SHRP 2 Products Chart

May 2014

SHRP2
STRATEGIC HIGHWAY RESEARCH PROGRAM

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

SHRP2

STRATEGIC HIGHWAY RESEARCH PROGRAM

SHRP 2 Products Chart **May 2014**

In 2005, Congress authorized the second Strategic Highway Research Program (SHRP 2) 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 SHRP 2, which expresses 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 Product Chart briefly describes the products of the research program and how their use can impact current practice. It tells where to find the tools and resources and provides the implementation status of the products and who to contact for further information.

Details about the research are on the web at www.TRB.org/SHRP2.

Details about product implementation activities and assistance are on the GoSHRP2 website at www.fhwa.dot.gov/goshrp2/.

Details about where and how states are using SHRP 2 Solutions are on the AASHTO website at www.shrp2.transportation.org.

TRANSPORTATION RESEARCH BOARD
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SHRP 2 Safety Research Products

May 2014

To address a critical gap in data about driver behavior, the SHRP 2 Safety Program conducted the most comprehensive naturalistic driving study (NDS) yet undertaken. The resulting database is the world's largest source of data on a broad range of drivers and driving conditions collected at six sites in the continental United States. A complementary and linked roadway database will make it possible to relate driver behavior to roadway characteristics. The foundational databases, along with SHRP 2-developed reduced data sets and analysis support tools, will be used by private public, and academic researchers to improve highway safety for the next 20 years.

PRODUCT (Project Numbers)	**Impact on Practice**	**Product Status**	**Implementation Status**
Data to Improve Highway Safety			
Naturalistic Driving Study database (NDS) (S05, S06, and S07) The NDS database contains comprehensive video and vehicle sensor data collected from drivers and their vehicles over a three-year period in six locations across the United States. The database contains 2 petabytes of data from 5.4 million trips taken by 3,147 volunteer drivers for between 4 and 24 months each—nearly 50 million miles of driving. The data include continual records of each vehicle's position, speed, acceleration, steering and brake activity at all times during each trip. They also include forward radar data and video camera views looking forward in front of the vehicle, backward behind the vehicle, and toward the driver's face and hands. The study was conducted in six areas in Florida, Indiana, North Carolina, New York, Pennsylvania, and Washington. The six areas contain a mix of road types and climate conditions. Approximately equal numbers of male and female drivers in all age groups participated. The database can be accessed by qualified researchers to analyze what is actually happening behind the wheel as drivers are driving in their everyday or "natural" driving conditions. The NDS was developed and collected through three SHRP 2 research projects. Project S05 designed the NDS database. Project S06 managed the data collection. The six S07 projects conducted the data collection.	Analysis of the NDS data can address many questions about driver behavior that cannot be studied accurately with data from crashes, observations, or surveys. The data show how drivers really drive, how they interact with vehicular, roadway, and environmental features, what they are doing just before they crash, and why some risky situations do not produce crashes. The analyses can help refine existing countermeasures and develop new ones to reduce crashes, injuries, and fatalities.	Data collection was completed in November 2013. Initial quality control was completed in March 2014. Final quality control will be completed by Dec. 31, 2014. The database is currently available for limited use by qualified researchers with a data sharing agreement. The NDS will be linked to the Roadway Information Database (RID) by December 2014, as described below. The S05 report, *Design of the In-Vehicle Driving Behavior and Crash Risk Study* (Report S2-S05-RR-1) is available at www.trb.org/Publications/Blurbs/165119.aspx. The S06 and S07 reports will be available in 2014. Documentation for the full study is available on the InSight website https://insight.shrp2nds.us/.	The NDS is implemented by studies that analyze the NDS data. Three analysis contracts are already using the data—see the S08 projects below. A solicitation for additional studies will be included in Round 4 IAP (June 2014). The NDS and RID data will be available for general use in January 2015. **CONTACTS:** Ken Campbell, kcampbell@nas.edu, Aladdin Barkawi, Aladdin.Barkawi@dot.gov, and Kelly Hardy, KHardy@aashto.org

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Roadway Information Database (RID) (S03, S04A, and S04B) The RID contains roadway data as well as other contextual information from three sources: 1) New roadway data on approximately 12,500 centerline miles in the six study areas. The data, which SHRP 2 collected using automated data collection vehicles, was quality assured by an independent third party to meet project specifications (Project S04B); 2) Existing roadway data was acquired from a national source and from state inventories in the six study states; and 3) Supplemental information was acquired was from national and state sources. The new data include horizontal curvature, grade, cross-slope, lanes, shoulders, medians, rumble strips, barriers, lighting, intersections, and all MUTCD signs. The existing roadway inventory data vary by state. The supplemental data include crash histories, traffic, weather, work zone information, changes to infrastructure, roadway capacity improvements, safety enforcement laws, FRA grade crossings, and Highway Performance Monitoring System files. All these data from the three categories are referenced to a common basemap with national coverage and are managed in a geospatial database. Project S04A designed and managed the RID database, obtained the existing and supplemental data, and quality assured the new roadway data collected under Project S04B. Project S03 evaluated several mobile data collection vendors to assist in selecting one for the S04B data collection.	The RID provides the roadway context for the data collected from the vehicles in the NDS. Linking the RID data with the NDS can address questions of how driver behavior is affected by roadway characteristics. The analyses can help refine existing roadway countermeasures and develop new ones to reduce crashes, injuries, and fatalities.	Detailed roadway data collection was completed in November 2013. Existing and supplemental data collection will be completed in 2014 and the RID database will be complete and documented by Dec. 31, 2014. The database is currently available for qualified researchers on a limited basis without the supplemental data that is being added in 2014. The S04A report will be available in 2014. The S03 report, *Roadway Measurement System Evaluation* (S2-S03-RW-1) is available at www.trb.org/Publications/Blurbs/165410.aspx.	The RID is implemented by using the RID data. Two of the three analysis contracts are already using RID data—see the S08 projects below. A solicitation for additional studies will be included in Round 4 IAP (June 2014). The NDS and RID data will be available for general use in January 2015. **CONTACTS:** Charles Fay, cfay@nas.edu, Aladdin Barkawi, Aladdin.Barkawi@dot.gov, and Kelly Hardy, KHardy@aashto.org
NDS-RID Linkage Database (S31, Task 1.7) The NDS database of trips and the RID database of roadway segments are in the process of being linked. Each NDS trip will be linked to the RID to identify the roadway segments on which it traveled. Each RID roadway segment will be linked to identify the NDS trips that traveled over it.	Analyses of the linked data can address many questions of how driver behavior and roadway characteristics interact. This knowledge can help reduce crashes through improved roadway design and operations.	Linking will be complete and documented by Dec. 31, 2014.	A solicitation is included in Round 4 IAP (June 2014). It is anticipated that some studies done under this solicitation will use the NDS-RID linkage database. **CONTACTS:** Ken Campbell, kcampbell@nas.edu, Aladdin Barkawi, Aladdin.Barkawi@dot.gov, and Kelly Hardy, KHardy@aashto.org

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Data Analysis Tools and Results			
InSight NDS Website (S31 Task 1.1) Users can access NDS background information and NDS data through the Insight website https://insight.shrp2nds.us/. Background information includes a study overview, a data access guide, data dictionaries for all data subsets and variables, and sample data from driver assessments, face video, and trip videos and time series data. Data accessible through the website include: > Trip summary file: categorical data on each trip that describe the driver, the vehicle, trip length, maximum speed and braking, and much more > Crashes and near-crashes: event files for the approximately 700 crashes and 7,000 near-crashes contain categorical data from the trip summary file and other data coded manually, such as driver distraction and cell phone use. Epoch files for each crash and near-crash contain about 30 seconds of time series data and forward video > Baselines: similar event and epoch files for approximately 30,000 randomly selected baseline periods of driving across all vehicles in the study. Users can query and tabulate the data on-line.	The website is the best way for NDS users to learn about the data and to explore what data are available to study the questions they are interested in. Some questions can be studied directly from the website trip summary data or the crash, near-crash, and baseline data.	The April 10, 2014 website release contains over 1 million trips, over 100 crashes/near-crashes, and most variables. Additional trips and variables will be added in releases in July and October 2014. The website data and variables will be complete by December 31, 2014. Documentation for all website data is available on the website.	The InSight website is available for use. Access information is on the home page https://insight.shrp2nds.us/. **CONTACTS:** Ken Campbell, kcampbell@nas.edu, Aladdin Barkawi, Aladdin.Barkawi@dot.gov, and Kelly Hardy, KHardy@aashto.org
Analysis of SHRP 2 Naturalistic Driving Data (S08A, B, and D) Analyses of early NDS data to address three high-priority topics: safety on rural two-lane curves, driver inattention, and offset left-turn lanes. Phase 1 demonstrated proof-of-concept; three contractors are conducing full analyses in Phase 2. Final reports are due July 31, 2014 and will be available later in 2014. **Integration of Analysis Methods and Development of Analysis Plan** (S02) A compilation of priority research topics and sample plans for analyzing NDS data.	Results from these analysis projects can be used to design or refine cost-effective measures to reduce road departure crashes, warn inattentive drivers, and help DOTs design intersections that balance crash risk with construction and maintenance costs. The project developed a list of more than 400 potential research topics, identified the highest-priority research questions, and developed five sample work plans for addressing those questions. The report provides useful background information for those who wish to use NDS data.	A report summarizing the Phase 1 work in all four projects, *Initial Analyses from the SHRP 2 Naturalistic Driving Study: Addressing Driver Performance and Behavior in Traffic Safety*, is available at www.trb.org/Main/Blurbs/168727.aspx. Final reports will be available in 2014. The report, *Integration of Analysis Methods and Development of Analysis Plan* (S2-S02-RW-1) is available at www.trb.org/Publications/Blurbs/166051.aspx.	**CONTACTS:** Ken Campbell, kcampbell@nas.edu, Aladdin Barkawi, Aladdin.Barkawi@dot.gov, and Kelly Hardy, KHardy@aashto.org

SHRP 2 Renewal Research Products

May 2014

SHRP 2 Renewal products are tools and resources to renew roads and bridges in less time, with less disruption to traffic and communities. They include advanced methods for bridges, nondestructive testing techniques, pavements, project delivery, and underground utilities. Together these products help transportation agencies meet the challenge to get in, get out, and stay out.

