SHRP 2

STRATEGIC HIGHWAY RESEARCH PROGRAM

Accelerating solutions for highway safety, renewal, reliability, and capacity

Publications Catalog

TRANSPORTATION RESEARCH BOARD

OF THE NATIONAL ACADEMIES

Transportation Research Board

2013 Executive Committee*

SHRP 2 Publications Catalog January 2014

In 2005, Congress authorized the second Strategic Highway Research Program to focus for a fixed time on a small number of big challenges facing the nation:

- The aging Interstate highway system and other roads, vital to commerce and to mobility, need to be renewed, but current traffic volumes, close-by communities, and expectations of the driving public demand more efficiency in the renewal process than traditional methods can deliver.
- The costs of congestion are mounting and they reach far beyond the roadway. Traffic congestion contributes to the number of crashes and fatalities, to greenhouse gas emissions, to increased costs of moving goods, and to driver frustration and diminished quality of life.
- The gains in reducing traffic crashes and fatalities are eroding as technologies compete for drivers' attention, the number of aging drivers increases, and there is relatively little objective basis for addressing driver behavior.

Addressing these challenges became the mission of the second Strategic Highway Research Program, which expressed its intent in this vision statement: A highway system that actively contributes to improved quality of life for all Americans by providing safe, efficient mobility in an economically, socially, and environmentally responsible manner.

This catalog lists the available research reports that document more than 100 research projects, and other publications that provide guidance and tools for implementing the research results.

All SHRP 2 research reports will be available on the TRB website at http://www.trb.org/StrategicHighwayResearchProgram2SHRP2/SHRP2ResearchReports.aspx. Reports that are also printed will be available from the TRB online bookstore.

*To make research available as early as possible, SHRP 2 is temporarily posting final reports that have been submitted by the research team, undergone technical review according to the relevant National Academy of Sciences procedures, and accepted for publication. These prepublication drafts, which have not been edited or formatted for publication, will be replaced by the final versions as they complete the editorial process. They are marked by an asterisk.

Transportation Research Board

SHRP 2 Staff

Ann M. Brach, Director
Stephen J. Andrle, Deputy Director
Neil J. Pedersen, Deputy Director, Implementation and Communications
Cynthia Allen, Editor
Kenneth Campbell, Chief Program Officer, Safety
JoAnn Coleman, Senior Program Assistant, Capacity and Reliability
Eduardo Cusicanqui, Financial Officer
Richard Deering, Special Consultant, Safety Data Phase 1 Planning
Walter Diewald, Senior Program Officer, Safety
Shantia Douglas, Senior Financial Assistant
Charles Fay, Senior Program Officer, Safety
Carol Ford, Senior Program Assistant, Renewal and Safety
Jo Allen Gause, Senior Program Officer, Capacity
Rosalind Gomes, Accounting/Financial Assistant
James Hedlund, Special Consultant, Safety Coordination
Alyssa Hernandez, Reports Coordinator
Ralph Hessian, Special Consultant, Capacity and Reliability
Andy Horosko, Special Consultant, Safety Field Data Collection
William Hyman, Senior Program Officer, Reliability
Linda Mason, Communications Officer
Reena Mathews, Senior Program Officer, Capacity and Reliability
Matthew Miller, Program Officer, Capacity and Reliability
Michael Miller, Senior Program Assistant, Capacity and Reliability
David Plazak, Senior Program Officer, Capacity
Rachel Taylor, Senior Editorial Assistant
Dean Trackman, Managing Editor
Connie Woldu, Administrative Coordinator

The Second Strategic Highway Research Program

America's highway system is critical to meeting the mobility and economic needs of local communities, regions, and the nation. Developments in research and technology—such as advanced materials, communications technology, new data collection technologies, and human factors science—offer new opportunities to improve the safety and reliability of this important national resource. Breakthrough resolution of significant transportation problems, however, requires concentrated resources over a short time frame. Reflecting this need, the second Strategic Highway Research Program (SHRP 2) has an intense, large-scale focus, integrates multiple fields of research and technology, and is fundamentally different from the broad, mission-oriented, discipline-based research programs that are the mainstay of the highway research industry.

The need for SHRP 2 was identified in TRB Special Report 260: Strategic Highway Research: Saving Lives, Reducing Congestion, Improving Quality of Life, published in 2001 and based on a study sponsored by Congress through the Transportation Equity Act for the 21st Century (TEA-21). SHRP 2, modeled after the first Strategic Highway Research Program, is a focused, time-constrained, objective-driven program designed to complement existing highway research programs. SHRP 2 focuses on applied research in four areas: Safety, to prevent or reduce the severity of highway crashes by understanding driver behavior; Renewal, to address the aging infrastructure through rapid design and construction methods that cause minimal disruption and produce lasting facilities; Reliability, to reduce congestion by using travel time reliability as a tool for planning, designing, and operating highway systems; and Capacity, to integrate mobility, economic, environmental, and community needs in the planning and designing of new transportation capacity.

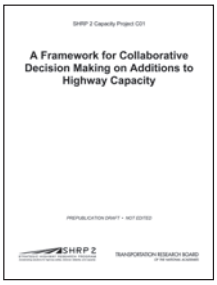
SHRP 2 was authorized in August 2005 as part of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). The program is managed by the Transportation Research Board (TRB) on behalf of the National Research Council (NRC). SHRP 2 is conducted under a memorandum of understanding among the American Association of State Highway and Transportation Officials (AASHTO), the Federal Highway Administration (FHWA), and the National Academy of Sciences, parent organization of TRB and NRC. The program provides for competitive, merit-based selection of research contractors; independent research project oversight; and dissemination of research results.

SHRP 2 Reports
Available by subscription and through the TRB online bookstore: www.TRB.org/bookstore
Some reports are also available as e-books. They are identified in this document.
Contact the TRB Business Office: 202-334-3213
More information about SHRP 2: www.TRB.org/SHRP2

Contents

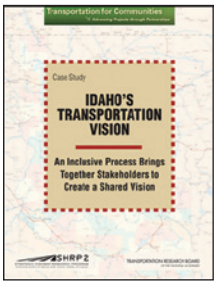
COLLABORATIVE DECISION MAKING

A Framework for Collaborative Decision Making on Additions to Highway Capacity (C01)*



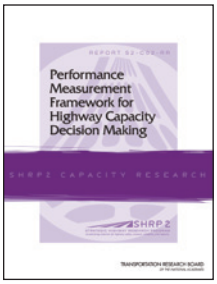
When planning for highway capacity, successful practice requires the right people, with the right information to be at the right place at the right time. To improve collaboration among decision makers, SHRP 2 Project C01 (A Framework for Collaborative Decision Making on Additions to Highway Capacity) developed a flexible and adaptable framework that provides specific information on how to support collaborative decision making within existing laws and regulations. The final report describes the framework, summarizes the findings from case studies used to develop the framework, and describes the web tool developed around the framework, Transportation for Communities—Advancing Projects through Partnerships (TCAPP).

Case Studies in Collaboration (C01)



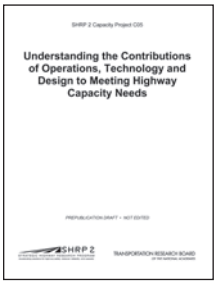
One way to understand how collaboration can be incorporated into transportation decision making is through the use of case study examples. These cases represent successful use of collaboration across a variety of transportation applications in 23 projects; they document real-world best practices, pitfalls, and lessons learned. The case studies were developed in 2007 through Capacity Project C01: A Framework for Collaborative Decision Making on Additions to Highway Capacity and were integrated into Transportation for Communities—Advancing Projects through Partnerships (TCAPP).

Performance Measurement Framework for Highway Capacity Decision Making (Report S2-C02-RR-2)



This project developed a performance measurement framework to support the collaborative decision guide for additions to highway capacity developed under the SHRP 2 Capacity research program. The report examines five broad areas of performance including transportation, environment, economics, community, and cost. Under these headings, the report identifies 17 performance factors, each of which is linked to key decision points in the CDMF.

Understanding the Contributions of Operations, Technology, and Design to Meeting Highway Capacity Needs (C05)*



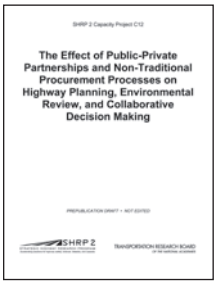
The final report for SHRP 2 Project C05, Understanding the Contribution of Operations, Technology, and Design to Meeting Highway Capacity Needs is a guide to using enhanced simulation methods that can test the impact of alternative traffic operations strategies and demonstrate whether or not they solve a highway capacity problem. The report describes the enhancements and methodology used to evaluate the effectiveness of the strategies, either singly or in combination; presents an illustrative application of the enhanced model and methodology as a demonstration of the new and more comprehensive insights that can be obtained by engineers, planners, and decision makers; and recommends an additional enhancement for informing both analysts and decision makers about the opportunities to employ operational improvement strategies in lieu of new construction.

Linking Community Visioning and Highway Capacity Planning (Reports S2-C08-RR-1 and S2-C08-RW-2)

The purpose of SHRP 2 project C08, Community Visioning Approach to Support the SHRP 2 Collaborative Decision-Making Framework for Additions to Highway Capacity, was to help transportation agency practitioners assess the possibilities of community visioning efforts, identify practical steps and activities when engaging in visioning, and establish links between vision outcomes and transportation planning and project development processes. To these ends, this research presents a model—the Vision Guide—for the preparation, creation, and implementation of a visioning process. A companion web tool was also developed. The final report, Linking Community Visioning and Highway Capacity Planning, provides a framework that identifies the basic process and core elements of a vision and establishes possible linkages to transportation planning efforts. This structured, simplified process will better enable practitioners to engage in visioning in support of transportation planning. Also available as e-book for iPad and other ePub format readers (Google Play, Apple iBookstore) and for Kindle (Amazon Kindle Store).

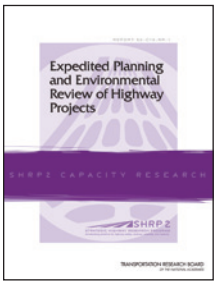
The appendices, which include case studies and a collection of resources, were published as a separate document, S2-C08-RW-2, and are available only as a PDF. The Vision Guide is connected to the transportation planning and project development processes identified in related SHRP 2 Capacity research and presented in the Decision Guide structure on the website Transportation for Communities—Advancing Projects through Partnership (TCAPP), found at www.transportationforcommunities.com.

