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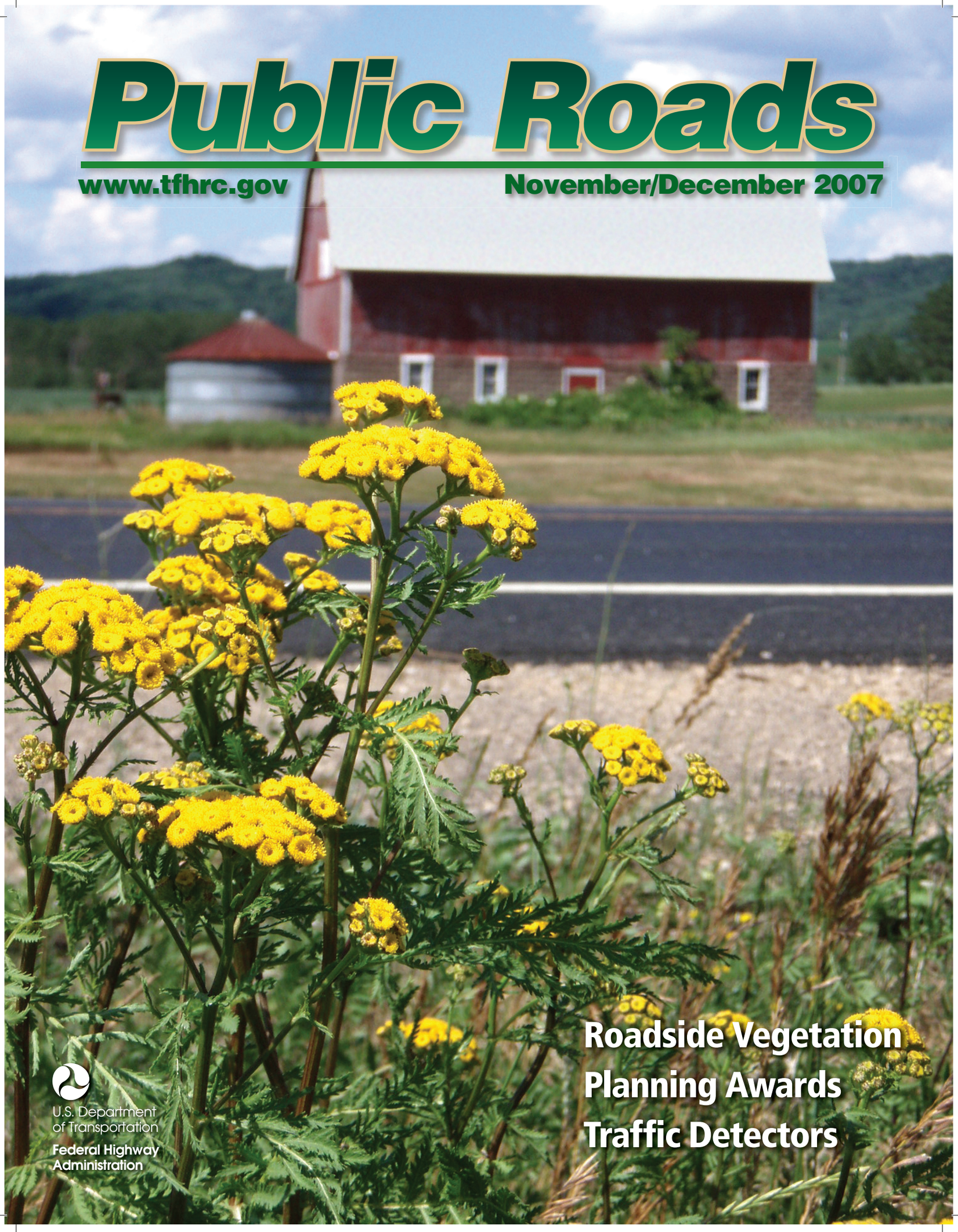

Roadside Vegetation
Planning Awards
Traffic Detectors

U.S. Department of Transportation
Federal Highway Administration

Public Roads

November/December 2007 www.tfhrc.gov Vol. 71, No.3

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

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Front cover—Bright yellow tansy is growing alongside State Highway 35 in rural Wisconsin. At first glimpse, motorists might mistake tansy for a native wildflower, but this weed belies its beauty by degrading pastures and replacing indigenous vegetation. Introduced for medicinal and ornamental purposes, common tansy, or *Tanacetum vulgare*, is spreading across the Northern States. For more about roadside vegetation, see "The Greening of Public Roadsides" on page 2 of this issue of PUBLIC ROADS. *Photo by Bonnie L. Harper-Lore*.

Back cover—Dandelions blanket the shoulder of this rural county road, which connects to Minnesota State Highway 19. This yellow springtime bloomer invades roadsides, farmlands, parks, and other natural areas throughout the Midwest, degrading pasture quality and displacing native wildflowers like Jacob's ladder, or *Polemonium reptans*, which is the purplish flower in the foreground. *Photo by Bonnie L. Harper-Lore.*

U.S. Department of Transportation
Federal Highway Administration

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Mary E. Peters, *Secretary*

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E-mail: martha.soneira@fhwa.dot.gov.

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Guest Editorial

Changing the Way Highways Operate

It is not news that congestion has reached epic proportions. According to *The 2007 Urban Mobility Report* published by the Texas Transportation Institute, "Congestion caused urban Americans to travel 4.2 billion hours more and to purchase an extra 2.9 billion gallons of fuel for a congestion cost of $78 billion." This growing traffic leads to costly delays that undermine the American quality of life, jeopardize the economic system, waste fuel, and contribute to pollution. The available highway capacity simply is not keeping pace with traffic demand. In addition to adding capacity, another solution is to optimize the operation of the existing system.

In 2007, the U.S. Department of Transportation (USDOT) challenged the transportation community to find revolutionary solutions to traffic congestion across the country. One such effort started in August 2007 when USDOT announced the selection of five cities to become Urban Partners with the Agency to tackle congestion. Through Urban Partnership Agreements, USDOT and its partner cities will use an unprecedented, four-pronged approach that includes tolling, transit, technology, and telecommuting. With new technology as the key enabler, the four parts will work together to spread the traffic load more evenly across the transportation system.

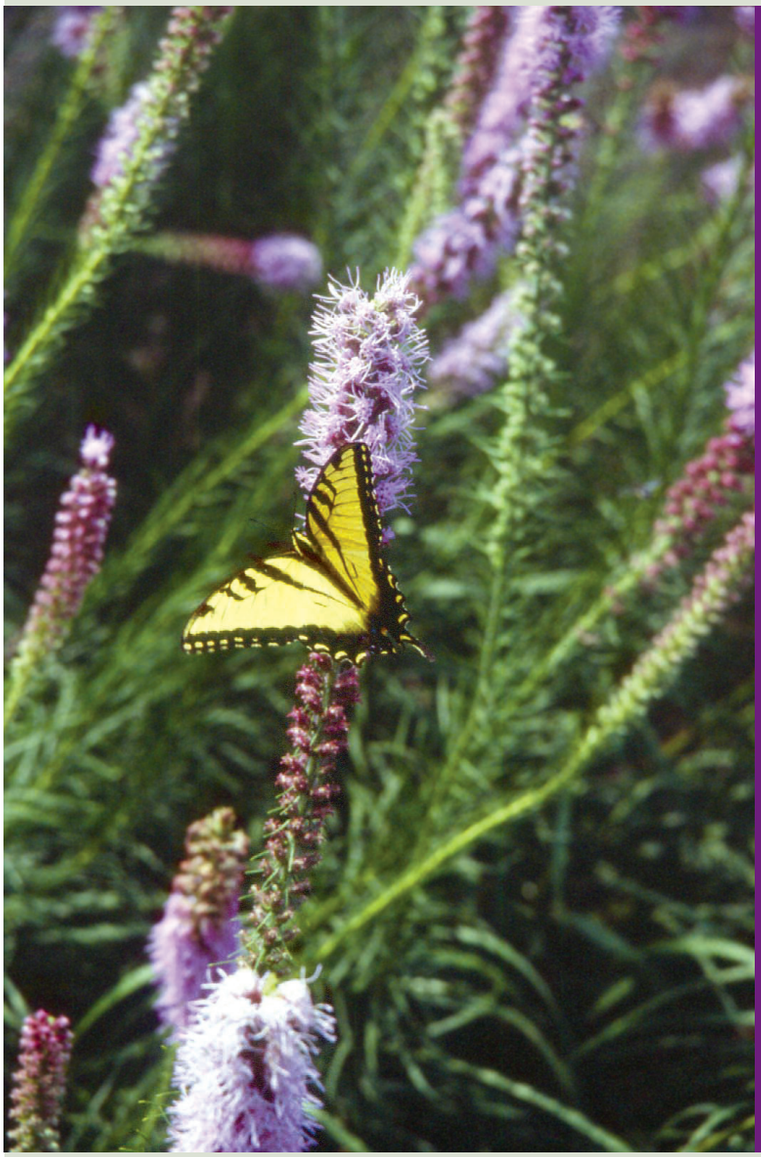
At the Federal Highway Administration's (FHWA) Turner-Fairbank Highway Research Center, several research projects concentrate on developing a range of new methods and technical innovations to reduce congestion. Smart sensors and traffic signals should be able to sense traffic, adapt to it, and keep it moving to help reduce delays. Adaptive signal controls using new, low-cost, ACS Lite software already help move vehicles faster. Technologies such as global positioning systems, geographic information systems, more powerful cell phones, and even new higher powered dedicated communication systems may one day be able to help improve communications between cars and the roadside. Technologies like these already have facilitated electronic toll collection, reducing delays at toll plazas. The evolution of these communications technologies will enable in-vehicle navigation systems to identify not only what street a vehicle is on but also the specific lane on which it is located.

FHWA's Office of Operations R&D is using modeling and simulations to determine the trajectory of an oncoming vehicle and whether it will end in a crash, gauge whether a vehicle will run a red light, and determine if it is safe for a vehicle to make a left turn at a red light. Advanced research will develop and evaluate concepts for innovative vehicle-highway automation, new methods for data acquisition, and new ways to improve the operation of traffic signal systems.

This issue of PUBLIC ROADS features an article titled "A New Look at Sensors," which describes some of the latest and most effective strategies to sense the characteristics of vehicles. They enable advanced adaptive control and ramp metering systems to accommodate the impacts of varying, and often increasing, traffic flow and incidents, and thus reduce congestion and minimize travel time variability.

Research solutions have contributed to the success of the transportation system. Infrastructure research provides new ways to build roads that last longer. Safety research makes roads less dangerous and crashes more survivable. The ultimate goals of applied research and long-term, exploratory advanced research in the operations area are to one day eliminate traffic congestion and crashes altogether.

Joseph I. Peters
Director
FHWA Office of Operations R&D



The Greening of Public Roadsides

by Amit Armstrong, Scott Riley, David Steinfeld, and Kim M. Wilkinson

FHWA reinforces its commitment to environmental stewardship by developing an integrated approach to establishing native plants along roadsides.

Motorists demand that road modifications not only improve safety and mobility but also preserve, protect, and, where possible, promote healthy natural environments. In recent years the Federal Highway Administration (FHWA) has taken a leadership role in moving beyond regulation-driven mitigation approaches to proactive environmental stewardship that promotes healthy ecosystems.

Native plants are one of the foundations of ecological health and function. Revegetating roadsides with native plants is key to managing environmental impacts and improving conditions for healthy ecosystems.

According to George Fekaris, project manager for FHWA's Western Federal Lands Highway Division (WFLHD), "Our clients, the Federal land management agencies, need and want [roadside revegetation with native plants], and it's the right thing to do, both economically and environmentally."

Past approaches to post-construction roadside revegetation often failed, despite policy initiatives, customer desires, good intentions, and widespread recognition of the many economic, aesthetic, and ecological benefits of native plants. The lack of a consistent interdisciplinary, interagency team approach with early (3-years minimum) project participation, and inadequate communication and stated objectives among all involved parties at Federal, State, county, and private levels, often leads to revegetation failure. With dedicated interdisciplinary, interagency commitment, teamwork, and revegetation guidelines, roadside revegetation projects will succeed while fulfilling broad-ranging agency objectives.

Fekaris continues, "Our ability to successfully establish native plant communities on roadsides is the linchpin that will determine whether the 12 million-plus acres that make up the transportation corridors of this country will be a hospitable environment to plants, mammals, birds, and other forms of life—or a wasteland."

(Above) Native plants support insects and other forms of life. Here, a butterfly is perched on the flower of a prairie blazing star (*Liatris pycnostachya* Michx). *Photo: Thomas D. Landis, Native Plant Nursery Consulting.*

Benefits of Native Plants

Native plants along roadsides offer ecological, economic, safety, and aesthetic advantages. Ecologically, healthy native plant communities often are the best long-term defense against invasive and noxious weeds. Economically, maintenance costs for managing problematic vegetation are reduced, as are concerns that herbicides might cause pollution or that weeds from roadsides might invade neighboring lands.

In addition, well-planned, desirable vegetation supports transportation goals for safety and efficiency by stabilizing slopes, reinforcing infrastructure, and improving the road user's experience by creating natural beauty and diversity along the roadside.

The ineffectiveness of past roadside revegetation efforts resulted in problems such as erosion and sediment loading, thereby affecting soil and water quality. Visually, when road disturbance is not healed properly, the aesthetic experience of the road user is diminished.

Collaboration and Long-Term Goals Essential

According to Paul T. Anderson, the U.S. Department of Agriculture's (USDA) Forest Service (USFS) environmental streamlining liaison to FHWA, an integrated and collaborative approach is needed. "When protection or re-establishment of native vegetation was considered, it was too often an afterthought," he explains.

In some cases the goal was too shortsighted. Revegetation was considered important to improve the appearance of the roadside disturbance, but efforts emphasized seeding of exotic species because these were perceived as cheap, readily available, and quick to establish on disturbed sites. These exotics either spread to become problematic weeds or failed to persist because they were not locally appropriate.

"A collaborative process with an eye on long-term results, not just quick cover, is needed," says Anderson.

FHWA's Fekaris adds, "You often see failures from lack of coordination. Specialists tend to work in isolation from each other. The engineers decide the slope grade, the soils person comes along and tries to stabilize or add soil, and then the revegetation person is invited to throw some seeds on top of that. In a year or two, it starts to fall down—you have an ugly, bare, or weedy disturbance, and folks wonder why."

WFLHD recognized that overcoming the obstacles to successful establishment of native plants would require more than just technical information. A systematic, comprehensive approach is needed. With

Safety First: Plants Support Safety Goals

The overriding goal of any road construction or modification project is safety, and rightly so. The establishment of locally adapted native plant communities supports transportation safety goals in a number of ways, but one of the most important is by improving the function of roadside engineering. Appropriate vegetation can enhance visibility and support design features to help drivers recover if their vehicles leave the pavement.

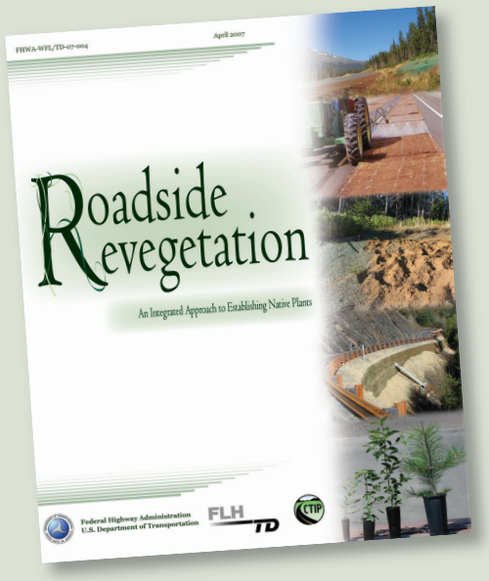
When native plants are incorporated into road design, they can improve long-term slope stability while softening visual experiences. For example, hydroseeding with exotic grasses has been the conventional approach to stabilizing road cuts, but many grasses have shallow root systems and short lifespans. Hydroseeding with a mix of forbs and native grasses over a matrix of planted shrubs and small trees will increase slope stability and prevent slumps and debris flows onto the road. Revegetation efforts poorly integrated with natural processes can threaten the function and structural integrity of the road itself, leading to premature deterioration of the road's infrastructure.

David E. Steinfeld, USFS

Native plants improve cut-slope stability, as shown here on a two-lane road.

David E. Steinfeld, USFS

Native grasses, forbs, and shrubs can be established by hydroseeding. Here, workers are spraying a mix of water and native plant seeds onto a hillside adjacent to a road project.



Shown here is the front cover of *Roadside Revegetation.*

environmental stewardship as one of FHWA's "vital few" goals for road projects, revegetation has to be considered at every phase of design and construction. Engineering and natural resource sciences need to be brought together in a collaborative way.

A Productive Partnership

To meet this need, WFLHD embarked on a project to develop, in collaboration with USFS, an approach to roadside revegetation that is:

- *Goal-oriented:* Integrates revegetation with transportation objectives and customer needs, including safety, mobility, long-term ecological health, and cost effectiveness
- *Collaborative:* Incorporates the knowledge of biological scientists and engineers through collaborative processes and interagency cooperation
- *Context sensitive:* Recognizes that each project has unique ecological characteristics and that source-identified, locally adapted plant varieties ensure functional, self-sustaining plant communities, not just quick cover

USFS and WFLHD synthesized the findings of their collaboration into a comprehensive report that can serve as a guide for practitioners and planners. The report, *Roadside Revegetation: An Integrated Approach to*

Breaking New Ground: Innovative Plant Materials and Installation Techniques

David E. Steinfeld, USFS

"Tall pot" stock types, shown here at a nursery, can help revegetate difficult sites. They are grown in modified PVC pipe containers and develop vigorous root systems.

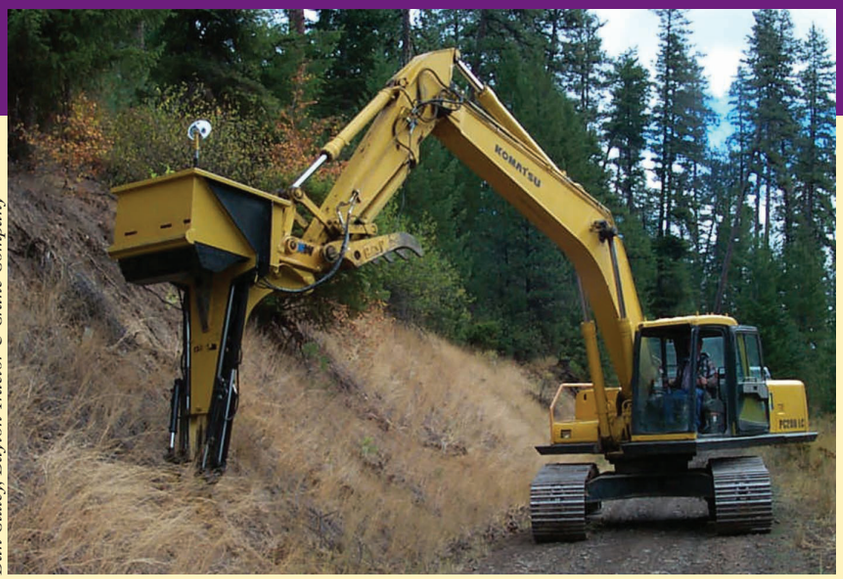
David E. Steinfeld, USFS

A worker is using a tractor with a sprayer attachment to apply native grass and forb seeds to erosion blankets.

