

Transportation Is Primary  
Focus of Area 41 Think Tank  
at Texas A&M

Sharing Information  
Is Key to Solving  
Transportation Problems

TTI, TxDOT Team Up to Test  
Connected-Vehicle Technology

TEXAS TRANSPORTATION

VOL. 51 | NO. 1 | 2015

# Researcher

## Patching the Oil Patch

*The Cost of Progress*

The logo for the Texas A&M Transportation Institute, featuring a stylized graphic of three slanted parallel lines to the left of the text.

Texas A&M  
Transportation  
Institute

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# TEXAS TRANSPORTATION Researcher

VOL. 51 | NO. 1 | 2015

**ON THE COVER:** Discovering new energy sources can have a positive impact on the economies of the states where they're found and the nation as a whole. But getting those new resources to market takes a toll on the transportation infrastructure. TTI researchers are helping agencies mitigate the impact on the state's transportation network.



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Dennis L. Christiansen, P.E.

**Editor**

Chris Pourteau

**Managing Editor**

Samantha Atchison

**Writers**

Rick Davenport

David Dennis

Bernie Fette

Gabriella Medina

Terri Parker

Chris Pourteau

Chris Sasser

Katie Turnbull

**Art Director**

John Henry

**Designers**

Vicky Nelson

Stacy Schnettler

**Photographer**

James Lyle

**Proofreader**

Michelle Benoit

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*Texas Transportation Researcher* (ISSN 00404748) is a quarterly publication of TTI Communications, Texas A&M Transportation Institute, 3135 TAMU, College Station, Texas 77843-3135. Periodicals postage paid at College Station.

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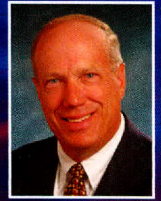
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by Dennis Christiansen  
Agency Director

# Research is Another Resource Texans Can Rely On

**Texas is a resource-rich state.** Blessed with oil and natural gas reserves, Texas has been a principal supplier of natural resources for the nation for more than a century. Although resource development is always welcome — and a boon to the state's economy — planning for it can be challenging.

New discoveries of oil and gas reserves drive how and where they're developed, as we saw recently with the Eagle Ford Shale formation in South Texas. Two-lane rural roads designed for farmers and ranchers driving pickup trucks proved inadequate for 18-wheelers hauling heavy loads. Roads began to fail faster and require maintenance more often than originally scheduled. Other aspects of the transportation network — like regional airports, railroads and ports in Texas — are impacted as well.

Although the energy boom in Texas has slowed recently due to falling oil prices abroad, there's no doubt that once prices stabilize again, the same issues — which become safety issues when infrastructure fails — will once again challenge the Lone Star State. Now is a good time to apply lessons learned by Texas A&M Transportation Institute (TTI) researchers about how to mitigate the impacts of energy development on the Texas transportation system.

This issue of the *Texas Transportation Researcher* looks at a number of these challenges. The use of new innovative maintenance techniques, like using foamed asphalt, can make road repairs faster and less costly. We've partnered with the Texas Department of Transportation (TxDOT) to produce technical briefs that educate district engineers about procedures that can help them maintain local infrastructure while minimizing costs.

When 90 percent of the freight on the Texas portion of the Gulf Intracoastal Waterway is petroleum and chemical related, properly maintaining our state's maritime system significantly impacts the economy, and TTI researchers have made recommendations to TxDOT for how to improve maintenance. A study by our Transportation Policy Research Center looked at eight other states dealing with these issues. In a separate transportation pooled-fund project led by TxDOT, TTI researchers will help states share experiences and conduct additional research. And by evaluat-

ing the impact of energy development on pavement over time, we can help TxDOT refine its planning process as it prioritizes future projects.

Through research, we're learning how to better cope with the impact of the energy sector on our infrastructure when booms occur while aiding Texas in achieving the economic benefits that come with natural resource development. Properly timing the implementation of research findings is a critical aspect to achieving a good return on the investment of research dollars. While resource development might be at a momentary lull in Texas, the state has an opportunity to help better coordinate the transportation network and the private sector to redress existing maintenance and safety problems and work toward troubleshooting similar issues in the future. To that end, TTI is working with TxDOT and our other partners by producing quality research that leads to practical, implementable solutions for Texans — solutions sometimes necessary even at the best of times. ■



# Filling In Knowledge Potholes

## TTI Correlates Trends in Energy Developments and Pavement Conditions

**The truth is, nobody likes potholes.** But when you're responsible for the integrity of your roadways, finding the funds to proactively plan maintenance is difficult when limited resources are already stretched to the limit. Add to that challenge new energy developments bringing hundreds of heavy trucks to two-lane roads, and it doesn't take long for those potholes to multiply, sometimes exponentially.

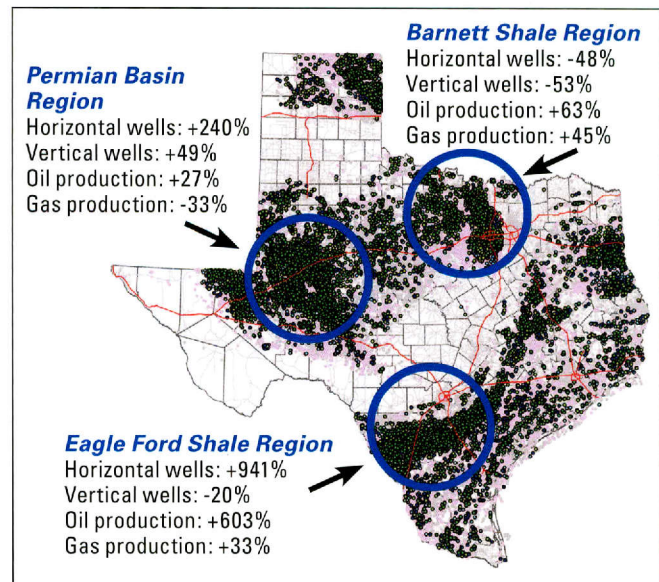
For the past few years, the Texas A&M Transportation Institute (TTI) has studied the relationship between energy developments and the transportation system in Texas. A study in 2011 helped the Texas Department of Transportation and other stakeholders forecast future energy-development locations using a geodatabase and analysis tools prepared by TTI Senior Research Engineer Cesar Quiroga and his team. In 2013, following a study funded by TTI's Transportation Policy Research Center, the Institute submitted more detailed findings regarding the impact of the state's energy-development activities to the Texas Legislative Budget Board.

