriction example discussed in the Williams article appears to document a 38 percent reduction in 16-year old driver crashes per capita for an incident of this type (*22*). A recent study on the impact of GDL passenger restrictions also showed that they produced a reduction in 16-year old driver crash involvement (*5*, *23*).

Rural and Urban Differences

Very few research projects focused on behavioral LSIMs attempt to differentiate between their rural and urban impacts. Two studies were found that discussed the potential difference a GDL program may have on urban and rural crashes, but it was not the focus of the research documented (*24*, *25*, *26*). A GDL study in Florida estimated that it may have reduced the fatal and injury crash involvement for 15- to 17-year old drivers in urban areas by as much as 12 percent, but only decreased the same type of crashes by 3 percent in rural areas (e.g., a population of less then 2,500) (*25*). The same study also found an overall reduction of 11 percent in the injury and fatal crash rate ratio (16 year old drivers to 25- through 54-year old drivers per 10,000 people in the population) due to the GDL program (*25*). Conversely, a 27 percent reduction in the overall 16-year old driver crash rate per 10,000 people in the population of North Carolina was found after its GDL program was implemented (*26*). In addition, the reduction in the 16-year old driver crash rate per 10,000 people in the population in rural and urban areas was also similar (i.e., about 26 percent) (*26*). It should also be noted that it appears both these evaluations considered the rural and urban location of the crash rather than the location of the 16-year old driver home. In general, the results of these two studies conflict and this appears to indicate this is an area for future research.

Implementation Challenges

There are several challenges that must be overcome if comprehensive GDL programs and/or the three individual GDL program components mentioned above are quantified within a RSPII. The first challenge is related to the ease or difficulty with which the significance or effectiveness of an existing three-stage GDL program (or its individual components) can be determined. Different research results may need to be applied to the various GDL program designs. The variability in the current status of the GDL programs and their components in each state will likely require one or more generalizations to determine the expected safety impacts of changes to these policies. For example, the crash reduction research that focused on the individual GDL components is relatively specific about the characteristics of the components studied (e.g., the introduction of nighttime driving restriction from 10 PM to 5 AM). The laws in many states, however, may not completely match these characteristics. The target group of crashes, injuries, and/or fatalities must also match or be adjusted to those in the research results (e.g., 16-year old driver fatalities or fatal crashes). Finally, the inclusion of both three-stage

GDL programs and individual component impacts in a RSPII is likely to strongly confound its results. The crash, injury, and/or fatality target groups for these measures overlap significantly. In fact, it appears that the sum of the estimated safety impacts from the implementation of the individual components is greater than the expected from the implementation of a three-stage GDL program. The safety impacts of the three-stage GDL program and the three GDL program components considered here are clearly not mutually exclusive. It is decided that only one of these LSIMs, therefore, should be applied within the RSPII framework.

Alcohol Impairment Measures

In 2007 approximately 32 percent of the fatalities from traffic crashes within the United States involved an alcohol-impaired driver (i.e., blood alcohol content (BAC) ≥ 0.08) (*27*). Motor vehicle fatalities, injuries, and crashes can also be defined as alcohol-related or alcohol-involved and include someone that has a BAC ≥ 0.01 (or someone suspected of drinking). The definition for alcohol-related and/or alcohol-involved motor vehicle incidents can sometimes vary in the research and in crash reporting. In each state, however, there is typically a comprehensive set of laws that attempts to reduce the number of intoxicated drivers involved with crashes.

Four "proven" LSIMs (See Table 3.1) related to alcohol impairment were tentatively accepted for a more detailed consideration and possible application within a RSPII framework. These LSIMs included administrative license revocation, sobriety checkpoints, mandatory attendance at alcohol treatment, and ignition interlock implementation. The following discussion describes the research related to the safety impacts of these LSIMs and any challenges that were identified that might impact their application within a RSPII framework. Almost no research was found that attempted to differentiate the rural and urban impacts of these LSIMs, but when it was available it is noted.

Administrative License Revocation

The existence of an administrative license revocation (ALR) law was tentatively accepted for potential application within a RSPII framework. ALR laws allow law enforcement officers to revoke or suspend the license of a driver if he or she fails a BAC test. This action, however, is taken before the driver is actually convicted of a DUI in criminal court. Many states, approximately 41, have ALR laws but they vary in their application.

Several research project summaries that focused on the safety impacts of ALR laws were summarized in NCHRP Report 622 and the Guide (*4*, *5*). In fact, based on the content of these studies it is suggested in NCHRP Report 622 that ALR laws result in a 13 to 15 percent reduction in alcohol-related crashes (*5*). A recent study by Wagenaar and Maldonado-Molina, however, used up to two decades of fatal crash data and found that ALR or pre-conviction suspension laws reduced alcohol-related driver (i.e., a BAC ≥ 0.0) fatal crash involvement by 5 percent (*28*). It was also concluded that the impact was similar for crashes involving drivers above and below the legal impairment level (i.e., a BAC ≥ 0.08). Zador, et al. found a similar reduction in all fatal crashes due to administrative license suspensions (*29*). When combined with other laws the impact of ALR is also larger. For example, Hedlund, et al. reviewed research that showed a reduction in alcohol-related fatal crashes of 30 percent when an ALR policy was combined with other alcohol-related laws (*4*).

Rural and Urban Differences The Zador, et al. study mentioned above also found that administrative license suspensions decreased the fatal crash involvement of all drivers within urban areas twice as much as rural areas (*29*). The involvement of drivers in fatal urban and rural crashes was decreased by 5.2 and 2.5 percent, respectively.

Implementation Challenges A general review of the research that focused on crashes involving alcohol in some manner revealed they evaluated a wide variety of safety data and measures (e.g., different alcohol-involvement definitions, BAC levels, etc.). For example, NHTSA, in past years has published information about crash fatalities that were alcohol-related (i.e., driver, motorcycle operator, pedestrian, or bicyclist with BAC $\geq$ 0.01) and those that were considered alcohol-impaired incidents (i.e., driver or motorcycle operator with BAC $\geq$ 0.08). In fact, the authors of NCHRP Report 622 also indicate that the ALR policies may reduce alcohol-related crashes by 13 to 15 percent, but the target group for this LSIM was the motor vehicle fatalities related to incidents involving alcohol-impaired drivers (See Table 3.1) (*5*). It is suspected that this difference includes the reasonable assumption that the research based on alcohol-related incidents applied equally to both types of crashes. In addition, the population of fatalities connected to alcohol-impairment is a subset of those fatalities defined as alcohol-related (*27*). Therefore, this assumption could be considered conservative in its quantification of potential ALR safety impacts. The definition of an alcohol-impaired versus alcohol-related drivers is also more consistently applied throughout the United States and this makes the identification of the LSIM target group an easier task.

Sobriety Checkpoints

The consideration of sobriety checkpoint impacts within a RSPII framework was also tentatively accepted in the initial LSIM selection process. Sobriety checkpoint laws allow every driver or some sample of drivers to be checked for alcohol impairment at specific locations along a roadway. The Guide includes a reference to a 2004 article by Fell, Lacey, and Voas that includes more detail about sobriety checkpoints (*4*, *30*). In 2007 it was estimated that 40 states and the District of Columbia allowed sobriety checkpoints, but only a few of these jurisdictions did them on a regular basis (4*4*, *31*). A survey in 2000, for example, found that only 11 states completed sobriety checkpoints on a weekly basis (*4*, *30*). It is generally accepted that sobriety checkpoints must be held regularly and be widely advertised to be effective.

The research into the safety impacts of sobriety checkpoints appears to indicate that their effectiveness may vary. The Guide and NCHRP Report 622, however, both focus on the results of a study completed by Center for Disease Control (CDC) and Prevention researchers (*4*, *5*, *32*). This CDC study reviewed the results from 11 "high-quality" selective breath-testing sobriety checkpoint projects (Elder, et al. 2002). It concluded, based on this review, that these activities reduced a combination of all types of alcohol-related crashes by a median value of about 20 percent (*4*, *32*). More specifically, fatal and injury crashes were reduced by about 20 percent and property damage by about 24 percent (*32*). A review of random (versus selective) breath-testing sobriety checkpoints found similar crash reduction results (*32*). A review of 14 high-quality sobriety checkpoint studies by Peek-Asa in 1999, however, showed a wider range for their impacts with an expected decrease of 8 to 71 percent in alcohol-related fatalities (*33*).