The partnership between FHWA and USFS led to the use of new stock types of native plants and methods for installing them along roadsides. To ensure that plants become established in highly disturbed sites, restoration specialists developed innovative "tall pot" stock types. These plants are grown in modified polyvinyl chloride (PVC) pipe containers and have vigorous root systems from 0.6 to 0.9 meter (2 to 3 feet) in length.

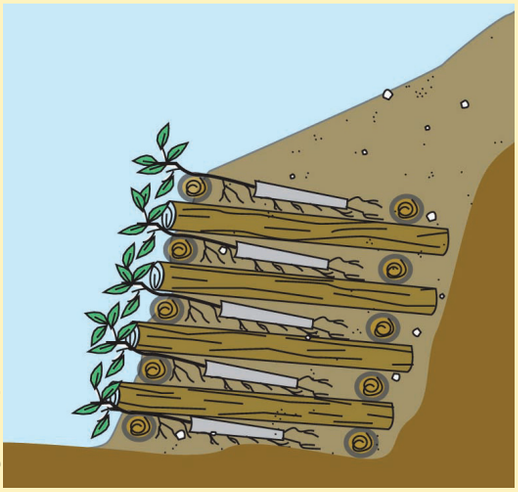
Tall pots can be installed manually during the building of biotechnically engineered structures such as live crib walls. The expandable stinger planter (a mechanized planter probe attached to an excavator boom) can be used to plant tall pots or long cuttings in rocky soils or even through riprap (a layer of rocks used to prevent erosion on a slope). Because the roots are installed so that they penetrate beyond the surface layer, the plants are able to tap into deep moisture sources. They survive better and grow faster, even on harsh sites.

The restoration specialists also developed an operational way to mass produce seeded blankets. Long lengths of erosion fabric are seeded and glued with a tackifier (a resin adhesive). After drying, the blankets are rolled and transported to the project site where they are installed on the outer surface of gabions (baskets or cages filled with earth or rocks), which are backfilled with topsoil. The result is biologically functional and attractive roadsides.



Dan Culley, Dayton Tractor & Crane Company

An expandable stinger attached to an excavator boom, as shown above, can plant nursery stock on steep slopes or in riprap.



Logan Steinfeld

(Above) As illustrated in this diagram, tall pots incorporated in "live" crib walls, where the root systems can grow deep into the slope, can improve slope stability at roadcuts.

David E. Steinfeld, USFS

(Right) A researcher stands beside a gabion wall that was revegetated using a seeded erosion blanket.

Diverse Native Plant Communities: The Best Defense Against Weeds

Vehicles carry weed seeds along roadways, and the disturbance of road construction creates the ideal habitat for invasive species such as Himalayan blackberry (*Rubus discolor*) and Scotch broom (*Cytisus scoparius*). To make matters worse, the frequent disturbance of mowing creates the ideal habitat for weeds.

In addition, mowing roadsides is expensive, ranging from $5.75 to $230 per cut per acre, according to the January 2006 issue of *Better Roads* magazine. Herbicides are another option for controlling roadside weeds, but contractors charge from $2.37 to $455.16 per acre per application. Besides, many members of the public are not tolerant of large-scale spraying of pesticides in their immediate environment.

Preventing weed establishment is the key to reducing herbicide use. The establishment of healthy native plant communities is one of the best and most cost-effective long-term defenses against invasive and noxious weeds. Prompt sowing and planting of native plants after roadside disturbance creates a physical barrier against weed establishment, while providing a beautiful landscape for travelers to enjoy.

David E. Steinfeld, USFS

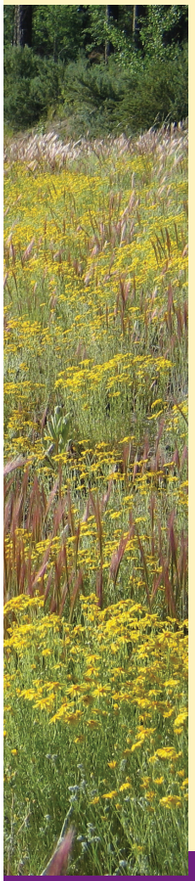
Establishing Native Plants, brings theoretical and practical information to bear on the challenge of revegetating roadsides with native plants. Available on the Web (www.wfl.fha.dot.gov/td/revegetation.htm), the guide is designed to help fill current information and technology gaps, share strategies and techniques, facilitate collaborative processes through interagency and interdisciplinary coordination, and help practitioners through the process of successfully establishing native plant communities on roadsides. In addition, a summary report, *A Manager's Guide to Roadside Revegetation Using Native Plants* (www.wfl.fha.dot.gov/td/revegetation.htm), provides information for managers and planners on how to support successful processes.

"It's been exciting to watch this collaboration unfold," says Thomas D. Landis, retired USFS national nursery specialist. "Field-level practitioners with a long history of successful roadside native revegetation projects were tapped to develop the approach, integrating expertise from soil science, botany, restoration ecology, engineering, and other disciplines. The result is practical, user-friendly information that will be valuable to anyone concerned with establishing native plants on roadsides."

Building on a Legacy

FHWA is a pioneer in addressing concerns about incorporating native plants in road projects. In 2000, FHWA published a landmark book edited by B.L. Harper-Lore and M. Wilson, *Roadside Use of Native Plants,* that brought the importance of roadside native plants to national attention. Since then, FHWA has been a leader in supporting information resources and research to establish and manage native plants. FHWA helped support development of Integrated Roadside Vegetation Management (IRVM) programs to better manage roadside plants beyond repeated applications of herbicides. In 2005, FHWA helped support the National Academy of Sciences in producing a report titled *Assessing and Managing the Ecological Impacts of Paved Roads*.

Internally, FHWA also has invested in several initiatives to improve integration of ecological concerns with road planning. These programs include the Eco-Logical approach, Context Sensitive Solutions, Exemplary Ecosystem Initiatives, the newly formed Green Highways Partnership, and other cutting-edge initiatives and policies.



(Left) Native grasses and forbs on a revegetated slope.

(Right) Himalayan blackberry (*Rubus discolor*, at left) and Scotch broom (*Cytisus scoparius*, yellow-flowered plant at right) are growing along this revegetated roadside.

Sally Long, USFS

Roadside Revegetation builds on these visions by applying the concepts of integrated planning, ecological thinking, context sensitivity, and environmental stewardship to the challenge of establishing native plants on roadsides.

While advances were being made within FHWA and the transportation community, progress also was underway in the science and practice of restoration ecology and native plant propagation. For example, the Society for Ecological Restoration International published guidelines and principles applicable to restoring ecological function to degraded sites.

Plant geneticists at a number of Federal agencies came to a consensus about what truly defines a "native" plant and developed seed collection, transfer, and propagation guidelines to ensure that locally adapted materials are used with optimum results. And in both the public and private sectors, seed and plant producers and installers developed innovative methods to meet unique site conditions.

"Tremendous strides have been made in native plant technologies over the past decade," says USFS National Nursery Specialist Kas Dumroese, editor of the *Native Plants Journal*. "Seed collection, storage, and nursery production capabilities are stronger than ever, and plant quality has never been higher. Innovative stock types and installation methods are literally breaking new ground in terms of where and how native plants can be established. This report [*Roadside Revegetation*] is the first I've seen to apply the knowledge of cutting-edge native plant technologies to the goal of revegetating roadsides."

To achieve the goals expressed in *Roadside Revegetation*, WFLHD Division Engineer Clara Conner says, "We need to have some proven tools to ensure that native plant species are used and established whenever possible as a result of highway and road improvements. We have a responsibility to provide our partners with tools and strategies to provide long-term ecological, economic, and aesthetic gains from establishing native plants on roadsides. This report does this and more. With the process outlined in *Roadside Revegetation*, native vegetation concerns are fully integrated into the larger processes of road design and construction."

Scott Riley, USFS

Placing no-spray signs like this one is a method of identifying areas to protect from herbicide application.

Features of the Report

Roadside Revegetation synthesizes an integrated approach that can be used for effective revegetation of roadsides and other disturbed areas associated with road construction, modification, or obliteration. The report will be of interest to public and private sector practitioners, and to transportation and planning professionals, land managers, policymakers, and owners and operators of roads.

After introducing the challenges of roadside revegetation, the report provides a systematic, interdisciplinary guide through the four stages of the revegetation process. The first stage, initiation of a project, involves creating bridges between nonengineers and engineers on terminology and technical concepts to improve communication. It also creates key relationships to navigate the decision process. Essential steps to coordinate revegetation efforts with road planning and construction are detailed in the report, including budgetary and scheduling issues.

The second stage, planning, guides readers through the process of defining project objectives, assessing the site, overcoming limitations, strategizing revegetation procedures, and integrating the revegetation activities with the road project.

The third stage, implementation, offers information on how to make the project unfold in the field, coordinate contracts, create budgets, and build timelines for caring for the plants as they mature. Implementation guides included in the report provide practical how-to information for cost-effective site treatments and revegetation tactics.

Finally, the monitoring stage describes how to assess the effectiveness of the revegetation project, correct any shortcomings, and add to future knowledge. Some sample monitoring protocols are included to help readers select monitoring methods appropriate to their project's goals. Once vegetation has been established, long-term management dovetails with the practices outlined in IRVM programs.

The report can be consulted during any phase of a revegetation project. It is also intended to serve as a foundation for training in revegetation processes.

Goal-Oriented

"Integrating ecological considerations into all phases of road development—from planning to construction, vehicle use, and ongoing maintenance—is a continuing challenge," Lance Gunderson, chairman of the Committee on Ecological Impacts of Road Density, said at the National Research Council of the National Academies. "Practitioners are moving in that direction and are encouraged to continue in that direction. We suggest that integrative assessments done earlier in the planning process are a key solution to this chronic issue."

Taking up this challenge, the report illustrates how to integrate revegetation into decision processes. It includes an outline of typical timelines and indicates the most opportune windows for collaboration as projects develop.

"Whenever disturbance to soils and vegetation are planned, revegetation specialists should be part of the discussion," FHWA's Fekaris says. "Their involvement will not only help minimize the construction footprint but also will help us plan to facilitate faster recovery of natural vegetation in the road corridor after disturbance."

Coordinating timelines so the appropriate people are involved at optimal times is the key to working together to preclude problems and optimize results. "The report walks the reader through a generic process and shows people on both the engineering and revegetation ends when and how they should be collaborating," Fekaris says.

The approach employed in *Roadside Revegetation* recognizes that financial and personnel resources are limited. The approach is feasible technically and economically, and is designed to produce long-term gains for native plants, ecological functions, and soil and water protection.

Context Sensitive

Given the unique ecological factors at play in each project, the report is not prescriptive but rather provides principles and a step-by-step process for practitioners to take into the field to generate and implement their own locally appropriate, context sensitive revegetation plan. Because the goal is plant communities that are functional in the long term, the approach is intended to facilitate the process of developing locally appropriate steps on a project-by-project basis. Top-down

and ground-up information are integrated to meet the specific challenges at hand.

"If anyone is under the impression that there are some simple instructions or a 'one-size-fits-all' plant mix that you can apply under any circumstances and be successful 100 percent of the time—forget it," says USFS's Landis. "There are too many variables."

He continues, "People working to establish native plants on roadsides have to be adaptable. This report is a conceptual exercise, guiding the reader through every phase of a revegetation project. Guidelines are provided with many examples so that even inexperienced personnel can identify unique site characteristics and how to best manage them. The process and tools needed to arrive at appropriate solutions are logical and simple to apply. By following the steps outlined in this report, practitioners will be able to generate the information they need to revegetate any roadside project."

Collaborative

Collaborative approaches are the key to success. A Context Sensitive Solutions approach incorporates principles that embody early and continuous stakeholder involvement, including the use of interdisciplinary teams to facilitate the best solution for each individual project. According to Anderson, "Nature doesn't divide the world into disciplinary categories. Neither can we, if we want to be successful. Subsoil, soil, and living plants are linked together to create slope stability. Therefore, engineers, soil specialists, and plant specialists have to work together to get the results we are looking for."

He continues, "This often requires interagency cooperation, too. If everyone works in isolation, it doesn't cut it. On the other hand, when engineers and revegetation specialists collaborate from day one, the result can be even greater than the sum of the parts."

The report provides timelines and processes for effective collaboration throughout the phases of the project. For example, the early stages of project development include key opportunities for collaboration. When design engineers are discussing disturbances to soils and vegetation, the revegetation specialist can help determine what types of disturbances are feasible to revegetate using native plants or propose alternatives that facilitate revegetation. The revegetation specialist's work in developing the regrowth plan, advising on how to reduce the construction footprint, and protecting native vegetation on the project site will become an integral part of the road construction plan. Then, after the vegetation is reestablished, coordination with the road-owning agency is essential to ensure that maintenance methods are appropriate for native vegetation. For instance, if blanket herbicide application is standard practice along roadsides, the road owner may need to revise its maintenance methods to avoid undoing portions of the revegetation.

A Way Forward

Although limited resources such as funding and time are important factors, establishing desirable vegetation is widely recognized as an essential and cost-effective step to improve the safety, efficiency, and effectiveness of roads and associated management, according to R.L. Berger in a 2005 Transportation Research Board report, *Integrated Roadside Vegetation Management*.

The *Roadside Revegetation* report generated through the collaboration of FHWA's WFLHD and USFS is available on the Web with highly interactive features. The report can be used as a guide during any phase of a project or as a foundation for training.

According to Robert Lale, director of project delivery for WFLHD, "We're solving this problem in a collaborative way, bringing people together from different organizations. Engineering and the natural sciences work together to meet these challenges in a holistic manner, starting even before any disturbance to soil or vegetation takes place."

Lale continues, "This report will help [FHWA's Federal Lands Highway (FLH) Program] to achieve its goals by improving our ultimate end product, the finished road, and [will help FLH] to do a better job meeting our partners' needs. Not only will our partners and the driving public be happier, but the other communities affected by road projects—the plants, animals, and other forms of life—will be better served, too. We're committed to that."

Amit Armstrong, Ph.D., P.E., is a technology deployment engineer at WFLHD in Vancouver, WA. He has been with FHWA for 5 years, coordinating deployment of new, innovative, emerging, and underutilized technologies in design and construction of roads on Federal lands projects. He has more than 15 years of experience in numerical simulation and visualization of natural systems and is a licensed professional engineer. Armstrong received his doctorate in civil engineering from Texas Tech University.

Scott Riley has been with USFS for 10 years. He has worked in Idaho, Oregon, and Washington as a botanist and currently is a roadside restoration coordinator with the Forest Highways Program in Idaho, Montana, Oregon, and Washington. He holds a bachelor's degree in botany from Boise State University.

David Steinfeld has been with USFS for more than 30 years. He has worked as a field soil scientist and geomorphologist in Oregon and Utah, as an assistant nursery manager and nursery culturist at the J. Herbert Stone Nursery in Oregon, and as a revegetation specialist for Region 6 in Oregon. For the past 8 years, Steinfeld has worked with FHWA on revegetating road construction disturbances with native plants. He holds a bachelor's degree in agriculture (soil science) from Oregon State University.

Kim M. Wilkinson is a writer/editor and consultant specializing in environmental management. She has a bachelor's degree in human/natural ecology and anthropology from Emory University, a master's degree in environmental management from Yale School of Forestry & Environmental Studies, and 10 years of experience with revegetation projects.

For more information, contact Amit Armstrong at 360-619-7668 or amit.armstrong@dot.gov. The reports can be downloaded from www.wfl.fhwa.dot.gov/td/revegetation.htm.

New Vehicle Technologies May Help Older Drivers

by David Band and Mike Perel

(Above) NHTSA is conducting research to help make vehicles safer for older drivers like this woman signaling a right turn. *Photo: AAA Foundation for Traffic Safety.*

Night vision enhancement, adaptive cruise control, lane departure warnings, and other innovative systems enhance transportation safety for senior motorists.

According to the Federal Highway Administration's (FHWA) *Highway Statistics 2005,* the United States had more than 29 million older drivers in 2005, accounting for 15 percent of the U.S. driving population. These older road users value the independence associated with the ability to drive. When that ability is lost, they can become more isolated from the friends and activities they enjoy. Driving cessation also has been linked to declines in health and mental well-being.

Although increased mobility has a number of benefits for older citizens, it also can increase safety risks due to age-related declines. A National Highway Traffic Safety Administration (NHTSA) report, *Model Driver Screening and Evaluation Program, Volume 1: Project Summary and Model Program Recommendations,* notes declines such as decreased visual performance, more restricted head and neck movement, and slower reaction times. Older drivers' fragility also makes them more prone to serious injuries from vehicle crashes.

An earlier article in this PUBLIC ROADS series on senior mobility described some of the efforts by the Federal Government, industry, associations, and academia to address the challenges of providing safe mobility to older Americans. (See January/February 2006, "The Older Driver Comes of Age," by Thomas Granda and Shirley Thompson.) These activities include FHWA efforts to define and promote roadway improvements for older drivers and pedestrians, and NHTSA programs to help States, licensing authorities, and health professionals assess the driving capabilities of older drivers.

"Another essential NHTSA activity is making vehicles safer," says NHTSA Associate Administrator for Vehicle Safety Research Joseph Kanianthra. "NHTSA understands that making the design of vehicle subsystems compatible with the capabilities of the full spectrum of the driving population is a key to helping improve driver performance and, ultimately, safety. In the case of older drivers, their capabilities related to vision, response time, and dexterity often decrease in addition to their susceptibility to serious injuries, even in less severe crashes compared to younger drivers. NHTSA considers these performance limitations in its studies of advanced vehicle technologies to help drivers avoid and survive crashes. The research challenge is to determine how the systems can be engineered to be compatible with older drivers' capabilities so that the safety benefits can be realized and accepted by the driving population at large."

Advanced Vehicle Technologies

Older drivers make up a large segment of new car buyers. In 2006, 21 percent of the principal purchasers of new passenger cars in the United States were 65 years old and over. The vehicles they purchased in their younger days were very different from those they drive today, but even back then, many of them benefited from technologies such as seatbelts, power brakes, and power steering.

Today, a number of advanced technologies that were only in the research stage several years ago have made their way into vehicles that are on the road now. Among these technologies are infrared night vision, advanced headlighting systems, adaptive cruise control, lane departure warning systems, lane change crash warning systems, and parking aids. Each of these technologies can help older drivers avoid crashes.

Others that can help reduce severe injuries include sensor-based intersection warning systems and advanced restraint systems, such as improved front and side air bags, and improved vehicle structures. In addition, navigation systems and advanced communication systems offer conveniences to older drivers and, in fact, all motorists.

For advanced technologies to provide a benefit without creating new safety problems, their design and operation have to be compatible with the needs and capabilities of older drivers. If older motorists cannot hear warning sounds, have difficulty focusing on displays, or become distracted or overwhelmed by complicated technologies, they might not gain overall safety benefits. In addition, some of these technologies might encourage older adults to continue driving well beyond when they would ordinarily cease operating vehicles, introducing other age-associated driving challenges. Such problems could make the technologies "bitter pills" that may afford some benefits but also could create some adverse side effects.

Night Vision Enhancement

One of the most common complaints of older drivers is the difficulty of driving at night. Starting around age 40, people lose some of their ability to see low-contrast objects. They also recover more slowly from exposure to glare. These difficulties can shorten the distance at which drivers can detect and recognize objects. One type of technology that promises to extend the range of driver vision and improve safety is the infrared night vision system.

Current night vision systems increase the visibility of objects by presenting a high-contrast image of the forward scene on an interior visual display. The images are acquired either from a far-infrared (FIR) camera that is sensitive to the heat radiated from objects on the roadway or from a near-infrared (NIR) camera that detects reflected infrared radiation (IR) from an IR source on the vehicle. The NIR system can show roadway objects that are not detected in an FIR system, such as road signs and lane markings.