A new chapter in that research currently being completed by Quiroga correlates locations and trends of oil and gas energy developments with changes in pavement conditions over the last few years. The study is being sponsored by TTI's Transportation Policy Research Center and looks at energy developments and roadway infrastructure conditions in three regions — Barnett Shale, Eagle Ford Shale, and Permian Basin — and compares these regions with other parts of the state.

"If we can better understand the relationship between where energy development is happening and the conditions of the transportation network in those areas, state, local and county officials can more effectively plan maintenance activities," says Quiroga.

Researchers gathered data on pavement conditions — including pavement distress, ride and condition scores at the state, county and regional levels — and overlaid them on an updated county-level geodatabase of energy developments. Some of what they learned is captured in the graphic accompanying this story.

"Our findings reflect the dramatic changes that the energy sector has produced in the state over the last few years, and also looks at the period before that," says Quiroga. "Compared to 2006–2009, the total number of new



*Increased energy development in Texas has been concentrated in three regions particularly. The green dots show where wells have been completed in the state between 2010 and 2013.*

horizontal wells developed in 2010–2013 using hydraulic fracturing techniques increased by more than 60 percent statewide. However, changes were much more significant by region — for example, 941 percent in the Eagle Ford Shale region and 240 percent in the Permian Basin region. Hydrocarbon production increased spectacularly as well. Unfortunately, pavement condition scores decreased. Despite increases in maintenance expenditures, it's clear that the state is not keeping up with these new developments." ■



For more information, contact  
**Cesar Quiroga** at (210) 321-1229 or  
[c-quiroga@tamu.edu](mailto:c-quiroga@tamu.edu).







For the Texas portion of the Gulf Intracoastal Waterway to be the most efficient contributor to the Texas economy it can be, it must be properly maintained.

# Dredging Up Business

## TxDOT Considers Maintenance Options for the Gulf Intracoastal Waterway in Texas

**The Gulf Intracoastal Waterway (GIWW) stretches 1,100 miles, from St. Marks, Florida, to Brownsville, Texas.**

The waterway's 379-mile Texas portion (the GIWW-T) links 11 deep-draft ports and 13 shallow-draft ports and handles two-thirds of the entire waterway's traffic. In 2012, 90 percent of GIWW-T freight was classified as petroleum and chemical related.

Maintaining the GIWW-T is a big job. Ostensibly it's the responsibility of the U.S. Army Corps of Engineers. In 1975, the Texas Coastal Waterway Act named the Texas Department of Transportation (TxDOT) as the official non-federal sponsor for the GIWW-T, with the primary responsibility of providing right-of-way and disposal areas for by-products of dredging operations and maintenance.

As federal funds have shrunk, the gap has widened between the GIWW-T's maintenance needs and services provided by the Corps. Yet, it's still important to properly maintain the GIWW-T.

"Without proper maintenance, the economy suffers," explains Jim Kruse, director of the Texas A&M Transportation Institute's (TTI's) Center for Ports and Waterways. "For example, the GIWW-T should be dredged to its designed depth, or it takes more barge movements to transport the same amount of cargo. That inefficiency ends up costing someone — the shipper, the consumer — money somewhere along the way."





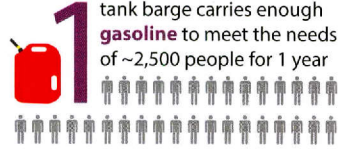

This practice of *light loading* by shippers is often necessary to avoid running aground in an insufficiently dredged channel. The outdated Brazos River Floodgates are another pressing issue. Yet, without federal funding, the Corps cannot address these challenges.

At TxDOT's request, Kruse and his TTI team conducted research to identify the most pressing maintenance issues on the GIWW-T. Their research included approaches TxDOT could use to assist the Corps in financing needed maintenance. The costs associated with failing to address the GIWW-T's maintenance problems were also identified.

"TTI's research has given us the information to properly evaluate the GIWW-T's maintenance needs," says Sarah Bagwell, TxDOT's maritime planning and strategy director. "Now it's up to us to work with our partners at the Corps as well as legislators at the state and federal levels to maximize the GIWW-T's potential for Texas and the nation." ■

**In 2013, the loss of just one foot of water depth in the GIWW-T would have increased the cost of doing business by roughly \$58.7 million — or nearly 15 percent. These costs must, at some point, be passed on to consumers.**

### GIWW-T QUICK FACTS

 <p><b>#2</b> Texas' rank in total U.S. waterborne <b>tonnage moved</b> (2011)</p>	 <p><b>34,000</b> number of <b>towboat trips</b> on the GIWW-T (2011)</p>	 <p><b>90%</b> freight classified as <b>petroleum and chemical-related</b> (2012)</p>
<p><b>\$31M</b> estimated wholesale <b>value of seafood</b> enabled by the GIWW-T</p> 	<p><b>1</b> tank barge carries enough <b>gasoline</b> to meet the needs of ~2,500 people for 1 year</p> 	<p><b>75m tons</b> freight moved on the GIWW-T (2011)</p> 
<p><b>#3</b> waterway for <b>tonnage</b> only the Mississippi and Ohio Rivers ship more tonnage</p>		



For more information, contact **Jim Kruse** at (713) 613-9210 or [j-kruse@ttimail.tamu.edu](mailto:j-kruse@ttimail.tamu.edu).





*Development of the energy sector in West and South Texas has taken a heavy toll on the state's roadways.*

## A Recipe for Road Rehabilitation

**Roads in South and West Texas are taking a pounding** from energy-sector traffic. The affected roads are most often narrow farm-to-market (FM) roads with thin-asphalt surfaces. They're now carrying 20 to 50 times more truck traffic than they were designed for. Weigh-in-motion data indicate that many of these trucks are also overloaded.

The Texas Department of Transportation (TxDOT) is looking for ways to widen and strengthen these roads, though rehabilitation efforts are often hindered by a lack of detours around the roadway needing repairs. For safety reasons, TxDOT requires all work to be performed during daytime hours. The roads must be open to traffic before dark, which restricts a contractor's rehabilitation options.

Texas A&M Transportation Institute (TTI) researchers Tom Scullion and Stephen Sebesta approached TxDOT with a rehabilitation method known as foamed asphalt. The method is currently being used internationally to successfully deal with similar energy-sector traffic.

"Texas tried foamed asphalt 15 years ago, before anybody else did. It didn't work because the contractor wasn't properly prepared and did not do the up-front site evaluation, which is critical," Scullion, manager of TTI's Flexible Pavements Program, says.