Rural and Urban Differences At least two of the random breath-testing sobriety checkpoint studies reviewed by Elder, et al. evaluated sobriety checkpoints within rural areas (*32*). Both of these studies were completed in Australia and evaluated proxies for alcohol-related crashes (i.e., late-night injury crashes and injury crashes during "high alcohol times"). The Elder, et al. article shows that the results of these studies appear to produce conflicting rural results (*32*). No other research was found that considered the rural and urban differences that may exist in the safety impacts of sobriety checkpoints. There is no reason to expect, however, that there would be a difference if the sobriety checkpoints were implemented in a similar manner. In addition, NHTSA has recently released a set of guidelines for the implementation of sobriety checkpoints with low levels of staffing. They have found that these types of checkpoints can be effective (*1, 34*).

Implementation Challenges There are several sobriety implementation challenges that should be considered as this LSIM is considered for application within a RSPII framework. First, it appears that the range of safety improvements that might be expected due to a sobriety checkpoint could be quite large. The range in the impacts within the research, however, may be due to the variety of data considered (e.g., fatal crashes versus property damage crashes) and the design or characteristics of the sobriety checkpoint programs or efforts being evaluated. These differences will need to be considered if the rural safety impacts of sobriety checkpoints are quantified within a RSPII framework. It is also possible that the range in the research results may be the by-product of study reviews grouping, evaluating, and summarizing dissimilar studies. If this grouping is not done correctly the results of a meta-analysis of this type are questionable. Second, the application of the impacts of this measure will need to consider how widespread and/or how often sobriety checkpoints are and could be used in each state. This information, however, may not be readily available. Third, the reality of implementing this type of measure in a rural area (i.e., along roadway segments with low volume) needs to be considered. One of the reasons sobriety checkpoints are not used more often is most likely a lack of funding and personnel. Finally, the assumption that sobriety checkpoints can reduce all severities of alcohol-related crashes, of all severities needs to be more closely evaluated. In addition, the applicability of the research results (i.e., alcohol related crashes) to the target impact group identified in NCHRP Report 622 for this LSIM (i.e., alcohol-impaired crashes) needs to be confirmed (*5*). In this case it appears to be a valid assumption. Alcohol-impaired-driving fatalities are also a subset of alcohol-related incidents, and this approach could also be considered conservative in its quantification of potential sobriety checkpoint safety impacts (*27*). The definition of an alcohol-impaired driver is also consistent throughout the United States.

Mandatory Attendance at Alcohol Treatment

It is generally acknowledged that some drivers arrested for being under the influence (DUI) of alcohol while operating a motor vehicle may have an alcohol abuse problem. The medical community generally believes that alcoholism requires treatment and can not be cured solely through the application of punishment (e.g., revocation of a driver's license, jail time, etc.). In fact, it is generally accepted that treatment, when combined with sanctions, is a more effective approach. Legislation that requires DUI offenders to attend mandatory treatment sessions exists in some states and was defined a "proven" behavioral highway safety countermeasure in NCHRP Report 622 (*5*). This LSIM was tentatively accepted for further consideration and potential inclusion within a RSPII framework.

The Guide notes that at least 42 states require alcohol assessment of some (but not all) DUI offenders (*4*). , However, data related to the use of the various mandatory alcohol treatment programs that exist is not generally available (*4*). Wells-Parker, et al. have reviewed the literature focused on DUI offender alcohol treatment programs (*4*, *35*). They concluded that the implementation of mandatory attendance at alcohol treatment resulted in a 7 to 9 percent average reduction in DUI arrest recidivism (*35*). The studies they reviewed also showed a small positive impact on alcohol-involved crashes, but their evaluation of alcohol-involved fatal crashes was not useful (i.e., it did not meet their minimum analysis criteria). The Wells-Parker, et al. conclusions were used by NCHRP Report 622 to propose that the safety impact of mandatory alcohol treatment programs was a 7 to 9 percent reduction in alcohol-related crashes (involving previously arrested DUI offenders) (*35*). The target group identified in NCHRP Report 622 (See Table 3.1) for this LSIM was the fatalities connected to alcohol-related crashes involving drivers with a previous DUI (*4*).

Rural and Urban Differences No studies were found that attempted to differentiate between the impacts this LSIM might have in rural and urban areas. However, there is no reason to expect that the relative impacts on roadway safety in low and high population areas would be different.

Implementation Challenges There would be several challenges to the application of this LSIM within a RSPII framework. For example, a number of states have some type of mandatory treatment for drivers arrested for DUI, but the applications vary widely from state to state. The existing programs that meet the criteria of those used in the research would need to be identified. In addition, a measure would need to be defined that quantified how often mandatory alcohol treatments were applied within each state. These types of program details, however, do not appear to be readily available. Finally, the assumption that the percent reduction in DUI arrest recidivism (due to mandatory alcohol treatment) will produce a similar reduction in alcohol-related crashes or fatalities (with previously arrested DUI offenders) should be closely considered. Not only can a second arrest occur without a reported crash occurring, but a crash or fatality could occur without an arrest. The impact of these types of incidents is expected to be small, but they should be acknowledged. A better understanding of the impact this LSIM may have on fatal alcohol-related crashes (with previously arrested DUI offenders) is also necessary.

Ignition Interlock Implementation

Alcohol ignition interlocks are devices that do not allow a vehicle to start if a driver has a blood-alcohol content (BAC) above a pre-set level (typically 0.02). These devices are often used as part of a probation agreement with a DUI offender. They are designed to ensure that an offender does not drive intoxicated during the time period they are in place. The consideration of these devices within a RSPII framework was tentatively accepted in the initial selection process.

In 2007, 45 states and the District of Columbia allowed the use of ignition interlocks on some (but not all) DUI offenders (*4*, *36*). The Guide also indicated that Marques concluded about 100,000 ignition interlocks were being used within the United States in 2006, but that this only represented about 10 percent of the "eligible offenders" (*4*). These devices, of course, are also only effective while they are in the vehicles of DUI offenders (*4*). A study by Beck, et al., for example, showed that recidivism for drivers with multiple alcohol-related offenses was almost 65 percent lower (in comparison to a control group) for the year the ignition interlock was in place. However, when the device was removed in the second year the recidivism rates for the two groups were statistically the same (*37*, *38*).

There have been several studies that either summarize or evaluate the use, effectiveness, and implementation of alcohol ignition interlock programs (*4*, *5*, *38*, *39*). NCHRP Report 622 summarized some of these studies and proposed that DUI recidivism was reduced by between 37 and 90 percent when ignition interlocks were implemented (*4*, *38*, *39*). Beirness and Marques, for example, reviewed 10 studies that showed recidivism with an ignition interlock in place was about 50 percent of that experienced by drivers that did not use one (*4*, *38*). The target group proposed for this LSIM in NCHRP Report 622 was the fatalities connected to alcohol-related crashes involving drivers with a previous DUI (*4*). The impact calculations used in NCHRP Report 622 also assumed that the expected reduction in recidivism due to an ignition interlock would result in a similar reduction in the target group of alcohol-related fatal crashes (*4*). No studies, however, were found that quantified this 1:1 relationship or its applicability in the short-term (i.e., while the ignition interlock is in place) or long-term.

Rural and Urban Differences No studies were found that attempted to differentiate between the impacts this LSIM might have in rural and urban areas. However, there is no reason to expect that the relative impacts on roadway safety in low and high population areas would be different.

Implementation Challenges One of the challenges related to the application of this LSIM within the RSPII framework include the need to determine how often ignition interlocks were used in each state. Most states allow the use of ignition interlocks, but they are not applied consistently. A measure and/or a set of criteria would need to be developed to identify those states that would benefit from a more significant implementation of an ignition interlock program. Desirably, the states identified would be similar to those evaluated in the research. The short-term impact of ignition interlocks should also considered closely if this LSIM is applied within the RSPII framework. In addition, the assumption that a reduction in short-term recidivism is matched by a similar reduction in alcohol-related crash fatalities (for drivers with a previous DUI) needs to be better understood. It is likely that this 1:1 relationship is not completely possible in either the short-term or the long-term.

