Public Roads

www.fhwa.dot.gov

January/February 2014

U.S. Department of Transportation

Federal Highway Administration

Introducing SHRP2 Solutions

Responding to Hazmat Incidents

Environmental Excellence Awards

Public Roads

—featuring developments in Federal highway policies, programs, and research and technology—

January/February 2014 www.fhwa.dot.gov Vol. 77, No. 4

Articles

Page 2

Page 10

Page 14

Departments

Front cover—The New York State Department of Transportation, the Vermont Agency of Transportation, and other Federal and State partners collaborated to build the new Lake Champlain Bridge, shown here. The new structure replaces the original bridge built in 1929 and closed in 2009 due to structural deficiencies. For more information, see "Setting the Bar for Excellence" on page 14 in this issue of PUBLIC ROADS. *Photo: © Andy Ryan.*

Back cover—The project to replace the old Lake Champlain Bridge between New York and Vermont involved archaeological reconnaissance and data recovery and monitoring to locate and identify historical and cultural resources near the project site. An excavation in Vermont revealed this "H"-shaped chimney foundation, likely from a 1731 French fort, discovered adjacent to a footing of the old bridge. For more information, see "Setting the Bar for Excellence" on page 14. *Photo: University of Vermont Consulting Archaeology Program.*

U.S. Department of Transportation
Federal Highway Administration

U.S. Department of Transportation
Anthony Foxx, *Secretary*

Federal Highway Administration
Victor Mendez, *Administrator*

Office of Research, Development, and Technology
Michael Trentacoste, *Associate Administrator*

Paula Magoulas, *Editor-in-Chief*

Paula Magoulas, *Publication Manager, Creative Director*

Norah Davis, *Editor*

John J. Sullivan IV, *Associate Editor*

Paula Magoulas, *Distribution Manager*

Editorial Board
J. Paniati, chairman; J. Curtis, D. Elston, T. Furst, D. Kim, J. Lindley, A. Lucero, R. McElroy, G. Shepherd, W. Waidelich

Public Roads (ISSN 0033-3735; USPS 516-690) is published bimonthly by the Office of Research, Development, and Technology, Federal Highway Administration (FHWA), 1200 New Jersey Avenue, SE, Washington, DC 20590. Periodicals postage paid at Washington, DC, and additional mailing offices.

POSTMASTER: Send address changes to *Public Roads,* HRTM, FHWA, 6300 Georgetown Pike, McLean, VA 22101-2296.
The editorial office of *Public Roads* is located at the McLean address above.
Phone: 202–493–3398. Fax: 202–493–3475.
Email: paula.magoulas@dot.gov.

Public Roads is sold by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Requests for subscriptions should be sent directly to New Orders, Superintendent of Documents, P.O. Box 979050, St. Louis, MO 63197-9000. Subscriptions are available for 1-year periods. Paid subscribers should send change of address notices to the U.S. Government Printing Office, Claims Office, Washington, DC 20402.

The electronic version of *Public Roads* can be accessed through the Turner-Fairbank Highway Research Center home page (www.fhwa.dot.gov).

Guest Editorial

Fostering a Culture of Innovation

The Federal Highway Administration (FHWA) has a long history and well-established culture of creating, finding, and sharing innovations. This tradition can be traced to the establishment of the agency as the U.S. Office of Road Inquiry in 1893. In the early days of road building, the office supported the Good Roads Movement by identifying best practices in the industry and helped spread those practices from State to State.

Throughout its 120-year history, FHWA has served as an incubator and champion for innovation. Beginning in the late 1980s, the first Strategic Highway Research Program (SHRP) helped improve winter highway maintenance and revolutionized the design of asphalt pavement by producing the Superpave (SUperior PERforming Asphalt PAVEments) system. FHWA partnered with the Transportation Research Board (TRB) in conducting this research and took a leadership role in encouraging implementation of the SHRP products. A few years later, FHWA created a list of priority, market-ready technologies and innovations, which took ideas and prototypes and turned them into ready-to-deploy products that yielded significant benefits to transportation practitioners and motorists.

In 2009, FHWA Administrator Victor Mendez launched the Every Day Counts (EDC) initiative, which identified and deployed innovations aimed at shortening project delivery, enhancing roadway safety, and protecting the environment. EDC elevated the importance of innovation within FHWA and broadened the reach of innovation among industry stakeholders in the public and private sectors. In EDC's first round, FHWA chose several proven but underutilized technologies and innovations for priority deployment and encouraged widespread adoption by the transportation industry. The program also built State-based networks to support the deployment of innovations. FHWA recently launched the second round of EDC, which offers additional products and processes to help improve safety and speed project delivery.

All cultures are built on relationships. FHWA's culture of innovation is founded on collaboration with State and local partners. Working with the American Association of State Highway and Transportation Officials (AASHTO) and its affiliates, TRB, and various industry partners, FHWA has created an environment in which ideas and research are turned into transportation solutions.

Cultures are constantly evolving, and so is FHWA's. The agency is moving forward with another program to advance innovation. In partnership with AASHTO and TRB, FHWA is implementing the second round of the Strategic Highway Research Program, called SHRP2.

Like the first SHRP, this new program is turning applied research into a menu of ready-to-deploy products and processes—known as SHRP2 Solutions—that State and local partners can adopt to help them save lives, money, and time in delivering transportation projects.

Further, FHWA and AASHTO established an Implementation Assistance Program to help States and local partners deploy SHRP2 Solutions. This program is the focus of an article titled "*Now* Is the Time for Innovation," on page 2 in this issue of PUBLIC ROADS. The article introduces the various SHRP2 products and explains how to obtain technical assistance and where to find resources to deploy SHRP2 Solutions.

Although these technology and innovation programs have different names, they are actually integral parts of FHWA's culture of innovation. They all complement and build off each other. State and local agencies can choose which products and processes best meet their needs. This rich menu, and innovations still to come, will help the entire industry improve and evolve to meet the transportation needs of future generations.

Jeffrey F. Paniati, P.E.
Executive Director
Federal Highway Administration

Realizing that status quo approaches alone can't do the job, more and more DOTs are changing how they work. To help them address the thorniest transportation issues, SHRP2 Solutions offer tools for the road ahead.

Now Is the Time for Innovation

by Judith Johnson and Laurie Butts

(Above) The Michigan Department of Transportation (MDOT) posted these travel-time estimates to help motorists make informed decisions when roadwork might cause unexpected delays. The second Strategic Highway Research Program (SHRP2) develops products such as its Organizing for Reliability Tools (L01/L06). This suite of tools helps agencies improve their capability for collaboration across departments to implement workable solutions like using real-time traveler information from transportation management centers during construction projects. *Photo: MDOT.*

The Nation's 4-million-mile (6.4-million-kilometer) highway system is the backbone of the U.S. economy. The highways carry 65 percent of the country's $15 trillion in freight traffic and 88 percent of the noncommercial miles traveled. But this infrastructure has largely exceeded its design life and is inadequate for today's traffic volumes. The system is deteriorating, with resulting impacts on safety, mobility, and the economy.

Addressing these issues, renewing the highway infrastructure, and delivering excellent customer service are the goals of the second Strategic Highway Research Program (SHRP2), a national partnership of three key transportation organizations. Partnering in SHRP2 are the Federal Highway Administration (FHWA), the American Association of State Highway and Transportation Officials (AASHTO), and the Transportation Research Board (TRB).

Through SHRP2, a multidisciplinary group of researchers and other transportation professionals aim to identify workable solutions that State departments of transportation (DOTs) can implement. The solutions also can be implemented by local roadway agencies, metropolitan planning organizations (MPOs), divisions of FHWA's Office of Federal Lands Highway, and resource agencies, among others, to better serve the traveling public.

"With SHRP2, Every Day Counts, and our overall focus on innovation, we are creating an environment where ideas and research are turned into transportation solutions," says FHWA Executive Director Jeff Paniati. "SHRP2 in particular turns applied research into a menu of ready-to-deploy products and processes that our State and local partners can choose from to help save lives, money, and time on their transportation projects. All of this is helping us foster a culture of innovation in the transportation industry."

SHRP2 builds on the success of the first SHRP, which ran from 1988 to 1993, and produced, among other innovations, a new technology for addressing snow and ice on highways. SHRP also developed Superpave (SUperior PERforming Asphalt PAVEments), a technology for creating greater durability.

After the success of the first SHRP, Congress authorized SHRP2 in the 2005 Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) with the goal of delivering groundbreaking products to address specific challenges identified by State DOTs and leaders of the transportation industry. These challenges include reducing crashes and improving safety; renewing roads and bridges more rapidly; delivering projects through targeted collaboration; and operating a more reliable, less congested highway system. The products themselves vary markedly and range from decisionmaking processes to training programs, management tools, and new technologies. They can be used singly or in combination, depending on the user's specific needs and available resources.

SHRP2 has completed about 100 research projects and prioritized more than 65 resulting products as part of a $169 million, 5-year implementation plan. The program is at the forefront of transportation innovation, helping the Nation's highway community enhance productivity, boost efficiency, increase safety, and improve reliability. Early adopters are tapping the rich and growing SHRP2 resource to find new solutions to the problems facing America's roads.

"We are at a tipping point in the highway community," says Rhode Island DOT Director and AASHTO President Michael Lewis. "Professionals are faced with overwhelming challenges such as rapidly deteriorating infrastructure and increasing congestion, compounded by limited funds and greater public criticism when projects don't go as planned. Status quo approaches are no longer bridging the gap, and despite the inherent challenges in trying a new technique, more and more highway professionals are eager to embrace practical innovations that can offer significant benefits to all our customers."

From Research to the Road: The Value of Collaboration

The implementation phase of SHRP2 has only just begun—and it is already changing how DOTs work and their expectations for the highways of tomorrow. To expedite adoption of SHRP2 innovations, the partners launched the SHRP2 Implementation Assistance Program in February 2013 to provide financial and technical support to early adopters of SHRP2 products. The collaborative approach that drives SHRP2 research is carried through into product implementation to ensure that the needs of potential users are incorporated into every stage of technology transfer.

These products are supporting State DOTs and industry leaders as they confront the difficult

Stan Lims, The Press-Enterprise

SHRP2's Railroad-DOT Mitigation Strategies (R16) product contains model agreements, as well as recommended practices and training materials, to help public agencies speed negotiations with railroads during highway planning for construction projects similar to this one.

challenges involved in meeting the following highway-changing goals:

- Dramatically reducing traffic injuries and fatalities
- Completing major roadway projects on time or ahead of schedule, with public support
- Minimizing traveler disruption while roads are repaired
- Increasing the reliability of travel times, enabling motorists to estimate the length of their trips accurately

In addition to 10 products that SHRP2 deployed in 2013 (9 through the SHRP2 Implementation Assistance Program and 1 through FHWA's Every Day Counts initiative), another 14 products are anticipated to launch in 2014, and more to come in 2015. SHRP2 managers at FHWA, AASHTO, and TRB are committed to engaging potential users in prioritizing these products.

With organizations in three-quarters of the States across the Nation participating in the rapid deployment of SHRP2 products, DOTs, MPOs, and other agencies are demonstrating that they are eager to use practical new approaches and innovative techniques to improve the way that they do business. They are ready for the future *now*.

From its beginnings, SHRP2 has been a collaborative process, its direction informed by the challenges faced by State DOTs, local and tribal agencies, and the highway industry as they work to improve the Nation's roadway system. Today, with a growing number of emerging products and limited funds available for implementation, product developers, State DOTs, and industry professionals are focusing their combined energies on identifying which innovations to deliver first for the greatest impact and benefit.

"The success of this program is predicated on these products being implemented by State, local, and other transportation agencies," says Amy Lucero, director of technical services at FHWA. "It just makes sense that we look to these groups to help us judge the applicability of these products and their priority [for implementation] as they emerge from research."

The process of prioritizing products in SHRP2's implementation plan occurs about once a year. In 2013, prioritization included a survey of AASHTO committees to gauge the value and readiness of each product. Next came a meeting of the AASHTO implementation task force, composed of dozens of State DOT leaders, who refined the list. SHRP2 product experts and implementation leaders from FHWA then collaborated with AASHTO to advance one set of recommended priority products.

"We are committed to a collaborative effort with this and other SHRP2 activities, and FHWA will continue to work very closely with AASHTO and TRB on implementation," says Lucero.

What Are SHRP2 Solutions?

The SHRP2 Solutions portfolio includes products that can be applied across the entire life cycle of a roadway. The products belong to numerous topic areas, including pavements, bridges, risk management, planning and design, construction, and maintenance and operations. SHRP2 Solutions are designed to help transportation professionals by giving them the tools to do their jobs more efficiently, use resources more wisely, and systematically engage key partners in decisionmaking.

"We call the results of SHRP2 research 'solutions' because, in many cases, the products are processes, software, guides, testing procedures, collaborative decisionmaking protocols, and specifications designed to fill knowledge gaps that have prevented existing innovations from being used more widely," says Pam Hutton, SHRP2 implementation manager at AASHTO.

The names of SHRP2 Solutions consist of a title and then a letter and number combination. An example is Guidelines for the Preservation of High-Traffic-Volume Roadways (R26), which is a guide that enables the user to evaluate more than a dozen techniques for roadway preservation that have been applied successfully for decades to roads with low traffic volumes. This solution weighs the durability, quality, and service life benefits of various preservation techniques and determines which are best suited for specific conditions. Using the right preservation technique on high-traffic-volume roads can extend service life and the time between major, expensive rehabilitations. The software includes a decisionmaking matrix to simplify the numerous and often complex factors that drive decisions about pavement rehabilitation. The factors include traffic levels, pavement and climate conditions, available work hours, and treatment performance and cost. The guide offers a step-by-step sequence for weighing the various technical inputs and selecting treatments that are most appropriate for a specific road.

Advancing the State of the Practice

Across the country, State DOTs are turning to SHRP2 for practical solutions and innovations. As agencies experience the benefits and successes of implementing SHRP2 products, some DOTs are moving to deploy multiple SHRP2 Solutions to address various problem areas across their transportation systems. Iowa, Pennsylvania, and Michigan are among the early adopters.

Iowa: The Accelerated Bridge Solution

In 2011, as a demonstration project for FHWA's Highways for LIFE, the Iowa Department of Transportation (Iowa DOT) used SHRP2's Innovative Bridge Designs for Rapid Renewal (R04) toolkit to help with the replacement of the Keg Creek Bridge near Council Bluffs. The replacement took just 2 weeks, rather than the 6 months normally required for a bridge of this size and type. Although methods for accelerated bridge construction have been used across the United States for more than 15 years, most agencies have applied them on large bridges that have a substantial impact on mobility and require contractors with specialized skills.

Continued on page 6.

Supporting Early Adopters

With increased scrutiny into how taxpayer dollars are spent and an imperative to do more with less, transportation professionals are always looking for ways to do their jobs better, faster, and more efficiently. Doing so often requires changing an approach or using a new tool, but trying something new comes with its own challenges. To speed the widespread use of SHRP2 innovations, FHWA and AASHTO launched a multifaceted, competitive Implementation Assistance Program to provide financial and technical assistance to early adopters of SHRP2 products. Since its inception, the program has rolled out 14 SHRP2 products, which now are being used in 135 transportation projects across the country.

About twice a year, products ready for implementation—known as SHRP2 Solutions—are selected to be part of the implementation assistance offering. The program provides up to three levels of support for each SHRP2 Solution, depending on the product's current usage, risk, and geographic saturation:

1. Proof-of-concept pilots are opportunities to help evaluate the readiness of a particular product.
2. Lead adopter incentives help offset costs associated with product implementation and risk mitigation.
3. User incentives are available when products are ready for widespread deployment and when funding is needed to support implementation in a given jurisdiction. Agencies can use the funds to conduct a variety of activities such as internal assessments, changes in system processes, and peer exchanges.

FHWA evaluates applications for support based on several criteria, including geographic location, current or past interest in implementing similar products, demonstrated ability to implement new products or processes, and willingness to share experiences with others through peer exchanges or other means.

"Being a lead State is just part of our culture," says Malcolm Dougherty, director of the California Department of Transportation, which currently is implementing five SHRP2 products. "Innovation can sometimes pose a risk, but also it can provide significant benefits. We've learned a lot from peers who adopted other innovations ahead of us, and we're eager to both benefit from SHRP2 Solutions and share our experiences with others."

Two implementation assistance offerings are planned in 2014. Applications for the round three offering will be accepted January 17–February 14, 2014, while the fourth round offering is scheduled to open in June. To learn more about SHRP2 products and upcoming opportunities for implementation assistance, visit www.fhwa.dot.gov/GoSHRP2.

