NEW HAMPSHIRE

DEPARTMENT OF TRANSPORTATION

HIGHWAY SAFETY IMPROVEMENT PROGRAM

MANUAL AND GUIDANCE

Highway Safety Improvement Program
Data Driven Decisions

New Hampshire HSIP Committee

December 2013

Protection of Data from Discovery & Admission into Evidence

23 USC 148(h)(4) stipulates that data compiled or collected for the preparation of the HSIP Report "…shall not be subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in an action for damages arising from any occurrence at a location identified or addressed in such reports…" This information is also protected by 23 USC 409 (discovery and admission as evidence of certain reports and surveys).

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ABBREVIATIONS

BCR: Benefit Cost Ratio
CDIP: Crash Data Improvement Program
CEA: Critical Emphasis Area
CMF: Crash Modification Factor (or Crash Modification Function)
CRF: Crash Reduction Factor
CRMS: Crash Reporting Management System
FY: Fiscal Year (Federal FY 2014 is Oct. 1, 2013 – Sept. 30, 2014)
GIS: Geographic Information System
HRRR: High Risk Rural Road
HRRRP: High Risk Rural Roads Program
HSE: Highway Safety Engineer
HSIP: Highway Safety Improvement Program
HSM: Highway Safety Manual
IHSDM: Interactive Highway Safety Design Model
ISIP: Intersection Safety Improvement Plan
KA: Killed and Incapacitating Injury crashes (also Fatal and Severe, or FS)
KABC: Killed, Incapacitating, Non-Incapacitating, and Possible Injury crashes (also Fatal and All Injury, or FI)
MAP-21: Moving Ahead for Progress in the 21st Century
MIRE: Model Inventory of Roadway Elements
MIRE-MIS: Model Inventory of Roadway Elements – Management Information System
MMUCC: Model Minimum Uniform Crash Criteria
MPO: Metropolitan Planning Organization
NH: New Hampshire
NHDOS: New Hampshire Department of Safety
NHDOT: New Hampshire Department of Transportation
NHDTZ: New Hampshire Driving Toward Zero
PDO: Property Damage Only
RPC: Regional Planning Commission
RSA: Road Safety Audit
SAFETEA-LU: Safe, Accountable, Flexible, and Efficient Transportation Equity Act: A Legacy for Users
SHSP: Strategic Highway Safety Plan
SPF: Safety Performance Function
STIP: State Transportation Improvement Plan
TRCC: Traffic Records Coordinating Committee
TZD: Toward Zero Deaths

INTRODUCTION

The Safe, Accountable, Flexible, and Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) was signed into law on August 10, 2005. It established the Highway Safety Improvement Program (HSIP) as a core Federal-aid program. In order to ensure the appropriate expenditure of HSIP funds by the States within their programs, Federal Highway Administration (FHWA) established regulations governing the development and implementation of HSIP under Title 23 CFR 924, as well as general policy memorandums. With the advent of the Moving Ahead for Progress in the 21st Century (MAP-21) legislation, signed July 6, 2012, HSIP funding has nearly doubled and there is more flexibility in the types of eligible projects and activities.

The purpose of this manual is to provide documentation and guidance to New Hampshire Department of Transportation (NHDOT) staff and other safety stakeholders involved with implementing the HSIP in New Hampshire (NH). The plan does not address the expenditures of Section 130 Railway-highway crossing funds.

The guidance within this manual should be formally reviewed annually to ensure it accurately reflects present practice, with important updates made as needed to reflect changes in legislation, funding, program requirements, and standards of practice in highway safety. The document shall be amended with concurrence from the FHWA Division Office based on recommendations from the HSIP Committee, which has been established to guide and monitor the HSIP in NH. It is the responsibility of this Committee to steer the State's HSIP. The membership of the HSIP Committee is listed below.

Chair: NHDOT Assistant Director of Project Development

FHWA Highway Safety Engineer
Local Agency (Representative, rotating)
Metropolitan Planning Organization (Representative, rotating)
NHDOT Highway Design (Administrator, Chief of Preliminary Design, and Safety Engineers)
NHDOT Highway Maintenance (Administrator or Delegate)
NHDOT Planning and Community Assistance (Administrator or Delegate)
NHDOT Traffic (Administrator and Delegate)
Regional Planning Commission (Representative, rotating)

Metropolitan Planning Organization (MPO), Regional Planning Commission (RPC), and local agency positions on the Committee should be staggered, rotating members every several years to include representation from all areas of the state. Committee meetings are typically held monthly to review projects for selection into the program and get status reports from project managers. MPOs and RPCs are encouraged to incorporate the HSIP process in their Transportation Improvement Plan development.

In addition to this document, an annual report of the implementation and effectiveness of the HSIP is required by FHWA. The HSIP Report ensures that program implementation occurs as intended to achieve the Strategic Highway Safety Plan's (SHSP) purpose and is used in combination with other State annual reports to inform Congress of safety efforts across the country. The report is to be submitted to the FHWA division office by August 31st of each year.

PROGRAM PURPOSE

The overall purpose of this program is to achieve a significant reduction in fatalities and serious injuries on all public roads through the implementation of highway safety improvement projects. This includes both infrastructure-related projects and non-infrastructure projects, selected and justified by proven data-driven approaches. All highway safety improvement projects should be chosen and implemented with the goal of reducing fatalities and serious injuries on public roads and the achievement of State safety targets. Some projects will directly impact these performance measures through the implementation of engineering or behavioral countermeasures, while others may advance the data systems and analysis capabilities of the State to more accurately identify locations with the highest potential for safety improvement, evaluate the performance of highway safety improvement projects, or identify high risk roadway characteristics and driver behaviors.

In 2006 FHWA established a new approach to advancing safety by focusing on performance. In order to effectively meet performance targets, States must apply limited resources to the areas that are most likely to achieve results. The requirement to develop and regularly update a SHSP ensures that this approach is maintained. NH annually tracks and reports performance measures including the number of fatalities and severe injuries and fatalities and severe injury rates per vehicle mile traveled. Several other performance measures of specific interest to the State are listed in the NH SHSP.

NH has embraced the goals and vision of the Toward Zero Deaths (TZD) initiative. The State named its SHSP *New Hampshire Driving Toward Zero Deaths* in recognition of the National plan, and created a public outreach program with the same name to promote change in New Hampshire's safety culture (nhdtz.com). The initiative recognizes that even one traffic death is unacceptable and sets the aggressive goal to reduce all deaths on the Nation's highways, a goal virtually achieved in the aviation industry in the past several decades. Dozens of public and private stakeholders from across the State have come together in a collaborative effort to update and carry out the strategies in the SHSP. The vision of Driving Toward Zero is embodied in NH's goal of reducing the number of fatalities and serious injuries by 50% by 2030, equaling an annual reduction of 3.4%. This is measured as a five-year rolling average with the most recent data. Maine and Vermont share this target, and to that end MaineDOT and VTrans have formed a tri-state collaborative partnership with NHDOT to more effectively reach the collective regional goal. NHDOT has also incorporated the reduction of fatalities into their Balanced Scorecard, representing one of the twelve Strategic Objectives of the agency.

The concept of a focused approach has been further reinforced with requirements for data-driven decision making and resource allocation. 23 USC 148(c)(2), as amended by section 1401(a)(1) of SAFETEA-LU, Identification and Analysis of Highway Safety Problems and

Opportunities, delineates specific requirements for determining safety problem identification and countermeasure analyses. The legislation also provides flexibility in the use of HSIP funds to address a State's non-infrastructure safety issues. It is clear from legislation that safety funds are to be used on the most effective treatments and activities at the locations with the greatest needs, or potential thereof, and that the best available data is to be used to determine the proposed treatments. NH has been moving forward with implementation of the Highway Safety Manual (HSM) as a participant in the NCHRP 17-50 Lead State Initiative to facilitate this process and allow for more robust analysis of the roadway network. Use of Part A, Part B, and Part D of the HSM is growing, while implementation of Part C is in the beginning stages in NH.

MAP-21 continued building on the concept of a safety data system that has the capability to identify key safety problems, establish their relative severity, and then adopt strategic and performance-based goals to maximize safety. Recent improvements to the NH data system include a phased initiative to implement electronic crash reporting through the State's Crash Report Management System (CRMS), the compilation of the Model Inventory of Roadway Elements (MIRE) fundamental data elements (FDE), and the completion of the National Highway Traffic Safety Administration (NHTSA) Traffic Records Assessment. One of the key outcomes of the Traffic Records Assessment was that performance measures for data quality are needed, including measures of timeliness, accuracy, completeness, uniformity, integration, and accessibility in order to guide improvements to the data and data systems.

The States are required to define a clear linkage between the behavioral NHTSA-funded Highway Safety Program and the HSIP through the State SHSP. The 2012 version (2nd edition) of the NH SHSP identifies 9 critical emphasis areas (CEA) to be addressed by safety stakeholders in NH, listed below.

- Adolescent Drivers
- Comprehensive Safety Data Improvement
- Crash Locations
- Distracted Driving
- Impaired Driving
- Motorcycles and Vulnerable Roadway Users
- Older Drivers
- Speeding
- Vehicle Occupant Protection

The "4-E's" of safety (education, enforcement, engineering, and emergency management services) should be considered in selection and development of HSIP projects, however the intent of the HSIP is to primarily target engineering-related countermeasure improvements. The crash types of special interest have been identified in the Crash Locations CEA. The next major update to the SHSP is scheduled for 2016, while more minor updates to the plan and strategies outlined in each section should be reviewed at least annually.