Primary Seat Belt Laws

It is generally accepted that an increase in the use of seat belts reduces motor vehicle crash fatalities. In fact, NHTSA has indicated that the use of seat belts is associated with about a 45 percent reduction in passenger car front seat crash fatal injuries (*8*, *40*). Therefore, the expected safety impact of primary seat belt law upgrades was accepted during the initial selection process (See Table 3.1) for further consideration within a RSPII framework.

Every state, except New Hampshire, has some type of law requiring the use of seat belts. These laws can apply to all the occupants in a motor vehicle or just those in the front seat. They also vary by how infractions can be enforced. Primary enforcement seat belt laws (sometimes called standard enforcement laws) allow drivers to be stopped and cited solely for a seat belt use violation. Secondary enforcement seat belt laws, on the other hand, only allow citations to be issued for a seat belt use violation if a driver is stopped for another offense.

Research has shown that overall seat belt usage and motor vehicle fatality reductions are greater for primary rather than secondary enforcement laws. This research is supported by the data annually released by NHTSA and described in NCHRP Report 601 "The Impact of Legislation, Enforcement, and Sanctions on Safety Belt Use" (*8*). In 2005, for example, the seat belt use rate for states with a primary enforcement laws averaged about 87 percent, but states with secondary enforcement laws had an average usage rate of only 73 percent (*40*). The research team for NCHRP Report 601 also considered recent upgrades of seat belt laws from secondary to primary enforcement and, based on the data available, found an average increase of 9.7 percent in seat belt usage (if known) by vehicle occupants killed in crashes (*8*). They also estimated that this increase in seat belt use would result in four to five percent fewer fatalities and six percent fewer moderate-to-serious injuries (*8*). Three other studies, however, found that this type of seat belt law upgrade resulted in a seven percent reduction in *passenger vehicle driver* deaths, an eight percent reduction in *passenger vehicle front seat occupant* deaths (see NCHRP Report 601), and a 13.4 percent in *motor vehicle occupant* deaths, respectively (*8*, *41*, *42*). Shults, et al. also reviewed 13 seat belt law upgrades from secondary to primary enforcement and found that five of the studies indicated a median decrease in overall crash fatalities that was eight percent greater in states with primary seat belt laws (*4*, *43*). A seven to eight percent reduction in fatalities (See Table 3.1) has been proposed in NCHRP Report 622 to estimate the safety impact of a secondary to primary enforcement change in seat belt legislation (*4*, *5*, *8*, *41*).

The effectiveness of seat belts has probably been studied more than any of the LSIMs in Table 3.1. In fact, NHTSA regularly releases a summary of the lives saved due to the use of restraints in the United States. NCHRP Report 601 discusses the seat belt usage among persons in potentially fatal crashes, or UPFC that can be used to calculate the number of lives saved or deaths avoided due to upgrades in seat belt enforcement (*8*). The UPFC is a measure of the seat belt usage by a hypothetical population of passengers who were saved by using a seat belt and those belted and unbelted passengers who died in a motor vehicle crash (*8*). NHTSA has also developed the BELTUSE software to, among other things, automate the calculation of the number of lives saved or deaths avoided due to a seat belt law change from secondary to a primary enforcement (*8*, *44*). In fact, the inputs to the BELTUSE software can be changed to specifically estimate the fatalities avoided along rural roadways due to seat belt law enforcement upgrade. In other words, the lower seat belt usage rates along rural roadways can be taken into account.

Rural and Urban Differences

Earlier in this report it was noted that the seat belt usage rate for motor vehicle occupants killed in rural roadway crashes was lower than that found in urban areas. Seat belt usage survey results also generally support this finding. NCHRP Report 601 also indicated that secondary to primary enforcement seat belt law upgrades "frequently" appear to impact "high-risk" groups (e.g., rural motorists) as much or more than "lower-risk" groups (*8*). Rural motorists are considered "high-risk" because of their lower seat belt usage rates (*8*). The overall fatality reduction impacts of seat belt law upgrades, therefore, may actually be a conservative estimate for its impact in rural areas. However, no research was found that specifically attempted to calculate the difference in the rural and urban impacts of a seat belt law enforcement upgrade.

Implementation Challenges

There are currently 23 states with secondary enforcement seat belt laws. In addition, New Hampshire has no requirement for the use of seat belts. The research that has quantified the potential safety impact (See Table 3.1) of seat belt enforcement upgrades, however, has not generally differentiated between the application details of the secondary or primary laws. In others words, the expected safety impacts are the same for secondary to primary seat belt enforcement upgrades whether it applies to all passengers or just those in the front seat. The treatment of New Hampshire, the only state that has neither a secondary nor primary enforcement seat belt law, must also be considered. The potential reduction in fatalities due to the introduction of a primary seat belt enforcement law in a state with no previous seat belt usage law could be larger than those that do. The impact of these differences should be considered in the application of this LSIM within the proposed RSPII framework.

Motorcycle Helmet Use Law

In 1975 universal helmet use laws for motorcycle riders existed within 47 states and the District of Columbia (*4*). This law requires all motorcycle users to wear approved helmets and, because it encompasses all riders, it is considered the easiest to enforce. Since 1975, however, a large number of states have completely repealed and/or weakened their helmet laws. In 2007, only 20 states and the District of Columbia had universal helmet laws. However, all but three states (i.e., Illinois, Iowa, and New Hampshire) had motorcycle helmet laws that applied to specific motorcycle riders (e.g., 18 to 21 year olds). These changes in motorcycle helmet use laws have typically led to a decrease in observed helmet use and increases in motorcycle crash injuries and fatalities. More specifically, the helmet usage rates observed in states that have repealed their universal helmet use law often decreased from 80 to 90 percent (or more) to about 50 to 60 percent (*4, 45*). In 2006, for example, a study by Glassbrenner and Ye found that motorcycle helmet use in states with universal laws was approximately 83 percent (*4*, *46*). It was only about 50 percent in states with no law or a law that applied only to younger riders (*4*, *46*). The change in usage appeared to only be related to whether a universal helmet law was in place or not.

During the initial LSIM selection process the safety impacts due to changes in motorcycle helmet laws was accepted for further consideration within a RSPII application framework. The research on this subject has generally shown that the universal use of motorcycle helmets effectively reduces rider fatalities and injuries. The potential safety impact for motorcycle helmet use law upgrades that is shown in Table 3.1 is from a United States General Accounting Office (GA0) review of 46 "methodologically sound" studies (*47*). The GAO review considered 20 studies that compared motorcycle rider fatality rates during time periods with universal helmet use laws to those before a law was enacted or after it was repealed. A "great majority" of the motorcycle rider fatality rates were 20 to 40 percent (See Table 3.1) lower during the time periods with the universal helmet use law than those without it. Seven of the 20 studies compared fatalities in states with and without universal helmet use laws and found that they were 12 to 28 percent (with most reductions greater than 20 percent) lower in the state without this type of law (*47*). Thirteen studies used crash data to compare the motorcyclist fatality rates per 10,000 registered motorcycles during time periods with and without a universal helmet law. The fatality rates calculated were12 to 62 percent lower during the time periods with the law (*47*). A similar comparison of fatalities per 100 motorcycle crashes within 5 of these 13 studies also showed rates that were 4 to 41 percent lower during the time periods with universal helmet use laws (*47*). Studies completed since the GAO report according to the Guide, also show that helmets can reduce motorcycle rider fatalities by 22 to 37 percent and brain injuries by 41 to 65 percent (*4*). A NHTSA study by Deutermann in 2004, for example, found that helmets were 37 percent effective at preventing motorcycle crash fatalities (*4*, *48*).

Rural and Urban Differences

No studies were found that attempted to differentiate between the impacts this LSIM might have in rural and urban areas. However, there is no reason to expect that the effectiveness of motorcycle helmets would be different in low and high population areas. The helmet usage rates in rural areas, on the other hand, may be different than those in urban areas (or those observed in past studies) before and after the enactment of a universal helmet law. Literature on this particular subject will continue to be pursued during Phase II of this project.