The Effect of Public-Private Partnerships and Non-Traditional Procurement Processes on Highway Planning, Environmental Review, and Collaborative Decision Making (C12)*



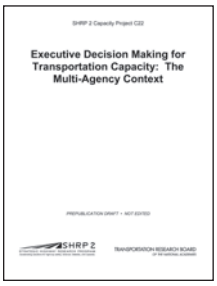
Public-private partnerships (P3s) are contractual agreements between public agencies and private entities that allow for greater private-sector responsibility in the design, delivery, financing, operation, and maintenance of transportation improvements as compared to traditional design-bid-build procurements. SHRP 2 Project C12, The Effect of Public-Private Partnerships and Non-Traditional Procurement Processes on Highway Planning, Environmental Review, and Collaborative Decision Making, assessed the interplay between the use of P3s and the transportation and environmental planning processes in order to identify how and when P3s are best considered as a means to procure transportation improvements. The final report documents these activities.

Expedited Planning and Environmental Review of Highway Projects (Report S2-C19-RR-1)



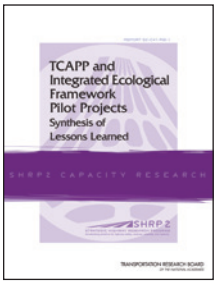
Delay in delivering new transportation projects is a national concern because it increases costs, prolongs congestion, and denies the nation the economic and mobility benefits of added transportation capacity. The final report for SHRP 2 Project C19, Expedited Planning and Environmental Review of Highway Projects, will be of interest to practitioners in the areas of long-range planning, corridor planning, programming, and environmental review. It describes constraints on expediting project delivery and useful strategies for achieving expedited delivery. While the strategies and constraints are associated with planning and environmental review, many of the strategies are applicable to design and construction. The results of this project are also available on the SHRP 2 website Transportation for Communities—Advancing Projects through Partnerships (TCAPP). TCAPP provides a series of self-evaluation questions organized around the constraints to help determine whether an agency is structured to regularly deliver projects in an expedited manner. Also available as e-book for iPad and other ePub format readers (Google Play, Apple iBookstore) and for Kindle (Amazon Kindle Store).

Executive Decision Making for Transportation Capacity: The Multi-Agency Context (C22)*



Transportation for Communities—Advancing Projects through Partnerships (TCAPP) provides agencies and practitioners with guidance on reaching collaborative decisions as they work through the traditional transportation planning, programming, and permitting processes. TCAPP is designed for practitioners, but to succeed in practice, it will need support from upper-level managers and CEOs within transportation agencies and environmental resource agencies. The purpose of SHRP 2 Project C22, Executive Decision Making for Transportation Capacity: A Multi-Agency Context, was to translate the benefits of TCAPP into marketing principles, potential strategies, and messages for transportation and resource agency decision makers. The final report documents the research, synthesizes the findings, and presents principled direction from the market research and some potential next steps.

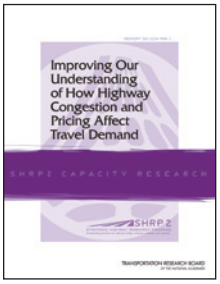
TCAPP and Integrated Ecological Framework Pilot Projects: Synthesis of Lessons Learned (Report S2-C41-RW-1)



Transportation for Communities—Advancing Projects through Partnerships (TCAPP) provides agencies and practitioners with guidance on reaching collaborative decisions as they work through the traditional transportation planning, programming, and permitting processes. TCAPP also serves as a portal to other tools, including the Integrated Ecological Framework (IEF), which was developed to serve as a primary resource for those seeking to balance transportation needs with environmental protection. To test both the premises of TCAPP and the IEF, SHRP 2 conducted four pilot tests of TCAPP in Project C18 and four pilot tests of the IEF in Project C21. The SHRP 2 Project C41 Synthesis Report presents an overview of the TCAPP and IEF pilot studies, and it highlights and synthesizes key findings of the research.

DYNAMIC INTEGRATED MODELS AND NETWORKS

Improving Our Understanding of How Highway Congestion and Pricing Affect Travel Demand (Report S2-C04-RW-1)



Over the past 30 years, a large body of research has been carried out to better understand and predict how traveler behavior changes in response to fluctuations in traffic congestion and in the price of travel. The objective of SHRP 2 Project C04, Improving Our Understanding of How Highway Congestion and Pricing Affect Travel Demand, was to synthesize that research to select the most important and well-founded behavioral hypotheses, and then to test those hypotheses statistically on data sets in the United States. The results are documented in the final report, which is intended for those who carry out or direct modeling into highway congestion and pricing policies, and for planners and decision makers who would like to gain a deeper technical appreciation and understanding of particular issues. An unabridged, unedited version of Chapter 3: Demand Model Specifications and Estimation Results is available electronically.

Partnership to Develop an Integrated, Advanced Travel Demand Model and a Fine-Grained Time-Sensitive Network (C10A)*

Transportation decision makers use travel demand and forecasting models to provide information about the impacts of transportation and land-use investments and policies, as well as demographic and economic trends. Improved models can help agencies make more informed decisions about adding highway and transit capacity, improving traffic operations, introducing priced roads, and improving traveler information. SHRP 2 Project C10A, Partnership to Develop an Integrated, Advanced Travel Demand Model and a Fine-Grained Time-Sensitive Network, created a model that integrated an advanced travel-demand model with a fine-grained, time-dependent network in order to evaluate the interplay of traveler behavior and transportation network conditions, including mode options, so that more realistic estimates of travel demand can be generated. The model's performance was then demonstrated through validation tests and policy analyses. The final report documents the implementation, calibration/validation, and sensitivity testing of the model.

ECONOMIC IMPACT ANALYSIS

Interactions Between Transportation Capacity, Economic Systems, and Land Use (Report S2-C03-RR-1)

The Capacity focus area of SHRP 2 is broadly based on the concept that better tools for considering the social, environmental, and economic effects of highway projects as they are planned, programmed, and carried out will result in improved and more rapidly implemented projects. A web-based tool and a large database of informative case studies were developed in Capacity project C03 to support more rapid assessment of the long-term economic impacts of highway capacity projects. With these tools, economic impacts can be considered for a greater number of potential projects and this step can take place earlier in the planning process. Also available as e-book for iPad and other ePub format readers (Apple iBookstore, Google Play) and for Kindle (Amazon Kindle Store).

Development of Tools for Assessing Wider Economic Benefits of Transportation (C11)*

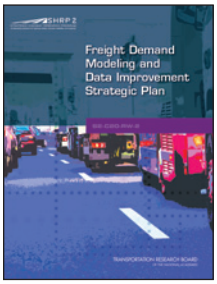
Two SHRP 2 projects studied the economic impacts of transportation projects—Interactions between Transportation Capacity, Economic Systems, and Land Use merged with Integrating Economic Considerations Project Development (Project C03) and Development of Improved Economic Analysis Tools Based on Recommendations from Project C03 (Project C11). Project C03 developed a screening tool, known as T-PICS, which can predict the general range of economic impacts associated with various transportation projects. As a complementary effort, Project C11 developed four spreadsheet tools that can be used to examine specific changes in transportation conditions that are associated with individual project proposals and their economic consequences. The final report for project C11 describes this effort and the four spreadsheet tools, which are available at www.tpics.us/tools.

FREIGHT

Freight Demand Modeling and Data Improvement (Report S2-C20-RR-1)

Freight traffic has generally been growing at a rate faster than passenger traffic on the nation's highway network. As a result, freight bottlenecks have begun to develop at various points throughout the network. Capacity Project C20, Freight Demand Modeling and Data Improvement Strategic Plan, assessed current practice in freight demand modeling and freight data as they relate to highway capacity planning and programming. The research report documents the process used to develop a strategic plan aimed at improving the state of the practice in these areas. Also available as e-book for iPad and other ePub format readers (Apple iBookstore, Google Play) and for Kindle (Amazon Kindle Store).

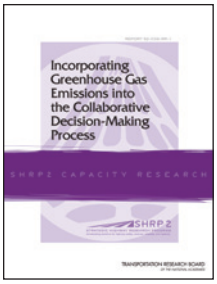
Freight Demand Modeling and Data Improvement Strategic Plan (Report S2-C20-RW-2)



Freight traffic has generally been growing at a rate faster than passenger traffic on the nation's highway network. As a result, freight bottlenecks have begun to develop at various points throughout the network. Capacity Project C20, Freight Demand Modeling and Data Improvement Strategic Plan, assessed the state of the practice of freight demand modeling and freight data as they relate to highway capacity planning and programming. It also developed a strategic plan, which suggests strategic research initiatives that could begin to improve the practice of freight demand modeling and freight data.

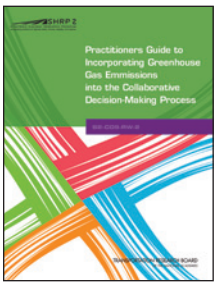
GREENHOUSE GASES

Incorporating Greenhouse Gas Emissions into the Collaborative Decision-Making Process (Report S2-C09-RR-1)



The final report from SHRP 2 Project C09, Incorporating Greenhouse Gas Emissions into the Collaborative Decision-Making Process, presents information to practitioners on how GHG emissions can be incorporated into transportation planning and decision making. Background information on the role of the transportation sector in GHG emissions is described, as are the different trends and factors that will influence future GHG emissions from this sector. Different GHG emissions reduction strategies are presented along with information on cost effectiveness and other means of evaluating the feasibility of such strategies. A technical framework is presented that provides information on the models, data sources, and methods that can be used to conduct GHG emissions analysis. Case studies are used to illustrate different scales and institutional contexts for GHG analyses. Gaps in knowledge and proposed research conclude the report. Also available as e-book for iPad and other ePub format readers (Apple iBookstore, Google Play) and for Kindle (Amazon Kindle Store).

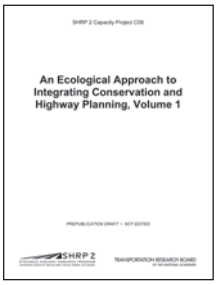
Practitioner's Guide to Incorporating Greenhouse Gas Emissions into the Collaborative Decision-Making Process (Report S2-C09-RW-2)



The Practitioner's Guide to Incorporating Greenhouse Gas Emissions into the Collaborative Decision-Making Process describes four decision contexts—long-range planning, programming, corridor planning, and NEPA/permitting—along with questions that analysts should ask when interested in incorporating greenhouse gas (GHG) emissions into key decision points in each process. A technical framework is presented that provides information on the models, data sources, and methods that can be used to conduct GHG emissions analysis. An appendix to this report provides more detailed technical information that will be useful during such an analysis.