The foamed asphalt recipe is simple. Heat asphalt to 320 degrees. Introduce a small stream of water. When the water hits the asphalt, it evaporates instantly. As the water expands, it carries the asphalt with it, creating bubbles of asphalt. The foamed asphalt is thoroughly mixed with recycled pavement material and does a very good job of spreading and coating it. The pavement material can then be compacted immediately, and the material cools rapidly.



“In the laboratory this is probably the most underwhelming treatment you’ve ever seen. Where does the asphalt go? It can’t be easily observed. However if you grab a handful of the treated material and squeeze it very tightly, you’ll see tiny spots of asphalt on your hand,” Scullion notes.

Other methods such as cement stabilization require more water than foamed asphalt. They also take longer to dry and cure, and they don’t stand up to early traffic loads. Foamed asphalt allows contractors to rehabilitate a section of roadway and open it to traffic in a few hours.

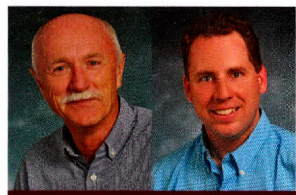
However, the true benefit of foamed asphalt only becomes apparent when you check the moisture susceptibility of the treated material. Measurements at TTI have shown retained strengths of 70 to 80 percent when the samples are submerged in water for 24 hours. This property recently proved the value of foamed asphalt on a project on FM 99 in TxDOT’s Corpus Christi District.

“On FM 99, they finished the job on a Friday. The road was to be surfaced on Monday. It rained 4 inches over the weekend. The water ran off. No damage. Any other treatment would have been a disaster with that amount of rain on it,” Scullion says. All test sections are constantly monitored to see how they’re performing.

**Any road that’s a candidate for foamed asphalt must undergo a full engineering evaluation to see what’s underneath the surface.**

Any road that’s a candidate for foamed asphalt must undergo a full engineering evaluation to see what’s underneath the surface. Employing ground-penetrating radar and a falling-weight deflectometer, and evaluating core samples, are necessary before any rehabilitation begins. This up-front testing prevents unwanted surprises later on.

While it costs a little more initially to use foamed asphalt, Scullion feels that its life-cycle benefits far outweigh the initial expense. “It appears foamed asphalt is a good product that, even under intense heavy traffic loads, will last for 10 years. The roads will be safer and will last longer,” he says. ■



For more information, contact **Tom Scullion** at (979) 845-9913 or [t-scullion@tamu.edu](mailto:t-scullion@tamu.edu), or **Stephen Sebesta** at (979) 458-0194 or [s-sebesta@ttimail.tamu.edu](mailto:s-sebesta@ttimail.tamu.edu).



*Before a road can be deemed a good candidate for foamed asphalt, engineers first have to see what’s underneath it.*



*Staff members confirm proper foaming of the asphalt in TTI’s laboratory foaming plant prior to mixing test batches for the mixture design.*



*These samples of recycled pavement were treated with foamed asphalt to develop full-depth recycling options for using existing pavement in rehabilitating roadways — a more cost-effective and environmentally friendly approach compared to rebuilding the entire roadway from scratch.*



# TxDOT, TTI Team Up to Address Roadway Damage Resulting from Energy Development



About 900 oil/gas drilling rigs (about half of all rigs in the U.S.) operate in Texas.



Estimates of truck traffic for well development and early production range from 1,000 to 4,000 loaded trucks per well.

**The energy sector is having a dramatic positive economic impact on Texas and the nation.** But

many Texas roadways have experienced accelerated pavement degradation due to heavy truck loads and increased traffic. An interagency agreement between the Texas Department of Transportation (TxDOT) and the Texas A&M Transportation Institute (TTI) seeks to give districts the necessary tools to combat this problem.



The rapid development of the state's oil and gas resources requires large volumes of relatively heavily loaded trucks per well. Approximately 900 oil/gas drilling rigs (about half of all rigs in the United States) operate in Texas. Estimates of truck traffic for well development and early production range from 1,000 to 4,000 loaded trucks per well.

“One of the major issues facing TxDOT maintenance forces is repairing the road network damaged by the extra traffic servicing wells,” says TTI Executive Associate Director and Senior Research Fellow Jon Epps. “The maintenance and repair of the Texas roadway system have required an ever-increasing amount of TxDOT’s financial resources and available workforce.”

The TxDOT Maintenance Division/Pavement Asset Management group and an interdisciplinary research team at TTI are working together to provide support to the districts in affected areas and to supply decision-making information. The project objectives are to:

*Dangerous failure at the edge of the pavement is caused by traffic loads. One of the technical briefs developed by TxDOT and TTI researchers focuses on shoulder repair techniques.*





Heavy truck traffic presents challenges for maintenance crews repairing or rehabilitating roadways.

- determine and analyze experiences by personnel in the field;
- facilitate communication across district lines to share information; and
- develop documentation and guidelines to capture best practices.

“What we’re trying to achieve with this effort is to get the latest research and information related to energy-sector roadway repair strategies to the districts most impacted,” says TxDOT Transportation Engineer Mark McDaniel. “This is an evolving field, and we want to use our district visits and workshops to define district practices associated with oil/gas development and production.”

The group has presented two workshops, one in San Antonio and one in Odessa. The group has also prepared a series of energy-sector technical briefs documenting the findings of pavement analyses used to determine recommended shoulder widths and corresponding roadway widths, and shoulder/edge repair techniques. The briefs are quick-read documents providing useful information for the districts.

“Even though there has been a recent slowdown in the energy-development sector, it is still critical that the districts work to repair their roadways,” says Epps. “Hopefully these workshops and supporting documents will help to ensure that the correct and most current state-of-the-practice guidelines are being used.” ■

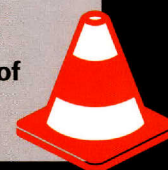


For more information, contact  
**Jon Epps** at (979) 458-5709 or  
j-epps@tamu.edu.

## Energy-Related Roadway Impact — By the Numbers

According to a study conducted by TTI for TxDOT, repair costs for state and local government roadways are estimated at **\$2 billion per year**. If financial resources are not available to repair the roadways, equipment damage and lower operating speeds resulting from rough roads could cost the energy-development industry from **\$1.5 to \$3.5 billion annually**.

Maintenance costs on farm-to-market roads impacted by oil/gas development and production traffic have increased in some areas of the state from **\$500–\$1,500 per mile** (prior to impacts) to **\$35,000–\$45,000 per mile** (after development started). It’s forecasted that **approximately \$500 billion will be expended** on oil/gas-impacted roadways in each of the next three years.