Implementation Challenges

There will be a few challenges related to the consideration of this LSIM within the RSPII application framework. These challenges are somewhat similar to those identified for the upgrade in seat belt enforcement. For example, the impact and effectiveness of this LSIM has been studied extensively and NHTSA has also released its methodology to calculate the lives saved by motorcycle helmets (which is similar to lives saved calculation for seat belts). However, there are also various types of motorcycle helmet laws in existence and the impact of implementing a universal helmet law within a state with no helmet law may be different than an upgrade in a state with a law that only applies to a particular portion of motorcycle riders (e.g., 18 to 21 year olds). A generalization in the application of the RSPII framework may be necessary in this case to apply the potential safety impact of a universal helmet law (See Table 3.1) to any state that does not have one. Fortunately, the research that is currently available indicates that this approach may be appropriate. Overall, the challenges related to the implementation of this LSIM within the RSPII framework appear to be minimal.

Automated Speed Enforcement

During the initial LSIM selection process the safety impacts connected to automated speed enforcement were tentatively accepted for further consideration within a RSPII application framework. Vehicle speed or speed choice (i.e., exceeding the posted speed limit or driving too fast for conditions) is a contributing factor in a majority of rural roadway crashes. In fact, 57 percent of the drivers involved in fatal rural crashes in 2006 were in rural areas (*1*). It is also generally accepted that vehicle speed increases also result in increased injury severities (*49*). Certain types of crashes (e.g., single-vehicle run-off-the-road) can also increase with speed. In addition, as the speed of an individual vehicle deviates from the average traffic flow speed along a roadway the probability of a crash increases (*49*). Overall, these relationships are also generally more important along high-speed undivided rural roadways.

In the United States one relatively recent response to the safety concerns related to vehicle speed is the introduction of automated enforcement. Camera and detection technologies are available that monitor and photograph vehicles traveling at speeds above a pre-specified threshold (e.g., “X” miles per hour above the posted speed limit). This type of automated enforcement has been used extensively throughout Europe, but has only been applied in 40 to 50, mostly local, jurisdictions within the United States (*50*). The automated speed enforcement that is used in the United States is also often restricted to particular situations (e.g., work zones, school zones, residential areas, etc.). In September 2008 the IIHS indicated that only the state of Arizona was using automated enforcement speed cameras along regularly operating state roadways. Illinois, on the other hand, uses them within their work zones statewide (*50*).

A number of automated speed enforcement research studies have shown its potential for speed reduction and/or safety improvement (*51*, *52*). For example, an IIHS study showed that six months after the implementation of mobile speed cameras within the District of Columbia the average vehicle speed was reduced by about 14 percent (*51*). In addition, the number of vehicles traveling more than 10 miles per hour over the posted speed limit decreased by 82 percent (*51*). NCHRP Report 622 also referenced the results of a review of 14 research studies that focused on speed camera programs in Australia, Canada, New Zealand, Norway, and the United Kingdom (*5*, *52*). Based on this review, the authors of NCHRP Report 622 propose that, on average, automated speed enforcement cameras reduce speed-related crashes (including speed-related crash fatalities) by 20 to 40 percent (*52*). More specifically, Pilkington and Kinra indicate that the studies they reviewed found a 5 to 69 percent reduction in crashes within the immediate vicinity of camera sites, a decrease in injuries of 12 to 65 percent, and a 17 to 71 percent decrease in fatalities (*52*). They also concluded that their review found consistently positive evidence that the implementation of automated speed enforcement improved safety, but that better data would improve the type of evaluation they had completed (*52*).

Two jurisdictions with different types of automated speed enforcement programs have also completed evaluations of their systems. Scottsdale, Arizona conducted a 9 month pilot study of its automated enforcement cameras along an 8-mile segment of high-speed (i.e., 65 mile per hour (mph) posted speed limit) urban freeway. It was shown that the proportion of drivers traveling along this segment at more than 75 mph declined from 15 percent to about 1 or 2 percent (*53*). However, this percentage of excessive speeders almost returned to its original level (i.e., 12 percent) when the system was discontinued (*53*). Similar, but smaller, impacts on speed were also found at a comparable site about 25 miles away (*53*). This was considered to be a desirable “halo effect” or “spillover” of the automated speed enforcement trial (*53*). Safety improvements due to an automated speed enforcement system were also found by Perez, et al. along an urban freeway beltway around Barcelona, Spain (*54*).

Urban and Rural Differences

Many of the studies described above evaluated automated speed enforcement within urban areas. Very little information was found about the potential impact of automated speed enforcement efforts in rural areas. Wilson, et al. did examine 26 international studies that focused on a wide range of speed enforcement detection devices (*55*). Twenty-one of these studies evaluated the safety impact of these devices and found reductions of 14 to 72 percent in all crashes, 8 to 46 percent in injury crashes, and 40 to 45 percent in fatality and serious injury crashes within the immediate vicinity of the automated enforcement cameras (*55*). Five of the studies Wilson reviewed, however, also appeared to focus on rural area automated speed enforcement implementation and seven studies evaluated similar activities in rural and/or semi-rural areas (*55*). The studies completed for the rural area installations found a 20 to 71 percent reduction in crashes due to the implementation of automated speed enforcement (Wilson). In addition, eight of these 12 studies found injury crash reductions of 14 to 34 percent after the implementation of automated speed enforcement cameras (*55*). The two studies that estimated or modeled crash fatality reductions due to automated speed enforcement found a decrease of 13 and 17 percent (*55*). Overall, there was a significant amount of variability in the studies reviewed by Wilson, et al. and the results noted above need to be used with caution (*55*).

Implementation Challenges

There are several factors that will need to be considered if the automated speed enforcement LSIM is chosen for application within a RSPII framework. The implementation of this type of technology in the United States is relatively untested, but the research results from other countries are promising. In addition, the technology has been implemented along some high-speed roadways in the United States, but its application and potential safety impacts along typical rural two-lane highways has not occurred and/or been documented. The validity and/or cost effectiveness of this type of LSIM along these types of rural roadways must be addressed if it is applied within the RSPII framework. For example, the cost of these systems may generally require roadways with significant roadway volumes and/or the ability to easily move them from one rural location to another. Any traffic volume implementation requirements that are placed on the application of automated speed enforcement equipment, however, will limit the rural roadways eligible for this LSIM (e.g., four-lane segments near urban areas). In addition, the need to move the speed cameras from one location to another would likely limit the potential safety impacts of these technologies to the short-term. Therefore, although there is no reason to expect that the effectiveness of the speed camera technology will change in rural areas, an estimate of the safety impacts of these devices along rural roadways within the RSPII framework may still require some adjustment to the mostly urban results of the current research.

LSIM CANDIDATE SELECTION CONCLUSIONS

The 23 behavioral highway safety improvement measures that were considered for inclusion and potential implementation within a RSPII framework are listed in Table 3.1. An initial selection process, based on the application of the four selection criteria identified in Chapter 1, resulted in the "acceptance" or "tentative acceptance" of 11 LSIMs from this list. Each of these LSIMs was then evaluated more closely during a final candidate selection process. The research related to their safety impacts was summarized and, if available, any differences in their urban and rural influence noted. In addition, any challenges that might need to be overcome during their application within a RSPII framework were identified.

The results of the process described above (and in this chapter) confirmed that the three LSIMs "accepted" during the initial selection process should be applied within the RSPII framework proposed in the next chapter and implemented in Phase II of this project. These three LSIMs included:

- Comprehensive Graduated Driver Licensing Program
- Primary Seat Belt Laws
- Motorcycle Helmet Use Laws

The LSIMs that were "tentatively accepted" during the initial LSIM selection process, on the other hand, included:

- Graduated Driver Licensing Program Components
  - Extended Learner's Permit
  - Night Restrictions
  - Passenger Restrictions
- Alcohol Impairment Measures
  - Administrative License Revocation
  - Sobriety Checkpoints
  - Mandatory Attendance at Alcohol Treatment
  - Ignition Interlock Implementation
- Automated Speed Enforcement

Based on the information in this chapter the research team selected three of the "tentatively accepted" LSIMs listed above for application within a RSPII framework during Phase II of this project. The three individual graduated drivers licensing program components listed above were not selected. The impacts of the implementation of a comprehensive or three-stage GDL program has already been chosen for consideration and the research on the safety impacts of this LSIM appeared to be more comprehensive than that completed for the individual GDL program components. There is also research available that considers the safety impacts of comprehensive or three-stage GDL programs that contain different numbers of components (including the IIHS ratings previously noted). The variability in the designs of three-stage GDL programs will likely require the use of this type of research and the definition of some general program application categories based on the components they contain.