A recent review indicates at least seven vehicle models in the United States offer night vision systems.

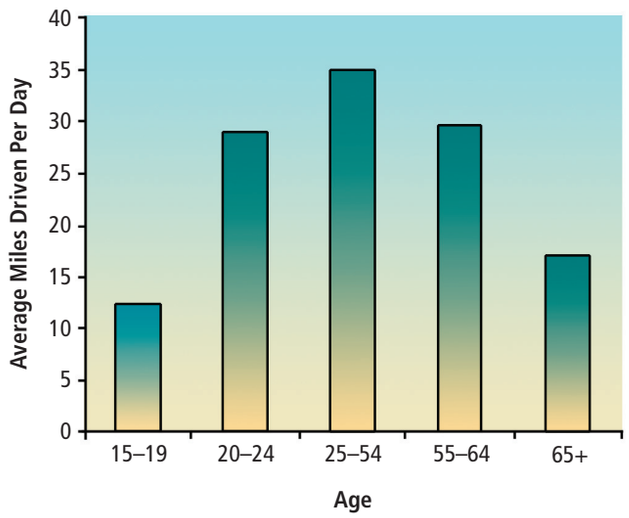
As eyes age, the effects of nighttime headlight glare become more pronounced, as this photo of a city street on a rainy night suggests. Now being researched are advanced headlighting systems that can adjust their lighting pattern to changing conditions and hence reduce glare.

AAA Foundation for Traffic Safety

Age-Associated Driving Statistics

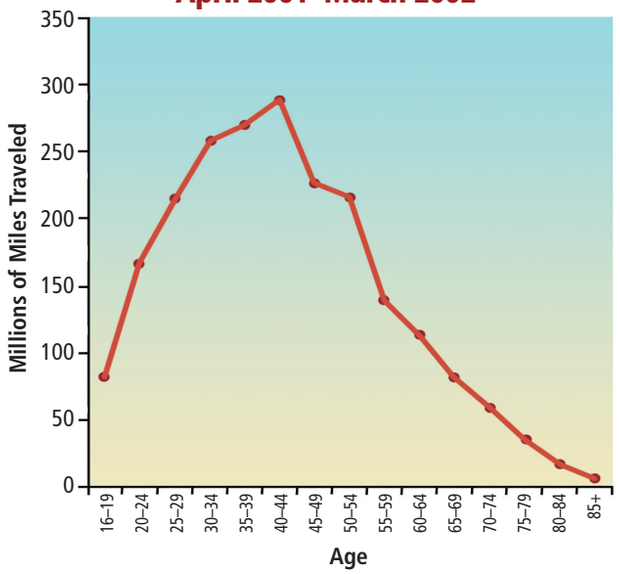
Due in part to age-associated changes, many older drivers tend to self-regulate their driving behavior by avoiding freeways, high-traffic roads, and peak hours. These self-imposed restrictions are one reason that older drivers travel fewer miles per day and accumulate lower annual miles traveled than younger drivers. As a result of their reduced driving, combined with their lower risk taking and greater experience, older drivers have a lower fatality rate per capita than drivers under 65. However, when comparing fatal crash rates per mile traveled across age groups, drivers over 70 are at greater risk than other age groups.

Miles Driven Daily by Age, 2001



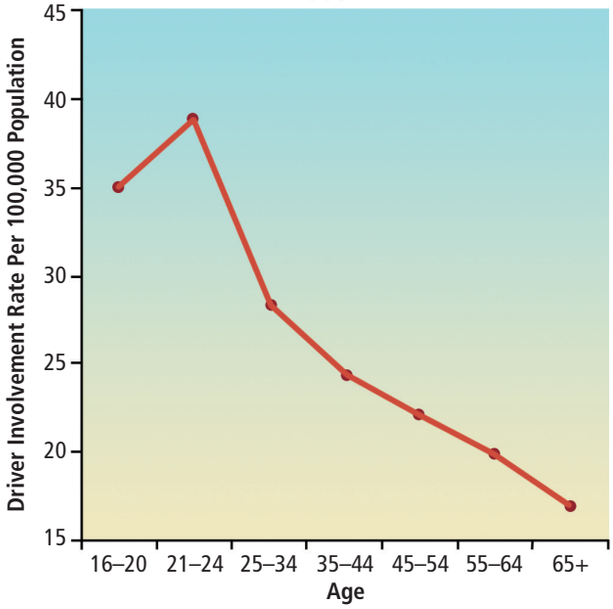
Source: USDOT, 2001 National Household Travel Survey.

Millions of U.S. Vehicle Miles Traveled By Age Group, April 2001–March 2002



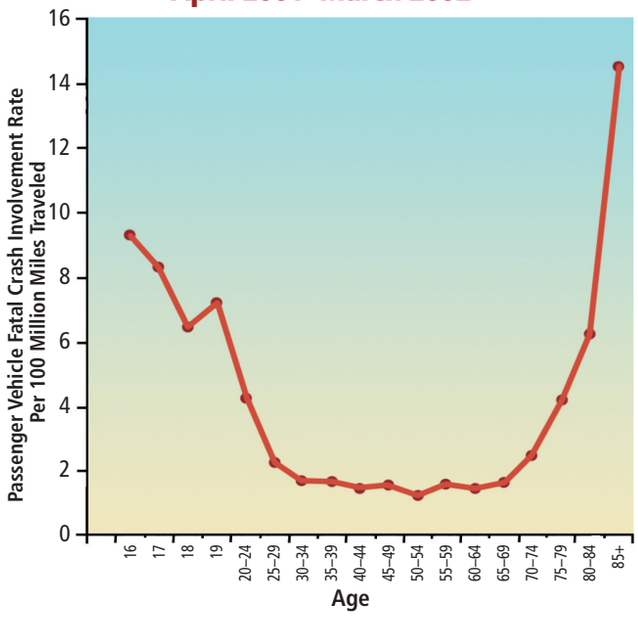
Source: Insurance Institute for Highway Safety, Fatality Facts 2005.

Driver Involvement Rates In Fatal Crashes, 2005



Source: NHTSA, Traffic Safety Facts 2005 Data.

Passenger Vehicle Fatal Crash Involvement Per 100 Million Miles Traveled, April 2001–March 2002



Source: Insurance Institute for Highway Safety, Fatality Facts 2005.

Whether these systems will benefit older motorists depends on the system's ease of use and acceptance by drivers.

An FHWA study summarized in volume 1 of the *Enhanced Night Visibility* series showed that informed drivers on a test track using an FIR night vision system in clear weather had longer pedestrian detection distances than when using low-beam headlamps. Surprisingly, although older drivers did benefit from the night vision system, they did not benefit as much as younger drivers. Similarly, a study conducted by the University of Michigan Transportation Research Institute (UMTRI), reported in *Driver Performance and Workload Using a Night Vision System,* found that night vision systems provide greater improvement for younger drivers than for older motorists.

To better understand driver acceptance of night vision systems and potential safety issues, NHTSA has been obtaining information from drivers who have purchased such systems. "As the public begins to purchase vehicles with new technologies, studying their reactions can provide valuable insights about the benefits and reveal potential problems earlier," says John Hinch, director of NHTSA's Office of Human-Vehicle Performance Research.

In one such study, *Exploratory Study of Early Adopters, Safety-Related Driving with Advanced Technologies*, most participants were over 60. Of the 15 drivers responding in this exploratory study, about half thought the system improved their comfort and ability to recognize objects. Several commented, however, that the display was distracting and hard to use.

These results suggest that a number of questions need to be answered before the potential value of these night vision systems is known: Whether older drivers can shift their attention between the interior display and the roadway, how the field of view of the scene on the display affects object detection, and whether the system will encourage more night driving, which may increase older drivers' mobility but also their exposure to risk.

Recently, automobile makers and the research community have worked on integrating enhancements into night vision systems that will warn drivers when pedestrians are in the driver's path. The aim is to reduce the workload involved in scanning the display, improve detection distances, and improve the actions taken by the driver when an object is detected. Work conducted by UMTRI, summarized in *Improving Pedestrian Detection with a Simple Display for Night Vision Systems,* has shown that night vision systems that include warnings may have advantages in object detection. NHTSA and other research organizations are continuing to investigate whether this refinement will help older drivers.

Advanced Headlighting

Until night vision systems are improved, older drivers will have to rely primarily on headlamp illumination to guide them at night. Although brighter headlamps could benefit older motorists (and younger drivers, too), more intense lights can increase the problem of glare. This tradeoff cannot be fully resolved with conventional designs. Almost any attempt to increase the light to improve seeing distance will increase glare to other drivers.

According to Mark Rea, director of the Rensselaer Polytechnic Institute Lighting Research Center, "This tradeoff presents a greater challenge for older drivers due to their changing eyesight. With increasing age, the lens of the eye transmits less light and scatters incoming light more than with younger drivers. This combination of factors makes it more difficult for older drivers to see at night."

NHTSA is investigating the potential of adaptive front lighting systems (AFS) to help resolve the tradeoff between visibility and glare. These systems can adjust the amount of forward lighting automatically to increase illumination when and where necessary for improved vision. An ongoing NHTSA program is assessing this technology, determining how it can help drivers see better at night, and developing methods to evaluate its safety-related benefits.

One type of AFS currently available on high-end cars is a curve lighting system that adds light in the direction the steering wheel is turned. Other AFS features may be possible as new technologies are developed for controlling the direction and intensity of the light and for sensing the location of oncoming vehicles.

One such technology includes a video system to analyze the road and the position of other road users, plus an optical system that can control the shape of the light beam distribution. The intensity can be reduced selectively for the area around the eyes of oncoming drivers.

"In anticipation of this type of technology, we are undertaking research to evaluate the visual needs of drivers as a basis for developing requirements for an AFS that can automatically lower the intensity to reduce glare when other drivers are nearby," says Hinch.

Such a system would provide a double bonus for older drivers: giving them more illumination for seeing without causing a significant degradation of visibility and discomfort to other drivers.

Adaptive Cruise Control

Adaptive Cruise Control (ACC) is a system that can maintain a set distance to the vehicle ahead ("lead vehicle") automatically within a given speed range. ACC systems first entered the U.S. market in 2000. Since then, the number of ACC-equipped vehicles has been increasing steadily. According to an NHTSA inventory of available systems, ACC was available in 26 vehicle models in 2005 and 2006.

To better understand driver behavior when using ACC as well as Forward Collision Warning (FCW), NHTSA sponsored an Automotive Collision Avoidance System Field Operational Test. This field test involved 96 drivers with vehicles equipped with ACC as well as FCW. Drivers using ACC systems were found to have longer following distances to the vehicle ahead (headway) and fewer lane changes than when using conventional cruise control or no cruise control. In addition to these safer behaviors, drivers who have slower reaction times may benefit from the quick braking of ACC in response to an unexpected deceleration of the lead vehicle.

Even more promising is the finding that older drivers (defined in this study as drivers in their 60s) used the systems more often than younger

When an older driver is following another vehicle as these cars are doing, adaptive cruise control systems can help maintain a safe distance from the vehicle ahead. Research has shown that older drivers rate these systems even higher than younger drivers do. *Photo: AAA Foundation for Traffic Safety.*

and middle-aged drivers. This increased use may explain why the older drivers rated ACC more favorably than their younger counterparts.

If drivers do not clearly understand how ACC works, however, they might lull themselves into a false sense of security and increase crash risks in some situations. To assess the potential for this problem, NHTSA is obtaining information from drivers who purchased cars with ACC. One of the findings of *Exploratory Study of Early Adopters, Safety-Related Driving with Advanced Technologies* was that only 1 percent of users knew that their ACC does not detect stopped vehicles in the lane ahead. This misunderstanding has the potential to increase crash risk if drivers do not brake because they expect the ACC to stop for them.

To determine where any unintended consequences might occur from this type of automated system, NHTSA will explore driver reaction to ACC in a simulator study on the National Advanced Driving Simulator at the University of Iowa. That study will measure the extent to which older and younger drivers using ACC react safely in emergency situations, such as sudden braking by a lead vehicle. If problems are found, driver education and improvements to ACC design and operation may be needed to assure that the positive benefits are not compromised.

Lane Departure Warning Systems

When drivers unintentionally leave their lanes, they are at much greater crash risk. If an inattentive driver is warned prior to unintentionally leaving a lane, some crashes can be avoided. For drivers with slower reaction times, such warnings may give them the extra seconds needed to avoid a crash.

Current lane departure warning (LDW) systems use a camera to analyze roadway markings and provide a warning to alert a driver who has moved out of the lane. LDW systems were introduced first in 2005 by one automaker and currently are offered on two of that manufacturer's model lines. Additional automakers plan to make similar systems available in the near term.

NHTSA recently completed a study, *Road Departure Crash Warning System Field Operational Test,* to evaluate drivers' reactions to a vehicle system that provides an auditory and seat vibration warning when it detects that the vehicle is

drifting out of the lane. The test included younger (20–30), middle-aged (40–50), and older (60–70) drivers. Across all age groups, the system increased the use of turn signals, influenced drivers to remain more centered in their lanes (lower standard deviation of lane position), and decreased the time spent returning to the original lane after a lane departure. These measures do not provide a direct link to a decrease in crash risk but are indicators of safer driving behaviors. Older drivers rated the system high in terms of comfort, convenience, and willingness to purchase.

Under many conditions LDW systems are expected to have an effect similar to roadway rumble strips, which also alert drivers when they unintentionally leave their lanes. An indication of benefits can be found in a study conducted by FHWA, *The Effectiveness and Use of Continuous Shoulder Rumble Strips*, which found that rumble strips reduced run-off-road crashes in New York State by up to 65 percent.

Current LDW systems only provide a warning to the driver when the system detects a lane departure. The next generation of these systems will take a more active role by increasing steering resistance or taking over steering control. Active systems could reduce even more of these crashes, but older driver reaction to automation of this type needs to be better understood.

Lane Change Collision Avoidance Systems

Lane change crashes account for about 10 percent of the all crashes reported in NHTSA's General Estimates System. The common scenario in these types of crashes is that the driver is unaware of the other vehicle when he or she performs a lane change or merge. All vehicles have blind spots that cannot be seen in the sideview or rearview mirrors. This blind zone presents a risk for drivers of all ages but can be a particular concern for those older drivers with decreased neck flexibility and decreased ability to turn and look directly into blind zones.

To help prevent lane change crashes, technologies have been developed to detect and warn drivers of vehicles in their blind spots. If the warning systems enable older drivers to spend less time looking to the side when changing lanes, the drivers can focus more on the forward scene and reduce the risk of a rear-end crash due to the unexpected deceleration of a leading vehicle.

The first lane change collision avoidance system (LCCAS) entered the U.S. market in 2007. This system interprets images from cameras mounted in the sideview mirrors and activates a warning light when an object is detected in the blind zone.

To understand how drivers respond to LCCAS variants, NHTSA is conducting research that was summarized in a 2007 Enhanced Safety of Vehicles paper, "Performance of Drivers in Two Age Ranges Using Lane Change Collision Avoidance Systems in the National Advanced Driving Simulator." Driver lane change performance when using conventional mirrors was compared to performance when using LCCAS. The results suggest that drivers in both age groups (16–21 and 65+) made safer judgments when using LCCAS because they maintained longer distances from an approaching vehicle in the passing lane.

Whether these systems actually will help prevent lane change crashes and be accepted by older drivers will depend on factors such as the ease of seeing the warning light, the rate of false alarms, and nondetected vehicles if the sensors are not 100 percent reliable.

Parking Aids

According to NHTSA's *Vehicle Backover Avoidance Technology Study,* an estimated 183 fatalities

This driver's drifting across the lane divider might be unintentional. To reduce unintentional lane departures, warning systems have been developed and shown to increase safe driving behaviors for drivers of all ages. *Photo: AAA Foundation for Traffic Safety.*

Parking aids can help drivers like this woman who is backing up her vehicle. Although the aids do serve as a supplement to a driver's vision, research has shown that in many scenarios these systems are not effective in preventing pedestrian backovers. *Photo: AAA Foundation for Traffic Safety.*

and at least 6,700 injuries annually are caused by vehicles backing into pedestrians and bicyclists. Drivers over age 70 have the highest rates of involvement in fatal backover crashes per licensed driver.

"Currently, no car company offers a safety feature that is designed specifically to address this crash problem," says Michael Monk, director of NHTSA's Vehicle Research & Test Center. However, "parking aids" marketed as convenience features are increasingly prevalent in the U.S. passenger vehicle fleet. They include sensor-based systems that indicate to the driver the distance between the rear bumper and an object by means of an audio or visual display. Parking aids also include camera-based systems that present a rearview image on an interior display. An inventory of model year 2005/2006 vehicles found that 100 models offered parking aid systems. These devices may help older drivers in slow speed parking situations when they have difficulty turning to the rear to check how close they are to other vehicles. However, due to the limitations of this technology, improved designs and interfaces are needed to provide more reliable safety benefits.

NHTSA identified some of these limitations in *Experimental Evaluation of the Performance of Available Backover Prevention Technologies*, which found that in some locations behind vehicles, children are not reliably detected by sensor-based technologies. Also, when an object is detected while a vehicle is already in motion, most systems do not provide warning in enough time for the driver to avoid the object. According to NHTSA's *Exploratory Study of Early Adopters, Safety-Related Driving with Advanced Technologies*, many drivers do not understand the limitations of their systems. Sixty-seven percent of motorists surveyed thought their system operated over 9.7 kilometers per hour (6 miles per hour), yet nearly all systems do not operate above this speed.

The Llaneras et al. study, reported in the article "Design and Evaluation of a Prototype Rear Obstacle Detection and Driver Warning System," published by the Human Factors and Ergonomics Society, and the McLaughlin et al. article, "Driver Performance Evaluation of Two Rear Parking Aids," published in the *Proceedings of the 18th International Technical Conference on the Enhanced Safety of Vehicles* and cited in an NHTSA 2006 Report

to Congress, described other limitations that indicate that even when the system detects an object and warns the driver, most study participants still backed into the object when it appeared unexpectedly.

Rearview camera systems have a wider detection range than sensor-based systems. They also can improve driver responses because they provide visual confirmation of objects in a vehicle's path. However, camera systems also have their limitations. Conditions such as direct sunlight, snow, rain, and sharp inclines degrade the view. There also is evidence that drivers do not always observe the display when backing up.

To transform these technologies from convenience systems to true "backover" prevention systems, NHTSA is engaged in an Advanced Collision Avoidance Technology project in partnership with General Motors and the Virginia Tech Transportation Institute. This project will produce a tool for the objective evaluation of backover prevention technologies. Such a tool could be used to evaluate how effective the technologies are with the visual search patterns and slower reaction times of older drivers, which have implications for the timing of warnings and the location of visual displays.

Navigation Systems

Older drivers often report that they refrain from traveling on unfamiliar roads. This might be due to increased trouble in making navigation decisions or a fear of getting lost. Invehicle navigation systems can extend older drivers' mobility by giving them more confidence when traveling in unfamiliar locations. For older drivers who have difficulty searching for street signs, the voice directions can help lower their visual workload.

Support for these benefits is evident in an NHTSA-sponsored report, *Exploratory Study of Early Adopters, Safety-Related Driving with Advanced Technologies.* Of the older drivers (age 60+) who had a navigation system in their vehicles, approximately 73 percent felt that it increased their willingness to drive in an unfamiliar area. Ninety-eight percent of drivers (all ages) felt that using a navigation system is better than using a paper map.