With respect to eligibility for funding, 23 USC 148(a)(4) provides a sample listing of eligible highway safety improvement project types. However, it is important to note that only data-driven projects that target strategies identified in the State SHSP are eligible for funding in NH. Furthermore, given the limited funding available, funds should be prioritized to help ensure that projects with the greatest safety return will be the top priority. For example addressing crashes involving animals is a possible eligible activity per MAP-21, but since it is not addressed in the current version of the SHSP as a CEA or related strategy, and higher safety needs have been identified, HSIP funds should not be used for that purpose in NH.

23 USC 148(e)(2) makes clear that other Federal-aid funds are eligible to support and leverage the safety program. Improvements to safety features, such as guardrail, that are routinely provided as part a broader Federal-aid project should be funded from the same source funds as the broader project when that safety feature is included in the broader project, not HSIP funds. This allows the HSIP funds to be reserved for stand-alone safety projects thereby allowing for true targeting of safety needs. This is consistent with the provision of separate funding for safety projects and with FHWA's long-standing position on the use of safety funds.

Although MAP-21 eliminates the requirement for every State to set aside funds for High Risk Rural Roads (HRRR), a State is now required to obligate funds for this purpose if the fatality rate on HRRR roads increases over a two-year period. States are also now required to incorporate strategies into their SHSPs that focus on older road users if fatalities and serious injuries per capita for those users increase. The specifics of these rules are discussed later in this manual.

PROJECT IDENTIFICATION

MAP-21 amended the definition of a highway safety improvement project to include strategies, activities, and projects on a public road that are consistent with a State SHSP and correct or improve a hazardous location or feature, or address a highway safety problem. The State is charged with identification of highway safety improvement projects at hazardous locations on the basis of crash experience, crash potential, or other data-supported means as codified in 23 USC 148(c)(2)(B). The State's HSIP utilizes three approaches to identify sites for improvement: Network Screening, Systemic Approach, and Road Safety Audits. Each approach uses a different method to identify sites with potential for safety improvement for further review.

The best solutions to the safety concerns at some sites may yield proposed projects that go beyond the reasonable scope of an HSIP project. This is typically the case when their cost is greater than the anticipated benefits or the overall cost of right-of-way, environmental, and construction of improvements is deemed too costly for the overall budget. Low-cost, interim improvements at these sites may however be warranted for HSIP funding if such countermeasures will significantly improve safety at the location until a larger project is constructed.

Network Screening

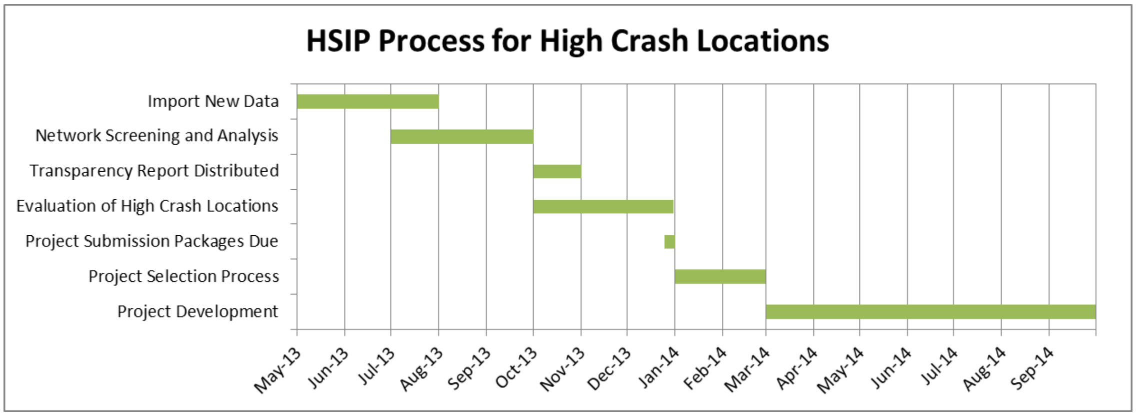
The traditional approach to identifying safety improvements, and the most common engineering practice, has targeted sites with the highest number of crashes and focused on strategies to treat the hazards at those locations. While this approach is not the most efficient method for reaching statewide performance targets it is still important to address safety concerns at the sites that are identified to have the highest potential for safety improvement in the State as part of the Hazard Elimination program. The peak searching network screening methodology in Chapter 4 of the HSM is used to implement the traditional approach in NH. NHDOT has adopted the Safety Analyst software to make the screening process more efficient and results more accurate than with other tools. The primary goal of the HSIP network screening analysis is to identify locations on all public roadways with potential for improvement in lane departure and intersection-related crashes resulting in fatal and severe injury, as addressed in the Crash Locations CEA in the SHSP. For specific information about the screening methods used in NH refer to the HSM, Safety Analyst documentation, or review documentation for *Using Safety Analyst in NH*.

The project identification process for network screening begins each year around May as the Bureau of Highway Design receives an annual update of crash data. The NHDOT Highway Safety Engineer (HSE) updates Safety Analyst to include the most recent data, safety performance functions (SPF), and distributions. Screening efforts should not only focus on lane departure and intersection crashes, but also evaluate other potential safety issues that would be of interest in future updates to the Crash Locations CEA and in other safety programs. Additional results should be developed for crash types that are addressed in other SHSP CEAs that could potentially benefit from engineering improvements, e.g. older driver crashes. Analysis to calculate various performance measures for the SHSP and HSIP should be conducted once the dataset is finalized.

The results are distributed to NHDOT Districts, Bureau of Planning and Community Assistance, Bureau of Traffic, MPOs, RPCs, and other safety stakeholders in October in the form of the transparency report, which lists the sites ranked in each analysis and reports any data relevant to evaluating sites in their jurisdictions. These groups are encouraged to review the results of the analysis and provide comments on known aspects of specific locations to NHDOT Bureau of Highway Design. Comments may include but are not limited to recent work or upcoming capital improvement projects in the area, significant changes to traffic patterns or volumes in the past several years, and local experience and insight on crashes. Although no longer required under MAP-21 the transparency report will continue to help in developing projects and completing submittal packages for HSIP funding consideration.

Sites that are identified through this method will not necessarily be programmed in the HSIP. Further investigation into the observed crash data, perceived safety concerns, potential for countermeasure implementation, and safety economics will be conducted to better understand the potential for HSIP eligibility and funding levels at the proposed sites. NHDOT will use the input from all stakeholders in their investigative analysis. Sites with significant environmental impacts, right-of-way constraints, or costly improvements may be recommended for projects under other funding sources. Sites that have had recent changes or improvements will be withdrawn from consideration until such time as subsequent crash data suggests further improvements be considered. A minimum of three years of crash data is needed for evaluation following any significant constructed improvements. Similarly, sites known to have impending changes either through a larger capital project or other improvement (e.g., from a proposed development in the area) are also removed from consideration unless the HSIP Committee identifies low-cost improvements that could be implemented in short order and would make a significant safety impact in the meantime.

The final list of potential projects that result from these steps in the process should have Project Submission Packages completed. The HSIP Committee will select, prioritize, and schedule projects during the Project Selection Process from January to March, and projects programmed for the next year will move forward in Project Development through September. The annual cycle is completed and all annual funding is to be obligated by the end of the Federal Fiscal Year (FY) on September 30. As crash data management processes change within the State, or crash data is made available to NHDOT HSEs more frequently, this process should be reviewed to make sure that the timeliness remains appropriate for the data availability. The chart shown below shows the entire timeline for a project entering the HSIP through network screening.



Systemic Approach

The systemic approach to safety involves improvements to roadways that are widely implemented based on high-risk roadway features correlated with particular severe crash types. This method is very different from the traditional approach used in network screening in that locations receiving improvements are not necessarily required to have a demonstrated crash history. Systemic improvements serve as a strong complement to improvements identified through network screening, together treating the most hazardous sites and reducing the risk of severe crashes across the entire network.

Systemic countermeasure programs have also been shown to be more effective at reducing the overall number of crashes in the state than spot improvements, meaning that successful management of these programs will be essential in reaching State performance targets for reduction of fatalities and severe injuries. Whereas spot improvement projects only influence the safety at a single site or small area, systemic countermeasures are installed in entire towns, districts, or statewide with the potential to treat a large number of safety concerns and change driver behaviors. This is typically accomplished by implementing a large number of low-cost countermeasures that generally have a proportionally large safety benefit. Thus, it is the intent of the NH HSIP to use systemic countermeasure treatments as a significant means to improve highway safety in the State.

The systemic approach is iterative, flexible, and applicable to a variety of systems, locations, and crash types. Similar to the network screening approach, systemic planning involves problem identification, countermeasure selection, and project prioritization. The first step in the systemic process is to analyze system-wide crash and roadway data to target crash types (e.g., lane departure) and associated roadway risk factors (e.g., curves or roadside hazards) that make a significant contribution to the number of fatal and severe injury crashes in the State. Sites with these risk factors are identified and prioritized by potential for future severe crashes based on AADT, crash predictions for that roadway type, roadway characteristics, etc. Appropriate low-cost countermeasures (e.g., rumble strips) are then proposed to effectively address the specific crash types on roads with the identified risk factors. Finally, the chosen countermeasures are installed systemically at the selected sites.