SHRP2 Solutions Selected for Implementation Assistance

Round 1: February 2013	Round 2: August 2013	Round 3: January 2014	Round 4: June 2014
Implementing Eco-Logical (C06)	Expediting Project Delivery (C19)	Freight Demand Modeling and Data Improvement (C20)	T-PICS/Economic Analysis Tools (C03 & C11)
Innovative Bridge Designs for Rapid Renewal (R04)	Performance Specifications for Rapid Renewal (R07)	GeoTech Tools (R02)	Integrated Travel Demand Modeling (C10)
Managing Risk in Rapid Renewal Projects (R09)	Managing Risk in Rapid Renewal Projects (R09)	Precast Concrete Pavement (R05)	Technologies to Store, Retrieve, and Use 3D Utility Location Data (R01A)
Innovative Strategies for Managing Complex Projects (R10)	Railroad-DOT Mitigation Strategies (R16)	Identifying and Managing Utility Conflicts (R15B)	Nondestructive Testing Technologies for Concrete Bridge Decks (R06A)
Guidelines for the Preservation of High-Traffic-Volume Roadways (R26)		Pavement Renewal Solutions (Using Existing Pavement in Place and Achieving Long Life) (R23)	Rapid Technologies to Enhance Quality Control on Asphalt Pavements (R06C)
Organizing for Reliability Tools (L01/L06)			Mapping Defects in or Behind Tunnel Linings (R06G)
			Managing Risk in Rapid Renewal Projects (R09)
			Innovative Strategies for Managing Complex Projects (R10)
			Designing and Preserving Bridges to Achieve a 100-Year Service Life (R19A)
			Composite Pavement Systems (R21)
			Reliability Data and Analysis Tools (L02/05/07/08/37/38)

Iowa DOT

This crane is lowering a concrete bridge section onto pylons set in Keg Creek, located in western Iowa. The project is a pilot of Innovative Bridge Designs for Rapid Renewal (R04), a SHRP2 Solution for accelerating bridge construction.

The SHRP2 toolkit focuses on applying the same techniques to smaller, more routine bridge replacements, which account for the majority of bridges across the country. Standardized detailing makes designs less complicated and faster, enabling smaller contractors to compete for this type of work and effectively driving costs down.

Using another SHRP2 Solution, the agency has set its sights on significantly improving travel time reliability through development of a new Office of Traffic Operations. The office plans to use methodologies from SHRP2's Organizing for Reliability Tools (L01/06) to develop model processes and approaches, and establish reliability goals to create a state-of-the-art program from the ground up.

Pennsylvania: Harnessing The Benefits of SHRP2's Reliability Tools

As a recipient of SHRP2 implementation assistance, the Pennsylvania Department of Transportation (PennDOT) is using three of the strategies identified in SHRP2's Guidelines for the Preservation of High-Traffic-Volume Roadways (R26) in an effort to revitalize a large number of heavily traveled, aging roads.

"Roads across the State are underfunded for rehabilitation, our maintenance efforts are falling behind the need, and to complicate the situation, most were developed long ago using antiquated infrastructure technology," says PennDOT's Deputy Secretary for Highway Administration R. Scott Christie. "If we can extend service life through improved preservation techniques, we can stretch the interval between costly long-term rehabilitation projects, avoiding significant delays for drivers already traveling along busy corridors."

Like Iowa, PennDOT also is looking to improve reliability with a thorough assessment of operational capabilities, using Organizing for Reliability Tools (L01/06). Approximately 50 percent of the total State-owned mileage that PennDOT is responsible for is part of the "local" functional classification. This mileage typically is associated with lower-traffic-volume roadways but still requires significant funding and resources to maintain, so Christie says the agency is eager to harness the benefits of SHRP2's reliability tools.

The process will begin with a complete assessment of the agency's operations capabilities. As part of a corridor modernization program, PennDOT then will develop and identify roadway "tiers" with similar operational needs and establish a performance program to address all types of unexpected congestion. Under this assessment, PennDOT already is embarking on an effort to improve incident clearance through legislative changes and quick-clearance incentives for tow operators. Upon analysis of its program, PennDOT found that Pennsylvania drivers sit longer in backups from traffic crashes and incidents than drivers do in other States, specifically because Pennsylvania lacks the regulations and tow incentives provided elsewhere.

Michigan: Solutions For Complex Projects

Over the next year, the Michigan Department of Transportation (MDOT) plans to deploy four SHRP2 innovations on projects statewide.

Continued on page 8.

SHRP2 Focus Areas

To achieve the program's overall goals of saving lives, reducing congestion, and enhancing quality of life through improved highways, the SHRP2 partners organized the research into four focus areas: renewal, reliability, capacity, and safety. In the SHRP2 implementation phase, the focus areas enhance the transportation context for interrelated products and demonstrate the diversity of SHRP2 Solutions.

SHRP2's multidisciplinary National Traffic Incident Management Responder Training Program (L12/L32), for example, brings together police, firefighters, DOT staff, towing operators, medical personnel, and other incident responders for hands-on exercises in incident resolution. The training aims to improve responder and motorist safety while clearing incidents more quickly.

Here (left to right), Matt Voorhees and Joe Rutledge, both of the Indiana State Police, join Michael W. Beck of the Indiana Law Enforcement Academy in a tabletop exercise. *Photo: Indiana Traffic Incident Management Effort (IN-TIME).*

Focus Area	Products Enable Highway Professionals To Do the Following	Current Products
Renewal	Renew and rapidly repair deteriorating infrastructure using already available resources, thereby minimizing impacts on users during construction, creating longer lasting facilities, and providing significant cost savings through improved techniques and processes.	• Cost-effective bridge designs for faster, longer lasting replacement • Pavement preservation techniques for high-traffic-volume roadways • Model agreements and strategies to improve coordination with railroads and utilities • Performance specifications for bridges, pavements, and geotechnical applications, and various project types (design-build, design-build-warranty) • Project planning and risk management techniques for rapid renewal
Reliability*	Identify ways to reduce unexpected congestion and create more predictable travel times through improved operations, eliminating or minimizing disruptions in the system.	• Training for faster, safer multiagency incident clearance • Assessment tool and systematic approach to improving systems operations
Capacity	Expedite the planning and design of highway projects that meet the environmental, economic, and mobility needs of communities, and introduce new processes for project development to support and sustain this new way of doing business.	• Planning techniques for advancing infrastructure projects while protecting the environment • Strategies for expediting environmental review and transportation planning by systematically engaging key stakeholders in the decisionmaking process
Safety**	Foster safer driving through an unprecedented analysis of driver behavior and roadway characteristics in crash, near crash, and ordinary driving scenarios. Over time, the work in this focus area will do the following: • Help infrastructure, vehicle, and behavioral programs work together in a seamless operation. • Create a better understanding of how the driver, the vehicle, and the roadway interact. • Enable the development of combined measures to minimize crash risks.	• Two robust and linked databases that include unprecedented information about driver behavior and roadway characteristics

**The article "Training Millions of Responders," which appeared in the November/December 2013 issue of PUBLIC ROADS, covered efforts to improve traffic incident management, a part of the reliability focus area.*

***The article "Trip Traces," which appeared in the May/June 2013 issue of PUBLIC ROADS, covered SHRP2's Naturalistic Driving Study, a part of the safety focus area.*

A paving crew is compacting this section of asphalt pavement in Lewisburg, PA. SHRP2's Guidelines for the Preservation of High-Traffic-Volume Roadways (R26) helps agencies select the right preservation technique for roadways based on specific conditions. These low-cost strategies extend the service life of pavements and the time between major and costly rehabilitation projects.

Two of these products are aimed at expediting delivery for complex, large-scale projects.

In 2015, MDOT will begin a 20-mile (32-kilometer) reconstruction on I–75 along Lake Erie. This stretch is the busiest freight corridor in the State, and the project involves impacts on 40 acres (16 hectares) of wetlands, threatened and endangered species, water quality, and impaired streams. Integrated planning with a number of resource agencies will be vital.

To ensure that the needs of all stakeholders are considered without delaying the project, MDOT will use SHRP2's Implementing Eco-Logical (C06), a process that maps the steps needed to apply FHWA's ecological approach to highway planning. The steps are outlined in the 2006 publication, *Eco-Logical: An Ecosystem Approach to Developing Infrastructure Projects* (FHWA-HEP-06-011).

Specifically, the project will involve the collaborative work of a number of environmental and community agencies to identify ecological priorities within the region using the methodology outlined in C06's nine-step Integrated Ecological Framework process. A technical advisory committee composed of staff from MDOT, FHWA, the Southeast Michigan Council of Governments, Michigan Natural Features Inventory, The Nature Conservancy, and other community and resource groups will meet at least 12 times over the next 3 years to review the project scope and solicit input to ensure that environmental concerns are addressed early, not just during permitting.

"By working with all stakeholders to identify and implement mitigation prior to needing resource agency permits, we expect to save time and money, while building trust for project implementation," says MDOT Director Kirk Steudle, past president of AASHTO, who also chairs AASHTO's implementation task force and the SHRP2 implementation advisory committee.

MDOT also plans to use the SHRP2 Solution, Innovative Strategies for Managing Complex Projects (R10), on two massive rehabilitation efforts, one of which is a 6.7-mile (10.8-kilometer) section of I–94. Built in the 1950s, I–94 is one of the oldest urban interstates in the country, and it intersects I–96, SR–10, and I–75 within a 1.2-mile (1.9-kilometer) segment. Average annual daily traffic in the project area currently ranges from 120,000 to more than 160,000 vehicles and is expected to grow by more than 35 percent by the year 2025.

The purpose of the I–94 rehabilitation is to improve mobility, safety, pavement, and bridges, while separating local traffic from I–94 traffic. One lane of traffic will be added in each direction on I–94 to provide needed capacity, and continuous service roads will be constructed adjacent to the freeway to reconnect neighborhoods and facilitate transit service.

Planners for the I–94 rehabilitation will need to address a number of project complexities, including the following:

- Replacement of numerous railroad bridges and 60 vehicular bridges
- Dense urban area
- Aging public and private utilities, some of which are unknown because they have been underground for more than 40 years
- Poor soil conditions
- Numerous left-hand entrances and exits

LA DOTD

These workers with the Louisiana Department of Transportation and Development (LA DOTD) are demonstrating intelligent compaction, a technology under SHRP2's Performance Specifications for Rapid Renewal (R07). Intelligent compaction measures the density of soil subgrade, subbase, and hot-mix asphalt layers in real time with the use of GPS and a continuous roller, helping improve pavement performance and durability.

A project in this northern California valley was part of an early pilot of SHRP2's Implementing Eco-Logical (C06) product when it was in the research phase. The product is an ecosystem-based approach to planning and constructing infrastructure projects.

Stephen Josef, courtesy of Sonoma Land Trust

MDOT will address these issues with the help of SHRP2's next-generation methodology for project management, which adds financial and context considerations to more traditional project management models that consider only technical, schedule, and cost dimensions. The Innovative Strategies for Managing Complex Projects (R10) suite includes 13 project execution tools as well as case studies. Agencies can use the suite to develop comprehensive plans for project management, create maps to display project complexities visually, control costs, and allocate resources efficiently.

"We first piloted SHRP2's five-dimensional project management methodology in 2012 and immediately recognized the value of the approach in helping us develop project plans and identify barriers to success," says Steudle. "By applying it to the I–94 rehabilitation project, we expect to develop a more comprehensive project plan that will reduce the risk of unexpected delays and costs during construction."

Meeting Tomorrow's Needs Today

One of the most significant and widespread challenges facing highway agencies is the loss of vital, individual and institutional knowledge due to the retirement of experienced professionals. Many SHRP2 products address this challenge by collecting case studies and best practices in various areas and presenting them in ways that can be easily accessed through online applications or Web sites. For example, SHRP2's product Expediting Project Delivery (C19) collates the results of a comprehensive literature review and interviews with State DOT personnel to identify the 16 most common causes of delays in project planning and environmental reviews, and recommends 24 mitigation strategies. Through the implementation of C19, critical information and experiences addressing common constraints will be documented and shared to benefit transportation agencies in minimizing the effects of losing individual and institutional knowledge.

SHRP2 Solutions are as diverse as the challenges they seek to solve. Although some point to specific methodologies, others address critical issues through longer term, but scalable, organizational and process changes. Organizing for Reliability Tools (L01/06), for example, provides a methodical approach that helps agencies design business processes to improve responses to unexpected events that cause congestion, such as weather, special events, and traffic incidents. The process begins with a workshop on improving systems operations and management that assesses an agency's current capabilities by evaluating business processes, technologies, staffing, and organizational culture.

The product's guidebook and online tool then help identify key gaps and strategies for improving reliability through the systematic upgrading of operational processes. Actual changes to the operational structure may take years to implement, but the agency benefits from a thorough assessment of its current capabilities, particularly in relation to how similar DOTs are operating throughout the country.

SHRP2 will continue to launch proven innovations as research and pilot projects are completed. By implementing SHRP2 Solutions, the transportation community will strengthen the highway system to serve the Nation efficiently and effectively throughout the 21st century.

"We consider what is best for the country, where we are moving as an industry, and what would best serve all the citizens in the United States," Steudle says. "This is a once-in-a-lifetime chance to identify a set of new innovations that will benefit our fellow transportation departments."

Judith Johnson is a national marketing specialist with FHWA's Office of Technical Services, specializing in strategic marketing, communications planning, and technology deployment. She has an executive certificate in strategic marketing management from Emory University, graduate studies in journalism and public relations from the University of Missouri, and a bachelor of arts in English from Fisk University. She is a certified mediator and trained facilitator.

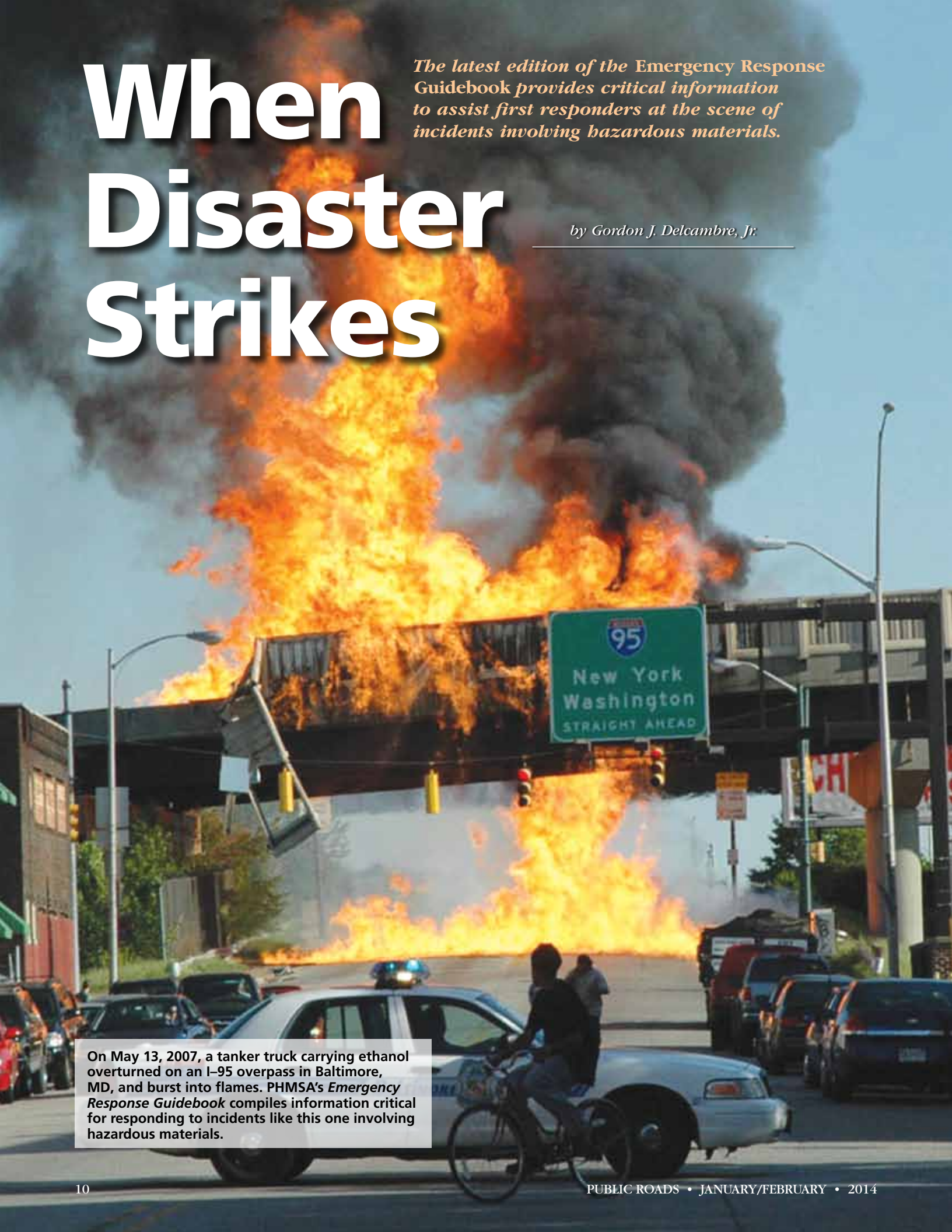
Laurie Butts is a senior communications specialist who works with the U.S. Department of Transportation's Volpe National Transportation Systems Center to help Federal, State, and local agencies promote transportation safety programs and innovations. She has a bachelor's degree in corporate communications from James Madison University and a master's degree in marketing from Westminster College in Utah.

For more information, contact Judith Johnson at 404-562-3682 or judith.johnson@dot.gov.

When Disaster Strikes

The latest edition of the Emergency Response Guidebook *provides critical information to assist first responders at the scene of incidents involving hazardous materials.*

by Gordon J. Delcambre, Jr.



On May 13, 2007, a tanker truck carrying ethanol overturned on an I–95 overpass in Baltimore, MD, and burst into flames. PHMSA's *Emergency Response Guidebook* compiles information critical for responding to incidents like this one involving hazardous materials.

Imagine driving down a limited-access highway. As you near an exit ramp, you glance in your rearview mirror and see a tractor-trailer truck approaching fast behind you. As you prepare to exit, you can tell that the truck is hauling a fuel tank that looks like it might hold gasoline. You note a small, bright red diamond placard mounted on the truck's grille. The truck follows you onto the exit ramp. As you navigate the ramp's sharp curve, you wonder if the truck might be traveling too fast to handle the curve safely.