Since the introduction of navigation systems in the 1990s, they have become increasingly popular. An inventory of 2005/2006 model year vehicles found at least 144 vehicle models in the United States

Navigation systems such as the one shown here can enhance drivers' willingness to drive in unfamiliar areas, but they also can be a source of distraction. *Photo: AAA Foundation for Traffic Safety.*

Statistically, older drivers like the woman shown here are overrepresented in intersection crashes. Research at USDOT is underway to investigate vehicle technologies that may reduce this crash type. *Photo: AAA Foundation for Traffic Safety.*

that offered navigation systems. Aftermarket systems also are increasing in numbers and popularity, perhaps due in part to lower prices.

Because of the complexity associated with using navigation systems, they have the potential to cause distraction problems. Operating the touch screen features can require drivers to look at the display. Navigation systems constantly display visual information that can attract driver attention away from the roadway. This problem is amplified for older drivers, who typically take longer to read and interpret information.

In general, however, older motorists are more conscious of the safety implications of looking away from the road. This behavior was evident from the NHTSA early adopters study mentioned earlier, which found that only about 22 percent of older drivers looked away from the road more frequently and for longer periods of time when using their navigation systems. In contrast, about 47 percent of drivers aged 20 to 39 admitted that the navigation system led them to look away from the road more often.

Distraction problems can be minimized through application of human factors principles and methods to the design of the interface. For example, a paper by Dr. A. Pauzié of the French National Institute for Transport and Safety Research, Laboratoire Ergonomie et Sciences Cognitives pour les Transports, "In-vehicle Communication Systems: The Safety Aspect," published in *Injury Prevention,* has shown that increasing text size helps older drivers reduce glance times at the display to times similar to those of younger drivers. Another approach to reduce distraction is to lock out features selectively when the vehicle is in motion. For instance, many navigation systems prevent drivers from entering a destination address while the vehicle is in motion. However, such lock-out controls often are not available in the growing aftermarket segment of navigation systems.

Many navigation systems present directions with speech prompts that may enable drivers to keep their eyes on the road. Experimental work, such as T.A. Ranney et al.'s article, "Effects of Voice Technology on Test Track Driving Performance: Implications for Driver Distraction," and T.A. Dingus et al.'s paper, "Effects of Age, System Experience, and Navigation Technique on Driving with an Advanced Traveler Information System," both published by the Human Factors and Ergonomics Society, has found that speech systems can reduce visual distraction.

Drivers also appear to use the voice instruction feature. According to the early adopters study, 52 percent of navigation users surveyed (all ages) rely on the voice instructions as opposed to the visual display. The older group used the voice instructions more than the younger drivers. However, about 38 percent of the older drivers still relied on the visual display. Perhaps improvements to the speech-based systems would lessen the need to look at the display while driving. Some systems may impose high cognitive demands on drivers that could affect their attentiveness to the driving task. Many human factors questions still remain about how the design of speech systems can minimize the visual and mental workload on older drivers and how to make the devices simple enough that more drivers will use them.

Intersection Warning Systems

That older drivers are involved disproportionately in intersection crashes was confirmed in a 2007 NHTSA report, *Analysis of Fatal Motor Vehicle Traffic Crashes and Fatalities at Intersections, 1997 to 2004.* Although older drivers are overinvolved in crashes where they fail to yield to other vehicles, the study also found that they are frequently in crashes involving running a red light or stop sign.

For older drivers, these crashes probably are more often a result of failing to notice the traffic control than willful disregard of the sign or traffic signal. Thus, a system that alerts drivers when they are in danger of violating a stop sign or red light could reduce the occurrence of these crashes. The U.S. Department of Transportation's (USDOT) Intelligent Transportation Systems (ITS) program is working on a project, Cooperative Intersection Collision Avoidance Systems–Violation (CICAS-V), that will create and fieldtest this type of countermeasure. One goal is to identify and develop an effective warning for drivers of all ages. If these systems match the performance capabilities of older drivers, they will have the potential to reduce a significant safety problem.

The Need for Integration of Multiple Warning Systems

As the state of technology advances, multiple warning systems may be installed in vehicles in the future. Vehicles may be equipped with combinations of ACC and forward collision, side collision, and intersection warnings. If so, then older drivers could become confused or distracted by the different sources of information. These problems can be minimized through application of human factors principles to interface design. Message priority schemes and standardized auditory warnings are examples of the requirements needed to help older drivers sort out the information in a timely manner.

NHTSA and the ITS program are exploring the issues associated with integrating collision warnings through an Integrated Vehicle-Based Safety Systems field operational test. The program is developing vehicles with integrated road departure, lane change, and forward collision warning systems and will evaluate driver performance using those integrated systems. The study is expected to lead to recommendations for effective and acceptable integration of multiple warning systems.

Improved Crash Injury Protection

As indicated by the crash statistics and evidence from actual crash investigations, many fatalities of older drivers and passengers are due to their fragility, especially in cases of thoracic trauma. An older person's lesser ability to tolerate crash forces results in a higher risk of rib fracture and a poorer long-term outcome compared to younger occupants.

Stephen Ridella, chief of NHTSA's Human Injury Research Division, says, "Strategies for making the vehicle more protective for elderly occupants are underway. These efforts include revising seatbelt design guidelines to improve the ease of use and prevent misuse and examining the potential for advanced restraint systems that could mitigate thoracic injuries. These systems could include adjustable-force seatbelt retractors, four-point seatbelts, and adaptive airbag technology. These advanced systems also may need to be included in rear seat systems where the elderly often sit."

Advanced restraint systems for the elderly can be effective only if the systems are given information regarding occupants' ages and health status. With this added information, the appropriate belt load limit, airbag inflator output, and even airbag deployment pattern can be adjusted. Efforts have been made to install vehicle sensors to measure bone density, occupant stature, and seating position to enable the restraint system to be tuned for the appropriate response based on sensed occupant status and crash severity.

Next Steps

The technologies mentioned here cover only a portion of the growing number of advanced invehicle technologies. New innovations are making their way into the market constantly. Some have the potential to help both older and younger drivers but may not be as effective as possible unless they are designed to be compatible with the capabilities and limitations of older drivers. Quite often, however, what is a good design for older drivers is beneficial for younger ones as well.

NHTSA recently hosted a forum for government representatives, research organizations, automakers, and suppliers to discuss the human factors issues that affect many of these advanced technologies. One safety issue noted during the forum was the need to assure that these systems are effective and minimize potential adverse consequences for a wide range of the driving population.

Recommendations at the forum included greater efforts to share information among researchers, development of human factors guidelines for accommodating older drivers, and production of adaptive systems that can adjust system operation and interface characteristics to different drivers' characteristics.

Maintaining safe mobility for older drivers will require continued assessment of the use and acceptance of new vehicle technologies, analyses of the factors associated with crashes involving older road users, and a more detailed understanding of the range of the performance capabilities of vanguard technologies. NHTSA and other organizations will continue to address these needs with research to help provide guidance for vehicle safety regulations and for older drivers and vehicle manufacturers.

David Band is a psychologist (human factors) with NHTSA's Human Factors/Engineering Integration Division. He holds a B.S. in psychobiology from Binghamton University and an M.S. in applied psychology from Clemson University.

Mike Perel is the chief of NHTSA's Human Factors/Engineering Integration Division. He holds a B.S. in electrical engineering from Carnegie Mellon University and an M.S. in industrial engineering from Ohio State University.

For more information, contact David Band at 202–366–5677 or david.band@dot.gov, or Mike Perel at 202–366–5675 or mike.perel @dot.gov.

Spotlight on Transportation Planning

by Jody McCullough and Elizabeth Machek

FHWA and FTA are partnering to recognize innovative practices at the State, local, and tribal levels.

The Nation's intermodal transportation system exists to serve the public. Transportation planning therefore needs to include public input and consider land use, the environment, development, safety, and national security. Transportation planners examine past, present, and prospective trends and issues associated with the demand for moving people and goods—all of this at various scales and frames of reference: local, rural, tribal, metropolitan, statewide, national, and international.

According to Michael D. Meyer, P.E., director and professor at the Georgia Institute of Technology's Georgia Transportation Institute (GTI), "Transportation planning guides the development of an area's transportation system and thus has a significant impact on the economic vitality and quality of life of the Nation's communities."

New Jersey FIT: Future in Transportation (NJFIT) is an initiative to integrate land use and transportation decisions to mitigate growth in traffic demand. An NJFIT visioning study and the opening of the River LINE light rail transit (shown here) have created a significant foundation for economic development and redevelopment in historic towns along the southern Delaware River. *Photo: Brent Barnes, New Jersey Department of Transportation.*

Whether using state-of-the-art tools to model travel demand, encouraging transit-oriented development, or devising innovative ways to involve the public in decision-making, communities across the country are realizing the benefits of effective transportation planning.

To recognize groundbreaking efforts at the State, local, and tribal levels, in 2004 the Federal Highway Administration (FHWA), Federal Transit Administration (FTA), and American Planning Association (APA) partnered to sponsor the Transportation Planning Excellence Awards. The biennial program highlights outstanding initiatives to develop, plan, and implement innovative transportation planning practices.

"Excellent planning work occurs in many communities and States across the country, but the Transportation Planning Excellence Awards winners went well beyond the standard practices and incorporated truly innovative and extraordinary efforts," says Associate Administrator Gloria Shepherd of the FHWA Office of Planning, Environment, & Realty. "These winning projects are making outstanding contributions to the field of transportation planning."

GTI's Meyer, who served as a judge for the 2006 awards, adds, "These awards recognize innovation, creativity, and leadership … and sometimes risk taking."

In 2006, FHWA, FTA, and APA recognized 11 winners for 13 projects and applauded 7 other projects with honorable mentions. "The projects are not only focused on the technical aspects of transportation project implementation, but also on the process and public outreach effort necessary to be successful," Meyer says. "Often the projects show strong connection between the physical and operational characteristics of transportation facilities and supporting land use, pricing, and environmental strategies that make the facilities more effective."

With the 2008 awards just around the corner, FHWA, FTA, and APA are preparing to recognize the latest standouts in transportation planning. The 2006 projects highlighted below represent a small cross section of the exemplary work being undertaken and may provide signposts to guide the next generation of innovative projects.

Through the Connecting Savannah initiative, officials in Savannah, GA, hosted public meetings to enlist input on regional mobility. These participants at a January 2005 meeting are discussing a wall-mounted aerial photo of the region.

Mark Wilkes, Chatham Urban Transportation Study

Arizona: Tribal Transportation

Arizona has a large Native American population and 22 tribal governments. Tribal land encompasses approximately 28 percent of the State's land. The tribal land is crisscrossed by nearly 2,170 kilometers (1,350 miles) of State highways. In 1999 the Arizona Department of Transportation's (ADOT) Transportation Planning Division, Civil Rights Office, and Partnering Section formed the Arizona Tribal Strategic Partnering Team. In addition to ADOT, other major stakeholders include the Arizona tribes, FHWA, and the Bureau of Indian Affairs.

The team's purpose is to bring together representatives from Federal, State, tribal, and local governments and agencies to discuss State-tribal transportation issues and to develop interagency forums through which those issues can be addressed. The team meets on a quarterly basis, documenting discussions and distributing information to stakeholders and key State officials.

One major accomplishment was hosting three regional forums and a followup statewide forum held in early 2007, which gave participants a better understanding of their respective programs and responsibilities. Also, the team is developing a guidebook on State-tribal transportation resources and training on State-tribal relations.

Georgia: Connecting Savannah

East-west mobility has been a long-standing concern for Savannah, GA, exerting pressure on the region's quality of life, economic vitality, and tourism industry. In the past, local transportation officials undertook numerous engineering studies to develop solutions but failed to garner sufficient public support for implementation. In February 2004, however, the Chatham Urban Transportation Study, which is the metropolitan planning organization (MPO) for the region, initiated a new planning process called Connecting Savannah: Moving People—Making Neighborhoods.

The goal of Connecting Savannah is to engage diverse populations in meaningful discussions about how to improve mobility in the region. Outreach included a branding campaign, a project Web site, brochures, visualization tools, and surveys. More than 300 people participated in the process, including neighborhood organizations, local businesses, community leaders, and government officials. As a result, new transportation policies and improvements now are moving toward implementation.

Wyoming: PlanCheyenne

Cheyenne, a small community in southeastern Wyoming with just two local government entities, recognized the value of bridging gaps between traditionally autonomous groups to plan for the region's growth. The Cheyenne Metropolitan Planning Organization's PlanCheyenne incorporates, for the first time, the community's separately developed comprehensive plan, master transportation plan, and parks and recreation master plan.

"This commonsense approach created a plan that addresses a broad

Tom Mason, Cheyenne Metropolitan Planning Organization

Citizen participation in developing PlanCheyenne included a design charrette, several workshops, and a scenario-building exercise to help determine the future direction for the community. Participants at one such meeting are shown here discussing a map.

cross section of issues," says Matt Ashby, AICP, director of urban planning for the city of Cheyenne and project manager for PlanCheyenne. "The traditional Western skepticism toward planning evaporated, and the community embraced the process."

Created with extensive involvement of citizens, city and county officials, and planners, PlanCheyenne represents a complete revamping of the region's approach to growing as a "community of choice," Ashby says. "The community's goal is to be a place where people from all walks of life can find a place to live and thrive in Cheyenne. Be it through a variety of housing options, transportation choices, employment opportunities, or recreation amenities, Cheyenne's goal is to be a place where people choose to live."

Public support and partnerships were critical. One creative strategy for engaging the public involved partnering with a community college, where three professors agreed to structure their course curricula around PlanCheyenne to solicit student perspectives on growth in the region.

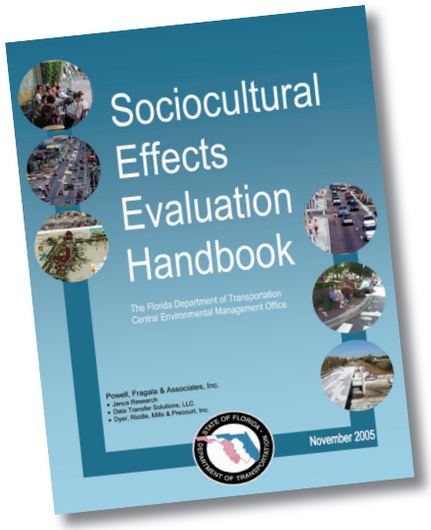
Colorado: Metro Vision 2030 Plan

The Denver, CO, region is made up of more than 50 cities and counties and is home to 2.5 million people. By 2030 the population is expected to increase to 3.8 million, creating 800,000 new jobs. To manage future growth and development, transportation needs, and environmental quality, the Denver Regional Council of Governments (DRCOG) created the Metro Vision 2030 Plan—the region's comprehensive 25-year plan.

Through Metro Vision 2030, DRCOG is deploying innovative planning and implementation tools to integrate transportation and land use at the local and regional levels. The plan includes a voluntary urban growth boundary and a policy that encourages high-density, mixed-use urban centers to absorb growth and support transit. Plans for multimodal corridors integrate transportation facilities with urban growth areas, urban centers, and parks and open spaces. Another feature is a process for ranking transportation projects to encourage community and project-level implementation of Metro Vision 2030's growth, development, and multimodal policies.

Florida: Evaluating Sociocultural Effects

Facing unprecedented population growth and development, the Florida Department of Transportation (FDOT) developed the *Sociocultural Effects Evaluation Handbook* to identify and assess the potential



Shown here is the cover of FDOT's *Sociocultural Effects Evaluation Handbook*. *Photo: FDOT.*

Judges for 2006 Awards

FHWA and FTA thank the following experts who volunteered to serve as judges for the 2006 awards:

- Linda Aitkin, Minnesota Department of Transportation
- Whit Blanton, Renaissance Planning Group
- Jacky Grimshaw, Center for Neighborhood Technology
- Richard Hawthorne, Maryland-National Capital Park and Planning Commission
- John Mason, former mayor of Fairfax, VA
- Dr. Michael Meyer, Georgia Institute of Technology, School of Civil and Environmental Engineering Transportation Group
- Shelley Poticha, Reconnecting America
- Dr. Mary Lynn Tischer, Virginia Department of Transportation

Honorable Mentions

FHWA, FTA, and APA recognized the following projects as honorable mentions during the 2006 awards for their contributions to the field of transportation planning.

- The Binghamton Metropolitan Transportation Study developed Transportation Tomorrow: 2030—Placemaking for Prosperity, a long-range transportation plan for Binghamton, NY. Using a scenario-planning framework, Transportation Tomorrow: 2030 demonstrates how transportation investments can help achieve community development goals in a region with a declining population and economic challenges.
- Idaho's Coeur d'Alene Tribe, the Idaho Transportation Department, and Kootenai County are using FTA funds to operate Citylink, a free, fixed-route bus system serving two counties and nine cities in rural and urban areas.
- When reconstructing the interchange at I–40 and Coors Boulevard—one of the busiest intersections in the State—the New Mexico Department of Transportation (NMDOT) initiated a major public involvement campaign. The department invited the community to participate in decisionmaking on aesthetic considerations such as wall textures, bridge sculptures, and colors for the project, which had an 18-month design-build schedule.
- The Houston-Galveston Area Council in Texas employed a geographic information systems (GIS) tool to identify areas for strategic investments in pedestrian and bicyclist facilities. The GIS methodology assesses various demand indicators without the need for extensive field observations, and facilitates prioritizing investments at the regional level.
- To gather data for travel demand models, the Michigan Department of Transportation conducted a survey of household travel, collecting 48 hours of travel information from more than 14,000 households statewide. A public awareness campaign involving the media, State legislature, and municipalities encouraged Michigan residents to participate.
- In South Carolina, the Spartanburg Area Transportation Study conducted a series of workshops in eight communities in Spartanburg County to help create pedestrian and bicycling plans.
- To inform the State's transportation plan, the Washington State Department of Transportation conducted 150 one-on-one interviews with high-volume freight shippers and carriers to identify their needs. The department also conducted focus groups to invite feedback on draft recommendations. The data helped prioritize freight investments outlined in the State's transportation plan.

Hank Padilla, NMDOT

The redesigned I–40 and Coors Boulevard interchange in Albuquerque, NM, shown here, was successful largely due to NMDOT's efforts to involve the public in decisionmaking.

Lisa Bollinger, Spartanburg Area Transportation Study

During a workshop in Inman, SC, attendees participate in a "human curb extension" exercise to experience first-hand how a driver might respond to pedestrians at a curb extension, which is a traffic-calming measure.

effects of a transportation project on a community in terms of social, economic, land use, mobility, aesthetic, and relocation issues. The handbook's objectives are to avoid, minimize, or mitigate adverse impacts on community resources and create transportation projects that enhance and sustain communities.

Evaluating sociocultural effects begins during project planning and continues through construction, operation, and maintenance. The process encourages integrating transportation and land use planning and balancing transportation needs with those of the natural and human environment. Topics in the handbook include determination of the project need and study area, identification of data requirements, development of an inventory of community characteristics, assessment of public opinion, and determination of solutions.

Arizona: Regional Transportation Plan

The Maricopa Association of Governments (MAG) in Arizona recently completed a regional transportation plan that changes the course of transportation planning in the Phoenix metropolitan area from an almost exclusively car-centered approach to one significantly more multimodal. The $16 billion plan recognizes that all transportation modes are necessary for continued mobility and calls for investing $5 billion to expand bus and light rail service.