In 2009, the State identified its first systemic project focusing on rural signing improvements. Since that time, the following additional systemic programs have been implemented: shoulder and centerline rumble strips and stripes, median barrier improvements, guardrail and end terminal improvements, rural curve signing and delineation, and an Intersection Safety Improvement Plan (ISIP). These programs are expected to continue in the next few years, with the ISIP growing in levels of effort as the phased implementation process begins.

Within the next year the State plans to develop a system that is capable of regularly evaluating the effectiveness of its implemented countermeasures. Evaluation of systemic projects should be considered when developing this data. This is vital in determining which programs should be allocated more or less funding, and whether the sites receiving treatments were correctly identified as those with potential to reduce fatal and severe crashes. A new feature for Safety Analyst is planned within the next couple of years with the capability to easily identify and evaluate systemic projects. Information showing the overall effectiveness of the current programs will also guide the Committee's review of funding allocations for projects selected in each project identification method; e.g. if systemic countermeasure projects are more cost-effective than other types of HSIP projects then a greater amount of funding should be spent on them in the program.

Road Safety Audits

NH has adopted Road Safety Audits (RSA) as a means to identify potential safety improvements on existing roadways or those with planned construction. The NHDOT RSA program is designed to provide the opportunity for agencies to submit for consideration their concerns about unsafe sites that have not been programmed through other methods.

RSA requests to NHDOT will not necessarily result in obligation of HSIP funds, and can be conducted to address a variety of safety concerns. Locations from all submitted RSA applications are reviewed to determine if an RSA is warranted at that location. In the case that the site does not exhibit quantitative safety concerns or the HSIP Committee determines a project to improve safety would not be economically justified, but an RSA is still approved, it will be geared toward exploring engineering alternatives and the possibility of securing funding sources outside of the HSIP. After review NHDOT may also decide to incorporate the site into an active systemic improvement program and forego a complete RSA. The NHDOT RSA process is shown in a flow chart (Appendix – Road Safety Audit Process).

To request a RSA, a HSIP Candidate Location Package shall be submitted to the NHDOT HSE. The HSIP Candidate Location Package shall include, at a minimum, the following information:

- A completed NHDOT RSA Application (Appendix – Sample RSA Application Form). The RSA Application shall be signed by the local governing body (e.g. Board of Selectmen) or their designee, the NHDOT District Engineer (if the identified location affects state-maintained infrastructure), and the applicable Regional Planning Commission;
- A description of the location with a summary of the safety problem(s) at the site;
- A map showing the study location for the audit;
- A summary of traffic volume data at the location (AADT for segments, turning movement data for intersections);
- Crash reports for the location for the most recent ten-year period;
- A crash diagram displaying the time, type, and severity of crashes at the location;
- Photographs of the location; and
- Any other information that will help the HSIP Committee accurately evaluate the RSA application and perceived safety concerns.

Municipal stakeholders are encouraged to contact their RPC for assistance in compiling the required information for the HSIP Candidate Location Package. Following submission to the NHDOT HSE, HSIP Candidate Location Packages are reviewed and prioritized by the HSIP Committee. Cost-effective countermeasures identified for a site may qualify for HSIP funding, however all RSA projects seeking HSIP funding must enter the Project Selection Process to be weighed against other potential projects before being programmed in the HSIP.

The multidisciplinary audit team consists of a diverse group of stakeholders that includes local officials such as police and fire chiefs, business and land owners adjacent to the site, NHDOT engineering staff, and a facilitator (typically a consultant) to conduct the RSA.

An RSA typically takes three to four hours, which includes a presentation of the process, a site visit, and a discussion of proposed countermeasure alternatives. Effectiveness, applicability, and local stakeholder approval should be considered in this discussion. The RSA should be conducted at a date and time of day that best allows the audit team to observe the proposed safety concerns. The facilitator compiles the observed safety concerns and proposed countermeasures from the RSA in a report, which generally recommends short, medium, and long term solutions and identifies the parties responsible for implementing each. Short and medium term solutions can often be implemented within normal maintenance or operations programs. Long term solutions would generally require some measure of capital improvement that would need to be included within a transportation improvement program.

Factors that determine the potential improvement funding sources and funding levels include roadway ownership, the net safety benefit, and anticipated effectiveness of the proposed improvements. Findings from RSAs should be organized and saved for consideration in updates to the SHSP, as RSA results are an important factor in identifying emphasis areas that are common concerns of state and local stakeholders.

Non-Infrastructure Projects

Similar to infrastructure-related projects, non-infrastructure projects should be consistent with the NH SHSP and based on crash experience, crash potential, crash rate, or other data-supported means. HSIP funds should be used to implement proven, effective strategies in order to support the State's safety performance targets. Strategies should either add to existing successful non-infrastructure programs (but not replace existing funding sources), or be used to implement new activities proven through research. In addition, the safety benefit and economic effectiveness of both infrastructure and non-infrastructure projects should be considered during the Project Selection Process described later in this manual. Non-infrastructure projects must be approved by the NHDOT HSIP Committee in competition with all other projects.

Examples of eligible non-infrastructure projects include behavioral countermeasures; safety culture programs; transportation safety planning; collection, analysis, and improvement of safety data; and road safety audits. The HSIP Committee has previously funded data improvements, road safety audits, and safety culture and public outreach efforts of the New Hampshire Driving Toward Zero (NHDTZ) program. HSIP contributes about $250,000 annually to NHDTZ, or about 3% of total HSIP funding. There are many opportunities to build on these efforts and to coordinate with other agencies in non-infrastructure programs.

SAFETY ECONOMICS

Economic consideration of safety benefits is critical for every infrastructure and non-infrastructure project. Each infrastructure project in the HSIP must have an expected benefit cost ratio (BCR) of greater than 1.0 and contribute to a reduction in fatalities and severe injuries. BCRs for proposed projects should be calculated according to current safety engineering practices, using the most applicable crash modification factors and functions (CMFs). Non-infrastructure projects should be economically justified with a net benefit when possible, but at a minimum must meet the requirements for data improvement or other eligible non-infrastructure projects under Title 23.

The BCR for infrastructure projects is calculated as the present value of safety benefits of the implemented countermeasures divided by the present value of the project costs (including preliminary engineering, right-of-way, construction, and maintenance). The estimated safety benefits are determined by predicting the expected crash reduction of each countermeasure using either SPFs or CMFs and calculating comprehensive costs of the reduced crashes using the values shown below. The most recent ten-year period of crash data should be used in the calculation of observed or expected safety benefits, except when the data is not available or major construction significantly changed the nature of the roadway within the period of analysis.

Comprehensive Societal Crash Costs (2013 Dollars)	
Killed (K)	$ 5,463,500
Incapacitating Injury (A)	$ 291,300
Non-Incapacitating Injury (B)	$ 106,400
Possible Injury (C)	$ 60,200
Property Damage Only (U or N)	$ 9,800
Fatal and Injury (K, A, B, or C)	$198,200
Injury (A, B, or C)	$107,600

This table shows the 2013 dollar equivalent of the comprehensive societal cost of crashes as listed in HSM Appendix 4A, updated using the procedure on pages 4-84 through 4-87[1]. This

[1] American Association of State Highway and Transportation Officials (AASHTO), 2010. Highway Safety Manual. 1st edition, Washington, D.C.

estimated cost to the State includes lost wages, fringe benefits, lost production, medical costs, property damage, insurance premium increases, etc. FHWA has released more recent estimates but the HSIP Committee has decided that using the numbers in the HSM will lead to better project identification results and selection due to the impact on fatal crashes in analysis. These costs should be used in all economic calculations involving safety benefits for engineering applications in NH, including HSIP Submittal Packages and Safety Analyst. Conducting a study of crash costs experienced in NH is the only way to truly understand the comprehensive costs of crashes analyzed in the HSIP in NH.

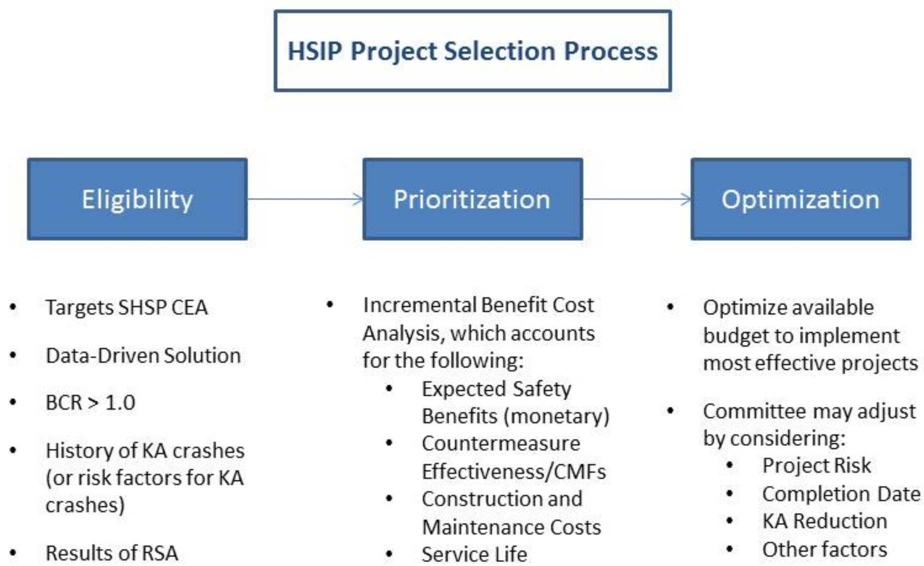
Note that when comparing BCRs for projects in NH to those realized by projects in other States or countries, it is important to consider the impact of comprehensive crash costs as well as regional differences in construction costs. Each State can use different sources for crash costs to be used in their analyses. For this reason BCRs may be higher or lower for projects achieving similar crash reduction with the same countermeasures.