During the final selection process it was also decided that at least one LSIM related to seat belt use, speeding, and alcohol impairment (despite some expected challenges with their application) should be chosen for application within a RSPII framework. The safety impact of a primary seat belt law has already been accepted for further consideration and automated speed enforcement (i.e., speed cameras) is the only LSIM focused on speeding. Both will be considered during Phase II of this project.

There were four LSIMs related to alcohol impairment that were initially selected. The implementation of any one of these four within a RPSII framework will present some challenges. The sobriety checkpoint LSIM has had research that evaluated its impact on alcohol-related injury and fatality crashes (*5*). In addition, NHTSA believes that sobriety checkpoints with low-level staffing area can be effective (*34*). Therefore, it is proposed that sobriety checkpoints be considered within a RSPII framework during Phase II of this project. The high level of variability in the application and effectiveness of the mandatory alcohol treatment LSIM, on the other hand, led to the conclusion that it would not be applied during Phase II. For some of the same reasons a similar conclusion was reached with respect to the ALR LSIM. The potential impact on alcohol-related fatal crashes of this LSIM was also somewhat smaller than those expected from the selected sobriety checkpoints. Finally, the ignition interlock LSIM is implemented after an alcohol-related driving conviction has occurred. The target group of this LSIM, therefore, is somewhat different than that defined for sobriety checkpoints. The ignition interlock implementation LSIM, therefore, was selected for further consideration within the RSPII framework during Phase II of this project. The fact that the research results for this LSIM are focused on recidivism rather than crashes, injuries, or fatalities will be one of the challenges that need to be overcome during its application within a RSPII framework.

Overall, six LSIMs were selected for quantification within a RSPII framework during Phase II of this project. These six LSIMs included the following:

- Comprehensive Graduated Driver Licensing Program
- Primary Seat Belt Laws
- Motorcycle Helmet Use Laws
- Sobriety Checkpoints
- Ignition Interlock Implementation
- Automated Speed Enforcement

The application of these LSIMs within the RSPII framework proposed in Chapter 4 will need to overcome various challenges. Some of these challenges are discussed in this chapter and the next. Others challenges will also likely be discovered during the Phase II implementation activities. Alternatively, the limitations these challenges place on the results will need to be explained. Each of the LSIMs selected in this chapter will need to be applied in the most appropriate and detailed manner possible within the constraints of this project. However, the quantification of the LSIM impacts should be guided by the characteristics of the research subjects and results (along with any application criteria defined by the project team). All this information will be used to define the type of safety impact an LSIM may have and help identify the states that will benefit the most from its implementation (i.e., which states have applicable "before" status). However, the variability of the LSIM legislation in the United States will likely require some generalizations during the application of the RSPII framework. The impact of these generalizations on the results of the RSPII framework should be documented. Finally, the overlap in the expected safety impacts and target groups of the selected LSIMs should also be considered closely and taken into account when the RSPII framework results are presented.

Chapter 4
Proposed RSPII Framework and Pilot Application

In the last chapter six LSIMs were identified for further consideration in Phase II of this project. It is proposed that the potential safety impacts due to the implementation of these be calculated within a RSPII framework. Several challenges that would need to be overcome to complete this task were also identified. The steps proposed for the RSPII implementation framework are described in this chapter. These are the general tasks that will need to be completed for a state-by-state rural safety quantification of the LSIMs selected. The details of how they are completed will vary by LSIM and will be described in the Phase II report for this project. A pilot application of the proposed RSPII framework, however, is described in this chapter. A similar, but likely more detailed, step by step description will be completed for all six LSIMs in Phase II of this project.

PROPOSED RSPII FRAMEWORK

The proposed RSPII framework for a state-by-state rural safety impact quantification of LSIMs includes six steps. The objective of this framework is to guide the completion of this type of quantification for each of the LSIMs selected in Chapter 3. The six steps proposed for the RSPII framework are shown in Figure 4.1 and described below.

Step 1: Define Potential Safety Impact

The first step proposed for the RSPII framework is the definition of the magnitude and type (e.g., injuries, fatalities, etc.) of the safety impacts expected due to the implementation of each LSIM. These potential or expected impacts will be based on the research results discussed in the previous chapters of this report. The focus of this research, however, is fatalities and/or fatal crashes. Therefore, in some cases, the research results related to the safety impact of some LSIMs (e.g., overall crash reduction) may need to be adjusted to estimate this type of impact. The research results related to the implementation of ignition interlocks, for example, focuses on its expected reduction in previously convicted drunk-drivers being rearrested (i.e., recidivism). If at all possible, for this research, a method would need to be developed to convert this type of impact into a potential reduction in rural crash fatalities. The approaches used to make this type of conversion would vary by LSIM. Finally, it should also be noted that most of the research focused on LSIMs does not specifically differentiate between their rural and urban safety impacts. However, this also means that in most cases there is generally no evidence that the effectiveness of the LSIMs would be different in rural and urban areas. The typical assumption in the application of the RSPII framework, therefore, will be that the LSIM safety impacts in the research apply to both rural and urban areas. In some cases it is expected that this may be a conservative assumption.

Step 2: Determine Applicable Target Group

The second step proposed for the RSPII framework is determination of the applicable target group of fatalities, injuries, and/or crashes to which the expected safety impacts from step one should be applied. The target groups proposed by NCHRP Report 622 for the six LSIMs selected are noted and discussed in Chapter 3 (*5*).

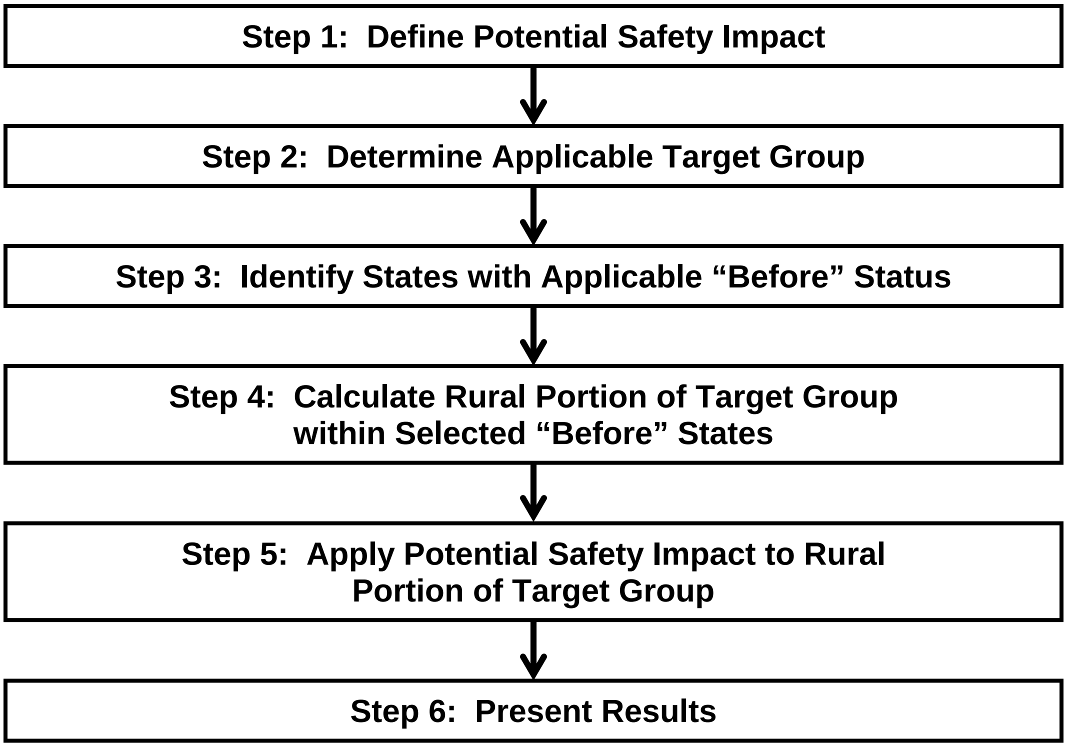

FIGURE 4.1. Proposed RSPII framework.