INTEGRATING CONSERVATION, HIGHWAY PLANNING, AND ENVIRONMENTAL REVIEW

An Ecological Approach to Integrating Conservation and Highway Planning, Volume 1 and Guide to the Integrated Ecological Framework (C06A)*



Typically, environmental issues in transportation decision making are considered in relative isolation and overlapping regulatory processes of different agencies are addressed relatively independently. Resource and transportation agencies recognize that this approach can result in less desirable outcomes for the natural environment, while causing delays and increased expenses. SHRP 2 launched two projects—Integration of Conservation, Highway Planning, and Environmental Permitting Using an Outcome-Based Ecosystem Approach (C06A) and Integration of Conservation, Highway Planning, and Environmental Permitting Through Development of an Outcome-Based Ecosystem-Scale Approach and Corresponding Credit System (C06B)—to support the integration of transportation and ecological planning.

These projects developed the Integrated Ecological Framework (IEF), a nine-step process for integrating ecological planning and transportation planning. Volume 1, An Ecological Approach to Integrating Conservation and Highway Planning summarizes SHRP 2 Project C06A. A companion document, Guide to the Integrated Ecological Framework, describes the IEF and outlines a way to integrate the conservation and restoration needs and objectives of multiple entities. The IEF process and the Guide are both incorporated into the web-based resource www.transportationforcommunities.com. Known as TCAPP, this home for many SHRP 2 Capacity products is a decision support system for planning, programming, and project development activities.

An Ecological Approach to Integrating Conservation and Highway Planning, Volume 2 (Report S2-C06-RW-2)

The tight budgets faced by government at all levels make it vital that every dollar spent on environmental mitigation and restoration in transportation project development is well spent. The final report for SHRP 2 project C06, An Ecological Approach to Integrating Conservation and Highway Planning,) is intended to help transportation and environmental professionals apply ecological principles early in the planning and programming process of highway capacity improvements to inform later environmental reviews and permitting. Ecological principles consider cumulative landscape, water resources, and habitat impacts of planned infrastructure actions, as well as the localized impacts. The report introduces the Integrated Ecological Framework (Framework or IEF), a nine-step process for use in early stages of highway planning when there are greater opportunities for avoiding or minimizing potential environmental impacts and for planning future mitigation strategies. This report provides a structured collaborative way to approach these issues; it does not address environmental mitigation and permitting actions required by current law or regulation. Essential content from the C06 project is available on the Transportation for Communities: Advancing Projects through Partnerships website at www.transportationforcommunities.com.

Pilot Tests of TCAPP and the Integrated Ecological Framework

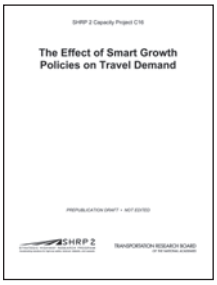
SHRP 2 ran two sets of pilot tests to examine the premises of the Integrated Ecological Framework (IEF) and the Transportation for Communities—Advancing Projects through Partnerships (TCAPP) web tool, which were developed in SHRP 2 Capacity projects. The C18 series of pilots (Pilot Test the

Collaborative Decision-Making Framework with Three DOTs, Including a Self-Assessment Method) tested TCAPP in four scenarios with the Washington State Department of Transportation (DOT), Puget Sound Regional Council, Minnesota DOT, and the Pikes Peak Area Council of Governments (Colorado). The main objective of the C18 series was to test TCAPP while it was still under development and to use feedback obtained from the pilots to modify the product and enhance its usefulness to practitioners. The C21 series of pilots (Pilot Test the C06 A & B Approaches to Environmental Protection) tested the IEF in Colorado, Oregon, California, and West Virginia. Each of these pilots tested specific steps of the 9-step IEF process. The reports from these eight pilot tests are:

- Pilot Test of the Ecological Approaches to Environmental Protection Developed in Capacity Research Projects C06A and C06B
- The Rogue Valley Ecological Framework: Mapping Open Space, Ecologically Important Areas, and Ecological Corridors for Transportation Planners, Agencies, Municipalities, Developers, Conservation NGOs, and Citizens
- California Pilot Test of the Ecological Approaches to Environmental Protection Developed in Capacity Research Projects C06A and C06B
- West Virginia Division of Highways' Roadmap to a Watershed Approach for Maximizing Ecological Lift through Compensatory Mitigation Activities
- Pilot Test of the TCAPP Collaborative Decision-Making Framework Including a Self-Assessment Methodology: Washington State's SR 509 Project
- Long Range Transportation Planning Process: Puget Sound TCAPP Pilot Test
- A New Route to Complete Streets? Using the TCAPP Model in Grand Rapids, Minnesota
- Assessment of Pikes Peak Area Council of Government's Use of TCAPP in Developing a Long-Range Transportation Plan: Technical Evaluation
- TCAPP and Integrated Ecological Framework Pilot Projects: Synthesis of Lessons Learned

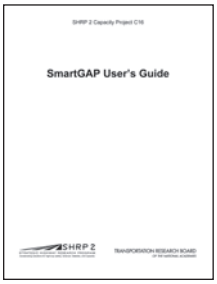
SMART GROWTH

The Effect of Smart Growth Policies on Travel Demand (C16)*



Smart growth policies are often considered by planning agencies as a strategy to reduce congestion, emissions, and other impacts on travel demand. SHRP 2 Project C16, The Effect of Smart Growth Policies on Travel Demand, developed two products to help practitioners understand how smart growth impacts travel demand: (1) a synthesis of research, and (2) a user-friendly software tool that can be used to evaluate the impact of smart growth strategies on travel demand. The final report includes the synthesis of research and describes the software.

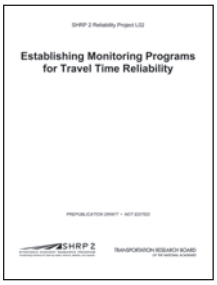
SmartGAP Software and User's Guide (C16)



Smart Growth Area Planning (SmartGAP) is a scenario planning software tool that synthesizes households and businesses in a region and determines their travel demand characteristics based on the characteristics of the built environment and transportation policies that affect their travel behavior. SmartGAP was developed as part of the SHRP 2 Project C16, The Effect of Smart Growth Policies on Travel Demand, which built on existing work in this field, while recognizing that this is a relatively new arena of study in transportation planning. The User's Guide introduces SmartGAP and it provides instructions for installing and using the software.

DATA AND ANALYSIS FOR TRAVEL TIME RELIABILITY PERFORMANCE

Establishing Monitoring Programs for Travel Time Reliability (L02)*



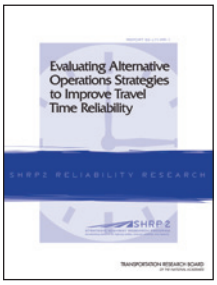
Travel time reliability monitoring programs can help transportation agencies—especially those with transportation management centers—monitor the performance of their system, understand the impacts of the various influencing factors, provide credible information to the system users about what travel time reliability to expect, and decide what actions to take to help improve reliability. SHRP 2 Project L02, Establishing Monitoring Programs for Mobility and Travel Time Reliability, created a suite of methods to help transportation agencies monitor and evaluate travel time reliability. The final report provides a brief narrative about what reliability is and how it can be measured and analyzed.

The project also produced a Guide to Establishing Monitoring Programs for Travel Time Reliability*. The report explains why such a system is useful, how it helps agencies do a better job of managing network performance, and what a traffic management center team needs to do to put a travel time reliability monitoring program in place.

Analytical Procedures for Determining the Impacts of Reliability Mitigation Strategies (Report S2-L03-RR-1)

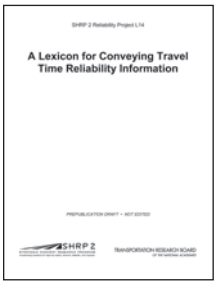
To predict the effects of highway improvement strategies on travel time reliability, SHRP 2 Project L03, Analytical Procedures for Determining the Impacts of Reliability Mitigation Strategies, developed predictive relationships between highway improvements and travel time reliability. How can the effect of an improvement on reliability be predicted? Alternatively, how can reliability be characterized as a function of highway, traffic, and operating conditions? The final report presents two models that can be used to estimate or predict travel time reliability. The models have broad applicability to planning, programming, and systems management and operations. Also available as e-book for iPad and other ePub format readers (Apple iBookstore; will be available on Google Play) and for Kindle (Amazon Kindle Store).

Evaluating Alternative Operations Strategies to Improve Travel Time Reliability (L11)*



SHRP 2 Project L11, Evaluating Alternative Operations Strategies to Improve Travel Time Reliability, identified and evaluated strategies and tactics for satisfying the travel time reliability requirements of users of the roadway network—those engaged in freight and person transportation in urban and rural areas. The intent of this project was to provide a short-term perspective regarding system operations and travel time reliability, and to produce a long-term view with innovative ideas that can be implemented in the future. The final report presents a set of options regarding technological changes, operational solutions, and organizational actions that have the potential to improve travel time reliability both now and in the future (by the year 2030). Will be available as e-book for iPad and other ePub format readers (Apple iBookstore, Google Play) and for Kindle (Amazon Kindle Store).

Traveler Information and Travel Time Reliability (L14)*



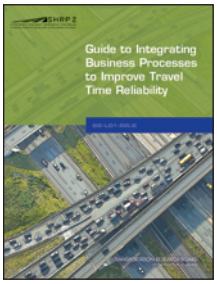
With the right travel time reliability information, travelers can optimize their travel choices. To help transportation agencies communicate this information to travelers, SHRP 2 Project L14, Traveler Information and Travel Time Reliability, conducted a series of human factors experiments with input from a literature review, expert interviews, and a technology and innovation scan. This project produced two reports: (1) A Lexicon for Conveying Travel Time Reliability Information, which provides information on appropriate ways to introduce and provide travel time reliability information to travelers; and (2) Effectiveness of Different Approaches to Disseminating Traveler Information on Travel Time Reliability, which describes the research project.