Of the four methods discussed in HSM section 7.4.1 that are acceptable for estimating the change in crashes for a proposed project, NH is currently using Method 4 (HSM p. 7-4) – the least statistically reliable method. The NH HSIP Project Application Spreadsheet can be used to develop BCRs, net benefits, and annual fatal and severe injury crash reduction using this method (Appendix - Sample HSIP Project Application Spreadsheet). When crash data is more complete and accurate, NHDOT intends to use Method 3 in Safety Analyst to calculate BCRs and other economic metrics for selected proposed projects and countermeasures as a result of network screening. In order to use the more reliable Methods 1 or 2 NH will need to either calibrate Part C SPFs or develop SPFs with NH data.

It is important that all proposed projects be evaluated fairly and equally. This means that accurate CMFs and SPFs should be used to evaluate project benefits, and all projects entering the Project Selection Process during a year should use the same CMFs for each countermeasure in order to ensure projects are evaluated fairly. An updated list should be provided by NHDOT in the HSIP Project Application materials or along with the network screening results of the most applicable CMFs to NH for use throughout the State. Economic calculations should be reviewed to ensure that accurate and applicable CMFs have been used; any adjustments to CMFs are reasonable for the proposed countermeasures, site characteristics, and crash history; and CMF standard error has been considered. Finally, for projects that have multiple countermeasures, the overlapping of crash reduction should be considered in choosing a method to combine CMFs.

PROJECT SELECTION PROCESS

The Project Selection Process consists of three steps starting with an initial eligibility determination, then prioritization of selected projects, and finally optimization of prioritized list of eligible projects within the annual budget. The most effective projects are quick, low cost, have minimal environmental and right-of-way impacts, and are expected to make significant improvements to safety. Systemic and non-infrastructure projects may not have the data required to go through all steps of this process (if benefits are difficult to estimate or quantify, etc.). The committee will use their best judgment to evaluate these alongside other projects that do have the necessary data. The following flowchart shows the Project Selection Process and the considerations in each step:



Eligibility is ultimately determined by the MAP-21 legislation as explained earlier; however the HSIP Committee will choose which projects are programmed within those requirements. Incremental Benefit Cost Analysis is used for prioritization of projects, which ranks projects or countermeasures based on net benefit. This process is described on HSM pages 8-2 to 8-4 and 8-7 to 8-13. The net benefit is calculated on the HSIP Project Application spreadsheet (Appendix – Sample HSIP Project Application Spreadsheet (Page 1)). NHDOT applies the state-of-the-art Integer Programming optimization tools in Safety Analyst to create an optimal set of improvement projects. This is briefly described in HSM pages 8-4 to 8-6, and in more detail in the Safety Analyst Module 3 White Paper. This process maximizes project net benefits within a budget constraint assuming reducing crashes, and likewise reducing fatal and severe crashes, is the only objective. The HSIP Committee should adjust the optimized project list if any other factors need to be considered. In the future NHDOT could move toward multi-objective resource allocation methods that use decision-making algorithms for optimization in order to programmatically weigh multiple decision criteria.

The Project Selection Process typically takes place in January and February for projects identified through network screening, however it is a continual effort as other projects may enter the program at other times throughout the year. The HSE should maintain updated lists of prioritized and optimized projects. Eligible projects that are not selected should remain in the queue to be weighed against all projects to be selected for the next FY budget. It is the intent of the Committee to have several higher priority projects on shelf that can enter the program to fill unexpected budget gaps in a FY caused by delays to programmed projects.

PROGRAM FUNDING

The State Transportation Improvement Plan (STIP) lists the funding for HSIP/HRRR as a line item. Projects are selected for HSIP funding through the procedures outlined earlier, and a prioritized list of projects is maintained for the present and subsequent fiscal years. Ideally all funds obligated for a given year are allocated to projects that will most efficiently improve highway safety in NH. HSIP funds allocated to New Hampshire can be carried over for up to three years beyond the year allocated before they lapse. If the program obligates fewer funds in projects each year than the program is allocated in those years, the unobligated balance builds up and eventually can lead to a lapsing of funds. Therefore it is important for the program to not only plan to obligate essentially the same amount of funds it is allocated in any given year, but also for the program to have projects on-shelf to take the place of projects that get delayed for various reasons.

The values shown in the table below are anticipated Federal and State Resources for the HSIP in years 2013 – 2016 and reflect values in the STIP. Actual amounts used will be based on funds made available from these sources and the availability of projects ready to move ahead in the project development process.

Funding Source	2013	2014	2015	2016
Federal Resources	$8,838,998	$8,838,998	$8,838,998	$8,838,998
State Resources	$890,000	$890,000	$890,000	$890,000
Total	$9,728,998	$9,728,998	$9,728,998	$9,728,998

The initial strategy was to set aside up to ten percent of HSIP funding for locally requested improvement projects stemming from RSAs and to balance the remainder between projects identified through the network screening process and systemic countermeasure treatment programs. This is no longer the case as the program has grown. No matter the method used to identify a project, all projects should be weighed fairly using the criteria presented in the Project Selection Process section of this manual. Funding decisions are based on the expected benefits of the projects rather than the identification method. Only the most efficient and beneficial projects should be programmed each year. The Committee may choose to review the funding allocations annually for each project identification method and adjust the budget based on their effectiveness.

Section 148(e)(1) of SAFETEA-LU allowed States to use up to 10% of their HSIP appropriation as flexible funding "to carry out safety projects under any other section," which includes projects consistent with the State SHSP that promote awareness of the public and educates the public concerning highway safety matters, projects to enforce highway safety laws, and projects to provide infrastructure and infrastructure-related equipment to support emergency services. MAP-21 removed the cap of 10% of the HSIP apportionment, which allows States to allocate their funding toward the projects that will best fit their data-driven needs and reduce fatalities and serious injuries, whether infrastructure-related or not. Eligible highway safety improvement projects are defined as any strategy, activity or project on a public road that is consistent with a State SHSP and corrects or improves a hazardous road location or feature, or addresses a highway safety problem. This can include training and education activities. In addition, States are no longer required to certify that they have met safety infrastructure needs in order to fund non-infrastructure projects.

The table below shows the schedule to be used in the event an HSIP project exceeds the original estimate. Projects exceeding the thresholds indicated in the table will require review by the HSIP Committee to determine continued HSIP eligibility. Because projects must maintain a BCR of at least 1.0 to remain eligible, the initial calculations of BCRs for proposed projects should include a cost contingency 30%-50% higher than the original estimate to account for any increases to the cost in design and construction. This is not applicable to all projects, e.g. certain systemic and non-infrastructure projects, and can be omitted in such cases.

Original Estimate	Threshold
0 to 300k	40%
300k to 600k	30% or 125k (whichever is greater)
> 600k	20% or 180k (whichever is greater)

The Federal share for highway safety improvement projects is 90 percent, except as provided in 23 USC 120 and 130. Section 120(c) allows certain types of highway safety improvement projects to be funded at 100%: traffic control signalization, traffic circles (a.k.a. roundabouts), safety rest areas, pavement marking, commuter carpooling and vanpooling, rail-highway crossing closure, or installation of traffic signs, traffic lights (a.k.a. street lights), guardrails, impact attenuators, concrete barrier end treatments, breakaway utility poles, or priority control systems for emergency vehicles or transit vehicles at signalized intersections. MAP-21 added to this list projects for maintaining minimum levels of retroreflectivity of highway signs or pavement markings, and shoulder and centerline rumble strips and stripes.

EVALUATION AND PERFORMANCE

Project Evaluation

Regular evaluation of project performance is required as part of 23 USC 148(c)(2)(F). An assessment of the effectiveness of highway safety improvement projects and the extent to which the improvements funded under HSIP have contributed to reducing the number of fatalities and severe injuries and the rate of fatalities and severe injuries per vehicle mile traveled, with a breakdown by functional class and ownership, must be reported to FHWA annually in the HSIP Report. Effectiveness of data improvement activities must also be evaluated per 23 USC 148(c)(2)(A)(ii). It is important that NH develop a process to evaluate projects to fulfill this requirement. This could be easily implemented in a construction project or countermeasure database tool that would indicate when projects are old enough to have enough crash data required for a before-after evaluation, or when there are enough projects to evaluate the overall effectiveness of a specific countermeasure in NH. The cost-effectiveness and expected reduction, in the form of a CMF or crash frequency, will be tracked for all HSIP projects at a minimum. Determining the safety effects of all projects regardless of funding source will produce less biased evaluations of countermeasures. Additionally project cost-effectiveness must be considered in future updates to SHSP strategies.

Performance Measures

23 USC 150 establishes that for the purpose of carrying out the HSIP, States are to measure and assess the number of serious injuries and fatalities and the rate of serious injuries and fatalities per vehicle mile traveled. NH should continue to maintain and provide these measures on an annual basis. The performance targets set forth as part of the NH SHSP aim to reduce these performance measures by 50% by 2030 using the 2010 five-year rolling average as the base year. This equates to a 3.4% reduction in each measure per year, a goal that to date has been more than met. The penalties for not reaching, or not making significant progress toward meeting these targets, are presented in 148(i).

