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U.S. Department of Transportation

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

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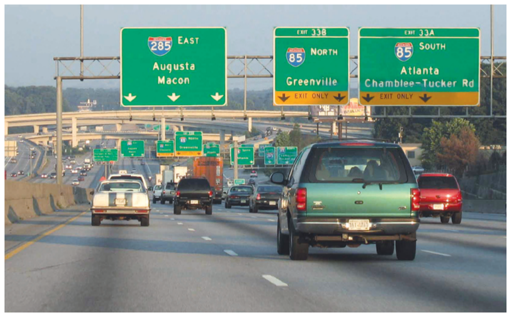
Articles



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Departments

Front cover—In 2008, the Maine Department of Transportation (MaineDOT) reconstructed 18 miles (29 kilometers) of I–295 southbound. The department's strategy to close the roadway (shown here near Exit 43) and perform the work during the height of tourist season angered some and baffled others. But teamwork, community partnerships, and 16-hour workdays turned this controversial rehabilitation project into a model for Maine. For more information, see "Rehabbing Maine's I–295 Southbound" on page 12 in this issue of PUBLIC ROADS. *Photo by Paul Giguere, MaineDOT.*

Back cover—Built in 1968, the Marquette Interchange in Milwaukee (shown here) is an example of a complex interchange. The Wisconsin Department of Transportation (WisDOT) recently reconstructed the facility to increase capacity and enhance safety by adding lanes, reconfiguring ramps and connectors, and improving the aesthetics of bridges, retaining walls, and fencing. WisDOT completed the $810 million project in 2008 ahead of schedule and under budget. For more information, see "Designing Complex Interchanges" on page 2 of this issue of PUBLIC ROADS. *Photo by WisDOT.*

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Guest Editorial

Managing Research Within FHWA

Spending time at the Turner-Fairbank Highway Research Center (TFHRC) makes one aware of the tremendous resources offered by the Federal Highway Administration (FHWA) at that facility and the opportunities for working together to bring to life innovations that address current and future challenges. Moving research efforts into real application in the field is critical to the Nation's transportation network.

As innovations transition from research to development to deployment, various FHWA offices play critical roles. Sometimes the office that has the lead is clear. For example, the Resource Center has the primary responsibility for carrying out technology deployment, with the support of the rest of FHWA. The program offices, which are responsible for defining the overall goals with input from both internal and external stakeholders, develop policy and offer guidance in making innovation a part of everyone's daily business. Research management and development of new technology are handled differently depending on the subject area. Some are led by the program offices, while TFHRC takes the lead in other areas. No matter who is in charge, everyone has responsibility to work together to achieve the defined goals. TFHRC, as FHWA's research arm, has the overall task of managing the highway research program and is the one division that is knowledgeable about all research and development projects.

Obtaining stakeholder input is critical in making sure that research is meeting the needs of the transportation community and the public. In FHWA's 2010 Strategic Implementation Plan, the agency underscores a national performance objective to "establish a transparent and ongoing highway community-wide process to identify national highway research and technology priorities." This objective includes establishing a framework for this process of coordinating with internal and external partners and stakeholders to identify research priorities.

For those unfamiliar with TFHRC, let this be said: the research capabilities of the FHWA laboratories are amazing. This facility is one of the few places in the United States where full-scale testing can be set up and accomplished in a short time. For example, after the I–35W bridge over the Mississippi River in Minneapolis, MN, collapsed in August 2007, TFHRC stepped in to perform testing on the bridge gusset plates. TFHRC researchers quickly changed gears, reordering priorities to provide the needed floor space, freeing up appropriate equipment, and involving nationally and internationally known experts to coordinate the necessary testing support.

In this fast-paced world, innovation will have to move even more quickly from research to deployment. The transportation community constantly is challenging TFHRC to solve the latest highway problem. Reacting quickly to solve new challenges requires dynamic personnel with the experience and ability to translate issues into viable research and development projects. The topics that need to be addressed are broad and varied, as well as exciting: implementation of the Strategic Highway Research Program 2, bridge remedial action, pavement preservation, accelerated project delivery, asset management, design visualization, infrastructure security and blast protection, innovative construction contracting, and green technology.

For example, this issue of PUBLIC ROADS features an article, "Developing Advanced Methods of Assessing Bridge Performance," that describes FHWA's research under the Long-Term Bridge Performance Program. This program will collect scientific quality data from a representative sample of the Nation's highway bridges to improve knowledge of bridge performance and deterioration, and ultimately enhance the safety and reliability of highway structures.

More is demanded from every research dollar spent, and the way to maximize the return on investment in this economy is through innovation.

Melisa L. Ridenour

Melisa L. Ridenour
Eastern Federal Lands Highway
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Highway engineers address numerous challenges when planning the elaborate freeway interchanges needed in densely populated urban areas.

Designing Complex Interchanges

by Mark Doctor, George Merritt, and Steve Moler

Imagine a hypothetical motorist driving on a freeway in an unfamiliar big city. As the motorist approaches an interchange in heavy traffic, the freeway that he is traveling widens from four to six lanes. An overhead sign stretching across all lanes gives him choices for multiple destinations. But before he realizes it, the sign disappears behind him. Anxiety sets in as he wonders which lane to take. Adrenaline rushes through his bloodstream as he makes a series of quick lane changes. Seconds later, at the interchange, he steers abruptly onto a connector ramp, hoping that he is going in the right direction.

This motorist has just experienced driving through a "complex interchange," a facility that typically contains many lanes, usually four or more in each direction, and carries high traffic volumes through a maze of tightly spaced ramps and connectors. Drivers often have to make multiple lane changes requiring intense attention and rapid decisionmaking. Navigating complex interchanges can present challenges for most motorists, especially aging drivers and those unfamiliar with the area.

(Left) Reconstruction of complex interchanges, such as the Springfield Interchange (shown here) near Washington, DC, often requires design choices for which there are few, if any, formal written guidelines. *Photo: Trevor Wrayton, Virginia DOT.*

As the Federal Highway Administration (FHWA) and State departments of transportation (DOTs) plan improvements to complex interchanges, they face the challenges of making those facilities more efficient and easier to use. At the same time, FHWA and DOTs confront the additional needs to meet higher traffic demands, adopt modern engineering standards, and improve safety.

Many interchange improvement projects are constructed in major metropolitan areas where high traffic volumes, dense land use, and local access requirements are the norm. Under these circumstances, many new and reconstructed interchanges will become more complex than ever before, creating additional challenges for those who design, operate, and use those facilities.

The following guidance and tips gleaned from the literature and from field experience could help highway designers deal with a few of the more important issues they face when designing complex interchanges.

System and Service Interchanges

Transportation officials broadly classify interchanges based on their functionality. A system interchange carries traffic from one freeway to another via a network of ramps and connectors. A service interchange connects a freeway with local surface streets or arterials. Diamond, cloverleaf, and partial cloverleaf interchanges are typical examples of service interchanges. Both system and service interchanges must provide an appropriate balance between regional mobility and local road access.

"In certain ways, the current guidance and practices utilized for the majority of system interchanges are not always sufficient for more complex conditions," says Jeffrey Shaw, a safety and design engineer with the FHWA Resource Center. "The complexities of some newer and larger system interchanges, particularly those in major metropolitan areas, may require engineers to make design choices for which there are few, if any, formal written guidelines."

One of the primary design issues is that complex interchanges usually do not have conventional layout patterns like diamond and cloverleaf service interchanges. Instead, each complex interchange is unique, customized by State DOTs to meet the specific transportation needs of that location and region.

According to Shaw, adding to the challenge is the uncertainty regarding how motorists will comprehend the completed design—geometry, signing, pavement markings—and whether they will be able to perform the driving maneuvers safely and appropriately.

Success Story: The Marquette Interchange

The Wisconsin Department of Transportation (WisDOT) faced these kinds of guidance issues when in mid-2005 the agency began reconstructing the Marquette

Interchange, which links three interstates (I–94, I–43, and I–794) in downtown Milwaukee. The interchange, originally built in 1968, was carrying twice the traffic volume it was designed for and had reached the end of its design life.

The reconstruction involved adding additional lanes to increase capacity, eliminating all left-side (fast-lane) exits and entrances by reconfiguring ramps and connectors, improving ramp design and spacing to minimize conflicts involving vehicles entering and exiting the mainline, and improving the aesthetics of bridges, bridge piers, retaining walls, and fencing. The $810 million reconstruction was completed in August 2008, ahead of schedule and under budget.

"The challenge is that no two complex interchanges are alike," says David Nguyen, a WisDOT design engineer who supervised the project's design and planning phase. "You have to develop designs that fit the environment in which the complex interchange is going to be constructed or reconstructed."

Developing designs sometimes requires incorporating complex accesses to local roads and streets and eventually connecting the new system to the older network on the project fringes, Nguyen said. "If you're building a new interchange with increased capacity, you eventually have to merge those extra new lanes back into the old system. How you accomplish this is the big question for which there is sometimes not a lot of formal written guidance," he says.

Four key issues for interchange designers' attention are ramp spacing, guide signing, route continuity, and lane balance. These issues, either individually or combined, can affect the project's design, traffic flow, safety, and cost. Satisfying the competing needs of system and service interchanges (regional mobility and local access) becomes even more critical at complex interchanges.

Ramp Spacing

To attain an appropriate balance between regional mobility and local access, entrance and exit ramps must be adequately spaced. When the spacing is too close, poor safety performance and traffic operations often result. Heavy traffic entering and exiting the freeway at adjacent ramps typically leads to congestion.

In addition, adequate ramp separation is needed for clear and simple guide signing. The Institute of Transportation Engineers' (ITE) *Freeway and Interchange Geometric Design Handbook* states that combining system and service interchanges can contribute to sign message overload, lead to inconsistent sign designs for geographically dispersed locations, and introduce movements that surprise or contradict the expectations of motorists.

The use of ramp braids, in which entrance and exit ramps cross paths but are physically separated with one ramp crossing over the other, is one option for improving operations at closely spaced interchanges.

Another is the introduction of collector-distributor (C-D) roads, which use auxiliary lanes separated from the freeway mainline so that local entering and exiting traffic will avoid conflicts with through traffic. A C-D system reduces weaving movements on the mainline while minimizing entrance and exit points on the through lanes.

C-D roads were a major component in the recent reconstruction of the I–85/SR–316 complex interchange northeast of Atlanta, GA. The reconstruction incorporated a network of C-D roads that separated the local traffic from entering the freeway mainline until after the I–85/SR–316

WisDOT

Many complex interchanges, such as Milwaukee's Marquette Interchange, shown here, are located in metropolitan areas where reconstruction is difficult and complex.

Aerial Innovations of Georgia, aerialga.com

This aerial shows a system interchange northeast of Atlanta, GA, that carries traffic from one freeway to another and a service interchange just to the north that connects the freeway with a local surface road.

Meeting Driver Expectations

Of all the recently completed interchange improvements in the United States, the reconstruction of the I–85/SR–316 complex interchange in suburban Atlanta, GA, by the Georgia Department of Transportation (GDOT) exemplifies what can be accomplished to improve safety and mobility at this kind of interchange.

The I–85/SR–316 interchange is located in Gwinnett County where the average commute times are the highest in the Atlanta metropolitan area and the 18th highest nationwide. In just 2 years, from 2004 to 2006, the average daily traffic (ADT) on I–85 at SR–316 jumped from 177,932 to 206,700. Afternoon peak period speeds at the interchange before reconstruction averaged a little more than 34 miles per hour, mi/h (55 kilometers per hour, km/h) on northbound I–85, compared with about 56 mi/h (90 km/h) after reconstruction. To meet these heavy traffic demands, improve safety, and minimize impacts on three shopping malls in the area, GDOT, in partnership with FHWA and Gwinnett County, began reconstructing the interchange in early 2006.

The I–85/SR–316 interchange consists of a system interchange that carries traffic from one freeway to another and a service interchange that connects the freeways with local surface streets and roads. Several service interchanges are in close proximity to the I–85/SR–316 system interchange, including ramps at Pleasant Hill Road and Steve Reynolds Boulevard to the south and the Duluth Highway and Sugarloaf Parkway to the north. Boggs Road cuts nearly perpendicular through the heart of the system interchange.

Before the reconstruction, local traffic entering at the Pleasant Hill Road service interchange going northbound on I–85 conflicted with mainline traffic trying to exit I–85 onto eastbound SR–316, a classic example of local traffic conflicting with through or regional traffic. Traffic headed westbound on SR–316 entered I–85 on the left side of the freeway and conflicted with the faster moving southbound I–85 traffic. The resulting weaving (lane changing) conflicts in both directions, including at a shopping mall exit, caused major congestion and delays during peak hours.

The absence of high-occupancy vehicle (HOV) lanes within the system interchange was also a major concern. Physical limitations such as the left-side entrance of westbound SR–316 to southbound I–85 prevented the HOV system from being expanded beyond this location. Increasing interchange capacity with additional general-purpose lanes raised air quality compliance issues.

The only way to solve these safety, congestion, and air quality problems was to reconstruct the entire system interchange and upgrade some of the service interchanges. After several years of planning, GDOT awarded a $147 million contract to a joint venture in November 2005.

Constructing a network of 17.6 miles (28 kilometers) of new HOV lanes and ramps separated local and general-purpose traffic. To eliminate the left-side entrance from westbound SR–316 to southbound I–85, GDOT constructed a new "flyover" ramp over I–85 so traffic could enter on the interstate's right-hand side. To mitigate the weaving at entrances and exits from Pleasant Hill Road, GDOT constructed a network of 11 lane miles (18 kilometers) of collector-distributor (C-D) roads to prevent local traffic from entering the freeway mainline until after passing through the I–85/SR–316 system interchange.

By the time the reconstruction was complete in October 2008, GDOT had built 13 new bridges, the new HOV lanes, the C-D roads, extensive pavement resurfacing, hundreds of new drainage structures, erosion control infrastructure, and new retaining and barrier walls.

GDOT kept the system interchange fully operational during the entire 3-year reconstruction with no lane closures during peak commute times. All work requiring lane closures was done at night or on weekends, and GDOT allowed no work in the travel lanes during holiday weekends.

The combination of the new flyover ramps, HOV lanes, C-D roads, and other improvements enhanced the overall safety and efficiency of the system interchange and nearby service interchanges. Postconstruction traffic studies show afternoon peak period (4 p.m. to 7 p.m.) vehicle speeds have increased on average from 34.3 mi/h to 56 mi/h (55.2 km/h to 90 km/h), a 64 percent increase. Average noon to 8 p.m. vehicle speeds have increased from about 49 mi/h before reconstruction to 60 mi/h (79 km/h to 97 km/h) after construction.

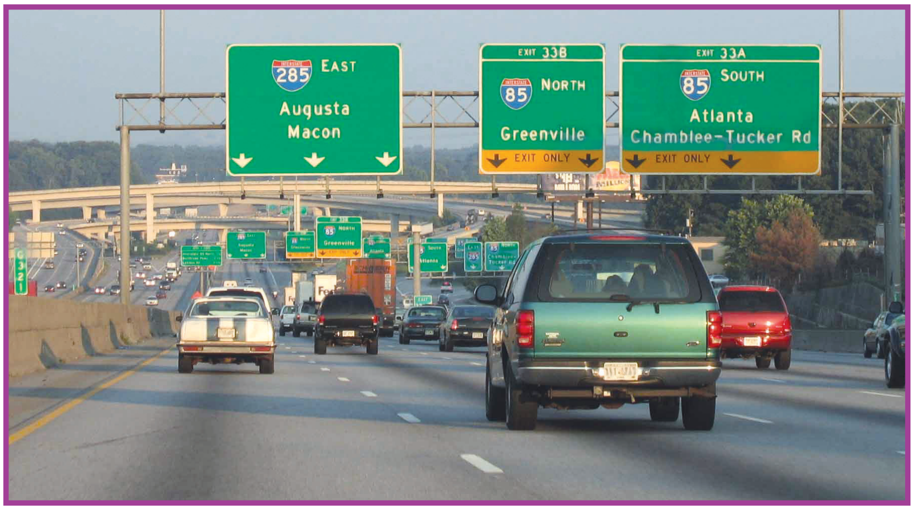
GDOT estimates that these speed improvements save motorists about $18,000 per day on northbound I–85 during the evening rush hour. This calculation resulted from measuring the reduced trip time through the corridor and assigning a value of $10 per hour or about 17 cents per minute for every minute saved per commuter. The result translates into a savings of about $400,000 per month using about 22 work days per month, or $4.85 million annually, according to GDOT figures.

With completion of the I–85/SR–316 interchange, the public has a safer and more operationally efficient regional transportation system today—and for years to come.

Steve Moler

Aerial Innovations of Georgia, aerialga.com

The system of collector-distributor roads shown here at the recently reconstructed I–85/SR–316 interchange northeast of Atlanta, GA, are auxiliary lanes separated from the freeway mainline to avoid conflicts between through traffic and local entering and exiting vehicles.



Guide signing requirements for complex collector-distributor systems can be unique and challenging, as shown in this signing sprawl on a Georgia highway.

system interchange. (See "Meeting Driver Expectations" on page 6.)

But care must be taken with the design of C-D roads because some drivers might be unfamiliar with this type of roadway configuration. Guide signing requirements for complex C-D systems can be unique and challenging. For example, if a C-D road has one physical exit from the freeway but then splits off into various directions later on, clearly signing these multiple choices is critical.

Guide Signing

Service ramps embedded within or close to a system interchange generally increase the complexity of the overall design, requiring clear signing so that drivers can understand the correct way to navigate through the interchange and take their intended route.

The 2003 edition of FHWA's *Manual on Uniform Traffic Control Devices* (MUTCD) offers standards and guidance for interchange signing. The manual provides an example of guide signing for a simple C-D roadway that serves two exit ramps within the same interchange. However, the MUTCD does not specifically illustrate signing for application on more complex C-D systems that serve multiple interchanges.

Appropriate freeway signing principles and practices should be followed. Diagrammatic style signs for the purpose of displaying successive exits should be avoided on freeway C-D systems due to the excessive amount of information that is presented.

Early coordination of signing and geometric alternatives can be useful in refining a concept or eliminating geometric alternatives that cannot be signed effectively. For example, DOTs might want to consider additional entry points to a C-D road for longer C-D systems. The use of a supplemental guide sign also might be effective when the number of destinations served by a C-D system exceeds that recommended for display on the primary guide signs to minimize the informational load on drivers.

The American Association of State Highway and Transportation Officials' *A Policy on Geometric Design of Highways and Streets*—the AASHTO Green Book—offers this advice: "The signing of each design should be tested to determine if it can provide for the smooth, safe flow of traffic. The need to simplify interchange design from the standpoint of signing and driver understanding cannot be overstated."

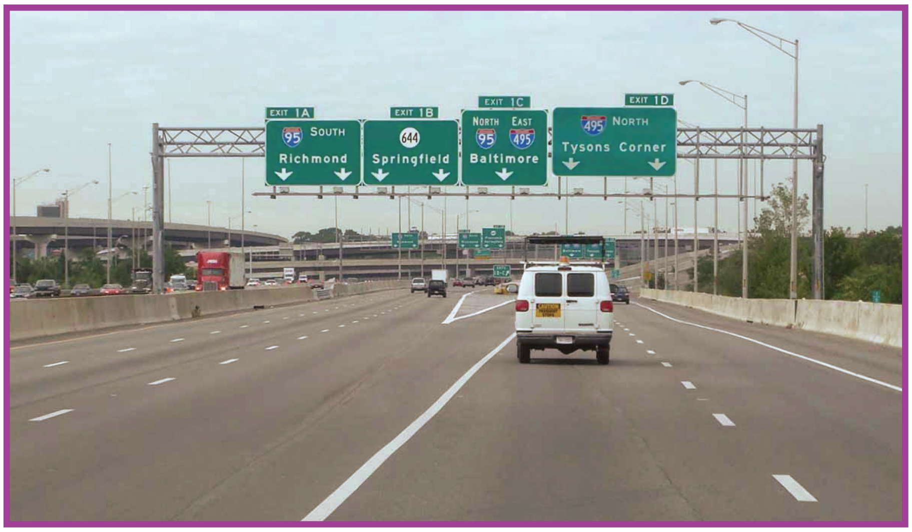
"In sum, remember the signing golden rule: clarify and simplify," says Fred Ranck, a safety design engineer with FHWA's Resource Center Safety and Design Team.