PRODUCT (Project Numbers)	**Impact on Practice**	**Product Status**	**Implementation Status**
Bridges			
Innovative Bridge Designs For Rapid Renewal (R04) A design toolkit for prefabricated bridge elements was developed that includes standard design concepts for foundation systems, substructure and superstructure systems, subsystems, and components. A guide and examples are also provided. It includes standard plans, model specifications for design and construction and detailed examples.	Standardized approaches streamline the activities required to design, fabricate, and erect bridge replacement systems in less time, and install them in hours or days, rather than weeks or months. With this toolkit, local contractors can use typical equipment to gain the benefits of accelerated bridge construction techniques. Changing the project delivery model with these techniques can provide economies of scale in manufacturing and construction, reduce traffic disruption, and increase safety.	The toolkit, the final report, and videos of bridge construction using the design toolkit and ABC techniques in Iowa and New York are available at http://www.trb.org/Main/Blurbs/167693.aspx.	Included in the Round 1 IAP. Eleven states are receiving implementation assistance. **CONTACTS** are Shay Burrows, shay.burrows@dot.gov and Patricia Bush, pbush@aashto.org
Bridges For Service Life Beyond 100 Years: Innovative Systems, Subsystems, and Components (R19A) The Service Life Design Guide is a new reference volume that addresses design, fabrication, construction, operation, maintenance, repair, and replacement issues for both new and existing bridges during the entire service life of the bridge. The Guide provides information and procedures to systematically design new and existing bridges for the service life and durability. It includes a framework for service life design and has 11 chapters, and 7 appendices each devoted to a certain bridge component or aspect of the service life design process.	Addressing the service life of every bridge component at the design stage ensures that the overall structure can be maintained to reach a design life of 100 years. The Guide equips designers to design longer-lasting bridge components that are easier to inspect, maintain, and replace, and are better suited to their environment—factors that reduce maintenance, lane closures, and work zones.	The *Design Guide for Bridges for Service Life* is available at www.trb.org/Main/Blurbs/168760.aspx. The final report, *Bridges for Service Life Beyond 100 Years: Innovative Systems, Subsystems, and Components*, is available at http://www.trb.org/Main/Blurbs/169729.aspx. The Guide will be further developed to incorporate additional chapters and practical examples, and will likely be published by AASHTO.	Renamed as "Service Life Design for Bridges." Included in the Round 4 IAP (June 2014). **CONTACTS:** Anwar Ahmad, anwar.ahmad@dot.gov and Patricia Bush, pbush@aashto.org

PRODUCT (Project Numbers)	**Impact on Practice**	**Product Status**	**Implementation Status**
Bridges for Service Life Beyond 100 Years: Service Limit State Design (R19B) The Service Life Guide Specification and Framework provides draft design codes for standard bridges based on service limit state. The companion tool kit includes data sets related to durability, fatigue, fracture, and redundancy as integral issues of service life; performance measures; and comprehensive design procedures leading to longer and more predictable service life.	When individual bridge components, such as bridge bearings, deck joints, and columns and piles deteriorate at different rates, bridges can be closed for repair far too often. Designing bridge components and systems to service limit states extends the service life of the entire structure, yields significant savings through reduced maintenance and, by reducing road closures, reduces safety risks for workers and road users.	Portions of this work are expected to be incorporated into the AASHTO Bridge Specifications. The Service Life Guide will continue to be developed under AASHTO guidance. The final report, *Bridges for Service Life Beyond 100 Years: Service Limit State Design*, is available at http://www.trb.org/Main/Blurbs/170201.aspx. The tool kit is forthcoming.	Renamed as "Service Limit State Design for Bridges." **CONTACTS:** Matt DeMarco, matthew.demarco@dot.gov and Greta Smith, gsmith@aashto.org
Nondestructive Testing Techniques			
A Plan for Developing High Speed, Nondestructive Testing Procedures for both Design Evaluation and Construction Inspection (R06) This project identified existing NDE techniques and practices, emerging technologies, and apparent gaps between current and future inspection requirements and existing and emerging technology. An R&D plan was developed to address the gaps and seven follow-on projects were undertaken.	With advanced NDE technologies, agencies will be better equipped to meet the challenges of rapid renewal projects.	The project is complete. The final report, *A Plan for Developing High-Speed, Nondestructive Testing Procedures for Both Design Evaluation and Construction Inspection* (SHRP 2 Report S2-R06-RW) is available as an Adobe PDF document. Project R06 generated 7 related projects (R06A-G). The products of each are included in the NDToolbox, available at http://www.ndtoolbox.org/.	**TRB CONTACT:** Andrew Horosko, ahorosko@nas.edu
Nondestructive Testing Technologies for Rapid Renewal (R06A) The NDToolbox is an online collection of techniques and technologies for identifying deterioration on concrete bridge decks, quality control of construction materials and pavements, and condition assessment of pavements and tunnels.	The NDToolbox includes technologies that were independently evaluated so owner agencies can be confident in their choice of technology and method. The webtool also has added information on technologies that were the focus of research in projects R06B-G. The NDToolbox supports faster and more effective condition assessments that help reduce traffic delays and safety risks from lane closures.	The final report, *Nondestructive Testing to Identify Concrete Bridge Deck Deterioration*, (SHRP 2 Report S2-R06A-RR-1) is online at http://www.trb.org/Main/Blurbs/167278.aspx. Videos of the SHRP2 field validation of NDT technologies are at http://www.trb.org/StrategicHighwayResearchProgram2SHRP2/Pages/Video-FieldValidationTestingofNondestructiveTestingTechnologiesonaConcreteBridgeDeck_511.aspx.	Renamed as "Nondestructive Testing Technologies for Concrete Bridge Decks." Included in the Round 4 IAP (June 2014). **CONTACTS:** Matt DeMarco, matthew.demarco@dot.gov and Evan Rothblatt, erothblatt@aashto.org

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Evaluating Applications Of Field Spectroscopy Devices To Fingerprint Commonly Used Construction Materials (R06B) The project evaluated portable quality-control technologies to verify the unique fingerprint of common construction materials in the field. The project compiled data sets for the unique signatures of many common construction materials. The most successful generic procedures were expanded into draft AASHTO standard specifications for a method for fingerprinting chemical admixtures in freshly mixed portland cement concrete and a method for determining the metal content in paint.	The ability to confirm that the material being used onsite meets contract specifications will allow real-time verification of construction operations and prevent costly rework to replace noncompliant material. Field verification also means that contractors can quickly move to the next project operation without waiting for results of laboratory analysis to verify the type and quality of the material, saving both time and money.	Agency-oriented model specifications are being refined for each testing method. Pilot tests conducted with two DOTs have been completed. The report, *Evaluating Applications of Field Spectroscopy Devices to Fingerprint Commonly Used Construction Materials* (SHRP 2 Report S2-R06B-RW-1) is at www.trb.org/Main/Blurbs/167279.aspx. A field test report is expected in 2014.	Renamed as "Techniques to Fingerprint Construction Materials." **CONTACTS:** Steve Cooper, Stephen.J.Cooper@dot.gov and Evan Rothblatt, erothblatt@aashto.org
Specifications For Using Rapid Infrared and Radar Technologies for Quality Control of Asphalt Pavements During Construction (R06C) The project developed two nondestructive techniques for detecting defect areas in asphalt pavements during construction. PAVE-IR measures the real-time mat temperature. Ground-penetrating radar measures pavement density after rolling. Recommendations for equipment and testing protocols were also developed. A training video explaining how to use the technologies and interpret the data has been produced.	These technologies overcome some drawbacks of standard testing methods to advance practice and provide new efficiencies in pavement construction. Costly and time-sensitive nuclear testing becomes unnecessary. Both technologies (infrared and radar) test essentially 100 percent of the pavement area, providing much more inspection coverage than existing quality control methods. Detecting defect areas during construction allows the paving crew to adjust in real time, which avoids costly corrections and more reliably produces long-lasting pavements.	These technologies were pilot tested in Vermont in conjunction with FHWA's Every Day Counts program; further tests were conducted in Pennsylvania and Virginia. The final report, *Using Both Infrared and High-Speed Ground Penetrating Radar for Uniformity Measurements on New HMA Layers* (Report S2-R06C-RR-1), training materials, video, and specifications for testing procedures are available at www.trb.org/Main/Blurbs/167280.aspx. A field test report will be available in spring 2014.	Renamed as "Rapid Technologies to Enhance Quality Control on Asphalt Pavements." Included in the Round 4 IAP (June 2014). **CONTACTS:** Steve Cooper, Stephen.J.Cooper@dot.gov and Evan Rothblatt, erothblatt@aashto.org
Guidelines For Using NDT Methods to Identify Delamination in Asphalt Pavements (R06D) Guidelines for using two new technologies to detect subsurface delamination in asphalt pavement. Both ground- penetrating radar and impact echo and seismic analysis of surface waves accelerate data acquisition.	Single-pass and full-lane coverage techniques significantly increase testing efficiency, reduce the time that technicians are exposed to traffic, and reduce data collection costs. These NDT techniques improve the ability to detect a key cause of pavement failure faster, with less manual analysis, and less risk to drivers and technicians.	Two prototypes are in development and pilot-test sites will be identified. Guidelines for using the technologies are being refined. The equipment is expected to be available for commercial use in 2014. The final report, *Testing to Identify Delaminations Between HMA Layers, Volume 1* (SHRP 2 Report S2-R06D-RR-1) is available at www.trb.org/Main/Blurbs/167281.aspx.	Renamed as "Advanced Methods to Identify Pavement Delamination." **CONTACTS:** Greta Smith, gsmith@aashto.org and Steve Cooper, Stephen.J.Cooper@dot.gov