The Older Drivers Special Rule also requires that States measure and assess the five-year average rate of fatalities and severe injuries per capita for drivers and pedestrians over the age of 65. This is reported annually in the HSIP Report.

The NHDTZ Coalition also established a number of performance measures relating to the SHSP CEAs and strategies. These measures are classified into leading indicators – those meant to track the cause of crashes or the implementation of preventative activities and behaviors – and lagging indicators – those that track the effect of crashes or the impacts of the SHSP strategies. The successful implementation of the leading indicators should positively affect the trends of the lagging indicators.

SPECIAL RULES

MAP-21 established two special rules for the HSIP. One continues to emphasize High Risk Rural Roads safety and the other is a new rule targeting Older Drivers and Pedestrians. The function of these rules is to encourage States to improve safety in specific areas of interest. NH is required to report on their progress and the performance measures related to these rules in the HSIP Report.

High Risk Rural Roads Program

SAFETEA-LU created the High Risk Rural Roads Program (HRRRP) as a sub-program to the larger HSIP, dedicating funds to be set-aside for use on roadways that met the SAFETEA-LU definition of HRRR. Since the creation of this program in 2009, NH has focused on lane departure crashes through the installation and improvement of warning signs, object markers, and delineators. MAP-21 did away with the HRRR set-aside, though those roadways are still eligible for HSIP funding and similar activities to what was done under SAFETEA-LU.

The new HRRR Special Rule, established in 23 USC 148(g)(1), states:

> If the fatality rate on rural roads in a State increases over the most recent 2-year period for which data are available, that State shall be required to obligate in the next fiscal year for projects on high risk rural roads an amount equal to at least 200 percent of the amount of funds the State received for fiscal year 2009 for high risk rural roads under subsection (f) of this section, as in effect on the day before the date of enactment of the MAP-21.

MAP-21 also revised the definition of "High Risk Rural Road" to include any rural major or minor collector or rural local road with significant safety risks, as defined by a State in accordance with an updated SHSP. Subsequent guidance by FHWA states that FHWA will use a five-year rolling average for the fatality rate when conducting this calculation.

Therefore if the 5-year rolling average fatality rate increases on these roads in the most recent 2-year period New Hampshire must set aside $900,000 of its annual HSIP funding to be obligated for HRRR improvements in the next fiscal year using the MAP-21 definition requirements for HRRR. FHWA will use FARS and HPMS data to calculate the fatality rates and notify NHDOT of whether the Rule applies for the next FY. If the funds set aside as part of the enactment of the HRRR Special Rule are not spent in the next FY, the remaining funds are returned to FHWA and redistributed among all states.

Using the MAP-21 definition requirements NHDOT has defined the term High Risk Rural Road to mean:

Any roadway functionally classified as a rural major or minor collector or rural local road on which:

1. The expected crash frequency for fatalities and injuries exceeds the predicted crash frequency for similar roadways, as calculated using Safety Performance Functions, including logical extensions and gaps of these identified roadway segments, or
2. Roadways segments and intersections otherwise identified and approved for Road Safety Audits (RSAs), as per the NHDOT HSIP Manual and associated procedures, or
3. Roadways with similar high risk attributes to those defined in number 1 and 2 above when considering systemic safety countermeasure treatments.

Though there is no longer a specific pot of money for an HRRR program under MAP-21, NHDOT has chosen to continue to fund statewide systemic improvements on these roadways though the HSIP program. Data shows that crashes are overrepresented on these roadways, especially on curves, and as such are targeted in the NH SHSP. A statewide analysis of lane departure crashes is used to identify towns with the greatest number of the targeted crash types. The prioritized list is filtered by each of the nine RPCs. Towns are selected from each RPC. Sixteen towns chose to participate in the first phase of the program. Each year the HSE will identify the next round of eligible towns using a regional crash rate map. Other systemic countermeasure treatments for HRRRs should be considered in the future as data quality and analysis improve for these roadways.

Older Drivers and Pedestrians

MAP-21 established a new Special Rule for Older Drivers and Pedestrians. This rule is codified in 23 USC 148(g)(2), which states:

> If traffic fatalities and serious injuries per capita for drivers and pedestrians over the age of 65 in a State increases during the most recent 2-year period for which data are available, that State shall be required to include, in the subsequent Strategic Highway Safety Plan (SHSP) of the State, strategies to address the increases in those rates, taking into account the recommendations included in the publication of the Federal Highway Administration entitled 'Highway Design Handbook for Older Drivers and Pedestrians' (FHWA-RD-01-103), and dated May 2001, or as subsequently revised and updated.

Each year NHDOT must determine whether the Special Rule applies for the most recent 2-year period for which data are available. In order to calculate the rates required for this rule, the number of KA crashes involving drivers and pedestrians 65 years of age and older (from the

FARS database) is divided by the number of people 65 years of age or older per 1000 total population (provided by FHWA) for the most recent 7 years of data. The State compares the 5-year rolling average of the calculated rate for the most recent 2-year period in order to determine whether the rate of older driver and pedestrian fatalities and serious injury crashes has increased per the Special Rule. The Special Rule did not apply for the comparison of the 5-year rolling average rates in 2009 and 2011, required in the 2013 HSIP Report.

The 2012 update of the Strategic Highway Safety Plan includes an Older Driver CEA. However if the Special Rule applies in the future, the New Hampshire Driving Toward Zero Deaths Coalition for the SHSP should consider adding, modifying, or focusing more on the strategies within the existing CEA to better target older driver and pedestrian crashes. If future versions of the SHSP do not target the Older Drivers CEA, under MAP-21 it would need to be reintroduced as an CEA in the next version subsequent a year where the Special Rule applies.

SAFETY DATA

Data is one of the fundamental elements of the HSIP. All strategies and projects should be data-driven, which means that an immense amount of data must be collected and managed in order to effectively administrate, implement, and evaluate the HSIP. The term "safety data" means crash (including crashes, vehicles, and injuries), roadway (including segments, intersections, and ramps), and traffic data on a public road. The model elements that should be included in these datasets are presented in the Model Minimum Uniform Crash Criteria (MMUCC) and the MIRE data dictionaries, published by NHTSA and FHWA respectively. Section 148(c)(2) lays out the minimum requirements for a safety data system, which includes sections for data improvement, data performance measurement, and how data should be used as a tool to advance analysis capabilities.

The State collects and manages a great deal of safety data under several agencies with different purposes and management practices. NHDOT Bureau of Planning and Community Assistance manages the highway basemap; Bureau of Highway Design manages the intersections and ramps; NH Department of Safety (NHDOS) manages crash data and submits to NHDOT for further processing and geolocating; and NHDOT, RPCs, MPOs, and others collect and maintain traffic volume databases. Statewide crash, roadway, and traffic volumes are now linked in the safety databases maintained by NHDOT, though the links between all source datasets are not live at this time. These safety datasets are copied and derived versions of snapshots of the original databases, recreated at least annually to include the most recent road inventory and most recent ten years of crash and traffic data. Older datasets are archived during this process. Implementation of a MIRE-MIS or similar system to create live database links and a dashboard will be important in using more advanced tools and providing access to timely data. To suit the needs of the safety program, the most recent ten years of crash and traffic volume data should be maintained. There is a need for a comprehensive data dictionary that includes: data elements from all safety datasets; agency responsible for the element; and which systems and technologies require each element for analysis.

NH has recently taken steps toward improving the State safety data system. As an effort to implement Safety Analyst and the HSM, NHDOT developed methods to extract data from the highway basemap to create databases of all public intersections, intersection legs, and ramps. The process was automated for intersections as part of the MIRE-Management Information System (MIRE-MIS) Lead State project, which also included collection of additional data for State-maintained intersections. The manual collection of the same data for the nearly 30,000 local intersections statewide remains incomplete (estimated at 6,000-10,000 hours of effort).

Several other efforts are planned for the next few years. Implementation of the CRMS that allows crash reports to be submitted electronically is in the first phase. The NH Department of

Information Technology developed the system and NHDOS has taken on much of the training efforts. During the first phase all state police were trained and are using the CRMS to submit all crash reports as of the summer of 2013. Any known bugs are being compiled and fixed. The second phase, to have the most widely used software vendor by local police departments electronically submit crash reports to CRMS, is planned to be completed by February 2015. Together the rollout from these phases will include about 70% of law enforcement agencies in the state, which accounts for about 85% of the crash reports. The final phase would result in nearly all agencies using the CRMS system.

NHDOT plans to develop a safety database of construction projects and implemented countermeasure information including costs, countermeasure types, locations, and other related information. This data will allow NHDOT to more efficiently and reliably evaluate the safety effectiveness of completed projects, whether funded by HSIP or not. Regular evaluation of improvement efforts and countermeasures is a key requirement in the roadway safety management process and in the HSIP.

The HSIP Committee has begun to pursue the Crash Data Improvement Program (CDIP) that was previously offered by FHWA Office of Safety and is now offered through NHTSA. CDIP makes crash data experts available to the State to evaluate the quality of the crash data and data systems. The State receives a list of reasonable recommendations to improve upon the deficiencies noted in the assessment. CDIP also offers a one day workshop to help the attendees understand the importance of data quality and how to make improvements to the State crash databases. Finally NH may be eligible for federal funding to implement one or more of the recommendations from the CDIP report as part of the program. FHWA Office of Safety's Roadway Safety Data Program is planning a similar offering for roadways called the Roadway Data Improvement Program and several other initiatives that could be of interest in the future.