Route Continuity

The AASHTO Green Book defines this concept as providing a route on which changing lanes is not necessary to continue on the through route. Interchange designs that adhere to route continuity make the driving task simpler by reducing the need for through drivers to change lanes and typically result in simpler signing and improved traffic operations. Guidance for route continuity in typical interchanges is well documented in the AASHTO Green Book. But strategies for providing appropriate route continuity are less defined for complex interchanges.

Consider the example of the Springfield Interchange, about 15

This view of Virginia's Springfield Interchange after a recent reconstruction shows how a motorist seeing three traffic lanes split to the right and two to the left might become confused over which is the main route. Designers should not rely on guide signing alone but should strive to provide a geometric design consistent with route continuity principles.



Interior optional lanes such as the one forking here can require quick driver decisions over a short distance. Some designers prefer using all dedicated lanes due to simpler signing and better driver understanding.

miles (24 kilometers) southwest of Washington, DC, where I–95, I–395, and I–495 merge near Alexandria, VA. State transportation officials observed drivers making late lane changes, sometimes missing their desired exits at this fork, presumably because they intuitively perceived the split with the most number of lanes as the through or main route. Adding to the potential confusion was a divergence that could be mistaken for a left-hand ramp.

The Virginia Department of Transportation modified the advance guide signing to help clarify the divergence. Because of the geometry of the interchange, route continuity is perhaps counterintuitive to drivers. Ideally, the cues provided by the geometry and the information provided by guide signing will be in harmony. Designers should not rely on guide signing alone but should strive for a geometric design that is consistent with route continuity principles.

"An interchange, like any roadway segment, communicates information to motorists through its geometry and signs," says Thomas Granda, a senior psychologist with FHWA's Office of Research, Development, and Technology at the Turner-Fairbank Highway Research Center in McLean, VA. "For instance, when drivers see three lanes splitting to the right and two lanes splitting to the left, they might interpret the split with more lanes as the main route," says Granda. "The highway geometry could communicate that message to the driver despite guide signs clearly indicating otherwise. This apparent information discrepancy can delay driver decisionmaking, cause the driver to take the wrong route, or even worse, cause the driver to radically change lanes at the last second in order to correct his or her mistake."

The AASHTO Green Book provides additional guidance on designing to achieve consistency with this principle: "In the process of maintaining route continuity, particularly through cities and bypasses, interchange configurations need not always favor the heavy movement but rather the through route. In this situation, heavy movements can be designed on flat curves with reasonably direct connections and auxiliary lanes, equivalent operationally to through movements."

The ITE *Freeway and Interchange Geometric Design Handbook* provides additional advice: "It is the through facility (the designated route) that should always maintain its directional character. However, any predominant movement separating from the freeway should form a well-aligned exit on the right, operationally equivalent to the through movement."

Adhering to the principle of route continuity becomes particularly challenging when the through route carries substantially less traffic than the exiting movement. To allow the through route to "maintain its directional character," it is desirable for the through route to have at least as many lanes as the route exiting on the right. In a constrained urban setting, it is often difficult to construct additional lanes.

Even when this principle is satisfied, the overall composition can influence the frequency of errant driver behavior, such as sudden lane changes and abrupt braking.

Designers should strive to define, anticipate, understand, and consider the cumulative effects of a design in working to meet the intent of the AASHTO guidance on route continuity. In unusual or complex situations, applying a strict and narrow interpretation of the concept of route continuity may not provide the intended operational benefits.

Lane Balance

The lane changing and traffic shifting that occurs in advance of an interchange can be disruptive to free-flowing traffic and can add to the complexity of the driving task. Lane balance is a design principle involving the proper arrangement of traffic lanes on the freeway and ramps in order to realize efficient traffic operation by minimizing the required number of lane shifts. To achieve lane balance at an exit, according to the AASHTO Green Book, "The number of approach lanes on the highway should be equal to the number of lanes on the highway beyond the exit, plus the number of lanes on the exit, minus one." Simply stated, the lane balance principle for exits provides for one more lane going away that will help flush traffic away from the divergence area.

Highway designers achieve lane balance configurations through the appropriate use of auxiliary lanes and optional lanes. An optional lane on the approach to an interchange allows the driver the choice of exiting or staying on the through route. Although optional lanes offer operational advantages, they can pose challenges with regard to signing, driver understanding, and utilization. This is particularly true at complex interchanges that have four or more lanes approaching a major fork or an exit where more than two lanes diverge from the main route.

The AASHTO Green Book defines a major fork as "a bifurcation of a directional roadway of a terminating freeway route into two directional multilane ramps that connect to another freeway, or of a freeway route into two separate freeway routes of about equal importance." At these locations, a designer must choose whether to employ the optional lane design or use a split with dedicated lanes. A dedicated lane does not offer drivers a choice, but rather commits them to choosing and staying in a certain lane to reach their desired destination.

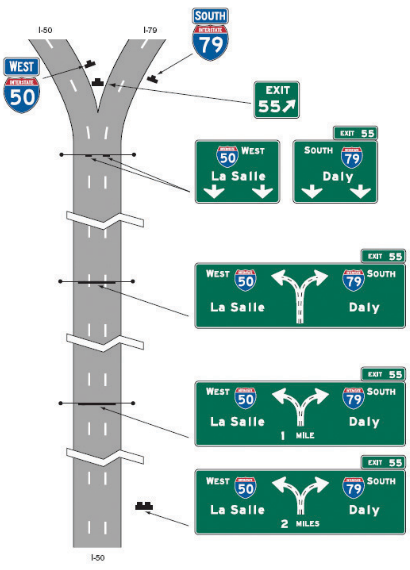
The text in the AASHTO Green Book strongly suggests a need to provide an optional lane at a major fork: "Operational difficulties invariably develop unless traffic in one of the interior lanes has an option of taking either of the diverging roadways. This guidance is driven partially by the need to provide lane balance through an interchange. Use of an optional lane makes achieving lane balance a more straightforward exercise. However, lane balance also can be achieved through the dedicated lane style with the application of an auxiliary lane on approach to the divergence.

In complex conditions, signing for an optional lane may be confusing to drivers and fail to positively communicate the presence of an optional lane. Overhead guide signs, especially the long truss signs with multiple panels that extend across all lanes, need to clearly convey which is the optional lane. In some cases where down arrows are not properly aligned with their respective lanes, drivers might have difficulty differentiating the optional lane.

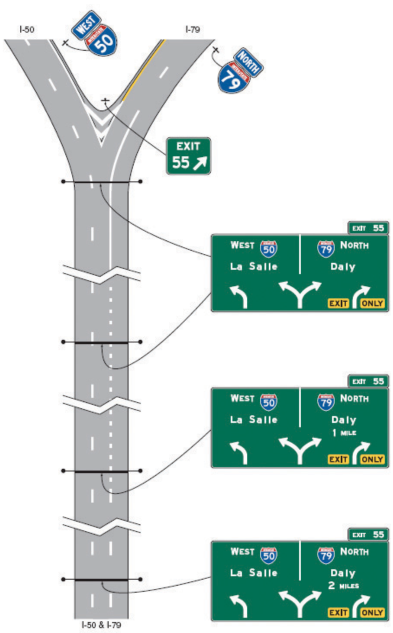
The sign design should be congruent with the motorist's three-dimensional view from behind the wheel. The lane that the driver is in, or lane perspective, also can make a significant difference. Horizontal and vertical curvature can add to the difficulty in discerning which arrows belong to which lanes. Because of these challenges, the optional lane may then be underutilized or create a potential safety concern since it can introduce a rapid driver decision point within a limited sight preview distance. The context of the location as well as consideration of the geometry and ability to effectively sign should influence whether an optional lane or dedicated style is used.

The MUTCD illustrates signing schemes for major forks with dedicated lanes and an optional lane. In a recent notice of proposed amendment to the MUTCD, FHWA offered a change to the diagrammatic signs for splits with an optional lane. The proposed new design provides an arrow shaft for each lane. The change is based on a recommendation with supporting evidence found in the FHWA *Highway Design Handbook for Older Drivers and Pedestrians* (FHWA-RD-01-103).

Because the MUTCD does not specifically illustrate how to provide effective signing in complex environments, the provisions for guide signing should be applied holistically and systemically rather than individually. Ultimately, sound engineering judgment should be applied with a clear understanding of what the view will be from the driver's perspective. Signing also should be consistent with the pavement markings and the visual foreground and background.



The top diagram shows guidance for signing optional lanes from the 2003 edition of the MUTCD. The lower diagram shows a suggested new design for diagrammatic guide signing of optional lanes whereby the number of arrow shafts matches the number of lanes on the roadway at the sign's location, and each arrow is placed directly above the lane to which it applies.



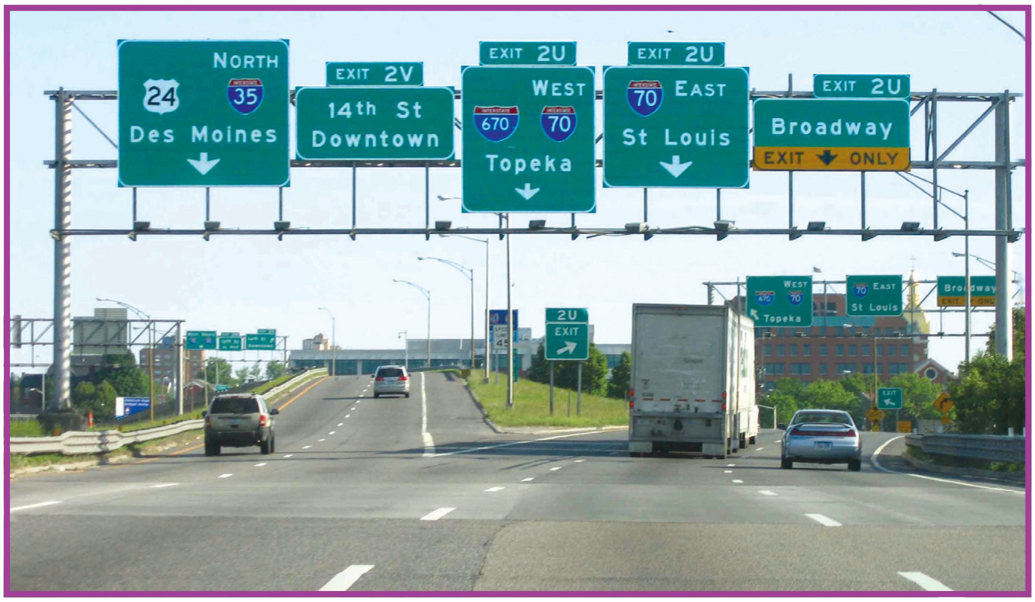
Source: MUTCD.

Advance Guide Signing

Perhaps the most critical strategy for assisting drivers through complex interchanges is signing placed ahead of the interchange to provide information that prepares drivers to make decisions and maneuvers in advance. Improper or inadequate signing can impair a driver's ability to read and understand critical guidance information because of mental overload and other factors. The results can include delayed decisionmaking, erratic driver behavior, and maneuvering errors at the decision point.

Proper placement and use of advance guide signs is just as important as signs displayed at the decision point. Proper placement will enable drivers to execute more gradual lane changes over a longer distance. Signs at the decision point serve to confirm the lane decisions made on the approach.

Advance guide signing also must be adequately spaced to give drivers time to read and comprehend the information. Signs with too much detail or spaced too closely can cause information overload. According to a National Cooperative Highway Research Program report, *Additional Investigations on Driver Information Overload*, the load imposed by a given array of information is not simply a function of the total number of "bits" of information contained in



In complex conditions, such as at this interchange, the amount of information can overwhelm some drivers. Highway designers should pursue interchange geometry that facilitates using clear, logical, and simple signing that complements driver expectations.

the array. The tasks the driver is engaged in, the roadway situation, and the driver's skill level are essential, interacting factors. Mental overload also depends on driver expectations, experience, and familiarity with the roadway. The presence of interacting traffic, roadway geometry, navigational choice points, and other traffic control devices and information sources also are critical factors that contribute to driver overload.

Sign Consistency

Sign consistency includes layout technique, legend details, and sign material quality. Achieving consistency within an entire corridor in lane assignment arrows, diagrammatic legends, and even letter height can reduce the driver's workload. DOTs should even evaluate materials, including retroreflectivity, lighting, and the age and condition of signs, on a corridor basis.

Agencies also should position signs where they can communicate with motorists most effectively rather than at the most convenient or least costly locations. Sometimes existing sign trusses and supports are used to minimize costs, even though the location might not be ideal. Other times the condition of the support structure prevents upgrading panels with new and needed information because of the additional weight. Designers and traffic engineers should emphasize proper sign location early in a project life cycle so that if additional costs are incurred, the scope and budget can absorb the added work.

Proper selection of control cities and destinations is critical in communicating with drivers unfamiliar with a region. Despite temptations to add local destinations, using AASHTO control cities and destinations is the proper approach. Those cities are nationally recognized destinations that give important directional guidance to almost all drivers and especially to unfamiliar drivers at critical diverge points. Local destinations might be important to local drivers, but they provide little, if any, guidance to unfamiliar drivers and can add to their confusion. For example, when traveling eastbound on I–80 approaching the I–580/I–880 interchange in Oakland, CA, destinations such as Sacramento (I–80), Stockton or Los Angeles (I–580), and San José (I–880) provide better directional guidance for unfamiliar drivers than local California destinations such as Richmond, Walnut Creek, or San Leandro.

"An important philosophy of interchange design is that if it cannot be clearly and simply signed, it should not be built," says Shaw of FHWA's Resource Center. Providing draft signing and marking plans with each conceptual geometric alternative can help vet the interstate access proposal. In some cases, this approach has resulted in eliminating alternatives that otherwise would have met nominal AASHTO geometric design criteria but would have resulted in awkward advance guide signing. "The goal for complex interchange locations should be for the geometry and the guide signing to complement each other," says Shaw.

Two Techniques for Improved Design

The use of design visualization in the decisionmaking process could improve complex interchange projects. Design visualization employs techniques such as computer graphics, driving simulators, and animation to provide a representation of proposed alternatives and their associated impacts. Designers traditionally have used visualization to convey the final design to decisionmakers, stakeholders, and the public. Some transportation agencies are finding new ways to integrate visualization into project development, such as using visualization not just for public involvement, but also in the design phase.

The use of road safety audits (RSAs) during the planning and preliminary design also could improve complex interchanges. An RSA is a formal safety performance examination of an existing or future road or intersection, carried out by an independent, multidisciplinary team. The RSA team estimates and reports on potential road safety issues and identifies opportunities for overall safety improvements.

Highway engineers do not have to wait until a complex interchange is built and put into operation before doing an RSA. In fact, the greatest benefit of an RSA comes during the planning and early design stages, when the scope, schedule, and budget are able to absorb changes resulting from the review. Since complex interchanges typically involve large scopes and costs, application of RSAs can serve to reduce scope creep and cost overruns, while ensuring that safety is not compromised.

Wisconsin performed an RSA during the final design phase of the Marquette Interchange. Even though the design was more than 90 percent complete, an RSA team identified potential safety issues and provided recommendations that could still be implemented at a low cost. Among the recommendations were extending a concrete barrier to prevent undesirable movements across lanes, enhancing advance guide signing in an area of limited weave distance, restricting certain crossroad intersection movements during peak periods, and posting advisory speed signs along some ramp curves.

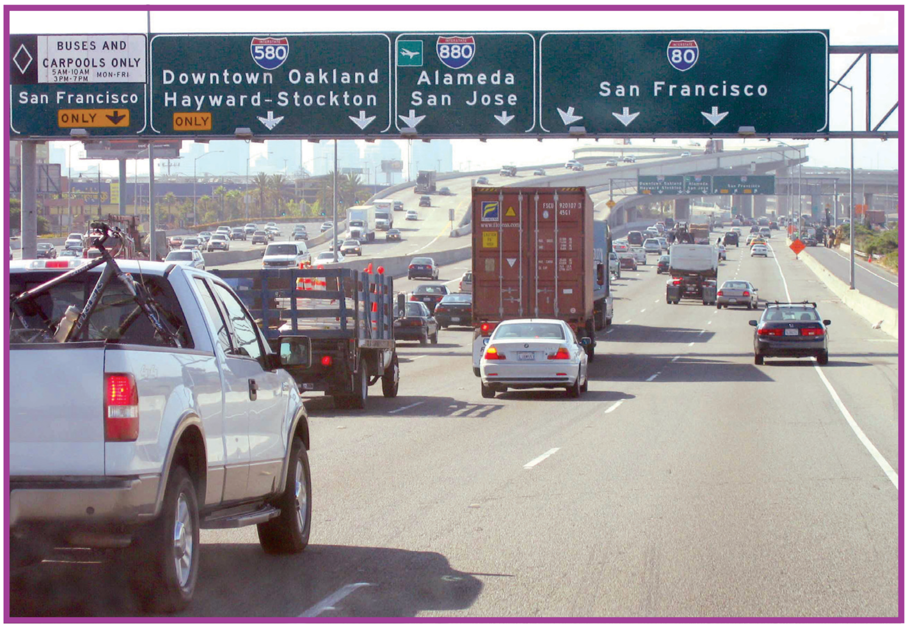
Although the RSA came late in the project, the State agreed that it added value to the final design. Because of this positive experience, WisDOT crafted a policy that encourages performing an RSA on interchange projects much earlier in the design process, allowing for greater flexibility when responding to potential safety issues identified by the RSA team.

What Next?

First, the transportation community needs to expand knowledge of driver performance as a function of various design configurations and associated signing at complex interchanges. Researchers and designers need to evaluate various lane management techniques—such as optional versus dedicated lanes and techniques for ending auxiliary lanes—to better understand operational and safety performance.

Researchers also need to clarify and quantify the relationship between speed, the composition of traffic flow, and the frequency and severity of crashes at interchanges with complex geometric designs. Finally, quantifying the relationship between signing and quality of operations is needed.

When designing complex interchanges, taking the entire corridor into consideration, not just the interchange itself, can improve the overall safety and efficiency of the regional transportation system. Understand the sum of the parts. Keep in mind that access to the local network might be competing against achievement of regional mobility. Establishing appropriate project goals for balancing conflicting interests is highly recommended. Think in terms of a performance-driven design, not simply a standards-driven design. As designers implement these recommendations, perhaps drivers, in the end, will feel far less uncertainty and distress when driving through a complex interchange.



Overhead guide signs such as this multipaneled truss sign at the MacArthur Maze interchange in Oakland, CA, need to make the optional lane clear. A driver traveling in the far right lane might have difficulty discerning the interior optional lanes.

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George Merritt has been a safety and design engineer at the FHWA Resource Center in Atlanta since 2008, after joining FHWA in 2001. He started his career as a pavement engineer for the Indiana DOT before becoming an assistant area engineer in FHWA's Alabama Division and then a transportation engineer in the Georgia Division. He earned a B.S. in civil engineering from Trine University in Angola, IN.

Steve Moler is a public affairs specialist at the FHWA Resource Center in San Francisco, CA. He has been with FHWA since 2001, assisting the agency's field offices and partners with media relations, public relations, and public involvement communications. He has a B.S. in journalism from the University of Colorado at Boulder.