It is. The next thing you know, the tanker truck's tires are squealing and smoking. The top-heavy payload lists left under the momentum and…crunch. The tanker flips onto its side, and liquid gushes out onto the pavement. Vehicles behind the truck slam on their brakes, and a few seconds later traffic is at a standstill. You've just witnessed a hazardous materials incident.

What happens next falls under the purview of the U.S. Department of Transportation's (USDOT) Pipeline and Hazardous Materials Safety Administration (PHMSA), which regulates the hazardous materials (hazmat) industry. Ensuring the safe transport of hazmat cargoes in the highway environment is a responsibility shared with more than 40,000 registered shippers and carriers as well as the State and local emergency responders who often are first on the scene when an incident occurs.

The roadmap for assessing the situation at the scene of a highway incident involving hazardous materials is the *Emergency Response Guidebook* (ERG) published by PHMSA. Using the guidebook, first responders can quickly determine the nature of the material released and identify appropriate next steps to secure the scene and ensure a safe and orderly response.

"The ERG is an invaluable tool that provides emergency responders with critical information and guidance during the initial stages of a hazmat emergency," says PHMSA Administrator Cynthia Quarterman. "Taking the proper action during those critical first minutes has a huge impact on the safety of both first responders and the people they serve."

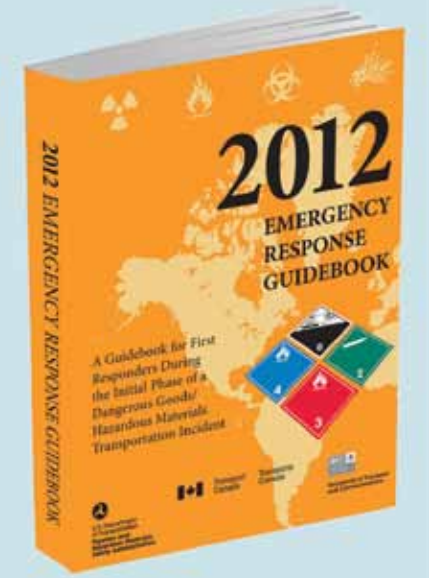
The latest edition of the ERG hit the streets in May 2012. Revisions include reorganized and updated information as well as new tables highlighting protective action distances for large spills involving six common gases that are toxic if inhaled. Here's a look at what's inside the 2012 ERG's bright orange jacket and how the guidebook's content can help save lives.

Creating the Gold Standard

USDOT is committed to ensuring that hazardous materials are transported safely and reliably, regardless of which mode of transportation a shipper chooses. Yet, in an imperfect world, the risk of incidents is always a concern, especially considering that nearly 1 million shipments of hazardous materials crisscross the Nation's highways every day.

As the USDOT administrative arm charged with ensuring the safe transport of hazardous materials, PHMSA's priority is to deliver critical knowledge directly into the hands of the Nation's first responders. That's where the ERG comes in. The guidebook was developed jointly with Transport Canada and Mexico's Secretariat for Communications and Transportation, and with assistance from a number of other interested parties from U.S. Government and industry.

Funding for the ERG comes through PHMSA's Hazardous Materials Emergency Preparedness grant program. All grant monies are funded by registration fees paid by hazmat industry shippers and carriers. Each year, a portion of those fees is set aside to pay for the production, printing, and distribution of the ERG.



The 2012 *Emergency Response Guidebook*, shown here, is available free to the Nation's first responder community.

First published in 1980, the ERG has since become the gold standard for assessing and responding to the initial phase of transportation incidents involving hazardous materials. The guide is available free to public safety agencies in all States and territories, plus Native American tribes, typically through designated emergency management agencies or offices. In 2012, PHMSA distributed more than 2 million copies of the guidebook to firefighters, emergency medical technicians, and law enforcement officers nationwide.

These first responders use the guidebook to identify specific risks associated with compromised hazardous materials. They also use it to determine measures they should take to protect themselves and the public, and to follow procedures for containing the incident as quickly and safely as possible.

The guidebook does not, however, provide information on the physical or chemical properties of hazardous materials. Nor should it be considered a substitute for emergency response training, knowledge, or sound judgment, as it does not address all possible circumstances associated with a hazmat incident. Although PHMSA designed the guide specifically for use at transportation-related hazmat incidents, the document could offer some limited value in applications at fixed facilities such as warehouses or manufacturing plants.

"As a chief fire officer and incident commander myself, I've responded to many hazmat incidents and have relied upon the ERG to identify those products involved, and what to do and what not to do," says PHMSA Deputy Administrator Timothy Butters. "At PHMSA, we understand the importance of first responders having accurate information during the first critical minutes of a hazmat incident."

Labeling of Hazmat

According to law, shipping documents, also known as manifests, bills of lading, or shipping papers, must accompany all hazmat shipments. In addition, PHMSA requires placards to be mounted on transport

Placards like this one provide critical information to emergency first responders at the scene of a hazmat incident.

vehicles and freight containers carrying these materials. The placards are diamond shaped and 9.84 inches (250 millimeters) on each side and are mounted on the side, front, and rear of tanker trucks and containers. The placards are color coded according to hazard class. For example, orange indicates explosives, while red is used for flammable and combustible liquids like gasoline. This visual clue immediately tells responders that a tanker or container is carrying a hazardous material.

Together, the manifests and placards provide vital information to identify the hazardous materials being transported. They are among the primary sources of information that first responders need upon arriving on the scene of a hazmat incident.

Organization of The Guidebook

For ease of use, PHMSA grouped the content of the ERG into color-coded pages. The front and back sections of the guidebook are white pages containing background and reference information. For example, the front matter includes a figure summarizing the various color-coded hazmat placards and the colorful symbols that help identify which hazardous substance is onboard.

The white pages also include charts to aid in identifying the various types of tank cars used in highway and railroad environments, as well as a section on the hazard identification numbers displayed on intermodal containers. In the white pages in the back section of the guidebook, users will find a list of emergency response telephone numbers in Canada, Mexico, and the United States.

The ERG organizes the hazmat information alphabetically and according to United Nations (UN) identification numbers, giving responders a choice of two ways to quickly identify the specific or generic classification of the materials involved in the incident. The alphabetical list of hazardous materials is contained in a section with blue-bordered pages.

A section of yellow-bordered pages lists the hazmat and dangerous goods according to their four-digit UN numbers. The United Nations Economic and Social Council's Subcommittee of Experts on the Transport of Dangerous Goods assigns and maintains the 4-digit UN numbers used worldwide to identify dangerous goods, including hazardous materials. The numbers appear in ascending order, referenced against the name of the hazardous material. With each entry is a reference to the relevant guide page (more on these later) listing the appropriate safety actions responders should take when dealing with an incident involving that specific material.

Next are orange-bordered pages, dubbed "guide" pages, which provide specific recommended safety actions. This section, arguably the most important in the ERG, consists of a total of 62 individual guides, each providing safety recommendations and emergency response information to protect first responders and the public. Each guide page is designed to cover a group of hazardous materials that possess similar chemical and toxicological characteristics. In greater detail the orange pages outline the potential hazards of the materials, the public safety issues of note, the protective clothing needed during a response, and the evacuation distances recommended.

Making the right decisions during the initial phases of an incident often will determine how quickly an incident is resolved. "There's a certain protocol for handling fires and emergencies that involve hazardous materials," says PHMSA Chief of Outreach and Training Tom Kiddy. "The guidebook serves as a quick reference for trained first responders."

The ERG on the Scene

Back at the scene of the aforementioned hypothetical tanker crash, first responders armed with the ERG and a pair of binoculars survey the scene from a safe distance. Of particular interest would be the placards mounted on the side, front, and rear of the tanker truck. These visual clues immediately tell responders that the tanker is carrying a hazardous material. Zeroing in with the binoculars, the responders try to make out the UN identification number inscribed on the placard. In this case, it's 1203. A quick flip to the yellow-bordered

Shown here is the proper placement of the hazmat placards on the back and sides of gasoline tanker trucks.

Starting with the 2012 edition, emergency first responders can access the ERG via mobile applications on smartphones, like this one in use at the scene of a hazmat incident.

pages in the ERG under identification number 1203 confirms that the material in the tank is gasoline, which is a Class 3 flammable material and one of nearly 3,000 hazardous materials regulated by USDOT.

Turning next to the ERG's orange-bordered guide pages, responders will find a list of potential hazards—fire, explosion, health—associated with a gasoline spill and instructions describing safe response tactics. For example, in terms of hazards, Guide 128 in the ERG explains that "vapors may travel to source of ignition and flash back" and that "inhalation or contact with material may irritate or burn skin and eyes."

Guide pages also describe the protective clothing (such as a self-contained breathing apparatus) required for a flammable liquid spill involving a tanker and outlines appropriate emergency response tactics. For example, responders need to remove all ignition sources from the immediate area—no smoking, flares, or sparks. They also need to prevent the gasoline from entering into waterways and cover the spill with dry earth, sand, or other non-combustible materials before transfer to containers for transport offsite for disposal. If a fire is involved, suppression efforts could include use of dry chemical, carbon dioxide, water spray, or regular foams and need to take place at a safe distance or using unmanned hose holders.

The orange-bordered pages also list first aid responses. In the case of a gasoline spill, the responses could include moving any victims to fresh air, providing artificial respiration if needed, and then removing and isolating contaminated clothing and shoes.

Evolving With the Times

Revised every 4 years, the ERG continues to evolve to accommodate new hazardous materials, technologies, and response tactics. "We collect user feedback and incorporate those suggestions and changes into new editions of the ERG," Kiddy says. "We also hold public meetings and roundtables and solicit formal comments from our stakeholders using the *Federal Register*."

Expanded or revised sections of the 2012 edition include the following:

- Shipping documents
- Isolation and evacuation distances
- Railcar identification chart
- Road trailer identification chart
- Pipeline safety information
- Addition of a table listing six gases that are toxic by inhalation
- Addition of a chart noting safe standoff distances from improvised explosive devices

In addition to printed copies, emergency responders now can access the ERG through various personal mobile devices including smartphones and tablets. PHMSA partnered with the U.S. Department of Health and Human Services' National Library of Medicine to develop smartphone applications (apps) for the 2012 ERG. The mobile ERG apps make it easier for firefighters, police, and other emergency first responders to locate the information they need quickly using the app's search function. The apps are available to responders and the public free of charge through mobile phones' apps stores.

Another benefit of the digital version is ease of reading, even during nighttime emergencies when light is limited. (See "Mobile Apps Bring Flexibility to Emergency Response" on page 32 in this issue of PUBLIC ROADS.)

Delivering useful guidelines for addressing hazmat incidents into the hands of emergency professionals operating in the transportation environment helps ensure public safety, which is USDOT's primary purpose. With the ERG, emergency first responders have the latest and most complete information to handle any situation.

Battalion Chief Martin Ranck, with the Fairfax County (Virginia) Fire and Rescue Department's hazardous materials response team, sums up the ERG's role: "When firefighters and other emergency responders arrive on the scene of a potentially dangerous hazardous materials incident, they can feel confident that they're equipped with the most current information to make the appropriate decisions during those first critical moments."

Gordon J. Delcambre, Jr., is a senior public affairs specialist with PHMSA. He is a retired U.S. Navy captain and graduate of the Defense Information School Public Affairs Officer Course and Hazardous Materials Compliance & Enforcement Course (49 CFR Safety & Security Compliance).

For more information, visit www.phmsa.dot.gov. To purchase a copy of the guidebook, visit http://bookstore.gpo.gov. Printed copies are available for sale to the public through the U.S. Government Printing Office's Bookstore and other commercial vendors. Spanish and French language versions are available as well.

Setting the Bar for Excellence

by Rachel Strauss

FHWA honors innovative approaches to incorporating environmental stewardship into transportation planning and delivery.

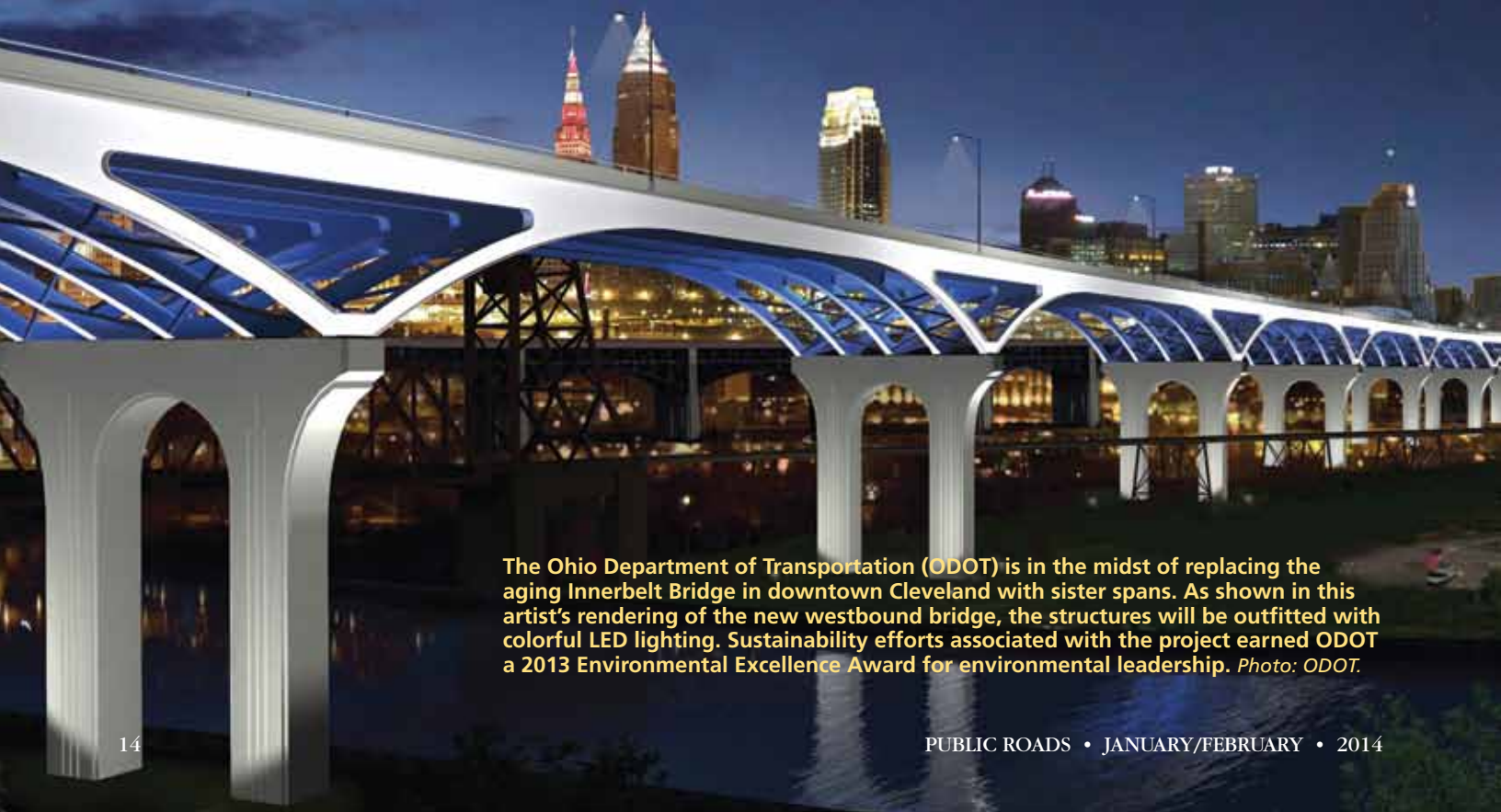
To achieve transportation goals while minimizing adverse effects on the natural environment, transportation agencies often need to innovate. Whether adopting new approaches to streamline processes, using innovative technologies, or creating partnerships to meet a diversity of goals, State departments of transportation (DOTs) and other transportation stakeholders across the country are successfully incorporating environmental protection into long-term transportation solutions.

Starting in 1995, the Federal Highway Administration (FHWA) has sponsored the biennial Environmental Excellence Awards program to recognize outstanding contributions in this area. The recipients have used FHWA funding to implement programs and processes that encourage environmental stewardship and sustainable planning while also meeting the Nation's growing transportation needs.

Categories cover topics ranging from air quality, wetlands, and ecosystems to environmental research and leadership to nonmotorized and multimodal transportation. For the 2013 awards, FHWA added three new award categories—collaboration and partnership; geospatial tools, technology, and analysis; and programmatic agreements. The new categories recognize the evolving state of the practice and promote processes and projects within these categories that demonstrate measurable streamlining benefits.

The 2013 awards program attracted more than 100 applications. An independent panel of judges consisting of subject matter experts from Federal agencies, nonprofit organizations, and academia carefully reviewed the entries and narrowed them down to 13 award recipients, who were recognized in June 2013 at a ceremony hosted by FHWA. The event was held in Virginia Beach, VA, in conjunction with the annual meeting of the American Association of State Highway and Transportation Officials' (AASHTO) Standing Committee on the Environment.

"The winning entries demonstrate a commitment to protecting and enhancing the environment while also shortening project delivery, advancing innovative technology, and going greener," says Gerry Solomon, director of FHWA's Office of Project Development and Environmental Review. "They demonstrate that we can have a high-quality transportation system and a healthy environment."



The Ohio Department of Transportation (ODOT) is in the midst of replacing the aging Innerbelt Bridge in downtown Cleveland with sister spans. As shown in this artist's rendering of the new westbound bridge, the structures will be outfitted with colorful LED lighting. Sustainability efforts associated with the project earned ODOT a 2013 Environmental Excellence Award for environmental leadership. *Photo: ODOT.*

The award-winning projects described below offer a look at how some of the innovative approaches at work across the country incorporate environmental considerations into transportation planning and project delivery.