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Real-Time Smoothness Measurements on Portland Cement Concrete Pavements During Construction (R06E) The project evaluated tools to measure concrete pavement smoothness in real time during construction; model specifications and construction guidance were developed.	Measuring pavement smoothness during construction, rather than after the concrete sets, allows immediate remediation resulting in a better quality product and reduced need for expensive grinding.	Of seven devices studied, two were selected for further evaluation and demonstration: the GOMACO Smoothness Indicator and the Ames Engineering Real-Time Profiler. The devices were evaluated during concrete paving projects in Georgia, Arkansas, Texas, Michigan, and New York. The final report, *Real-Time Smoothness Measurements on Portland Cement Concrete Pavements During Construction* (SHRP 2 Report S2-R06E-RR-1) and product information are available at http://www.trb.org/Main/Blurbs/167282.aspx.	Renamed as "Tools to Improve Pavement Smoothness on PCC in Real Time During Construction." Included in the Round 4 IAP (June 2014). **CONTACTS:** Greta Smith, gsmith@aashto.org and Steve Cooper, Stephen.J.Cooper@dot.gov
Continuous Pavement Deflection Device Assessments (R06F) The project produced a catalog of devices for measuring continuous deflection and detailed evaluation of traffic speed deflectometers, detailed assessment of the most promising devices, case studies, fact sheets, training materials for a workshop on the topic, research needs statements, and a dissemination and implementation plan for the technology.	Continuous deflection measuring devices are increasingly used to support pavement management business processes. Techniques that don't disrupt traffic are of special interest. The evaluations identified promising characteristics of these young technologies and areas for future development. They have advanced network-level data collection and show promise for project-level use.	The final report, *Assessment of Continuous Pavement Deflection Measuring Technologies* (SHRP 2 Report S2-R06F-RW-1), is available at www.trb.org/Main/Blurbs/167283.aspx.	**CONTACT:** Steve Cooper, Stephen.J.Cooper@dot.gov
User Guide for Mapping Defects in or Behind Tunnel Linings (R06G) The project produced TUNNELCHECK software to support integration of ground-penetrating radar and video-collected data to identify problem areas in a tunnel more quickly and a user's manual for selecting NDT technologies that can detect defects behind or within tunnel linings.	Selecting the best method for inspecting tunnel linings can not only add life to the structure, it can also reduce disruptive detours and lane closures. Practitioners can use the Guide to select NDT technologies that improve inspection and detection and reduce traffic disruption.	This technology has been piloted in tunnels in Colorado and Texas, and in the Chesapeake Bay area of Virginia. The final report *Mapping Voids, Debonding, Delaminations, Moisture, and Other Defects Behind or Within Tunnel Linings* is available at http://www.trb.org/Main/Blurbs/168768.aspx.	Renamed as "Nondestructive Testing for Tunnel Linings." Included in the Round 4 IAP (June 2014). **CONTACTS:** Matt DeMarco, matthew.demarco@dot.gov, Jim McDonnell, jmcdonnell@aashto.org, and Greta Smith, gsmith@aashto.org

PRODUCT (Project Numbers)	**Impact on Practice**	**Product Status**	**Implementation Status**
Pavements			
Web-Based Technical Support Tool For Geotechnical Solutions (R02) The technology selection tool and resource developed in the research identified and evaluated more than 40 geotechnical solutions to common embankment, cut slope, structure/foundation interface, and pavement foundation issues.	This web-based tool can accelerate the design and construction process by providing practitioners with a convenient and efficient way to identify and apply appropriate geotechnical solutions to site-specific conditions and issues based on specific performance requirements. With this tool practitioners can select advanced techniques with confidence and realize benefits of cost-effective and time-saving innovations.	GeoTechTools, the online technology selection tool and resource, is available at http://www.fhwa.dot.gov/goshrp2/Solutions/Renewal/R02/GeoTechTools The final report, *Geotechnical Solutions for Soil Improvement, Rapid Embankment Construction, and Stabilization of the Pavement Working Platform* (SHRP 2 Report S2-R02-RW-1), and the *Web-based Guidance System Development Report*, which describes how technologies were selected for inclusion in GeoTechTools, are available at www.trb.org/Main/Blurbs/168148.aspx.	Renamed as "GeoTech Tools." Included in the Round 3 IAP. Fifteen states are receiving implementation assistance. **CONTACT:** are Silas Nichols, silas.nichols@dot.gov and Evan Rothblatt, erothblatt@aashto.org
Modular Pavement Technology (R05) The research resulted in guidelines and tools for the selection, design, construction, installation, and maintenance of precast concrete pavement systems, and tools for cost/benefit assessment in situations where the technology may apply.	Modular pavement technology use is rising, but little guidance has been available to make the most of these systems. This research provides guidance transportation agencies can use to design, fabricate, construct, and maintain PCP systems that can speed up roadway reconstruction without sacrificing quality and to reopen lanes sooner.	The final report, *Precast Concrete Pavement Technology* (SHRP 2 Report S2-R05-RR-1), includes the guidelines and is available at www.trb.org/Main/Blurbs/167788.aspx.	Renamed as "Precast Concrete Pavement." Included in the Round 3 IAP. Five states are receiving implementation assistance. **CONTACTS:** are Sam Tyson, sam.tyson@dot.gov and Jameelah Hayes, jhayes@aashto.org

PRODUCT (Project Numbers)	**Impact on Practice**	**Product Status**	**Implementation Status**
Composite Pavement Systems (R21) The project produced guidelines, validated models, techniques, and specifications for using two composite pavement systems: a thin, high-quality hot-mix asphalt layer over a portland cement concrete (PCC) structural layer; and a thin, superior PCC surface over a second, less-expensive, recycled PCC layer. The guidelines include practical recommendations for construction specifications and techniques, life-cycle costing, quality management procedures, and training materials. Revisions to AASHTO MEPDG software and to the Manual of Practice were also developed.	Composite pavements have delivered longer service life with excellent surface characteristics and structural capacity, while being economical and sustainable. But objective studies of their use and installation have been inadequate to support widespread adoption. This project conducted the validation and produced needed documentation so that transportation agencies can have confidence that the composite pavement systems they install and maintain will be long-lasting and have predictably low life-cycle costs.	A field section was constructed at MNRoads and at the accelerated pavement testing facility at UC-Davis Pavement Research Center. *Composite Pavement Systems: Volume 1: HMA/PCC Composite Pavements* (SHRP 2 Report S2-R21-RR-2) is available at http://www.trb.org/StrategicHighwayResearchProgram2SHRP2/Blurbs/168145.aspx and *Composite Pavement Systems: Volume 2: PCC/PCC Composite Pavements* (SHRP 2 Report S2-R21-RR-3) is at http://www.trb.org/StrategicHighwayResearchProgram2SHRP2/Blurbs/168533.aspx. *2008 Survey of European Composite Pavements* (SHRP 2 Report S2-R21-RW-1) is available at http://www.trb.org/StrategicHighwayResearchProgram2SHRP2/Blurbs/163693.aspx.	Included in the Round 4 IAP (June 2014). **CONTACTS:** are Steve Cooper, Stephen.J.Cooper@dot.gov, and Jameelah Hayes, jhayes@aashto.org
Using Existing Pavement In Place (R23) The project produced a web-based scoping tool and easy-to-follow Project Assessment Manual with model specifications and case studies for incorporating existing pavements into rapid renewal road construction projects.	The new guide identifies the optimal conditions for using existing pavements and the best approaches for ensuring they last longer when they are incorporated. These pavements have the potential to serve up to 50 years and can reduce the need for more costly and time-consuming reconstruction projects using all new materials. The end results are longer-lasting pavements that cost substantially less, use substantially less new material, and can be constructed more quickly.	The Pavement Design Life guide is being expanded to include solutions that provide 30 to 50 year life. Guidelines and other new information from projects R05 and R21 are being incorporated into the tool. The Washington State DOT estimates it will realize a 30% cost savings over the life of the new pavement and a 50% reduction in user delay by applying this method. The final report, *Using the Existing Pavement In-Place and Achieving Long Life*, is available at www.trb.org/Main/Blurbs/168146.aspx.	Renamed as "Pavement Renewal Solutions." Included in the Round 3 IAP. Nine states are receiving implementation assistance. **CONTACTS:** Steve Mueller, Steve.Mueller@dot.gov and Evan Rothblatt, erothblatt@aashto.org

PRODUCT (Project Numbers)	**Impact on Practice**	**Product Status**	**Implementation Status**
Preservation Approaches for High-Traffic-Volume Roadways and Guidelines for Preservation of High-Traffic-Volume Roadways (R26) The Guide developed in this project clarifies key factors that affect preservation treatment decisions. It includes preliminary and final feasibility matrices for hot-mix asphalt and portland cement concrete-surfaced pavements that engineers can use to quickly determine if a particular treatment type is recommended for particular distress types and severity levels. Example decision matrices simplify the complex factors involved and give steps for weighing technical inputs.	These are the first systematic and comprehensive documents to provide the technical background and decision-making framework needed to bring proven preservation strategies widely into play for high-volume roads. By helping engineers to quickly and confidently select the right treatment at the right time for a given pavement, the guide can help transportation agencies embrace preservation instead of rehabilitation or reconstruction to realize significant savings.	The report, *Preservation Approaches for High-Traffic-Volume Roadways* (Report S2-R26-RR-1) is at www.trb.org/Publications/Blurbs/165280.aspx and the *Guidelines for the Preservation of High-Traffic-Volume Roadways* (SHRP 2 Report S2-R26-RR-2) are at www.trb.org/Publications/Blurbs/164965.aspx.	Renamed as "Guidelines for the Preservation of High-Traffic-Volume Roadways." Included in the Round 1 IAP. Eleven states and the District of Columbia are receiving implementation assistance. **CONTACTS:** Thomas Van, Thomas.van@dot.gov and Jameelah Hayes, jhayes@aashto.org
Project Delivery			
Identifying and Reducing Worker, Inspector, and Manager Fatigue in Rapid Renewal Environments (R03) The project resulted in rapid renewal workforce fatigue risk factor definitions, and fatigue risk management practices and techniques; a toolkit for managing workforce fatigue in the rapid renewal environment; model training and outreach materials to assist in future implementation.	Tools to manage workforce fatigue and increase worker safety will help transportation agencies reduce the risks from worker fatigue of accelerated schedules, longer day shifts, night and weekend work, and work conducted in protected zones adjacent to traffic that are often associated with rapid renewal projects. Reducing worker fatigue in rapid renewal environments can reduce worker injuries due to fatigue, increase project productivity, and keep projects on time and within budget.	The final report, *Identifying and Reducing Worker, Inspector, and Manager Fatigue in Rapid Renewal Environments* (SHRP 2 Report S2-R03-RW-1, is available at http://www.trb.org/Main/Blurbs/168767.aspx. The guidebook, *Fatigue Risk Management Guide for Rapid Renewal Highway Construction Projects*, is available at http://www.trb.org/Main/Blurbs/168766.aspx.	Renamed as "Worker Fatigue Management." **CONTACTS:** Brian Cawley, brian.cawley@dot.gov and Greta Smith, gsmith@aashto.org