*The policy of FHWA is to maintain the interstate highway system to provide the highest level of service in terms of safety and mobility. Additional information about FHWA's policy on interstate access (*Federal Register *February 11, 1998, FR Vol. 63, Number 28, pages 7045–7047) is available at www.fhwa.dot.gov/programadmin/fraccess.cfm.*

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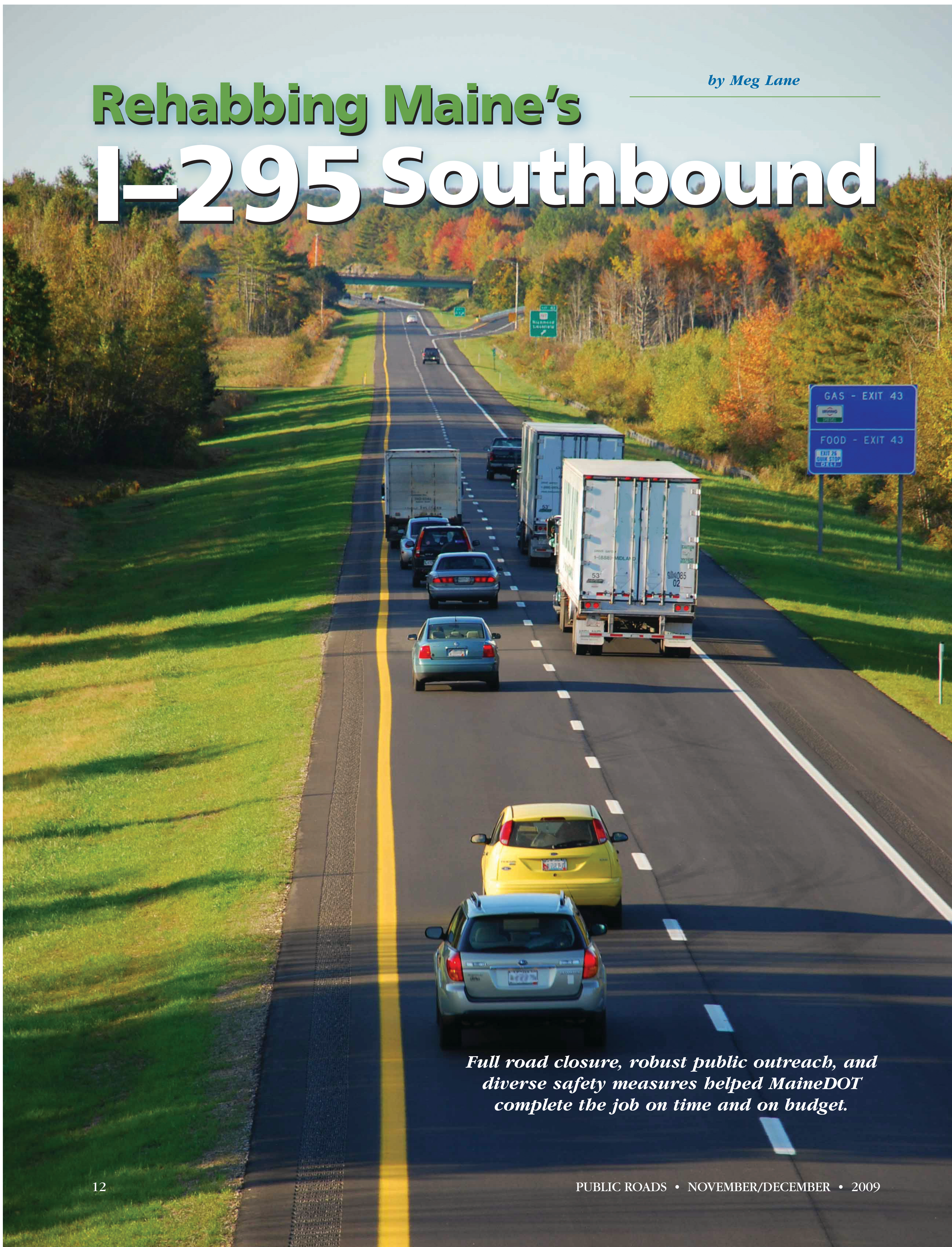
Rehabbing Maine's I-295 Southbound

by Meg Lane



Full road closure, robust public outreach, and diverse safety measures helped MaineDOT complete the job on time and on budget.

Maine's I–295 between Gardiner and Topsham is a critical section of highway in the southern part of the State. I–295 serves as an offshoot from Maine's only north-south interstate, I–95 (Maine Turnpike), and provides closer access to tourist destinations such as Freeport and coastal communities between Portland and Augusta. According to the Maine Department of Transportation (MaineDOT), the road carries approximately 13,500 cars per day during the peak summer travel season, when residents and tourists alike flock to the State's lakes, mountains, and coastal communities.

Constructed in the early 1970s using concrete slabs, I–295, like many roads from that era, was beginning to show signs of accelerated deterioration. The culprit: alkali silica reactivity (ASR), which is a chemical reaction between the alkali in the cement and silica in certain aggregates. The reaction creates a gel that attracts water in the concrete, leading to premature deterioration in structures such as pavements and bridges. Infrastructure affected with ASR exhibits cracking and, in heavily distressed structures, movement due to excessive expansion.

"The concrete was literally breaking up in place, causing pieces to come loose in the roadway," says Brad Foley, who was then MaineDOT's safety office director. "This posed a significant maintenance and safety issue."

Maine's harsh winters, with low temperatures and heavy snowfall, offer no favors to the highway industry, virtually requiring paving and other construction activities be performed between May and October. In January 2008, the MaineDOT design team proposed a bold plan: Shut down the 18-mile (29-kilometer) stretch of I–295 southbound from Gardiner to Topsham—during the peak of the State's $10 billion summer tourism season—to reconstruct the pavement.

MaineDOT

This closeup of the old concrete pavement along I–295 southbound shows cracking due to ASR-related deterioration.

At a press conference to announce the general contractor selected to execute the project, MaineDOT Commissioner David Cole acknowledged the seeming incongruity of the proposed schedule. "Summer is clearly an important time in Maine for both local and national tourists to visit our beautiful State," he said. "Unfortunately, due to our weather conditions, this is the only time paving of this nature can be completed. We are confident that the alternative routes and the plans we have put in place will help to get motorists safely and efficiently to their destinations."

Sensitive to the potential impact on Mainers, visitors, and the economy, MaineDOT set firm dates for start (June 16, 2008) and completion (August 30, 2008) and offered its contractor a $2 million incentive for early completion, promising penalties for delays. The ambitious plan worked. It worked so well, in fact, that the department used the same approach in summer 2009 to reconstruct the northbound lanes of I–295. The I–295 southbound project came in on time and on budget and was a safety and public relations success. Here's how.

(Left) Thanks to 16-hour workdays and 7-day workweeks, MaineDOT reopened a newly reconstructed I–295 southbound (shown here) to traffic on June 10, 2008, approximately 20 days ahead of schedule despite an abnormally rainy summer. *Photo: MaineDOT.*

Project Nuts and Bolts

The $28 million project, 90 percent funded by the Federal Highway Administration, included laying down 181,000 tons of asphalt, rehabilitating five bridges, and installing 7 miles (11 kilometers) of guardrail.

MaineDOT chose full road closure instead of partial closure or having I–295 northbound serve as both northbound and southbound lanes for several reasons. Due to Maine's short construction season, the department estimated that the project would take three construction seasons to complete with partial closure, versus just 3 months with full closure. Detouring all traffic to I–295 northbound was deemed cost and time prohibitive ($37 million to $43 million versus $28 million for full closure), considering the additional time and money that would have been required to improve guardrails, reconstruct shoulders, and build crossovers and new on and off ramps. Most important, safety issues such as lack of shoulder width, inability for first responders to reach crash sites, and the increased volume of vehicles took that option out of contention.

At midnight on June 15, 2008, MaineDOT closed the project section and diverted southbound traffic to alternate roads: the Maine

Turnpike (I–95), ideal for trucks and other traffic headed to Portland and points south, and Route 201, a rural highway running through small towns and the recommended route for travelers heading to the Brunswick/Freeport area. In addition to signage on the highway, motorists learned about the alternate routes through print ads in local newspapers; posters at rest areas, tollbooths, and tourist destinations; and radio spots aired during prime drive times.

Construction kicked off with a subcontractor removing the old concrete by milling the top 3 inches (7.6 centimeters) off the concrete slabs. The material was then either placed on the shoulder or delivered to an onsite staging area. At the staging area, a portable crusher processed the material for reuse as shoulder aggregate. The millings from the surface of the existing concrete pavement served not only to provide shoulder aggregate but also reduced the extent of in-slope regrading needed.

The next step was "rubblizing" the remaining concrete pavement. Rubblization is the process of applying high-frequency vibration to break up concrete slabs in place into pieces 6 inches (15.2 centimeters) or smaller. This material was left in place to provide a frost-resistant aggregate base for the new hot mix asphalt (HMA) roadway to be placed later. The contractor completed this process in less than 2 weeks.

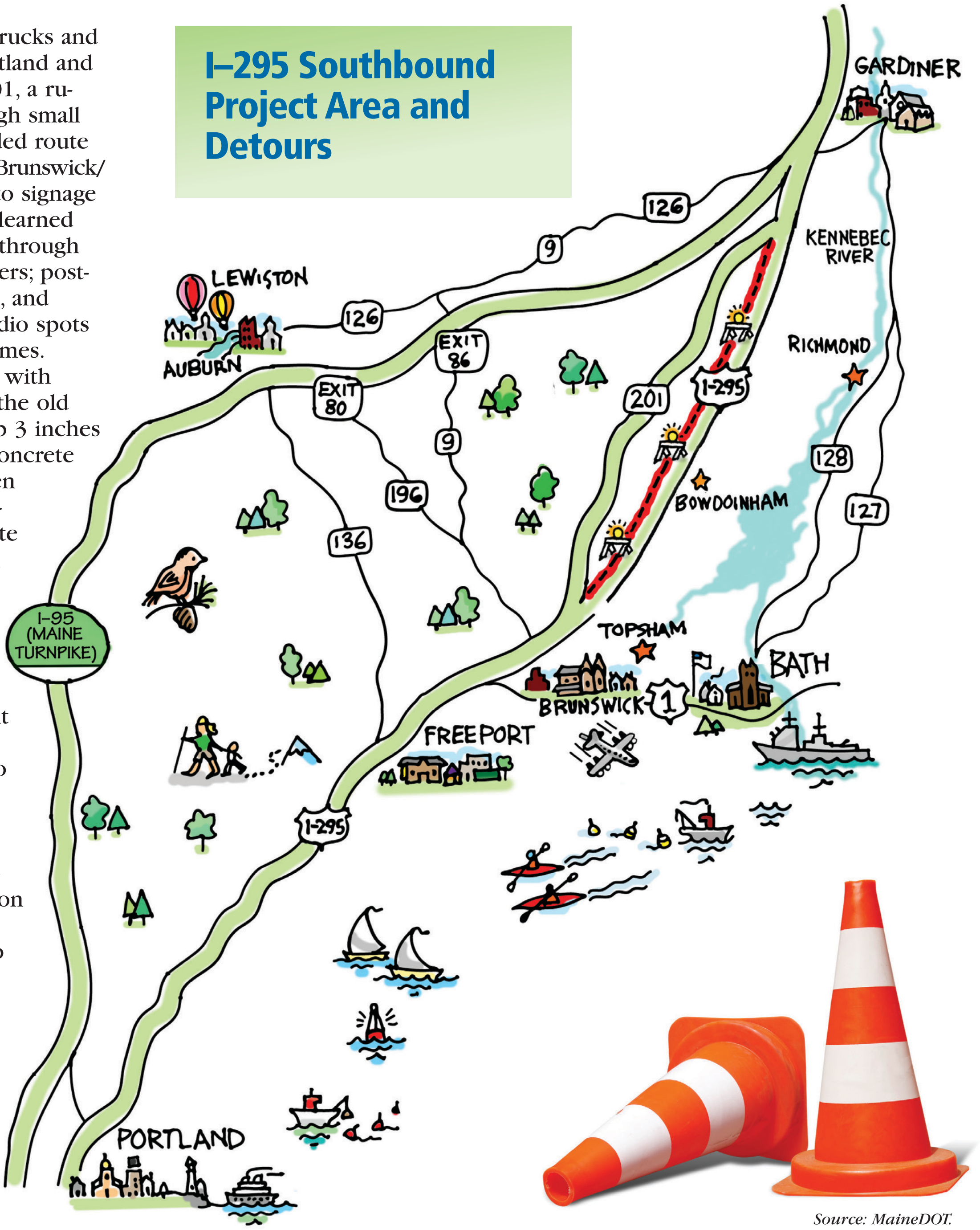
Cold planers previously had removed the remaining asphalt shoulder pavement. Over the next 5 weeks, the workers rehabilitated three bridge decks, replacing approach slabs and end caps, as well as upgrading decks and expansion joints.

By June 23, the contractor began trailing the rubblization process with paving. The plan called for 8 inches (20.3 centimeters) of HMA pavement over the rubblized concrete. For this effort, the contractor employed up to five paving crews at one time to meet the schedule. In some cases, crews used a technique known as echelon paving, where pavers are positioned side by side but slightly offset and lay down multiple lanes of HMA. Upon completion of paving, the contractor installed the guardrail and rumble strips for safety.

"Thanks to 16-hour workdays and a 7-day-a-week schedule, and despite a rainy summer, MaineDOT opened I–295 southbound to traffic on August 10, approximately 20 days ahead of schedule," says Jim Hanley, government affairs manager with Pike Industries, Inc., which was the project's general contractor.

MaineDOT offered 5 percent quality incentive pay for smoothness and another 5 percent for HMA factors including density, voids in mineral aggregate, and asphalt content. In the end, the contractor earned a 2.8 percent quality incentive for smoothness and achieved a 2.2 percent quality incentive for the HMA properties.

I–295 Southbound Project Area and Detours



Source: MaineDOT.

This map shows the I–295 project area, as well as the detour routes: I–95 (Maine Turnpike) and Route 201.

MaineDOT

Rather than trucking waste concrete from the existing pavement offsite, crews recycled the material onsite, as shown here, to rehabilitate the paved shoulders.

Keeping It Green

"MaineDOT conserves, recycles, and reuses whenever it's practicable and when doing so does not significantly affect the quality of the final product," says Joyce Taylor, assistant director of the MaineDOT Bureau of Project Development.

According to the general contractor, the I–295 southbound project generated 55,000 tons (49,895 metric tons) of waste concrete that typically would have been hauled offsite to a fill site. Instead, 100 percent of that concrete waste was recycled onsite to rehabilitate the paved shoulders, and 30,000 tons (27,216 metric tons) of old asphalt pavement from the shoulders was recycled into new HMA. Hanley says these measures reduced fuel use, preserved natural resources, and kept heavy trucks off the highways adjacent to the project.

Another innovative practice was the creation of a staging area adjacent to I–295, which the contractor used to process the old concrete and then return it to the shoulders without trucks leaving the closed worksite. The contractor also used the staging area to store waste pavement, which was later moved to the company's Augusta location for processing and 100 percent recycling back into new HMA.

Open Communication

"Based on initial reactions from the public, as well as from tourism and business professionals, the road closure had the potential to discourage visitors during the peak travel season," says Herb Thomson, director of MaineDOT's Office of Communications.

To address these concerns, the department partnered with a local marketing and communications agency to help with the design and implementation of a multifaceted communications campaign that would raise awareness, encourage safety, and maintain public support before, during, and after the project. First, the department formed an advisory committee consisting of business and community leaders to gain their insights and share communications goals, tactics, and resources. In addition to offering counsel, these leaders served as project ambassadors. Members included representatives from the communities along the corridor, the Maine Office of Tourism, Maine Merchants Association, Maine Motor Transport Association, chambers of commerce, Maine Turnpike Authority, Maine Restaurant Association, and AAA Northern New England. This committee met regularly to review communications strategies and address issues raised by their constituents.

To assist businesses that rely on I–295 traffic, MaineDOT increased informational signage along Route 201 regarding gas, food, and lodging. The Maine Turnpike Authority distributed traveler information at tollbooths and posted additional signage along the turnpike to remind drivers where to exit in order to reach Freeport and other tourist destinations.

MaineDOT

This crew is installing new guardrail along the repaved highway.

MaineDOT

The contractor established this onsite recycling and staging area where a portable crusher (shown here) processed the waste concrete into shoulder aggregate.

Ensuring a solid and positive partnership was important to the department. "MaineDOT worked swiftly to address the initial resistance that was reflected in and encouraged by the early negative media coverage," Thomson says, "which focused on the use of Route 201 as an alternate route and the decision to do a full closure during the peak of the tourist season."

At the press conference to announce the project contractor, the department clearly outlined the project's necessity and the strategies that would be used to maintain safety and convenience during construction. "We did everything we could to address issues directly, and to give a clear explanation for the full closure," Thomson says.

The outreach campaign included sending letters to residents living along the Route 201 detour reminding them to use extra care when walking along the road and when parking. Posters distributed at major employers, hospitals, and local businesses provided project information, including start and end dates, and a map showing the construction area and alternate routes. The department also issued fliers with safety tips for students and their families to local schools, and provided a phone number that the public could call for information on the project or to express concerns.

MaineDOT also maintained a Web site with a live webcam of the alternate routes, photos, and regular project updates. Throughout the project, MaineDOT sent email alerts and media advisories regarding changes in traffic patterns, significant traffic impacts, and project milestones. Communications materials encouraged trucks and Portland-bound traffic to use the turnpike instead of Route 201. As a result, 50 percent of the traffic ended up using the turnpike, well above the 35 percent targeted by the department.

The marketing and communications agency helped MaineDOT design a targeted advertising plan that would reach both residents and visitors in conjunction with extensive press outreach. Print ads in daily newspapers and radio spots targeting tourists ran throughout the summer. News crews attended two media tours hosted by MaineDOT officials to provide insider access to the project as work progressed. Weekly media updates included project status and information related to traffic impacts. Media interviews with businesses along Route 201 reported that the increase in traffic actually resulted in increased sales throughout the closure period.

As a precaution, the team also developed a detailed crisis communications plan to ensure clear directives and messaging, but, says Thomson, "Thankfully, the crisis plan did not need to be used."

Safety and Traffic Flow

"MaineDOT's highest priority was to ensure the safety of motorists, residents along the Route 201 detour, and work crews," says Foley, the former MaineDOT safety office director. "The decision to close the highway completely enabled multiple crews to work safely without traffic at multiple locations along the project corridor." Full closure also offered a safer option for motorists, as they would not be distracted by extensive work zones along a major highway.

According to Thomson, MaineDOT's communications director, residents along Route 201 had "serious reservations about the safety of putting all this additional traffic on a sleepy, rural road," he says. But MaineDOT took several steps to maximize safety for residents and motorists alike. Engineers redesigned the traffic plan for Route 201, including making improvements to the Route 197 intersection and installing flashing lights at the intersection of Route 125 and Route 138. Route 201 was treated almost like a work zone with heavy signage, reduced speed limits, and increased law enforcement, which encouraged motorists to drive more cautiously. MaineDOT also stationed a patrol truck on Route 201 to assist motorists with questions or items like gas, water, or calls for assistance.

In addition, the department deployed a number of safety devices, including optical speed bars and camera/radar sites. The use of optical speed bars (chevron stripes painted on the roadway) along the detour helped motorists feel the need to slow down. Camera and radar sites regularly recorded pictures of traffic flow, enabling MaineDOT to monitor and respond quickly to any congestion issues. These devices also continually recorded radar data, so the department and its partners in law enforcement could target where and when enforcement would be most effective. The camera/radar installations triggered alerts for traffic managers whenever travel speeds dropped below 35 miles per hour (56 kilometers per hour) so personnel could address problems and change variable message signs as needed.

Along the detour route, the radar captured motorists' approach speeds, triggering a display of notices on variable message signs. At low to normal speeds, the signs posted general messages about the road ahead, such as "Turning and Entering Traffic Ahead" and "Watch for Walkers." For drivers traveling at high speeds, the signs displayed a speed warning, encouraging motorists to slow down. Standard, static signage, such as road, regulatory, warning, and directional signs, also were used, in addition to pavement markings. Regular inspection of the devices helped ensure that all traffic control devices were being used to their maximum effectiveness.

With these measures in place, Foley says, traffic flowed smoothly on the detour throughout the summer. According to MaineDOT officials, each alternate route added no more than 15 minutes to drive times. Plus, although Route 201 historically sees an average of five reportable crashes during this part of the summer, there were no reported crashes during the course of the project.

The safety benefits of the full closure provided a clear lesson for MaineDOT as it moves forward with future road construction projects. "Based on the success of the full closure on southbound I–295, MaineDOT decided to implement a similar strategy in summer 2009 when it rehabilitated the northbound lanes," Foley says.

Meg Lane is communications project manager at MaineDOT. With a degree in marketing communications, she is responsible for multifaceted public information campaigns for the department. The communications efforts on the I–295 southbound project have been recognized with awards from the Maine Public Relations Council and the national Mercury Award sponsored by MerComm, Inc.

For more information, contact Meg Lane at 207-624-3197 or Meg.E.Lane@maine.gov.

MaineDOT

Optical speed bars, shown here painted on the pavement, were among the safety enhancements MaineDOT deployed on the Route 201 detour.

Through technical assistance and capacity building, these centers help native peoples meet safety and mobility needs in Indian country.

The Role of TTAPs in Tribal Transportation

by John J. Sullivan IV and Clark Martin

Each year, motorists log more than 2 billion vehicle miles (3.2 billion vehicle kilometers) on Indian Reservation Roads (IRR), which are public roads to and within Indian reservations, trust lands, restricted lands, and Alaska Native villages. The IRR program, administered jointly by the Federal Highway Administration's (FHWA) Office of Federal Lands Highway (FLH) and the U.S. Department of the Interior's Bureau of Indian Affairs (BIA), provides funds for planning, design, construction, and maintenance activities on these roads, which contribute to the health, safety, and economic development of Native American communities.