Promoting Environmental Streamlining

The ability to streamline projects and move them quickly from the planning stages to implementation is a key concern for many agencies. By integrating environmental considerations earlier in the transportation planning process, the following four award recipients demonstrate best practices in expediting project review and delivery.

Colorado Streamlines Environmental Assessment. When the Colorado Department of Transportation (CDOT) and its partners began the environmental assessment for the I–70 Twin Tunnels project near Idaho Springs, CO, they made streamlining a key component of the process. The project, which involves adding an eastbound lane and expanding the eastbound tunnel, will improve safety and reduce congestion throughout this mountain corridor.

The project team, which included CDOT, the FHWA Colorado Division Office and Field Legal Services Division (Western), and several consulting firms, successfully incorporated environmental streamlining practices that went beyond the normal scope of preliminary design by establishing an early involvement agreement related to legal reviews. Site visits by legal staff and reviews of the draft environmental assessment enabled the project team to resolve legal concerns early in the process. These efforts resulted in a compressed comment period and a savings of at least 1 month in the overall schedule.

Oregon and Washington Expedite Reviews With Programmatic Consultations. The Oregon Department of Transportation (ODOT), FHWA Oregon Division, and the National Marine Fisheries Service collaborated on a programmatic consultation that provides a framework for compliance with the Endangered Species Act on Federal-aid highway projects. The programmatic consultation applies to 95 percent of consultations regarding the State's Federal-aid transportation projects. Specifically, it covers 17 federally listed aquatic species and 16 critical habitats.

In place since 2012, the programmatic consultation has already yielded measurable results in project streamlining. To date, more than 20 projects have used the agreement, with an overall reduction in consultation timelines of up to 85 percent—or 170 days.

The State of Washington also created a programmatic consultation to expedite reviews required under the Endangered Species Act. The Washington State Department of Transportation (WSDOT), FHWA Washington Division, and the National Marine Fisheries Service worked together to develop the programmatic consultation, which applies to projects either funded by FHWA or requiring a permit from the U.S. Army Corps of Engineers. Two expedited approval pathways streamline the process, while

Winners of the 2013 Environmental Excellence Awards

Air Quality Improvement and Climate Change
- Building the West Coast Electric Highway for a Cleaner, Energy-Independent Future

Collaboration and Partnership
- Moses Creek Wetland Restoration: A Collaborative Opportunity to Restore Wetland Functions in an Urban Setting

Cultural and Historical Resources
- Lake Champlain Bridge: Preserving Cultural Heritage

Ecosystems, Habitat, and Wildlife
- Indiana Bat Programmatic Conservation Memorandum of Agreement

Environmental Leadership
- Cleveland Innerbelt Green 7

Environmental Research
- Wildlife Crossing in Utah: Determining What Works and Helping to Create the Best and Most Cost-Effective Structure Designs

Environmental Streamlining (Every Day Counts)
- Twin Tunnels Environmental Assessment

Geospatial Tools, Technology, and Analysis
- Apache Trail Historic Geographic Information Systems Inventory

Nonmotorized and Multimodal Transportation
- Tahoe-Pyramid Bikeway

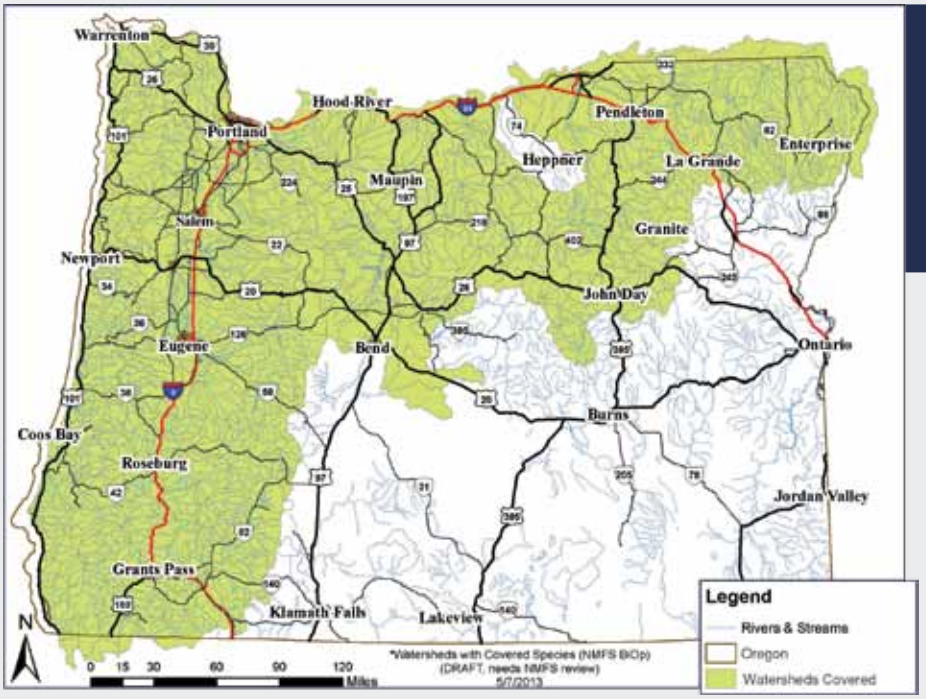
Programmatic Agreements
- Oregon Federal-Aid Highway Endangered Species Act Programmatic
- Washington State Department of Transportation Endangered Species Act Programmatic With the National Marine Fisheries Service

Roadside Resource Management and Maintenance
- Integrated Roadside Vegetation Management, Invasive Species Control, and Native Plant Establishment Projects

Wetlands, Watersheds, and Water Quality
- Lowry Avenue Bridge Over the Mississippi River—Improving Water Quality

Mike Keleman, CDOT

Colorado's I–70 Twin Tunnels widening project will expand the eastbound tunnel to improve safety and reduce congestion along this segment near Idaho Springs. Here, crews are removing rock from the bore being widened during blasting activities.



This map shows the coverage area for a programmatic consultation to address endangered species and critical habitats in Oregon. The consultation will help streamline environmental reviews for Federal-aid highway projects in the State. *Source: FHWA Oregon Division.*

reporting and communications tools help monitor and track progress, expectations, and conditions. The consultation covers 17 critical habitats and 24 species, including salmonids, marine mammals, green sturgeon, eulachon, and rockfish.

Up to 70 percent of WSDOT's projects requiring consultations under Section 7 of the Endangered Species Act are expected to use the programmatic consultation. Results to date show a reduction of almost 90 percent in consultation timelines for the six projects using the agreement.

Kentucky Protects Bats and Their Habitat Through a Memorandum of Agreement. The Indiana bat (*Myotis soldalis*) is an endangered species found in Kentucky and throughout the eastern United States. Because the bat's habitat spreads across such a wide territory, many of Kentucky's transportation projects have the potential to affect the species. In the past, every project required a biological assessment under the Endangered Species Act or faced time-of-year restrictions, which often resulted in delays and increased costs.

In 2012, the Kentucky Transportation Cabinet, the FHWA Kentucky Division, and the U.S. Fish and Wildlife Service's Kentucky Ecological Services Field Office signed a programmatic memorandum of agreement for conservation of the Indiana bat. The agreement provides options for compliance with the Endangered Species Act, significantly reducing the time and expense of consultations regarding the Indiana bat. The agreement standardizes biological surveys and assessments and establishes a means to protect the bats by allowing agencies to pay into the Indiana Bat Conservation Fund, administered by a third-party nonprofit organization.

The new programmatic process goes beyond project-level mitigation to provide recovery-based conservation benefits for the Indiana bat in the form of habitat protection and restoration, as well as priority monitoring and research projects. The agreement ensures that ecosystem and habitat concerns are integrated into the earliest stages of planning and project development to avoid and minimize impacts.

To further promote streamlining, the U.S. Fish and Wildlife Service developed a map of Kentucky that highlights known occurrences of the Indiana bat. The map helps transportation officials determine the amount they would need to pay into the conservation fund based on a project's location. Those in areas without known occurrences might require a lower payment and proceed with construction more quickly. For projects in areas with known occurrences, transportation officials can coordinate earlier and work together more efficiently to determine the payments needed for the conservation fund.

"The [memorandum of agreement] gives agencies options and flexibility so they can choose the steps they wish to take and how to address potential impacts on the species," says Phillip DeGarmo, a wildlife biologist at the U.S. Fish and Wildlife Service's Kentucky Ecological Services Field Office. DeGarmo, who helped establish the agreement, adds, "From a biological standpoint, it just makes sense."

Advancing Innovative Technology

Technology and research are advancing the ways in which agencies think about and apply environmental considerations to transportation

Adam Mann

Transportation projects, such as road widening and realignment, could affect habitat of endangered species like the Indiana bat, shown here. Kentucky's memorandum of agreement provides a standard approach for biological surveys and assessments related to protecting this bat and its habitat.

A programmatic consultation providing Endangered Species Act coverage for Washington State Department of Transportation projects influenced the design of this bridge, which helps ensure that fish can pass easily beneath the roadway.

projects. The following 2013 award recipients were recognized for their groundbreaking applications of data and technology to improve environmental outcomes.

West Coast Electric Highway Builds Infrastructure for a Cleaner, Energy-Independent Future in Oregon. An extensive network of fast-charging stations for electric vehicles along I–5 and connecting corridors is changing the way people travel in Oregon and Washington. The Oregon Department of Transportation (ODOT) and its private partner, AeroVironment, are installing 43 charging stations throughout the State, making it easier for drivers to use nonpetroleum fuel sources in Oregon and encouraging a shift toward use of electric vehicles. This network—collectively known as the West Coast Electric Highway—also includes 12 charging stations in Washington.

The deployment of a robust network of charging stations means that electric vehicles will be able to travel beyond the typical battery range of around 100 miles (161 kilometers). In March 2012, ODOT completed the first stage of the project, installing 10 fast-charging stations covering more than 200 miles (322 kilometers) of I–5. A fast-charging station can recharge an electric vehicle in anywhere from 10 to 30 minutes. With funding from the U.S. Department of Transportation's Transportation Investment Generating Economic Recovery grant program, known as TIGER II, ODOT installed an additional 22 stations as of June 2013 and aims to complete the remaining 11 by summer 2014.

Electric vehicles emit fewer pollutants than conventional automobiles and produce zero local emissions. By encouraging greater use of alternative fuel vehicles, the West Coast Electric Highway will help improve air quality and reduce greenhouse gas emissions.

Research Improves Safety for Wildlife in Utah. Collisions between drivers and mule deer, elk, moose, and other wildlife passing through the roadway environment are an all-too-common occurrence in wilderness areas. Between 2007 and 2013, a research project focused on wildlife crossings in Utah employed motion-sensing cameras to monitor how wildlife used crossing structures, culverts, and bridges. The study resulted in recommendations for crossing structure designs that could help prevent future collisions.

Utah State University led the research team, with support from the Utah Department of Transportation (UDOT) and the Utah Division of Wildlife Resources. The team used 44 cameras to produce more than 2 million images over 40,000 camera days, monitoring 38 structures on 7 highways and interstates. The images provided the researchers with photographic evidence to support their recommendations, such as placement of fencing in situations where wildlife have ample culverts and bridges that enable them to pass under the roads. In part because of this study, shorter culverts, open bridges with terrestrial paths for wildlife to travel, and attached wildlife fencing are the new standard.

These operating procedures also provide the State with substantial cost savings by reducing wildlife-vehicle collisions. For example, UDOT engineers found that two of the culvert crossing structures monitored in the study reduced collisions along I–15 by more than 90 percent and paid for themselves in less than 3 years.

GIS Inventory Helps Protect Historic Apache Trail in Arizona. Travelers have long enjoyed Arizona's historically significant State Route 88 corridor, also known as the Apache Trail. Built in the early 1900s as a wagon road, the

ODOT

A convoy of electric vehicles departs from one of the charging stations in Oregon that is part of the West Coast Electric Highway.

RockSol Consulting Group, Inc.

Maintenance crews are repairing a historic retaining wall along a segment of State Route 88, also known as the Apache Trail, in Arizona.

corridor provides views of majestic canyons and vast wilderness areas in Maricopa County. The road's many features have helped to support its eligibility for the National Register of Historic Places.

Given the age of the Apache Trail, local officials face a number of challenges in maintaining the highway infrastructure. Many of the road's unique historical engineering features, including one-lane bridges and rock structures, are more than 80 years old. One 39-mile (63-kilometer) segment is paved for only 19 miles (31 kilometers). Sections with steep grades make travel challenging for many visitors to the area.

To catalog the historical resources and improve management practices, the FHWA Central Federal Lands Highway Division, the Arizona Department of Transportation (ADOT), and the U.S. Forest Service's Phoenix office partnered to develop a comprehensive geographic information system (GIS) inventory of more than 850 roadway features in the corridor. The GIS inventory enables partner agencies to identify the location, condition, and rehabilitation needs of specific roadway features such as culverts and retaining walls. The inventory includes locations, images, and videos of all the corridor elements, including character-defining features, through 2010. In addition, ADOT maintenance staff continues to document and photograph features and identify changes.

The GIS inventory has led to further efforts to protect this historic corridor. Project partners, working with the Arizona State Historic Preservation Office and FHWA Arizona Division, are establishing a programmatic agreement for the roadway in accordance with Section 106 of the National Historic Preservation Act of 1966. The goal of the agreement is to consult on a programmatic basis to cover a range of activities that may be redundant or have similar impacts on the roadway, and to outline a process for treatment and maintenance in keeping with the road's historic character. The inventory also resulted in ADOT developing a detailed maintenance and operations plan for the corridor in 2012. These activities will help partners protect the cultural resources and historic nature of the roadway.

"The Apache Trail is a spectacular and unique resource, particularly for a State highway," says Thomas Puto, a project manager with the FHWA Central Federal Lands Highway Division. "The inventory has produced a fully functioning database that all project partners can access and update. Prior to the inventory, agencies did not have a comprehensive record of what the resources along the corridor were or when they were built. The inventory provides a way to identify the corridor's character-defining features and to preserve these features from a cultural and historical resource perspective."

Collaborating with Partners

Much of the work performed by awardees could not be done without the collaborative support and participation of their many partners. The following 2013 award recipients illustrate some of the possible achievements that can be reached by collaborating with project partners to accomplish goals and meet deadlines.

Partnership Hastens Replacement of Historic Bridge Between New York and Vermont. Built in 1929, the historic Lake Champlain Bridge was closed in October 2009

Utah State University

This image from a motion-sensing camera shows a bull elk crossing beneath a wildlife arch bridge under I–70 in Utah.

because of structural deficiencies. Without this critical connection, travelers faced an 85-mile (137-kilometer) detour over rural roads to reach their destinations.

The New York State Department of Transportation (NYSDOT) and the Vermont Agency of Transportation (VTrans), together with an extensive list of other partners, including Federal and State agencies in both States, quickly jumped into action. Within just 2 years, a brand new Lake Champlain Bridge opened to traffic.

To protect nearby historical and cultural resources, project partners used innovative methods such as archaeological reconnaissance, data recovery and monitoring during construction, plus state-of-the-practice seismic techniques to evaluate the effects of construction on the foundations of nearby historic buildings. They also established two programmatic agreements with the States' historic preservation offices to facilitate the Section 106 process.

NYSDOT and VTrans partnered with local historians and preservationists to document the original bridge's legacy and historical significance and to develop a comprehensive commemoration program, which includes a resource guide, filmed oral history accounts, a documentary film, a history book, and interpretive displays at five sites. Two of the sites, in Port Henry, NY, are located within sight of the bridge. The other three sites, located in Addison, VT, and Crown Point, NY, are in close proximity to the bridge.

The project to build the new Lake Champlain Bridge shows how close collaboration between State DOTs and their partners and stakeholders can expedite delivery of projects spanning State lines.

Wisconsin Project Restores Wetland Functions in an Urban Setting. When the Wisconsin Department of Transportation (WisDOT) was looking for a mitigation site to compensate for unavoidable wetland impacts from a bypass project on U.S. 10, nearby Moses Creek rose to the top of the list. The creek runs through Schmeeckle Reserve, a protected area north of Stevens Point, WI, that consists of approximately 280 acres (113 hectares) owned by the University of Wisconsin–Stevens Point. Officials with the university, the St. Paul District of the U.S. Army Corps of Engineers, and the city of Stevens Point agreed that restoring Moses Creek to its natural state could achieve many of WisDOT's objectives and then some. The effort also would help improve flood management and connect the community to the natural environment.

"Our ultimate goals were very similar," says Janet Smith, environmental coordinator for WisDOT's North Central Region. "In addition to restoration, we wanted to increase diversity, provide high-quality habitat, improve drainage, and educate the public."

WisDOT and its partners worked together to restore the wetland and aquatic habitat surrounding Moses Creek and the adjacent area. In collaboration with the university, WisDOT enlisted students to collect data on water quality and conduct vegetation studies. To encourage visitors to the protected area, WisDOT installed a boardwalk trail through Schmeeckle Reserve and added interpretive signs, providing the local community with opportunities for walking and wildlife watching.

Right from the start, the project involved many stakeholders, which helped to encourage collaboration and community building. "Everyone was able to come together and bring the project to fruition," Smith says. "The project is an aesthetic gem for the community."

Enhancing the Environment

Encouraging transportation agencies to think about the effects of their activities on the natural environment is at the core of FHWA's Environmental Excellence Awards. The 2013 winners are leading the way in their efforts to encourage activities and approaches that preserve and protect the environment in the delivery of transportation improvements.