**“One of the major issues facing TxDOT maintenance forces is repairing the road network damaged by the extra traffic servicing wells. The maintenance and repair of the Texas roadway system have required an ever-increasing amount of TxDOT’s financial resources and available workforce.”**

*Jon Epps,  
TTI Executive Associate Director and  
Senior Research Fellow*



# Researchers Test Emergency Exit Signs for Tunnels



**About 15 years ago, several catastrophic, deadly highway tunnel disasters occurred in Europe.** As a

result, researchers began to evaluate methods to more effectively help stranded motorists reach emergency exits. The green “running man” sign — an international symbol for “emergency exit” — was adopted to help communicate with motorists. The United States has yet to adopt its widespread use.

In a project for the National Cooperative Highway Research Program, the Texas A&M Transportation Institute (TTI) is testing the effectiveness of the sign in the event of a tunnel disaster.

“There is currently no uniform system or strategy used in U.S. tunnels to guide drivers when an emergency happens,” says TTI Associate Research Scientist Laura Higgins. According to Higgins, project supervisor, emergency vehicles and personnel are often unable to reach stranded motorists in a tunnel due to other vehicles.

“We addressed two major questions,” says Higgins. “How do you let people trapped in a tunnel know they need to leave their vehicles to evacuate, and how do you direct them to emergency

exits in an environment where there may be smoke and reduced visibility?”

The team constructed a 60-foot tunnel inside TTI’s Environmental and Emissions Research Facility and presented 63 participants with different emergency response scenarios to gauge their reactions. Researchers used different types of sign lighting, from backlit-with-LED signs to glow-in-the-dark signs. The tunnel also had pathways marked by LED lights, which alternated between a steady glow and flashing sequentially in the direction of the exit. Researchers added artificial smoke to the tunnel so participants could assess the signs and lighted pathways for best visibility.

“We have the data; now we’re working on the analysis,” notes Higgins. “The

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**“We addressed two major questions: how do you let people trapped in a tunnel know they need to leave their vehicles to evacuate, and how do you direct them to emergency exits in an environment where there may be smoke and reduced visibility?”**

*Laura Higgins,  
TTI Associate Research Scientist*

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encouraging thing is that the majority of the participants understood the green running man symbol.” ■



For more information, contact **Laura Higgins** at (979) 845-8109 or [l-higgins@tamu.edu](mailto:l-higgins@tamu.edu).





# TRANSPORTATION

## Is Primary Focus of Area 41 Think Tank at Texas A&M

**The Lone Star State** is facing future challenges that cut across traditional lines of thinking and require cross-cutting solutions as well. The Texas A&M University System has created the Area 41 Institute to help solve these multidisciplinary problems.

The Institute's name is a nod to the military installation called Area 51, which is known for developing innovative aircraft, as well as the fact that Texas A&M University is home to the presidential library of George H. W. Bush, the 41st president of the United States.

"Area 41 is a university-based think tank aimed at identifying and helping to solve seemingly intractable issues in Texas' future," says Bill Stockton, Texas A&M Transportation Institute (TTI) executive associate director. "I don't believe anything like it has ever been developed before at the university level, and TTI is excited to be a part of it."

Area 41's mission is to "foster and support collaborative research and education across The Texas A&M University System on critical issues facing the state of Texas and the nation in the next three decades." Specific focus areas include transportation, water, energy, health care, education, and food safety and security.

"The A&M System is already well known for its research capabilities, especially in the areas of transportation, agriculture and energy — many of the same fields that have been identified as having critical challenges going forward," A&M System Vice Chancellor for Research Jon Mogford explains. "Area 41 will allow our exceptional staff to look beyond the horizon and make a real impact on our future quality of life."

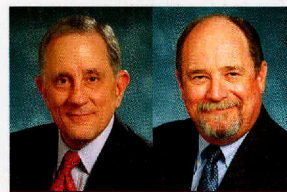
The Texas state demographic projects that the state's population will grow from its current 26 million to more than 40 million by 2050. With congestion already a huge issue for many urban areas, how do we ensure mobility with nearly 15 million more people? How will we meet their freight needs? What about water availability? Will we be able to reliably feed everyone?

"Many of these looming problems intertwined, so makes good sense determine where

these problems intersect and, in the long term, come up with solutions before we reach a crisis," Stockton notes.

Most university research is conducted to meet a sponsor's need to address an immediate, specific problem. Typically, no money exists to deal with future problems, even if they can be foreseen decades in advance. To initiate funding for this new research process, \$1 million was allocated to Area 41 in the A&M System budget. Officials anticipate funds from state, private and non-profit sources that share concerns about the future of Texas and, by extension, the nation.

"We think Area 41 can become an expert panel for policy makers and legislators, providing input on how their decisions might impact our future," Mogford says. ■



For more information, contact **Bill Stockton** at (979) 845-9947 or [stockton@tamu.edu](mailto:stockton@tamu.edu), or **David Ellis** at (979) 845-6165 or [d-ellis@ttimail.tamu.edu](mailto:d-ellis@ttimail.tamu.edu).



# Sharing Information Is Key to Solving Transportation Problems

## Workshop Facilitates Information Sharing Among State, Local Agencies

**The Texas A&M Transportation Institute (TTI) hosted the Transportation and Energy Sector Development Workshop** on May 6–7, 2014, in Arlington, Texas. The workshop was co-sponsored by the Transportation Research Board (TRB) of the National Academies, the Texas Department of Transportation (TxDOT) and the Upper Great Plains Transportation Institute (UGPTI) at North Dakota State University.

Participants in the workshop included researchers and personnel from state departments of transportation, metropolitan planning organizations, local governments, consulting firms and energy-sector development businesses.



TTI Executive Associate Director Katie Turnbull opened the workshop by reviewing recent TRB activities associated with transportation and energy-sector development. She also highlighted the workshop's objectives of sharing information, developing contacts and networking with peers, identifying areas for further research, and targeting methods for ongoing communication and coordination.

Michael Morris, director of transportation for the North Central Texas Council of Governments, challenged

workshop participants to think creatively in addressing the transportation needs associated with the challenges and opportunities presented by current energy developments in Texas and throughout the country. He suggested that innovative engineering, funding and financing, and safety treatments are all needed.