PRODUCT (Project Numbers)	**Impact on Practice**	**Product Status**	**Implementation Status**
Performance Specifications for Rapid Renewal (R07) Guide performance specifications were developed for hot-mix asphalt, portland cement concrete, concrete bridge decks, embankment/pavement foundations, other geotechnical application areas, work zone traffic control, and quality management. Guidelines were also developed for specification writers and a manual for executives and decision makers.	Clearly specifying the desired performance goals for accelerated road and bridge projects rather than specifying methods can encourage contractors to apply greater control and ingenuity, reduce costly construction oversight, and apply construction management resources more efficiently. This product provides tools owner agencies can use to reduce claims, reduce inspection costs, accelerate construction, and improve project quality.	Three pilot tests were conducted: Missouri DOT tested geotechnical performance specifications. Virginia DOT tested performance specifications for a hydraulic cement concrete bridge deck. Louisiana DOT evaluated use of roller-integrated compaction monitoring technology and mechanistic-based in situ point measurements on a new pavement section. The final report, *Implementation Guidelines: 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*, as well as *Guide Performance Specifications*, are available at http://www.trb.org/Main/Blurbs/169109.aspx.	Included in the Round 2 IAP. Six states are receiving implementation assistance. **CONTACTS:** Jennifer Balis, Jennifer.balis@dot.gov and Evan Rothbaltt@aashto.org
Risk Manual for Rapid Renewal Projects (R09) This project produced a guide to using a formal risk management process that helps optimize performance for accelerated reconstruction projects, offering practical methods for identifying, assessing, mitigating, allocating, and monitoring risk. Case studies, a risk/action checklist, implementation tools, and a training course for conducting risk assessments are included.	The innovative approaches and compressed schedules often involved in rapid renewal projects can amplify problems or risks. With advanced project management techniques, project managers can maximize opportunities, avoid poor project outcomes, and significantly improve the likelihood of project success.	The product was piloted on a project in North Carolina. A risk assessment workshop was held in Seattle, Washington. The *Guide for the Process of Managing Risk on Rapid Renewal Projects* is available at http://www.trb.org/Main/Blurbs/168369.aspx.	Renamed as "Managing Risk in Rapid Renewal Projects." Included in Rounds 1, 2, and 4 of the IAP. **CONTACTS:** Carlos Figueroa, carlos.figueroa@dot.gov and Greta Smith, gsmith@aashto.org

PRODUCT (Project Numbers)	**Impact on Practice**	**Product Status**	**Implementation Status**
New Strategies For Managing Complex Projects (R10) The project developed a five-dimensional approach to project management that adds project context and funding mechanisms to the three standard factors of cost, schedule, and engineering requirements.	Methods for assessing complexity factors will help managers make rational resource allocations and guide planning and implementation. The approach is fully scalable and can be used for all types of projects. It will also guide managers through a process to fully integrate project teams across the entire lifecycle, a foundation of project success. Project managers can proactively identify, plan for, and manage their projects to reduce the schedule and cost impacts that arise out of risk.	Case studies were conducted for complex projects such as: Capital Beltway HOV/HOT, Northern VA; Doyle Drive, San Francisco; I-40 Crosstown in Oklahoma City; and Louisville-Southern Indiana Ohio River Bridge. The report, *Project Management Strategies for Complex Projects* is available at www.trb.org/Main/Blurbs/167481.aspx. The supplemental guidebook, *Guidebook: Project Management Strategies for Complex Projects* is available at http://www.trb.org/Main/Blurbs/167482.aspx. Training materials now in draft form will be available late in 2014.	Renamed as "Project Management Strategies for Managing Complex Projects." Included in Rounds 1 and 4 of the IAP. **CONTACTS:** Carlos Figueroa, Carlos.Figueroa@dot.gov and Jameelah Hayes, jhayes@aashto.org
WISE: Workzone Impact and Strategy Estimator Software (R11) Software was developed to analyze the impacts on road users of multiple, concurrent work zones across a network or complex corridor. A users guide accompanies the software.	This tool will help agencies assess the optimal sequencing of renewal projects, and help determine the cost-effectiveness of strategies to minimize, manage, and mitigate road user costs from safety or operational perspectives.	The WISE software is fully developed. It was tested in Iowa and Arizona using historical data to validate its parameters and pilot tests in New York and Florida used the software to analyze projects in the planning phase. The report, *Strategic Approaches at the Corridor and Network Level to Minimize Disruption from the Renewal Process*, the supporting *WISE Users Guide*, and the WISE decision support software are available at www.trb.org/Main/Blurbs/168143.aspx.	Renamed as "WISE: Work Zone Impact Estimation Software." Contacts: Tracy Scriba, tracy.scriba@dot.gov and Greta Smith, gsmith@aashto.org

PRODUCT (Project Numbers)	**Impact on Practice**	**Product Status**	**Implementation Status**
Utilities and Railroads			
Encouraging Innovation in Locating and Characterizing Underground Utilities (R01) A web-based software tool was developed to help select site-specific technologies for locating underground facilities. The reference report documents state-of-the-art location methods and underground utility marking technology as well as successful practice.	This tool helps practitioners select the most appropriate location technology for project site conditions and utility characteristics. Project delays, redesign costs, and safety risks can all be reduced when transportation agencies know the location and characteristics of underground utilities within the project right-of-way early in the project design phase.	Two reports and the SAULT web-based selection tool are available at www.trb.org/Publications/Blurbs/165879.aspx. *Encouraging Innovation in Locating and Characterizing Underground Utilities* (SHRP 2 Report S2-R01-RW) and *Development of the Selection Assistant for Utility Locating Technologies* (SHRP 2 Report S2-R01-RW-2). SAULT, the Selection Assistant for Utility Locating Technologies is available online at http://138.47.78.37/sault/home.asp.	Renamed as "Encouraging Innovation in Locating Utilities." **CONTACTS:** Amanda Rutherford, Amanda.rutherford@dot.gov and Greta Smith, gsmith@aashto.org
Technologies To Support Storage, Retrieval, and Use of 3D Utility Location Data (R01A) The product is a data model for storing 3D utility information and a demonstration of how the data model can be used in a work-flow production environment to acquire, store, visualize, and update 3D utility information.	Utilities that are unknown or mistakenly recorded routinely consume resources and cause project delays. The 3-D data model will provide easy identification, tracking, and retrieval of information so that an increasingly comprehensive record of utility information beneath public rights-of-way can be created. Ready access to this information can eliminate costly and dangerous surprises during construction and reduce the time spent on "refinding" known utilities.	A prototype data model was piloted and evaluated in cooperation with Virginia DOT and technology and utility providers in 2013. The research report, data model, and user's guide are forthcoming.	Renamed as "3D Utility Location Data Repository." **CONTACTS:** Amanda Rutherford, Amanda.rutherford@dot.gov and Greta Smith, gsmith@aashto.org
Utility-Locating Technologies (R01B) Two functional prototypes were developed: a multi-channel ground-penetrating radar system to locate utilities in one pass and a new multi-sensor platform that combines electromagnetic induction and 3D ground-penetrating radar to produce utility location data.	Locating underground utilities is made more complicated by variation in material types, soil types, and depth of location. Combining sensor technologies on a single platform can save time, improve accuracy, and provide data that designers can use to engineer site-specific project solutions.	The project is complete. Both technologies require further development to be commercially viable. The final report is forthcoming.	**CONTACTS:** Amanda Rutherford, Amanda.rutherford@dot.gov and Greta Smith, gsmith@aashto.org

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Innovation in Locating Deep Utilities (R01C) Two technologies to expand the zone in which underground utilities can be located and identified were developed. Prototype long-range radio frequency ID and low-frequency acoustic location technologies were developed and tested.	Delays and costs of excavation and risks of utility conflicts can be avoided if utilities can be reliably located, even when deep underground, with nondestructive techniques. The technologies in development go beyond the shallow underground utility location technologies and expand the locatable zone capability needed to find deep utilities.	The project is complete. Both prototypes require further development to reach commercial readiness. Project reports are forthcoming.	Renamed as "Innovation in Location of Deep Utilities." **CONTACTS:** Amanda Rutherford, Amanda.rutherford@dot.gov and Greta Smith, gsmith@aashto.org
Integrating the Priorities of Transportation Agencies and Utility Companies (R15) The report examines current practices, opportunities for enhancement, and anticipated barriers to integrating utility and transportation agency priorities in highway renewal projects. 13 best practices that span the whole project life cycle are explored.	Increasing demand for accelerated project delivery and less traffic disruption highlight the need for increased coordination between transportation agencies and utility owners. The successful practices described in the report can help both parties reduce costs and delays when utilities and transportation projects intersect.	The final report, *Integrating the Priorities of Transportation Agencies and Utility Companies*, (SHRP 2 Report S2-R15-RW) is available at www.trb.org/Publications/Blurbs/161801.aspx.	**TRB CONTACT:** Matt Miller, mamiller@nas.edu
Identification of Utility Conflicts and Solutions (R15B) Two versions of a unified utility conflict matrix have been developed: a stand-alone, spreadsheet-based matrix ("UCM lite"); and an advanced UCM prototype that enables the management of conflicts in a database environment.	With these tools, users can organize, track, and manage the conflicts that frequently arise when utility lines are located under highways. They are scalable, support a range of project sizes and conditions, and generate easily accessible information to help all parties make more informed decisions. Earlier identification of potential conflicts can lead to more timely and less costly solutions.	The spreadsheet "UCM lite" and the training material, data model, and database are available at www.trb.org/main/blurbs/166731.aspx along with companion documentation that describes their structure and usability. In project R15C, the utility conflict matrix has been pilot tested with cooperation from state DOTs. A pilot test report will document the findings.	Renamed as "Identifying and Managing Utility Conflicts." Included in the Round 3 IAP. Eight states are receiving implementation assistance. **CONTACTS:** Amanda Rutherford, Amanda.rutherford@dot.gov and Greta Smith, gsmith@aashto.org

PRODUCT (Project Numbers)	**Impact on Practice**	**Product Status**	**Implementation Status**
Strategies for Improving the Project Agreement Process Between Public Agencies and Railroads (R16) This project produced model legal agreements, recommended practices, sample contracts, and training materials to resolve underlying sources of conflicts and streamline review and agreement processes. Two follow-on projects, R16A and R16B, were undertaken to develop a community of interest in support of agreement strategies and to identify strategies to communicate about the products of R16.	Whenever railroad and highway projects intersect there is potential for delay and increased costs. Streamlining the process with standard agreements and practices will save money and time for both railroads and public agencies. To establish a community of interest that will sustain and update the work of R16, pairs of champions, each pair representing a Class 1 railroad and a DOT, were recruited. The community is the mechanism for building broad support for continuing cooperation and advancing practice.	The report, *Strategies for Improving the Project Agreement Process between Highway Agencies and Railroads* (SHRP 2 Report S2-R16-RR-1) and model agreements are available online and from the TRB Bookstore at www.trb.org/Publications/Blurbs/164283.aspx.	Renamed as "Railroad-DOT Mitigation Strategies." Included in the Round 2 IAP. Six states are receiving implementation assistance. Online community of interest. **CONTACTS:** Joe Taylor, Joseph.Taylor@dot.gov and Greta Smith, gsmith@aashto.org

SHRP 2 Reliability Research Products

May 2014

Products of Reliability research in SHRP 2 address the opportunity to improve travel time reliability by reducing the impact of unexpected congestion due to weather, work zones, special events, and random surges in demand. The research addressed reliability within the following themes: data, analytic tools, planning and programming, organizational capability, and innovation.