Planned Bikeway to Span 116 Miles (187 Kilometers) in California and Nevada. The Truckee River between Lake Tahoe, CA, and Pyramid Lake, NV, is a scenic and historic corridor with adjacent freeways and railroad tracks. Many sections of the corridor, however, lack safe and convenient access for nonmotorized transportation modes, such as bicyclists and pedestrians. Proponents of the Tahoe-Pyramid Bikeway aim to change that. This

Vermont Division for Historic Preservation

Crews are installing the first girder of the new Lake Champlain Bridge at the Chimney Point State Historic Site in Vermont. The DOTs in New York and Vermont partnered with their respective historic preservation offices and a variety of other stakeholders to protect nearby historical and cultural resources during construction.

WisDOT

Restoring the Moses Creek wetland in Stevens Point, WI, involved installation of this boardwalk and interpretative signage to encourage public use and enjoyment of the site.

This section of the Tahoe-Pyramid Bikeway connects Reno to the residential community of Verdi, NV. The paved multiuse trail separates bicyclists and pedestrians from automobile traffic.

Tahoe-Pyramid Bikeway, Inc.

visionary project will establish a bicycle and pedestrian trail along the entire 116-mile (187-kilometer) length of the Truckee River.

Development of the bikeway is underway, with several segments already completed, such as the one extending from Verdi to Sparks, NV (east of Reno). About 200 bicyclists use the trail daily. A future section, east of Reno, will provide the only off-freeway route for residents to use when commuting to Reno by bicycle or on foot.

Maryland Reintroduces Native Habitats in Managing Roadside Vegetation. The Maryland State Highway Administration's Office of Environmental Design is tackling the issue of invasive species and vegetation management by focusing on roadside vegetation's environmental functionality rather than its aesthetic value. The agency is developing a network of native roadside habitats that are functional, healthy, and sustainable. Six projects are underway to remove invasive species and establish native habitats, including meadows, wetlands, and forest stands along roadsides and medians. The projects cover 446 miles (718 kilometers) along 14 highways in 14 counties throughout Maryland, in addition to 31 wetland mitigation sites.

The agency expects that this integrated approach to managing roadside vegetation will help curb the spread of invasive species and reduce related costs and environmental impacts.

Minneapolis Bridge Project Incorporates System to Treat Stormwater. The Lowry Avenue Bridge over the Mississippi River has provided a vital connection between north and northeast Minneapolis, MN, for more than a century. However, the bridge's open-grate deck enabled pollutants from vehicles and runoff to drain directly into the river below. When the time came to replace the bridge, officials with Hennepin County, the city's department of public works, and other public and private sector partners took the opportunity to develop and install an innovative water treatment system that improves the quality of discharged stormwater.

A new underground sand filtration system removes 85 percent of total suspended solids in stormwater from 10.5 acres (4.2 hectares) of the corridor surrounding the bridge and provides low-flow treatment for an additional 127 acres (51 hectares). Having this filtration system in place prevents more than 14,000 pounds (6,350 kilograms) of total suspended sediment from reaching the river annually.

Ohio Integrates Green Goals Into Cleveland Bridge Design. Early in the development of Cleveland's Innerbelt Bridge project, the Ohio Department of Transportation (ODOT) established seven categories of sustainability goals, known collectively as the Green 7, to be achieved during construction. The $293 million project involves building a new westbound I–90 bridge over the Cuyahoga River Valley in Cleveland, OH. Work began in fall 2010, and the new bridge was expected to open to traffic in late 2013.

When preparing the request for proposals for the design-build project, ODOT included four sustainability requirements in the scope for the design and construction phases: energy and energy efficiency, community environment, green building, and waste reduction and recycling. The design-build team later added three more categories: green project administration, materials and resources, and green construction practices.

"ODOT was interested in setting a standard of excellence for the implementation of sustainable design principles when we developed this value-based, design-build proposal," says David Lastovka, a transportation engineer with ODOT District 12. "We wanted to challenge teams to apply state-of-the-art techniques to

Sustainability Achievements on Cleveland Innerbelt Bridge Project

Diesel Fuel Savings	95,910 gallons	363,060 liters
Emissions Reduction	1,332 short (U.S) tons	1,208 metric tons
Landfill Waste Diversion	125,143 cubic yards	95,679 cubic meters
Recycled Steel	5,054,953 pounds	2,292,890 kilograms
Potable Water Savings	21,968,400 gallons	83,159,400 liters
Recycled Material Content	2,357 cubic yards	1,802 cubic meters

Source: ODOT. Results as of July 2013.

Maryland State Highway Administration

Following the eradication of invasive species in this median in 2010, the Maryland State Highway Administration seeded the area with native meadow in spring 2011.

the design and construction of this project. Teams submitted sustainability plans with their technical proposals, which were then scored against our sustainability criteria."

Throughout design and construction, ODOT and its design-build team adopted a variety of environmentally conscious approaches to achieve these goals. For example, they chose construction vehicles with greater load-carrying capacity to reduce vehicle emissions, committed to a two-for-one tree replacement program, installed pocket fish habitats in the steel bulkhead walls of the shipping channel, and achieved a 50 percent diversion rate for construction waste.

To track its sustainability performance, ODOT partnered with FHWA to pilot test FHWA's Infrastructure Voluntary Evaluation Sustainability Tool (INVEST). In fact, the Cleveland Innerbelt Bridge is the largest INVEST pilot project in the country and the largest transportation project ODOT has undertaken to date.

Establishing comprehensive sustainability goals on such a large and complex project was a challenging task. "It took a lot of people saying 'Yes' to focus on the sustainability concept," says Matthew Perlik, assistant environmental administrator with ODOT's Office of Environmental Services. "Saying 'Yes' to additional documentation, to more meetings, more analysis, and to thinking about how the work of the DOT improves a community in a variety of ways beyond just better transportation. This new approach to measuring how our projects impact the community has helped track and communicate the project successes and has made sustainability not just a concept, but a reality."

Models for Environmental Stewardship

All of the projects recognized in the 2013 Environmental Excellence Awards represent significant achievements in preserving and enhancing the environment in the course of delivering transportation projects. Through a variety of approaches, including promoting streamlining, advancing new technologies, and showing the value of collaborating with diverse partners, the winning entries demonstrate a strong commitment to environmental excellence and innovation.

"Each of the recognized projects provides innovative ideas that can lead to even more remarkable projects in the future," says FHWA's Solomon. "They represent the highest commitment to environmental stewardship and will serve as models for the rest of the Nation."

Rachel Strauss is a community planner at the Volpe National Transportation Systems Center in Cambridge, MA. She was the Volpe project manager for the 2013 Environmental Excellence Awards and worked with Marlys Osterhues and William Ostrum of the FHWA Office of Project Development and Environmental Review in coordinating the awards. Strauss holds a master's degree in city planning from the University of Pennsylvania.

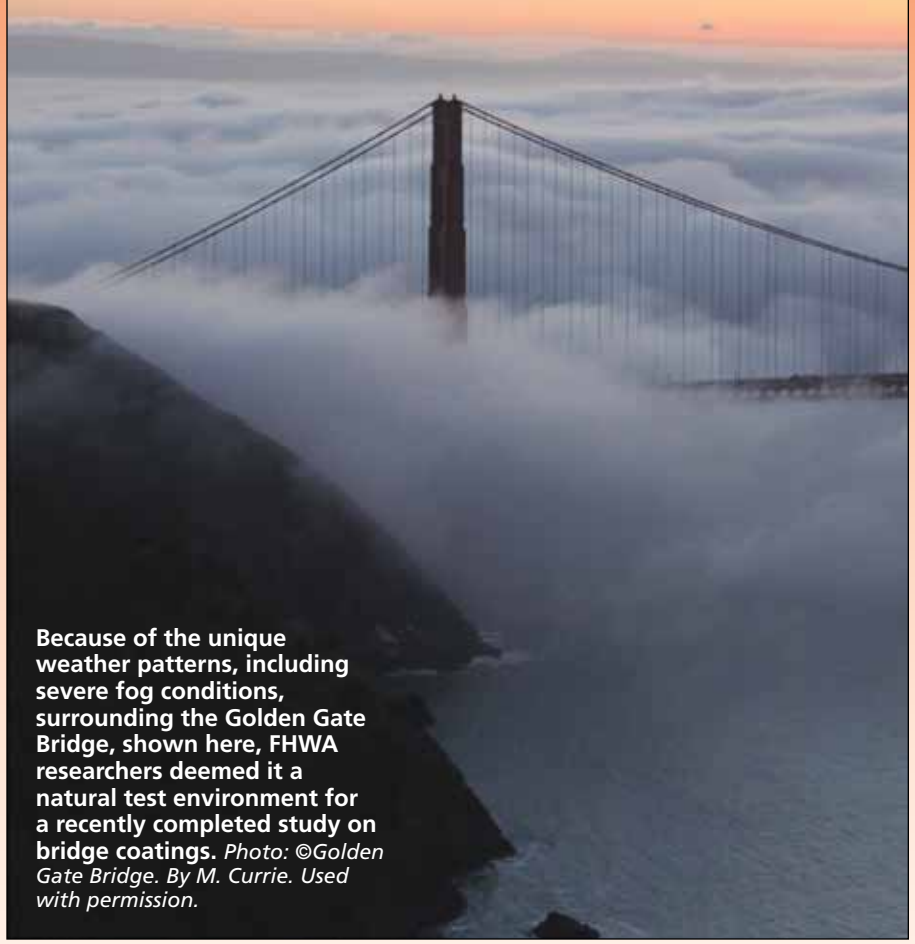
For more information about the award-winning projects or how to apply for future rounds, visit www.fhwa.dot.gov/environment/environmental_excellence_awards.

SRF Consulting Group

The new Lowry Avenue Bridge over the Mississippi River in Minneapolis, MN, integrates a landmark steel arch span with other technically advanced features. This bird's-eye view was taken in October 2012 when the bridge opened to traffic.

The Century Challenge

by Pradeep Kodumuri, Seung-Kyoung Lee, and Y. Paul Virmani



Because of the unique weather patterns, including severe fog conditions, surrounding the Golden Gate Bridge, shown here, FHWA researchers deemed it a natural test environment for a recently completed study on bridge coatings. *Photo: ©Golden Gate Bridge. By M. Currie. Used with permission.*

Researchers at FHWA set out to find bridge coatings that will last 100 years. Here's what they found.

Corrosion is the bane of many a bridge designer's existence. When steel bridge elements are inadequately protected from the natural environment, they face the risk of corrosion due to intrusion of moisture and salt. This corrosion can impair the long-term function and integrity of the structure.

To ward off corrosion, engineers have developed a variety of coatings that can be applied to steel surfaces to protect them from the elements. These coatings are critical to ensuring the long-term durability and integrity of bridge structures. Yet their application and maintenance pose a number of challenges. The current state of practice involves multilayer coatings typically consisting of a zinc-rich primer over an abrasive blast-cleaned surface and one or two additional coating layers on top of the primer. A typical three-coat application for rehabilitating an existing steel bridge can account for as much as 20 percent of the cost of fabricating a new steel bridge. Repainting a bridge in the field is highly labor intensive and expensive, due to the need for scaffolding and containment measures, where the paint blasted from the surface needs to be collected and disposed of.

Current three-coat systems offer a service life up to 30 years before a major touchup is required. Researchers at the Federal Highway Administration (FHWA) want to more than triple that. In August 2009, staff in FHWA's Coatings and Corrosion Laboratory at the Turner-Fairbank Highway Research Center (TFHRC) in McLean, VA, initiated a study to identify a coating system that could provide 100 years of virtually maintenance-free service life at a cost comparable to existing coating systems. The goal was to identify coating systems that could dramatically extend the service life of the original shop-applied coating and thereby reduce the frequency of pricey repeat applications down the road.

Choosing the Coatings

The mission of the Coatings and Corrosion Laboratory is to use proven methods—and develop innovative new methods—for evaluating the durability of new coating systems, especially environmentally compliant materials, for their ability to protect steel bridges from corrosion over the long term. Researchers typically evaluate the coatings using both accelerated laboratory tests and natural outdoor exposure.

For this study, the researchers selected eight coating systems—three three-coat systems consisting of organic, inorganic, and moisture-cured zinc-based primers; four two-coat systems with various combinations of zinc-based primers and organic top coats; and a single-coat system of calcium sulfonate alkyd.

The researchers chose these coating systems based on previous FHWA studies and past experience at the laboratory. In particular, earlier studies indicated that the two-coat systems might compare favorably with the high-performing legacy zinc-rich three-coat systems. Another FHWA study revealed that single-coat systems could meet requirements similar to the three-coat systems for

specialty applications such as overcoating and maintenance purposes.

Of the eight coating systems chosen for the study, two of the three-coat systems were used as controls, and the remaining six coating systems were selected for testing. The FHWA researchers devised names for the coating systems based on their chemical compositions, such as inorganic zinc primer/epoxy/aliphatic polyurethane, and referred to the coatings by their acronyms, in this case, IOZ/E/PU.

Preparing the Test Panels

The researchers used two types of test panels for the study. The first, described as type I, was a conventional 4- by 6-inch (10- by 15-centimeter) steel plate, rectangular in shape. Research staff also developed a new type of test panel, dubbed type II, to more closely simulate the detailing of steel bridge members. Each type II panel was an 18- by 18-inch (46- by 46-centimeter) square and had V-shaped and inverted T-shaped welded attachments, an overlap joint, an angle attachment, and five bolt-nut assemblies affixed to the panel.

The researchers prepped the steel substrates using white metal blast cleaning, according to a surface preparation standard (SSPC-SP5) prescribed by the Society for Protective Coatings. Next, they coated all of the type I test panels according to the manufacturers' recommendations for dry film thickness.

For the larger type II panels, the researchers identified three areas on each panel that would be coated with varying dry film thicknesses. The majority of each type II panel was coated according to the dry film thickness recommended by the manufacturer. This area was termed nominal. One 7- by 8-inch (18- by 20-centimeter) square area within each panel received a lower amount of coating, a dry film thickness 20 percent less than target dry film thickness. Another 7- by 8-inch (18- by 20-centimeter) square area received a higher percentage of coating, a dry film thickness 20 percent greater than the target.

A Variety of Test Conditions

The researchers tested the panels under three types of conditions: accelerated laboratory testing, outdoor exposure testing at TFHRC, and outdoor exposure testing at the Golden Gate Bridge in San Francisco, CA.

Accelerated laboratory testing. The researchers performed accelerated laboratory tests consisting of 360-hour-long cycles that included three types of exposure: freezing, ultraviolet/condensation, and prohesion (related to protection and adhesion of protective coatings under certain corrosion test methodologies). The tests were carried out for 300 days, consisting of 20 cycles. The researchers examined the panels upon completion of every cycle and also at the conclusion of the accelerated laboratory testing.

Outdoor exposure testing at TFHRC. For the outdoor testing in Virginia, the research team installed the type I and II panels on two wooden racks that were inclined at 30 degrees and faced toward the south. To simulate natural weathering, all panels were left to weather outdoors. The researchers also designed an automatic system with a timer to dispense salt spray for a short period every 24 hours, which allowed for simulating natural weathering with salt spray.

Outdoor exposure testing at the Golden Gate Bridge. San Francisco's severe fog conditions and airborne chlorides create a harsh climate for steel structures, making the Golden Gate Bridge an ideal location for this study.

"This bridge is exposed to a number of microclimates because temperatures, wind speeds, and fog conditions can change within a fraction of a mile," says Dennis Dellarocca, paint superintendent for the Golden Gate Bridge.

As at TFHRC, researchers placed the type I and II panels on wooden racks inclined at 30 degrees. The racks were deployed on top of the south anchorage house near the south abutment of the Golden Gate Bridge. The research team evaluated the test panels every 6 months to assess coating performance.

Characterization Tests and Evaluation Techniques

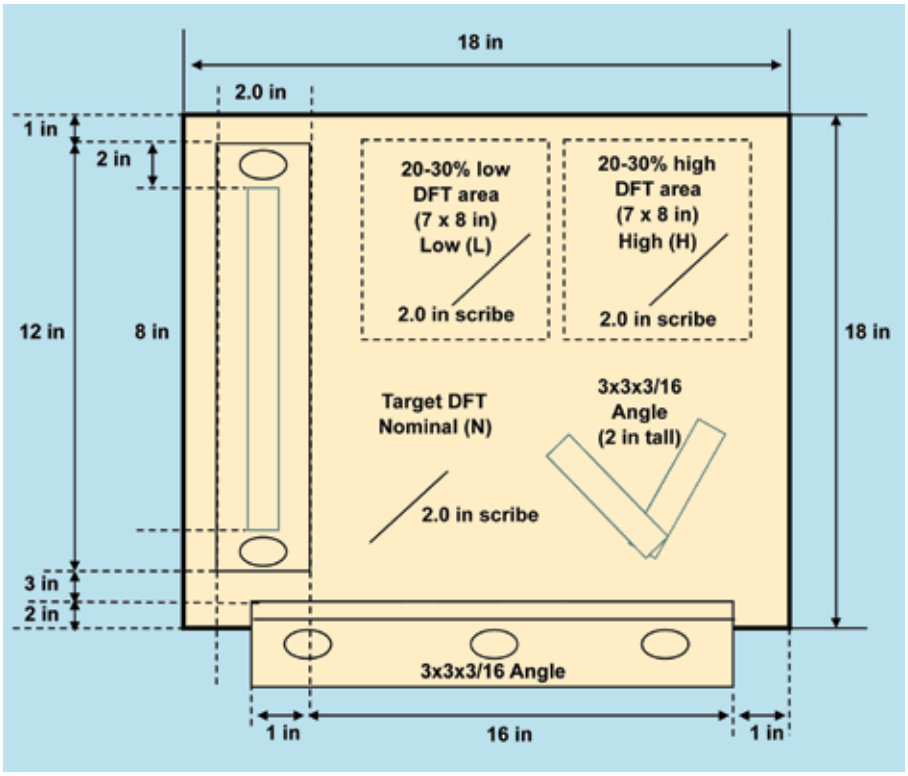
A series of tests helped characterize the performance of the coatings

Summary of Coating Systems

System ID	Acronym	Generic Coating Name
3-coat (control)	IOZ/E/PU	Inorganic zinc primer/epoxy/aliphatic polyurethane
3-coat (control)	ZE/E/PU	Zinc-rich epoxy primer/epoxy/aliphatic polyurethane
3-coat	MCU/E/F	Moisture-cured urethane zinc primer/ epoxy/fluorourethane
2-coat	ZE/PU	Zinc-rich epoxy primer/aliphatic polyurethane
2-coat	Zn/PS	Inorganic zinc primer/polysiloxane
2-coat	TSZ/LE	Thermally sprayed zinc primer/linear epoxy
2-coat	ZnE/LE	Experimental zinc primer/linear epoxy
1-coat	HRCSA	High-ratio one-coat calcium sulfonate alkyd

SK Lee

The research team developed the type II test panel, shown here, to assess how the coatings performed on typical components of a steel bridge, such as V-shaped welded attachments, angle attachments, and bolt-and-nut assemblies.