(Above) Shown here is the Chumash Highway, a State road named in recognition of its crossing of Indian ancestral lands. TTAP centers work with tribes to improve safety and mobility on roads that pass through modern-day tribal lands. *Photo: Jesse Groves, Jesse Groves Photography.*

Today, the U.S. Government recognizes 562 American Indian and Alaska Native tribes in the United States. Tribal governments, often in partnership with Federal, State, and local government agencies, face a distinct set of challenges building, operating, and maintaining safe roadways on tribal lands. These challenges include multijurisdictional authority, limited staffing and resources, and differences among the tribes in terms of land ownership and other factors, all of which make one-size-fits-all approaches unrealistic.

In 1991, to help tribal governments improve management of their transportation networks, FHWA created the Tribal Technical Assistance Program (TTAP). Today, seven regional TTAP centers provide a variety of training programs, an information clearinghouse, updates on new and existing technology, and personalized technical assistance to tribal governments. Through these core services, the TTAP centers offer help in workforce development, asset management, and solutions to safety, environmental, congestion, capacity, and other issues.

The TTAPs work with tribes in support of a number of FHWA programs related to road management and safety, including key programs administered by the FHWA program offices, with a particular focus on the IRR program managed by FLH. For example, TTAP centers provide assistance with transportation planning, development and coordination of tribal and State transportation improvement programs, environmental reviews and mitigation efforts, highway and work zone safety, and asset management. Further still, TTAPs support tribal initiatives related to freight, transit, rail, and intermodal systems.

Whether sharing information on the latest technologies, developing educational programs to encourage Native American students to pursue careers in transportation, or coordinating interagency and intergovernmental partnerships, TTAP centers are helping tribes improve safety and mobility on their roadways.

Tribal Sovereignty

The nature of the relationship between American Indian tribes and the U.S. Government is critical to respecting and understanding tribal transportation issues. The U.S. Constitution, treaties, court decisions, Federal statutes, and executive orders define the unique relationship between Indian tribes and the Federal Government. The United States acknowledges each tribe as a sovereign domestic entity within the United States, with the power to govern itself and manage its own affairs.

The issue of road ownership is a fundamental part of any transportation project. The IRR system consists of nearly 40,000 miles (64,400 kilometers) of public roads and 940 bridges owned by the BIA and tribal governments and more than 61,000 miles (98,000 kilometers) of public roads owned by State and local governments and other entities. For any one roadway project, multiple owners might need to be involved if roads owned by different entities intersect. Even if there might be one road owner, multiple governments could exercise jurisdiction concurrently over road construction, improvements, and maintenance projects in tribal communities. Consequently, multiple and competing laws regarding contract negotiations and employee rights could come into play.

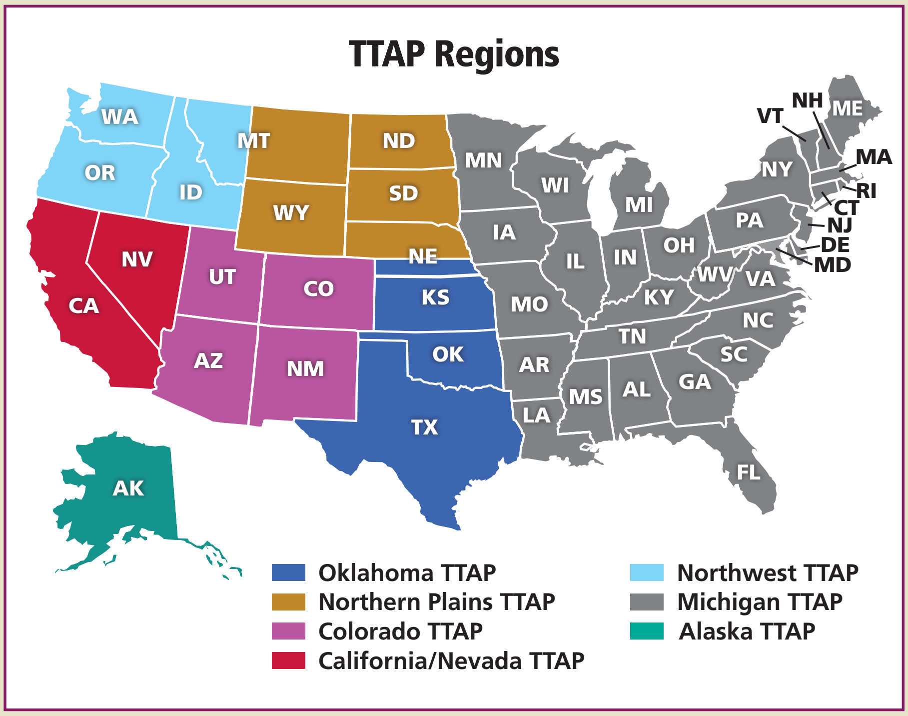
"Consultation between government entities, memoranda of understanding, or memoranda of agreement could be necessary to initiate, much less complete, a transportation project in Indian country," says Raquelle Myers, staff attorney with the National Indian Justice Center and the California/Nevada TTAP. "TTAPs address the training and technical assistance needs of tribes to help them understand the complex jurisdictional issues in Indian country, to engage the States in meaningful consultation, and to deal with issues concerning rights-of-way through Indian country."

Funding for Tribal Transportation

Due to the government-to-government relationship between tribes and the Federal Government, funding for tribal transportation systems comes directly from the U.S. Government—the U.S. Department of Transportation (USDOT), by way of FHWA, and BIA—to support the tribal IRR program priorities. The amount each tribe receives under the IRR program is determined by a formula driven by an annual inventory of transportation facilities eligible for Federal funding under the program. Tribes also are eligible for many Federal programs administered through State departments of transportation (DOTs).

Historically, tribes received Federal dollars for their transportation programs through a pool of money (IRR program funds) originated in FLH and administered through BIA. However, the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) provided an option for tribes meeting certain eligibility requirements to enter into IRR program agreements directly with FHWA, thus receiving their funds from FHWA rather than BIA. As of September 2009, 42 tribes had entered into these agreements.

FHWA allocates funding to BIA for those tribes working with BIA or the U.S. Department of the Interior's Office of Self-Governance, and then works with BIA to oversee and run the IRR program. Because FHWA is providing funding, both BIA and FHWA regulations (such as pertaining to environmental reviews and rights-of-way) apply to the IRR program. Since 2004, USDOT and BIA have used a software tool known as the Road Inventory Field Data System (RIFDS) to manage data needed for distributing transportation funds for planning, roads, and bridges. The



There are seven TTAP centers, each representing tribes located in specific States or regions of the country. *Source: LTAP/TTAP.*

National Tribal Transportation Conference

In November 2008, tribal transportation officials from across the country, as well as representatives from Federal, State, and local government agencies and the private sector, convened in Oklahoma City for the 11th Annual National Tribal Transportation Conference. The annual event features plenary sessions, vendor showcases, and a "roadeo" for equipment operators, during which participants compete with each other to perform precise movements or actions using various types of heavy equipment. The Tribal Technical Assistance Program (TTAP) centers collaboratively plan and host the annual conferences. Approximately 350 people attended the 2008 event.

John J. Sullivan IV for FHWA

At a "roadeo" for equipment operators held during the 2008 TTAP conference, skid steer operators attempted to knock this softball off a traffic cone without tipping over the cone.

Topics at the plenary sessions included right-of-way issues, asset management, road and equipment maintenance, safety, transportation and economic development, use of geographic information systems in tribal transportation planning, scenic byways, historic and cultural preservation, and transit planning and operations. One interactive session, dubbed the "IRR Planning Game and Tournament," gave participants an opportunity to compete in groups as they attempted to construct a transportation project while navigating through five categories of project development.

Speakers included FHWA Executive Director Jeffrey F. Paniati, who discussed FHWA's involvement and partnership in the Indian Reservation Roads (IRR) Program, and Leroy Gishi, chief of the Bureau of Indian Affairs' Division of Transportation, who shared his input on the status of the IRR inventory.

The 2009 National Tribal Transportation Conference was held in Phoenix, AZ, from November 16–19, 2009. For more information, visit http://ttap.colostate.edu.

software factors in adjustments for population growth and the relative needs of each tribe. RIFDS facilitates maintaining road and segment data, validating proposed data changes, managing the approval process for record changes at various levels, and generating a variety of reports. (Funding for IRR projects needs to be included in the appropriate State Transportation Improvement Program or other transportation planning venue to document fiscal constraint.)

Asset Management And Data Collection

Due to the nature of roadway ownership and jurisdiction on tribal lands, establishing partnerships and intergovernmental collaborations is critical to managing tribal roadway assets efficiently. Further, an effective asset management system can insulate tribal transportation personnel and elected officials, at least to some degree, from internal political influence as to what projects to build and rehabilitate, says Cheryl Cloud-Westlund, codirector of the Michigan Tech TTAP (which represents tribes in Minnesota and all States east of the Mississippi River and down to the Gulf of Mexico).

Using asset management software and principles to determine an appropriate mix of projects enables decisions to be based on data, use, and road conditions, "essentially removing the guesswork and individual posturing that comes with prioritizing road projects with limited resources," Cloud-Westlund says. "This process serves the interests of the users," while "saving the road owner money and extending the life and service of the roadway."

Because the tribal funding received from the IRR program depends on roadway inventories, tribes need accurate and up-to-date data on road mileage, crashes, safety problems, maintenance needs, and other network characteristics. But in many areas of the United States, crash reports collected by tribes and BIA are not regularly shared outside the enforcement community, so crash histories on Indian lands show few or no incidents. Lacking sufficient baseline and current data, tribes have to rely on national or State-level data to assess their roadways.

To address the lack of tribal-level data, the Michigan Tech TTAP is working with Michigan's Local Technical Assistance Program (LTAP) and a software development team to create an IRR version of "RoadSoft GIS." Michigan Technological University developed RoadSoft GIS software, which features geographic information system technology, to help local governments manage and analyze roadway and crash data. In March 2009, a product showcase at a meeting of the IRR Program Coordinating Committee in Washington, DC, demonstrated the value of the software for pavement and asset management and how the tribal version could incorporate elements of the IRR inventory.

At least one tribe is already using RoadSoft in partnership with a nearby local government. Michigan's Keweenaw Bay Indian Community, in collaboration with the Baraga County Road Commission, is maintaining the BIA inventory of its tribal roads, along with other county roads, using the software. Providing access to technology like this enables TTAP centers to help tribes and their local communities fill some of the existing data gaps, which will help improve transportation planning and asset management in the future.

Partnering and Intergovernmental Cooperation

With multiple jurisdictions and organizations involved in building, operating, and maintaining roads in Indian country, collaboration and resource sharing can help avoid duplication of efforts and equipment. TTAPs play a key role in promoting collaboration, Cloud-Westlund says. For example, TTAPs hold training on cross-jurisdiction collaboration, develop tools to make grassroots-level management easier, and teach tribes how to write and manage memoranda of understanding, contracts, and agreements. They build cultural and organizational understanding by educating State and local officials about the IRR program and how to work with tribes. And they educate tribes on how to leverage Federal, State, and local funds and how to manage and operate their road programs.

"When tribes want to know about Federal, State, or local programs, they come to TTAPs," Cloud-Westlund says, "And when Federal, State, and local officials want to know about tribes and their programs, they come to TTAPs. We are the common, neutral ground—a liaison and advocate for all."

One successful example is the establishment of a standing State-tribal committee in Minnesota that meets quarterly. The Minnesota Advocacy Council for Tribal Transportation consists of Minnesota DOT staff, representatives from each of the tribes in Minnesota, and other stakeholders, including cities, counties, FHWA, BIA, and the U.S. Forest Service. The Michigan Tech TTAP, which serves tribes in the Eastern and Midwest BIA regions, is a standing member of the committee, as is the Minnesota LTAP.

"This group has tackled common issues between the State and tribes, such as roadside vegetation management and signing," says Cloud-Westlund. "As a result of collaboration through this group, tribes now can order signs in bilingual format—English and Native language—through the Minnesota DOT sign shop."

Collaboration between tribal and local governments, such as the Keweenaw-Baraga partnership in Michigan, can deliver benefits ranging from resource sharing to improved asset management and more comprehensive transportation planning. Baraga County, located on Michigan's Upper Peninsula adjacent to Lake Superior, consists of five townships and two villages. The county is home to a population of 8,746, about 12 percent of which is Native American, and stretches across 904 square miles (2,340 square kilometers). The Baraga County Road Commission is responsible for the county road system, maintaining 496 miles (798 kilometers) of roads with operational funding from the Michigan Transportation Fund. The road commission receives the fourth smallest operational funding for county roads out of 83 counties in the State.

The Keweenaw Bay Indian Community is home to the Lake Superior Band of Chippewa, which has more than 3,100 enrolled members. The community is the largest and oldest reservation in Michigan, encompassing about one-third of the land area in Baraga County. With such a large area, much of the county road system lies within the reservation boundaries or serves the reservation and tribal members.

According to Douglas Mills, P.E., engineer and manager of the road commission, the close relationship between the tribe and road commission dates back to the early 1970s. "Many residents in the community had to travel through dust and mud," Mills says. "There was a need for blacktop roads, and the tribe assisted in financing the purchase of a blacktop plant for the county road commission." The tribe contracted with the road commission for many paving jobs on the reservation, enabling the agency to eventually pave more than 180 miles (290 kilometers) of roads cost effectively using a local workforce. Today, the tribe and road commission continue to collaborate on resurfacing and rehabilitating the roads improved during the 1970s and 1980s.

Douglas Mills, Baraga County Road Commission

Shown here is Arvon Road crossing Gomache Creek during a 2003 spring flood, before (left) and after (below) reconstruction. The project, completed in 2005, involved close collaboration between the Baraga County Road Commission and the Keweenaw Bay Indian Community, which performed damage assessments and followed through with other agencies to ensure that this critical asset remained safe and convenient for public travel.

Douglas Mills, Baraga County Road Commission

Jim Self, Oklahoma TTAP

The old Cimarron River Bridge, a multitruss steel structure built circa 1927 in Kingfisher County, OK, now is closed to vehicle traffic because it is structurally unsound and unable to handle modern traffic loads and volumes.

"The tribe's assistance over the years has had a long-lasting positive effect for everyone who uses the roads in Baraga County," Mills says. "Projects now are routinely completed by leveraging local, tribal, State, and Federal funding."

The intergovernmental collaboration includes both formal and informal agreements for planning and implementation. For example, the tribe and road commission use cooperative agreements to complete projects administered by BIA and local projects that benefit both communities. BIA staff provides support to both agencies on federally funded activities, including sharing expertise in road inventorying, planning, engineering, construction, and administration. Informal collaboration includes regular communication between the parties, cooperation in the transportation planning process, participation in training, and resource sharing. In addition to offering technical expertise in transportation topics, TTAP centers close the understanding gap between the various jurisdiction levels, effectively teaching and facilitating relationship building.

Over the years, the tribal council and road commission have logged a long list of joint projects. For example, in the past 15 years, 8 of the county's 42 bridges have been replaced through cooperative efforts. In 2002 and 2003, the agencies worked together to repair 12 sites damaged during flooding, at a cost of $1.2 million. The agencies improved numerous drainage structures throughout the area, increasing the size of culverts and providing for fish passage; completed a 3-year traffic-counting program throughout the county and reservation; and are collaborating on an adopt-a-roadway program on the reservation.

"Both agencies are focused on improving transportation for their constituents," Mills says. "Key to success is building relationships and mutual respect with each other as we try to reach our goals." His advice to others: "Meet on a regular basis and take the time to develop the relationships that will help the people you serve."

IRR Bridge Program

Bridges, in addition to roads, are an integral part of the surface transportation system—both on and off the reservation. To help tribes manage these critical assets, under the umbrella of the IRR program, FHWA and BIA jointly administer a pool of funding set aside for planning, design, construction, and maintenance related to existing bridges. SAFETEA-LU funded the IRR Bridge Program at $14 million per year for fiscal years 2005 through 2009. Tribes can use the funds to improve structurally deficient and functionally obsolete IRR bridges. To be eligible for replacement or rehabilitation under the program, a bridge must span 20

Jim Self, Oklahoma TTAP

The new Edward Harrison Sr. Memorial Bridge (right), named after a former chief, stands beside the obsolete bridge it replaced (far right). The old bridge, closed to vehicular traffic, will remain as a historic structure, open to foot traffic.

In Aleknagik, AK, some children travel to and from their school on boats like this until the water freezes over, when snowmobiles become the transportation mode of choice.

Jeff Ambrosier, Aleknagik School District

feet (6 meters) or more; be on a public road that meets the definition of an Indian reservation road; be unsafe due to structural deficiencies, physical deterioration, or functional obsolescence; and be listed in the National Bridge Inventory.

Because the U.S. Government owns the BIA bridges on Indian reservations, the program gives primary consideration and priority to eligible projects related to BIA- and tribal-owned bridges. If a State or county owns the bridge, the Federal contribution is 80 percent, with a required 20 percent local match. Tribes also can use regular (that is, road-related) IRR program funds for bridge projects.

"One of the major success stories here in Oklahoma is that, since inception of the IRR Bridge Program, tribes have used the funding to build or replace more than 80 bridges," says Jim Self, manager of the Oklahoma State University TTAP, which serves 44 tribes in Kansas, Nebraska, Oklahoma, and Texas. The projects range from simple structures spanning creeks and other small waterways to more complex structures such as a new bridge over the Cimarron River in Kingfisher County, OK, built by the Cheyenne and Arapaho tribes in cooperation with Kingfisher County and the Oklahoma DOT.

Establishing partnerships can help identify mutually beneficial projects and maximize funding to complete them. "If you are a county and cannot afford to build a needed bridge, the tribe in your area may be able to help," Self says. "If the bridge meets all of the requirements and is on the tribe's IRR bridge inventory, you might be able to access supplemental funding. A small infusion of capital can make a big difference."

He adds, "Besides providing better, safer bridges, the IRR Bridge Program is also good for tribal public relations. Many people don't know how much the tribes contribute to their local communities. A new bridge is usually a pretty obvious contribution." In partnering scenarios, signs or plaques posted on or near the completed structures, as partner entities do in Oklahoma, can give credit and recognition to the contributing entities.

As part of their training and technical assistance role, TTAPs offer or facilitate bridge construction, maintenance, and inspection classes and assistance.

Transportation Planning in Alaska

The types and conditions of roads on tribal lands can be all over the map. "I've seen some tribes whose roads are like those of third world countries," says Cloud-Westlund, from the Michigan Tech TTAP. "And the general population of motorists who drive on interstates and paved roads have no idea about the road conditions tribes typically operate on."

In Alaska, public "roads" even transcend pavement and gravel: "Many communities are not connected by traditional roads but by a river or an airport that brings goods and services to communities," says Kimberly Williams, director of the Alaska Tribal Technical Assistance Center (TTAC).

In Alaska's South Naknek, children are flown to school each morning because a river separates the community of Naknek from South Naknek. Similarly, in Aleknagik, the school is located on the North Shore, so children who live on South Shore Aleknagik travel to school each morning by boat. In the winter, they use an ice road, which is marked by spruce trees, to cross Aleknagik Lake by snowmobile.

Another distinctive feature of the tribal transportation system in Alaska is that in the winter, with heavy snows blanketing the region, travelers rely on trail markers (wooden stakes) to help them navigate when moving between communities. "From Barrow to Nome or Bethel to King Salmon, it is common for family members to visit one another in the winter using snowmobiles and following trail markers to guide their way," Williams says.

All this is to say that transportation planning for Alaska's tribal members can involve an altogether different approach. "Alaska is pretty complicated with land ownership and the many players involved in advancing transportation," Williams says. In rural Alaska, it is common to see a municipal government, tribal government, Alaska Native Claims Settlement Act village corporation, and regional corporation working hand in hand with the Alaska Department of Transportation and Public Facilities. In some instances, another layer of government that might be involved is a borough, which plays a role similar to that of a county. To advance an IRR project, a tribe needs to involve all these stakeholders from the planning process on through construction, which is required by SAFETEA-LU planning requirements.