PRODUCT (Project Numbers)	**Impact on Practice**	**Product Status**	**Implementation Status**
Data and Analysis for Travel Time Reliability Performance			
Establishing Monitoring Programs for Mobility and Travel Time Reliability (L02) This product presents ways to develop systems to monitor travel-time reliability. It provides a guidebook for designing, building, operating, and maintaining those systems, and interpreting the data. The guidebook describes where to place traffic detectors, how to impute missing data, fusion of data on the sources of non-recurring congestion, how to calculate the percentage contribution of different sources to total congestion, and the graphical signature for reliability improvement.	With the ability to analyze and address causes of non-recurring congestion and improve travel-time reliability, transportation agencies can reduce variability of travel time and provide the benefits of more reliable travel for commuters, travelers, and the freight industry.	The final report, *Establishing Monitoring Programs for Travel Time Reliability*, is available at http://www.trb.org/Main/Blurbs/168765.aspx, and the guidebook, *Guide to Establishing Monitoring Programs for Travel Time Reliability*, is available at http://www.trb.org/Main/Blurbs/168764.aspx. The *Handbook for Communicating Travel Time Reliability Through Graphics and Tables* is available at http://www.trb.org/Main/Blurbs/170608.aspx. Four pilot projects, L38A-D, are being conducted to test the functionality of L02 along with products from other projects (L05, L07, L08, and C11). The pilots are due to be completed in mid 2014.	Scheduled for the Round 4 IAP (June 2014). **CONTACTS:** Robert Rupert, Robert.rupert@dot.gov and Gummada Murthy, gmurthy@aashto.org

PRODUCT (Project Numbers)	**Impact on Practice**	**Product Status**	**Implementation Status**
Analytic Procedures for Determining the Impacts of Reliability Mitigation Strategies (L03) A foundation study was produced that defines reliability, presents recommended reliability measures derived from travel time distributions, presents the causes of congestion, explains how to build a data base for estimating prediction models, conducts before-and-after studies of operations and capacity improvements, and develops two sets of prediction models based on empirical data from numerous metropolitan areas.	This fundamental study has already influenced research and practice through the definitions of travel time reliability it offers and through its consideration of how one can effectively think about the variability of travel time. This study develops models for predicting travel time reliability. The simple prediction model that comes from this research has many uses in sketch planning, simulation, and initial evaluations of operations and other expenditures. The richer model has been incorporated into the SHRP 2 Project L07 Reliability spreadsheet tool to evaluate how different design treatments affect reliability.	The report, *Analytical Procedures for Determining the Impacts of Reliability Mitigation Strategies* (SHRP 2 report S2-L03-RR-1) is available at http://www.trb.org/Main/Blurbs/166935.aspx. Project L33, Validation of Urban Freeway Models, is pilot testing the L03 data rich and data poor models applicable to urban freeways to determine if the models behave well when validated on a different set of data. A second objective was to enhance the two sets of models as appropriate. The validation work is expected to confirm the predictive value of many of the models and provide insight for improving others. These same or refined models will be useful in the ways described above with regard to the L03 prediction models. A draft report, *Validation of Urban Freeway Models*, is in review.	L03 is not being independently implemented, but its results and equations have been incorporated into other SHRP 2 products. **CONTACT:** William Hyman, whyman@nas.edu. For information on L33, contact William Hyman, whyman@nas.edu, John Halkias, john.halkias@dot.gov, or Gummada Murthy, gmurthy@aashto.org.
Incorporating Reliability Performance Measures in Operations and Planning Modeling Tools (L04) The research produced a number of reports and an application guide for incorporating travel time reliability into micro- and meso-simulation models and for integrating reliability in demand and network models. The products also include prototype software that potentially can be integrated with many simulation packages so they can explicitly address travel time reliability.	The L04 research has resulted in prototype software that offers a new way of applying simulation models to more fully account for the factors that cause non-recurring congestion. The new methods are useful for project evaluation and many types of planning. The Scenario Generator produces randomized input into simulation models with regard to incidents, work zones, weather, etc. The Trajectory Processor generates distributions of origin-destination travel time from which a broad range of reliability performance measures can be derived.	A final report and application guidelines are in publication review. Technical reports of interest to modeling experts, software (a Scenario Generator and a Trajectory Processor) and corresponding user guides are also in review.	FHWA is developing an implementation strategy to further test and refine the products of Project L04. **CONTACTS:** William Hyman, whyman@nas.edu; Stephen Andrle, sandrle@nas.edu; John Halkias, john.halkias@dot.gov; and Gummada Murthy, gmurthy@aashto.org

PRODUCT (Project Numbers)	**Impact on Practice**	**Product Status**	**Implementation Status**
Traveler Information and Travel Time Reliability (L14) The research produced a report, including a lexicon, that provides preliminary suggestions on how transportation agencies can best communicate information about travel time reliability to motorists so they can make informed decisions and better plan to arrive at their destination on time.	With better public awareness and understanding of the variability of travel time, road users can quickly learn to work around nonrecurring delays due to incidents, bad weather, work zones, special events, and malfunctioning traffic control devices. This type of behavior can reduce delays on the system and improve performance.	*A Lexicon for Conveying Travel Time Reliability Information* is available at http://www.trb.org/Main/Blurbs/168810.aspx and the final report, *Effectiveness of Different Approaches to Disseminating Traveler Information on Travel Time Reliability*, is available at http://www.trb.org/Main/Blurbs/168809.aspx.	FHWA is developing an implementation strategy to further test the product of Project L14. **CONTACTS:** William Hyman, whyman@nas.edu; Jimmy Chu, jimmy.chu@dot.gov; and Gummada Murthy, gmurthy@aashto.org
Reliability in Planning, Programming, and Geometric Design			
Incorporating Reliability Performance Measures into the Transportation Planning and Programming Processes (L05) The products include a guide, a technical reference, spreadsheets applied to case studies, and other material to help agencies address travel time reliability in their plans and programs.	MAP-21 calls for performance based planning and programming and it covers a number of goal areas including travel time reliability. Improving performance by improving operational efficiency helps transportation agencies meet customer demands even in lean times. Understanding how different levels of expenditures are likely to affect reliability and other goal areas results in better use of scarce funding.	The research is complete. The suite of products is being piloted through project L38 in Washington, Minnesota, California, and Florida. The *Guide to Incorporating Reliability Performance Measures into the Transportation Planning and Programming Processes* is available at http://www.trb.org/Main/Blurbs/168855.aspx, the Technical Reference is available at http://www.trb.org/Main/Blurbs/168856.aspx, and the final report, *Incorporating Reliability Performance Measures into the Transportation Planning and Programming Processes*, is available at http://www.trb.org/Main/Blurbs/168854.aspx. Other L05 products posted for use in the L38 pilots can be found at http://www.trb.org/StrategicHighwayResearchProgram2SHRP2/Pages/RFP_L38_Resources_and_Reference_Material_628.aspx.	Portions of the research products will be integrated into PlanWorks, the TCAPP successor, which will be launched in summer of 2014. Scheduled for the Round 4 IAP (June 2014) **CONTACTS:** Douglas Laird, douglas.laird@dot.gov and Gummada Murthy, gmurthy@aashto.org

PRODUCT (Project Numbers)	**Impact on Practice**	**Product Status**	**Implementation Status**
Evaluating Cost-Effectiveness of Highway Design Features (L07) The products include a design guide, consisting of a compendium of design treatments likely to affect non-recurring congestion plus an Excel-based analytic tool that designers can use to evaluate the effects of such treatments on delay, safety, travel time reliability, and life-cycle benefits and costs.	The physical design of highway facilities is an important factor that affects travel time reliability. With these tools, design engineers can better determine which design options contribute to improved traffic operations through actions that can mitigate the effects of crashes, work zones and bad weather.	The report, *Identification and Evaluation of the Cost-Effectiveness of Highway Design Features to Reduce Nonrecurrent Congestion*, is available at: http://www.trb.org/Main/Blurbs/169767.aspx. The *Design Guide for Addressing Nonrecurrent Congestion* is available at: http://www.trb.org/Main/Blurbs/169768.aspx. The Analysis Tool is available at: http://www.trb.org/StrategicHighwayResearchProgram2SHRP2/Pages/L07_Analysis_Tool_708.aspx. Additional research is being conducted on the safety versus congestion relationship established in the original research. A supplementary report is expected in late 2014. Four pilot projects, L38A-D, are being conducted to test the functionality of the L07 research products along with products from projects L02, L05, L08, and C11. The pilots are due to be completed in mid 2014.	Scheduled for the Round 4 IAP (June 2014). **CONTACTS:** Jawad Paracha, jawad.paracha@dot.gov and Gummada Murthy, gmurthy@aashto.org, Ralph Hessian, rhessian@nas.edu and William Hyman, whyman@nas.edu
Incorporation of Travel Time Reliability into the Highway Capacity Manual (L08) The TRB Committee on Highway Capacity and Quality of Service approved incorporation into the Highway Capacity Manual (HCM) new chapters, developed under Project L08, detailing reliability analysis procedures for Freeway Facilities and Urban Streets. The computational engines for incorporating reliability into the 2010 HCM procedures require both products developed in SHRP 2, FREEVAL-RL and STREETVAL-RL, which feed the previous computational engines, FREEVAL and STREETVAL, that accompany the methods set out in the 2010 HCM. The computational engines for FREEVAL-RL and STREETVAL-RL are being updated along with their user guides.	The HCM is one of the most widely used transportation reference manuals in the United States and around the world. Incorporation of the L08 work into the HCM offers a new generation of analytic methods for conducting capacity and related analysis.	The final report, *Incorporation of Travel Time Reliability into the HCM*, is available at http://www.trb.org/Main/Blurbs/169594.aspx. Chapters 36 and 37, approved for inclusion in the Transportation Research Board's Highway Capacity Manual are available at http://www.trb.org/Main/Blurbs/169595.aspx. Links to download FREEVAL and STREETVAL are also on that page. Also, four pilot projects, to be completed in mid 2014, are evaluating the L08 products under project L38.	Scheduled for the Round 4 IAP (June 2014). **CONTACTS:** Jim Hunt, jim.hunt@dot.gov and Gummada Murthy, gmurthy@aashto.org