This diagram of the type II panel used in the study shows the dimensions of the various features and the locations of the scribes etched into the three areas with different coating dry film thicknesses (DFT). *Source: FHWA.*

on the panels before, during, and after the accelerated laboratory testing and outdoor exposure tests. In particular, the researchers looked at characteristics including color, gloss, dry film thickness, and adhesion strength. They also employed a technique known as Fourier transform infrared spectroscopy, which helps identify the chemical composition of paint coatings and metal surfaces. Further, they reviewed the samples to detect any discontinuities, such as pinholes, voids, cracks, thin spots, or contaminants in the coating film.

Specifically, the researchers evaluated the performance of the eight coating systems under the four test conditions—accelerated laboratory testing, natural weathering with and without salt spray at TFHRC, and natural weathering at the Golden Gate Bridge—according to several parameters. Those include gloss reduction, change of color, change of adhesion strength, development of surface defects, and growth of rust creepage at the scribe. (A scribe is a line scratch made with a cutting tool through the overcoat surface down to the steel substrate to simulate defects in the paint coating.)

How the Coatings Stood Up

In tests of this type, reductions in color and gloss are typically regarded as changes in the physical properties of a coating system. Changes in adhesion strength, the development of coating defects, and creep from the scribe are generally seen as indicators of the performance of a coating system in an exposure condition.

Results in gloss reduction/color change. Two two-coat systems (thermally sprayed zinc primer/linear epoxy and experimental zinc primer/linear epoxy) and the one-coat system (high-ratio one-coat calcium sulfonate alkyd) demonstrated the greatest gloss reduction. Both of the two-coat systems failed prematurely due to significant loss in color and gloss, and both had the same linear epoxy topcoat.

The two coating systems that exhibited the fewest gloss changes after tests were moisture cured urethane zinc primer/epoxy/fluorourethane (a three-coat system) and inorganic zinc primer/polysiloxane (another two-coat system). The three-coat control systems (inorganic zinc primer/epoxy/aliphatic polyurethane and zinc-rich epoxy primer/epoxy/aliphatic polyurethane) exhibited less than 30 percent gloss reduction after tests. Type II panels in natural weathering tended to show the greatest gloss reduction among all the coating systems.

The one-coat system (high-ratio one-coat calcium sulfonate alkyd) exhibited the most dramatic change

Pradeep Kodumuri, Henkel Corporation

The FHWA researchers installed the test panels on this angled wooden rack on the TFHRC grounds. As shown here, a spray mechanism periodically shot saltwater onto the panels to simulate natural weathering with salt exposure.

in color, ranging from a 2.7 percent change observed in the type I panels under accelerated laboratory testing to nearly 12 percent in the type II panels under natural weathering with salt spray. Two of the two-coat systems (thermally sprayed zinc primer/linear epoxy and experimental zinc primer/linear epoxy) also showed noticeable changes in color, ranging from about 3 percent to 4.5 percent across all samples and testing sites. These three coating systems also demonstrated the greatest gloss reductions.

The others exhibited less than 2 percent color changes after the tests. Because of scattered data among the different test conditions, the effects of salt spray and the type of test panel on color change were inconclusive, except that most coating systems exhibited the least percentages of color change under accelerated laboratory testing.

Accelerated Laboratory Testing of Type I Panels

Item	Freeze Exposure (Hours)	Ultraviolet/ Condensation Exposure (Hours)	Prohesion Exposure (Hours)	Total Exposure (Hours)
Each Cycle	24	168	168	360
Target Duration (20 Cycles)	480	3,360	3,360	7,200

Results in adhesion strength and surface defects. Except for the high-ratio one-coat calcium sulfonate alkyd and moisture-cured urethane zinc primer/epoxy/fluorourethane, all of the two-coat systems, including the controls, showed varying degrees of reduction in the adhesion strength at the end of testing in every test condition. The researchers did not observe a clear trend between reduction of adhesion strength and test conditions. Further, they were unable to obtain data on adhesion strength for the thermally sprayed zinc primer/linear epoxy coating at the end of the accelerated laboratory testing because the coating surface had become blistered.

The two-coat experimental zinc primer/linear epoxy panels showed the greatest reduction in adhesion strength. Both two-coat systems—thermally sprayed zinc primer/linear epoxy and experimental zinc primer/linear epoxy—which showed high variations in gloss and color, also suffered from the largest reductions in adhesion. The two control coatings (inorganic zinc primer/epoxy/aliphatic polyurethane and zinc-rich epoxy primer/epoxy/aliphatic polyurethane) and the zinc-rich epoxy primer/aliphatic polyurethane revealed the least amount of loss in adhesion strength. The other two-coat system, inorganic zinc primer/polysiloxane, showed a moderate loss (less than 40 percent) in adhesion strength.

Although the initial assessment of all coating systems showed no defects or evidence of invisible discontinuities on the surface, the accelerated laboratory testing resulted in severe surface deterioration as indicated by blistering, rusting, and cracking.

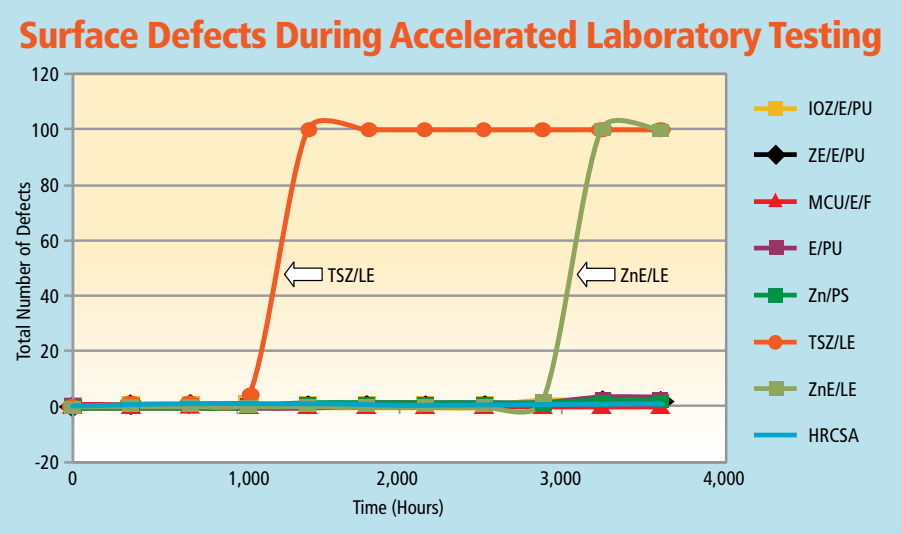
The two-coat thermally sprayed zinc primer/linear epoxy coating developed four defects after 1,080 hours (or 45 days) of accelerated laboratory testing, and the number of defects increased dramatically

Pradeep Kodumuri, Henkel Corporation

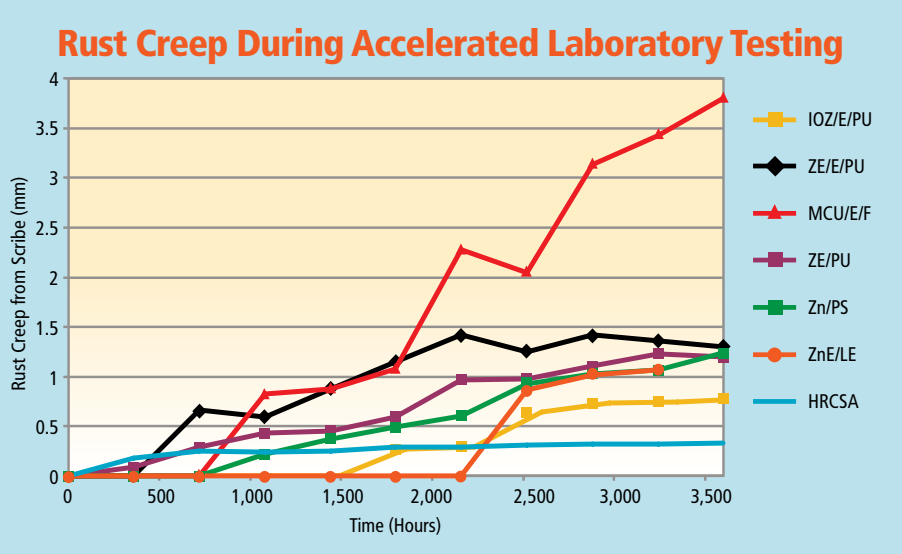
Type I (top row) and II (bottom rows) panels displaying a variety of coating types were arrayed on this rack for natural weathering testing at TFHRC in McLean, VA.

SK Lee

These coated type II panels were deployed at the Golden Gate Bridge.



As shown here, the thermally sprayed zinc primer/linear epoxy (TSZ/LE) and zinc-rich epoxy/linear epoxy (ZnE/LE) coatings applied to type I panels developed a high number of surface defects after 1,080 and 2,880 hours of accelerated lab testing, respectively. *Source: FHWA.*



After 3,500 hours of accelerated laboratory testing, the researchers found that the MCU/E/F coating showed the most rust creepage at the scribe. *Source: FHWA.*

after 1,440 and 1,800 hours (60 and 75 days) of testing. Following the appearance of the defects, excessive blistering, which covered more than 50 percent of the surface area, and cracking of the surface developed. The zinc-rich epoxy/linear epoxy coating showed no defects until 2,880 hours (120 days) of testing, followed by progressive changes leading to surface microcracks, which transformed into macrocracks. The three-coat moisture-cured urethane zinc primer/epoxy/fluorourethane coating did not develop any defects, while other coating systems developed only minimal coating defects (less than 1 percent of the surface area) upon completion of the accelerated laboratory testing at 3,600 hours (150 days).

Most of the type I panels did not develop any defects during outdoor exposure in natural weathering and natural weathering with salt spray. However, the thermally sprayed zinc primer/linear epoxy coating exhibited defects covering more than 80 percent of the surface area on most of the type I panels under natural weathering and natural weathering with salt spray.

Rust Creepage by Coating System

Coating System	Rust Creepage (mm)
HRCSA	0.3
IOZ/E/PU	0.8
ZnE/LE	1.2
ZE/PU	1.2
Zn/PS	1.2
ZE/E/PU	1.3
MCU/E/F	3.8

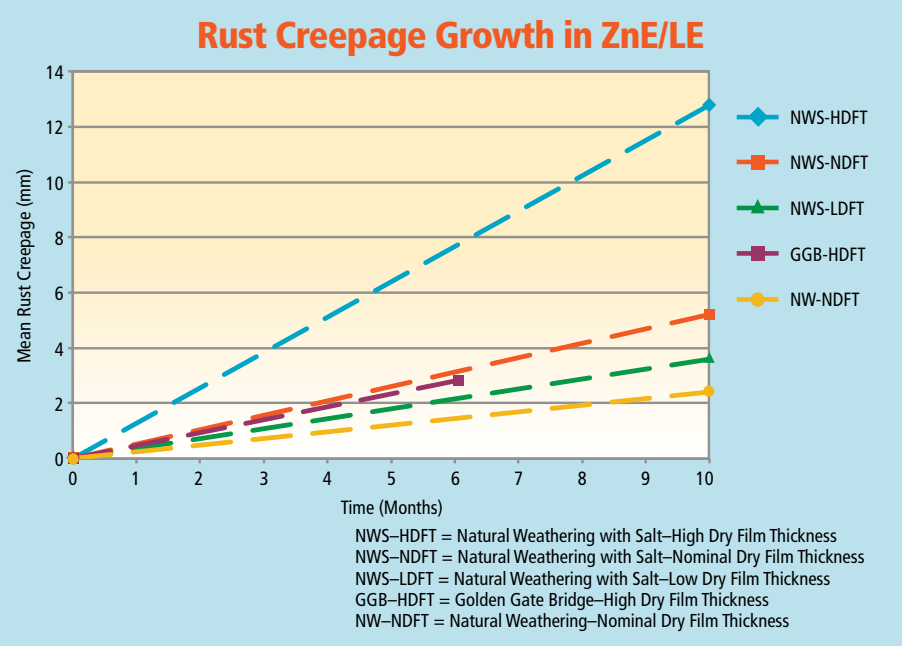
The experimental zinc primer/linear epoxy coating developed a few defects (less than 1 percent of the surface area) in the type II panels during both natural weathering and natural weathering with salt spray after 10 months of outdoor testing.

Type II panels also showed coating defects in areas such as nuts, bolts, the underside of the T-attachment, and the wide-angle attachment. The crevices and cracks at these joints are difficult to paint compared to flat metal surfaces. As expected, these defects became rust spots.

This finding confirms that it is difficult to avoid initial coating defects from applications on bridge structures in the field because of the complex shapes of the structural elements. Thus, these imperfect sites are then prone to advanced coating failures and subsequent steel corrosion in service environments.

Results in rust creepage from the scribe during accelerated laboratory testing. The researchers measured creep in millimeters from the scribe and calculated it as an average value over the creep area. Based on the mean creepage values at the end of 3,600 hours (150 days) of accelerated laboratory testing, the researchers ranked the coating systems from highest to lowest in terms of rust creepage.

The high-ratio one-coat calcium sulfonate alkyd coating showed the lowest amount of creep, which means it was the best performing coating system for creepage in the lab, while the moisture-cured urethane zinc primer/epoxy /fluorourethane coating demonstrated the worst creepage.



This graph plots the growth of rust creepage on the type II panels with the experimental zinc primer/linear epoxy (ZnE/LE) coating. The researchers concluded that due to the high level of rust creepage, around 0.51 inch (13 millimeters), a high dry film thickness is not recommended for applications using the experimental zinc primer/linear epoxy coating. *Source: FHWA.*

Results in rust creepage from the scribe during natural weathering and natural weathering with salt spray. During the outdoor exposure testing, none of the type I panels developed rust creepage during natural weathering or natural weathering with salt spray, except for the experimental zinc primer/linear epoxy coating, which had a low rust creepage of 0.16 inch (0.4 centimeter) at the end of the salt spray exposure.

For the type II panels, after 10 months of exposure testing in Virginia and 6 months of exposure at the Golden Gate Bridge, only the experimental zinc primer/linear epoxy coating system exhibited recognizable rust creepage. The portions of the panels with the higher percentage of dry film thickness, in particular, showed extremely high creepage—5.5 inches (14 centimeters)—under exposure to salt spray. Similarly, the nominal dry film thickness areas of the same panels showed creepage of about 0.23 inch (0.6 centimeter). The rest of the type II coating systems did not show any rust creepage.

Concluding Thoughts

After 3,600 hours (150 days) of accelerated laboratory testing, 10 months of natural weathering with and without salt spray exposure, and 6 months of outdoor exposure testing at the Golden Gate Bridge, the researchers reached the following conclusions. First, the test results from this study indicate that none of the selected coating systems, including the two three-coat control coatings, will provide maintenance-free corrosion protection to steel bridge structures for 100 years.

Premature failures of two of the two-coat systems—thermally sprayed zinc primer/linear epoxy and experimental zinc primer/linear epoxy—occurred in accelerated laboratory testing as well as outdoor exposure testing. Three of the coating systems—moisture-cured urethane zinc primer/epoxy/fluorourethane, zinc-rich epoxy primer/epoxy/aliphatic polyurethane, and inorganic zinc primer/polysiloxane—performed satisfactorily in some categories but poorly in others, compared to the best performers.

Further, the researchers concluded that high-performance coating technology, regardless of cost, is not ready at this time to deliver super-durable coating systems that can last more than 100 years without significant interventions for maintenance.

Until future research and development efforts produce coating systems with extended service life, the main goal should be to use the proven legacy three-coat systems correctly by reducing human errors and improper applications and following applicable specifications and manufacturers' literature.

Pradeep Kodumuri, Ph.D., is a senior research chemist at Henkel Corporation in Madison Heights, MI. He has experience with development, characterization, and evaluation of functional and protective coatings for many market segments. He has a Ph.D. in chemical engineering from Cleveland State University and an M.S. in chemical engineering from the University of Louisiana.