ORGANIZING TRANSPORTATION AGENCIES TO IMPROVE RELIABILITY

Integrating Business Processes to Improve Travel Time Reliability (Report S2-L01-RR-1)

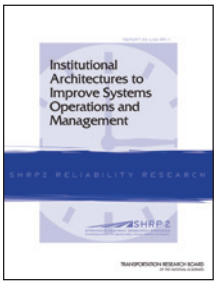
Improving travel time reliability is an emerging business activity for transportation agencies in the United States. To improve the reliability of travel times on their roadway networks, transportation agencies must advance on a number of fronts. These include collecting and analyzing data; integrating travel time reliability considerations into planning, programming, and project delivery; adopting innovative operational strategies and technologies; and modifying their institutional structures and business practices surrounding traffic operations. The final report for SHRP 2 Project L01, Integrating Business Processes to Improve Travel Time Reliability, addresses various ways that transportation agencies can reengineer their day-to-day business practices to improve traffic operations, address nonrecurring traffic congestion, and improve the reliability of travel times delivered to roadway system users. This report, along with the accompanying guide (Report S2-L01-RR-2: Guide to Integrating Business Processes to Improve Travel Time Reliability) and other SHRP 2 Reliability products related to institutional structures and business process reengineering, is intended to help transportation agencies move forward in addressing nonrecurring traffic congestion and delivering more reliable travel times on their highway networks. Also available as e-book for iPad and other ePub format readers (Google Play, Apple iBookstore) and for Kindle (Amazon Kindle Store).

Guide to Integrating Business Processes to Improve Travel Time Reliability (Report S2-L01-RR-2)



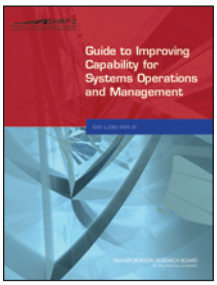
SHRP 2 Research Report S2-L01-RR-2: Guide to Integrating Business Processes to Improve Travel Time Reliability identifies influences that lead to process integration, common obstacles faced when implementing process integration, and an outline of the steps that can be referenced to implement and institutionalize processes. The steps reflect the need to define specific reliability goals, document current business processes and recommended changes, implement a process, measure outcomes against reliability goals, and institutionalize the process. The guide is not specific to any one process. Its purpose is to assist any agency that is seeking to improve travel time reliability through improved coordination and integration of multiple processes and agencies. Also available as e-book for iPad and other ePub format readers (Apple iBookstore, Google Play) and for Kindle (Amazon Kindle Store).

Institutional Architectures to Improve Systems Operations and Management (Report S2-L06-RR-1)



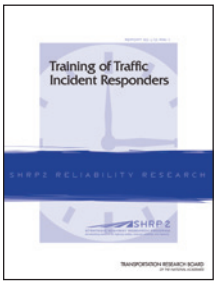
Strategies to improve travel time reliability often focus on highway operations. To be successful, operational strategies may require a collaborative and coordinated effort among many transportation organizations and within their key units. The purpose of SHRP 2 Project L06, Institutional Architectures to Advance Operational Strategies, was to identify strategies by which transportation agencies can adjust their institutional architecture—including culture, organization and staffing, resource allocation, and partnerships—to support more effective systems operations and management (SO&M). The final report, Institutional Architectures to Improve Systems Operations and Management, identifies new organizational models. It also provides the basis for a companion document, SHRP 2 Report S2-L06-RR-2: Guide to Improving Capability for Systems Operations and Management, which includes an examination of current state DOT practice and insights from other sectors with strong operational orientations. It establishes a systematic guidance framework based on the traceable relationships between the technical and business process features most supportive of effective SO&M and the institutional architecture that supports such processes. Also available as e-book for iPad and other ePub format readers (Apple iBookstore, Google Play) and for Kindle (Amazon Kindle Store).

Guide to Improving Capability for Systems Operations and Management (Report S2-L06-RR-2)



The Guide to Improving Capability for Systems Operations and Management can support transportation agencies in developing institutional arrangements to meet the special demands of congestion management, now emerging as a new transportation agency priority. In particular, the strategies appropriate to effective management of nonrecurring congestion present new challenges for agency policy, organization and staffing, resources, and partnerships, as well as for culture and leadership. This guide focuses on these special institutional challenges with a change management tool called the Institutional Capability Maturity Model. The model starts with agency self-evaluation to determine the current circumstances and provides incremental strategies for evolving toward institutional arrangements most supportive of congestion management. Also available as e-book for iPad and other ePub format readers (Apple iBookstore, Google Play) and for Kindle (Amazon Kindle Store).

Training for Traffic Incident Responders (Report S2-L12-RW-1)

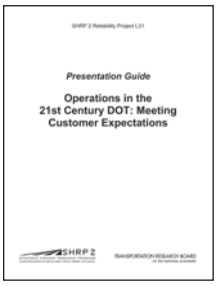


For every minute that an Interstate lane is blocked because of a traffic incident, a 4- to 5-minute travel delay can be expected. A strong interdisciplinary traffic incident management program can significantly decrease incident duration and, when combined with traveler information, can increase peak-period freeway speeds, reduce crash rates, and improve trip time reliability. The final report for SHRP 2 Project L12, Training of Traffic Incident Responders, describes two training curricula for traffic incident responders and managers: one for trainers and one for incident responders. The course material provides extensive training on the core competencies for interdisciplinary traffic incident response. It is designed to help responders understand and implement the national unified goal for traffic incident management: responder safety; safe, quick clearance; and prompt, reliable, and interoperable communications. This report, as well as other SHRP 2 Reliability products related to institutional structures and business process reengineering, is intended to help transportation agencies move forward in addressing nonrecurring traffic congestion and delivering more reliable travel times on their highway networks.

A Framework for Improving Travel Time Reliability (L17)*

Transportation systems management and operations (TSM&O) strategies can improve travel time reliability, which yields both safety and economic benefits and improves road-user experience. To date, only a few transportation agencies have TSM&O programs to address travel time reliability, but a common understanding of the causes of unreliable travel times and the actions that can improve reliability have the potential to make TSM&O programs more widespread. To help move TSM&O into mainstream agency practice, A Framework for Improving Travel Time Reliability (SHRP 2 Project L17) created the L17 Knowledge Transfer System, a web-based tool designed to provide convenient one-stop access to the complete range of existing and new TSM&O information. The KTS tool will be available for public use in early 2014. This tool integrates products from SHRP 2 Reliability research projects and other sources of TSM&O information, and it provides an umbrella structure for incorporating the many individual elements of TSM&O. The final report describes the creation of the L17 Knowledge Transfer System, research about TSM&O, and branding and communication strategies for the web tool.

SHRP 2 Presentation and Guide: Operations in the 21st Century DOT: Meeting Customer Expectations (L31)



Operations strategies that improve how efficiently people and goods move throughout transportation systems can often be implemented relatively quickly and economically, especially when compared with new construction, as a strategy to reduce congestion. The presentation Operations in the 21st Century DOT: Meeting Customer Expectations and the accompanying Presentation Guide were created in SHRP 2 Project L31, Reliability Workshops for State and Public Sector Managers. These materials were created for presentations to the chief executive officers and senior managers of state departments of transportation about the value of mainstreaming operations as a core mission and business practice in their agencies. The presentation is designed to be delivered within a 30-minute period and highlight not just the importance of transportation system operations but also tools that are now available through SHRP 2, the Federal Highway Administration (FHWA), and the American Association of State Highway and Transportation Officials (AASHTO) to assist states in advancing their state of practice in operations.

Train-the-Trainer Pilot Courses for Incident Responders and Managers (L32A)*

Traffic incidents account for up to 25% of all congestion and 40% of nonrecurring congestion. Improving traffic incident management (TIM) practices offers regions a highly cost-effective and sustainable opportunity to improve the reliability of their roadways. SHRP 2 Project L12, Improving Traffic Incident Scene Management, developed one of the first comprehensive, multidisciplinary, peer-validated national incident responder training curricula and materials for use by TIM programs in jurisdictions large and small across the country. To build on this research, SHRP 2 Project L32A, Train-the-Trainer Pilot Courses for Incident Responders and Managers, validated and improved the national TIM training program by training nearly 200 new TIM responders in four states. The final report for project L32A documents these activities.

DRIVER BEHAVIOR AND HUMAN FACTORS IN RELIABILITY

Feasibility of Using In-Vehicle Video Data to Explore How to Modify Driver Behavior That Causes Nonrecurring Congestion (Report S2-L10-RR-1)

The final report for SHRP 2 Project L10,Feasibility of Using In-Vehicle Video Data to Explore How to Modify Driver Behavior That Causes Nonrecurring Congestion, presents findings on exploring whether the data sets collected in naturalistic driving settings can be used to make inferences about the relationship between observed driver behavior and nonrecurring congestion. General guidance is provided on the protocols and procedures for conducting video data reduction analysis. In addition, the report includes technical guidance on the features, technologies, and complementary data sets that researchers should consider when designing future instrumented in-vehicle data collection studies. Finally, a new modeling approach is advanced for travel time reliability performance measurement across a variety of traffic congestion conditions. Also available as e-book for iPad and other ePub format readers (Google Play, Apple iBookstore) and for Kindle (Amazon Kindle Store).

RELIABILITY IDEA

Forecasting and Delivery of Highway Travel Time Reliability Information (SHRP 2 Reliability IDEA Research Report L15A)

To forecast travel time reliability on personal trips, SHRP 2 Project L15A, Provide Origin-to-Destination Travel Time Reliability Information on Google Map, developed predictive algorithms driven by historical and real-time traffic data. These algorithms were then used to calculate pretrip, time-dependent travel time information based on origin, destination, and departure time. In a field test on I-66 in Northern Virginia, travelers used a website to plan trips and chose to receive forecasts via e-mail, voice mail, or text message. Forecasting and Delivery of Highway Travel Time Reliability Information describes the development of the prototype and documents the field test.

Proximity Information Resources for Special Events (SHRP 2 Reliability IDEA Research Report L15B)

Travel time reliability—which is increasingly important to highways, arterials, transit, and air travel—is also important to pedestrians. When managing large crowds, performance measures relating to volume, density, and trajectory of pedestrians (crowd metrics) are essential. SHRP 2 Project L15B, Proximity Information Resources for Special Events, developed a mobile application, known as PRISM, to assist in management and communications during large events. The PRISM concept uses automated measurement capabilities to assess crowd metrics, bringing the concepts of transportation reliability to the pedestrian mode. PRISM was demonstrated at one event on the National Mall, using a deployment of 11 portable sensors at strategic locations such as entrances, crossroads, and stages. Data from the sensors was delivered in real-time to a monitoring station and was post-processed for in-depth analysis. Additional data streams from social media (Twitter and Flickr) simulated data streams reflecting the availability of space in nearby parking garages, and the location of a roving medic were integrated into the real-time monitor display.