PRODUCT (Project Numbers)	**Impact on Practice**	**Product Status**	**Implementation Status**
Organizing Transportation Agencies to Improve Reliability			
Integrating Business Processes to Improve Reliability (L01) A guide was developed to help transportation agency managers assess, develop, and integrate key business processes to improve travel time reliability.	Effective traffic management and operations are the result of a number of different business processes working together. This step-by-step guide to integrating processes at both operations and program levels helps transportation managers identify and leverage new efficiencies that improve the reliability of the network and conditions for its users, ultimately reducing delays and improving safety.	The final report, *Integrating Business Processes to Improve Travel Time Reliability*, SHRP 2 Report S2-L01-RR-1 is available as a PDF at http://www.trb.org/Publications/Blurbs/165283.aspx, in hardcopy, and as an e-book; and the *Guide to Integrating Business Processes to Improve Travel Time Reliability* (SHRP 2 Report S2-L01-RR-2) is available as a PDF http://www.trb.org/Publications/Blurbs/165284.aspx and in hardcopy through the TRB bookstore. After Project L06 was essentially completed, an enhanced web version of the Capability Maturity Model (CMM) was developed for AASHTO. It has been the basis for a large number of workshops. The web guidance includes a 1-minute self-assessment to help a person determine the operations capability and maturity of his or her agency. CMM is online at http://www.aashtosomguidance.org	23 states and the District of Columbia are receiving implementation assistance from the Round 1 IAP. **CONTACTS:** Reena Mathews, rmathews@nas.edu, Wayne Berman, Wayne.Berman@dot.gov, Patrick Zelinski, pzelinski@aashto.org, and Gummada Murthy, gmurthy@aashto.org
Institutional Architectures to Advance Operational Strategies (L06) Two companion publications—a guide and a research report—map out steps that agencies can follow to organize their own processes to successfully execute operations programs that improve travel time reliability. A version of the Capability Maturity Model (CMM) widely used in the information technology industry was developed and applied to highway operations.	The special demands of addressing nonrecurring congestion present new challenges for agencies in terms of policy, organization, staffing, resources, partnerships, culture, and leadership. With this CMM change-management tool, agencies can develop institutional arrangements that address the challenges and support more effective strategies for managing congestion and improving system operations.	The final report, *Institutional Architectures to Improve Systems Operations and Management* (SHRP 2 Report S2-L06-RR-1) is available at http://www.trb.org/Publications/Blurbs/165285.aspx. The *Guide to Improving Capability for Systems Operations and Management* (Report S2-L06-RR-2) is available at http://www.trb.org/Publications/Blurbs/165286.aspx.	24 states plus the District of Columbia are receiving implementation assistance from the Round 1 IAP. **CONTACTS:** Joe Gregory, joseph.gregory@dot.gov and Gummada Murthy, gmurthy@aashto.org

PRODUCT (Project Numbers)	**Impact on Practice**	**Product Status**	**Implementation Status**
Improving Traffic Incident Scene Management (L12) The project developed a coordinated, multidisciplinary training program for traffic incident responders and managers from transportation, police, fire, medical, towing and recovery, and other agencies, delivered through interactive seminars, tabletop role-play, and field practicum.	This training broadens responders' understanding of the roles and responsibilities each agency has at the scene of an incident and improves how they coordinate with each other. The result is faster and safer incident clearance for responders and travelers.	The final report, *Training of Traffic Incident Responders*, is available at http://www.trb.org/Main/Blurbs/166877.aspx. Project L32A conducted additional "Train-the-Trainer " classroom pilots to refine the curriculum. The report, *Train-the-Trainer Pilot Courses for Incident Responders and Managers* is available at http://www.trb.org/main/blurbs/168921.aspx. Two pilot projects are under way. L32B pilots an e-learning delivery method for traffic incident responder training courses, and L32C develops and tests a post-course assessment tool. L32B is slated for completion in summer 2014. L32C is completed, a report is forthcoming.	33 states are actively training; nearly 33,000 responders trained, and 67 Train-the-Trainer sessions developed in L32 have been held (as of January 2014). A goal is to train 1 million responders in 10 years. **CONTACTS:** Reena Mathews, rmathews@nas.edu, Jim Austrich, james.austrich@dot.gov, Paul Jodoin, paul.jodoin@dot.gov, and Kevin Sanders, ksanders@aashto.org
A Framework for Improving Travel Time Reliability (L17) The project developed a comprehensive online resource known as a Knowledge Transfer System that serves those involved in systems operations and management. The KTS includes a Business Case Primer that provides tools to identify "who, what, when, and how" to communicate the business case for transportation systems operation and management most effectively.	As state and local transportation agencies look to improve the functionality of their highway networks, systems management and operations has become a more critical function. This resource makes the latest information, techniques, and approaches readily available to practitioners and policymakers alike.	The final report, *A Framework for Improving Travel Time Reliability* is available at http://www.trb.org/Main/Blurbs/169243.aspx. A website with a searchable database of SHRP 2 Reliability products will be available at a later date.	The KTS is the foundation of the developing AASHTO National Operations Center of Excellence. **CONTACTS:** Robert Arnold, Robert.arnold@dot.gov, Patrick Zelinski, pzelinski@aashto.org, and Gummada Murthy, gmurthy@aashto.org
Operations in the 21st Century DOT: Meeting Customer Expectations (L31) The presentation "Operations in the 21st Century DOT: Meeting Customer Expectations" and the accompanying Presentation Guide 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 highlights 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.	The presentation "Operations in the 21st Century DOT: Meeting Customer Expectations" and the accompanying Presentation Guide are available on the TRB website at http://www.trb.org/main/blurbs/169179.aspx.	The presentation can be used either independently or in conjunction with Products L06 and L01 as transportation agencies develop strategic plans for addressing travel time reliability and traffic operations from an organizational standpoint. **CONTACTS:** joseph.gregory@dot.gov and Gummada Murthy, gmurthy@aashto.org

PRODUCT (Project Numbers)	**Impact on Practice**	**Product Status**	**Implementation Status**
Regional Operations Forums for Advancing Systems Operations, Management, and Reliability (L36) Regional operations forums will provide education and training to transportation agencies on the "best use" of SHRP 2 Reliability products. A final report, including presentations and software used, will document the process and findings.	Sources of unreliability account for approximately half of total congestion delay. Strategies, technologies, and practices provided through training in the proposed regional operations forums can reduce reliability-related delay.	The first regional operations forums were held in the summer of 2013, they will continue until the summer of 2014. The final report and training materials will be available in late 2014.	**CONTACTS:** Neil Pedersen, npedersen@nas.edu and Matthew Miller, mamiller@nas.edu, Gummada Murthy, gmurthy@aashto.org, and Tracy Scriba, tracy.scriba@dot.gov
Preparing for the Future			
Evaluating Alternative Operations Strategies to Improve Travel Time Reliability (L11) The product is a report useful for planning and systems engineering with regard to travel time reliability. It sets out requirements for reliability for both person travel and freight. It identifies alternative future scenarios for 2030 and a concept of operations. The study determines the cost effectiveness of a large number of different actions that can enhance reliability and explores a novel method for imputing the economic value of improving travel time reliability.	This report will be useful for developing performance-based plans, long-range plans, and corridor plans. The framework is consistent with MAP-21 planning requirements. The report emphasizes the role of technology and pricing, and is likely to stimulate future research on the economic valuation of reliability improvements.	The report, *Evaluating Alternative Operations Strategies to Improve Travel Time Reliability* (SHRP 2 report S2-L11-RR-1) is available at http://www.trb.org/Main/Blurbs/168142.aspx.	**CONTACTS:** William Hyman, whyman@nas.edu, Stephen Andrle, sandrle@nas.edu, Rich Taylor, rich.taylor@dot.gov, and Gummada Murthy, gmurthy@aashto.org
Archive for Reliability and Related Data (L13, L13A) Subsequent to a positive finding under a feasibility study in L13, an archive was developed in follow-on work in L13A that will permit the input, retention, and extraction of all structured and unstructured data used or produced by SHRP 2 Reliability related research. The archive has powerful tools for visualizing the data and can potentially ingest other reliability data or research results. The data is expected to endure for at least 25 years.	The archive is likely to be an important resource for researchers. Planners and practitioners with a strong analytic bent are likely to directly benefit, also. The value of the data in the archive may evolve as researchers extract data and enter the results of new reliability research. As new research based on this data is implemented, travel time reliability on the roads should improve.	The final report, *Requirements and Feasibility of a System for Archiving and Disseminating Data from SHRP 2 Reliability and Related Studies* (SHRP 2 Report S2-L13-RW-1), is available as an Adobe PDF document at http://www.trb.org/Publications/Blurbs/165408.aspx. The web-based archive is currently in development and is slated for completion in mid 2014.	**CONTACTS:** William Hyman, whyman@nas.edu, Walter During, walter.during@dot.gov and Gummada Murthy, gmurthy@aashto.org

PRODUCT (Project Numbers)	**Impact on Practice**	**Product Status**	**Implementation Status**
Local Methods for Modeling, Economic Evaluation, Justification and Use of the Value of Travel Time Reliability In Transportation Decision Making (L35A,B) The products are two reports on the step-by-step process used to develop, justify, apply, and assess the use of value of travel time reliability in project evaluation and decision processes. Project L35A is being conducted through a partnership of an MPO and a university. A state DOT and a university are conducting Project L35B.	L35A is using stated preference techniques to establish economic values of travel time reliability and then apply these values in integrated demand and dynamic traffic assignment models for both roads and transit. The economic analysis within this framework will help determine the best investments to make in the southwest corridor of the region. L35B is using a different economic valuation process for reliability rooted in widely applied methods of real options applicable to infrastructure and other contingent investments. The project team will demonstrate how this approach to valuing reliability improvements can be used to refine their benefit-cost analysis procedures. Both projects will build support for investments in operations through pilot testing a reliability performance metric and an economic value of travel time reliability and incorporating it into the analysis of investment alternatives at an agency level. As a result, projects L35A and B will shed light on how potential investments in operations may be undervalued.	The project is slated for completion by summer of 2014 with a final report due in the fall of 2014.	**CONTACTS:** William Hyman, whyman@nas.edu, Stephen Andrle, sandrle@nas.edu and Matthew Miller, mamiller@nas.edu; Rich Taylor, rich.taylor@dot.gov, and Gummada Murthy, gmurthy@aashtoi.org
Investing in Innovations			
IDEA Project: Origin-To-Destination Travel Time Reliability Information on Google Map (L15A) This concept exploration produced a report that describes a framework for giving drivers travel time reliability predictions. The framework would provide metro-wide network coverage and be integrated into traveler information systems operated by state DOTs or commercial enterprises.	This framework offers motorists the possibility of reducing the buffer time necessary to compensate for uncertain events such as accidents. The framework is applicable to any congestion-prone corridor.	The report is available at http://www.trb.org/Main/Blurbs/168305.aspx.	**CONTACTS:** Ralph Hessian, rhessian@nas.edu and Inam Jawed, ijawed@nas.edu. Further development and implementation of IDEA projects will be done by the private sector.