Pooling resources through nonprofit organizations is one way tribes are coming together to meet

Tribal Transportation Safety Summits

In 2008 and 2009, stakeholders in tribal transportation safety came together for 1-day summits held in Arizona, Minnesota, New Mexico, Washington, and Wisconsin to develop ideas and identify resources to reduce fatalities and serious injuries on tribal roadways. FHWA's Office of Federal Lands Highway sponsored the Tribal Transportation Safety Summits in coordination with FHWA division offices, State DOTs, TTAP centers, BIA, and other safety partners. The objectives were to prioritize safety issues and challenges for tribal transportation, identify safety resources available to the tribes, and develop processes for continuing a dialog among the Federal, State, and tribal transportation communities.

Overall themes included the four E's (engineering, education, enforcement, and emergency medical services) and data collection. Other themes have included transportation safety planning, leadership support for safety policies, and tribal education and training. The summits help foster existing partnerships and serve as a starting point for creating new ones.

The summits offered an opportunity for tribes to share practices. For example, the White Mountain Apache Tribe discussed using a simple, low-cost communications technique to share important safety messages with community members: The tribe distributes paper placemats with safety messages to local restaurants. And the Yavapai-Apache Nation invited a Safe Routes to School expert to visit the tribe and help them identify and address safety problems facing schoolchildren.

Participants inform tribal elders, leaders, and other safety stakeholders in their communities about the results and lessons learned to raise awareness and stimulate thinking about future directions in transportation safety education, enforcement, engineering, and data improvements.

For more information, visit http://flh.fhwa.dot.gov/programs/irr/safety.

transportation challenges. For example, the nonprofit corporation Kawerak provides services to improve the social, economic, educational, and cultural conditions throughout the Bering Strait region. "Many times small communities may not have the IRR tribal shares [funding from the IRR program] to move a project from planning to construction," Williams says. "But by working together through Kawerak, tribes are able to meet the transportation challenges for both large and small villages in northwestern Alaska."

The Alaska TTAC provides training to help tribal transportation personnel understand their rights and responsibilities, and to promote dialog with other stakeholders. "We participate in statewide transportation forums that bring many stakeholders together to discuss issues of common concern and how to achieve better working relationships with each other," Williams says.

Partnering and intergovernmental cooperation help stretch limited training dollars too. The Alaska LTAP center, for instance, recently hosted grader training and invited tribal transportation personnel to attend the course. Similarly, the TTAC collaborates with the Alaska Department of Transportation and Public Facilities' Civil Rights Office to promote employment of Alaska Natives on transportation projects. "Alaska is such a huge State," Williams says. "With our limited resources, if we didn't partner, we would not have the ability to offer these workshops individually."

Sharing Safety Solutions

Improving the safety of roads and mobility on tribal lands is another key focus of the TTAP centers. According to FHWA, motor vehicle crashes are the leading cause of death for American Indians between the ages of 5 to 44. TTAPs help FHWA encourage use of tools that can help improve safety, two of which are road safety audits (RSAs) and road safety audit reviews (RSARs). FHWA defines an RSA as a formal examination of the safety performance of an existing or planned road or intersection by an independent audit team. Some highway agencies define RSAs as assessments of *planned* facilities, while RSARs cover reviews of *existing* roadways. Both rely on independent review teams that perform site visits at targeted intersections or segments of roadways and then prepare written reports for the roadway owners, detailing the problems and recommending solutions to improve safety. Team members typically come from diverse backgrounds, including traffic safety, engineering, planning, design, construction, human factors, and law enforcement. TTAP centers help FHWA promote the use of RSAs by offering training and participating in audit reviews.

In May 2005, FHWA sponsored a series of four RSAs on tribal lands

Opus International Consultants

During an FHWA-sponsored RSA with the Standing Rock Sioux Tribe, the audit team visited Highway 1806 at the Four Mile Creek Bridge, where the tribe had identified maintenance issues as a safety concern.

and published the results in a report, *Tribal Road Safety Audits: Case Studies*. One of the RSAs took place on the reservation of the Standing Rock Sioux Tribe, which stretches across more than 2.3 million acres (930,800 hectares) in North and South Dakota. The road network, with segments owned or maintained by the tribe, BIA, the North and South Dakota DOTs, and counties, consists of paved and gravel roadways and secondary highways in rural and low-density urban environments. In addition to connecting the reservation's communities, these roads serve through traffic and provide access to the tribe's two casinos.

Sharon Johnson, safety and traffic engineer with the FHWA South Dakota division office, nominated Standing Rock Sioux Tribe to participate in an RSA case study because of its proactive stand on roadway safety and injury reduction. "The Standing Rock Sioux Tribe is well represented on several of our statewide safety committees and has shown a sincere desire to improve the safety of the traveling public," Johnson says. "The tribe was in the process of building a new school and was concerned about access to the highway. They also had concerns about access to a casino that had questionable sight distance."

The RSA team included representatives from the Standing Rock Sioux Tribe, Northern Plains TTAP, FHWA North Dakota and South Dakota division offices, North Dakota and South Dakota DOTs, BIA, North Dakota State University, and a contractor. The audit team drove the reservation roads to identify safety issues associated with road geometry, traffic operations, and maintenance.

Pete Red Tomahawk, director of transportation development and planning for Standing Rock Sioux Tribe, says the RSA identified specific steps his tribe can take to improve safety. For example, the tribe is signing an agreement with the South Dakota DOT to reduce the speed limit from 65 miles per hour, mi/h (105 kilometers per hour, km/h) to 55 mi/h (89 km/h) on a section of high-traffic roadway that crosses the Missouri River and curves toward the entrance to a casino. Another planned improvement is adding turning and acceleration lanes and installing lighting to alert motorists as they approach the casino. "Safety is a huge concern for our tribe," Red Tomahawk says. "A few years ago, three brothers died in a crash in this area. By lighting it up, we hope to help prevent crashes and save lives."

The Standing Rock RSA team visited this location on Highway 1806 in Kenel, SD. Here, the tribe was concerned about pedestrian safety, as the highway separates a residential area from the local grocery store.

Opus International Consultants

The RSA also improved coordination with the State DOTs and BIA on addressing tribal transportation issues. The tribe now participates in meetings with the States to ensure that tribal considerations are factored into State Transportation Improvement Programs. And in February 2009, the Northern Plains TTAP, FHWA, South Dakota DOT, and several tribes partnered to host a safety conference in Pierre, SD. The purpose of the conference was to focus on the future of transportation safety in South Dakota. Sessions covered transportation safety issues on reservations and development of tribal transportation safety plans.

Another safety improvement that has resulted from better communication between the States and the Standing Rock Sioux Tribe is installation of centerline rumble stripes and shoulder rumble strips on Highway 1806, south of the community of Mandan, ND. Highway 1806 is a busy two-lane road with relatively narrow shoulders that receives a lot of use due to a casino located between Mandan and Fort Yates. "This is one of first times centerline rumble stripes have been used in North Dakota," says Dennis Trusty, director of the Northern Plains TTAP. "This project happened as a result of conversations after the RSA, as the States and tribe continue working together to improve safety."

Red Tomahawk underscores the important role the TTAPs play in facilitating interagency and intergovernmental cooperation that can lead to improved safety. "TTAPs are strong advocates for RSAs and a critical partner in bringing together experts who can identify areas of concern and recommend safety improvements," he says. "The bottom line is preventing injuries and saving lives."

Workforce Development And Capacity Building

Whereas States and municipalities have managed their transportation systems autonomously for many years, tribes began overseeing their own transportation programs only after passage of the Intermodal Surface Transportation Efficiency Act of 1991, with a 2 percent planning set-aside. "Tribes are now developing their workforces," says Richard A. Rolland, director of the Northwest TTAP.

Transportation and public works are key components of tribal government that tribes have not always recognized in the past but are now rapidly moving to address. This movement underscores an expanding need for tribal members with careers in the sciences, engineering, and business.

The TTAP centers play a significant role in this effort by offering training and technical assistance to help tribes manage their road programs, understand the legislative processes and how to access funding sources, and create partnerships with other tribes, municipalities, agencies, and organizations. For example, a TTAP center can help a tribe develop GIS maps for transportation. "Many tribes have GIS maps for forestry and mining resources but not transportation," Rolland says. "The TTAP can provide assistance

Dick Winchell, EWU

Casey Moore, an EWU student with the Confederated Tribes of the Colville Reservation, downloads information for a tribal census project.

and training to help tribes gather data and plot maps suitable to meet BIA requirements."

The Northwest TTAP recently completed a GIS demonstration funded through the State of Washington and FHWA. The project links the GIS programs of Washington State, local counties, the U.S. Forest Service, and the Confederated Tribes of the Colville Reservation to maximize effectiveness in addressing transportation needs.

For tribal governments, workforce development and capacity building require a two-pronged approach: (1) developing the skills and knowledge of existing staff and (2) recruiting new generations of transportation professionals. TTAPs assist in delivery of key resources developed through the Coordinated Technology Implementation Program (CTIP), administered by FHWA's FLH. One is a series of videos that identify and discuss transportation careers and opportunities for American Indians. Unemployment is extremely high on many reservations, nearly twice the national average according to the U.S. Department of Justice. Introducing tribal members to the array of occupations in the transportation industry is vital.

A second opportunity is working with the Tribal Employment Rights Offices and facilitating coordination with State and local DOTs, as well as business operations on and near reservation lands. A third area is supporting the development of tribal and individual businesses through training and access to resources such as the ONABEN Indianpreneurship® program, which promotes Native American business development and entrepreneurship.

In many cases TTAP centers are housed within university systems, a situation that offers win-win opportunities for the tribes, universities, and students, and creates an opportunity to recruit and support American Indian students in new career paths. The Northwest TTAP, administered through Eastern Washington University (EWU), has supported local chapters of two national campus organizations that work to attract students interested in Indian affairs and help them network locally and around the country. One is the American Indian Business Leaders (AIBL), which supports and encourages American Indian students in the fields of business and planning networking. The other is the American Indian Science and Engineering Society (AISES), which aims to increase the number of engineers and scientists of American Indian descent. By supporting organizations like these, the TTAP is helping increase the visibility of Native American issues in higher education and grow the pipeline of young professionals with the leadership and technical skills to oversee tribal transportation systems.

"We hope our local chapters serve as a model for additional outreach and partnerships with other universities, community colleges, and high schools to establish local programs," says Dick Winchell, professor of urban planning at EWU and a principal investigator for the Northwest TTAP. "Our AIBL chapter, for example, has set a goal to work with local reservation high schools to create an AIBL chapter a year in partner high schools, in addition to supporting students at EWU." Both organizations help American Indian students understand and become comfortable in mathematics, sciences, engineering, and business curricula, and enable them to interact with American Indian professionals, engineers, and entrepreneurs.

"AISES is an organization that stands by its mission to enable students to achieve success through degrees in science and engineering," says Casey Moore, president of EWU's AISES chapter and a member of the Confederated Tribes of the Colville Reservation. "The organization clearly understands the benefit of supporting students who already have a 'Native' perspective. As a student involved with AISES, I have the opportunity to apply for scholarships and summer internships and to network with representatives from companies. AISES also teaches students how to be leaders. I know that by being involved with AISES I have made lifelong connections with other students and AISES board members and staff."

The Northwest TTAP also works with EWU students in the tribal

Dick Winchell, EWU

Tribal planning students from EWU and Coeur D'Alene Tribal Transportation Planner Francis "Lux" Devereaux (right) prepare for a smart growth charrette at the tribal headquarters.

planning program to conduct field research. A recent project invited students to complete a charrette (workshop) for a nearby tribe to assess the potential impact of smart growth principles on tribal transportation. The tribal planning director and transportation planner assisted in identifying key issues facing the tribe and selected a project site for the class to assess. Ultimately, the project results were presented to the tribal council and led to a number of followup activities, including a session on smart growth for tribal transportation planning at the TTAP-sponsored National Tribal Transportation Conference in November 2008.

"We also encourage our planning students to work directly for tribal governments as interns, and those students have completed a number of important projects," Winchell says. One student, Chamisa Bird-Radford, a member of the Spokane Tribe of Indians, helped develop and complete a tribal survey to assess transit demand and developed a transit plan for the tribe, working with professional planners and engineers. Bird-Radford also prepared a poster session on her work for the Transportation Research Board's annual conference in January 2009.

Tribes and ARRA

On February 17, 2009, President Obama signed the American Recovery and Reinvestment Act (ARRA) of 2009. Of the $26.6 billion available for highway investment, $310 million was allocated to the IRR program. FHWA will administer and distribute the ARRA funds according to the relative need distribution and population adjustment factors in the existing allocation methodology, with tribal shares determined according to fiscal year 2009 percentages. Like IRR funds, ARRA dollars are 100 percent Federal share, and tribes can use them to satisfy local match requirements on construction projects.

Unlike the States, which had 120 days to obligate half the ARRA money and use the rest by September 30, 2009, the tribes have until September 30, 2010, to obligate all IRR funds. Funds released or de-obligated after that date immediately expire and will not be available for re-obligation by any agency. To ensure use of the ARRA funds, the act authorizes the Secretary of Transportation to gather unobligated funds and redistribute them within the IRR program in February 2010.

"The ARRA IRR funds are a major challenge to administer, as funds are eligible for distribution to all 562 federally recognized tribes," says FLH Associate Administrator John Baxter. "That's where the TTAP centers can be very helpful—in providing technical assistance to tribes on the provisions of the ARRA and how to use the funds wisely in the short time they are available. For example, smaller tribes may not receive sufficient Recovery Act funds for a major construction project but do have the opportunity to implement low-cost safety improvements or use their funds as leverage with another partner. The TTAPs can help tribes understand their options."

To help tribes put these funds to use, TTAP centers are providing an assortment of services, such as developing information bulletins to help tribes understand ARRA policies, procedures, and reporting requirements. TTAPs also are sponsoring webinars and workshops focused on project management, covering the full range of steps from preconstruction activities to daily project management to inspections and project reviews.

For an IRR-eligible project to advance using the recovery funds, the project needs to be included in an FHWA-approved transportation improvement plan. In addition to construction projects, tribes can use ARRA funding for maintenance activities, as well as operational and safety projects. For smaller tribes in particular, Baxter recommends partnering with other agencies if possible, or defining a smaller project. Eligible projects could include chip seal and dust suppression projects, traffic signal and sign upgrades, traffic monitoring and weigh-in-motion equipment, dynamic message signs, road weather information systems, and guardrail replacement. Many of these types of projects, activities, and investments require limited or no environmental review time, making them attractive for quick deployment.

Moving Forward

The IRR program continues to grow, reflecting the growing needs of tribes to provide what is in many cases basic transportation infrastructure for their communities. "The IRR funds are vitally important to the economic future of tribes, to attract jobs and improve accessibility to employment opportunities," says FLH Associate Administrator John Baxter. "These funds are a fundamental building block for tribes to establish safe, livable communities through improved access to schools, basic health care, and hospitals."

As the transportation and economic development needs of tribal governments continue to evolve, so will the role of the TTAP centers, which deliver customized services and technical assistance to help streamline and improve tribal transportation.

Dick Winchell, EWU

This site, near Plummer, ID, was the focus of a charrette on smart growth opportunities for the Coeur D'Alene tribe.

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For more information, visit www.ltapt2.org or www.ltap.org, or contact Clark Martin at 703–235–0547, clark.martin@dot.gov. To locate a TTAP center, visit www.ltapt2.org/centers.

Developing Advanced Methods of Assessing Bridge Performance

The Federal Highway Administration (FHWA) strives to improve the performance of the U.S. highway system, where performance is described at the system level in terms of safety, reliability, effectiveness, and sustainability. The challenge is to understand and define the performance of various components of the system in terms of a common set of objective metrics, so that engineers can measure and improve the performance of each asset and critical component, and ultimately the entire system.

Transportation professionals currently describe the condition and performance of bridges and pavements by different and unrelated measures (for example, condition ratings, sufficiency rating, and health index for bridges; roughness index for pavements; and level of service for traffic).

FHWA researchers are working to improve safety, reliability, and other metrics for ongoing analyses of the condition of highway structures.

by Hamid Ghasemi, John Penrod, and John M. Hooks

"There are no uniform performance metrics or performance indicators for bridges in the United States, despite the fact that the current knowledge base of inventory information and condition data on bridges is by far the most extensive in the world," says Tom Everett, principal bridge engineer, FHWA.

Everett adds, "Currently, bridge inspection standards, methods, and the tools used for managing bridge programs are exemplary. But the level of understanding of how bridges perform and how to measure their performance satisfactorily falls well short of the optimum. Because of a general lack of critical data and an inadequate understanding of the multiple cause-and-effect relationships that govern the many aspects of bridge performance, most attempts at assessing that performance rely only on expert opinion, assumptions, and generalizations."

This problem is particularly exemplified when bridge performance is examined at the component level. A prime example is the performance of different kinds of bridge decks under varying types of environmental conditions, traffic loadings, maintenance practices, and protective measures.

To fill this knowledge gap, the Long-Term Bridge Performance (LTBP) Program has identified several high-priority issues where field investigation and analysis of the existing relevant data will provide quantitative measures of bridge performance. Collaboration with a number of State departments of transportation (DOTs) identified these high-priority performance issues.

The Bridge Infrastructure

A brief look at data from the National Bridge Inventory (NBI) provides a revealing picture of this large and vital public asset. The NBI database contains records for 600,000 structures, of which approximately 473,000 are single-span or multi-span bridges that carry roadway traffic over some other roadway or topographical feature, usually a stream or river. These bridges range from the typical overpass structures to magnificent signature bridges such as the Golden Gate Bridge, the Brooklyn Bridge, and the Sunshine Skyway Bridge.

Within this range, the diversity of the bridge infrastructure in terms of age, type, material, width, and length is broad. Several of these factors and others govern the performance of bridges, help explain differences in performance from one bridge to the next, and help predict future performance.

Age. The average age of the 473,000 bridges in the NBI is 40 years old. Age serves as a rough measure of the aggregate service provided by a bridge during its life. Age data also roughly correlate with periodic advancements in bridge materials, design standards, and construction processes. These advancements generally improve current and future performance.

(Left) This span in northern Utah is one of the pilot bridges being studied under FHWA's Long-Term Bridge Performance (LTBP) Program, which is developing uniform performance metrics for highway spans. *Photo: Utah State University.*

Service conditions. Service conditions might vary dramatically in terms of traffic volumes carried, truck loadings (including permit loads), and level of vulnerability to natural forces such as environmental, climatic, and hydraulic impacts, including ice, debris, wind, and seismic loadings. In many cases, the potential exists for significant damage from vessel or vehicular collision.

Type, frequency, and effectiveness of preservation, maintenance, repair, and rehabilitation. These factors vary significantly based on the level of experience and knowledge of the bridge personnel from the owner/agency, quality of work that is often performed by contractors, funding available for bridge programs, and agency priorities.

The NBI records also describe bridges using many different attributes and parameters, such as kind of material and design load.

Goals of the LTBP Program

Launched in 2008, the FHWA LTBP Program is a 20-year (or longer) major research effort addressing a number of objectives, such as achieving a deeper understanding of bridge performance, developing methods to measure it reliably, and using those measurements to improve the Nation's bridge infrastructure and thus the performance of the transportation system. FHWA will use the knowledge gained from the LTBP Program to solve a variety of problems related to bridge condition assessment and management, to develop new measurement tools, and to advance knowledge of bridge design, construction, inspection, maintenance, and preservation.

Specific goals include determining how and why bridges deteriorate (that is, advances in predictive models); determining the effectiveness of various management practices and maintenance, repair, and rehabilitation strategies; examining the effectiveness of durability strategies for new bridge construction, including selection of materials; and facilitating improvements in management practices through the use of quality data.

LTBP Strategic Plan

The LTBP Program is a large and complex undertaking that requires a carefully thought-out process for its success. A well-defined strategic action

This overpass in northern Virginia near the District of Columbia is another one of the bridges selected for the pilot study and is typical of the structures that the LTBP Program will be studying.

plan, with seven key steps, provides the program's overall direction.

This strategic plan is based on a heuristic (experience-based) approach in which the FHWA researchers have to define bridge performance first before initiating the data collection phase. Rather than establishing linear steps, the strategic plan requires ongoing quality control and assurance back to earlier phases as each of the remaining steps is reached. In other words, the process is iterative and will be refined multiple times during the life of the program, yielding new information.

Step 1: Defining Bridge Performance

The transportation user community expects bridges to accomplish their purpose (that is, to perform) in a satisfactory manner as measured against several objectives. Bridges should present a minimal safety hazard to users and minimal obstruction to the free flow of traffic during normal service, produce a minimal negative impact on the local and global environments during construction and subsequent maintenance work, ensure an acceptable level of risk against catastrophic failure, present an aesthetically pleasing appearance, and accomplish all of these objectives with minimal life-cycle costs.