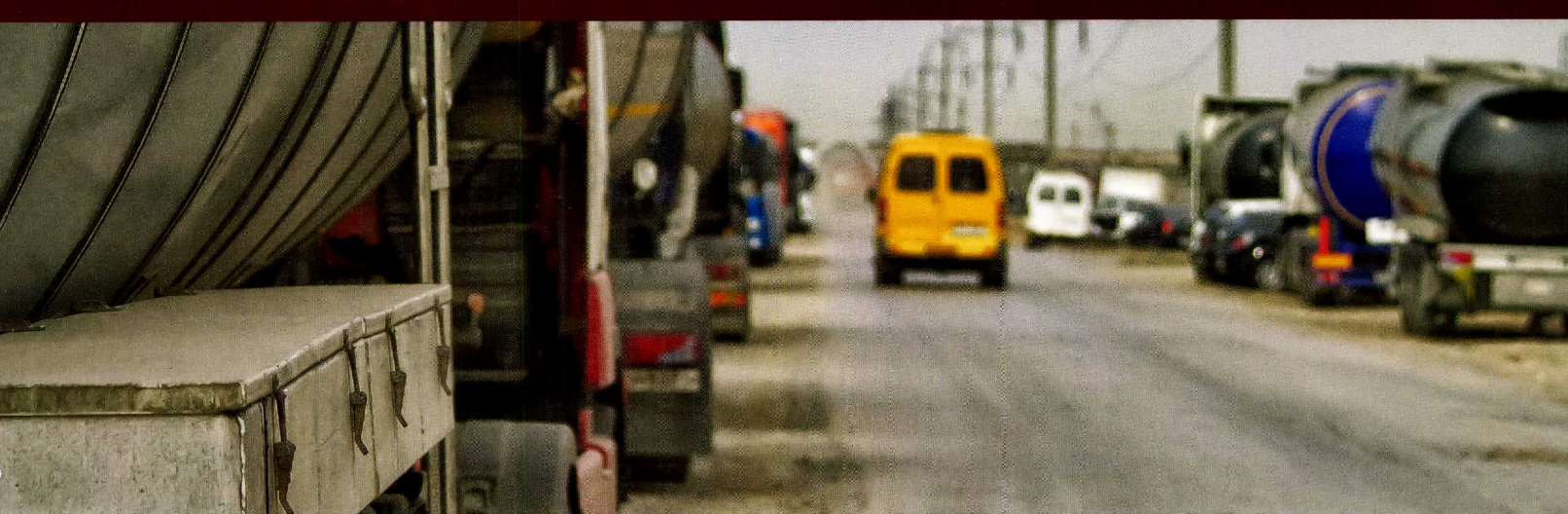
Denver Tolliver, UGPTI director, described freight system impacts from the Baaken Shale boom in North Dakota. Speakers from Louisiana, Colorado, New Mexico and Oklahoma discussed recent energy developments and highlighted approaches to address short- and long-term transportation needs. Speakers highlighted information on pavements, bridges, safety measures and incorporation of energy developments into the transportation planning process.

Mark Marek, TxDOT's director of engineering operations, discussed energy-related transportation issues in Texas and approaches being used to mitigate adverse impacts. Randy Bowers from the TxDOT Fort Worth District described the district's response to the Barnett Shale development. Caroline Mays, TxDOT freight planning coordinator, highlighted the development of the Texas State Freight Plan.

TTI Senior Research Engineer Cesar Quiroga provided participants with tips on collecting and analyzing energy-sector data for decision making based on recent research conducted for TxDOT. TTI Senior Research Scientist David Newcomb highlighted ongoing research for TxDOT examining the cost to industry from deteriorating roadways.

The workshop concluded with a discussion of possible follow-up activities. Pursuing a multi-state transportation pooled-fund study was suggested (see the story on the facing page). A variety of research topics were identified, and participants noted that enhancing coordination and communication across TRB committees would be beneficial. Periodic workshops and other information-sharing mechanisms were also suggested. ■





## TTI Assists States in Addressing Their Energy-Sector Transportation Issues

**The Texas A&M Transportation Institute (TTI) is assisting the Texas Department of Transportation (TxDOT) and other states to address issues and opportunities associated with energy-sector developments.** Six states — Louisiana, Montana, North Dakota, Ohio, Pennsylvania and Washington — are participating in the Transportation Pooled-Fund (TPF) Project: State Responses to Energy Sector Developments, which TxDOT is leading.

“As discussed by participants in the 2014 workshop, new and expanding energy-sector developments — oil, natural gas, coal, wind, biofuels and solar — are occurring in states throughout the country,” notes TTI Executive Associate Director Katie Turnbull. “Further, activities in one state may influence the transportation system in another state. This project implements one of the suggestions from the 2014 workshop.”

“TxDOT has learned a lot over the past few years responding to the transportation demands from the recent energy boom,” observes TxDOT Deputy Executive Director John Barton. “Other states are facing many of the same issues, and it makes sense to share information and work together on common concerns.”

“The project is examining techniques for infrastructure management, funding and financing, safety, industry engagement, planning and forecasting tools, and other related topics,” reports Joe Adams, implementation manager in TxDOT’s Research and Technology Implementation Office. “The focus is on practical applications for member states to better respond to demands on the transportation system from energy exploration, extraction and production.”

**“TxDOT has learned a lot over the past few years responding to the transportation demands from the recent energy boom. Other states are facing many of the same issues, and it makes sense to share information and work together on common concerns.”**

*John Barton,  
TxDOT Deputy Executive Director*


TTI researchers are identifying key issues in the different states, examining multi-state energy supply chains, summarizing current research and studies underway, conducting additional research, and developing problem statements for national research programs. TTI will also organize and facilitate workshops and TPF member state meetings.

“Although we face somewhat different situations, many of the issues are the same,” notes Barb Ivanov, Washington State Department of Transportation Freight Systems Division director. “We have much to learn from each other and much to learn from additional research.” ■



For more information, contact **Katie Turnbull** at (979) 845-6005 or [k-turnbull@tamu.edu](mailto:k-turnbull@tamu.edu).





LOOKING FOR LESSONS LEARNED:  
**TTI Examines Strategies  
Other States Use to Cope  
with Energy Development**



**48%** of all **active drilling rigs** in the country are in Texas

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**TTI Associate Research Scientist David Bierling and his team studied eight other states besides Texas that have also experienced rapid, intense energy development: Colorado, Kansas, North Dakota, Oklahoma, Pennsylvania, Utah, West Virginia and Wyoming.**

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**One way or the other,** the oil and gas industry seems to be ever-present in the minds of Texans. Through last summer, oil prices over \$100 per barrel were fueling a boom in drilling activity across the state, especially in the Permian Basin and Eagle Ford Shale formations. Texas was supporting 48 percent of all active drilling rigs in the country — more than any other state.