Seung-Kyoung Lee, Ph.D., is president of SK Lee & Associates in Fairfax, VA. Dr. Lee is the chair of the Transportation Research Board's Committee on Corrosion and also chair of the Bridge Steel Coatings subcommittee. He has a Ph.D. and M.S. in ocean engineering from Florida Atlantic University and a B.S. in naval architecture from Inha University in Korea.

Y. Paul Virmani, Ph.D., is a program manager with FHWA's Office of Infrastructure Research and Development. He has focused on reinforced and prestressed concrete and cable-stay bridge corrosion research for the last 30 years. Currently, he is responsible for research in the area of developing cost-effective corrosion protection systems for new construction and rehabilitation of existing salt-contaminated concrete bridges. Virmani has a Ph.D. from the University of Bombay (Mumbai), India, and an M.S. from the University of Rajasthan, India, both in physical chemistry.

For more information, contact Paul Virmani at 202-493-3052 or paul.virmani@dot.gov, Pradeep Kodumuri at 248-577-2056 or pradeep.kodumuri@henkel.com, or Seung-Kyoung Lee at 848-445-2977 or sk.lee2011@rutgers.edu. For the final report, visit www.fhwa.dot.gov/publications/research/infrastructure/structures/bridge/12044.

Along the Road

Along the Road is the place to look for information about current and upcoming activities, developments, trends, and items of general interest to the highway community. This information comes from U.S. Department of Transportation (USDOT) sources unless otherwise indicated. Your suggestions and input are welcome. Let's meet along the road.

Management and Administration

Administrator Mendez Celebrates Opening of DFW Connector

Federal Highway Administrator Victor Mendez joined State and local officials at the opening of the DFW Connector, a $1.1 billion transportation project designed to improve safety and navigation and minimize congestion around the Dallas/Fort Worth International Airport in Texas. The project received $260 million in Federal funding under the American Recovery and Reinvestment Act of 2009.

Texas Department of Transportation

The DFW Connector project improved highways and interchanges to increase safety and reduce delays around the Dallas/Fort Worth International Airport, including on State Highway 114, shown here.

The DFW Connector project involved reconstructing five highway interchanges to substantially reduce weaving and merging, making the interchanges safer for motorists. The project doubled the number of lanes and installed direct connect ramps where none previously existed. Without the ramps, motorists could have expected delays of up to 10 minutes at traffic signals in each direction. The project also featured managed toll lanes designed to keep traffic moving at 50 miles (80 kilometers) per hour at all times, as well as other roadway improvements that will reduce congestion for the 180,000 motorists traveling daily on State Highways 114 and 121 and other roads north of the airport.

The Texas Department of Transportation completed the project 9 months ahead of an already expedited 4-year schedule by using design-build contracting, which employs a single contractor for both design and construction. This project delivery method, encouraged by the Federal Highway Administration (FHWA) under its Every Day Counts initiative, reduced the timeline of the project by almost half compared to the timeline for the design-bid-build approach.

RITA Awards $63 Million in Research Grants

USDOT's Research and Innovative Technology Administration (RITA) announced approximately $63 million in grants to 33 University Transportation Centers (UTCs) to advance research and education programs that address critical U.S. transportation challenges.

UTCs conduct research that directly supports USDOT's priorities to promote the safe, efficient, and environmentally sound movement of goods and people. UTCs can be a single institution or a consortium of two or more nonprofit institutions of higher education led by one lead institution.

RITA received more than 140 applications for the program. The awarded grantees include five national UTCs, which address national transportation issues in line with USDOT's key strategic goals. These UTCs each received an award of $2.8 million. Eight regional UTCs, which focus on regional transportation needs, each received an award of $2.59 million. Twenty additional UTCs each received an award of $1.4 million.

UTCs work with regional, State, local, and tribal transportation agencies to help find solutions to challenges that directly affect their communities and the efficiency of the transportation system. The selected universities will research a wide range of issues. Some projects will look at ways to improve health and safety for all users of the transportation system, including bicyclists, pedestrians, and transit users. Others focus on reducing carbon emissions and other environmental impacts of transportation through a transition to zero-emission vehicles and fuels.

The complete list of grant recipients is available at www.rita.dot.gov/utc/about/grant_recipients/html/2013_grant_recipients.html. For more information about the UTC program, visit www.rita.dot.gov/utc.

RITA

Technical News

FHWA Releases Updated IHSDM Software

A new release of FHWA's Interactive Highway Safety Design Model (IHSDM) software, version 9.0.0, is now available. The software is a suite of analysis tools for evaluating the safety and operational effects of geometric design decisions. The new version provides an update to the Crash Prediction Module (CPM) to include freeway segments. The CPM faithfully implements the predictive method presented in Part C of the American Association of State Highway and Transportation Officials' *Highway Safety Manual*.

The updated module includes a beta version of crash prediction capabilities for freeway ramps, collector-distributor roads, and ramp terminals. These capabilities are based on draft *Highway Safety Manual* materials developed under the National Cooperative Highway Research Program's Project 17-45, "Enhanced Safety Prediction Methodology and Analysis Tool for Freeways and Interchanges." The CPM also covers two-lane rural highways, multilane rural highways, urban and suburban arterials, and freeway segments. The IHSDM includes five other evaluation modules applicable to rural two-lane highways: policy review, design consistency, intersection review, traffic analysis, and driver/vehicle.

The software is available for free download at www.ihsdm.org. For more information, contact Clayton Chen at 202-493-3054 or clayton.chen@dot.gov.

WSDOT's Delineator Pilot Project Aims to Improve Visibility and Safety

The Washington State Department of Transportation (WSDOT) will install state-of-the-art barrier delineators and LED shoulder and lane markers to enhance safety on I-90 over Snoqualmie Pass. The department received a grant for the project from FHWA's Highways for LIFE program in 2012. WSDOT officials believe that the new delineators will improve visibility and safety during low-light times and also require less frequent repair and replacement than older systems.

Roadway markings on this section of I-90 pose an ongoing maintenance challenge. Nearly 29,000 vehicles a day travel over the pass, which is a strategic freight corridor carrying a high percentage of trucks. The annual average snowfall at the summit is more than 36 feet (11 meters). In addition to rain and snow obscuring roadway visibility, plows, studded tires, and tire chains cause heavy wear on pavement striping.

Collisions during low-light times of the day account for more than 40 percent of the total crashes in the Snoqualmie Pass area. More than 75 percent of those low-light crashes occur from late fall to early spring, when lane delineation is most critical.

To better demarcate the pavement edge, WSDOT will use delineators made of reflective signing material mounted on thin aluminum plates bolted onto the concrete barriers along the roadway. These will be installed for 7 miles (11 kilometers) on both sides of the interstate and in the median.

To improve shoulder delineation, the department will recess solar-powered LEDs into the pavement of the shoulders and on median barriers in both directions. WSDOT also will install the LEDs along a half-mile (0.8-kilometer) test section of the eastbound interstate, placing them between the lanes to delineate the stripes as well as along the concrete shoulder barrier.

The project's goal is to reduce the 3-year average rate of fatalities and injuries on the treated section of I-90 by 20 percent. WSDOT will assess the effectiveness of the two delineation systems, including conducting a collision analysis, for use in difficult or complex detours and work zones around the State.

WSDOT

Public Information and Information Exchange

Report Ranks States with the Busiest Highways

FHWA recently released a report on the Nation's busiest interstates that shows that motorists drove more than 84.7 billion miles (136.3 billion kilometers) on California highways in 2011—more than 900 times the distance from Earth to the Sun—making the Golden State's highways the Nation's most heavily traveled. Overall, vehicles traveled 2.95 trillion miles (4.75 trillion kilometers) on U.S. roads in 2011—the eighth-highest level ever recorded, and nearly double the amount traveled in 1980.

Caltrans

California's I–5, shown here, was the Nation's busiest interstate in 2011.

Traffic volume data from 2011, the most recent available, show that I-5 in California was the busiest interstate that year, with 21.4 billion miles (34.3 billion kilometers) traveled. California's neighboring I-10 and I-110 followed as the second and third busiest interstates, respectively. Los Angeles' section of the I-405 serves an estimated 379,000 vehicles per day, making it the busiest interstate in any U.S. city.

Texas highways were the second most heavily traveled, with drivers logging more than 55.7 billion miles (89.6 billion kilometers) in 2011, followed by Florida at 34.7 billion miles (55.8 billion kilometers) and Ohio at 31.4 billion miles (50.5 billion kilometers). Illinois, Georgia, New York, Virginia, Pennsylvania, and North Carolina, respectively, round out the top 10.

"Data like these help us better understand the highway system and its needs," says Federal Highway Administrator Victor Mendez. "Analysis of the Nation's traffic patterns and areas of changing traffic volume will lead to safer, less congested roads and greater mobility for all Americans."

FHWA's Highway Performance Monitoring System computes data on miles traveled for all interstates and highways. These data are based on thousands of automatic traffic recorders operated around the clock by State departments of transportation (DOTs). More comprehensive data are published annually in FHWA's "Highway Statistics."

To see a complete list of the data, organized by State and interstate, visit FHWA's "U.S. Interstate Traffic Volume Analysis" Web page at www.fhwa.dot.gov/interstatebrief2011.

Annual Campaign Against Drunk Driving Focuses on Victims

The National Highway Traffic Safety Administration's (NHTSA) 2013 Drive Sober or Get Pulled Over campaign against drunk driving included a special focus on victims. NHTSA data show that every 3 hours in the United States, a drunk-driving crash claims the life of someone who was not driving drunk.

NHTSA

NHTSA supported its Drive Sober or Get Pulled Over campaign using television ads like this one, which shows an inebriated driver about to get behind the wheel. Later in the video, the driver is pulled over by law enforcement for drunk driving.

Nearly 10,000 people died in 2011 in drunk-driving crashes, according to NHTSA data. That's 27 people a day. More than one-third of those fatalities—3,371 people—were victims who were not the drunk driver. Of those victims, 1,612 were passengers in a drunk driver's vehicle, many of them too young to drive, including 91 children under the age of 15 years old. Another 1,049 were traveling in other vehicles involved in a crash with a drunk driver. And 710 victims were pedestrians or bicyclists. The remaining 6,507 deaths in 2011 were the drunk drivers themselves.

From August 16 to September 2, 2013, more than 10,000 police departments and law enforcement agencies across the country were out in force to crack down on impaired drivers in support of the Drive Sober or Get Pulled Over campaign. NHTSA launched a $14 million national advertising campaign to encourage vigilance and raise awareness of the enforcement efforts.

For more information and to view the Drive Sober or Get Pulled Over television ads, visit www.nhtsa.gov /drivesober.

NHTSA

AASHTO Presents Winners Of Photography Competition

The American Association of State Highway and Transportation Officials (AASHTO) announced the winners of its ninth annual Faces of Transportation photography contest. The national competition challenges State DOT employees and private citizens to photograph people and projects that are making communities better, while emphasizing the importance of transportation.

The theme for the 2013 competition was "A Snapshot of Transportation in America," which included three new categories: Building the Future, Opening Communities, and Taking the Road Less Traveled. Entry guidelines encouraged submitters to prominently feature people designing, constructing, using, and enjoying the Nation's transportation systems. AASHTO called for images to represent the positive effects that all modes of transportation have on individuals and communities. Twenty-eight DOT employees from 21 States and 6 private citizens submitted 121 photographs.

Connie Rus, an accomplished photographer and graphic designer based in Washington State, judged the submissions. Rus selected one State DOT and one private

Caltrans

AASHTO presented the People's Choice Award in its Faces of Transportation photography contest to photographer Bill Hall, who captured this image of a Caltrans engineer inspecting the cable band installation near the top of the San Francisco–Oakland Bay Bridge. The image also received an award for State DOT submissions in the competition's Building the Future category.

Georgia DOT

Georgia DOT photographer Cedric Mohr received the State DOT award in the Opening Communities category in AASHTO's Faces of Transportation photography contest. His winning photograph, shown here, depicts a technician inspecting a traffic signal in District 7 on the south side of Atlanta.

citizen as winners in each category, and also chose one photograph as the grand prize winner. In addition, visitors to the competition's Web site voted for a People's Choice Award winner.

The grand prize and People's Choice award-winning photographs both feature laborers at work on prominent sections of the San Francisco–Oakland Bay Bridge and were submitted by the California Department of Transportation (Caltrans). The People's Choice winner also received a category award. Other category winners include submissions by DOTs in Alaska and Georgia. Three private photographers won category awards with images from California and West Virginia.

For more information and to view the winning photos and other submissions, visit http://facesoftransportation.org.

AASHTO

Washington, British Columbia Host All Electric Vehicle Rally

In June 2013, a dozen electric vehicle owners converged near the U.S.–Canada border to begin a 1,500-mile (2,414-kilometer), 9-day road trip to Mexico using only electric power. Marketed as the BC2BC (British Columbia to Baja California) All Electric Vehicle Rally, the event symbolically connected the charging networks along the West Coast Green Highway, which stretches from the Canadian border through Washington State, Oregon, and California to the Mexican border.

Organizers dubbed the rally's kickoff the "Golden Plug" celebration to recall the ceremonial Golden Spike that signaled the completion of the first transcontinental railroad

WSDOT

An electric vehicle taking part in the BC2BC rally gets a quick charge from a roadside assistance truck during the kickoff celebration in Washington State.

in North America. Washington State Deputy Secretary of Transportation Cam Gilmour and Parliamentary Secretary to the British Columbia Premier for Intergovernmental Affairs Norm Letnick spoke at the event. Attendees had the opportunity to test drive the electric vehicles and talk with the rally drivers before the cars set off on their journey.

BC2BC organizer Tony Williams, along with his 10-year-old daughter, completed the same 9-day trip in an electric vehicle in June 2012. That experience led to the creation of BC2BC, an invitational rally that Williams hopes will turn into an annual event highlighting the Nation's early investment in electric vehicle transportation.

For more information on the West Coast Green Highway, visit www.westcoastgreenhighway.com.

WSDOT

Internet Watch

by Gordon J. Delcambre, Jr.

Mobile Apps Bring Flexibility To Emergency Response

When responding to highway incidents involving hazardous materials, such as a gasoline spill, time is of the essence. Fast action is often critical to minimizing hazards, but emergency personnel must take time to gather enough information about the situation to ensure an appropriate response. To help, the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) publishes a crucial resource for responders called the *Emergency Response Guidebook* (ERG).

In 2012, PHMSA published an updated version of the ERG that includes new evacuation tables for large toxic gas spills and standard response procedures for gas and liquid pipeline incidents. The agency also released a free mobile application that makes accessing the ERG's information at the scene easier than ever.

A Mobile ERG

The ERG provides the Nation's emergency responders with fast, easily accessible information to help them manage incidents involving hazardous materials. PHMSA produced the app version of the ERG jointly with the U.S. Department of Health and Human Services' National Library of Medicine. The app enables firefighters, police, and other emergency first responders to quickly locate the information they need using an electronic word search function, and ensures easy reading even during nighttime emergencies.

"The first 30 minutes are the most crucial when it comes to responding to a hazmat situation," says PHMSA Administrator Cynthia Quarterman. "The app is both mobile and flexible, and gives first responders the knowledge they need to protect themselves and their communities in an emergency."

The home screen features four main menu options: Search by Identifier, Search by Image, Browse Guide Pages, and Reference Material. The search functions enable responders to look up hazardous materials by shipping name, identification number, or placard image. (Placards are diamond-shaped signs posted on hazmat containers that help responders identify the types of materials being transported.) Users can browse the guide pages, which are listed in numerical order. Reference materials, which appear as white and green pages in the printed version, also are listed in the order in which they appear in the ERG. Users can zoom in for a closer look at all of the guide pages and reference materials, including tables highlighting recommendations for initial isolation and protective action distances.

Helping to Make WISER Decisions

The 2012 ERG mobile app is available as part of recent updates to the National Library of Medicine's Wireless Information System for Emergency Responders (WISER). The system is designed to assist first responders with incidents involving hazardous materials by providing a wide range of information on substance identification, physical characteristics, human health, and mass casualty response, as well as advice on containment and suppression.

Screen captures from the 2012 ERG mobile app.

WISER may be downloaded as an app on a variety of mobile devices and platforms, including Apple® iPad® and iPod touch®, Android™ devices, Microsoft® Windows® mobile devices, and Palm® and BlackBerry® units, as well as desktop computers and laptops. A Web-based version of the software called WebWISER is available at http://webwiser.nlm.nih.gov.

The ERG mobile app "provides essential tools to help first responders safely address hazmat incidents," says Chief Ernest Mitchell, head of the Federal Emergency Management Agency's U.S. Fire Administration. "I always found the ERG to be extremely valuable, and I believe that a copy should be in every emergency response vehicle and in the hands of every first responder in America."

For more information and links to download the ERG app, visit the "Important Documents and Resources" section at www.phmsa.dot.gov /prepare-respond.

Gordon J. Delcambre, Jr., is a senior public affairs specialist with PHMSA.

by Nicole Markisohn

Free Webinar Series Offers Practical Solutions

Practical solutions to help field personnel do their jobs more effectively day to day are an essential component of efforts to train the current and future transportation workforce. The National Highway Institute (NHI) developed the Real Solutions seminar series to facilitate the quick and effective transfer of industry knowledge among transportation professionals. The series consists of webinars covering topics that have included road safety audits, roadway tunnel design, evacuation planning, and bridge preservation.