There are many opportunities to improve each dataset. As a step forward in this process the State's Traffic Records Coordinating Committee (TRCC) has completed the Traffic Records Assessment offered by NHTSA to analyze the State's data systems. The most important outcome of that assessment was that the State should begin tracking data-related performance measures for timeliness, accuracy, completeness, uniformity, integration, and accessibility. NHTSA referenced a document titled *Model Performance Measures for State Traffic Records Systems* to explain the optimal performance measures that NH should be tracking for its data. These measures will allow the State to evaluate its data quality and direct its improvement efforts accordingly. Many more specific recommendations for each dataset were made in the Traffic Records Assessment final report.

The sections below discuss the Safety Analyst tools, followed by some of the most important data enhancements that can be made to support the HSIP.

Safety Analyst Software

In 2009 NHDOT adopted the AASHTOWare Safety Analyst™ software package to automate the roadway safety management process presented in Part B of the HSM. The four modules in Safety Analyst relate directly to the six chapters in HSM Part B:

Module 1: Network Screening (HSM Chapter 4)
Module 2: Diagnostics and Countermeasure Selection (HSM Chapters 5 and 6)
Module 3: Economic Appraisal and Priority Ranking (HSM Chapters 7 and 8)
Module 4: Countermeasure Evaluation (HSM Chapter 9)

The data requirements to fully implement the tools in Safety Analyst on all public roads are extensive. Phased implementation of Safety Analyst will be from 2010 - 2017 as shown below.

Phase	State Roads/Including Compact	Local Roads
Segment Data	Completed in 2010	Complete in 2012
Intersection Data	Completed in 2010 – 2012	Completed in 2013[2]
Ramp Data	Completed in 2013[3]	N/A
Traffic Data	2010 – 2013[4]	2010 – 2013[3]
Module 1	2010 – 2013	2013
Module 2	2010 – 2013	2014
Module 3	2010 – 2013	2014
Module 4	2013 – 2016	2016[5]

NHDOT is currently using Safety Analyst Module 1 for network screening on all public roadways, intersections, and ramps. The accuracy of the results is limited primarily by the quality of the crash data and locatability of the crash data, and secondarily by traffic volume data on local roads and rural collectors. In increasing the quality and usefulness of Safety Analyst as a tool to advance safety it is vital that these datasets be complete.

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[2] These will be implemented in 2013, but will not have the same MIRE elements as state roads until we invest approximately 6,000-10,000 hours of data collection (estimated by VHB in 2012 MIRE-MIS proposed work plan)

[3] Complete for current DOT data. About 50% of the traffic volumes for ramps are missing in Safety Analyst databases.

[4] Complete for all data available to Bureau of Highway Design (GIS roads layer and functional class 9 and 19 estimates)

[5] Data for state projects on local roads will be collected similarly to those on state roads, while collection of local project data will require a significant level of additional effort in coordination. For this reason collection of local data may not be realistic at this time.

As more work is done to implement Modules 2-4 Safety Analyst will be able to diagnose safety issues at locations of interest and recommend countermeasures to prevent those issues. These countermeasure selections are stored and evaluated for estimated economic effectiveness and priority relative to other proposed countermeasures. Finally countermeasures that have been constructed with adequate before and after periods of crash data can be automatically evaluated to understand the effectiveness of those countermeasures in NH. This data is an important factor in decisions to implement those countermeasures in the future. Working through this cyclical safety management process is the recommended method in the HSM to manage the safety of a road network.

Additional effort is required before Modules 2-4 can be fully used. The default settings for diagnostic scenarios, CMFs, countermeasure data, costs, and other related settings should be reviewed prior to deployment. A database of construction projects and countermeasures implemented during those projects must be developed for Module 4. This should have as many projects constructed in the state as possible within the last 7-10 years, and not just HSIP projects. Only evaluating the effects safety-related projects will introduce a regression-to-the-mean bias that would make countermeasures seem more effective than they would be if constructed or installed at other similar sites without the same high crash frequency. All customization of Module 2 and 3 should be complete in 2014 and Module 4 fully implemented by 2016.

Safety Performance Functions

SPFs are predictive models that are used to estimate the crash frequency of a site based on its traffic volumes, geometric and cross section characteristics, and other data. There are several common forms of SPFs. In the case of SPFs used in Safety Analyst, AADT and segment length are the only independent variables and roadway characteristics are factored into the subtype categories used to develop the SPFs. These SPFs are meant for planning-level network screening analysis only. The SPFs provided in HSM Part C and developed in most SPF research are meant for project-level analysis using the Predictive Method in Part C of the HSM. These either predict the crash frequency for a set of base conditions at the site’s traffic volume and modify the prediction using CMFs that account for differences between the base conditions of the model and those at the site being analyzed, or they predict the crash frequency without CMFs using a number of covariates for roadway characteristic data. NHDOT is only using the default SPFs in Safety Analyst for network screening at this time (developed with data from other states), but development of SPFs using NH data has begun to replace the Safety Analyst default SPFs and account for roadway types that are not available in Safety Analyst at this time, such as roundabouts. There is an update planned for Safety Analyst to allow SPFs of any form to be used for screening that should be implemented within the next year. FHWA Office of

Safety is also in the preliminary stages of developing a SPF Clearinghouse that will make SPFs readily available similar to how the CMF Clearinghouse presents CMFs. NHDOT should make an effort to allow for the use of these features as they become available.

In order to use the SPFs in HSM Part C or those developed with data from outside NH the functions must be calibrated. This process has not been completed for NH yet so project-level analysis is not used to evaluate the safety effects of proposed countermeasure alternatives. The procedure to calibrate SPFs is explained in the HSM and is done automatically for projects when using the Interactive Highway Safety Design Model (IHSDM), a tool capable of completing project-level predictive analysis using the SPFs from the HSM. Any SPFs developed for NH should be recalibrated every year. If new SPFs are developed every year they do not need to be calibrated.

Crash locatability, as described in a following section, affects the accuracy of SPFs because crashes that cannot be located in Geographic Information Systems (GIS), or non-locatable crashes, cannot be modeled in SPF development or calibration. However, non-locatable crashes have the same effect on predicted crash frequencies whether using SPFs developed for NH or calibrating other SPFs. For the reasons listed in this section, SPFs should be developed for NH when possible, rather than calibrated. Improvements to crash location information and crash type data elements will greatly improve the quality of quantitative safety analysis in NH.

Crash Modification Factors and Functions

CMFs are values that describe the effect of changes in a roadway on crash frequency. CMFs typically represent the effect of installing or removing engineering countermeasures on a roadway or set of roadways. In regard to the HSM these are called Part D CMFs. Another type of CMF is used as part of an SPF in the calculation of predicted crash frequency, and represents differences in roadway conditions. These are usually called Part C CMFs. Part C and Part D CMFs are not interchangeable and each has specific uses. The CMFs that will be discussed in the rest of this manual are the Part D CMFs, which are those used in calculation of safety benefits and widely available on the CMF Clearinghouse website (cmfclearinghouse.org), in Part D of the HSM, and other research. Crash modification factors are simply multiplicative factors that are used to compute the effect of implementing a countermeasure. Thus CMFs less than 1.0 indicate a reduction in crashes, while those greater than 1.0 indicate an increase in frequency. CMFs are similar to crash reduction factors (CRFs) but are displayed differently. For example a CMF of 0.65 would represent a 35% crash reduction when multiplied by the expected crash frequency at a site. The CRF for that same countermeasure would be 35. Crash modification functions work the same way, although the factor varies usually based on a characteristic of the roadway (e.g. intersection skew).

There are many considerations when applying CMFs in safety engineering. The first is the quality and confidence in the results of the study producing the CMF. Two measures of this are the star rating on the CMF Clearinghouse and the font format of the CMF values in the HSM. Only the CMF of the highest quality that is most applicable to the site and conditions in NH should be used for HSIP purposes. If no reliable CMFs are available, it is acceptable to estimate one based on experience and other similar CMFs. Another consideration is the combining of CMFs. Nearly all current research in development of CMFs assumes that safety effects of implemented countermeasures are independent. Countermeasures implemented together usually have reduced individual effects when combined since they will target some or all of the same crash types. The most common practice to determine the combined effects of implementing multiple countermeasures at one location is to multiply the CMFs together. In cases where the countermeasures act completely independently this is an appropriate application, but where the same crashes are affected by each countermeasure the combined effects are overstated with this method. There are several new methods proposed in recent research that can be used to account for these issues. Also note that combining effects of more than two or three countermeasures at a location increases the uncertainty in the resulting crash reduction due to differences in studies, data sources, etc. Therefore careful review of CMF application is important in reviewing proposed project economic calculations.

There is a need for an update to the list of CMFs for use in NH. Currently there is a short list of CRFs that are provided with the HSIP Project Application Spreadsheet that is out of date and not comprehensive. The list should be updated to CMFs from CRFs to reflect the standard of practice and include a CMF for as many countermeasures that would be used in NH as possible. CMFs from all sources should be reviewed and one CMF for each application of the countermeasure selected for the State. The intent is to maintain an updated list of CMFs to be used in all applications of highway safety in NH. This would prevent improper application of CMFs not applicable to NH roads, and allow for fair evaluation of proposed projects implementing the same countermeasures. NHDOT has the capability to calculate effectiveness of implemented countermeasures in order to develop CMFs for NH.