This energy-development boom, while great for Texas' economy, was a double-edged sword. Heavy truck traffic on roads designed for low traffic levels was causing major damage. Increased maintenance costs, more risk to public safety, and more impacts on the environment were the result.



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**“The current energy market and recent drop in drilling activity present Texas with an opportunity to figure out how to deal with these impacts in the future when the drilling boom comes back.”**

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Leaders at the Texas A&M Transportation Institute (TTI) Transportation Policy Research Center (PRC) agreed it was time to explore what other states facing similar issues are doing. TTI Associate Research Scientist David Bierling and his team studied eight other states besides Texas that have also experienced rapid, intense energy development: Colorado, Kansas, North Dakota, Oklahoma, Pennsylvania, Utah, West Virginia and Wyoming. Specifically, researchers wanted to learn how departments of transportation (DOTs) in those states have addressed the impact of energy development-related freight activity on their roadway systems.

What does this mean for Texas? “The current energy market and recent drop in drilling activity present Texas with an opportunity to figure out how to deal with these impacts in the future when the drilling boom comes back,” answers Bierling. “By looking at what other states have done, Texas can

evaluate which policies, programs and practices might also work if they were implemented here.”

Bierling and his team found four notable mitigation techniques that other state DOTs currently have in place:

- posted and enforced weight limits,
- bonding and maintenance agreements between DOTs and industry,
- industry engagement programs, and
- capital improvement programs.

Traffic restrictions are one type of state DOT policy. Several states post vehicle weight limits, which are first determined by examining existing roadway conditions. Pennsylvania and West Virginia have used road-use maintenance agreements through contracts with industry to help their DOTs manage financial and maintenance impacts on roads. Pennsylvania also established a formal industry engagement program to help energy-sector stakeholders anticipate, report and resolve road infrastructure issues. Researchers also found that capital improvement programs may significantly increase state DOTs’ levels of funding and ability to appropriate those funds toward energy-developed areas.

The research indicates that techniques to better address energy-development impacts do indeed exist. However — coupled with the challenges the DOTs face — execution of policies can be very difficult. Across the board, DOT officials are facing multiple constraints that make it challenging to deal with energy-development impacts on state roadways. Along with limited financial resources, tracking the varying development time frames of the transportation and energy sector can be difficult. In other words, maintenance and development of the transportation network are often in reaction to energy-sector and related activities. Given that reality, it can be difficult to proactively sustain the transportation infrastructure.

“Many states with high levels of energy production have experienced the same roadway damage problems that we’ve seen here in Texas,” says PRC Director Ginger Goodin. “Our research in this area — based on lessons learned in those other states — can help to inform the related decisions that our state’s policy makers are facing.” ■



*For more information, contact **David Bierling** at (979) 862-2710 or [dhb@tamu.edu](mailto:dhb@tamu.edu).*

**“Many states with high levels of energy production have experienced the same roadway damage problems that we’ve seen here in Texas.”**

*Ginger Goodin,  
PRC Director and TTI Senior  
Research Engineer*







*Testing how vehicles can connect to the roadside infrastructure in a safe, efficient and reliable manner is one focus for TTI researchers.*

## **TTI, TxDOT Team Up to Test Connected- Vehicle Technology**

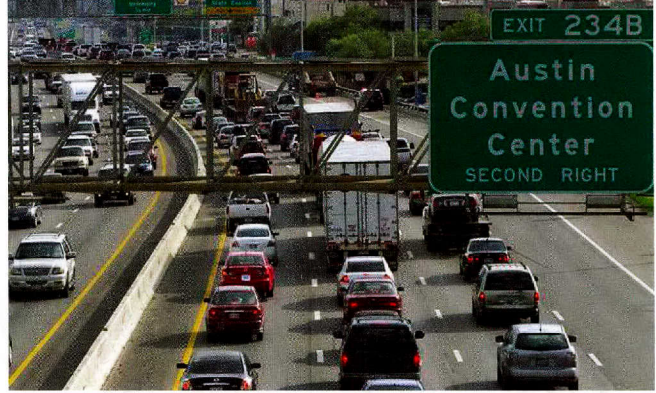
### **Connected vehicles are coming.**

The transportation industry is already working on standards and prototypes. And part of developing them is testing to ensure the future of transportation is as safe, efficient and reliable as possible.

A portion of I-35 could soon become a national test bed for connected-vehicle research, thanks in part to a four-year project that the Texas A&M Transportation Institute (TTI) is undertaking on behalf of the Texas Department of Transportation (TxDOT).

Funded by a U.S. Department of Transportation (U.S. DOT) grant, the \$2 million project — called I-35 Connected Work Zone — will initially focus on improving freight movement along the construction corridor by providing long-haul trucks a steady stream of traveler information through onboard devices capable of receiving work zone infrastructure data.





*The I-35 corridor in Austin is one of the most congested roadways in Texas. Connected vehicles could help improve mobility for commuters while simultaneously improving trip safety.*

**“Research and testing are vital steps forward as connected-vehicle technology moves from the cutting edge to the every day. This project is a natural next step in the long-term partnership of TTI and TxDOT working together to improve transportation for Texas and the nation.”**

*Christopher Poe,  
TTI Assistant Agency Director*

That information includes lane-closure locations, delay lengths and projected delays up to a week in advance.

“In this first phase of the Connected Work Zone project, the initial fleet of long-haul commercial trucks will be equipped with communication equipment and the technology needed to receive the existing I-35 traveler information and data we developed for the Waco District I-35 construction project,” says TTI Research Scientist Robert Brydia. Highway sensors gather real-time travel information on traffic conditions, which will be transmitted to the trucks in a way that will not distract truck drivers.

Freight movement efficiency has long been hindered by a lack of reliable traveler information. The goal of the U.S. DOT’s Freight Advanced Traveler Information System (FRATIS) program is to optimize freight operations and, therefore, the overall transportation system.

The current project is an enhancement to a Texas component of the FRATIS project currently under way among some smaller trucking firms in the Dallas-Fort Worth area. That effort involves using software to optimize processes for businesses that rely on short-haul freight movements. Minimizing empty truck trips and the rerouting of trips to avoid congestion can help reduce operating costs, thereby reducing shipping costs and perhaps, eventually, providing lower prices for consumers as well.

Although the next phase of the project has not been defined, it could involve equipping passenger vehicles with the same type of communication equipment capable of receiving real-time corridor information.