Transportation agencies strive to meet these objectives based on the best available understanding of how bridges perform under various sets of service conditions. The logical starting point for the LTBP Program's path to improved understanding of bridge performance is to break it down into specific issues and evaluate the existing gaps in knowledge that hinder understanding.

In the early development of the LTBP Program, the researchers clearly understood that the definition of bridge performance must be responsive to the needs of the primary stakeholders: the State and local DOTs and private road authorities that own and manage the bulk of the Nation's bridge infrastructure, along with Federal agencies and the bridge engineering community at large. These stakeholders are the ones who will apply the knowledge and lessons learned from the LTBP Program. To best serve these stakeholders, one of the early decisions was to establish an overall definition of bridge performance that addresses four broad categories: structural condition, structural integrity, functionality, and costs.

Diversity of Bridge Characteristics

NBI Item	Number of Types
Kind of material, main span, and/or approach span	10
Structure type, main span, and/or approach span	23
Design load	10
Bridge posting	6
Deck structure	9
Wearing surface	9
Membrane	5
Protective system	9

A critical factor in developing a more specific definition of bridge performance was outreach to the States. Members of the LTBP Program held focus group meetings at the offices of 10 State DOTs. The focus groups consisted of DOT experts responsible for the design, construction, inspection, management, and maintenance of bridges. The purpose was to determine the aspects of bridge performance that are considered the highest priorities by these DOTs.

The major findings were remarkably similar from State to State. Regardless of the geographic region, high on the list of priorities were performance issues related to concrete decks, joints for bridge decks, scour at substructures, and deterioration of concrete substructure units. The approaches each DOT takes to these problems differ widely, but there was a consistent desire to understand the performance issues better and to refine or revise the approaches to ensure better performance.

Based on the LTBP Program's internal research and on the input from stakeholders, the researchers identified 20 bridge performance issues and grouped them into different categories. The knowledge gained through the program might increase or decrease the number of issues. Bridge experts from the program grouped the issues into like categories. (See "High-Priority Performance Issues" on page 32.)

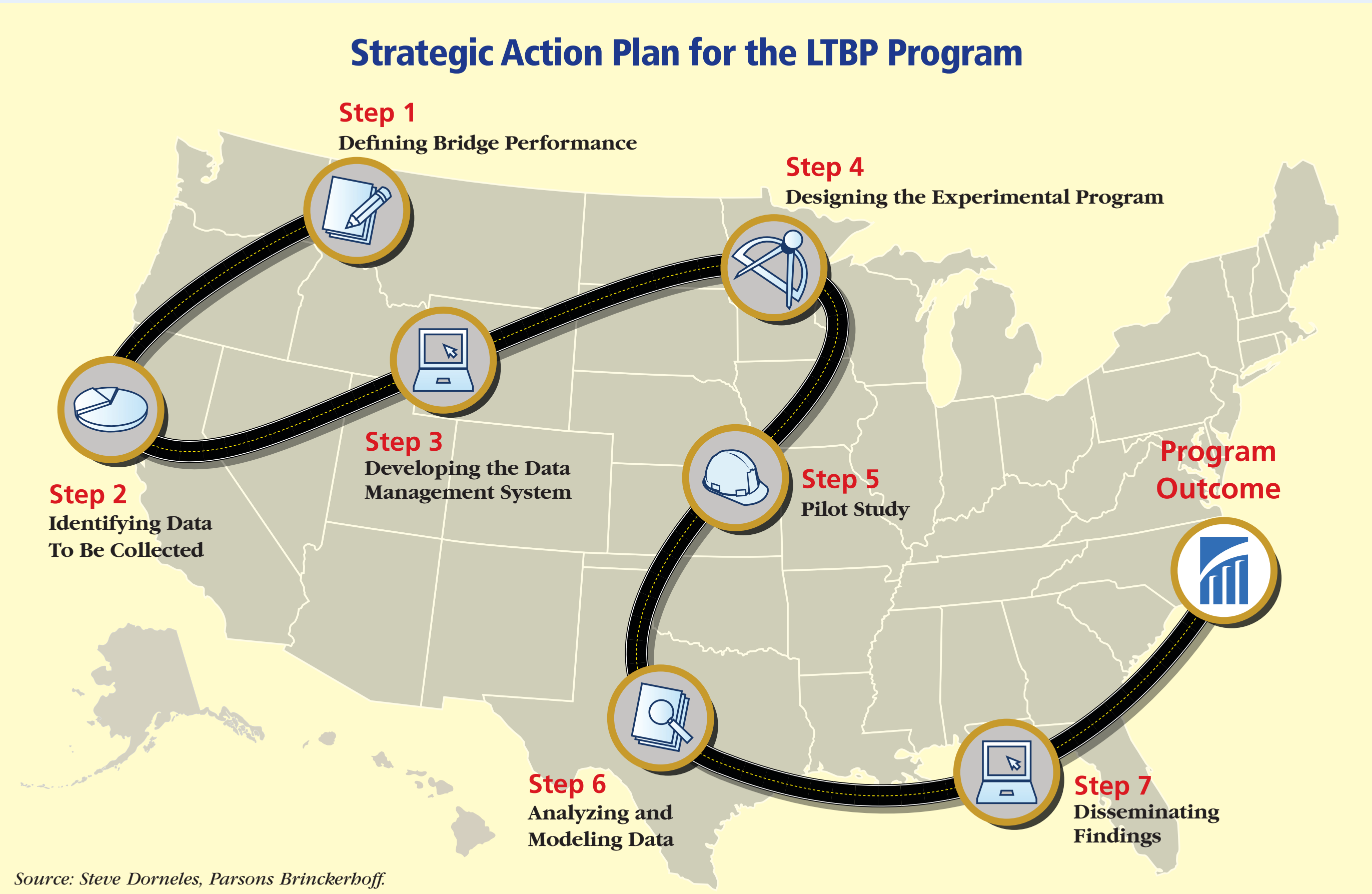
Step 2: Identifying Data To Be Collected

The effort to define bridge performance leads somewhat seamlessly into the next three steps, which are in turn interrelated. The process by which the second step is achieved involves addressing each of the high-priority bridge performance issues by identifying the knowledge available to analyze each issue, the critical gaps in current knowledge, the specific parameters that might be useful in characterizing the issue, and the methodology required to obtain high-quality data for each parameter.

Also required is deciding among visual inspection, destructive or nondestructive testing, and sensors for long-term monitoring; determining whether practical, effective, and affordable technology is available to gather the necessary data; and establishing whether standard testing methods exist or if custom protocols must be developed. The final stage in step 2 is adopting and developing specific data collection protocols for each of the chosen data collection methodologies.

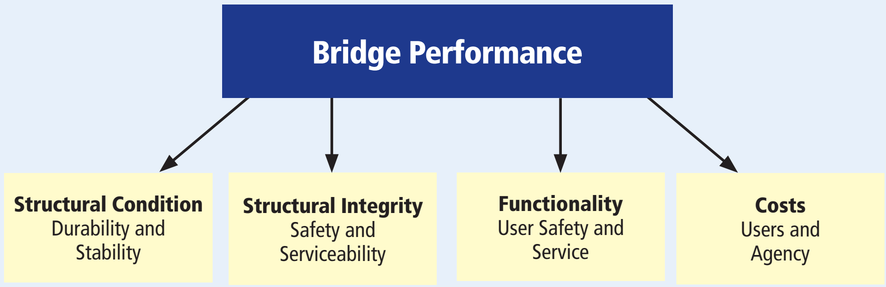
For almost all bridges, a large amount of data has been generated, collected, and stored because of previous activities related to that bridge. This "legacy data" may include design specifications, as-built plans, inspection reports, maintenance history, traffic data, crash data, weather data, etc. To the extent possible, this data will be extracted from existing files, reports, and electronic databases for use in evaluating various aspects of performance.

In addition to legacy data, the LTBP Program will gather a large volume of quantitative field data gleaned from detailed visual and hands-on inspections, nondestructive testing, embedded sensors for periodic long-term monitoring, and live load tests. Together with additional bridge-related data (for example, geospatial and weather data), this will represent an immense



Source: Steve Dorneles, Parsons Brinckerhoff.

Main Categories of Bridge Performance Issues



Source: FHWA.

source of information helpful for a better understanding of bridge performance and deterioration.

To exploit this information efficiently, however, the bridge engineering community needs a new generation of data management and analysis tools. These new tools will be created as part of the development of the data infrastructure described in step 3.

The process of accomplishing step 2 and the results achieved provide critical input into steps 3 and 4, while feedback from those steps helps refine and improve the conclusions achieved in step 2.

Step 3: Developing the Data Management System

The LTBP Program aims to provide a single source of information for researchers, bridge owners, and other stakeholders seeking detailed information from heterogeneous data sources to develop more accurate bridge performance models. The data and information collected in the LTBP Program will provide a more detailed and timely picture of bridge health, improve knowledge of bridge performance, and ultimately help promote the safety, mobility, longevity, and reliability of the Nation's highway transportation bridges.

To support these goals, the LTBP Program developed an open, scalable, and extensible data management and analysis infrastructure. Openness will be achieved by designing software components with documented interfaces that use service-oriented architecture components for intercomponent communication. Scalability will be achieved by allowing seamless integration of additional hardware to address increasing data volume and usage requirements. Extensibility will be achieved by designing the data infrastructure in a modular and flexible way that enables system administrators to add new data sources and types with characteristics similar to existing data sources.

The researchers will use state-of-the-art data warehousing and mining techniques to facilitate efficient verification and large-scale testing of new research hypotheses. The data integration framework is based on a hybrid model in which the various data sources are linked and brought together in the same data warehouse. A software middle layer, mapped to the actual database, ensures a smooth and transparent integration of various data sources. In addition, the middle layer also can handle federated data supplied by other systems or databases via Web services. The core LTBP data warehouse itself is distributed across several computers in order to ensure a fast querying process.

To support the needs of various user groups, the proposed data infrastructure will employ recent advances in visualization technologies, such as Internet applications that enable users to interact with the data in dynamic, interactive ways

High-Priority Performance Issues

Category	Issue
Decks	Performance of untreated concrete bridge decks
	Performance of bridge deck treatments (membranes, overlays, coatings, sealers)
	Performance of precast reinforced concrete deck systems
	Performance of alternative reinforcing steels
	Influence of cracking on the serviceability of high-performance concrete decks
Joints	Performance, maintenance, and repair of bridge deck joints
	Performance of jointless structures
Steel Bridges	Performance of coatings for steel superstructure elements
	Performance of weathering steels
Concrete Bridges	Performance of bare or coated/sealed concrete superstructures and substructures (splash zone, soils, or exposed to deicer runoff)
	Performance of embedded or ducted prestressing wires and post-tensioning tendons
	Performance of prestressed concrete girders
Bearings	Performance of bridge bearings
Foundations and Scour	Direct, reliable, timely methods to measure scour
	Performance of scour countermeasures
	Unknown foundation types
	Structure foundation types
New Construction	Performance of innovative materials and designs
Risk	Risk-based management approach
Functionality	Operational performance of functionally obsolete bridges

from anywhere at any time; an interactive, map-based user interface; and a set of automated interfaces for programmatic access to data. For example, one Web-based application enables users to search for bridge structures based on cross-domain criteria, such as weather statistics, traffic information, and condition ratings from the past 20 years.

Step 4: Designing the Experimental Program

The work included in this step provides the detailed framework for each experimental study that will address one of the high-priority bridge performance issues. The thought process behind each study also provides input into the final stage of step 2 (adopting and developing specific data protocols for each of the chosen data collection methodologies). Once each specific study is designed, the final approach to data collection on the critical parameters can be revised as necessary. The revision might mean eliminating or adding parameters to fine-tune the data collection protocols and/or modify the testing frequencies.

A well-designed experimental program is the key to collecting data that will support a better understanding of bridge performance. The design begins with postulating the critical questions about what governs the performance issue being studied. For example, when considering bridge decks that are untreated (that is, have not been overlaid with a wearing course or treated with a sealing compound), critical questions might include the following:

1. What is the current condition of the deck concrete?
2. What is its permeability?
3. What is the rate of deicer application on the deck?
4. What is the existing chloride profile in the deck?
5. What is the rate of corrosion, if any, on the reinforcing steel?
6. What are the annual climate fluctuations in the vicinity of the bridge?
7. What is the truck load history that this deck has been exposed to?

In addition to current values, how will the value of these parameters or measurements change over time? A proper experimental study can be developed only after such questions are addressed.

Each experimental study will be developed to assess the relationships of one or more of these critical issues to some aspect of the performance of the deck. For example, studying annual climate fluctuations might elicit data that suggest a significant relationship between freeze-thaw cycles and a measured level of scaling of the surface of a concrete deck. Each study's parameters will include types of testing to be done and the instrumentation and sensors to be deployed. For example, answering the question about the condition of concrete decks might require a field survey of a deck using the conventional chain drag method (chain dragged across deteriorated concrete makes a hollow sound) or mapping cracks visible on the surface or taking advantage of technology such as ground penetrating radar (high-frequency electromagnetic waves detect cracks, voids, and delamination). The LTBP researchers also will develop data collection protocols, such as standard test methods, frequency of testing, and duration of the study. Finally, the researchers will select a representative sample of bridges for the study.

Step 5: Pilot Study

Concurrent with the latter stages of steps 2 through 4 is the beginning of the second phase of the LTBP Program, the pilot study (step 5). The primary objective is to validate the methods and protocols developed for data collection under the first phase of the program. To date, the researchers have selected an extensive array of nondestructive evaluation (NDE) sensors for long-term monitoring. In addition, they developed a protocol for visual and hands-on inspection of the LTBP Program bridges and protocols for each of the testing and monitoring regimens.

Just as bridge selection will play a vital role in the long-term data collection phase of the program, the data collection phase is also crucial in the selection of the bridges for the pilot study. To validate the program protocols in as many environments as possible, the LTBP Program selected seven States that provide a fair representation of the environmental conditions and types of structures throughout the United States. The team kept the sample size to a minimum in order to focus on refining and testing the protocols and guidelines. The selected States are

These workers are conducting a detailed evaluation of the northern Virginia bridge deck. On the left, a worker is using an impact-echo and complementary ultrasonic testing to detect and characterize delamination. The worker on the right is using ground penetrating radar to assess concrete alterations resulting from deterioration.

Rutgers University

Rutgers University

Researchers in this van are conducting a GPR survey on a bridge deck using two perpendicular horn antennas while traveling at speeds up to 30 miles per hour (48 kilometers per hour). The horn antennas enable dual polarization of electromagnetic waves, which provides more accurate reflection from transverse rebars when the longitudinal rebars are the top ones, which is often the case with slab bridges.

California, Florida, Minnesota, New Jersey, New York, Utah, and Virginia.

The LTBP Program has initiated the instrumentation and monitoring of bridges in Utah and Virginia to test and validate the LTBP Program inspection protocols and guidelines. The Virginia bridge, located on U.S. Route 15 over I–66 at Haymarket, VA, which is a short drive from the District of Columbia, is an overpass typical of the bridges that the LTBP Program will focus on. The bridge is a continuous two-span, built-up steel girder bridge constructed in 1979. The average daily traffic is approximately 16,000 vehicles (as provided by the Virginia DOT), of which an estimated 6 percent is truck traffic. The bridge has a cast-in-place concrete deck with no overlay and no stay-in-place forms that allow visual access to the deck's top and bottom sides. The deck itself is beginning to display early signs of deterioration, which will be key in validating NDE techniques and other instrumentation focused on identifying deterioration in bridge decks.

The second bridge, located in northern Utah near Utah State University, is a single-span, precast concrete girder bridge with integral abutments. This bridge (I–15 over Cannery Road just west of Perry, UT) has a waterproof membrane with an asphalt overlay, which will enable the program to validate that data collection methods will work with overlays.

As mentioned earlier, many States have indicated that failing joints are a major concern—one that the focus groups indicated leads to additional performance issues. By selecting the Utah bridge, the LTBP Program will obtain an early look at a jointless structure, which will help researchers identify key performance issues to be investigated on similar spans.

Although the program has not yet identified the other five specific bridges in the pilot study, it has determined the types of structures that will be studied, including new construction, concrete box beams, prestressed bulb tee, simple span steel girder, and adjacent concrete box beam girder bridges. These structures make up approximately 70 percent of the bridge population in the inventory. In addition, the pilot project will look at bridges with cast-in-place and precast decks, plus those using various forms of overlay and stay-in-place forms.

Step 6: Analyzing and Modeling Data

By studying as much variety as possible through a limited sampling, the LTBP Program will validate the data collection methods, guidelines, and protocols for visual inspection, instrumentation, and NDE developed while addressing the performance issues identified through the focus groups. This effort will provide the opportunity to refine and streamline the data collection process before rolling out to a larger sampling as part of the long-term data collection phase.

The research team does not view validation of the protocols, methods, and guidelines for data collection as independent from the long-term data collection phase. The selection and instrumentation of the pilot bridges and subsequent data collection need to be consistent with the objectives of the long-term data collection phase. The information gathered during the pilot study will feed directly into the long-term phase and provide early answers to questions that can be researched fully in the near future.

Step 7 and Beyond

During the pilot study phase, FHWA will review and refine the test protocols as appropriate. As the pilot study phase proceeds, FHWA will review the refined test protocols, research reports, and findings from the pilot study, and then disseminate them to stakeholders (bridge experts from DOTs, academia, and private industry) for review and evaluation. This process is expected to continue during the pilot study and beyond.

The long-term data collection on a much larger sample of bridges (that is, between 200 and 600 bridges depending on future program funding levels) will commence after the pilot study. The information gathered from such a large sample of bridges over the long term will help FHWA achieve the objectives of the LTBP Program.

Why Improve Performance Measurements At All?

Bridge performance is a concern for virtually everyone: commuters, tourists, deliverers of goods and services, emergency responders, national security officials, and other travelers. It is also of concern to legislators who create transportation programs and provide funds for the design, construction, inspection, maintenance, repair, and replacement of bridges. Stakeholders include administrators who manage bridge programs within transportation agencies, engineers and planners who design and build highways and bridges, and maintenance and management engineers and other personnel who maintain these structures at a satisfactory level of service.

Bridge performance measures can have multiple uses, depending on the perspective and responsibilities of those who are affected. The average traveler looks for reassurance about highway safety, rapid assistance from first responders, and reduced traffic congestion. Legislators might use specific performance measures to assess the ability of public agencies to implement the transportation decisions and programs that they create and fund, plus the overall effectiveness of those programs.

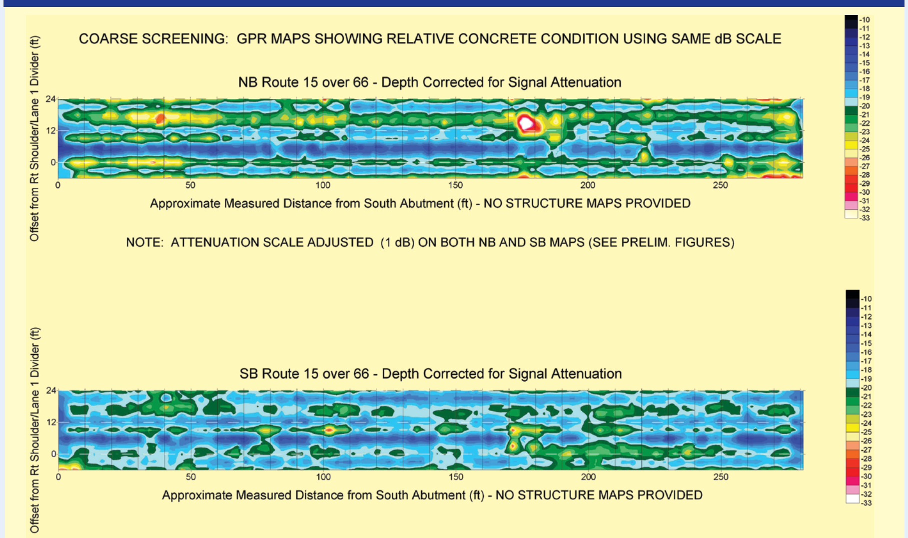
Engineers and planners need to factor performance into bridge planning, design, and construction by applying lessons learned from the performance of previously built structures. Bridge maintenance and management personnel use measures of performance to evaluate policies, practices, techniques, and materials that they employ. News outlets use simple performance measures and statistics to inform the public and key bridge constituencies about critical issues related to the transportation system.