Real Solutions launched as a collection of articles in 2007, and then became a free series of monthly webinars in 2008. "We recognized a need for a national forum where transportation professionals could discuss their experiences solving problems in the field at the State and local level with the broader transportation community," says Rick Barnaby, director of training at NHI. "Innovative problem-solving is happening every day, and now through the Real Solutions seminar series, we have a venue for that information to be shared."

Cutting-Edge Information from Industry Experts

Each webinar is available at no cost to participants and features leading national experts presenting cutting-edge industry information. A recent webinar, for example, outlined changes to the bridge design specifications regarding drilled shaft foundations that were approved by the American Association of State Highway and Transportation Officials Subcommittee on Bridges and Structures just a week before the webinar took place.

Presenters also provide real-world examples from their experiences in the field, detailing how to develop and implement solutions. A webinar called "Performing Pre-Construction Phase Road Safety Audits (RSAs)" demonstrated the positive impact of pre-construction audits by reviewing a case study of a proposed improvement to a California roadway. This proposed improvement included the addition of a complex merge. By conducting a pre-construction audit, planners were able to determine that improved guide signs were critical to the safety performance of the roadway.

By enabling experts to deliver information directly to a nationwide network of transportation professionals, the Real Solutions seminar series helps ensure that the transportation workforce is kept up to date on key advances in their fields.

The seminar held in June 2013, "Innovations in Non-Destructive Testing for Deep Foundations [Thermal Integrity Profiler] TIP," featured a state-of-the-art testing method for drilled or bored deep foundation elements. The presenter was an engineer who helped design and develop the testing equipment. In addition to discussing the new testing method, the presenter explained the advantages and disadvantages of other testing methods and answered attendees' questions about the practical application of each method.

NHI

Real Solutions webinars, like this one on performing pre-construction phase RSAs, are recorded and available for free on the NHI Web site.

Connecting Transportation Professionals

Conducted as Web-conference trainings, the webinars create a two-way channel of communication and enable subject matter experts to interact directly with transportation professionals across the country. The webinars also are widely accessible—anyone with a telephone and a Web browser that supports Adobe® Flash® can participate. A recent Real Solutions seminar connected more than 130 transportation professionals from a variety of backgrounds and organizations to discuss the practical application of a new modeling technology that provides 3-D design visualization for RSAs.

Real-time poll and chat capabilities engage attendees in the seminar content, enabling the presenter to respond to questions and discuss information most relevant to the audience. This direct line of communication ensures that attendees have the opportunity to solicit the information they need to apply in their day-to-day activities in the field.

Recordings of previous webinars, including discussions and question and answer sessions, are available on the NHI Web site at www.nhi.fhwa.dot.gov/about/realsolutions.aspx. To register for upcoming webinars, visit the Web Conferencing Event Calendar at www.nhi.fhwa.dot.gov/resources/webconference/eventcalendar.aspx.

Nicole Markisohn is a contractor for NHI.

Intelligent Transportation Systems (ITS)

ePrimer

Build your knowledge and expertise in ITS with a new, easy-to-use, FREE Web resource.

Photos courtesy of Thinkstock.

The *ITS ePrimer* provides transportation professionals, educators, students, and others with a series of up-to-date, Web-based modules describing key ITS topics, with a multimodal perspective.

- **Up-to-date, comprehensive information on ITS fundamentals**
- **Interactive Web links and videos**
- **ITS-focused modules and related slide presentations**
- **Free**
- **24-hour online access**

Web-Based Modules

- Introduction to ITS
- Systems Engineering
- Transportation Management Systems
- Traffic Operations
- Personal Transportation
- Freight, Intermodal, and Commercial Vehicle Operations
- Public Transportation
- Electronic Toll Collection and Pricing
- Supporting ITS Technologies
- Rural and Regional ITS Applications
- Sustainable Transportation
- Institutional Issues
- Connected Vehicles
- Emerging Issues

Keep pace with rapidly advancing transportation technology. Expand your knowledge at:

www.pcb.its.dot.gov/ePrimer.aspx

U.S. Department of Transportation

Communication Product Updates

Compiled by Lisa Jackson of FHWA's Office of Corporate Research, Technology, and Innovation Management

Below are brief descriptions of communications products recently developed by the Federal Highway Administration's (FHWA) Office of Research, Development, and Technology. All of the reports are or will soon be available from the National Technical Information Service (NTIS). In some cases, limited copies of the communications products are available from FHWA's Research and Technology (R&T) Product Distribution Center (PDC).

When ordering from NTIS, include the NTIS publication number (PB number) and the publication title. You also may visit the NTIS Web site at www.ntis.gov to order publications online. Call NTIS for current prices. For customers outside the United States, Canada, and Mexico, the cost is usually double the listed price. Address requests to:

National Technical Information Service
5301 Shawnee Road
Alexandria, VA 22312
Telephone: 703–605–6000
Toll-free number: 1–888–584–8332
Web site: www.ntis.gov
Email: customerservice@ntis.gov

Requests for items available from the R&T Product Distribution Center should be addressed to:

R&T Product Distribution Center
Szanca Solutions/FHWA PDC
13710 Dunnings Highway
Claysburg, PA 16625
Telephone: 814–239–1160
Fax: 814–239–2156
Email: report.center@dot.gov

For more information on R&T communications products available from FHWA, visit FHWA's Web site at www.fhwa.dot.gov, the FHWA Research Library at www.fhwa.dot.gov/research/library (or email fhwalibrary@dot.gov), or the National Transportation Library at ntl.bts.gov (or email library@dot.gov).

Composite Behavior of Geosynthetic Reinforced Soil Mass (Report) Publication Number: FHWA-HRT-10-077

Geosynthetic reinforced soil (GRS) structures, such as retaining walls, embankments, and load-bearing foundations, have gained popularity in the United States and abroad for their distinct advantages over conventional structures. For example, GRS structures typically are more tolerant to differential settlement and seismic loading and easier and more cost effective to construct.

This report highlights a study that investigated the composite behavior of a GRS mass. One of two elements that make up a GRS wall, the mass consists of compacted soil reinforced with geosynthetic material. Researchers have conducted many studies on the behavior of GRS structures, but the interaction between the soil and geosynthetic reinforcement in a GRS mass has not been fully examined.

Current design concepts hold that the reinforcement material's strength and the spacing between reinforcements contribute equally to the performance of a GRS structure. This has encouraged designers to use stronger reinforcement at greater intervals to reduce time and effort in construction.

Researchers at the University of Colorado Denver, in collaboration with FHWA, conducted a series of tests on a large-size generic soil geosynthetic composite to examine the behavior of a GRS mass under well-controlled conditions. The tests clearly demonstrated that reinforcement spacing has a much stronger effect than reinforcement strength on the performance of the GRS mass. The researchers established an analytical model to describe the relative contribution of reinforcement strength and reinforcement spacing. Based on the model, they developed an equation to calculate the load-carrying capacity of a GRS mass and verified the equation using data from their tests and experiments by other researchers. The full results of this study are incorporated in the guidance outlined in the *Geosynthetic Reinforced Soil Integrated Bridge System Interim Implementation Guide* (FHWA-HRT-11-026) for the integrated bridge system.

This report is available to download at www.fhwa.dot.gov/publications/research/infrastructure/10077/index.cfm. Printed copies are available from the PDC.

Field Evaluation of a Restricted Crossing U-Turn Intersection (TechBrief) Publication Number: FHWA-HRT-12-037

A restricted crossing U-turn (RCUT) intersection is a promising treatment used to minimize right-angle crashes where two-lane minor roads intersect with rural four-lane divided highways. This TechBrief compares the operations of an unsignalized RCUT intersection in Maryland with a roughly comparable conventional stop-controlled intersection on the same corridor. It also summarizes the results of several crash analyses for intersections converted from conventional designs to RCUT designs along two four-lane divided highway corridors in Maryland.

The researchers found that fewer traffic conflicts occurred at the RCUT intersection, which eliminates

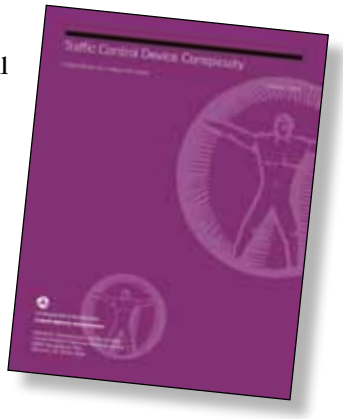
conflicts between vehicles turning left off the highway and vehicles from the minor road turning left onto the highway. The RCUT design that directed left-turning and through traffic from the minor road to turn right and travel to a directional U-turn crossing added about 1 minute to total travel time. Although acceleration lanes are not an intrinsic part of the RCUT design, they were part of the design at the RCUT observed in this study. Drivers who made left or through movements from the minor road appeared to make effective use of them.

Crash analyses, including a 3-year before-and-after study, suggest a decrease in the average number of crashes per year of between 28 percent and 44 percent. The data also suggest that the overall severity of crashes that occurred was lower with the RCUT design than with a conventional stop-controlled intersection. The researchers observed a 9-percent reduction in the proportion of crashes that result in injuries or fatalities.

The observational data and the crash analyses indicate that the RCUT design offers a substantial safety benefit, while the travel time penalty is small. The researchers strongly recommend use of acceleration lanes for right turns and U-turns to reduce traffic conflicts and minimize the delay incurred while drivers wait for acceptable gaps in the mainline traffic.

This document is a technical summary of the report *Field Evaluation of a Restricted Crossing U-Turn Intersection* (FHWA-HRT-11-067). It is available to download at www.fhwa.dot.gov/publications/research/safety/hsis/12037/index.cfm. Printed copies are available from the PDC.

Traffic Control Device Conspicuity (Report)
Publication Number: FHWA-HRT-13-044



The conspicuity of a traffic control device refers to the probability that the device will be noticed. But there is no agreed-upon measure to determine conspicuity. Researchers have suggested various measures including eye fixations, recall, and verbal reports. However, conspicuity is not solely a property of the traffic control device itself; it must include consideration of the surrounding environment. For example, roadside vegetation, outdoor advertising, or location of placement could influence whether a motorist sees the device and is able to take appropriate action in a timely manner.

This report discusses four studies focused on the conspicuity of traffic control devices. Researchers examined the effect on driver behavior and performance of messaging features within the right-of-way in a variety of contexts. The team aimed to compile information to help develop evidence-based guidance supporting more effective communication to roadway users.

The first study used multidimensional scaling, a series of techniques used to identify key factors that characterize drivers' perceptions of the environments in which the control devices exist. The study revealed that two factors, clutter and predictability, characterized the roadway environments included in the research.

In the second study, researchers recorded drivers' eye glances to traffic control devices on a 34-mile (55-kilometer) drive. After passing selected control devices, the research team assessed driver recall of a device by asking the drivers to identify it. The study demonstrated that warning signs are seldom glanced at and only about half of them are recalled just 2 seconds after they are passed. About 20 percent of speed limit signs received glances, but drivers were aware of the posted speed limit about 80 percent of the time.

The third study examined drivers' ability to detect speed limit and warning signs. Researchers found that cluttered backgrounds reduced motorists' ability to detect speed limit signs, but the detectability of fluorescent yellow-green warning signs was not affected by background clutter.

The fourth study examined the effect of background environment on drivers' ability to read traffic control devices. Researchers discovered the background had no effect on the readability of speed limit signs and had a small effect on the readability of warning signs.

To fully understand the influence of environment in detection and awareness of traffic control devices, more research is necessary. Multidimensional scaling could be a useful tool in that effort, but other methods of characterizing the environment also are warranted.

This report is available to download at www.fhwa.dot.gov/publications/research/safety/13044/index.cfm. Printed copies are available from the PDC.

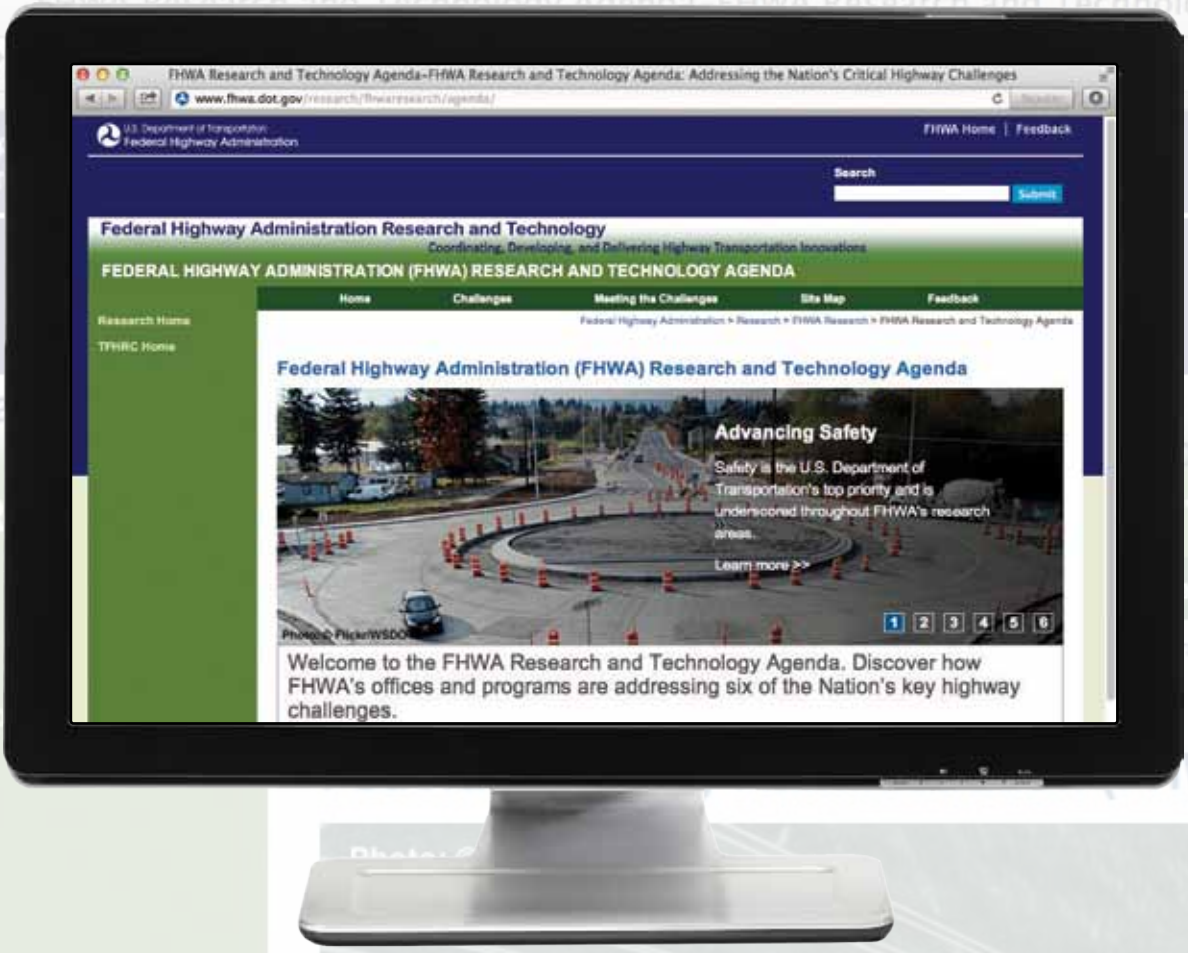
Reporting Changes of Address

PUBLIC ROADS has two categories of subscribers. One includes the organizations and people who receive the magazine without charge; the editorial office of the magazine maintains the mailing list for this group. The other category is the group of people and companies that pay to receive the magazine; the mailing list for this group is maintained by the Superintendent of Documents for the U.S. Government Printing Office.

Free copies are distributed to offices of the Federal Highway Administration, State highway agencies, technology transfer centers, and selected leaders who have responsibility for highway-related issues. Most of these copies are mailed to offices for their internal distribution or to people by position title rather than by name. If any office or individual subscriber in this category has a change of address, please send the complete previous mailing address and the complete new address to our distribution manager, Paula Magoulas, via email (paula.magoulas@dot.gov), telephone (202–493–3398), or mail (Paula Magoulas, PUBLIC ROADS Distribution Manager (HRTM), Federal Highway Administration, 6300 Georgetown Pike, McLean, VA, 22101-2296).

Paid subscribers who have an address change should notify the U.S. Government Printing Office, Claims Office, Washington, DC, 20402; or call 202–512–1800; or fax 202–512–2168. Please do not send an address change for a paid subscription to the editorial office of PUBLIC ROADS. We do not manage the paid subscription program or mailing list, and we are not able to make the requested change.

Collaboration.
Solutions.
Results.



Introducing the R&T Agenda

The Federal Highway Administration's (FHWA) Research and Technology (R&T) Agenda provides a window into how the agency is addressing national transportation challenges. FHWA created the R&T Agenda to achieve the following goals:

- Provide a high-level overview of and context for FHWA's R&T activities
- Share the FHWA R&T story, including what the agency is doing and why
- Improve transparency of the R&T portfolio to stakeholders
- Highlight the crosscutting work of FHWA offices and programs

Check it out!

Visit the site. Review the priorities. Share your feedback.

Do it all at www.fhwa.dot.gov/research/fhwaresearch/agenda.

U.S. Department of Transportation
Federal Highway Administration

U.S. Department
of Transportation
Federal Highway Administration
Attn: HRTM
1200 New Jersey Avenue, SE
Washington, DC 20590

Official Business
Penalty for Private Use $300

PERIODICALS
POSTAGE & FEES PAID
FEDERAL HIGHWAY ADMINISTRATION
ISSN NO. 033-3735
USPS NO. 516-690

FHWA-HRT-14-002
HRTM-20/1-14(5M200)E