“Research and testing are vital steps forward as connected-vehicle technology moves from the cutting edge to the every day,” says TTI Assistant Agency Director Christopher Poe. “This project is a natural next step in the long-term partnership of TTI and TxDOT working together to improve transportation for Texas and the nation.” ■



*For more information, contact  
**Christopher Poe** at (972) 994-2206  
or [cpoe@tamu.edu](mailto:cpoe@tamu.edu), or  
**Robert Brydia** at (979) 845-8140  
or [r-brydia@gamu.edu](mailto:r-brydia@gamu.edu).*



# TTI ADVISORY COUNCIL

## *Advancing the Vision*

The Texas A&M Transportation Institute (TTI) Advisory Council is comprised of a small group of high-level transportation professionals from across Texas and every sector of the transportation world. The council, which meets annually, offers a tremendous service to the Institute by advising on transportation issues and trends and supporting TTI's research programs and initiatives. TTI profiles several council members in each issue of *Researcher*. ■

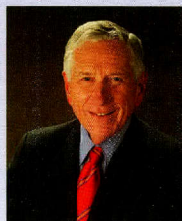


**Roger Guenther**  
*Executive Director*  
*Port of Houston*  
*Authority*  
*Houston, Texas*

*Guenther*

Roger Guenther was named executive director of the Port of Houston Authority in January 2014 and has 26 years of experience at the port. Formerly he was deputy executive director of operations and was responsible for all container and break-bulk cargo operations, management and construction of capital development projects, facility and asset maintenance, and real estate interests.

He also has served in various capacities related to facilities management, including master planning of the Bayport Container Terminal, redevelopment of the existing Barbour's Cut Terminal, and procurement of all container-handling cranes and equipment over the last two decades. Guenther previously served as an engineer with Emscor, Inc., in Atlanta, Ga. He is a member of the Port Authority Advisory Committee for the Texas Department of Transportation. ■

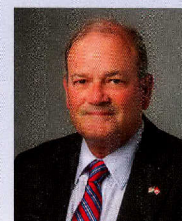


**Drayton McLane, Jr.**  
*Chairman*  
*McLane Group*  
*Temple, Texas*

*McLane*

Drayton McLane, Jr., is chairman of the McLane Group, a parent company consisting of family-owned companies operating throughout the world, including McLane Advanced Technologies, which pursues technology advancements for the commercial, government and defense industries. For 30 years, he was CEO of the McLane Company, his family's wholesale grocery business. Following the McLane Company's merger with Wal-Mart, Inc., in 1990, he became vice chairman of Wal-Mart. He also served as chairman and CEO of the Houston Astros Baseball Club for 19 seasons.

McLane's board appointments include chairman of the Board of Trustees at Baylor Scott and White Healthcare, vice president at large for the Boy Scouts of America national board, and board director of the Bush School of Government and Public Service Board of Visitors at Texas A&M University. ■



**LtGen Joe Weber, USMC (Ret)**  
*Executive Director*  
*Texas Department of*  
*Transportation*  
*Austin, Texas*

*Weber*

Under the direction of the Texas Transportation Commission, Weber is responsible for the strategic direction and overall management of the Texas Department of Transportation's (TxDOT's) policies and operations. He maintains relationships with state elected leaders and represents TxDOT before the Texas Legislature. Formerly he was vice president for student affairs at Texas A&M University, where he was responsible for the oversight of more than 900 student organizations and activities, and all student services and support associated with student development and success.

Weber served 36 years in the U.S. Marine Corps, where he held numerous command and leadership positions throughout the United States and overseas, including tours in Europe, South America, Southeast Asia and Iraq. He was responsible for the supervision of a variety of infrastructure projects, including road, port, aviation and rail systems. ■



# Walton, Holmes Inducted into Texas Transportation Hall of Honor

C. Michael Walton and Ned S. Holmes were recognized for contributions to Texas transportation in December at separate Texas Transportation Hall of Honor induction ceremonies in Austin. Walton was inducted as the Hall's 40th member Dec. 1; Holmes was inducted as the 41st member Dec 18.

"We have a state that has been blessed to have an outstanding transportation system, a system that has served the state well," said TTI Agency Director Dennis Christiansen. "It's widely recognized that the development and sustainment of that kind of system are the result of visionary leadership by a relatively small group of individuals. Mike Walton and Ned Holmes are especially deserving to be in this elite group."

Walton, who holds the Ernest H. Cockrell Centennial Chair in Engineering and is a professor of civil engineering at The University of Texas, is internationally known for 40 years of leadership in transportation engineering and policy analysis. A member of the National Academy of Engineering, he's held leadership positions on numerous technical and professional society boards and committees, including the American Road and Transportation Builders Association, the Transportation Research Board and the Intelligent Transportation Society of America, among others. He's widely recognized as a transformative figure in bridging the gap between transportation research and industry practice.

Holmes — a businessman, banker, and residential and commercial real estate developer — has made significant contributions to transportation infrastructure in the greater Houston area and across Texas. He is chairman and CEO of Holmes Investments, Inc. In 2007, he was appointed to the Texas Department of Transportation Commission, where he served until 2012. He championed construction of the Grand Parkway in Houston and helped obtain funding to expand US 290. He also served as chair of the Transportation Transformation Group, a coalition of state departments of transportation advocating nationally for transportation funding and reform. Holmes also chaired the Port of Houston Authority from 1988 to 2000 during a significant growth period in the port's infrastructure. ■



*Walton ceremony participants (left to right):* Nicholas Rubio, U.S. president of Cintra; Chandra Bhat, director of the Center for Transportation Research at The University of Texas; Linda Watson, president and CEO of the Capital Metropolitan Transportation Authority; Mike Walton; John Barton, deputy executive director of Texas Department of Transportation (TxDOT); Dennis Christiansen, TTI agency director; and Bob Skinner, former executive director of the Transportation Research Board.



*Holmes ceremony participants (left to right):* LtGen Joe Weber, USMC (Ret), TxDOT executive director; Tom Kornegay, former executive director of the Port of Houston Authority; Dennis Christiansen, TTI agency director; Tom Johnson, executive vice president of Associated General Contractors of Texas; Ned Holmes; Doug Pitcock, Jr., chairman of the board and CEO of Williams Brothers Construction Co., Inc.; David Laney, Dallas attorney and former chair of the Texas Transportation Commission; John Barton, deputy executive director of TxDOT; and Ted Houghton, chair of the Texas Transportation Commission.