Online Traffic Simulation Service for Highway Incident Management (SHRP 2 Reliability IDEA Research Report L15C)

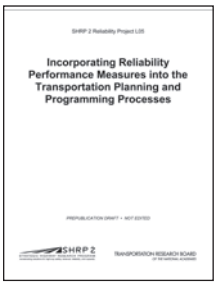
Active transportation and demand management (ATDM) systems let transportation agencies dynamically manage recurring and nonrecurring congestion based on prevailing traffic conditions in order to maximize the effectiveness and efficiency of traffic networks. SHRP 2 Reliability IDEA Project L15C, Online Traffic Simulation Service for Highway Incident Management, enhanced and tested three features in a decision-support system for ATDM, known as Relteq Harmony: 1) a user interface for scenario management and reporting simulation results, 2) a utility for automatic traffic model generation based on daily traffic data (daily model calibration), and 3) playbook incident scenarios for a California travel corridor. The final report documents these activities.

Urban Travel Reliability Analysis with Consumer GPS Data (SHRP 2 Reliability IDEA Research Report L15D)

SHRP 2 Project L15D, Urban Travel Reliability Analysis with Consumer GPS Data, explores the potential for commercially available GPS data for monitoring and assessing the reliability performance of a transportation system and, in the long term, for providing route guidance to travelers. The project generated new databases and interfaces that can be used to conduct reliable routing experiments. The final report describes the exploration of the concept, provides results of an evaluation study, and summarizes the findings.

RELIABILITY IN PLANNING, PROGRAMMING, AND GEOMETRIC DESIGN

Incorporating Reliability Performance Measures into the Transportation Planning and Programming Processes (L05)*



When transportation agencies incorporate travel time reliability performance measures and strategies into the transportation planning and programming process, they consider operational improvements alongside more traditional types of capital improvements. SHRP 2 Reliability Project L05, Incorporating Reliability Performance Measures into the Transportation Planning and Programming Processes, developed guidance for transportation planning agencies to help them achieve this integration. This project produced three reports: a Guide for planning, programming, and operations managers that focuses on the choices and options needed to integrate reliability into the planning and programming process; a Technical Reference that can help technical staff select and calculate the appropriate performance measures to support the development of key planning products; and a Final Report that summarizes the research conducted as part of this project, including a literature review, state-of-the-practice survey, and validation case studies conducted to test the concepts and methods evaluated as part of this project.

Identification and Evaluation of the Cost-Effectiveness of Highway Design Features to Reduce Nonrecurrent Congestion (L07)*

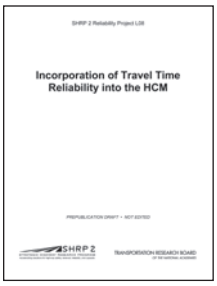
More reliable travel times can improve highway system performance, enhance supply-chain vitality, and reduce frustrating delays in trips we take daily. SHRP 2 Project L07, Identification and Evaluation of the Cost-Effectiveness of Highway Design Features to Reduce Nonrecurrent Congestion, addresses how transportation agencies can improve travel time reliability through geometric design treatments that reduce delays caused by unexpected congestion. Three separate analyses of the design treatments were conducted: operational, safety, and benefit-cost.

The results of this research provide a method for incorporating the economic savings from both reduced delay and improved reliability for a design treatment over its life cycle. Design treatments that are commonly used to address recurrent congestion can also be analyzed using the approach developed in this research, which takes into account not only the delay improvements associated with the treatment, but the potential improvements to reliability as well. Taking these benefits into account results in a more accurate valuation of a design treatment's net present benefit and benefit-cost ratio. The final report describes the results.

The project also developed a Design Guide for Addressing Nonrecurrent Congestion, which is a catalog of the design treatments considered in this research. The Guide provides planners, designers, operations engineers, and decision makers with a toolbox of possible options for addressing nonrecurrent congestion through design treatments.

Additionally, the project developed an analysis tool that can be used to measure the operational effectiveness and economic benefit of design treatments for a freeway segment of interest. The analysis tool allows highway agencies to compare the benefits and costs of implementing various nonrecurrent congestion treatments at specific locations.

Incorporation of Travel Time Reliability into the Highway Capacity Manual (L08)*



Travel time reliability aims to quantify variation in travel times. It is defined using the entire range of travel times for a given trip, for a selected time period (for example, the p.m. peak period on weekdays), and over a selected horizon (for example, a year). SHRP 2 Project L08, Incorporation of Travel Time Reliability into the Highway Capacity Manual (HCM) had two objectives: 1) incorporate nonrecurring congestion impacts into the HCM procedure; and 2) expand the analysis horizon from a single study period to an extended time horizon of several weeks or months to assess the variability and the quality of service the facility provides to its users. This project created two proposed chapters for the Transportation Research Board's Highway Capacity Manual (HCM) that introduce the concept of travel time reliability and offer new analytic methods. The chapters were prepared under SHRP 2 Project L08, but they have not been officially accepted by the Highway Capacity and Quality of Service (HCQS) Committee of the Transportation Research Board. The HCQS Committee has responsibility for approving the content of the HCM. The project final report and the Proposed Chapters for Incorporating Travel Time Reliability into the Highway Capacity Manual are available on the TRB website.

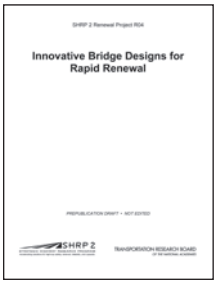
Requirements and Feasibility of a System for Archiving and Disseminating Data from SHRP 2 Reliability and Related Studies (Report S2-L13-RW-1)

The final report for SHRP 2 Project L13, Requirements and Feasibility of a System for Archiving and Disseminating Data from SHRP 2 Reliability and Related Studies, provides an assessment of the feasibility of developing and populating an online archive for the great variety and volume of data being produced by the SHRP 2 Reliability focus area research program. The goal of the archive, if feasible, is to provide researchers and other interested parties with ready access to data needed to independently validate the results of SHRP 2 Reliability research and to conduct follow-on research. For this project, the term "data" was defined in the broadest way possible to include statistical data, analytical tools and models, written reports, pictorial data, and video data.

The follow-on project to build and populate the archive is L13A, Design and Implement a System for Archiving and Disseminating Data from SHRP 2 Reliabilities and Related Studies/Assistance to Contractors to Archive their Data for Reliability Projects.

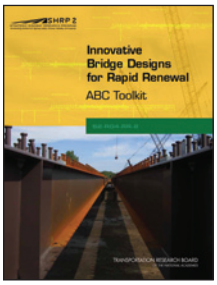
BRIDGES

Innovative Bridge Designs for Rapid Renewal (R04)*



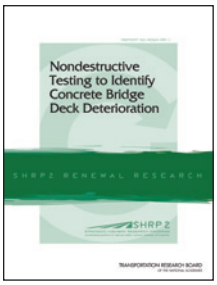
Accelerated bridge construction (ABC) techniques have the potential to minimize traffic disruptions during bridge renewals, promote traffic and worker safety, and also improve the overall quality and durability of bridges. To make ABC techniques more applicable to typical bridges, SHRP 2 Project R04, Innovative Bridge Designs for Rapid Renewal developed standardized and scalable approaches to designing and constructing complete bridge systems for rapid renewals. The final report documents the development of those approaches, describes a demonstration project that was completed in 2011 using the ABC standards developed in this project, and introduces the Innovative Designs for Rapid Renewal Toolkit, which is available as a separate document.

Innovative Bridge Designs for Rapid Renewal: ABC Toolkit (Report S2-R04-RR-2)



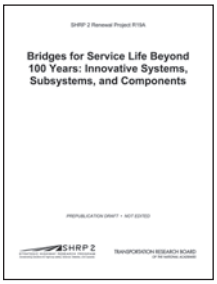
The Innovative Bridge Designs for Rapid Renewal: ABC Toolkit includes design standards and design examples for complete prefabricated bridge systems, and it proposes specification language for accelerated bridge construction systems suitable for future inclusion in the American Association of State Highway and Transportation Officials (AASHTO) Load and Resistance Factor Design (LRFD) Bridge Design and Construction Specifications. Also available as e-book for iPad and other ePub format readers (Apple iBookstore, Google Play) and for Kindle (Amazon Kindle Store).

Nondestructive Testing to Identify Concrete Bridge Deck Deterioration (Report S2-R06A-RR-1)



The number of concrete bridge decks in poor structural condition is one of the biggest problems affecting bridges in the United States. Nondestructive testing (NDT) techniques have the potential to quickly and reliably provide the needed information about under-the-surface conditions of these decks. The objective of SHRP 2 Project R06A, Nondestructive Testing to Identify Concrete Bridge Deck Deterioration, was to conduct an independent evaluation of the capabilities and limitations of the most common NDT techniques for detecting and characterizing typical deterioration mechanisms in concrete bridge decks. The final report documents this evaluation and it grades and ranks the technologies based on the results. The main product of this project is an electronic catalog for practitioners, known as the NDToolbox, which can recommend technologies for detecting particular deteriorations. Also available as e-book for iPad and other ePub format readers (Apple iBookstore, Google Play) and for Kindle (Amazon Kindle Store).

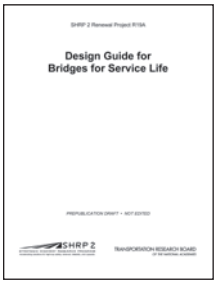
Bridges for Service Life Beyond 100 Years: Innovative Systems, Subsystems and Components (R19A)*



Designing bridges for enhanced service life is increasingly important as demands on resources grow. Addressing service life issues at the design stage is significantly less costly than taking maintenance and preservation actions while a bridge is in service. However, design for service life must be approached systematically, using a general framework that can apply to all bridges while also allowing for specifics that are unique from one bridge to another.

SHRP 2 project R19A, Bridges for Service Life beyond 100 Years: Innovative Systems, Subsystems and Components, developed the Design Guide for Bridges for Service Life to provide information about and define procedures for systematic approach to designing for service life and durability for both new and existing bridges. It includes new concepts and approaches that offer improvements to current practice and have the potential to enhance the service life of bridges. This final report details how the Guide was developed and provides results from extensive individual research efforts leading to new details and concepts that can mitigate factors that have historically limited service life of bridges. The Design Guide is also available as a prepublication draft.