Crash Locatability

Crash location is one of the most important data elements for safety performance analysis. Location information from the crash report is used to programmatically geolocate crashes for use in GIS and Safety Analyst using several linear referencing systems. Without location data crashes cannot be related to roadway data. There are a large proportion of crashes that remain non-locatable after this processing (about 35-40% of all crashes), which must be geolocated manually in GIS before they can be used in analysis. At this time this is only completed for fatal and severe injury crashes to ensure they can all be analyzed. The HSIP requirement to identify the number of fatalities and serious injuries on all public roads in the State with a breakdown by functional classification and ownership in the State is codified in 23 USC 148(c)(2)(D)(v) and 23 USC 148(i). However in order to accurately screen the roadway network to identify hazardous locations and determine high risk roadway features, a much higher percentage of accurately located crashes resulting in all injury types is required for NH. SPF development or calibration, and technical safety analysis tools, cannot account for crashes that have not been located in GIS even if location data was reported. It is also known that some crashes are located incorrectly, or only partially located (e.g. at the midpoint of a route), creating an artificially high or low crash frequency at a site.

Efforts to correct these location errors are important in developing a high quality dataset. Sites with higher crash frequencies are typically removed from network screening results if these types of issues are apparent in the data, while sites with artificially low crash frequencies due to these errors are impossible to determine. Network screening, diagnosis of safety issues, and economic calculations to determine safety benefit are all negatively affected by non-locatable crashes. As crash locatability improves, it will make the relative frequency, severity, and type of crashes more accurate in regard to the actual crashes that sites have experienced. Improvements in programmatic location techniques and logic are expected to improve the quality of historic crash data, while the new Crash Reporting Management System that allows for electronic crash reporting is expected to greatly improve collection of higher quality crash data in the future.

Crash Types

Crash types are an important factor in diagnosing safety issues at sites and in identifying high risk roadway elements for systemic treatments and emphasis areas. Many countermeasures (e.g., roundabouts, signals) are effective at reducing one or many crash types, but may increase crashes of other types. Crash types for single-vehicle crashes are typically well documented in the database, however the majority of multi-vehicle crashes do not have a reported crash type or it is unknown. There are several elements in the crash data that can be used to predict the type of crash, such as direction of vehicle or pre-crash vehicle action, but these are not being used to compute crash types. Quality of data input for crash type, or “DIAGRAMCODE” from the crash report , is sporadic at best as this information is typically specified by point of impact (12 clock points signifying sides of the car) and/or described in the gist. This data currently does not make it into the database. When the CRMS is in place statewide several crash types will be available from the crash report.

Enhancements to the crash type element would allow engineers to more quickly identify safety issues, select appropriate countermeasures to treat those crash types, and perform more accurate economic evaluations of the safety benefits. The effectiveness of systemic treatments implemented in NH would also improve, especially at intersections and urban areas where the majority of crashes are multi-vehicle.

Crash Severity

NH uses a variation of the common KABCO injury scale, or severity index, for reporting crash severity as shown below:

K	Killed
A	Incapacitating Injury
B	Non-Incapacitating Injury
C	Possible Injury
U	Unknown Injury
N	No Apparent Injury

Fatal and severe crashes include killed and incapacitating injury severity levels (KA or FS). Fatal and all injury crashes include killed, incapacitating, non-incapacitating, and possible injury crashes (KABC or FI). These are the most common severity groups used in highway safety. Note that any comparison of the number of incapacitating injuries or crashes in NH to what are considered severe injuries or crashes in other states may be incorrect if the state or states do not use the KABCO scale. Unknown injury and no apparent injury crashes are both considered property damage only (PDO). National research is planned to evaluate the differences in injury scales used by states, and may recommend a uniform injury scale to be used in the future that would normalize the performance measures reported for HSIP and other programs.

Horizontal Curves

Of critical importance to roadway safety in NH is a clear understanding of the geometric conditions where fatal and severe injury crashes are occurring on horizontal curves. Lane departure crashes are one of the two types of crashes addressed in the Crash Locations CEA of the NH SHSP, and are the predominant and most severe crash type on curves. It is known that the average crash rate for sections of horizontal curvature is about two to three times the average rate for tangent sections on similar roadways. Changes in driver expectancy, speed inconsistencies, and vehicle maneuvers are common contributing factors to crashes on curves. NHDOT is evaluating several methods that could be used to develop a curve database to allow for analysis of specific curve characteristics that contribute to lane departure crashes. In 2012 a NHDOT consultant proposed a methodology to use the differences in bearing in each point collected along the road from the State's video log data to identify sections of curvature. There are also other methods that can be used such as performing a similar calculation of bearing differential between consecutive vertices in the GIS roads basemap, or to estimate radius of curvature and plot the center of the circles created by the curves in the roadway using sets of three consecutive vertices. In the latter GIS method, used by NHDOT for identifying curves for the Highway Performance Monitoring System, the plotted centers of the circles are well grouped spatially in sections of curvature. The accuracy of each method should be a major consideration when moving forward with a plan to continue this project.

The intent is to progress with collection and verification of curves on all public roads throughout the state using one or more of these methods, either by a consultant, NH LTAP, or NHDOT staff. Our strategy is to create site subtypes of horizontal curves, accounting for curve length, radius, superelevation, presence of spiral transition, roadway type, and area type. Speed and AADT may also be evaluated. Once the distributions of these subtypes are determined, SPFs will be created for each subtype.

Local Roads and Traffic Volumes

Municipally-maintained local roads and intersections are included in the screening with State-maintained sites and are evaluated using the same methodology. The majority of traffic data is not available for rural collectors and rural and urban local roads (functional class 8, 9, and 19), and therefore the volumes are estimated by the median of measured AADT on roads of the same functional class and county. Separate SPFs for urban and rural local roads (functional class 9 and 19) are used in network screening to account for the estimation of volume data on nearly all of those roadways.

Not only does this incompleteness create inaccuracies in network screening, but it creates difficulties in evaluating High Risk Rural Roads and developing SPFs. Whereas AADT is the most significant indicator of crash frequency, it is difficult to evaluate safety risks and predict crash frequencies on roadways that do not have measured traffic volume data. An effort to compile all traffic volume data from NHDOT, MPOs, RPCs, and other sources, whether measured or modeled, would significantly improve the safety analysis capabilities of NHDOT.

Below is a table of the centerline miles that have measured AADT values by federal functional class:

Area Type	FC #	Functional Class Description	Centerline Miles	% with AADT
RURAL	1	Principal Arterial--Interstate	362.2	95.84%
	2	Principal Arterial--Other	403.7	96.10%
	6	Minor Arterial	472.9	99.45%
	7	Major Collector	1094.3	99.70%
	8	Minor Collector	1146.0	50.04%
	9	Local--Public	7965.6	6.54%
URBAN	11	Principal Arterial--Interstate	228.9	93.24%
	12	Principal Arterial--Other Freeways and Expressways	155.6	81.50%
	14	Principal Arterial--Other	254.3	83.73%
	16	Minor Arterial	513.5	97.29%
	17	Collector	506.1	98.59%
	19	Local--Public	3599.7	5.18%

APPENDIX

Glossary

Benefit-Cost Ratio (BCR): Present Value of Safety Benefits ÷ Present Value of Construction Costs and Maintenance

Highway Safety Manual (HSM): A document, released in 2010 and published by AAHSTO, intended to provide practitioners with the best factual information and proven analysis tools to facilitate integration of quantitative safety analysis into roadway planning, design, operations, and maintenance decisions. The primary focus of the HSM is to promote application of predictive methods that more accurately assess the safety impacts of transportation projects and programs than less reliable, commonly used tools.

Intersection-Related Crashes: Crashes where the location of first harmful event was reported as "At Intersection" or "Intersection Related" and geolocated within the intersection influence zone (100 ft for urban intersections or 250 ft for rural intersections, unless otherwise specified during data collection).