More reliable performance measures will enable bridge owners to evaluate congestion and traffic safety more accurately. Performance measures also help provide an accurate determination of load capacity and any resultant need for load restrictions; identify clear links between a specific action and a change in performance level of some bridge feature; and improve knowledge of how and why bridges deteriorate (that is, lead to advances in predictive models). Better performance measures also can improve understanding of the effectiveness of various maintenance, repair, and rehabilitation strategies, as well as management practices; determine the effectiveness of durability strategies for new bridge construction, including selection of materials; and facilitate improvements in bridge management practices using high-quality, quantitative data.

Finally, improved performance measures will help transportation personnel evaluate bridge serviceability and durability; improve design, construction, and maintenance strategies; establish priorities for resource allocations within the transportation system and within the bridge infrastructure; evaluate organization-wide policies and programs; improve system reliability and accountability; and establish risk-based evaluations of bridges vulnerable to catastrophic failure.

The LTBP Program will continue to reach out to subject matter experts, policymakers, stakeholders, industry, and academia to help refine the program's findings and to collect the necessary data and knowledge to meet the Nation's bridge needs and goals. The pilot program began in September 2009 and will last 2 years. Steps 1 through 6 will be refined and updated as new information is gathered from field investigations and input from stakeholders during the program.

GPR Survey Results on the Virginia Pilot Bridge



These two plots show electromagnetic waves traveling through a reinforced concrete deck toward the rebars, which are metallic and therefore the strongest reflectors. The waves are attenuated in part due to the geometry of wave propagation, but mostly due to concrete deterioration and the presence of moisture and chlorides. The relative magnitude of the attenuation is a qualitative indicator of the degree of deterioration. The areas plotted in hot colors describe areas of high attenuation and deterioration, while those in cold colors describe the opposite. *Source: Rutgers University.*

Dr. Hamid Ghasemi manages the FHWA LTBP Program. He joined the Office of Infrastructure Research and Development (R&D) at FHWA's Turner-Fairbank Highway Research Center in 1994 and was named FHWA's Engineer of the Year in 2001. His work emphasizes seismic-related issues, structural health monitoring, post-hazard evaluation, computer modeling, and structural analysis. He received his doctorate in structural engineering from the University of Kentucky.

John Penrod is currently the FHWA LTBP Program pilot study manager. He earned his B.S. in civil engineering from Georgia Institute of Technology, has 8-plus years of design experience, and is a licensed professional engineer.

John M. Hooks is a consultant at Highway R&D Services. He has more than 40 years of experience in bridge engineering and research, both with FHWA and subsequently as a consultant on several projects.

For more information, visit www.tfhrc.gov/ltbp or contact Hamid Ghasemi at 202–493–3042 or hamid.ghasemi@dot.gov.

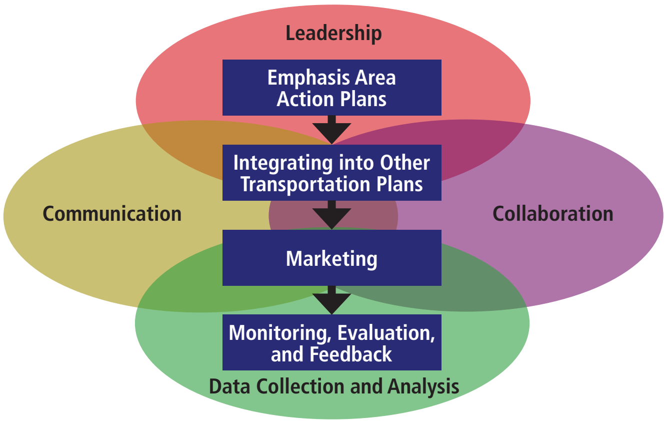
Along the Road

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

Now Available: Draft SHSP Implementation Process Model

The Federal Highway Administration (FHWA) Offices of Safety and Planning, the National Highway Traffic Safety Administration, the Federal Motor Carrier Safety Administration, and other safety stakeholders recently released a draft process model to help States implement Strategic Highway Safety Plans (SHSPs). As described in *The Essential Eight: Fundamental Elements and Effective Steps for SHSP Implementation*, the model highlights successful practices and processes to help States implement their plans.



The SHSP implementation process model identifies four fundamental elements and four steps for successfully implementing strategic highway safety plans.

An SHSP is a statewide, coordinated safety plan that provides a comprehensive framework for reducing highway fatalities and serious injuries on public roads. An SHSP enables all highway safety programs in the State to work together to align resources. The model's "essential eight" refers to the four fundamental elements—leadership, collaboration, communication, and data collection and analysis—and the four steps for successful SHSP implementation—emphasis area action plans, linkage to other plans, marketing, and monitoring, evaluation, and feedback.

"The model is not meant to be a one-size-fits-all solution," says Tamiko Burnell, a transportation specialist with FHWA's Office of Safety. "Each State must determine which elements of the model are useful for overcoming that State's unique barriers and will result in transportation safety improvements that save lives and reduce injuries."

Developing the model entailed reviewing the practices of States that have implemented aspects of their SHSPs successfully. Researchers conducted extensive interviews with leaders and champions from those States and performed indepth examinations of statewide and metropolitan transportation plan and program documents, highlighting exemplary approaches and noteworthy practices. After completing a 6-month pilot phase using the model in 10 States, transportation officials expect a final publication in spring 2010.

For more information, access the draft model at http://safety.fhwa.dot.gov/hsip/shsp/ipm_draft/process_model/process_model.pdf.

Technical News

MaineDOT Uses Innovative Paving System to Reduce Runoff

The Maine Department of Transportation (MaineDOT) is applying a porous paving system on Maine Mall Road, a high-volume public road, as a means to protect the surrounding Long Creek Watershed—a 3.5-square-mile (9.1-square-kilometer) area in the Portland, Scarborough, South Portland, and Westbrook municipalities. The porous pavement's coarser stone allows rain and snowmelt to pass through the surface to the gravel and sand filtering system below, treating, cooling, and reducing the peak runoff rate of untreated runoff going directly into surface waters.

MaineDOT identified the porous paving system as one way to contribute to the Long Creek Restoration Project, a collaborative, community-based initiative to bring the stream back into compliance with State and Federal water quality standards, and to open up new recreation opportunities for residents and visitors.

"Urban roads typically have little additional right-of-way for the installation of traditional stormwater treatment systems," says MaineDOT Project Manager Peter Newkirk. "Porous pavement is a system that does not require any additional area, and in this application, [it] discharges to Long Creek through our existing subsurface drainage system, providing cooler, cleaner, and slower water to the stream."

Transportation agencies have used porous pavement in the Northeast on parking lots and roads with low traffic volumes, and for more than 20 years on busier roads in warmer climates. To use the approach on a high-volume road that also must withstand a cold climate, MaineDOT

Peter Newkirk, MaineDOT

MaineDOT's use of a multilayered porous paving system (shown here) will help protect Long Creek Watershed from direct runoff from a heavily traveled roadway.

engineers developed a multilayered pavement. The infiltration bed is hidden under a coarse asphalt surface that otherwise looks like a standard road surface. In total, the project will retrofit approximately 1.5 acres (0.6 hectare) of what used to be impervious surface within the watershed.

MaineDOT

Traffic Analysis Toolbox Adds New Guides for Modeling and Simulation

FHWA has added two new volumes to its Traffic Analysis Toolbox series, offering departments of transportation (DOTs) guidance in using a range of analytical tools to plan and manage work zones. Both volumes address work zone modeling and simulation, and the importance of analyzing work zone impacts.

Volume VIII in the series, *Work Zone Modeling and Simulation—A Guide for Decision-Makers* (FHWA-HOP-08-029), offers guidance to executive-level staff on how analytical tools can support work zone decisions throughout a project's life cycle. The guide identifies six areas to consider when analyzing work zones: safety impacts for motorists, safety impacts for workers, mobility impacts, economic considerations, environmental concerns, and user costs.

The second guide, Volume IX, *Work Zone Modeling and Simulation—A Guide for Analysts* (FHWA-HOP-09-001), provides guidance to researchers and managers in charge of analyzing or developing models and approaches for work zones. The volume contains case studies including a pavement reconstruction project on I–15 in California, rehabilitation of the Going-to-the-Sun Road in Montana's Glacier National Park, and reconstruction of the Woodrow Wilson Bridge outside Washington, DC.

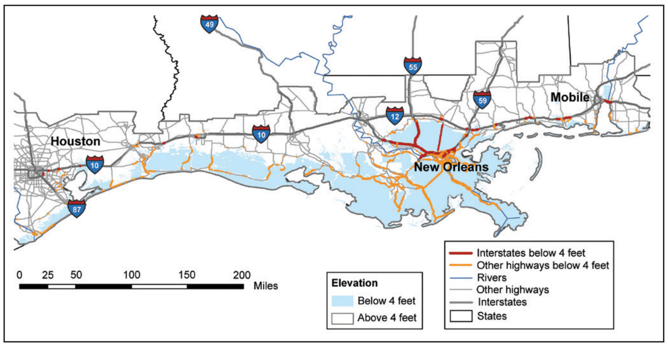
Volumes VIII and IX of the Traffic Analysis Toolbox are available at www.ops.fhwa.dot.gov/wz/traffic_analysis.

Public Information and Information Exchange

Climate Change Report Cites Impacts On Transportation Industry

According to *Global Climate Change Impacts in the United States*, a report released by the White House's United States Global Change Research Program, climate change poses significant challenges for the Nation's transportation system. The report concludes that although it is widely recognized that transportation affects climate change, the transportation community also needs to realize that climate change can and will affect the transportation system.

Recognizing the important role the transportation system plays in the Nation's livelihood, the report suggests that the transportation industry should take steps to reduce the risks through redesign or relocation of certain infrastructure, increased redundancy of critical services, and operational improvements. Among the key concerns are sea-level rise and storm surges, which will increase the risk of major coastal impacts. Another concern is flooding from increasingly intense downpours, which will increase the risk of disruptions and delays in air, rail, and road transportation, and damage from mudslides in some areas. Further, the increase in extreme heat could limit some transportation operations and cause pavement and track damage. More intense, strong hurricanes could lead to more evacuations, infrastructure damage and failure, and transportation interruptions.



This map shows major roads at risk in the Gulf Coast region in the event of sea-level rise of nearly 4 feet (1.2 meters). *Source: United States Global Change Research Program.*

The report was coordinated by the United States Global Change Research Program and produced by a consortium of experts from government science agencies and several major universities and research institutes. The report focuses on climate change impacts in different regions of the country and on various aspects of society and the economy, such as energy, water, agriculture, health, and transportation.

For more information, access the full report at www.globalchange.gov.

United States Global Change Research Program

Researchers Credit Economic Factors For Drop in Traffic Congestion

Though it might not be evident on the roads, traffic congestion took a break from its worsening trend in the last half of 2007, according to the *2009 Urban Mobility Report*, published recently by the Texas Transportation Institute. However, experts warn that the slowdown in congestion growth is minimal and temporary. When the economy rebounds, they say, expect traffic problems to do the same.

The 2009 report tracks traffic patterns in 439 urban areas in the United States from 1982 through 2007. According to the study, travelers spent 1 hour less stuck in traffic and wasted 1 gallon (3.8 liters) less gasoline than they did in 2006. This slight change represents a break in near-constant growth in traffic over 25 years.

"This is a very small change," says David Schrank, one of the study's authors. "No one should expect to be driving the speed limit on their way to work because of this."

Other study highlights illustrate the effects of the Nation's traffic problems, including the overall cost to Americans based on wasted fuel and lost productivity, which amounted to $87.2 billion in 2007, or more than $750 for every U.S. traveler. The total amount of wasted fuel topped 2.8 billion gallons, or 3 weeks' worth of gas for every traveler, and the amount of wasted time totaled 4.2 billion hours—nearly one full workweek for every traveler.

To reduce traffic congestion, the researchers suggest a diversified approach, including adding roadway and public transportation capacity in the places where it is needed most and providing alternate routes and toll lanes for faster and more reliable trips. Other solutions include offering programs such as ridesharing, flexible work times, and telecommuting to help travelers avoid traditional rush hours.

Texas Transportation Institute

Tool Available to Assess Highway Networks

FHWA and the National Center for Pavement Preservation (NCPP) have updated *A Quick Check of Your Highway Network Health* (FHWA-IF-07-006)—a tool to help highway agency managers assess the needs of their pavement networks and determine if their resource allocations are adequate. The updated brochure includes a worksheet that agencies can use to perform a pavement network evaluation.

When using the *Quick Check* tool, an agency first evaluates reconstruction and rehabilitation work by examining the lane miles, design life, and lane-mile cost for each proposed project or planned strategy. Then the agency evaluates pavement preservation treatments by examining the life extension offered by the treatment (such as concrete joint resealing, thin hot-mix asphalt overlays, microsurfacing, and chip seals) and related costs. By comparing the strategies and related costs, agencies can determine the most efficient and beneficial actions to use on their highway networks.

In addition to the updated brochure, FHWA and NCPP have also updated a PowerPoint® presentation and an Excel® worksheet that agencies can use to input data to obtain immediate results.

To view the brochure, visit www.fhwa.dot.gov/pavement/preservation/if07006.pdf, or access the PowerPoint and Excel files at www.fhwa.dot.gov/pavement/pub_details.cfm?id=478. To obtain a printed copy, contact Christopher Newman at 202-366-2023 or christopher.newman@dot.gov, or the National Center for Pavement Preservation at 517-432-8220.

Web Site on Work Zone Safety Launches Multilingual Section

The National Work Zone Safety Information Clearinghouse recently launched a multilingual section of its award-winning Web site at www.workzonesafety.org. The International Resources section of the site provides materials on road construction zone safety in Arabic, Chinese, French, Japanese, Spanish, and Russian to supplement its extensive English language resources.

The National Institute for Occupational Safety and Health asked the clearinghouse to create the new section in recognition that work zone safety is a serious global public health issue and to provide valuable information to other countries as they initiate programs to repair and modernize their transportation infrastructure. The clearinghouse is a project of the American

Shown here is the Web site for the National Work Zone Safety Information Clearinghouse.

Road & Transportation Builders Association's Transportation Development Foundation, operated in cooperation with FHWA and the Texas Transportation Institute. It includes information related to laws, regulations, standards, guidelines, research publications, and training resources associated with traffic and road closures.

The clearinghouse offers the international resources in both the original language and in English. When translations are available, the site provides the original documents and links to the translations to help facilitate communication and promote work zone safety for users around the world.

For more information, visit www.workzonesafety.org.

American Road & Transportation Builders Association

PBIC Updates Image Library

The Pedestrian and Bicycle Information Center (PBIC) recently redesigned its library of images related to walking and bicycling. The PBIC Image Library, accessible at www.pedbikeimages.org, is a searchable collection of free, high-quality images of people, transportation facilities, and livable places in the United States and more than 10 other countries. Site visitors can search by keyword or browse by popular search terms, such as bike lane, crosswalk, and pedestrian signal. Users also can search for images by State or country, photographer, or a specific format or print quality.

The photos are available for download and use in any noncommercial projects including Web pages, presentations, and reports. There are no costs or royalties associated with using the images; however, users must adhere to the guidelines posted on the site. Site visitors also can upload their own pedestrian- and bicycle-related photos for others to use.

PBIC

FHWA Releases Guidebook on Converting HOV to HOT Lanes

As part of its continuing effort to mitigate traffic congestion on U.S. highways, FHWA's Office of Operations, on behalf of the High Occupancy Vehicle/Managed Use Lanes Pooled Fund Study, recently released *Considerations for High Occupancy Vehicle (HOV) Lane to High Occupancy Toll (HOT) Lane Conversions Guidebook* (FHWA-HOP-08-034).

The document explores the planning, design, and ongoing operation and maintenance of HOT facilities, and provides technical guidance to assist State and local transportation planners and designers in determining where HOV to HOT lane conversions are feasible. The guidebook provides a summary of best practices and lessons learned from HOT facilities currently in operation.

According to the document, highway agencies and toll authorities across the United States operate more than 2,500 HOV lane miles, with approximately 2,500 more planned over the next 30 years. Although many HOV facilities outperform general purpose highway lanes in terms of person throughput, when carpool formation is low, HOV lanes may go underutilized and do not achieve congestion relief benefits.

The guidebook is intended to assist State departments of transportation, metropolitan planning organizations, policymaking agencies, enforcement agencies, and others involved in the planning and management of HOV and HOT lanes. Three case studies illustrate key practical insights and lessons learned.

To access the report, visit www.ops.fhwa.dot.gov/publications/fhwahop08034/index.htm. For more information on the High Occupancy Vehicle/Managed Use Lanes Pooled Fund Study, visit http://hovpfs.ops.fhwa.dot.gov.

Personnel

FHWA Names Federal Highway Administrator, Deputy Administrator

In July 2009, the U.S. Senate confirmed former Arizona State transportation official Victor Mendez as administrator of FHWA. In his role as the Nation's top Federal highway official, Mendez will deal with critical and timely issues, including implementing the largest new investment in U.S. infrastructure in years, and the reauthorization of the surface transportation law, which will guide Federal investment in roads and bridges for years to come.

As the former director of the Arizona Department of Transportation, Mendez delivered statewide construction programs on time, including major infrastructure improvements throughout the State. In addition, he worked to improve the agency's customer service within motor vehicle and highway division offices.

FHWA also named Gregory G. Nadeau as deputy administrator. Before joining FHWA, Nadeau served as deputy commissioner for policy, planning, and communications with MaineDOT, where he managed the State's transportation planning, freight, and business services.

FHWA's Adams Selected as a Top Newsmaker

Engineering News-Record, a weekly trade magazine for the construction industry, selected Mike Adams, a research geotechnical engineer at FHWA's Turner-Fairbank Highway Research Center (TFHRC), as one of its Top 25 Newsmakers for 2008. The magazine recognized Adams for his promotion of geosynthetic reinforced soil (GRS) technology, which is used for building efficient and cost-effective bridge substructure components.

Adams' research on GRS technology includes constructing and load testing a full-scale instrumented bridge pier at TFHRC in McLean, VA, which successfully demonstrated the ability to construct a reinforced soil bridge pier with segmental blocks.

NATIONAL HIGHWAY INSTITUTE

Training Update

by John J. Sullivan IV

NEPA Course Brings States And Tribes to the Table

That road building affects the natural and cultural environments is a given. The nature and extent of the impacts vary, however, so the National Environmental Policy Act (NEPA) is needed to help decisionmakers balance environmental and human needs in transportation project development. NEPA contains statements of policies and goals that result in procedures to ensure that environmental information is made available to public officials and citizens before agencies make final decisions on infrastructure projects.

Perhaps nowhere is the NEPA process more important—or complex—than in the context of transportation development on tribal lands. "NEPA requirements are one of the biggest challenges that a transportation office faces," says Gary Stevig, assistant director and transportation planner for Chickaloon Native Village in Alaska. "The process costs time and money, but it's worth it. We need to protect the environment."

Mitigating a Unique Challenge for Tribes

The Indian Reservation Roads (IRR) program, jointly administered by the Federal Highway Administration (FHWA) and the Bureau of Indian Affairs, addresses the transportation needs of tribes by providing funds for planning, design, construction, and maintenance activities. To use the IRR funds, tribes need to comply with NEPA procedures. However, for tribes with small staffs to handle transportation projects, the NEPA process can be particularly challenging. "Whereas State agencies have separate departments and large staffs to handle construction, right-of-way, maintenance, etc., my director and I do it all," Stevig says. "And reporting requirements are lengthier than for States."

That's where the National Highway Institute (NHI) comes in. An NHI course, NEPA and Transportation Decisionmaking (FHWA-NHI-142005), covers the FHWA policies and procedures for applying NEPA requirements to project development and decisionmaking processes related to transportation facilities. The course examines the evolution of environmental policy and the integration of social, environmental, and economic factors into the Federal framework of laws, regulations, policies, and guidance, ultimately leading to transportation projects that serve the best overall public interest.

Stevig attended a session in Anchorage, AK, in 2008. "Our tribe was first to apply NEPA under a new form of contract, a Federal highway agreement for Indian reservations," he says. "We've gone through our first NEPA project and found the process to be complex. But the NHI course provided critical information on how the NEPA process works, so we'll be better prepared in the future."

According to Stevig, the 3-day session format provides ample time for participants to practice applying the concepts to hypothetical transportation projects. "With training, too often you read the material in class, and then put the training manual on a shelf and never look at it again," he says. "But with NHI's NEPA course, you're not staring at text in a book. The instructors led us through exercises to help us connect the dots."