The plan took 4 years to develop and required numerous technical studies and extensive public participation. Strong leadership and advocacy from elected officials and key

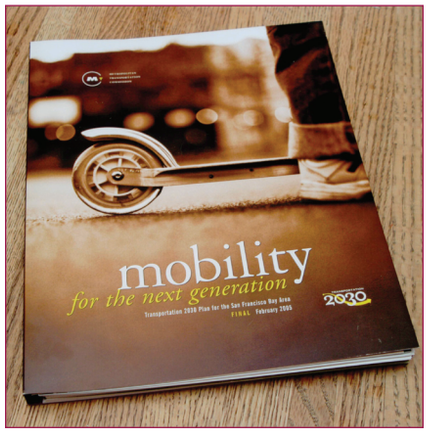
business leaders, who vigorously supported the plan within the legislature and in their communities, were crucial in gaining public support, including legislative endorsement and voter approval of a half-cent sales tax to help fund the plan.

Massachusetts: New Design Manual

After years of construction delays due to community concerns and environmental issues, in 2003 the Massachusetts Highway Department (MassHighway) set out to overhaul its design manual with a renewed focus on involving community stakeholders. The result was the 2006 release of the *Project Development & Design Guidebook*, which incorporates community setting as a design factor, features more flexible design standards, is strongly multimodal, and supports early planning and coordination to create safe, attractive roads. The guide will make transportation projects more compatible with Massachusetts's rich historic, environmental, community, and cultural resources.

Spurred by the Governor's Communities First policy, MassHighway took a radically new approach by appointing a task force that included local officials, planners, and advocacy and professional organizations to oversee the guidebook's creation. This bold decision enhanced the department's credibility with some of its strongest critics, who felt the department favored drivers' desires over community concerns.

The process of developing the guidebook prompted MassHighway to establish multidisciplinary teams for project development and appoint bicycle/pedestrian coordinators in each of its district offices to act as community liaisons. The department also invited planners, historic preservationists, and environmental specialists to serve on its project review and design committees.



Shown here is *Mobility for the Next Generation*, the Transportation 2030 Plan for the San Francisco Bay area. *Photo: Peter Beeler, ©2007.*

California: Transportation 2030 Plan

The Metropolitan Transportation Commission (MTC) of San Francisco, CA, was honored for two initiatives. The first is its Transportation 2030 Plan, a comprehensive roadmap for maintaining, fine-tuning, and expanding the nine-county San Francisco Bay area's transportation network. Developed through an unprecedented public involvement effort that began in 2003 and involved thousands

NJDOT and New Jersey Transit spearheaded a public-private partnership that tamed the Rutherford Circle in northern New Jersey and redeveloped adjacent properties with intensive mixed-use development. *Photo: Brent Barnes, NJDOT.*

of bay area residents and transportation agencies, the plan identifies three investment strategies to achieve its goals: adequate maintenance, system efficiency, and strategic expansion.

The plan sets forth dozens of calls to action that articulate how MTC and its partners can implement the long-range vision by raising revenues, enacting new laws, or rethinking old policies. Among the plan's cutting-edge initiatives are use of high-occupancy toll lanes, aggressive deployment of intelligent transportation systems technologies to squeeze more efficiency out of the existing network, and improving mobility options for low-income residents.

California: Transit-Oriented Development

MTC's second award-winning project is its Transit-Oriented Development (TOD) Policy for Regional Transit Expansion Projects, which aims to promote cost-effective transit, ease regional housing shortages, create vibrant communities, and preserve open space. Adopted in July 2005, the policy sets performance criteria for land use in a manner that meets MTC's ridership, livability, and transit cost-effectiveness goals, yet allows local jurisdictions the flexibility to address regional land use goals in ways that support local policies.

The TOD policy includes three key elements: establishment of corridor-based requirements for housing density around transit stations; development of plans for station areas, funded in part with MTC dollars; and creation of corridor working groups to engage key stakeholders in developing station area plans.

Design charrettes, such as the one shown here, are a key strategy for involving community members in the NJFIT initiative.

Brent Barnes, NJDOT

Minnesota: Performance-Based Plans

Two projects submitted by the Minnesota Department of Transportation (Mn/DOT) earned awards as well. The first is Mn/DOT's 2003 Statewide Transportation Plan and 2005 district-level plans, which are among the Nation's first comprehensive, performance-based, State transportation planning efforts. Created in consultation with resource management and economic development agencies, the statewide plan established a framework for long-range investment planning, with performance measures and targets in 10 policy areas.

Following adoption of the statewide plan in August 2003, Mn/DOT conducted an agencywide rollout and training process in preparation for the district-level plans, which identify investment levels needed to meet targets. The district-level plans detail a prioritized, fiscally constrained, 20-year implementation program. Together, the plans are a critical link between Mn/DOT's strategic goals and the capital investment program in its State Transportation Improvement Program.

Minnesota: Statewide Freight Plan

Mn/DOT's second project is the Minnesota Statewide Freight Plan, one of the first comprehensive, performance-based freight plans in the Nation. The plan creates a framework for communication among public and private transportation stakeholders, including the Minnesota Freight Advisory Committee, to articulate policies, strategies, and performance measures for freight transportation.

The freight plan is oriented toward innovative financing and public-private partnerships, and has enabled Mn/DOT to improve its coordination with Federal agencies on freight issues.

New Jersey: Future in Transportation

The New Jersey Department of Transportation charted a new course for developing transportation projects by creating incentives and offering technical assistance to municipalities to plan for transit-oriented, compact, mixed-use development. Known as New Jersey FIT: Future in Transportation, the initiative uses corridor studies and development of "transit villages" to help communities integrate land use and transportation decisions and mitigate growth in traffic demand.

The corridor studies use visioning, a collaborative and creative process that leads to a shared community vision and common values, and other tools to establish sensible land use patterns and promote lively, walkable main streets. The transit village initiative creates incentives

for new housing and mixed-use development that encourages walking, biking, and transit ridership. Eleven State agencies are providing grants, loans, and/or technical assistance to municipalities that make the required land use changes to become designated transit villages. Seventeen villages have been designated to date, and more than 70 municipalities have expressed interest.

New York: Best Practice Model

The New York Metropolitan Transportation Council developed a model to predict the detailed travel patterns of a diverse population using numerous travel modes. The New York Best Practice Model is a behavior-based travel demand model that the council can use in air quality conformity analyses and major investment studies.

The model features innovative approaches such as using a location-based household travel survey; microsimulation to simulate the travel pattern of each person in the region, including nonmotorized traffic; and the concept of "journeys" instead of the more traditional "trips" as the unit of travel.

The journey, defined as travel between principal locations, identifies anchor points in an individual's travel pattern, such as home, work, or school. The traditional trip, home to work, for example, would identify the point of origin and destination. It would not, however, include details specific to the individual, such as daily stops at a day care center, gym, or other unique aspect of travel that might very well influence the individual's decision regarding mode choice. These approaches make the travel demand models more realistic and more effective tools in the planning process.

Nominations for 2008

FHWA and FTA will request submissions for the 2008 Transportation Planning Excellence Awards in January 2008. Anyone may submit a nomination; however, eligible nominations must be for a project, process, group, or individual involved in a project or process that has used FHWA and/or FTA funding to make an outstanding contribution to the field of transportation planning.

Entries will be judged on the basis of innovation, community and public involvement, partnerships and collaboration, multimodalism, equity, sustainability, and demonstrated results, effectiveness, replication, and transferability.

In addition to meeting these criteria, successful nominees will

Categories and Criteria for 2008 Awards

Transportation Asset Management Program

- Tracks system condition, needs, and performance
- Identifies costs for maintaining and preserving existing assets
- Identifies public expectations and desires
- Compares needs to available funding, including operating and maintenance costs
- Defines asset conditions so decisions can be made on how best to manage and maintain them
- Determines when to take action such as preservation, rehabilitation, reconstruction, capacity enhancement, or replacement

Education and Training

- Increases the quality and effectiveness of transportation planning
- Improves the capacity of the existing or future transportation planning workforce
- Improves quality of transportation planning education curricula
- Includes academic programs, training programs, and courses

Freight Planning

- Ensures efficient, seamless, and secure freight flow within and across U.S. borders
- Considers rail, commercial motor vehicle, waterway, and aviation facilities elements and connections throughout the planning process
- Incorporates freight analysis (such as size and weight dynamics), intermodal coordination, and technology into transportation planning
- Provides ongoing coordination with public and private freight companies

Homeland and Personal Security

- Integrates security into the metropolitan and statewide transportation planning processes, transportation plans, and programs through coordination with law enforcement and emergency management agencies
- Identifies critical transportation elements for emergency response
- Develops activities, programs, and systems prior to a disaster or emergency that are used to support and enhance prevention, response, and recovery
- Identifies and tests through modeling and exercises alternate route plans for evacuation or emergency situations
- Establishes preparedness and evacuation programs for mass transit systems
- Coordinates across jurisdictions and modes, including emergency response providers, State and local planning agencies, and Federal emergency management and homeland security, and involves outreach and systems analysis of emergency response
- Demonstrates leadership and resilience in responding to a federally declared emergency, or encourages hope and resilience in the wake of a disaster

Linking Planning and Operations

- Manages traffic demand by providing travelers with information and travel choices
- Develops regional frameworks for integrated deployment of intelligent transportation systems
- Identifies effective strategies to reduce delay caused by work zones and traffic incidents
- Achieves successful deployment of 511 traveler information
- Coordinates regional operations for safe and efficient movement of the public and freight
- Uses operational performance measurement to determine public perception of improvements in system operations and reduced congestion
- Uses, or contributes to, a congestion management process as the basis for monitoring and forecasting multimodal system performance and setting priorities for including projects and strategies in the plan and TIP

Modeling and Technology Applications

- Strengthens transportation planning with modeling and technology, such as GIS, travel demand forecasting, global positioning systems, incident management systems, and visualization tools
- Assesses current and potential problems, develops alternative solutions, or evaluates alternatives through scenario planning
- Uses visualization techniques and/or electronic media to strengthen public participation in the planning process, specifically to aid the public in understanding proposed plans

demonstrate excellence in the specific categories for which they are nominated. A project or organization may be nominated separately for more than one category, but each nomination should speak specifically to the project or organization's relevance to that category.

"The 2008 awards will have several expanded categories so we can find out about and share more examples of exemplary planning," Associate Administrator Shepherd says. The awards will focus on 12 major categories, chosen not only to reflect traditional transportation planning but also to recognize innovative initiatives, goals, and objectives that will help make the U.S. transportation system the best in the world.

Online application forms will be available in January 2008. All nominations are due by February 29, 2008. Winning entries will be selected by an independent panel of judges representing diverse backgrounds and expertise. Awards will be presented in summer 2008.

Jody McCullough is a transportation planner in the FHWA Office of Planning, Environment, & Realty. She is a member of the Transportation Planning Capacity Building Team, and her responsibilities include promoting scenario planning; providing technical assistance on visualization requirements, land use, sustainability, and livability for transportation planning; and overseeing the Transportation Planning Excellence Awards. She has a bachelor's degree in geography land use from Shippensburg University in Pennsylvania.

Elizabeth Machek is a community planner with the Planning and Policy Analysis Division at the Volpe National Transportation Systems Center, which is a Federal fee-for-service organization within the U.S. Department of Transportation and located in Cambridge, MA. Machek focuses on transportation and strategic planning, capacity building, parking management, and data collection and analysis. She holds a master's degree in city planning from the Massachusetts Institute of Technology and a bachelor's degree in Japanese studies and political science from the University of Tennessee, Knoxville.

For more information, contact Jody McCullough at 202-366-2825 or jody.mccullough@dot.gov, or Elizabeth Machek at 617-494-3442 or elizabeth.machek@volpe.dot.gov.

- Portrays the complex character of proposed transportation plans, policies, and programs at appropriate scales through visual imagery

Planning Leadership

- Demonstrates an agency or organization's leadership through innovative transportation planning initiatives and shares information about techniques by participating on national teams, at conferences, or in training
- Demonstrates that an agency or organization not only raised the standards in transportation planning but also is an example for others

Public Involvement and Outreach

- Promotes understanding and properly addressing the needs of different socioeconomic groups
- Avoids, minimizes, or mitigates disproportionately high and adverse effects, and/or ensures full and fair participation by all potentially affected communities for an effective transportation decisionmaking process
- Broadens participation in the transportation planning process by reaching out to community members who previously were not engaged in it
- Innovates by using public involvement methods such as electronic voting, visual preference surveys, public design forums, charrettes, handbooks, and other techniques
- Demonstrates how collaboration with the public and community outreach has successfully enhanced decisionmaking, the transportation planning process, and project development

Safety Planning

- Develops an exemplary Strategic Highway Safety Plan that involves a comprehensive, data-driven approach to highway safety and considers operational aspects of the highway system, in concert with other modes, for their benefits and impacts
- Integrates safety into comprehensive, systemwide, multimodal, and proactive surface transportation decisionmaking
- Considers all aspects of transportation safety—engineering, education, enforcement, and emergency medical response
- Includes transit, bicyclist, and pedestrian safety improvements in the transportation planning process
- Addresses current safety problems and prevents future hazards and problem behaviors

Transportation, Land Use, and Economic Development Integration

- Promotes coordination of transportation with land use and economic development
- Incorporates several land use tools such as ordinances, codes, or policy guidelines
- Shows coordinated planning across multiple jurisdictions
- Protects and enhances the environment, promotes energy conservation, improves quality of life, and promotes consistency between transportation improvements and State and local planned growth and economic development patterns
- Connects decisions about transportation infrastructure with land use and development decisions

Transportation Planning And the Environment

- Exhibits effective linkage and integration between transportation planning processes and the natural and human environment from systems planning through project development
- Acknowledges innovative efforts to protect the human environment
- Demonstrates exemplary efforts regarding Title VI of the Civil Rights Act of 1964 and environmental justice
- Protects or improves the natural environment, air quality, and habitats
- Results in improved air quality
- Incorporates context sensitive solutions

Tribal Transportation Planning

- Demonstrates innovative and exemplary tribal transportation planning
- Incorporates tribal government planning considerations throughout the planning process
- Shows coordinated tribal planning across multiple jurisdictions, including State and local planning agencies

FHWA's updated **Traffic Detector Handbook** *describes in-roadway and over-roadway technologies for vehicle detection as key to ITS deployment.*

by David Gibson, Milton K. "Pete" Mills, and Lawrence A. Klein

A New Look at Sensors

With more vehicles on the roads and less available capacity, congestion has become a national problem. Part of the challenge is to manage the movement of more vehicles on existing infrastructure, which is one objective of intelligent transportation systems (ITS).

(Above) Personnel from FHWA and the Virginia Department of Transportation are calibrating a video image processor (VIP) installation. VIPs are one type of over-roadway sensor.

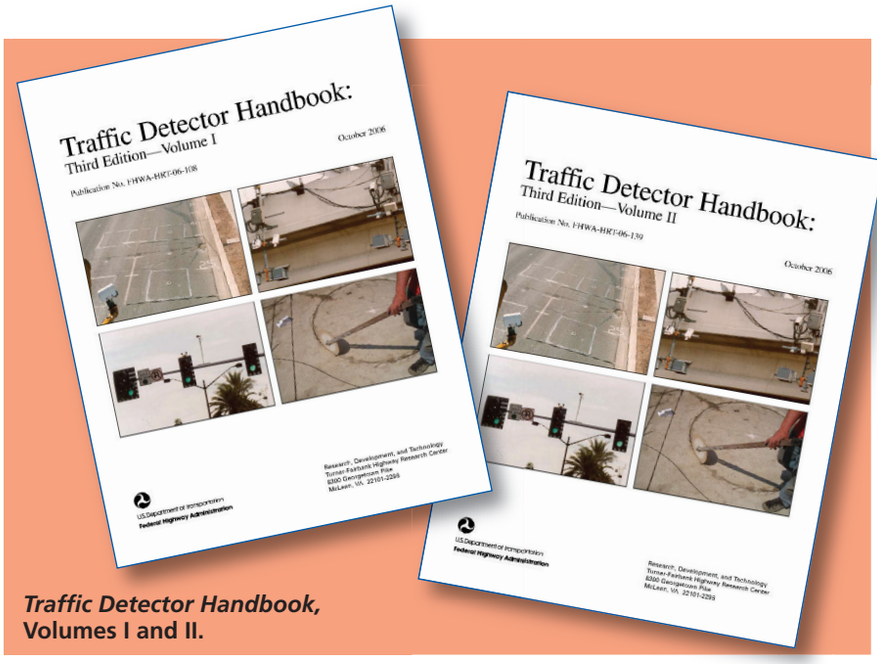
ITS applications rely on traffic flow sensors to provide vehicle detection; incident detection; ramp metering data; real-time traffic adaptive signal control; roadway volume and vehicle classification archival and planning data; and data for traveler, commercial, and emergency information services. The success of these ITS applications depends largely on the proper design, installation, and maintenance of sensor components.

Over the past 17 years, sensor manufacturers have developed new, more effective vehicle detection technologies, particularly for over-roadway sensors. During the same period, the manufacturers discontinued some over-roadway and in-roadway models. The new hardware is better able to meet the expectations of the ITS community.

To educate the transportation community on the latest sensor technologies, the Federal Highway Administration (FHWA) recently published a revised and restructured edition of the *Traffic Detector Handbook* (FHWA-HRT-06-108 and FHWA-HRT-06-139), a two-volume, comprehensive reference on sensors for traffic management on surface streets, arterials, and freeways. Previous editions of the handbook, published in 1985 and 1990, required updating to reflect the evolution, maturation, and state of the practice of sensor hardware and installations.

Antoinette Wilbur, former director of the FHWA Office of Operations Research and Development, writes in the revision's foreword: "The objective of the third edition of the *Traffic Detector Handbook* is to provide a comprehensive reference document to aid the practicing traffic engineer, planner, or technician in selecting, designing, installing, and maintaining traffic sensors for signalized intersections and freeways." She adds, "The information contained in this handbook is based on the latest research on available treatments and best practices in use by jurisdictions across the United States and elsewhere."

The revised handbook discusses selecting, configuring, installing, operating, and maintaining traffic sensors, along with new applications of sensors to advanced signal control, ramp metering, incident detection, efficient corridor operation, toll collection, collection of travel time and other data, priority vehicle and pedestrian detection, vehicle/driver safety, and other ITS functions. The enhanced descriptions of ITS applications and the other improvements discussed in the revised edition can help departments of transportation (DOTs) ensure long-term savings of public funds.



***Traffic Detector Handbook*, Volumes I and II.**

Types of Sensors

As defined in the handbook, "A traffic flow sensor is a device that indicates the presence or passage of vehicles and provides data or information that supports traffic management applications such as signal control, freeway mainline and ramp control, incident detection, and gathering of vehicle volume and classification data to meet State and Federal reporting requirements."

In-roadway sensors are embedded in the pavement or the subgrade, or they are taped or otherwise attached to the surface of the roadway. *Over-roadway* sensors are mounted above the roadway or alongside it.

One of the main types of in-roadway sensors is the inductive-loop detector, which consists of loops of wire embedded into sawcuts in the road pavement. A conductive metal object, such as a vehicle passing over or stopped within the sensor's detection area, decreases the loop's inductance (an electrical property), producing an electrical signal that is transmitted through a curbside junction box (a "pull box") to an electronics unit housed in a controller cabinet. The electronics unit analyzes the signal, interpreting it as the presence or passage of a vehicle, and sends an appropriate call to the controller.

According to the revised handbook, "Today, the inductive-loop detector is, by far, the most widely used sensor in modern traffic control systems." The handbook clarifies the calculations required to design properly functioning inductive-loop detector systems for intersection and highway applications.