During this step the appropriateness and applicability of these target groups will be evaluated by reviewing the research and the data readily available to implement the framework. The target group identified in Chapter 3 for each LSIM retained and/or adjusted based on the results of this evaluation. In addition, the target groups currently proposed in Chapter 3 sometimes overlap. In other words, more than one LSIM may influence the occurrence of the same crash because these incidents have ore than one contributing factor noted in their crash report. (e.g., a fatal crash report may indicate that an unbelted 16-year old driver that was speeding). The objective should be to minimize the overlap between the target groups identified and/or present the results from the individual LSIM application of the RSPII framework in a manner that takes it into account. In most cases, however, the overlap in the LSIM target groups cannot be completely removed.

Step 3: Identify States with Applicable "Before" Status

The third step proposed for the RSPII framework is the identification of the states that would be expected to benefit from the LSIM implementation. Desirably, this step would be completed by comparing the criteria used to define the "before" status of the LSIM evaluated in the safety impact research (See Step 1) to the current status of the appropriate LSIM in each state. In most cases, however, a match between these two is not possible because of the research documentation available, the analysis methods applied, and variability in the existing LSIMs. A generalization in the research criteria, for RSPII framework application purpose, is necessary.

Chapter 2 identified several organizations and Web sites that track and describe the status of LSIMs on a state-by-state basis. The definition of the criteria used to rate LSIMs in three existing indices was also noted. All of this information will be used to define the existing LSIM characteristics or criteria (if any related legislation exists at all) that need to exist within each state to give it an applicable "before" status and the potential to benefit from the implementation of the LSIM being considered. The criteria used will vary by LSIM and be clearly described in the Phase II report of this project. If necessary, a sensitivity analysis may also be completed that shows the potential impacts on the RSPII framework results if the criteria defining the applicable "before" status of an LSIM is changed. This type of analysis could also be applied to take into account the variability in past research results and the fact that they did not typically address the potential impacts of enforcement, training, budgets, etc. on these results.

Step 4: Calculate Rural Portion of Target Group within Selected "Before" States

The fourth step proposed for the RSPII framework is the calculation of the rural portion of the target group fatalities, injuries, and/or crashes defined in Step 2 for the "before" states selected in Step 3. The focus of this research is rural roadway motor vehicle crash fatalities and the primary tool that will be used to determine the size of this target group in the "before states will be the National Highway Traffic Safety Administration (NHTSA) Fatality Analysis Reporting System (FARS). This is the only national crash database not based on a sampling process, and it includes the characteristics of motor vehicle crashes throughout the United States that have resulted in a fatality. One of the characteristics included in FARS (if identified on the crash report) is whether a crash occurred along a rural or urban roadway functional class. The data in FARS about this crash characteristic will be used to define the rural fatality portion of the target groups defined in Step 3 for the states identified in Step 3. If the research results defining the safety impact of a LSIM are not focused on motor vehicle fatalities another resource will need to be used for conversion purposes.

Step 5: Apply Potential Safety Impact to Rural Portion of the Target Group

The fifth step proposed for the RSPII framework is the application of the potential safety impact(s) defined in Step 1 to the rural portion of the target group (See Steps 2 and 4) in the applicable "before" states (See Step 3). The information needed to complete this task is a combination of the results from the previous. The output of this step is the rural roadway fatality reductions that can be expected due to the implementation of a particular LSIM within the appropriate individual states and nationally. The presentation of these results occurs in Step 6 of the RSPII framework.

Step 6: Present Results

The sixth and final step proposed for the RSPII framework is the presentation of the results from the previous five steps. As previously mentioned, the focus of this research is rural roadway fatalities. Various safety measures can be used to present these types of results. Of course, the overall magnitude of the expected fatality reduction due to LSIM implementation can and will be documented. However, other types of safety measures might also be appropriate. Some of these measures could include a calculation of rural fatalities reduced per vehicle-miles-traveled or per capita. As indicated previously, the results of a sensitivity analysis may also be appropriate to take into account the variability in the research results. The impact on the results of changing the expected safety impact of a LSIM or its applicable "before" states, for example, might be presented. The impact on the framework results of using different decision-making or approaches during the completion of the five previous steps will be presented.

PILOT APPLICATION OF PROPOSED RSPII FRAMEWORK

During Phase 2 of this project the rural roadway safety impacts of all six of the LSIMs selected in Chapter 3 will be estimated through the application of the RSPII framework described above. A pilot application for one of these LSIMs within the proposed RSPII framework is described below. A more detailed application will occur in Phase II. The focus of this pilot application is the state-by-state estimation of the expected rural roadway safety impacts due to the implementation of a primary enforcement seat belt law. This LSIM has been the focus of many research projects and for this pilot application its impacts will be estimated through two methods. First, the NHTSA BELTUSE software package will be used to calculate the deaths avoided due to the enactment of a primary enforcement seat belt law. The software can estimate the reduction in motor vehicle crash fatalities if it is provided with the expected change in seat belt use (among occupants killed in motor vehicle crashes) due to the upgrade to a primary seat belt enforcement law. This type of software is not available for any of the other LSIMs selected for consideration. The second method that will be used to calculate the rural roadway safety impacts of a primary enforcement seat belt law is generally the approach suggested in NCHRP Report 622 (*5*). The potential safety impact and target group (See Table 3.1) proposed for this LSIM in that document will be applied. A similar approach, with various adjustments, will be used for all six LSIMs in Phase II of this project. The results of the RSPII framework pilot application are described below.

Step 1: Define Potential Safety Impact

As indicated, this pilot application will use two methods to quantify the change in rural roadway safety due to the introduction of a primary seat belt law. The potential safety impact used as input to these two methods is different. The potential safety impact proposed in NCHRP Report 622 for this LSIM is based on the results of research focused on seat belt legislation upgrades. It is estimated that an upgrade to a primary enforcement seat belt law may result in a 7 to 8 percent reduction in fatalities (See Table 3.1) (*5*). The BELTUSE software, on the other hand, estimates the passenger vehicle crash fatalities that could be avoided due to a seat belt enforcement upgrade. One of the measures the software can use to complete this estimate is the change in seat belt usage of occupants killed in crashes. NCHRP Report 601 concluded that more recent seat belt law upgrades have resulted in an average increase of 9.7 percent in seat belt usage (if known) by vehicle occupants killed in a crash (*8*).

Step 2: Determine Applicable Target Group

The applicable target groups defined for the two methods used in this pilot application were different. The focus of research results on this subject also varies somewhat (e.g., seat belt usage in passenger cars, change in driver fatalities, etc.). First, the target group proposed by NCHRP Report 622 for this LSIM is very specifically defined as those fatalities related to unbelted outboard front seat passenger vehicle occupants that are 13 years old or older (*5*). This target group was used in this pilot application, but without the outboard restriction. It may be altered for this LSIM during the more detailed Phase II application of the RSPII framework. The target group and the potential safety impact from Step 1 should be related and the 7 to 8 percent reduction in fatalities noted in the previous step may be more appropriately applied to a target group that includes all fatalities. A target group restricted to seating position, belt use, and passenger age may be more conservative than necessary. A more detailed evaluation of this target group will be completed in Phase II. The NHTSA BELTUSE software, on the other hand, uses the total number of passenger vehicle fatalities and seat belt usage, disaggregated by vehicle type and seating position, as input to estimate the fatalities avoided due to an upgrade in seat belt enforcement legislation.