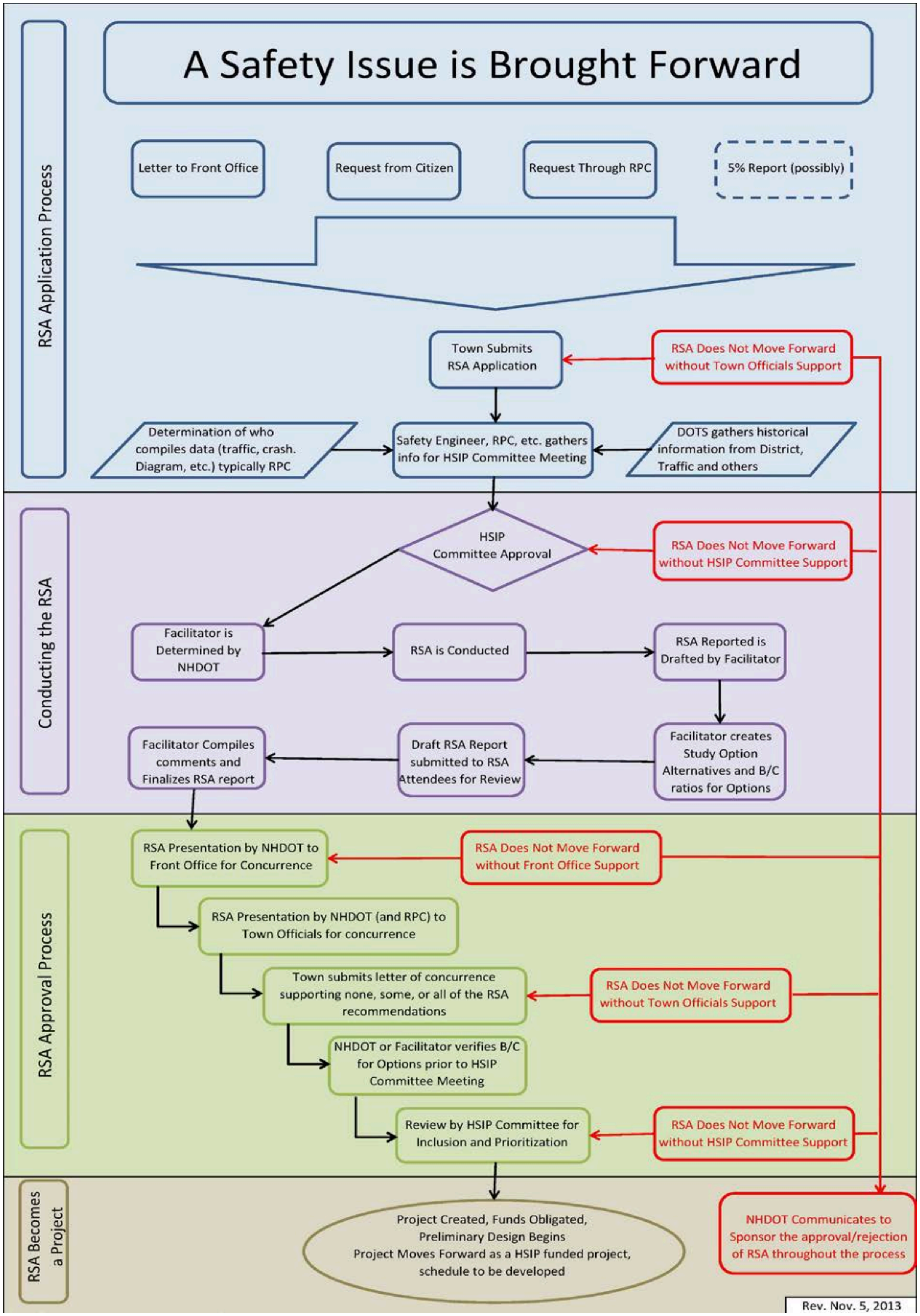
Lane Departure Crashes: Includes "Fixed Object" crashes, crashes where location of first harmful event was reported as "Off Roadway on Shoulder/Median" or "Off Roadway beyond Shoulder," Head-On, and Sideswipe (Opposite) crash types

Net benefit: Present Value of Safety Benefits – Present Value of Construction Costs and Maintenance

Network Screening: The process of analyzing sites along a roadway network to identify and rank sites with potential for safety improvement.

Safety Analyst: A set of state-of-the-art analytical tools for use in the safety decision making process to identify and manage a system-wide program of site-specific improvements to enhance highway safety by cost-effective means. This software automates the roadway safety management process presented in HSM Part B.

Road Safety Audit Process



Sample RSA Application Form

ROAD SAFETY AUDIT APPLICATION

1. Name, Position/Title, Address of Contact Person:

_________________________________ Phone Number: __________________
_________________________________ Fax:___________________________________
_________________________________ Email: __________________________________*

1. Type of assessment requested (planning, design, construction, existing): ____________________________
2. Specific location of proposed RSA project (intersection, spot location, road segment or project, or new facility):

Route(s): ______________________Intersecting Road ______________ Project: ____________________
From/To (if segment/project): ______________________________ Segment Length: _____________
City/Town/County: __________________________RPC____

3. Describe any improvement plans, including stage (scoping, design, construction, etc.), for this location:
____
4. Reasons for requesting RSA:
____
____
5. What is the crash experience for the most recent 10 -year period (total crashes, fatal crashes, injury crashes, crash rate, etc.)? (Attach Crash Records and Diagram (intersection) Not applicable for new facility)
____
____
6. Does your agency have a method to identify and prioritize road safety issues? ___________ If yes, where does this location rank within your agency's problem locations____
7. Average Daily Traffic (ADT) volume for road(s), turning movements intersections attached:________________
8. Please list month and/or days of week when safety issues are most prevalent, if applicable:
____
9. Describe any future development planned for this area:
____
10. Please include any additional road owners, photos and/or other information that highlight the location:
____
11. Signature (and printed name) of Person with Authority to Respond To/Implement the RSA Findings:

____ Date: ______________________

State Road District Engineer ___________________ City/Town Road Agency Signature __________________RPC Signature_______________

Submit Application to:

Michelle Marshall
Highway Safety Engineer
7 Hazen Drive, PO Box 483
Concord, NH 03302-0483

Phone: 603-271-1407
Fax: 603-271-7025
Email:memarshall@dot.state.nh.us

Sample HSIP Project Application Spreadsheet (Page 1)

HSIP-Application (Rev 8/20/13) New Hampshire Department of Transportation Highway Safety Improvement Program	New Hampshire DOT Department of Transportation	Project Towns:	Project #:
Highway Safety Improvement Project (HSIP) FY2013-14 Application		Date Rec'd	(for office use only)

Name:		Agency:		Tel:		Email:	
Street Address:		Cell:		Fax:		RPC Name:	
Town, State, Zip		Priority Rank: (if submitting 2+ applications this year)				Site submitted in past yrs?	

Site Type	NHDOT District	County	Major Road/Minor Road	Main-tenance	Traffic Control	MP Start/Major Rd SRI	MP End/Minor Rd SRI	Study Period Begins	Study Period Ends
Major Rd Funct Class			**Minor Rd Funct Class**			**Area Type**		**Federal System**	
Briefly Describe Problem and Proposed Work									

Crash Data	Severity / Crash Type		Rear End	Sideswipe Same Direction	Left Turn	Right angle	Run off Road	Head On/ Sideswipe - Opposite	Pedestrian	Bicycle	Other	Total Related Crashes	Crash Severity Distribution
	Fatal	K = 1											
	Injury	A = 2											
		B = 3											
		C = 4											
	PDO	U+N = 5+6											
		Total											

NOTE: For traffic data , please fill corresponding section for intersection and segment projects. Do not fill both traffic data sections.

Discount Rate (min rate of return): 3.0%

Traffic Data (Inter.)	Year	Enter. AADT	NB AADT	SB AADT	EB AADT	WB AADT	Other leg AADT	# of Approaches	Crash Rate (Intersection)	Critical Rate (Intersection)	Intersection Node	Traffic Annual Growth Rate
												0.01

Traffic Data (Segment)		Sec 1	Sec 2	Sec 3	Sec 4	Sect 5	Total/ Average	Speed Limit (Average)	Crash Rate (Segment)	Project location listed on the latest Transparency Report? (Y/N)
	Year									
	Segment Length (Mile)									
	Average AADT							Lane Width (ft)	Critical Rate (Segment)	
	Number of Lanes									

Method for combining multiple CMFs:

Project Cost Information

Improvement Action	Number	Improvement Description	Service Life	CMF Fatal	CMF Injury	CMF PDO	PE cost plus $5000 (2)	R/W Utility	Construction	Improvement Initial Cost	Annual Maintenance
	1									$ -	
	2									$ -	
	3									$ -	
	4									$ -	
	Total		0	1.00	1.00	1.00	Total Initial Cost	$ -		$ -	$ -

NOTE: (1) A local agreement is required upon notification of program approval for municipal maintained roads. (2) NH District and Central Office personnel charge review and administration time to project managed by municipalities. Safety Projects not managed by NHDOT shall include a minimum of $5,000 for NHDOT PE costs

Project Schedule (After STIP Approval)	Begin PE	Target Advert.	Begin Construction	Estimated Complete Date	Type of Plan

Project Administrated by:

Economic Evaluation	Benefit	Traffic Growth Factor (TGF)	Present Value of Safety Benefits	Cost	Present Value of Project Costs
		1.00	$ -		$ -
	Benefit Cost Ratio				
	Net Benefit				
	Annual KA Crash Reduction				

Project Benefit Information

Crash Severity	Societal Crash Cost	Related Crashes	Annual Crash Reduction	Estimated Annual Benefit
K	$ 5,463,500	0	-	$ -
A	$ 291,300	0	-	$ -
B	$ 106,400	0	-	$ -
C	$ 60,200	0	-	$ -
PDO	$ 9,800	0	-	$ -
Total		0	-	$ -

Person with Authority to Expend 10% Matching Funds:

Name (Print):		Signature:		Date:	

NHDOT anticipates providing the 10 percent match for the FY2013-14; however, the applicant should be able to supply the local match if state funding becomes unavailalble. Please submit an electronic copy of this spreadsheet to MEMarshall@dot.state.nh.us and mail a paper copy with signature to the address below.

Mailing address:

New Hampshrire Department of Transporation
Bureau of Highway Design
7 Hazen Drive, PO Box 483
Concord, NH 03302-0483
Attention: Michelle E. Marshall

Towns:
Town Engineers are requested to submit applications within their jurisdiction through the Regional Planning Commission and forward them to the State Highway Safety Engineer.

Districts:
Resident Engineers are requested to submit applications within their residency through the District Engineers and forward them to the State Highway Safety Engineer.

(3) The yellow are required inputs and white areas are optional. The gray areas are automatically generated by embedded formulas.
(4) For all fields, please refer to "Instruction for FY2011-12Highway Safety Improvement Project (HSIP)"

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