Other in-roadway sensors include magnetic detectors and magnetometers, which can be placed underneath a roadway or bridge. A magnetic detector senses changes in the Earth's magnetic field caused by passage of a nearby vehicle that contains ferrous material. A magnetometer measures the difference in the Earth's magnetic field caused by the passage or presence of a vehicle. Its ability to function as a presence sensor enables it to detect stopped vehicles. Because both of these sensors are passive devices, they do not transmit energy. Therefore, a portion of the vehicle must pass over the sensor for it to be detected. A magnetometer can detect two vehicles separated by as little as 0.3 meter (1.0 foot). This potentially makes the magnetometer as accurate as—or even better than—the inductive-loop detector at counting vehicles.

Examples of over-roadway sensors include video image processors, which use cameras mounted on tall poles adjacent to the roadway or

This electronics unit for an inductive-loop sensor is capable of identifying more than 20 vehicle classes. *Photo courtesy of Reno A&E, Reno, NV.*

on traffic signal mast arms over the road; microwave radar, laser radar, ultrasonic, and passive infrared sensors installed either alongside or above the road; and acoustic sensors installed alongside the road. The required mounting configuration is a function of the intended application. Modern over-roadway sensors provide a viable alternative to inductive-loop detectors.

Key changes in the new handbook include descriptions of enhanced infrared and microwave sensors, video image processors, and magnetometer sensors.

Sensor Applications And Functions

Sensor applications for traffic control and management continue to evolve. Originally used for signalized intersection control, sensors now supply real-time data for traffic adaptive signal control, mitigation of recurring and nonrecurring congestion on freeways, and gathering of volume and vehicle classification information for road use and planning purposes, among other applications.

The technologies discussed in the handbook are time tested for traffic management applications, although some might not provide the data required for a specific use. Some technologies, such as video image processing, microwave and laser radars, and inductive-loop detectors, continue to evolve by adding capabilities that measure additional traffic parameters, such as vehicle length, classification, or acceleration; track vehicles; improve spatial resolution; or link data from one sensor to those from another. Combinations of technologies are being integrated into one unit by manufacturers to provide more robust data under a variety of traffic flow conditions.

Most vehicle sensors in use today monitor the movement of vehicles past a given point. The data acquired are transmitted to a signal controller, traffic counter, or other device. The controller or counter processes some data locally, while other data are transmitted to a central computer or display monitor, in the case of camera imagery, at a traffic management center.

This wireless magnetometer is a type of in-roadway sensor that also can be placed underneath a roadway or bridge.
Photo: Sensys Networks, Inc., Berkeley, CA.

Although single inductive-loop detectors transmit direct information concerning vehicle passage and presence, other traffic flow parameters such as density and speed must be derived from algorithms that interpret or analyze the measured data. When these parameters are calculated from inductive-loop data, the values might not be sufficiently accurate for some applications (such as rapidly detecting freeway incidents).

Pavement deterioration, improper installation, and weather-related effects can degrade the operation of in-roadway sensors such as inductive-loop detectors. Street and utility repair also can impair loop integrity. Thus, effective loop installation, acceptance testing, maintenance, and repair programs are required.

On the other hand, according to the handbook, "Over-roadway sensors are becoming more popular as sources of real-time data for signal control and freeway traffic management. This is because of their ability to provide multiple lane data from a single sensor, reduced maintenance and increased safety to installation personnel, data types not available from loops or magnetometers, and competitive purchase and installation costs."

The traffic flow parameters measured with over-roadway sensors satisfy the accuracy requirements of many current freeway and surface street applications, provided suitable mounting is available. In terms of operation, the mounting location must provide an unobstructed view of vehicles for optimum performance.

When a sensor is installed directly over the lane of traffic that it is intended to monitor, its view and hence its ability to collect data are not obstructed. But when a sensor is mounted on the side of a roadway and views multiple lanes of traffic at a perpendicular or oblique angle

Dan Middleton, TTI

These two technicians are installing a wireless magnetometer sensor, flush with the surface in a pavement borehole.

to the direction of traffic flow, tall vehicles can block its view of distant lanes, potentially causing an undercount or false average speed measurement. Thus, sensor type, mounting height and location, vehicle mix, road configuration, and sensor viewing angles must be analyzed in light of the intended application.

Inductive-Loop Configuration for Detecting Small and Large Vehicles

The revised handbook compares various inductive-loop digital electronics units in terms of sensitivity and response time. Newer units and loop configurations are capable of vehicle classification. Special configurations of inductive loops have been developed to detect axles and their relative position on a vehicle. Such systems are used at toll plazas to elicit the correct payment for the vehicle class. The data obtained are vehicle type, length, speed, acceleration, number of axles, and axle separation.

The revised handbook also contains improved explanations of inductance calculation for the detection of small and large vehicles. One of the inherent problems associated with detection of bicycles is assuring that the rider will pedal within the loop's detection zone. When a bicycle or motorcycle travels along a loop wire, eddy currents are induced in the conducting wheel rims and frame. When the cycle is directly over the loop wire, coupling between the inductive loop and the cycle is maximized—hence detection of the cycle. Loop system sensitivity is defined as the smallest change of inductance at the electronics unit terminals that will cause the controller to activate. Many States specify that the electronics unit must respond to a 0.02 percent change in inductance.

Selection of Sensors

Traffic managers selecting a sensor should consider the intended application, ease of installation and maintenance, and design requirements.

Choosing a sensor for a specific application depends on data parameters, data accuracy, spatial resolution, detection area, appropriate data transmission media, location-specific installation requirements, initial cost, and acceptability of the maintenance burden that the sensor will impose.

Microwave radar sensors such as this one transmit a frequency-modulated waveform, which supports measurement of the distance between the sensor and a vehicle. This type of microwave sensor can detect both stopped and moving vehicles in multiple lanes or in multiple areas in a single lane.

EIS Electronic Integrated Systems Inc., Toronto, Canada

Traffic managers should assess these criteria, separately and in combination, as part of the selection process.

Installing and maintaining in-roadway sensors such as inductive-loop and magnetic sensors can disrupt traffic and pose a safety risk to the installers. But traffic managers continue to use in-roadway sensors for a number of reasons, including (1) aesthetic considerations, (2) integration with axle counting and weigh-in-motion applications requiring sensors under or on the road surface, (3) cost and safety issues associated with mounting over-roadway sensors where existing structures are unavailable, and (4) policies that prohibit over-roadway sensors in certain locations. Newly and properly installed inductive-loop detectors also can provide more accurate data than many over-roadway sensors when they are coupled with the advanced electronics units available from several manufacturers.

As for maintenance, the passage-detecting magnetic detector, despite limited applications, has managed to retain some popularity largely because of its ruggedness and long life with minimum upkeep.

Sensor technology and operating theory indicate that the principal in-roadway sensors (inductive-loop, presence-detecting magnetometers, and passage-detecting magnetic detectors) are suitable for some applications but unsuitable for others. For example, magnetic detectors generally cannot be used for vehicle presence detection.

In terms of ease of installation, the handbook notes: "Today, agencies

This microwave radar sensor is mounted on the same pole as a camera and a camera lowering device.

FDOT District 4, Fort Lauderdale, FL

often look favorably on eliminating a sawcut or replacing it with a drilled hole. The pervasiveness of deteriorating pavements has produced more interest in installing preformed loops, microloops, or pavement slabs with sensors already in place." The same concerns often lead to the selection of above-roadway sensors.

Finally, sensor selection for vehicle detection at intersections is a function of the types of timing intervals generated by the controller and the corresponding data needed to compute the intervals. Therefore, the timing interval types should be selected early in the design process.

Additional Advantages and Disadvantages Affecting Selection

The handbook compares the capabilities, strengths, and weaknesses of current sensor technologies in terms of installation, parameters measured, and performance in inclement weather and under variable lighting and changeable traffic flow.

The good performance of in-roadway sensors such as inductive loops, magnetic detectors, and magnetometers is due partly to their close proximity to the vehicles passing over them. Another advantage is that they are insensitive to inclement weather such as rain, fog, and snow. Their main disadvantage is their in-roadway installation, which necessitates a pavement cut. Also, inductive-loop detectors are not always appropriate for some traffic signalization applications. For example, long loops are not suitable for detecting oversaturated flow or long queues of vehicles.

Because a magnetometer's probes are buried in a drilled hole below the surface, the devices are especially useful in the Northeastern States and other cold regions, where pavement deteriorates more rapidly due to thermal expansion and contraction and suffers damage from snow-removal equipment. Another advantage is that magnetometer probes and lead-in wires tend to survive in crumbly pavements longer than ordinary loops.

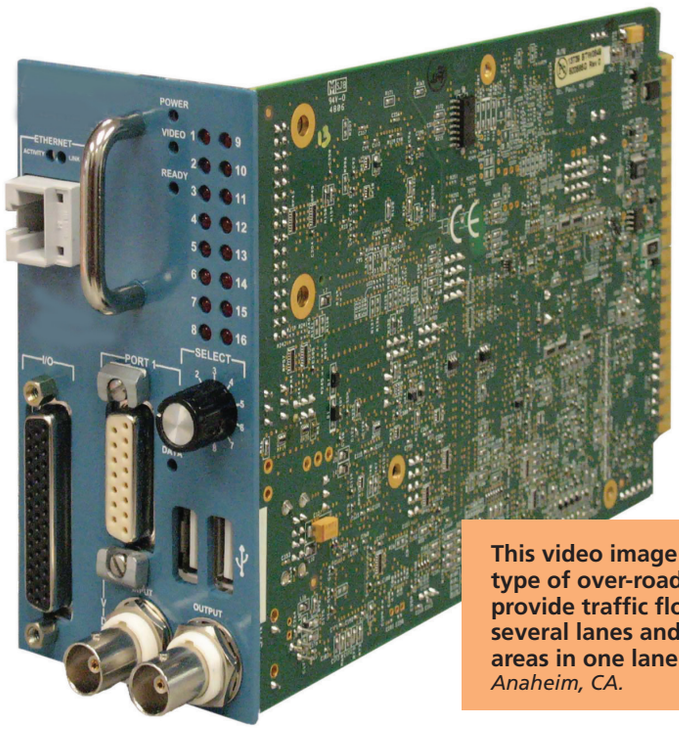
Unlike inductive-loop detectors, magnetometers usually will operate on bridge decks where uncoated steel is present and cutting the deck pavement for loop installation is not permitted. Another benefit is that they require fewer linear feet of sawcut. Modern magnetometers are built with both horizontal and vertical axis sensors. Therefore, they can operate virtually anywhere.

The over-roadway laser radar sensor transmits energy in the near infrared spectrum, which is just above the visible wavelength spectrum. An advantage of laser radar is that it transmits multiple beams for accurate measurement of vehicle position, speed, and class. Up to 11 standard and 20 user-defined classes can be reported. But its operation can be affected by fog or blowing snow when such conditions restrict visibility to less than the distance from the sensor to the road, typically 6 meters (20 feet). Another disadvantage is that its installation and maintenance, including periodic lens cleaning, require lane closure when it is mounted above the road.

Microwave radar sensors that transmit a frequency-modulated waveform, which supports measurement of the distance between the sensor and a vehicle, can detect stopped and moving vehicles in several lanes when mounted alongside the road. When mounted above a particular lane, they can detect vehicles in multiple areas in a single lane. But microwave radar sensors that transmit a continuous wave signal (one that is constant in frequency) cannot detect stopped vehicles and usually are limited to monitoring one lane of traffic, so traffic managers should consider these limitations when selecting a sensor for the chosen application. Data supplied by presence-detecting microwave radars include volume, lane occupancy, speed, and vehicle class by length.

Video image processors (VIPs) typically consist of one or more cameras, a computer for digitizing and analyzing the imagery, and software for interpreting the images and converting them into traffic flow data. Black-and-white image analysis is performed by algorithms that examine the variation of gray levels in groups of pixels (picture elements) contained in the video frames. A VIP system can provide traffic flow data across several lanes and in multiple areas in one lane. VIPs can classify vehicles by their length and report vehicle presence, volume, lane occupancy, and speed for each class and lane. VIPs also can register vehicle turning movements and lane changes.

But VIPs require line-of-sight views of the areas they monitor and are susceptible to inclement weather. Installation and maintenance, including periodic lens cleaning, require lane closure when a camera is mounted over the roadway. Performance is affected by vehicle shadows; the day-to-night transition; sun glint; vehicle/road contrast; and



This video image processor, a type of over-roadway sensor, can provide traffic flow data across several lanes and in multiple areas in one lane. *Photo: Econolite, Anaheim, CA.*

water, salt grime, icicles, and cobwebs on the camera lens. Reliable nighttime signal actuation requires street lighting and a camera mounting height of 9 to 15 meters (30 to 50 feet) in a side-mounting configuration for optimum presence detection and speed measurement. Some models are susceptible to camera motion caused by strong winds and vibration of the mounting structure.

The handbook states, "What seems to be clear is that agencies [that are] contemplating the use of video detection should approach it carefully as there are many pitfalls…It seems clear that it is also important to make sure a vendor is selected that can provide the latest improvements in video detection technology." On the other hand, the handbook adds that VIPs generally are cost effective when many detection zones or specialized data are required.

Finally, the handbook compares sensors in terms of costs for purchasing the hardware and software, plus installation, maintenance, and repair—all costs that should be factored into the selection decision. Installation costs, for example, include those for the technicians who prepare the road surface or subsurface (for inductive-loop or other surface or subsurface sensors), install the sensor and mounting structure (if one is required for over-roadway sensors), purchase and install the conduit, close traffic lanes, divert traffic, provide safety measures where required, and verify proper functioning of the device after installation is complete.

This VIP has an integrated camera and processor in one unit. VIPs can classify vehicles by their length and report vehicle presence, volume, lane occupancy, and speed for each class and lane.

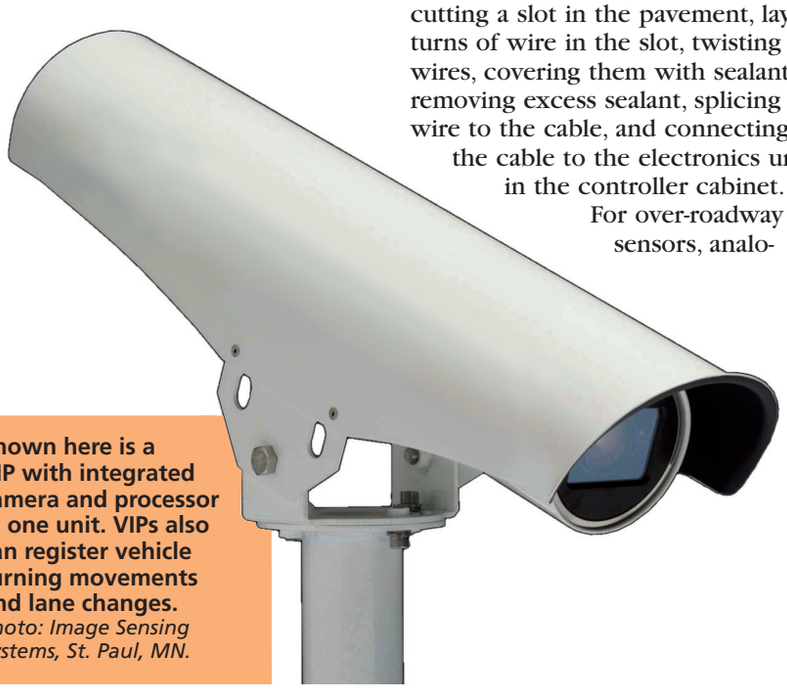
Traficon, Wevelgem, Belgium

Installation: Best Current Practices

The mechanical operations associated with sensor installation often present challenges. For example, installing an inductive-loop detector requires approved procedures for cutting a slot in the pavement, laying turns of wire in the slot, twisting the wires, covering them with sealant, removing excess sealant, splicing the wire to the cable, and connecting the cable to the electronics unit in the controller cabinet. For over-roadway sensors, analogous tasks and issues arise, such as installation of mounting structures, power and data cables, sensor alignment, and calibration verification. Over-roadway sensors require sign bridges, mast arms, poles, or similar overhead structures for mounting. If such a structure is not already in place, it must be installed to support the sensors.

An over-roadway sensor's field of view, that is, the area of the roadway within which a vehicle is detected and data are collected, is a function of sensor mounting height and aperture size, offset of the mounting location from the lanes to be monitored, elevation changes and curves in the road, and objects that can block the view. These factors must be taken into account when installing this kind of sensor.

Installation techniques and theories vary widely among traffic agencies. As noted in the handbook, "Procedures developed over time frequently become outdated or are no longer effective; yet there is often great resistance to change. In many cases, contractors perform sensor installation using proprietary shortcuts (and shortcomings)." The handbook notes, "Improper or sloppy installation causes many of the sensor failures and signal malfunctions that are observed."



Shown here is a VIP with integrated camera and processor in one unit. VIPs also can register vehicle turning movements and lane changes. *Photo: Image Sensing Systems, St. Paul, MN.*

Key changes in the revised handbook regarding installation include updates to the procedures for installing inductive loops and inclusion of new material that describes installation of above-roadway sensors. Because of the failures attributed to moisture or breaks in wire, the trend is to encase and seal the loop wires in a protective covering prior to sealing the sawcut. Some agencies choose to prewind the wires or preform the loops in the shop to ensure the proper number of turns and reduce installation time on the roadway. In addition, many inductive-loop detectors now are built into the pavement during construction of a new roadway or during repaving.

This rack-mount VIP uses a modular approach that enables the system to be configured for specific applications that can vary the numbers of video inputs, inputs from external systems and outputs to support complex uses, and Internet browser access to video imagery. *Photo: Iteris, Inc., Santa Ana, CA.*

Maintenance and Troubleshooting

The handbook notes, "Use of appropriate sensor installation techniques and specification of suitable materials and products will minimize maintenance and other life-cycle costs. However, even with superior design and installation, proper and regularly scheduled sensor maintenance is critical to effective and prolonged operation of traffic signal control systems and freeway surveillance and management systems."

Many factors such as inadequate budget and staffing deficiencies can contribute to lack of maintenance. "Budgetary problems, which continue to plague traffic agencies, have resulted in a cost consciousness that frequently focuses only on initial cost, rather than on lifetime cost," according to the handbook. "Consequently, less expensive products, materials, and processes are used in the original installation because of their lower initial cost."

Maintenance issues associated with inductive-loop detectors have changed considerably over the years. For example, the inductive loop's electronics unit, which formerly accounted for a considerable portion of sensor malfunctions, has matured to the point where many currently available digital models seldom experience failures. Recognizing the heavy demand on maintenance dollars, some manufacturers added circuitry that reduces the frequency of trouble calls to reset units attached to faulty loops.

Maintenance and life-cycle costs may be determined, in part, by published values of the mean time between failures. Some over-roadway sensors are designed to operate for 35,000 to 90,000 hours before a potential failure. The effects of lightning strikes and other natural or human-induced failure modes are not included in this number. Over a 10-year period, maintenance and replacement costs for these devices can be significantly less than for inductive loops, especially if commercial vehicle loads, poor subsoil, inclement weather, and utility improvements frequently require road resurfacing and loop replacement.

A 10-year study of inductive-loop maintenance costs in Houston, TX, found as few as 42 failures and as many as 341 failures per year in the 600 to 1,000 intersections maintained during the 1989–1998 study period. The calculated loop replacement costs per intersection varied from $107 to $628. Actual costs per intersection are probably higher because the calculation assumes all intersections had loops (some were not actuated and hence did not use loops), 100 percent of loop failures were discovered (some were not), and no maintenance besides replacement was performed.