Step 3: Identify States with Applicable "Before" Status

The third step in the proposed RSPII framework is to identify the states that are expected to experience most of the safety improvements related to the introduction of a primary enforcement seat belt law. The criteria used to define these states should be based on the research as much as possible. In this case, it was decided that the states with an applicable "before" status were those without a primary enforcement seat belt law. Those states with no seat belt law (i.e., New Hampshire) and primary seat belt laws that only applied to passengers of a particular age (e.g., 18 years old or younger) were also included, but North Carolina (which has a primary seat belt law that applies only to front seat passengers) was not. The research that analyzes the impact of upgrades to primary enforcement of seat belt laws does not generally adjust their results for these types of differences. Overall, 24 states were found that met the "before" status criteria defined for this pilot application. These states are listed below (*56*):

- Arizona
- Arkansas
- Colorado
- Florida
- Idaho
- Kansas
- Massachusetts
- Minnesota
- Missouri
- Montana
- Nebraska
- Nevada
- New Hampshire
- North Dakota
- Ohio
- Pennsylvania
- Rhode Island
- South Dakota
- Utah
- Vermont
- Virginia
- West Virginia
- Wisconsin
- Wyoming

Step 4: Calculate Rural Portion of Target Group within Selected "Before" States

The objective of the fourth step in the RSPII framework is to quantify the rural portion of the target group(s) defined in Step 2. In this research project the FARS database information will be used to accomplish this task. In this case, the 2006 rural portion of the BELTUSE software inputs was acquired from FARS for each of the states identified in Step 3. The total number of rural passenger vehicle fatalities and percentage of restrained rural fatalities are shown in Table 4.1. FARS was also used to quantify the rural portion of the target group proposed for this LSIM by NCHRP Report 622 (See Step 2). The total number of unbelted rural front seat passenger vehicle fatalities (≥ 13 years old) for each of the states identified in Step 3 is shown in Table 4.1 (the outboard restriction in target group identified by NCHRP Report 622 was ignored). It should be noted that the difference between the rural total and unrestrained front seat (≥ 13 years old) fatalities is significant.

Table 4.1. Rural Roadway Fatality Statistics in States with No Primary Seat Belt Law (2006)[1]

State	Total Rural Fatalities	Percent of Rural Fatalities Restrained	Unbelted Rural Front Seat Fatalities (≥ 13 Years Old)
Arizona	487	36.0	180
Arkansas	403	31.0	206
Colorado	233	38.1	114
Florida	931	36.8	479
Idaho	162	38.1	79
Kansas	293	40.6	148
Massachusetts	40	33.3	19
Minnesota	269	43.0	123
Missouri	641	28.4	387
Montana	206	31.7	116
Nebraska	186	38.0	91
Nevada	135	40.7	56
New Hampshire	55	21.6	39
North Dakota	86	31.8	51
Ohio	648	45.3	312
Pennsylvania	600	35.9	316
Rhode Island	1	0.0	1
South Dakota	138	18.8	88
Utah	147	54.0	38
Vermont	70	48.5	29
Virginia	487	35.4	273
West Virginia	268	37.9	126
Wisconsin	379	39.3	200
Wyoming	145	36.0	78

[1]All measures are for passenger vehicles only (i.e., cars, light trucks, and vans).

Step 5: Apply Potential Safety Impact to Rural Portion of the Target Group

The fifth step in the RSPII framework is to apply the safety impacts identified in Step 1 to the rural portion of the target groups defined in Step 4 (See Table 4.1). In this case, two methods were used to estimate this impact. First, a 7 percent reduction (See Step 1) was applied to the unbelted front-seat passenger vehicle fatalities (See Step 2) shown in Table 4.1. It is estimated that the introduction of a primary seat belt law (in the states indicated) would have reduced the total number of these fatalities by 248. Second, a state-by-state estimate of the rural fatalities avoided due to the implementation of primary seat belt law was calculated using the NHTSA BELTUSE software (See Table 4.2). It was estimated that 488 rural fatalities could have been avoided if a primary seat belt law had been implemented in the states listed. The difference in the two estimates shown in Table 4.2 is generally related to the differences in the approaches used and their target groups. For example, the BELTUSE software focuses on the impact of changes in seat belt usage of a hypothetical population consisting of vehicle passengers saved by seat belts and those retrained and unrestrained passengers that were killed. In addition, the number of rural unbelted front seat passenger vehicle fatalities (≥ 13 years old) is often only about half of the total number of passenger vehicle crash fatalities that do occur (without the age and seating location restrictions). Clearly, the choice of target group is one of the critical decisions made in the RSPII framework.

Step 6: Present Results

Two approaches were used to calculate the safety impact of an upgrade to a primary enforcement of seat belt usage. The magnitudes of the estimated rural fatalities avoided and reduced are shown in Table 4.2. During Phase 2 of this project similar calculations, using various approaches, will be completed for all six LSIMs selected for consideration in Chapter 3. The NHTSA BELTUSE software and the calculation of fatalities avoided, however, is only applicable to the primary seat belt law LSIM. It is also expected that additional fatality reduction safety measures will be calculated and presented for each LSIM. These additional measures might include estimates of rural fatality reductions in per capita and/or vehicle-miles-traveled

FRAMEWORK IMPLEMENTATION CHALLENGES

The implementation challenges described in Chapter 3 of this report were based on the type of difficulties the rural roadway safety impact quantification of various LSIMs within a RSPII framework might be expected to produce. This was one of the pieces of information that was used to select the LSIMs that will be considered during Phase II of this project. In this chapter the RSPII implementation framework was defined and a pilot application of the framework completed. These tasks provided a better understanding of the challenges that will need to be overcome to properly apply the six steps of the proposed framework. Many of the challenges that have been identified are connected to the assumptions and/or generalizations that will be necessary to apply research results that are available. Some of these challenges are briefly described below:

- The safety impacts of the LSIMs and their target groups will need to be specifically defined from the research. In addition, if the research results are not directly applicable to crash fatality reduction (the focus of this research) some type of conversion factor will need to be applied.

- The applicability of the LSIM research results to rural roadway safety will be assumed. Most of this research does not make the differentiation between the potential difference in LSIM safety impacts within urban and rural areas.
- The target group of crashes, injuries, and/or fatalities defined by the research for a LSIM should be similar to the target group used in the RSPII framework. The target groups identified in NCHRP Report 622 may or may not be appropriate. The objective is to define each target group as specifically as possible.
- The applicable "before" states for each LSIM need to be identified. Desirably, a minimum set of criteria that are related to the characteristics of the LSIMs evaluated in the research will be used to complete this task. It is clear however that some of the more significant research (and the basis of the LSIM safety impacts described in Chapter 3) include the evaluation of various LSIM adjustments. This type of situation may require some generalization in the criteria used to define the minimum LSIM status of applicable "before" states. This generalization should be done in a conservative manner so that only those states are identified that would benefit the most from the implementation of the LSIM.
- The target groups of the selected LSIMs are not mutually exclusive. Therefore, a decision will need to be made about whether or not the estimated rural roadway safety impacts of the selected LSIMs can be combined in some manner or if each impact will need to be presented individually. A critical factor in this decision is an estimate of how much overlap exists between the target groups of each pair of LSIMs (resulting in potential "double-counting" of the impacts). The significance of this overlap will vary for each of the LSIMs compared. An alternative approach is to estimate the potential impact of the "double counting" by presenting a range of results for each LSIM through the application of a safety impact or target group sensitivity analysis.

Table 4.2. Estimated Rural Fatalities Avoided and Fatality Reduction due to the Enactment of a Primary Seat Belt Law (2006)

State[1]	BELTUSE Software Estimate of Rural Fatalities Avoided[2]	Estimate of Unbelted Rural Front Seat Fatality (≥ 13 Years Old) Reduction[3]
Arizona	38	13
Arkansas	30	14
Colorado	17	8
Florida	65	34
Idaho	12	6
Kansas	20	10
Massachusetts	3	1
Minnesota	17	9
Missouri	45	27
Montana	15	8
Nebraska	13	6
Nevada	10	4
New Hampshire	4	3
North Dakota	6	4
Ohio	40	22
Pennsylvania	40	22
Rhode Island	0	0
South Dakota	11	6
Utah	10	3
Vermont	4	2
Virginia	34	19
West Virginia	18	9
Wisconsin	25	14
Wyoming	11	5
Total	488	248

[1]Maine recently enacted a primary seat belt law and was not included in this evaluation.
[2]Estimate of rural fatalities avoided based on an application of the NHTSA BELTUSE software.
[3]Estimate of rural fatality reduction based on the application of a 7 percent decrease in unbelted fatality target group identified in Table 4.1.