Fostering Collaboration

Participants learn the importance of a reasoned, collaborative process when developing and evaluating alternatives. They also learn how to balance an array of interests and values in making transportation decisions, and the milestones in transportation planning that link to the NEPA project development process. The instructors lay out the roles and responsibilities of various stakeholders and discuss alternative dispute resolution.

"The importance of keeping your word was a clear message," Stevig says. "We're all being taught the same things, which makes for better partners with shared values. Interagency coordination through the NEPA process is bringing States and tribes together at the beginning of projects, so we can share local knowledge to ensure that graves won't be disturbed and habitat can be preserved."

The course targets planning and environmental professionals who participate in the transportation decisionmaking process, including FHWA staff, State departments of transportation and their consultants, environmental resource agencies, local governments, tribal officials, and metropolitan planning organizations.

"I've taken training on NEPA about five times through different organizations, and NHI's version is the most successful in ensuring that attendees fully understand how the process works," Stevig says. "I can't say enough about the level of expertise that NHI brings to training."

To schedule a session, visit www.nhi.fhwa.dot.gov.

John J. Sullivan IV is associate editor of PUBLIC ROADS.

Photos: Chickaloon Native Village

The NEPA process was a critical timeline for reconstruction of All Elks Road in the Chickaloon Native Village, shown here in 2008 before the right-of-way was cut (left) and during construction in 2009 (right).

by Tim Breen

FHWA's Window Into Recovery

For much of 2008, the U.S. economy seemed a continuous source of bad news. In January 2009, President Barack Obama called for Federal intervention in the banking industry and a spending bill to jumpstart the economy. On February 17, he signed the $787 billion American Recovery and Reinvestment Act (ARRA), which provided $27.5 billion to the Federal Highway Administration (FHWA) to spend on construction projects and other programs that would put people to work.

President Obama also made it clear that he expects unparalleled transparency to surround the recovery effort so the public can see where its tax money is going. To meet that mandate, FHWA is providing access to information on its role and activities through its Web site at www.fhwa.dot.gov/economicrecovery. Site visitors can learn how FHWA is apportioning funds, the conditions placed on funding, and how projects are progressing.

Recovering Roads, Recovering Jobs

Including FHWA's share, ARRA provides a total $150 billion to support U.S. infrastructure—"the largest new investment since the construction of the interstate highway system," according to the White House. The spending is intended to "create nearly 400,000 jobs for American workers today and power enhanced economic growth for the decades to come."

Citing a report that the Nation's infrastructure deserved a "D" for its deteriorating condition, the White House said ARRA meets the challenge by ensuring that all States receive funding, localities are able to use funds for the projects they need most, and rural areas can address a backlog of infrastructure projects.

Visitors to the Web site will learn that the bulk of the agency's ARRA funding was available for obligation through September 30, 2010 (for fiscal years, FYs, 2009 and 2010). Of FHWA's $27.5 billion, ARRA set aside $840 million for non-State programs, which includes $550 million for investments on Indian reservations and Federal lands.

The Web site explains that FHWA apportioned the $26.6 billion in State funding using two formulas. Half the funding will be disbursed according to the Surface Transportation Program FY 2009 formula: 25 percent is based on each State's share of the total lane miles of Federal-aid highways, 40 percent is based on each State's share of the total vehicle miles traveled on Federal-aid highways, and 35 percent is based on each State's share of the estimated tax payments attributable to highway users paid into the Highway Trust Fund. FHWA will disburse the other half of ARRA funding based on the FY 2008 distribution of obligation limitation.

The Web site further explains that FHWA selected projects based on several criteria. First, it gives priority to projects that can be completed by February 17, 2012. Second, it favors projects in economically distressed areas. Third, it favors projects that can be started and completed quickly, including a goal of obligating at least 50 percent of funds by June 17, 2009. Finally, the agency prefers projects that maximize job creation and economic benefits.

Visitors to FHWA's ARRA Web site can link to www .recovery.gov, which keeps tabs on transportation and other spending under ARRA. *Source: Recovery Accountability and Transparency Board.*

Meeting Unparalleled Transparency Standards

FHWA has made delivery of the ARRA funding a top priority and uses its ARRA Web site to communicate activities and progress efficiently. The site contains comprehensive information on the agency's Recovery Act efforts, including funding distributions and requirements, answers to frequently asked questions, presentations and guidance materials, and training. FHWA continually adds new information to the site and updates progress daily.

Site visitors can access a number of resources to help with meeting implementation requirements, including reporting forms. An ARRA calendar of events also assists those responsible for providing data to FHWA by noting deadlines for required reporting.

FHWA's Web site also links to www.recovery.gov, the site run by the Recovery Accountability and Transparency Board, which oversees all aspects of ARRA. Through this portal, site visitors can access weekly updates on progress made by FHWA and the other agencies involved. As of September 3, 2009, FHWA Division Offices had authorized 7,124 projects in all States and Territories, for a total of $18.16 billion. Federal Lands authorized 43 projects for a total of $141.1 million.

Tim Breen is a contributing editor for PUBLIC ROADS.

Communication Product Updates

Compiled by Zachary Ellis 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.

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
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703–605–6000
Toll-free number: 800–553–NTIS (6847)
Web site: www.ntis.gov

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

R&T Product Distribution Center (PDC)
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 Turner-Fairbank Highway Research Center's Web site at www.tfhrc.gov, the National Transportation Library's Web site at http://ntl.bts.gov, or the OneDOT information network at http://dotlibrary.dot.gov.

2009 Crash Prediction Module Beta Release for the IHSDM

FHWA's Office of Safety Research and Development recently made available the 2009 Crash Prediction Module (CPM) beta release for the Interactive Highway Safety Design Model (IHSDM) software. The CPM includes capabilities to evaluate two-lane rural highways, multilane rural highways, and urban/suburban arterials. The CPM is one of six modules available from FHWA's 2008 public release of the IHSDM, which included crash prediction capabilities only for two-lane rural highways.

IHSDM is a suite of software analysis tools for evaluating safety and operational effects of geometric design decisions on highways. The software features six evaluation modules: policy review, crash prediction, design consistency, intersection review, traffic analysis, and a fully functioning beta version of a driver/vehicle module. FHWA researchers recently updated the algorithms of the CPM/IHSDM two-lane rural highways module and introduced newly developed modules for multilane rural highways and urban and suburban arterials. Users should install and operate the 2009 beta release of CPM and the 2008 public release separately.

FHWA is developing a technical workshop to provide training opportunities on the extended CPM functionalities. In addition, the National Highway Institute (NHI) offers a course called Interactive Highway Safety Design Model (FHWA-NHI-380071).

For more information or to download the CPM and IHSDM, visit www.ihsdm.org. For free technical support, email IHSDM.Support@fhwa.dot.gov or call 202–493–3407.

Exploratory Advanced Research Program (Brochure) Publication No. FHWA-HRT-09-025

A new brochure for the FHWA Exploratory Advanced Research (EAR) program is now available. Authorized by the Safe, Accountable, Flexible, and Efficient Transportation Equity Act: A Legacy for Users, the EAR program conducts longer term, higher risk research that will result in potentially dramatic breakthroughs for improving the durability, efficiency, environmental impact, productivity, and safety of highway and intermodal transportation systems.

The program addresses underlying gaps faced by applied highway research programs, anticipates emerging issues with national implications, and reflects broad transportation industry goals and objectives. The EAR program brochure summarizes 15 projects that FHWA awarded through two Broad Agency Announcements seeking research and development projects that could lead to transformational advances in highway engineering and intermodal surface transportation in the United States. The awards represent an estimated FHWA investment of more than $13 million, spanning multiple years. With cost-share agreements in place for most of these projects, the total estimated budget is more than $24 million.

For more information, visit www.fhwa.dot.gov/advancedresearch. Printed copies of the brochure are available from the PDC.

Safety Evaluation of Advance Street Name Signs (TechBrief) Publication No. FHWA-HRT-09-030

FHWA organized 26 States to participate in the Low Cost Safety Improvements Pooled Fund Study as part of its strategic highway safety plan. The purpose of the pooled fund study is to estimate the safety effectiveness of several unproven, low-cost safety strategies identified in the National Cooperative Highway Research Program *Report 500* series. This report examines the safety effectiveness of advance street name signs at signalized intersections.

Advance street name signs have the potential to reduce way-finding crashes because they provide drivers with additional time to make necessary lane changes and route selection decisions. The safety effectiveness of this strategy has not been thoroughly documented, and this study attempted to provide a crash-based evaluation through scientifically rigorous procedures, such as data collection and analysis from several States.


TECHBRIEF

Safety Evaluation of Advance Street Name Signs

FHWA Publication No.: FHWA-HRT-09-030

FHWA Contact: Roya Amjadi, HRDS-06, (202) 493-3383, roya.amjadi@dot.gov

This document is a technical summary of the Federal Highway Administration report, *Safety Evaluation of Advance Street Name Signs* (FHWA-HRT-09-029), which will be available online at http://www.tfhrc.gov/safety.

OBJECTIVE

The Federal Highway Administration (FHWA) organized 26 States to participate in the FHWA Low-Cost Safety Improvements Pooled Fund Study as part of its strategic highway safety plan support effort. The purpose of the pooled fund study is to estimate the safety effectiveness for several of the unproven, low-cost safety strategies identified in the *National Cooperative Highway Research Program (NCHRP) 500 Series* reports. One of the strategies chosen to be evaluated for this study was ad-vance street name signs at signalized intersections. This strategy is intended to reduce the frequency of older driver crashes and crashes related to way-finding (i.e., rear-end and sideswipe crashes) at signalized intersections. Advance street name signs have the potential to reduce way-finding crashes because they provide drivers with additional time to make necessary lane changes and route selection decisions. The safety effectiveness of this strategy has not been thoroughly documented; this study is an attempt to provide a crash-based evaluation through scientifically rigorous procedures.

Introduction

Intersections account for a small portion of the total highway system. Yet, approximately 2.42 million intersection-related crashes occurred in 2006, representing 41 percent of all reported crashes and 21 percent (8,291) of all fatal crashes. Crashes at signalized intersections represent about 51 percent (1.23 million) of all intersection-related crashes, of which, 2,740 crashes involved a fatality in 2006.[1]

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www.tfhrc.gov

According to the report, the use of advance street name signs is justified as a way-finding improvement given the low cost, particularly on a major road at three-legged intersections and locations with a relatively high average annual daily traffic count or high number of crashes. From a safety standpoint, the study found that this strategy might be justified as a measure to reduce sideswipe crashes at or near signalized intersections, but not to reduce total crashes.

This document is available at www.tfhrc.gov/safety/pubs/09030/index.htm. Printed copies are available from the PDC.

Safety Evaluation of Lane and Shoulder Width Combinations on Rural, Two-Lane, Undivided Roads (TechBrief)
Publication No. FHWA-HRT-09-032

The FHWA Low Cost Safety Improvements Pooled Fund Study evaluated the effectiveness of allocating fixed lane and shoulder widths for pavement on rural, two-lane, undivided roads. In other words, given a fixed roadway width for a rural, two-lane, undivided road, is it safer to provide wider shoulders or wider lanes? Previous research efforts had not documented the safety effectiveness of various allocations of total paved width, and this study attempted to provide a thorough evaluation.


TECHBRIEF

Safety Evaluation of Lane and Shoulder Width Combinations on Rural, Two-Lane, Undivided Roads

FHWA Publication No.: FHWA-HRT-09-032

FHWA Contact: Roya Amjadi, HRDS-06, (202) 493-3383, roya.amjadi@dot.gov

This document is a technical summary of the Federal Highway Administration report, *Safety Evaluation of Lane and Shoulder Width Combinations on Rural, Two-Lane, Undivided Roads* (FHWA-HRT-09-031), which will be available online at http://www.tfhrc.gov/safety.

Objective

The Federal Highway Administration (FHWA) organized a pooled fund study of 26 States to evaluate low-cost safety strategies as part of its strategic highway safety effort. The purpose of the FHWA Low-Cost Safety Improvements Pooled Fund Study is to evaluate the safety effectiveness of several low-cost safety strategies presented in the *National Cooperative Highway Research Program (NCHRP) Report 500 Series*. Although not identified in the *NCHRP Report 500 Series*, one of the strategies selected for evaluation in the pooled fund study was the allocation of lane and shoulder width for fixed pavement widths on rural, two-lane, undivided roads (i.e., given a fixed roadway width for a rural, two-lane, undivided road, is it safer to provide wider shoulders or wider lanes?). The safety effectiveness of various allocations of total paved width had not previously been thoroughly documented, and this study is an attempt to provide an evaluation through scientifically rigorous procedures.

Introduction

State and local agencies are often faced with a decision of how to enhance safety on rural, two-lane roads when the total paved width is to remain the same. More than 42,000 fatalities occur

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State and local agencies face the challenge of deciding how to enhance safety on rural, two-lane roads where the total paved width has to remain the same. The objective of this study was to determine the safety effectiveness of specific combinations of lane and shoulder widths on these types of roads. This strategy is intended to reduce the frequency of roadway departure crashes. Researchers applied matched case-control statistical analysis to geometric, traffic, and crash data for road segments in Pennsylvania and Washington to estimate crash modification factors.

Based on the results of this study, the researchers concluded that reallocating lane and shoulder widths for a fixed total paved width can be a cost-effective way to reduce crashes on rural, two-lane, undivided roadways. By comparing the results of this study with previous research, the authors determined that the effects of lane and shoulder width should be considered in the context of each other. That is, the crash modification factors for a given shoulder width might not be applicable across various lane widths.

This document is available at www.tfhrc.gov/safety/pubs/09032/index.htm. Printed copies are available from the PDC.

Transportation Research Program Administration in Europe and Asia
Publication No. FHWA-PL-09-015

FHWA, the American Association of State Highway and Transportation Officials, and the National Cooperative Highway Research Program sponsored a scanning study of Europe and Asia to review administration practices for transportation research programs. The scan team sought policy initiatives and process improvements to enhance transportation research administration in the United States.

The team found that in the countries it studied transportation research is directly related to national economic growth and competitiveness. The countries promote their transportation research efforts and consider transportation research and development to be valuable contributions to the national good. Further, the countries address intellectual property rights as a common practice that facilitates the delivery of transportation research results.

Recommendations for U.S. application include building international relationships in transportation research to achieve global goals, developing a nationally coordinated research framework, and strengthening the innovation process by examining international research institutes that link the creation and application of knowledge.

For a free copy of the scan report, email FHWA at international@dot.gov, or access the report online at www.international.fhwa.dot.gov. Printed copies of this scan report are available from the PDC.

Conferences/Special Events Calendar

Date	Conference	Sponsors	Location	Contact
January 11–13, 2010	Mid-Winter NCSTS Meeting	National Conference of State Transportation Specialists (NCSTS)	San Diego, CA	William Leonard 518-457-1046 wleonard@dot.state.ny.us www.naruc.org/ncsts
January 17–20, 2010	NAPA 55th Annual Meeting	National Asphalt Pavement Association (NAPA)	Maui, HI	Sandy Palacorolla 888-468-6499 x114 sandy@hotmix.org www.hotmix.org
February 2–5, 2010	World of Concrete	See conference Web site for a list of sponsors.	Las Vegas, NV	Jackie James 972-536-6379 jjames@hanleywood.com www.worldofconcrete.com
February 4–6, 2010	9th Annual New Partners for Smart Growth Conference	Local Government Commission	Seattle, WA	Michele Kelso Warren 916-448-1198 x308 mkwarren@lgc.org www.newpartners.org
February 8–11, 2010	XIII International Winter Road Congress	World Road Association	Quebec, Canada	Claudine Tremblay 418-528-6416 x3074 quebec2010@mtq.gouv.qc.ca www.piarcquebec2010.org
February 10–12, 2010	13th International Congress on Polymers in Concrete	University of Minho	Madeira Islands, Portugal	Secretary +351 253510206 icpic2010@civil.uminho.pt www.icpic-community.org/icpic2010
March 14–17, 2010	ITE 2010 Technical Conference	Institute of Transportation Engineers (ITE)	Savannah, GA	Sallie Dollins 202-289-0222 x149 sdollins@ite.org www.ite.org
March 19–20, 2010	Icon Expo 2010	National Concrete Masonry Association, Interlocking Concrete Pavement Institute, Cast Stone Institute	San Antonio, TX	Debbie Morris or Laura Helm 703-713-1900 dmorris@ncma.org or lhelm@ncma.org Iconexpo.org
March 21–25, 2010	Xtreme Concrete	American Concrete Institute	Chicago, IL	Event Services 248-848-3795 conventions@concrete.org www.concrete.org

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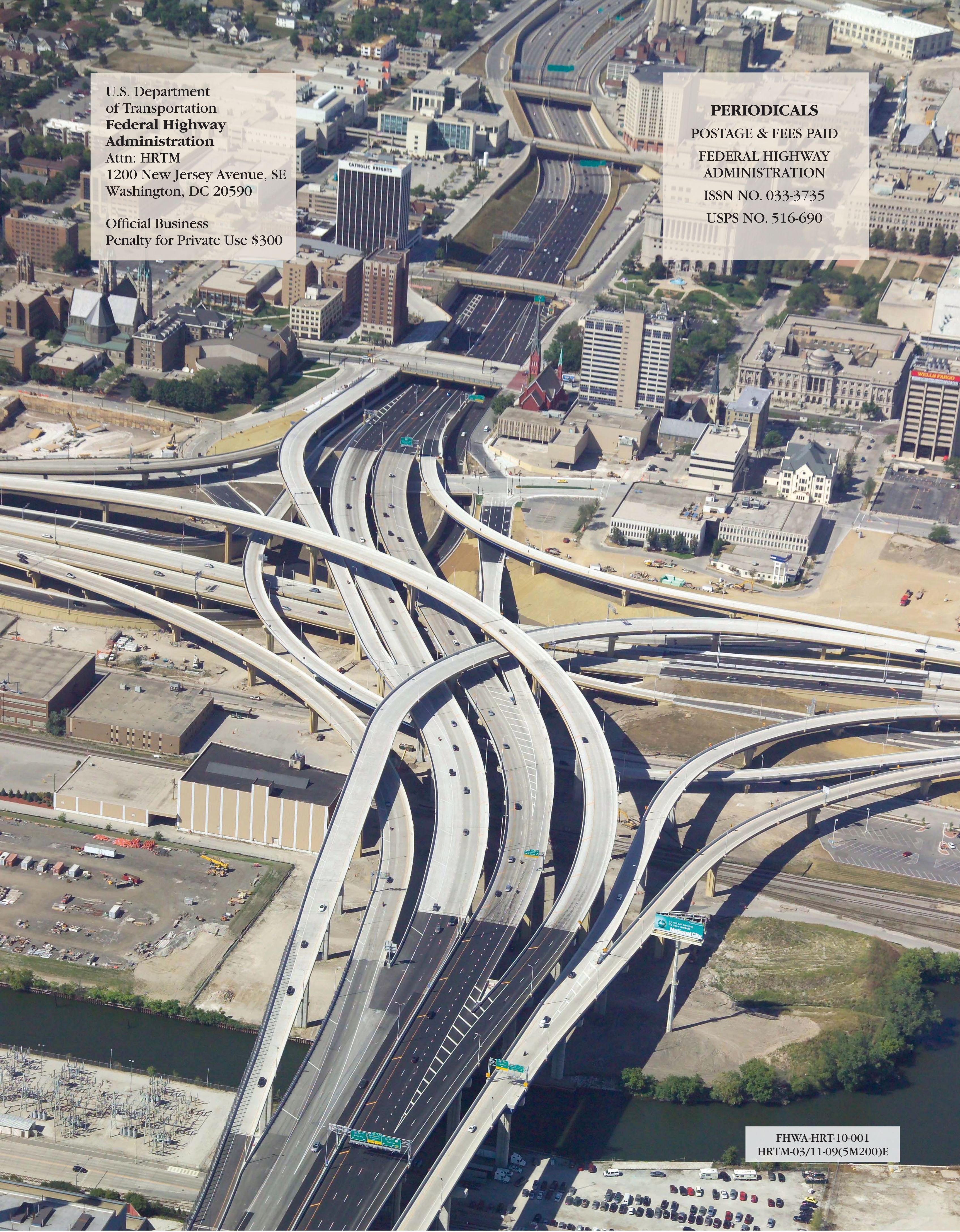

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