PRODUCT (Project Numbers)	**Impact on Practice**	**Product Status**	**Implementation Status**
IDEA Project: Proximity Information Resources for Special Events (L15B) The investigation yielded a final report and a mobile application to assist in management and communications during large events. The app provides access to critical information such as first aid, parking, shuttles, recommended driving routes, event program, timetables, and navigation of booths and stages.	The ability to measure the size and movement of crowds at large events and to communicate with them is a valuable step forward in emergency management.	The final report and a video introducing the mobile application are available at http://www.TRB.org/main/blurbs/168235.aspx.	**CONTACTS:** Ralph Hessian, rhessian@nas.edu and Inam Jawed, ijawed@nas.edu. Further development and implementation of IDEA projects will be done by the private sector.
IDEA Project: Online Traffic Simulation Service for Highway Incident Management (L15C) This proof-of-concept project explored the development of: (1) web based capabilities for traffic simulation scenario editing and maintenance; (2) automatic simulation model creation out of real-time traffic measurement data; and (3) a suite of incident scenarios and response strategies and test results from their use on one California freeway.	This product will allow operations planners to not only see how the freeway performed yesterday, or during last week, by looking at historical data, but also immediately recreate traffic behavior in the simulation, and then edit and test "what-if" scenarios.	The final report is available at http://www.trb.org/Main/Blurbs/168802.aspx.	**CONTACTS:** Ralph Hessian, rhessian@nas.edu and Inam Jawed, ijawed@nas.edu. Further development and implementation of IDEA projects will be done by the private sector.
IDEA PROJECT: Urban Travel Reliability Analysis With Consumer GPS Data (L15D) The project constructs travel time distributions at both link and route levels, and evaluates the reliability performance of alternative routes between a given origin-destination. A technical report describes the analytical approach and case study results.	This research will have an impact on our understanding of spatial and temporal characteristics of travel time reliability performance by documenting the various reliability indexes for drivers with different risk-taking preferences and analyzing randomly selected origin-destination pairs and time periods.	The report is available at http://www.trb.org/Main/Blurbs/169809.aspx.	**CONTACTS:** Ralph Hessian, rhessian@nas.edu and Inam Jawed, ijawed@nas.edu. Further development and implementation of IDEA projects will be done by the private sector.

SHRP 2 Capacity Research Products

May 2014

Delivering better highway projects faster—and reducing congestion related to highway capacity—begins with building consensus into early project phases. Capacity research in SHRP 2 has developed tools to systematically integrate environmental, economic, and community requirements into the analysis, planning, and design of new highway capacity. With this approach, decisions are carried forward, delays that can arise from conflict are avoided, and transportation agencies can deliver projects that align with community goals. Many products of the Capacity research are available through a web-based tool referred to during development as TCAPP and now renamed "PlanWorks, Better Planning. Better Projects."

PRODUCT (Project Numbers)	**Impact on Practice**	**Product Status**	**Implementation Status**
Collaborative Decision Making			
TCAPP: A Collaborative Decision-Making Framework (C01) (Now known as PlanWorks) TCAPP is a robust web-based tool that can be used as a trouble-shooting guide or a roadmap for changing a transportation agency's process when planning and developing highway projects. TCAPP helps navigate critical decision points for long-range transportation planning, corridor planning, programming, and environmental review and permitting, when project delays can be avoided.	By ensuring that the right people are engaged at the right time with the right information, projects move ahead without delays that often arise when decisions must be deferred or revisited. TCAPP's Decision Guide provides a framework for consistently delivering projects that address a community's economic, mobility, and environmental goals.	Transportation for Communities—Advancing Projects through Partnerships (TCAPP) integrates many Capacity research products. TCAPP and supporting case studies are available at the beta website www.transportationforcommunities.com. Improvements are being made to the beta version based on user feedback and the new version will be released in late 2014 under the name "PlanWorks." The report, *A Framework for Collaborative Decision Making on Additions to Highway Capacity*, is online at http://www.trb.org/Main/Blurbs/166046.aspx. Four pilot projects tested the functionality of TCAPP (C18A-D): the projects considered tolling, environmental conflict resolution, stakeholder agreement in project prioritization, and developing a Complete Streets plan. The final reports from these pilot tests and a synthesis of lessons learned, *TCAPP and Integrated Ecological Framework Pilot Projects: Synthesis of Lessons Learned*, (SHRP 2 Report S2-C41-RW-1) are available at http://www.trb.org/StrategicHighwayResearchProgram2SHRP2/PilotTestsofTCAPPandtheIntegratedEcologicalFramewo.aspx. Additional pilots are under way.	PlanWorks will debut in late 2014. **CONTACTS:** Gary Jensen, gjensen@dot.gov; Spencer Stevens, spencer.stevens@dot.gov; and Matt Hardy, mhardy@aashto.org

PRODUCT (Project Numbers)	**Impact on Practice**	**Product Status**	**Implementation Status**
Performance Measures for Highway Capacity Decision Making (C02) A framework and web-based tool were developed for selecting performance measures to evaluate major transportation projects. The web tool details how performance measures can be used in long-range planning, programming, environmental review, and permitting.	Beyond their analytical value, these performance measures form the basis for transparent and objective decisions that help stakeholders to understand transportation problems, which builds project support and avoids or reduces delay.	The report, *Performance Measurement Framework for Highway Capacity Decision Making*, (SHRP 2 Report S2-C02-RR) is available at http://www.trb.org/Publications/Blurbs/161859.aspx. The performance measurement framework is available in TCAPP at www.transportationforcommunities.com	**CONTACTS:** Egan Smith, egan.smith@dot.gov and Matt Hardy, mhardy@aashto.org
Linking Community Visioning and Transportation Investments, T-VIZ (C08) The research produced a new suite of visioning tools that includes a model approach, a step-by-step process, and case studies along with a guide and website intended to generate consensus and shared outcomes for transportation projects.	By investing in visioning early in the planning process, transportation agencies can generate community support not only for an individual project but for entire programs. This support can help agencies avoid delays in the environmental review and ecological permitting stages.	The T-VIZ website and accompanying training videos are available at http://shrp2visionguide.camsys.com/. The final report, *Linking Community Visioning and Highway Capacity Planning* (SHRP 2 Report S2-C08-RR-1), and case studies are available at http://www.trb.org/Publications/Blurbs/166047.aspx.	Renamed as "Transportation Visioning for Communities." **CONTACTS:** Brian Betlyon, brian.betlyon@dot.gov and Matt Hardy, mhardy@aashto.org
Greenhouse Gas Analysis Guide (C09) The Guidebook and website developed provide step-by-step procedures for considering, estimating, and reducing greenhouse gas emissions.	With these systematic procedures, an agency can anticipate strategies to answer public and regulatory issues related to GHG emissions, improve environmental outcomes, and benefit from time-saving protocols.	The guidebook website is at http://transportationforcommunities.com/shrpc01/ghg_application_kdps/26/0 *The Practitioner's Guide to Incorporating Greenhouse Gas Emissions into the Collaborative Decision-Making Process*, (SHRP 2 Report S2-C09-RW-2) and final report, *Incorporating Greenhouse Gas Emissions into the Collaborative Decision-Making Process* (SHRP 2 Report S2-C09-RR-1), are available at http://www.trb.org/Main/Blurbs/166940.aspx.	The Practitioner's Guide was incorporated into PlanWorks. **CONTACTS:** Diane Turchetta, dianne.turchetta@dot.gov and Matt Hardy, mhardy@aashto.org

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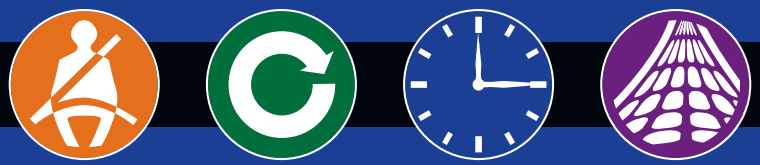
Considering Public-Private Partnerships in the Planning Process (C12) A business process was developed to help determine when and how to consider private-sector participation in the project planning process. The report addresses tolling, design-build, design-build-operate, leasing, and other forms of private-sector involvement.	Although private financing can attract new funding and can even expedite projects, it can also create tradeoffs that must be weighed against other stakeholder issues, such as environmental or neighborhood impacts. This report helps assess how and when to consider P3s as a means to procure transportation improvements.	The report, *The Effect of Public-Private Partnerships and Non-Traditional Procurement Processes on Highway Planning, Environmental Review, and Collaborative Decision Making* is available at http://www.trb.org/Main/Blurbs/168535.aspx.	Renamed as "Guide to Public-Private Partnerships and Nonstandard Procurements." The research results have been incorporated into PlanWorks. **CONTACTS:** Contact Patrick DeCorla-Souza, Patrick.decorla-souza@dot.gov and Matt Hardy, mhardy@aashto.org
Expedited Planning and Environmental Review (C19) A report and an assessment tool provide 24 strategies for addressing or avoiding 16 common constraints to speedy delivery of transportation planning and environmental review projects.	When transportation improvements fail to materialize, project costs and road user costs can escalate while public perception of agency performance deteriorates. Agencies can use the C19 strategies to anticipate where delays are likely to occur and to minimize delays during all phases of project development.	These strategies and tools are the basis for the Expediting Project Delivery Assessment Tool, a user-friendly assessment tool that is available in TCAPP. The report, *Expedited Planning and Environmental Review of Highway Projects* (SHRP 2 Report S2-C19-RR-1) is available at http://www.trb.org/Main/Blurbs/165282.aspx.	Nine states are receiving implementation assistance from the Round 2 IAP. The research results have been incorporated into PlanWorks. **CONTACTS:** Demaris Santiago, Demaris.santiago@dot.gov and Shannon Eggleston, seggleston@aashto.org.
Executive Decision Making for Transportation Capacity: The Multi-Agency Context (C22) This project developed marketing principles and potential strategies for communicating the value of TCAPP and a collaborative decision-making approach to executive decision makers.	Decision makers at federal, state, and local agencies will understand the value, benefits, and utility of integrating TCAPP (PlanWorks) into their general business practices to help reach consensus on projects to expand highway capacity and speed project delivery.	The report, *Executive Decision Making for Transportation Capacity: The Multiagency Context* (SHRP 2 Report S2-C22-RW-1), is available at http://www.trb.org/Main/Blurbs/168762.aspx.	Paired with PlanWorks for implementation. **CONTACTS:** Gary Jensen, gary.jensen@dot.gov, Spencer Stevens, spencer.stevens@dot.gov, and Matt Hardy, mhardy@aashto.org
Economic Impact Analysis			
Transportation Project Impact Case Studies (T-PICS) (C03) A web-based sketch-planning tool to measure the economic development impacts of a transportation project was developed.	With T-PICS planners can provide decision makers with better information for determining whether a region will be economically better off because of a transportation investment, and, if so, by how much. More realistic estimates lead to more credible decisions that can garner support and expedite the approval process.	The T-PICS tool, which includes 100 case studies, is available at http://transportationforcommunities.com/t-pics. The report, *Interactions Between Transportation Capacity, Economic Systems, and Land Use* (SHRP 2 Report S2-C03-RR-1) is available at http://www.trb.org/Main/Blurbs/166934.aspx.	Bundled with C11, renamed as "Economic Analysis Tools." The research results will be accessible through PlanWorks. Scheduled for the Round 4 IAP (June 2014). **CONTACTS:** Stefan Natzke, stefan.natzke@dot.gov and Matt Hardy, mhardy@aashto.org