Chapter 5
Conclusions and Next Steps

This Phase I report documents the results of activities completed to determine the feasibility of a research-based RSPII that could be used to quantify the rural roadway safety impacts of various LSIMs. Chapter 2 included a summary of the results from two recently completed documents that focused almost exclusively on the quality of the research and effectiveness of more than 100 behavioral highway safety countermeasures (some of which were LSIMs). The literature related to these countermeasures that was relevant to this project was reviewed and summarized by this project team. Three existing LSIM-related indices were also described in Chapter 2 and several Web sites and references identified that presented LSIM status information on a state-by-state basis. The information summarized in Chapter 2 led to the conclusion that a RSPII was feasible. Chapter 3 included a detailed description of the criteria and guidelines used to select the LSIMs that were most relevant to the objectives of this project and should have their rural roadway safety impact quantified within a RSPII framework. The application of these criteria and guidelines led to the initial selection of 11 LSIMs. A consideration of the research related to these LSIMs, along with an identification of the expected challenges related to their application within a RSPII framework, resulted in a recommendation that six of them be considered within Phase II of this project. Chapter 4 includes a description of the proposed RSPII framework and the results of a pilot application.

CONCLUSIONS

The following conclusions are based on the completion of the Phase I research activities documented in this report.

- A large amount of research has been completed that focuses on the effectiveness of individual LSIMs. This research, if relevant to this project, was summarized in this report. Two significant LSIM-related research summary documents, however, were recently completed. These documents focus on the effectiveness of more than 100 behavioral highway safety countermeasures (*4*, *5*). Each of these countermeasures was categorized with respect to the quality of research available about their effectiveness. Only a small percentage of the countermeasures had been evaluated with "high-quality" research that quantified their direct safety impacts (e.g., crash, injury, and/or fatality reductions).

- At least three indices exist that rank or rate various LSIMs. These indices are completed by the IIHS, ENA, and AHAS. One of the indices is updated monthly, another annually, and the third appears to be updated on a longer periodic basis. None of these indices appears to be directly based on the quantitative impacts of the LSIMs they summarize. They also do not focus on the potential rural roadway safety impacts of the LSIMs considered. Both of these research gaps are being considered in this project. The documents or Web sites that summarize the results of the indices also include information about the current status of the LSIMs within each state.

- It was concluded, based on the information in Chapter 2, that a RSPII was feasible. Several criteria were defined to select the safety improvement measures that were most relevant to the objectives of this project and should be considered within a RSPII framework. A countermeasure needed to have the following characteristics to be considered in this research::

  1. Legislatively-based
  2. Related to human behavior or choices,
  3. Direct safety impact quantified in an acceptable manner, and
  4. Potential impact on rural roadway safety.

  Additional guidance that was applied during an initial and final countermeasure selection process included a preference for research results that quantified fatality impacts (the focus of this research) and the need to have at least one LSIM that was designed to influence speeding, seat belt use, and alcohol impairment (three factors that are over-represented in rural roadway crashes).

- A total of 23 behavioral highway safety countermeasures (out of more than 100) were categorized in NCHRP Report 622 as "proven" with direct crash, injury, and/or fatality impacts based on "high-quality" research (*5*). This is the same as one of the critical selection criteria listed above. The application of the other selection criteria and guiding principles noted above resulted in the initial "acceptance" or "tentative acceptance" of 11 LSIMs from the list of 23.

- The research results and RSPII framework implementation challenges related to each LSIM initially selected were also evaluated as part of a final selection process. Based on the results of this evaluation the following LSIMs were selected for consideration within the RSPII framework during Phase II of this project:

  1. Comprehensive Graduated Driver Licensing Program
  2. Primary Seat Belt Laws
  3. Motorcycle Helmet Use Laws
  4. Sobriety Checkpoints
  5. Ignition Interlock Implementation
  6. Automated Speed Enforcement

  The state-by-state rural roadway safety impacts of these six LSIMs will be estimated and documented during the Phase II portion of this project. The challenges encountered during their quantification within the proposed RSPII framework (see below) will be addressed in some manner or the limitations they place on the results described.

- The RSPII framework developed and proposed in this report includes six steps. First, the potential safety impacts of each LSIM must be identified through the review of relevant research results. Then, the fatality target group must be defined and the states that might benefit from the implementation of the LSIM identified. These are the applicable "before" states. The rural portion of the target group should then be defined and the safety impacts on this target group due to the implementation of the LSIM calculated and presented.

- The pilot application presented in this report showed how a LSIM would be applied within the proposed RSPII framework. It also provided an example of the decisions that needed to be made during each step of the process (See Chapter 4) and the results that could be produced. The pilot application estimated the rural roadway safety impacts of a primary seat belt law. This is likely the most analyzed LSIM of the six selected. Two methods were applied to estimate the rural roadway safety impacts of a primary seat belt law. They used different estimation approaches and target groups. First, the NHTSA BELTUSE software (which would not be available for the other LSIMs) was applied and it estimated that 488 rural fatalities would be avoided if primary seat belt laws were implemented in the 24 applicable "before" states identified. Then, the potential safety impact and target group identified in NCHRP Report 622 were applied. In this case it was estimated that the number of rural fatalities related to unbelted front seat passenger vehicle occupants (≥ 13 years old) could have been reduced by 248 if primary seat belt laws were implemented in the 24 applicable "before" states identified. One of the primary reasons these results are different is because the target groups were different. The restraint use, seating location, and age constraints placed on target group proposed by NCHRP Report 622 limits its overall size in rural areas. The difference in the results also shows how critical the identification of the research-based safety impacts and target groups are in the application of the RSPII framework.

- The pilot application presented in this report also revealed some of the challenges that must be overcome to properly quantify the rural roadway safety impacts of a LSIM within the proposed RSPII framework. Most of the challenges identified were related to the proper application of the research results to the appropriate target group and "before" states. Much of the research that has been used to define the potential safety impacts of the LSIMs being considered evaluate or summarize the results of multiple studies that use various subject selection criteria. These studies may also consider several (rather than just one) LSIM adjustments (e.g., various before-and-after conditions). In addition, the status of existing LSIM designs within the United States is highly variable. Matching research characteristics and impact results with existing LSIMs will require some generalization. Another challenge that must be overcome is the fact that most LSIM research does not focus on rural roadway impacts. It is generally assumed that the impacts of the LSIMs are the same in urban and rural areas. Each of the challenges noted above must be overcome or the limitations they place on the RSPII framework results explained. In most cases, they can be addressed by generalizing the criteria used to select the target groups and/or the applicable "before" states. These types of generalizations will vary by LSIM but also weaken the robustness of the RSPII results. This situation will only improve as more specific and robust research is completed. The lack of highly specific and robust research is an inherent (and possibly uncorrectable) weakness in the application of a RSPII. The framework proposed and applications completed as part of this research project should be considered a first step in the development of a quantitatively-based RSPII.

NEXT STEPS

Phase II of this project will include the state-by-state quantification of the rural roadway safety impacts expected due to the 6 LSIMs selected. The decisions, generalizations, and/or assumptions made during the six steps of the RSPII framework will be documented for each LSIM. Updates to the process used in the pilot application, if necessary, will also be noted and new results calculated for the primary seat belt law LSIM. If one or more of the challenges to the application of a particular LSIM cannot be overcome the limitations they place on the validity of the results produced will be described. The overall rural fatality reduction results from the RSPII framework application will also be presented in the most appropriate manner considered possible. Desirably, both the individual LSIM results and a combination of impacts will be calculated and presented. The latter output may not be possible, however, due to the overlap in the target groups of the LSIMs being considered. It may be possible to combine the rural safety improvement results from some LSIMs but not others. This issue will be considered on a case-by-case basis. The results of a safety impact and/or target group sensitivity analysis may also be presented to estimate the potential influence any overlap in these two characteristics may have on the output of the RSPII framework.

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