Similarly, in a summary of maintenance costs for four VIP systems used by the Road Commission for Oakland County, MI, monthly camera maintenance averaged $5.05, and monthly

Technicians reposition, recalibrate, and clean a video camera used as a traffic sensor. The video camera is mounted on a vertical elevated pole attached to a horizontal signal head mast arm. The elevated pole is visible between the two buckets the technicians are standing in.

processor maintenance averaged $26.71 from 1995 through 1998. A total of 692 cameras and 194 controllers were included in the study. Costs included labor; fringe benefits; and truck, lift, and radio equipment.

Last Word

The world of traffic sensors is changing rapidly as manufacturers develop new technologies and retire older models. The new edition of the *Traffic Detector Handbook* will enable users to select specific technologies for various applications based on the sensors' capabilities, and to configure, install, and maintain the sensors to achieve an agency's goals for traffic management.

David Gibson is a highway research engineer on the Enabling Technologies Team in FHWA's Office of Operations Research and Development. He is a registered professional traffic engineer and has a master's degree in transportation from Virginia Polytechnic Institute and State University. His areas of interest include traffic sensor technology, traffic control hardware, modeling, and traffic engineering education. He worked with Milton K. "Pete" Mills on the first two editions of the *Traffic Detector Handbook* and the original Type 170 traffic signal controller system.

Milton K. "Pete" Mills is an electrical engineer, now retired, from the Office of Safety Research and Development at FHWA's Turner-Fairbank Highway Research Center (TFHRC). He holds a bachelor's degree in electrical engineering from North Carolina State University and a master's degree from The Catholic University of America. At TFHRC since 1968, he managed development and evaluation of systems for sensing vehicles from infrastructure and sensing infrastructure from vehicles. His current interests include sensor development and application, image processing methods, and Super Equation Shell software and numerical error propagation. Prior to joining TFHRC, he tested and evaluated aircraft and spacecraft antenna systems for the U.S. Navy and National Aeronautics and Space Administration.

Lawrence A. Klein, Ph.D., brings more than 30 years of aerospace and traffic management experience to the development of sensor and data fusion approaches for ITS and multiple sensor concepts for homeland security. He is the principal author of the third edition of the *Traffic Detector Handbook*; *Sensor Technologies and Data Requirements for ITS*, which discusses sensor applications for traffic and transportation management; *Sensor and Data Fusion: A Tool for Information Assessment and Decision Making*, which presents data and sensor fusion architectures and algorithms for identifying and tracking objects; and *Millimeter-Wave and Infrared Multisensor Design and Signal Processing*, which describes multisensor design and performance.

For more information, see the Traffic Detector Handbook*, Third Edition, Volume I at www.tfhrc.gov /its/pubs/06108/index.htm and Volume II at www.tfhrc.gov/its /pubs/06139/index.htm. Contact David Gibson at 202-493-3271 or david.gibson@dot.gov, Milton K. "Pete" Mills at 202-244-1136 or pete.mills@erols.com, or Lawrence A. Klein at 310-541-2622 or laklein@flash.net.*

Darcy Bullock, Purdue University

This worker is placing a tie down backer rod while installing turns of wire as part of an inductive-loop sensor.

California Department of Transportation

These workers are sawcutting slots in the pavement in which loop wires will be placed as part of the installation of an inductive-loop detector system. After the slots are cut, the debris is removed by power washing (see worker on left) and then blow drying the slot. This installation is being done at night to minimize traffic disruptions.

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

Five Cities Will Receive Federal Funding To Fight Congestion

In August 2007 USDOT announced that five of the country's most congested metropolitan areas were selected to participate in a new Federal program that will provide funding to fight traffic jams.

USDOT chose the following areas to participate in its Urban Partnership Agreements: the Minneapolis area, MN; Miami, FL; New York City, NY; San Francisco, CA; and the Seattle area (King County), WA.

The applications to participate in the program were similar in that they all proposed to levy tolls that vary based on traffic volumes. Each city also plans to beef up transit options for residents. In addition to funding, USDOT will support the winning proposals with technical advice and an expedited review process. USDOT has committed to allocate the Federal contribution in a lump sum, not in bits and pieces over several years. This approach will get projects off the drawing board and into action, making it easier for congested areas to implement plans to fight traffic.

FHWA Officials Tour Bypass in Vermont

In June 2007 Federal Highway Administration (FHWA) officials announced plans for a bypass in downtown Bennington, VT, to steer trucks away from streets, relieve congestion, improve safety, and boost the region's trade.

Neale Lunderville, secretary of the Vermont Agency of Transportation (VTrans), invited FHWA officials for a tour of Bennington Bypass. The tour included a drive on the completed western leg and a preview of the project's northern leg, which began construction in July 2007.

The northern leg will include a new interchange at Vermont Route 9, connector roads, and a welcome center. Combined, the western and northern segments of the project represent the full east-west bypass for traffic to and from New York into Vermont and will reduce the number of trucks going through downtown Bennington. A third leg is planned which, combined with the northern segment, will provide a north-south bypass for truck traffic in the area. VTrans is currently working on establishing a construction date for the third and last leg.

Vermont officials expect truck traffic to increase significantly in the coming years, and believe that without the bypass, higher truck volume could worsen the existing congestion in downtown Bennington. In 2002 Vermont shipped 37.9 million tons of goods worth $32 billion; by 2020 projected figures will reach 54.4 million tons worth $60 billion. The completed bypass will enable freight to move through the region more efficiently and without disrupting the quality of life in the area's historic towns.

Grants To Cut Construction Times For State Projects

As part of a program designed to reduce traffic jams near construction zones, USDOT will dedicate up to $1 million each to Arizona, Georgia, Maine, Missouri, Oregon, and Virginia projects.

Managed by FHWA, the Highways for LIFE (HfL) program provides grants to help States build roads faster, while making them last longer and be less costly to maintain. In addition to direct funding, the program may relieve States of their requirement to match project funding, potentially saving millions in State transportation funds.

The program aims to demonstrate how agencies can fix roads and bridges without causing new traffic delays, helping drivers avoid congestion.

These States represent the first round of 2007 recipients. More projects may receive HfL grants in the future. For more information on project funding, please visit www.fhwa.dot.gov/hfl/projects.cfm.

Federal Loan Jump-Starts Louisiana's Highway 1 in Port Fourchon

At a groundbreaking ceremony in April 2007, USDOT announced an innovative FHWA loan program that will aid replacement of Louisiana's Highway 1 (LA Hwy. 1) in Port Fourchon.

Wilbur Smith Associates

This artist's rendering depicts the first two-lane Leeville Bridge (left) that will replace the existing lift bridge (right) on LA Hwy. 1 north of Port Fourchon, LA. The two-lane drawbridge serves as the only evacuation route for thousands of workers and residents.

The Louisiana Department of Transportation and Development received a $66 million loan under USDOT's Federal credit assistance program to start the first stretch of the project. The plan includes an improved, elevated, two-lane highway running 13 kilometers (8 miles) from Port Fourchon to Leeville, including a bridge over Bayou Lafourche.

Provided through the Transportation Infrastructure Finance and Innovation Act, the loan offers Federal credit assistance to help large, capital-intensive projects move toward completion. Under the loan terms, Louisiana will repay the money using toll revenue generated by the road.

Currently, LA Hwy. 1 is a narrow, two-lane road ending at the Gulf of Mexico. It is the only highway to Port Fourchon used to transport oil and natural gas—about 18 percent of the Nation's supply. Construction on the first phase of the project started in fall 2007, with plans to open the road by 2011. The completed project will be an elevated, four-lane highway running roughly parallel to LA Hwy. 1.

Technical News

University Partnerships To Research Cost Cutting Through Technology

USDOT's Research and Innovative Technology Administration (RITA) is partnering with university-led research teams to reduce highway construction and maintenance costs through use of new technologies. The research teams will develop congestion pricing technologies for urban freight management, streamline and reduce the cost of environmental impact assessments in critical transportation corridors, explore use of remote imagery for monitoring rural road conditions, and develop cost-effective systems to monitor and test the structural integrity and lifespan of bridges and asphalt pavements.

Universities receiving funding from RITA for near-term product development include The Ohio State University, Rensselaer Polytechnic Institute, Mississippi State University, and University of California, Santa Barbara. Other universities receiving research funding include the University of North Carolina at Charlotte, South Dakota State University, and University of Wyoming.

For more information, contact Roger Lotz at 202-366-2246 or roger.lotz@dot.gov.

WSDOT Adds Traffic Cameras Near Puget Sound

The Washington State Department of Transportation (WSDOT) recently installed 16 new traffic cameras along roads in the greater Puget Sound region, bringing the total number of cameras online to 155. "We hear it over and over again," says WSDOT Traffic Engineer Martin Dedinsky, "'We love the traffic cameras. Please add more.'"

WSDOT adds new cameras to roadways and traffic maps either during a widening or safety project, as was the case on U.S. 2 in Monroe and State Route (S.R.) 522 and S.R. 531, or through allocation of funds by the legislature to address a recognized need, as with S.R. 532 near General Mark W. Clark Memorial Bridge and Tiger Mountain. The cameras provide advance traffic information, helping Puget Sound drivers make educated choices before they hit the road.

To view the traffic cameras, visit WSDOT's "Seattle Area Traffic" Web site at www.wsdot.wa.gov/traffic/seattle. The cameras and traffic maps also are available for many Web-accessible cell phones at www.wsdot.wa.gov/small.

WSDOT

TRB's 2006 Air Quality Journal Now Available

In May 2007 the Transportation Research Board (TRB) released the *Transportation Research Record: Journal of the Transportation Research Board, No. 1987*, an issue focused on air quality issues. The journal contains 17 papers that explore the emissions impacts of high-occupancy vehicle lane operations, the impact of toll collection and electronic screening on heavy-duty vehicle emissions, emissions from extremely low-emitting vehicles, evaluation of mobile source air toxic emissions, emissions from new and in-use transit buses, and ultrafine particle concentrations from hybrid urban transit buses.

Papers in this issue of the *Transportation Research Record* (TRR) also cover the following: a model for simulating traffic air quality; air quality measurements inside diesel truck cabs during idling; regional vehicle-mapping tables for the MOBILE emissions model; variability of mobile source air toxic emissions factors with MOBILE6.2; and emissions from dump trucks fueled with B20 biodiesel (20 percent biodiesel, 80 percent petroleum diesel) versus petroleum diesel. Other papers address the effects of driver behavior and road type on gas and particulate emissions; speed- and facility-specific emissions estimates for on-road, light-duty vehicles; a road pollution alert system; energy and environmental impacts of roadway grades; and commuter exposure to fine particulates inside automobiles.

Published on an irregular basis throughout the year, individual TRRs consist of collections of peer-reviewed papers on specific transportation subject areas and modes.

For more information, visit www.trb.org/news/blurb_detail.asp?id=7774.

TRB

Public Information and Information Exchange

Caltrans Awards $45 Million for Safe Routes to School

The California Department of Transportation (Caltrans) awarded $45 million to cities and counties to fund 88 projects for Safe Routes to School, a program designed to provide infrastructure and education to give students easier and healthier ways to travel to and from school safely.

"Safety is Caltrans' number one priority, and nothing is more important than ensuring the health and safe passage of our children," says Caltrans Director Will Kempton.

California expects to receive $68 million in Federal funding over the program's 5-year lifespan. Seventy percent of funds will go toward infrastructure projects such as new crosswalks and signage; 20 percent will be allocated to noninfrastructure projects such as faculty and student education; and 10 percent will be used to

www.pedbikeimages.org/Dan Burden

This crossing guard helps create safe routes to schools by directing kids to walk their bikes across the street.

develop standardized training, promotional materials, curricula, and other resources.

Safe Routes to School benefits children in elementary or middle schools, and improvements to infrastructure must be within 3 kilometers (2 miles) of a school. For the list of funded projects by region, visit www.dot.ca.gov/hq/LocalPrograms/saferoute2.htm.

Caltrans

New Guidebook To Help First Responders With HazMat Incidents

In June 2007 USDOT and the U.S. Department of Health and Human Services (HHS) joined forces to give firefighters and other emergency responders instant access to information that will help them determine the best ways to contain hazardous materials spills and battle chemical fires safely.

For the first time, emergency responders will have electronic access, through laptops and personal digital assistants (PDAs), to the *2008 Emergency Response Guidebook* under a new partnership between the two Federal agencies. The guidebook is the go-to reference for first responders to help them identify hazardous material classifications quickly, determine the best response, and protect themselves and the public immediately after an incident.

Development of the electronic guidebook was possible due to an agreement signed between USDOT's Pipeline and Hazardous Materials Safety Administration and the HHS National Library of Medicine. The library developed special software to give emergency responders access to the guidebook through PDAs as well as Microsoft® Windows®-based laptops and desktops. The software application, called the Wireless Information System for Emergency Responders (WISER), became available in late 2007.

For more information, visit http://wiser.nlm.nih.gov.

Reporting Changes of Address

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

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Training Update

by Brittany Boughter

A Framework for Freight Analysis

In 2002 the U.S. transportation system moved 17 billion metric tons (19 billion short tons), worth more than $13 trillion. By 2035, the volume will nearly double to 34 billion metric tons (37 billion short tons), worth about $38 trillion.

Recognizing the significant direct and indirect effects of freight movement on U.S. roadways and communities, the Federal Highway Administration's (FHWA) Office of Freight Management and Operations developed the Freight Analysis Framework (FAF) to provide a comprehensive picture of commodity flows in the United States. The tool covers local and long-distance domestic shipments as well as imports and exports of all commodities—from coal to electronics to municipal solid waste—by all modes of transportation.

The FAF was developed to raise awareness of freight issues and provide freight forecasts for policy studies of investment needs, truck size and weight limits, and cost allocation. The current version, FAF², includes estimates of values and tons of freight movement for 1997 and 2002, with forecasts through 2035. FAF² also includes estimates of commodity movements by truck volumes over specific highways for 2002 and 2035, and provisional estimates of values and tons for 2006. To educate freight, transportation, and planning professionals about trends and growth in trucking, the National Highway Institute (NHI) offers two courses, Integrating Freight in the Transportation Planning Process (FHWA-NHI-139001) and Uses of Multimodal Freight Forecasting in Transportation Planning (FHWA-NHI-139002). Both courses employ the FAF as a teaching tool.

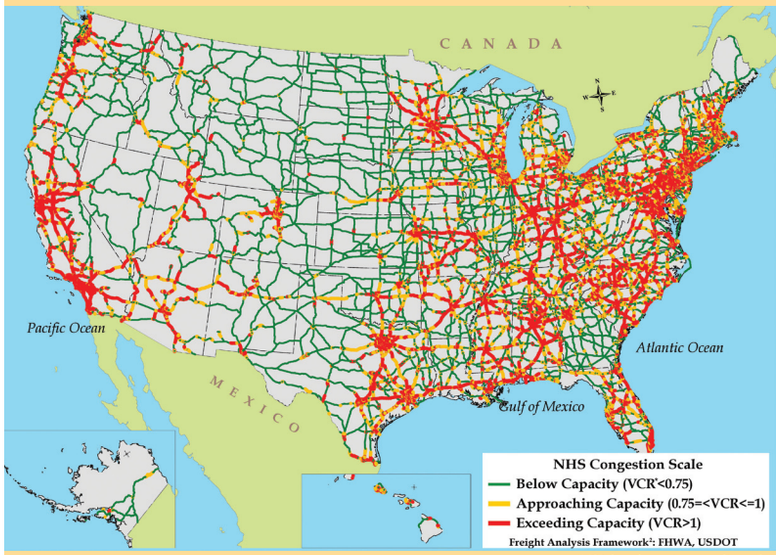
Integrating Freight in the Transportation Planning Process is a 2-day course designed to help public sector transportation planners incorporate freight data into their planning processes. "Incorporating the FAF helps attendees learn to anticipate trends and react accordingly," says Dr. Tianjia Tang, FHWA's program manager for the FAF. "Planners can download and manipulate the database to track the origin and destination of goods, thereby computing and illustrating various modes of transportation. FAF trend analysis determines transportation infrastructure needs in order to accommodate the goods movement."

Upon completing the course, participants will be able to do the following:

- Identify stakeholders
- Explain the role of modes in freight transportation
- Describe trends and their impacts on a State's transportation system and communities
- Discuss issues surrounding the use of freight data in the planning process
- Identify resources to help freight planning efforts at the State and metropolitan levels

The 3-day course, Uses of Multimodal Freight Forecasting in Transportation Planning, demonstrates the use and value of various forecasting techniques, discusses economic trends that influence freight growth, and explores the role of intermodal terminals and their impacts on local traffic.

NHS Estimated Peak Period Congestion: 2035



*VCR is volume-to-capacity ratio.

According to a preliminary analysis of FAF², in 2002 approximately 11 percent of National Highway System (NHS) roadways (based on roadway length) approached or exceeded their capacity, and 3.4 percent of roadway links exceeded their capacity. In 2035, approximately 40 percent of NHS roadways and 25 percent of the links will approach or exceed capacity, as shown on this map. *Source: FHWA.*

Upon completing the course, participants will be able to do the following:

- Explain why freight forecasting is important in the transportation planning process
- Discuss the roles of freight transportation modes
- Describe the influence of economic trends
- Describe the role of intermodal terminals and their impacts on local traffic
- Identify the impacts of freight on travel demand forecasts
- Identify publicly and privately available sources of freight data

Other NHI freight-related courses under development include Advanced Freight Planning (FHWA-NHI-139003), Principles of Effective Commercial Motor Vehicle (CMV) Size and Weight Enforcement (FHWA-NHI-139004), and Freight Planning and Environmental Considerations (FHWA-NHI-139005).

For more information on the FAF, visit www.ops.fhwa.dot.gov/freight. Visit www.nhi.fhwa.dot.gov for the latest information about NHI's freight courses.

Brittany Boughter is a contributing editor for PUBLIC ROADS.

Internet Watch

by Brittany Boughter

"Fight Gridlock Now" Web Site Expands

In May 2006 the U.S. Department of Transportation introduced the *National Strategy to Reduce Congestion on America's Transportation Network* (also referred to as the Congestion Initiative), a plan aimed at reversing the Nation's growing congestion problem. The initiative focuses on six areas: urban partnership agreements, public-private partnerships (PPPs), corridors of the future, reduction of southern California freight congestion, reduction of border congestion, and an increase in aviation capacity. Each component details manageable approaches and solutions to reverse congestion trends.

As the Congestion Initiative becomes more public and dynamic, the Federal Highway Administration's (FHWA) Office of Operations is working to engage and educate the public online. To reach the widest audience possible and explain specific elements of the initiative, FHWA maintains the "Fight Gridlock Now" Web site, www.fightgridlocknow.gov.

After more than a year online, the recently updated site continues to offer a user-friendly platform for public officials, transportation agencies, transportation professionals, businesses, and community leaders. The "Fight Gridlock Now" site is a forum to share the successes of innovative practices that can help the Nation meet its transportation funding needs, improve mobility, and reduce traffic congestion. It also serves as the main communications clearinghouse to inform and guide stakeholders through the application process for Congestion Initiative discretionary funds.

What's New

The site now offers additional resources and sections to meet the needs of the transportation community. Visitors can download the "Fork in the Road" brochure (www.fightgridlocknow.gov/forkintheroad.htm) and read an innovative dissection of surface transportation policies and what the transportation community can do to improve the congestion situation. The site hosts a "Press Coverage" section with published news stories on subjects such as congestion pricing, toll roads, PPPs, operations and technological improvements, general congestion, freight, and aviation. Visitors also have access to a "Toolbox" section with benchmarking and model legislation resources, a "Policy Corner" section with links to outside organizations, and an "Op-Eds" section with suggested further reading.