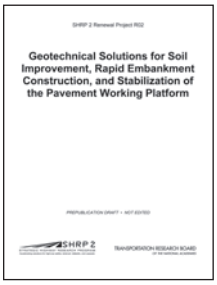
Design Guide for Bridges for Service Life (R19A)*



As limited resources demand enhancing service life of existing and new bridges, designing for service life is gaining importance. The cost of addressing service life issues at the design stage is significantly lower than taking maintenance and preservation actions while the bridge is in service. To provide information and define procedures for systematically designing for service life, SHRP 2 Project R19A, Bridges for Service Life beyond 100 Years: Innovative Systems, Subsystems and Components developed Design Guide for Bridges for Service Life, which can be used for both new and existing bridges. The objective of the Guide is to equip the user with the knowledge to develop specific optimal solutions for a bridge under consideration in a systematic manner using a framework that is both universal and adaptable.

PAVEMENT

Geotechnical Solutions for Soil Improvement, Rapid Embankment Construction, and Stabilization of the Pavement Working Platform (R02)*



Selecting an appropriate geoconstruction technology to use in transportation systems is a complex undertaking. To help engineers identify the appropriate geotechnical solutions for transportation infrastructure, SHRP 2 Project R02, Geotechnical Solutions for Soil Improvement, Rapid Embankment Construction, and Stabilization of the Pavement Working Platform created a web-based information system that catalogs 46 geoconstruction and ground improvement technologies. The final report for Project R02 describes the work efforts, results, and products, including the web-based system. The development report describes the development details of the system. Both reports are available on the TRB website.

Precast Concrete Pavement Technology (Report S2-R05-RR-1)

Modular pavement technologies, principally precast concrete pavement (PCP) systems, provide for rapid repair and rehabilitation of pavements and also result in durable, longer-lasting pavements. Rapid construction techniques can significantly minimize the impact on the driving public, as lane closures and traffic congestion are kept to a minimum. Safety is also improved by reducing road users' and workers' exposure to construction traffic. SHRP 2 Project R05, Modular Pavement Technology developed guidance to help highway agencies implement PCP systems. The final report, Precast Concrete Pavement Technology presents the findings and includes a review of the available PCP systems; a summary of applications to date; and guidelines for design, fabrication, installation, and selection of PCP systems. Will be available as e-book for iPad and other ePub format readers (Apple iBookstore, Google Play) and for Kindle (Amazon Kindle Store).

Composite Pavement Systems (Reports S2-R21-RW-1, S2-R21-RR-2, S2-R21-RR-3)

Many transportation agencies have expressed interest in composite pavement systems, specifically (a) high-quality relatively thin hot-mixed asphalt (HMA) surfacing over a new portland cement concrete (PCC) structural layer and (b) high-quality relatively thin PCC surfacing atop a thicker, structural PCC layer. SHRP 2 Project R21, Composite Pavement Systems reviewed the behavior, material properties, and performance of these two types of pavements.

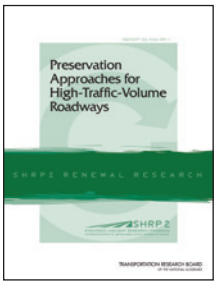
The two-volume final report describes the evaluation, improvement, and validation of applicable structural, climatic, material, and performance prediction models, and design algorithms. It also includes recommendations for construction specifications and techniques, life-cycle costing, and training materials. Volume 1 focuses on HMA/PCC Pavements; Volume 2 focuses on PCC/PCC Pavements; and the appendices provide survey results, details about the evaluations, and the history of the pavements. Will be available as e-book for iPad and other ePub format readers (Apple iBookstore, Google Play) and for Kindle (Amazon Kindle Store).

SHRP 2 Report S2-R21-RW-1: 2008 Survey of European Composite Pavements explores in-service composite pavement sites in the Netherlands, Germany, and Austria in order to help assess the design, construction, and performance of composite pavement systems. The report also examines other issues that should be considered in the design and construction of new composite pavement systems.

Using the Existing Pavement In-Place and Achieving Long Life (R23)*

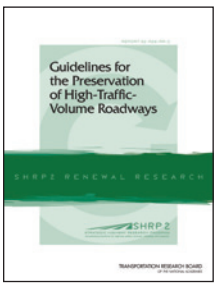
During the last 20 years, numerous infrastructure renewal projects have either modified the existing pavement in place or placed a new structural pavement on top of the existing pavement. SHRP 2 Project R23, Using Existing Pavement in Place and Achieving Long Life, developed reliable procedures for identifying when an existing pavement can successfully be used in place and how to incorporate it into the new structural pavement to achieve long life. The products include decision matrices, design tables, interactive software, and resource documents that provide valuable information regarding all aspects of a renewal project including project assessment, renewal selection, design, specifications, and construction. The final report documents these activities.

Preservation Approaches for High-Traffic-Volume Roadways (Report S2-R26-RR-1)



The final report for SHRP 2 Project R26, Preservation Approaches for High-Traffic-Volume Roadways, documents the state of the practice of preservation treatment on asphalt and concrete pavements. Although the focus of the project was on treatments suitable for application on high-volume roadways, this report also discusses current practices for low-volume roadways. The information presented is derived from a detailed survey of transportation agencies and a review of national and international literature. In addition, the report provides a general framework for how best practices are identified. Finally, general guidelines were developed for the application of preservation treatments on high-volume roadways. Presented as a separate document, Guidelines for the Preservation of High-Traffic-Volume Roadways considers traffic volume, pavement condition, work-zone requirements, environmental conditions, and expected performance. Also available as e-book for iPad and other ePub format readers (Google Play, Apple iBookstore) and for Kindle (Amazon Kindle Store).

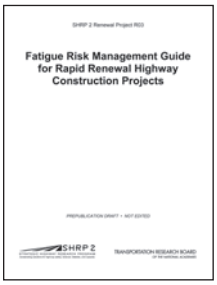
Guidelines for the Preservation of High-Traffic-Volume Roadways (Report S2-R26-RR-2)



Guidelines for the Preservation of High-Traffic-Volume Roadways addresses the application of preservation treatments on asphalt and concrete pavements. The guidelines consider traffic volume, pavement condition, work-zone requirements, environmental conditions, and expected performance. The information presented is derived from a detailed survey of transportation agencies and a review of national and international literature.

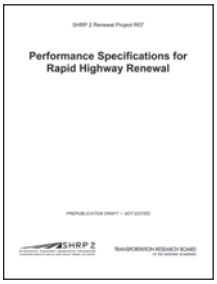
PROJECT DELIVERY

Fatigue Risk Management Guide for Rapid Renewal Highway Construction Projects (R03)*



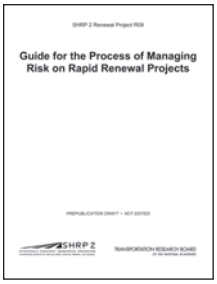
Performing the complex, dynamic, fast-paced work of rapid renewal construction is dangerous work. On any construction site, the risk of potential injury or death is higher than for most other occupational groups. To understand, manage, and reduce workforce fatigue risks to worker safety and construction productivity, SHPR 2 Project R03, Identifying and Reducing Worker, Inspector, and Manager Fatigue in Rapid Renewal Environments developed fatigue risk management strategies and tools designed to improve safety for employees, field supervisors, and project managers. The final report describes the methods and findings of Project R03, and the guide includes technical reference materials, fatigue training materials, guidance on organizational practices, and guidance and aids on work scheduling.

Performance Specifications for Rapid Renewal (R07)*



The benefits of performance specifications as compared with traditional means-and-methods specifications have been advocated by transportation owners, contractors, and materials suppliers for decades. It has been repeatedly demonstrated that performance specifications, when properly developed and implemented, provide creative solutions to save time, minimize disruption, and enhance durability. To help reach these goals in rapid renewal environments, SHRP 2 Project R07, Performance Specifications for Rapid Renewal, developed a suite of performance specifications for various highway project types and contracting scenarios. SHRP 2 also developed implementation guidelines to address project selection, specification development, risk allocation, and the transition from methods to performance specifications. The final report documents these activities. The implementation guidelines are available in two volumes—Volume I: Strategies for Implementing Performance Specifications: A Guide for Executives and Project Managers; and Volume II: Developing and Drafting Effective Performance Specifications: A Guide for Specification Writers. A separate document, Guide Performance Specifications, includes model specifications and commentary to address implementation and performance targets (for acceptance) for 13 routine highway items. Agencies can adapt guide specifications to specific standards or project conditions. The commentary addresses gaps, risks, and options.

Guide for the Process of Managing Risk on Rapid Renewal Projects (R09)*



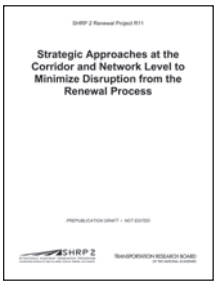
The innovative approaches and compressed schedules often involved in rapid renewal can amplify problems or risks. Advanced project management techniques are needed to maximize opportunities and avoid poor project outcomes. A formal and structured risk management approach—in which such potential problems can be adequately and efficiently anticipated, evaluated, and addressed before they occur—can optimize project performance and significantly improve the chance of project success. The guide developed in project R09, Guide for the Process of Managing Risk on Rapid Renewal Projects, describes a risk management approach specifically for rapid renewal projects, which can also be applied to non-rapid renewal projects.

Project Management Strategies for Complex Projects (R10)*

Because of their complex nature, rapid infrastructure renewal projects present a unique set of challenges. These projects cover a wide spectrum of project types, varying in engineering complexity, size, modality, jurisdictional control, financing approach, contract type, and delivery method. To help transportation agencies complete these projects, the final report for SHRP 2 Project R10, Project Management Strategies for Complex Projects, describes five-dimensional project management strategies for complex projects. The strategies include five methods for every complex project and 13 tools that may be helpful on complex projects.

Project R10 also developed a training program and a report titled Guidebook: Project Management Strategies for Complex Projects, which is available as a separate document. The Guidebook was developed to be independent of the training, while the training is based on the information in the guidebook.