PRODUCT (Project Numbers)	**Impact on Practice**	**Product Status**	**Implementation Status**
Improved Economic Analysis Tools (C11) A new suite of modeling and forecasting tools was developed. It provides the range of reasonable expectations for a proposed project by major economic impact and economic development performance measures.	This suite of tools helps planners make more comprehensive and realistic assessments of the economic impacts of highway capacity projects. The tools help planners estimate which highway capacity improvements will support economic vitality by providing better access to markets and the labor force, saving time and money otherwise spent as a result of traffic delays, improving safety, reducing pollution, and supporting a higher quality of life.	The tools are available via the T-PICS website: http://www.tpics.us/tools/. The final report, *Development of Tools for Assessing Wider Economic Benefits of Transportation* is available at http://www.trb.org/Main/Blurbs/169524.aspx. Pilot tests to validate the results and refine the usability of the tools are ongoing under project L38.	Renamed "Tools for Assessing Wider Economic Benefits of Transportation." Bundled with C03, as "Economic Analysis Tools." Also bundled with "Reliability Data and Analysis Tools" (L02/L05/L07/L08/C11). The research results will be accessible through PlanWorks. Scheduled for the Round 4 IAP (June 2014). **CONTACTS:** Stefan Natzke, stefan.natzke@dot.gov and Matt Hardy, mhardy@aashto.org
Integrating Conservation, Highway Planning, and Environmental Review			
Integrating Ecological Mitigation to Enhance Efficiency (C06) The Integrated Ecological Framework (IEF) provides clear, practical steps to enhance integration of and to support an ecological approach to environmental stewardship. The IEF provides a blueprint for a structured, multi-agency approach, with supporting tools and data.	The long-term benefits of applying the IEF process are better environmental outcomes and lowered costs associated with planning, environmental review, and regulatory decision making. In the short term, the IEF provides practical guidance on selecting and using the most appropriate and effective data, methods, tools, and processes to achieve an integrated, landscape-scale approach to transportation decision making.	The IEF process was pilot tested in California, Colorado, Oregon, and West Virginia. Reports from the pilot tests are available at http://www.trb.org/StrategicHighwayResearchProgram2SHRP2/PilotTestsofTCAPPandtheIntegratedEcologicalFramewo.aspx. The IEF and related tools are available in TCAPP, www.transportationforcommunities.com. *An Ecological Approach to Integrating Conservation and Highway Planning, Volume 1* is available at http://www.trb.org/Main/Blurbs/169515.aspx. *An Ecological Approach to Integrating Conservation and Highway Planning, Volume 2* is available at http://www.trb.org/Main/Blurbs/166938.aspx. *Guide to the Integrated Ecological Framework* is available at http://www.trb.org/Main/Blurbs/169516.aspx. The *Manager's Guide to the Integrated Ecological Framework* documents minor changes to the IEP based on the four pilots. It is available at http://www.trb.org/Main/Blurbs/170422.aspx.	13 states are receiving implementation assistance from the Round 1 IAP. The research results will be incorporated into PlanWorks. **CONTACTS:** David Williams, david.williams@dot.gov and Kate Kurgan, kkurgan@aashto.org

PRODUCT (Project Numbers)	**Impact on Practice**	**Product Status**	**Implementation Status**
Geospatial Resource for Ecology and Transportation (C40A and B) Project C40A developed a national-level integrated, geospatial ecological screening tool for early transportation planning to inform the environmental review process. Project C40B demonstrated the transferability of locally developed geospatial tools and data that support program- and project-level environmental screening.	With these advances, agreement on priority areas for preservation or conservation can be reached early in the process of planning new highway capacity. Data-based decisions can not only speed project delivery, but deliver projects that best balance community and environmental needs.	Products from this project are expected by the summer of 2014.	**CONTACT:** Mike Ruth, mike.ruth@dot.gov and Stephen Andrle, sandrle@nas.edu
Dynamic Integrated Models and Networks			
Improving Our Understanding of How Highway Congestion and Pricing Affect Travel Demand (C04) The research produced mathematical descriptions of the full range of highway-user behavioral responses to congestion, travel-time reliability, and pricing formatted for input to current and developing travel demand models.	Travel demand modeling systems can now reflect how travelers respond to congestion, travel-time reliability, and pricing so that decisions about operational improvements can be based on more realistic models. With better models, agencies better understand how operations projects can improve the function of their highway networks.	The report, *Improving our Understanding of How Highway Congestion and Price Affect Travel Demand* (SHRP 2 Report S2-C04-RW-1) is available at http://www.trb.org/Main/Blurbs/168141.aspx.	Bundled with C10, C05, and C16 and renamed as "Advanced Travel Analysis Tools." Scheduled for the Round 4 IAP (June 2014). **CONTACTS:** Brian Gardner, brian.gardner@dot.gov and Matt Hardy, mhardy@aashto.org
Understanding the Contribution of Operations, Technology, and Design to Meeting Highway Capacity Needs (C05) A guide for modelers was developed on how to compare the effectiveness of less complex operational strategies, such as intersection channelization, with more expensive and complex treatments, such as adding general-purpose highway lanes.	With the enhanced capability to measure the cost and effectiveness of traffic operations strategies, planners and decision makers can demonstrate whether a strategy solves a particular congestion problem and can more confidently act to improve the function of their highway networks.	The report, *Understanding the Contributions of Operations, Technology, and Design to Meeting Highway Capacity Needs*, is available at www.trb.org/Main/Blurbs/166939.aspx.	Bundled with C10, C04, and C16 and renamed as "Advanced Travel Analysis Tools." Scheduled for the Round 4 IAP. **CONTACTS:** Brian Gardner, brian.gardner@dot.gov and Matt Hardy, mhardy@aashto.org

PRODUCT (Project Numbers)	**Impact on Practice**	**Product Status**	**Implementation Status**
Integrated Advanced Travel Demand Model with Mode Choice Capacity and Fine-Grained, Time-Sensitive Networks (C10 A & B) The integrated models developed in this project dynamically evaluate the interplay of traveler behavior and transportation network conditions, including mode options. The transferability of model parameters was investigated.	With more realistic estimates of travel demand and time of day travel choices, agencies can make more informed decisions about adding highway and transit capacity, improving traffic operations, introducing priced roads, and improving traveler information.	The software, manuals, and documentation are available via an open source license at http://www.shrp2c10.org/SHRPC10Portal/Home.aspx. Pilot tests to validate the results and refine the usability of these tools were completed in 2013. Model sets are available for Jacksonville, FL, Sacramento, CA, and Burlington, VT. The final report for C10A, *Partnership to Develop an Integrated, Advanced Travel Demand Model and a Fine-Grained Time-Sensitive Network*, is available at www.trb.org/Main/Blurbs/169685.aspx. The final report for C10B, *Partnership to Develop an Integrated, Advanced Travel Demand Model and a Fine-Grained Time-Sensitive Network, Summary Report*, is forthcoming, as is the report, *Transfer of Activity-Based Model Parameters from Sacramento to Jacksonville and Tampa, Florida*. A network report and a software user's guide will be available later in 2014.	Bundled with C04, C05, and C16 and renamed as "Advanced Travel Analysis Tools." Scheduled for the Round 4 IAP (June 2014). **CONTACTS:** Brian Gardner, brian.gardner@dot.gov and Matt Hardy, mhardy@aashto.org.
The Effect of Smart Growth on Daily Travel (C16) SmartGAP is a free, open-source software tool to estimate the effects of different smart growth strategies on regional peak-hour travel demand and other transportation parameters. User guide also included.	These tools equip planners with scenario-forecasting tools to estimate smart growth's effect on peak-hour travel, sprawl, energy reduction, active travel, and carbon footprints. They offer a practical guide to applying land use strategies to reduce congestion.	The final report, *The Effect of Smart Growth Policies on Travel Demand*, is available at http://www.trb.org/Main/Blurbs/168761.aspx. The SmartGAP tool is available at www.trb.org/main/blurbs/168842.aspx.	Bundled with C04, C05, and C10 and renamed as "Advanced Travel Analysis Tools." Scheduled for the Round 4 IAP (June 2014). **CONTACTS:** Eric Phil, eric.phil@dot.gov and Matt Hardy, mhardy@aashto.org

PRODUCT (Project Numbers)	**Impact on Practice**	**Product Status**	**Implementation Status**
Planning for Freight Demand			
Freight Planning Guide (C15) This comprehensive guide, including case studies and examples, identifies strategies for incorporating market-driven freight considerations into highway capacity decision making.	Public agencies can use the guide to plan for and provide highway capacity that serves economic development by meeting both local community capacity needs and national shipping and market supply needs. Addressing projected freight growth can also address the potential for delays and safety concerns associated with unanticipated freight movement bottlenecks.	The freight planning guide, *Integrating Freight Considerations into the Highway Capacity Planning Process: Practitioner's Guide*, is available at http://www.trb.org/Main/Blurbs/170008.aspx. It has been incorporated into the TCAPP portal at http://www.transportationforcommunities.com/.	Scheduled for the Round 4 IAP (June 2014). The Freight Planning Guide will be available through PlanWorks. **CONTACTS:** Spencer Stevens, spencer.stevens@dot.gov and Matt Hardy, mhardy@aashto.org
Freight Demand Modeling and Data Improvement (C20) A strategic plan for achieving improved freight data sets and freight modeling practices.	Current freight planning and forecasting tools, data, and techniques are inadequate to support infrastructure planning that integrates the complex logistics practices of the freight industry. Better data and models are needed to make more informed investment decisions.	The report, *Freight Demand Modeling and Data Improvement* (SHRP 2 Report S2-C20-RR-1), is available at www.trb.org/Main/Blurbs/167628.aspx The Strategic Plan is available at http://www.trb.org/Main/Blurbs/167629.aspx	Eleven states are receiving implementation assistance through the Round 3 IAP. **CONTACTS:** Ed Strocko, ed.strocko@dot.gov and Matt Hardy, mhardy@aashto.org



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