Perhaps one of the most beneficial updates to the site is the addition of a "What's New" section that enables stakeholders to obtain information on anticongestion funding opportunities through downloads or links to funding application documents. In addition, the section shares the newest and most innovative thinking and practices among transportation agencies and academics.

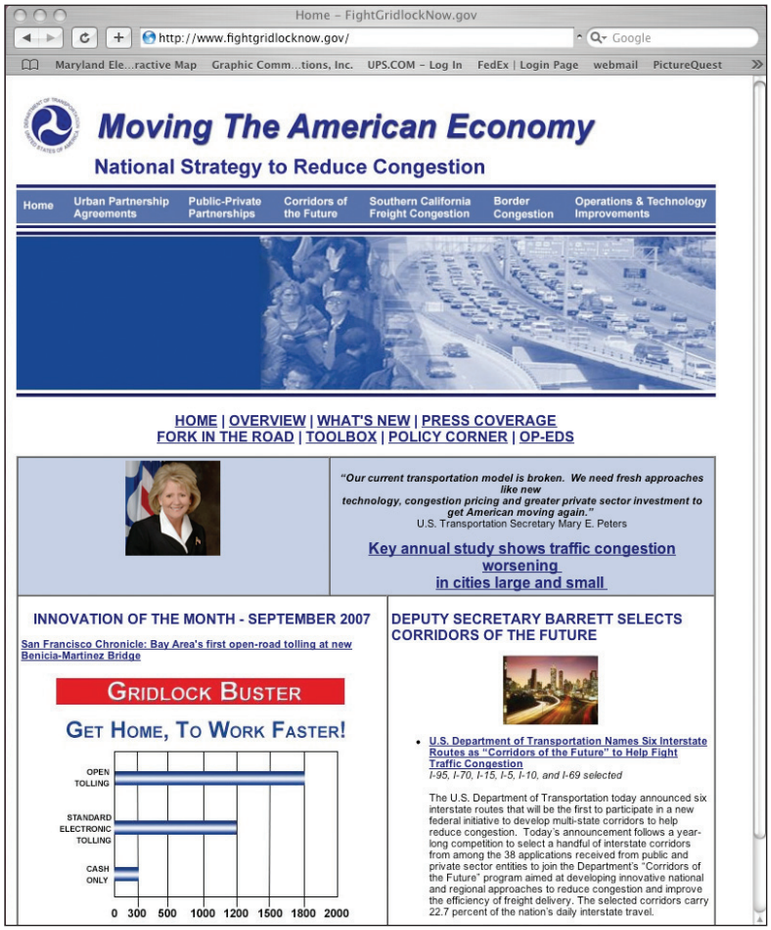
Future Growth

In addition to this recent revision to the site, FHWA's Office of Operations continues to focus on future updates. As transportation thinking and practices evolve, FHWA not only plans to meet the needs of transportation professionals, but also to continue adapting communications to reach members of the public who care about improving transportation and their communities.

FHWA's goal is for people to come away from the site having picked up innovative, long-term solutions to transportation needs in their communities. FHWA officials hope the site will help develop a passion among decisionmakers and the public to "think outside the box" and seek doable and sustainable solutions to the country's transportation needs.

To view the "Fight Gridlock Now" Web site, visit www.fightgridlocknow.gov. For more information, contact Stephen Fong at stephen.fong@dot.gov.

Brittany Boughter is a contributing editor for PUBLIC ROADS.



The FHWA "Fight Gridlock Now" Web site.

Communication Product Updates

Compiled by Zac Ellis of FHWA's Office of Research and Technology Services

Below are brief descriptions of 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)

Address requests for items available from the R&T Product Distribution Center to:

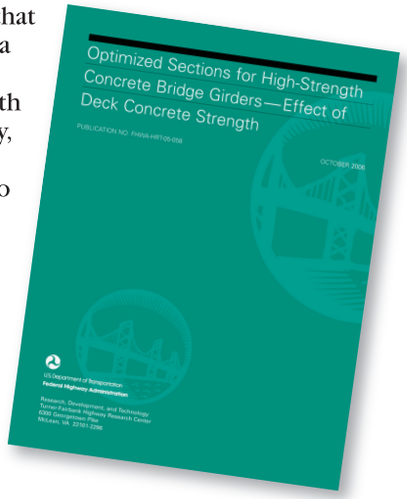
R&T Product Distribution Center, HRTS-03
Federal Highway Administration
9701 Philadelphia Court, Unit Q
Lanham, MD 20706
Telephone: 301–577–0818
Fax: 301–577–1421

For more information on R&T publications 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.

Optimized Sections for High-Strength Concrete Bridge Girders—Effect of Deck Concrete Strength Publication No. FHWA-HRT-05-058

For more than 25 years, concretes with compressive strengths in excess of 41 megapascals, MPa (6,000 pounds per square inch, psi), have been used in the construction of highrise building columns. Although the availability of high-strength concretes initially was limited to a few geographic locations, now there are more opportunities to use these concretes across the Nation. The technology to produce higher strength concretes has developed primarily within the ready-mix concrete industry for use in buildings, but researchers are now applying the same technology for use in concretes for bridge girders and decks.

Engineers have been concerned about the durability of concrete bridge decks for many years, resulting in the development of numerous strategies to improve performance. Many factors that enable production of a durable concrete also result in a high-strength product. Consequently, a durable concrete bridge deck is likely to have a high compressive strength. This report evaluates the effect of high performance concrete (HPC) on the cost and structural performance of bridge decks and high-strength girder construction. The report investigates several areas with the potential for improved structural performance through the use of HPCs.



This document is available online at www.tfhrc.gov /structur/pubs/05058/index.htm. Limited copies are available from FHWA's R&T Product Distribution Center. The document also is available from NTIS under order number PB2007-106399.

Long-Term Pavement Performance Program Falling Weight Deflectometer Maintenance Manual Publication No. FHWA-HRT-05-153

FHWA's Long-Term Pavement Performance (LTPP) program operates eight Dynatest® Model 8000 Falling Weight Deflectometers (FWDs) to collect deflection data on test sections of inservice pavements across the Nation. The LTPP program collected deflection data during daily operations for 15 years, giving the FWDs very little downtime. To keep the complex hydraulic, electrical, and mechanical FWDs operating effectively under demanding conditions, engineers continuously focused on preventive maintenance. A dedicated maintenance regime also was important to collecting high-quality data and ensuring that the equipment would pass rigorous annual reference calibrations. The owner's manual produced by the manufacturer provides guidance on most repairs and troubleshooting; however, eventually FWDs require service beyond routine maintenance—in other words, the time comes for a complete overhaul.

In spring 2003, one of the contractors overhauled an FWD it operated on behalf of the LTPP program. During the overhaul, the contractor documented the process with photos and described the process for disassembling and reassembling the FWD components and subcomponents. This document provides FWD owners, operators, and technicians with continuous operation maintenance guidelines to complement the owner's manual for the Dynatest® Model 8000.

This document is available online at www.fhwa.dot .gov/pavement/ltpp/pubs/05153. Copies are available from FHWA's R&T Product Distribution Center.

Long-Term Pavement Performance Program Manual for Falling Weight Deflectometer Measurements, Version 4.1
Publication No. FHWA-HRT-06-132

This document provides background information and field operations guidelines for collecting FWD data on LTPP test sections. It includes equipment setup and calibration, test locations, and test procedures.

This is the fourth major version of the *LTPP Manual for Falling Weight Deflectometer Measurements*. The first two were developed under the auspices of the Strategic Highway Research Program, while the latter two were completed under contract to FHWA. The latest revisions in this manual reflect changes in the data needs of the LTPP program and updates to the FWD equipment.

Current information and access to other technical references are available at www.tfhrc.gov/pavement/ltpp/ltpp.htm. Copies are available from FHWA's R&T Product Distribution Center. The document also is available from NTIS under order number PB2007-101960. To submit requests for LTPP data, technical questions, or user feedback, contact LTPP customer service by e-mail at ltppinfo@fhwa.dot.gov.

Advanced Quality Systems: Guidelines for Establishing and Maintaining Construction Quality Databases
Publication No. FHWA-HRT-07-019

The main objective of this study was to develop and present guidelines for establishing and maintaining database systems for construction quality issues in asphalt and concrete paving projects for State highway agencies. The study included a literature search and review, followed by a survey of construction quality practices at nine States and a more detailed review of practices at four of those States.

The information collected from survey responses and indepth interviews provided insights about the agencies' databases, data categories, analyses performed, links to other State databases, and reports generated. Results indicated that the nature of the collected information, level of detail, and duration of time over which this information is retained differ significantly from agency to agency. In addition, the current systems differ considerably in their architecture, purpose, data collection, and access procedures.

On a broad scale, the study revealed that agencies are somewhat "data rich and information poor" and are "mostly focused on entering, not retrieving data." Also, because of poor linkages between construction quality and pavement performance and cost data, there is a very limited ability to "close the loop" by showing how improvements in specifications and construction affect performance and life-cycle costs.

In addition to documenting these and other observations and findings, the report presents a detailed description of the features and capabilities of an ideal database on construction quality. It provides illustrative examples of how to improve the overall quality of highway pavement projects. The recommended database is a Web-based system with client server architecture. The system should contain modules (described in detail in the report) for the database server, quality assurance (QA) of input data, QA management, and data translation (referencing).

This document is available online at www.fhwa.dot.gov/pavement/concrete/pubs/07019/index.cfm. Copies are available from FHWA's R&T Product Distribution Center. The document also is available from NTIS under order number PB2007-103341.

Safety Assessment of Interchange Spacing on Urban Freeways (TechBrief)
Publication No. FHWA-HRT-07-031

The decision to build a new interchange between an existing pair of interchanges involves evaluating whether there is sufficient need for traffic to enter and/or exit the freeway at that location. The obvious intent is to reduce the systemwide travel times and delays for motorists by providing convenient freeway access and egress.

Although there are ways to evaluate these operational benefits quantitatively, researchers have been unable to measure the impact of a proposed interchange in terms of safety or the number of crashes per mile of freeway. This knowledge is essential for conducting a comprehensive cost-benefit analysis of new interchange projects. To fill this void, FHWA developed this TechBrief, which covers interchange spacing from a safety perspective by estimating regression models to express crash frequencies as a function of highway characteristics, including interchange spacing. The TechBrief also explores use of regression models to quantify the relationship between interchange spacing and fatal and injury crashes. The data used to build the regression models pertained to freeway sections from

7 urban freeways in California and 10 urban areas in Washington State.

This document is available online at www.tfhrc.gov/safety/pubs/07031/index.htm. Limited copies are available from FHWA's R&T Product Distribution Center.

Traffic Performance of Three Typical Designs of New Jersey Jughandle Intersections (TechBrief)
Publication No. FHWA-HRT-07-032

Although New Jersey jughandle intersections (NJJIs) have been around for more than five decades, researchers had not yet developed a simplified procedure to evaluate their performance in handling traffic compared to conventional at-grade intersections. A limited number of studies reported qualitative and quantitative comparisons of NJJIs, but traffic engineers and planners lacked readily available tools to estimate average delays, numbers of stops, and maximum queues.

For this study, researchers used the traffic simulation tool VISSIM to model typical geometries over a wide distribution of traffic flow conditions for three NJJI designs. Comparisons of NJJIs with conventional intersections for similar volume conditions revealed that NJJIs produced lower average intersection delays and higher intersection capacities for near-saturated traffic conditions and similar traffic performance for undersaturated conditions. Practitioners can use statistical models documented in this study to assess average intersection delays, average numbers of stops per vehicle, and maximum queue lengths for three types of NJJIs—forward ramps, U-turn ramps, and reverse ramps.

This document is available online at www.tfhrc.gov/safety/pubs/07032/index.htm. Limited copies are available from FHWA's R&T Product Distribution Center.

Synthesis of the Median U-Turn Intersection Treatment, Safety, and Operational Benefits (TechBrief)
Publication No. FHWA-HRT-07-033

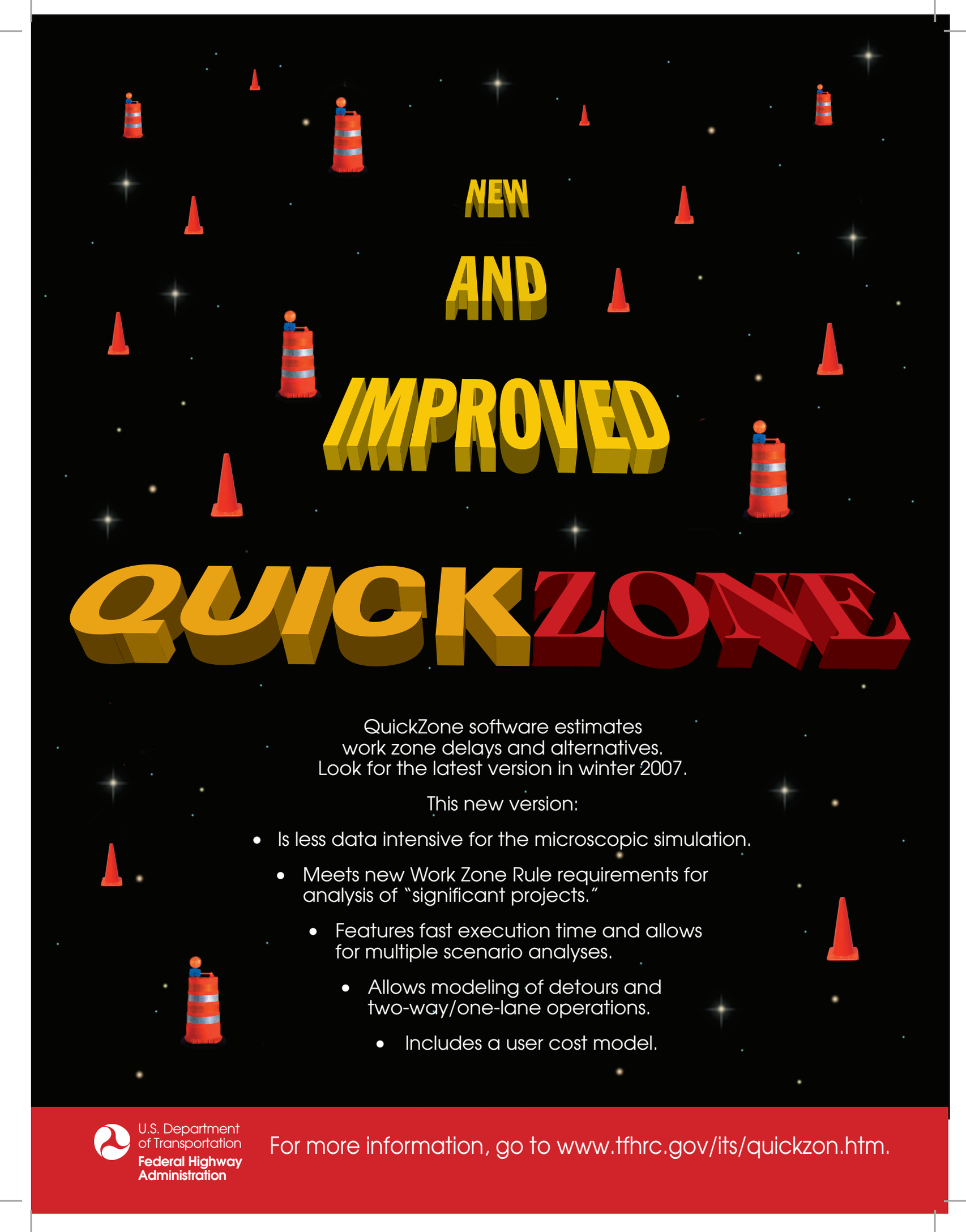
In the United States, congestion at intersections throughout urban and suburban areas continues to worsen and the number of crashes reported at intersections continues to increase. One potential treatment to combat congestion and safety problems at intersections is the Median U-Turn Intersection Treatment (MUTIT). Used extensively in Michigan for many years, the MUTIT was successfully implemented in Florida, Louisiana, Maryland, and New Jersey in recent years. The treatment eliminates direct left turns at signal-controlled intersections from major and/or minor approaches. Agencies can implement the MUTIT with or without signal control at median openings on a major road.

This synthesis summarizes the advantages and disadvantages of the MUTIT compared to conventional, at-grade, signal-controlled intersections with left turns permitted from all approaches. This TechBrief includes guidelines for the location and design of median crossovers on major roads. Many of the guidelines are borrowed from the Michigan Department of Transportation and address directional and bidirectional crossovers and widened areas called "loons" that facilitate the U-turn maneuver at roads with narrow medians and make it easier for larger vehicles to execute the turn. The TechBrief also presents information on the capacity and crash experience at MUTIT intersections relative to traditional intersections.

This document is available online at www.tfhrc.gov/safety/pubs/07033/index.htm. Limited copies are available from FHWA's R&T Product Distribution Center.

Conferences/Special Events Calendar

Date	Conference	Sponsors	Location	Contact
January 22–25, 2008	World of Concrete		Las Vegas, NV	Jackie James 972-536-6379 jjames@hanleywood.com www.worldofconcrete.com
January 26–30, 2008	NAPA 53rd Annual Meeting	National Asphalt Pavement Association (NAPA)	Phoenix, AZ	Carol Metzger 888-468-6499 cmetzger@hotmix.org www.hotmix.org
March 30–April 3, 2008	American Concrete Institute (ACI) Spring Convention	ACI	Los Angeles, CA	ACI Event Services 248-848-3795 conventions@concrete.org www.concrete.org
April 13–15, 2008	Lifesavers 2008 Conference (National Conference on Highway Safety Priorities)		Portland, OR	Mary Magnini 703-922-7944 mmagnini@cox.net www.lifesaversconference.org
May 4–6, 2008	4th Concrete Bridge Conference	Federal Highway Administration, National Concrete Bridge Council, and ACI	St. Louis, MO	Shri Bhidé 847-972-9100 sbhide@cement.org www.nationalconcretebridge.org/cbc
May 27–31, 2008	10th International Conference on Application of Advanced Technologies in Transportation	National Technical University of Athens	Athens, Greece	Prof. Matthew G. Karlaftis +30 210 7721280 mgk@central.ntua.gr www.civil.ntua.gr/aatt/aatt.htm
July 6–9, 2008	47th Annual Workshop on Transportation Law	Transportation Research Board	San Diego, CA	James McDaniel 202-334-3209 jmcdaniel@nas.edu www.trb.org/CRP/About/Legal.asp
August 11–16, 2008	6th International Conference on Case Histories in Geotechnical Engineering		Arlington, VA	Dr. Shamsher Prakash 573-341-4442 (Lindsay Bagnall, Conference Secretary) prakash@umr.edu 6icchge@umr.edu http://campus.umr.edu/6icchge
August 17–20, 2008	Institute of Transportation Engineers (ITE) 2008 Annual Meeting and Exhibit	ITE	Anaheim, CA	Christina Garneski for exhibitors Sallie Dollins for attendees 202-289-0222 ite_staff@ite.org www.ite.org/meetcon/index.asp



QuickZone software estimates
work zone delays and alternatives.
Look for the latest version in winter 2007.

This new version:

- Is less data intensive for the microscopic simulation.
- Meets new Work Zone Rule requirements for analysis of "significant projects."
- Features fast execution time and allows for multiple scenario analyses.
- Allows modeling of detours and two-way/one-lane operations.
- Includes a user cost model.

U.S. Department of Transportation
Federal Highway Administration

For more information, go to www.tfhrc.gov/its/quickzon.htm.

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