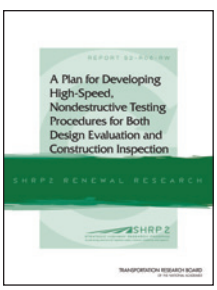
Strategic Approaches at the Corridor and Network Level to Minimize Disruption from the Renewal Process (R11)*



SHRP 2 Project R11, Strategic Approaches at the Corridor and Network Level to Minimize Disruption from the Renewal Process, developed a software tool known as WISE (Work zone Impact and Strategy Estimator), which is capable of evaluating the strategic impact of constructing renewal projects and programs at the regional or large corridor level. WISE can help program managers to sequence programs of projects in ways that maximize available resources, minimize disruptions to the traveling public and to adjacent land uses, and recognize political priorities. The final report for this project documents the development of WISE. Available as a separate document, the WISE User Guide explains how to use the software.

NONDESTRUCTIVE TESTING

A Plan for Developing High-Speed, Nondestructive Testing Procedures for Both Design Evaluation and Construction Inspection (Report S2-R06-RW)



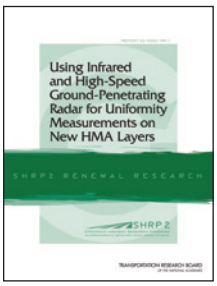
The final report for SHRP 2 Project R06, A Plan for Developing High-Speed, Nondestructive Testing Procedures for Both Design Evaluation and Construction Inspection, examines existing and emerging nondestructive evaluation (NDE) technologies and their current state of implementation to satisfy the NDE needs for highway renewal. The report also explores a research plan for the development of NDE technologies to address the most pertinent needs for bridges, pavements, tunnels, soils, and retaining walls through the life of the facility.

Nondestructive Testing to Identify Concrete Bridge Deck Deterioration (Report S2-R06A-RR-1) See page 18.

Evaluating Applications of Field Spectroscopy Devices to Fingerprint Commonly Used Construction Materials (Report S2-R06B-RR-1)

Spectroscopy technologies have been used on a limited basis for evaluating whether the materials delivered at the construction site agree with those specified. To promote broader use of these technologies for quality assurance tests, SHRP 2 Project R06B, Evaluating Applications of Field Spectroscopy Devices to Fingerprint Commonly Used Construction Materials evaluated practical portable spectroscopic equipment for in-situ analysis of a wide range of commonly used construction materials. The final report documents this evaluation and includes proposed American Association of State Highway and Transportation Officials (AASHTO) standards of practice for the analysis of titanium content in traffic paints by X-ray fluorescence and identification of chemical admixtures by attenuated total reflectance. Will also be available as e-book for iPad and other ePub format readers (Apple iBookstore, Google Play) and for Kindle (Amazon Kindle Store).

Using Both Infrared and High-Speed Ground Penetrating Radar for Uniformity Measurements on New HMA Layers (Report S2-R06C-RR-1)



The most common form of hot-mix asphalt (HMA) segregation, truck-end, occurs when HMA at the ends of the truckload is colder and sometimes coarser in gradation than normal. To detect truckload segregation, SHRP 2 Project R06C, Using Both Infrared and High-Speed Ground Penetrating Radar for Uniformity Measurements on New HMA Layers summarized the availability of infrared and radar systems suitable for testing essentially the entire surface area during new HMA construction, and then it demonstrated an infrared sensor bar system and two ground-penetrating radar (GPR) systems on construction projects in each of the four American Association of State Highway and Transportation Officials (AASHTO) regions. The final report documents these activities and includes recommendations for equipment and testing protocols when using infrared and GPR systems. Also available as e-book for iPad and other ePub format readers (Apple iBookstore, Google Play) and for Kindle (Amazon Kindle Store).

Nondestructive Testing to Identify Delaminations Between HMA Layers: Volumes 1-5 (Reports S2-R06D-RR-1, S2-R06D-RW-2, S2-R06D-RW-3, S2-R06D-RW-4, and S2-RO6D-RW-5)

Asphalt pavements with delamination problems experience early damage because delaminations provide paths for moisture damage and the development of stripping, slippage cracks, and pavement deformation. Early detection of the existence, extent, and depth of delaminations in asphalt pavements is key for determining the appropriate rehabilitation strategy and extending pavement. To improve detection, SHRP 2 Project R06D, Nondestructive Testing to Identify Delaminations Between HMA Layers, developed nondestructive testing techniques capable of detecting and quantifying delaminations in HMA pavements. Nondestructive Testing to Identify Delaminations Between HMA Layers: Volume 1 (SHRP 2 Report S2-R06D-RR-1) is a comprehensive summary of the study. Volumes 2 through 5 provide more detailed technical information. Will also be available as e-book for iPad and other ePub format readers (Apple iBookstore, Google Play) and for Kindle (Amazon Kindle Store).

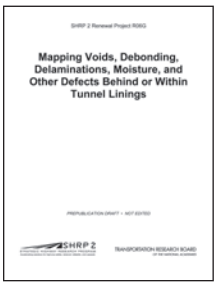
Real-Time Smoothness Measurements on Portland Cement Concrete Pavements During Construction (Report S2-R06E-RR-1)

Because smoothness specifications for concrete pavements require measurements of surface profile on the finished pavement for acceptance testing, problems are not corrected in real time, which can result in significant expenditures to correct surface irregularities. To develop a construction quality-control tool for detecting surface irregularities during concrete paving operations, SHRP 2 Project R06E, Real-Time Smoothness Measurements on Portland Cement Concrete Pavements During Construction, evaluated and conducted demonstrations of both emerging and proven technologies. Based on those results, the project developed model specifications and construction guidance to expedite the implementation of technologies that can provide an indication of smoothness in real time. The final report documents these activities. Will also be available as e-book for iPad and other ePub format readers (Apple iBookstore, Google Play) and for Kindle (Amazon Kindle Store).

Assessment of Continuous Pavement Deflection Measuring Technologies (Report S2-R06F-RW-1)

Nondestructive pavement evaluation devices can measure pavement deflections caused by a moving load, in some cases with little or no traffic control, which makes them more advantageous to use than stationary devices. SHRP 2 Project R06F, Development of Continuous Deflection Device evaluated current technologies implemented in different types of continuous deflection measuring devices, identified the most promising devices for effectively supporting pavement management decisions, evaluated the capabilities of these devices, and identified and illustrated applications that can be useful for supporting pavement management. The final report, Assessment of Continuous Pavement Deflection Measuring Technologies, documents the evaluation and includes a catalogue of existing continuous deflection measuring technologies and their characteristics.

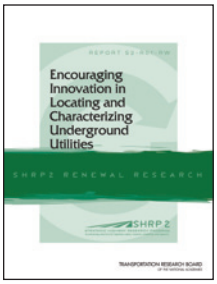
Mapping Voids, Debonding, Delaminations, Moisture, and Other Defects Behind or Within Tunnel Linings (R06G)*



Because tunnels typically service high-volume traffic and operate in aggressive environments, keeping tunnels open during inspection and minimizing tunnel closures and user delays must be carefully balanced with the need to conduct detailed inspections to ensure the safety of drivers. The objective of SHRP 2 Project R06G, High-Speed Nondestructive Testing Methods for Mapping Voids, Debonding, Delaminations, Moisture, and Other Defects Behind or Within Tunnel Linings, was to identify nondestructive testing technologies for evaluating the condition of various types of tunnel linings and tunnel lining finishes, and to evaluate the applicability, accuracy, precision, repeatability, ease of use, capacity to minimize disruption to vehicular traffic, and implementation and production costs of the identified technologies. The project also advanced hardware and software development for the most promising technologies and proved the validity of the selected technologies to detect flaws within or verify conditions of the targeted tunnel components. The final report documents these activities, and it also recommends test procedures and protocols to successfully implement these techniques.

UTILITIES AND RAILROADS

Encouraging Innovation in Locating and Characterizing Underground Utilities (Reports S2-R01-RW and S2-R01-RW-2)



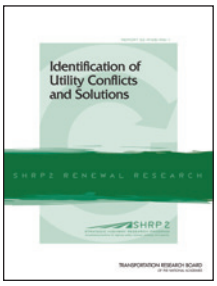
The final report from SHRP 2 Project R01, Encouraging Innovation in Locating and Characterizing Underground Utilities, explores underground utility locating practices, examines current and emerging technologies, and identifies potential areas for improvement and for subsequent research.

This project developed the Selection Assistant for Utility Locating Technologies (SAULT), a prototype web-based software tool that serves as decision support for identifying effective utility-locating methods for particular site and project environments. SAULT is available at 138.47.78.37/sault/home.asp. In-depth information about SAULT is available in SHRP 2 Report S2-R01-RW-2: Development of the Selection Assistant for Utility Locating Technologies

Integrating the Priorities of Transportation Agencies and Utility Companies (Report S2-R15-RW)

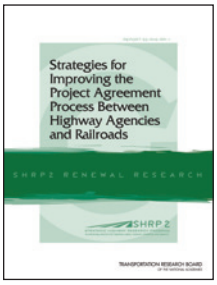
The final report for SHRP 2 ProjectR15, Integrating the Priorities of Transportation Agencies and Utility Companies, examines current practices, opportunities for enhancement, and anticipated barriers for integrating utility and transportation agency priorities in highway renewal projects. The report also explores 13 best practices that span the whole project life cycle and highlights a plan for future research in this field.

Identification of Utility Conflicts and Solutions (Report S2-R15B-RW-1)



When utility relocation is involved, construction generally takes longer and costs more. Identifying and resolving potential utility conflicts early in the design process can minimize these delays and costs. The final report for SHRP 2 Project R15B, Identification of Utility Conflicts and Solutions, provides comprehensive, optimized concepts and procedures for identifying and resolving utility conflicts that public agency and utility professionals can use to improve the highway project development process. The tools developed include two utility conflict matrices (UCMs) that enable users to organize, track, and manage the conflicts that frequently arise when utility lines are under highways: (a) a prototype stand-alone UCM in Microsoft Excel, which has a main utility conflict table and a supporting worksheet to analyze utility conflict resolution strategies; and (b) a prototype stand-alone utility conflict data model and database, which is a scalable UCM that enables the management of conflicts in a database environment. This project also developed a 1-day training course to instruct end users on how to use the optimized concept and tools, and strategies and guidelines that include specific steps to start and continue implementation.

Strategies for Improving the Project Agreement Process between Highway Agencies and Railroads (Report S2-R16-RR-1)



SHRP 2 Project R16, Strategies for Improving the Project Agreement Process between Highway Agencies and Railroads, examined the process by which highway agencies and railroads develop agreements for highway projects that interact with railways. The final report describes the underlying causes of delay in the project-agreement process and provides model processes to address them. The model agreements (Appendix C of the report) are available online in Microsoft Word format. Also available as e-book for iPad and other ePub format readers (Apple iBookstore, Google Play) and for Kindle (Amazon Kindle Store).

NATURALISTIC DRIVING STUDY

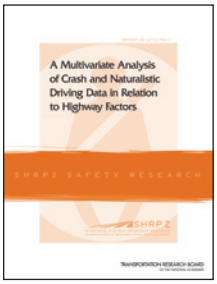
Development of Analysis Methods Using Recent Data (Report S2-S01A-RW-1)

In anticipation of the large volume of data to be collected during the SHRP 2 naturalistic driving study (NDS), several projects were undertaken to demonstrate that it is possible to use existing NDS data and data from other sources to further the understanding of the risk factors associated with road crashes. More specifically, the four projects conducted under the title Development of Analysis Methods Using Recent Data examined the statistical relationship between surrogate measures of collisions (conflicts, critical incidents, near collisions, or roadside encroachment) and actual collisions. This final report presents the results of one of these projects. The primary objective of this work was to establish an analytic foundation for using conflicts and near crashes as surrogate measures. The project introduced a counterfactual analytic approach suggesting that a traffic event qualifies as a crash cause under two conditions: (a) both the event and the crash occurred and (b) had the event in question not occurred, then the crash also would not have occurred. Data from site-based field studies and vehicle studies were used to extend these ideas from a trajectory model to more complicated scenarios. The report introduces an approach to microscopic (i.e., individual event) modeling of crash related events, where driver actions, initial speeds, and vehicle locations are treated as inputs to a physical model describing vehicle motion.

Analysis of Existing Data: Prospective Views on Methodological Paradigms (Report S2-S01B-RW-1)

In anticipation of the large volume of data to be collected during the SHRP 2 naturalistic driving study (NDS), several projects were conducted to demonstrate that it is possible to use existing data from previous naturalistic driving studies and data from other sources to further the understanding of the risk factors associated with road crashes. More specifically, the four S01 projects, entitled Development of Analysis Methods Using Recent Data, examined the statistical relationship between surrogate measures of collisions (conflicts, critical incidents, near collisions, and roadside encroachment) and actual collisions. SHRP 2 Report S2-S01B-RW-1: Analysis of Existing Data: Prospective Views on Methodological Paradigms presents the results of one of these projects. The primary objective of this project was to investigate structured modeling paradigms for analysis of naturalistic driving data (NDD). Five research questions were identified and various models (such as, event-based models and categorical-outcome models) were applied to NDD to determine appropriateness for analysis and suggestions for future analyses.

A Multivariate Analysis of Crash and Naturalistic Driving Data in Relation to Highway Factors (Report S2-S01C-RW-1)



In anticipation of the large volume of data to be collected during the SHRP 2 naturalistic driving study (NDS), several projects were undertaken to demonstrate that it is possible to use existing NDS data and data from other sources to further the understanding of the risk factors associated with road crashes. More specifically, the four projects conducted under the title Development of Analysis Methods Using Recent Data examined the statistical relationship between surrogate measures of collisions (conflicts, critical incidents, near collisions, or roadside encroachment) and actual collisions. This report describes the approach developed in Project S01C, which is based on a unified statistical analysis of crash data and surrogate events using a spatial referencing system and a common measure of exposure.

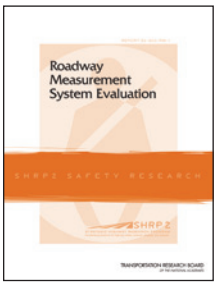
Evaluation of Data Needs, Crash Surrogates, and Analysis Methods to Address Lane Departure Research Questions Using Naturalistic Driving Study Data (Report S2-S01E-RW-1)

A large component of the safety research undertaken in SHRP 2 is aimed at reducing injuries and fatalities that result from highway crashes. Through a naturalistic driving study (NDS) involving more than 3,000 volunteer drivers, SHRP 2 expects to learn more about the interactions among driving behavior and vehicle and roadway characteristics. In anticipation of the large volume of data to be collected during the SHRP 2 NDS, several projects were conducted to demonstrate that it is possible to use existing NDS data and data from other sources to further the understanding of the risk factors associated with road crashes. More specifically, the four projects conducted under the title Development of Analysis Methods Using Recent Data examined the statistical relationship between surrogate measures of collisions (conflicts, critical incidents, near collisions, or roadside encroachment) and actual collisions. SHRP 2 Report S2-S01E-RW-1: Evaluation of Data Needs, Crash Surrogates, and Analysis Methods to Address Lane Departure Research Questions Using Naturalistic Driving Study Data presents the results of one of these projects.

Integration of Analysis Methods and Development of Analysis Plan (Report S2-S02-RW-1)

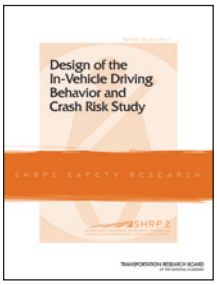
The objective of the SHRP 2 Naturalistic Driving Study (NDS) is to reduce traffic injuries and fatalities by preventing or reducing the severity of collisions. Every 1% reduction in crashes can prevent 330 deaths and about $2 billion in annual medical expenses and other losses from these crashes. SHRP 2 Research Report S2-S02-RW-1: Integration of Analysis Methods and Development of Analysis Plan describes the analysis plan for the SHRP 2 NDS. High-priority research questions were identified in Phase I. Phase II identified the critical elements and issues to address in the analysis of the SHRP 2 NDS data and provided sample work plans for five high-priority research questions. The resulting analysis plan will guide the development of the subsequent Safety Project S08, Analysis of In-Vehicle Field Study Data and Countermeasure Implications, and assist researchers planning to use the SHRP 2 NDS data.

Roadway Measurement System Evaluation (Report S2-S03-RW-1)



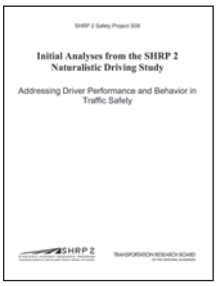
The final report for SHRP 2 Project S03, Roadway Measurement System Evaluation, documents the evaluation of automated/mobile data-collection services to provide data on roadway features and characteristics considered important for safety analysis, especially analysis of data from the SHRP 2 Naturalistic Driving Study (NDS). The Safety research program requires data on roadway features and characteristics to support analysis of the NDS data. To obtain these roadway data, SHRP 2 set out to procure the services of a vendor to collect data at highway speed. However, at the time, no validation of vendors' capabilities to collect these data was publicly available. As a result, SHRP 2 conducted its own evaluation—the rodeo. The objectives of the rodeo were to determine the capabilities of the industry (as represented by 10 participating vendors) and to prequalify a list of vendors to bid on the project that would collect new roadway data in the six NDS sites throughout the United States.

Design of the In-Vehicle Driving Behavior and Crash Risk Study: In Support of the SHRP 2 Naturalistic Driving Study (Report S2-S05-RR-1)



This report provides a summary of the key aspects of the planning effort supporting the SHRP 2 Naturalistic Driving Study (NDS). SHRP 2 Safety Project S05: Design of the In-Vehicle Driving Behavior and Crash Risk Study (Study Design) designed the SHRP 2 NDS, which collected data on "naturalistic," or real-world, driving behavior of more than 3300 drivers. The resulting data will provide a wealth of information regarding driving behavior, lane departures, and intersection activities, which is anticipated to be of interest to transportation safety researchers and others for at least 20 years. Also available as e-book for iPad and other ePub format readers (Google Play, Apple iBookstore) and for Kindle (Amazon Kindle Store).

Initial Analyses from the SHRP 2 Naturalistic Driving Study: Addressing Driver Performance and Behavior in Traffic Safety (S08)*



SHRP 2 is conducting the largest and most comprehensive naturalistic driving study (NDS) to date. In parallel, the Roadway Information Database (RID) will contain detailed roadway data collected on approximately 12,000 centerline miles of roads in and around the six regional study sites plus additional information about crash histories, traffic and weather conditions, work zones, and active safety campaigns in the study areas. In 2012, four analysis contracts were awarded under SHRP 2 Project S08 (Analysis of the SHRP 2 Naturalistic Driving Study Data) to study specific research questions, such as using the early SHRP 2 NDS and RID data to study lane departures on two-lane rural roads. In Phase 1, which concluded in December 2012, each contractor obtained an initial set of data, tested and refined their research plan, and developed a detailed plan for their full analyses. This report summarizes each contractor's Phase 1 work.

SITE-BASED RISK STUDY

Site-Based Video System Design and Development (Report S2-S09-RW-1)

In addition to the naturalistic study of driving behavior, the SHRP 2 Safety program's research also includes a site-based risk study, which focuses on vehicle trajectories at specific locations, such as intersections. The final report, Site-Based Video System Design and Development, describes the work that was done in the latter track to develop and test the Site Observer—an on-site, video-based data collection system prototype with the potential for widespread application by researchers and state and local authorities to examine intersection safety. By tracking individual vehicles through an intersection, the Site Observer prototype provides a basis not only for viewing crashes and near crashes but also for developing objective measures of intersection conflicts and collecting before-and-after data when design or operational changes are made at intersections. It also yields detailed and searchable data on the normal driving population so that exposure measures can be determined.

THE NATIONAL ACADEMIES

Advisers to the Nation on Science, Engineering, and Medicine

The **National Academy of Sciences** is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Upon the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Ralph J. Cicerone is president of the National Academy of Sciences.

The **National Academy of Engineering** was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. C. D. (Dan) Mote, Jr., is president of the National Academy of Engineering.

The **Institute of Medicine** was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, upon its own initiative, to identify issues of medical care, research, and education. Dr. Harvey V. Fineberg is president of the Institute of Medicine.

The **National Research Council** was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both Academies and the Institute of Medicine. Dr. Ralph J. Cicerone and Dr. C. D. (Dan) Mote, Jr., are chair and vice chair, respectively, of the National Research Council.

www.national-academies.org

Transportation Research Board Oversight Committee for the Strategic Highway Research Program 2

TRANSPORTATION RESEARCH BOARD

OF THE NATIONAL ACADEMIES

SHRP 2 Reports

Available by subscription and through the TRB online bookstore: www.TRB.org/bookstore

Some reports are also available as e-books. They are identified in this document.

Contact the TRB Business Office: 202-334-3213

More information about SHRP 2: www.TRB.org/SHRP2