*Established in 2000 to recognize individuals who have played significant roles in the development and advancement of Texas transportation, the Texas Transportation Hall of Honor is located in the main conference room of TTI's Gibb Gilchrist Building on the campus of Texas A&M University. Each inductee is represented by a plaque that bears his or her likeness.*



# TTI Researchers and Students Recognized, Honored at TRB

***The Transportation Research Board (TRB) Annual Meeting is the world's largest gathering of transportation professionals. Each year, numerous Texas A&M Transportation Institute (TTI) researchers and students attend the Washington, D.C., event. The 2015 annual meeting was Jan. 11–15.***



*Kirk Steudle, director of the Michigan Department of Transportation and chair of the TRB Executive Committee; and TTI Executive Associate Director Katie Turnbull. Photo courtesy of TRB.*

## ***Turnbull Honored with TRB's Carey Award***

TTI Executive Associate Director Katie Turnbull was presented with TRB's W. N. Carey, Jr. Distinguished Service Award, recognizing her outstanding service to TRB and transportation research.

Since 1988, Turnbull has provided uninterrupted service as a chair or member of 23 TRB councils, groups, sections, committees, panels and task forces, and has written or coauthored 39 TRB publications. Most recently, she served as chair of the TRB Technical Activities Council.

"Throughout my career, I have been fortunate to work with an outstanding group of volunteers and TRB staff on numerous projects and activities. TRB has enriched both my professional career and my personal life. It's provided me with numerous opportunities to help address key transportation issues and to help make a difference," Turnbull said. ■



*Dan Turner, chair of the TRB Technical Activities Council, presents the D. Grant Mickle Award to TTI Senior Research Engineer Kay Fitzpatrick, TTI Associate Research Engineer Marcus Brewer and TTI Associate Research Scientist Raul Avelar (not pictured).*

## ***TTI Researchers Honored with D. Grant Mickle Award at TRB***

Three TTI researchers received the prestigious D. Grant Mickle Award, given to the best paper in the field of operation, safety and maintenance of transportation facilities.

TTI Senior Research Engineer Kay Fitzpatrick, TTI Associate Research Engineer Marcus Brewer and TTI Associate Research Scientist Raul Avelar were honored for Driver Yielding at Traffic Control Signals, Pedestrian Hybrid Beacons, and Rectangular Rapid Flashing Beacons in Texas — a Texas Department of Transportation research project that examined the effectiveness of three types of pedestrian crossing devices. Fitzpatrick, the principal investigator for the project, also received the D. Grant Mickle Award in 2012. ■





Left to right: TTI Division Head of Marketing, Communications and Agency Relations Terri Parker, TTI Director Emeritus Herb Richardson, TTI Executive Associate Director Jon Epps, TTI Research Engineer Amy Epps Martin and TTI Director of External Initiatives Melissa Tooley.

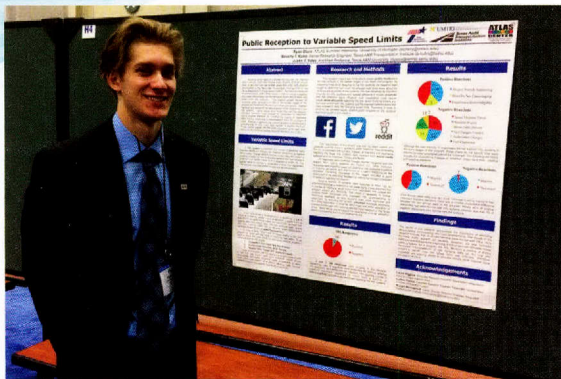
## ***Epps Receives ARTBA's Steinberg Award***

TTI Executive Associate Director Jon Epps was honored with the American Road and Transportation Builders Association's 2015 S. S. Steinberg Award, which is presented annually to an individual who has made remarkable contributions to transportation education. The award is named after the founding president of the association's Research and Education Division.

Epps is considered a pioneer in the field of asphalt pavement because of his innovations related to recycling and testing. He is also responsible for improving the materials and processes used by the pavement construction industry.

"I have been very fortunate to work with great people, especially students, during my career," Epps says of the Steinberg Award. "Being an educator has been one of the most rewarding parts of my job. I've always tried to bring research into practice, and I thank ARTBA for this great honor." ■

## ***ATLAS Intern Presents Poster at TRB following VSL Research Project***



Stone

Michigan — became the first ATLAS intern to present a poster at TRB's 2015 Annual Meeting. Ryan Stone, an undergraduate at the University of Michigan, conducted research to determine the public's perception of variable speed limits (VSLs). His poster was accepted for presentation following a TRB peer review. Stone determined that the vast majority of people had negative feelings about VSLs. He concluded that perceptions would improve once the public was educated through awareness and outreach efforts. ■

A summer intern with the new Advancing Transportation Leadership and Safety (ATLAS) Center — a University Transportation Center formed between TTI and the Transportation Research Institute at the University of

## ***TTI Associate Researcher Named 2014 SWUTC Student of the Year***



Brimley

Brad Brimley, a Texas A&M University transportation engineering student, has been selected as the Southwest

Region University Transportation Center (SWUTC) Student of the Year. The honor is bestowed on the best and brightest from the SWUTC consortium, which includes five universities: Texas A&M, The University of Texas at Austin, Texas Southern University, Louisiana State University and the University of New Orleans. He received the honor at the Council of University Transportation Centers banquet, held at the TRB Annual Meeting. ■



## Crawford Elected as ITE Texas District Director



Crawford

**T**TI Associate Research Engineer Jason Crawford was recently elected to serve as the Texas District director of the Institute of Transportation Engineer (ITE) International Board of Direction. The term is from Jan. 1, 2015, to Dec. 31, 2017.

ITE is an international educational and scientific association of transportation professionals responsible for meeting mobility and safety needs. ITE facilitates the application of technology and scientific principles for research, planning, functional design, implementation,

operation, policy development and management for any mode of ground transportation.

Crawford, who has been an ITE member since 1989, will be working with the 17-member board to develop policy and establish budgets for ITE's operation. There are eight districts that meet in person four times a year. According to Crawford, among the challenges the board will face is defining what ITE is in the coming 5 to 10 years. That includes determining how the board selects new officers in the future. ■

## Fitzpatrick, Briaud Receive Regents Awards



Left to right: Board of Regents Vice Chairman Cliff Thomas, Mark Simmons (Fitzpatrick's husband), Kay Fitzpatrick and Board of Regents Chairman Phil Adams.



Left to right: Board of Regents Vice Chairman Cliff Thomas, Jean-Louis Briaud and Board of Regents Chairman Phil Adams.

**K**ay Fitzpatrick and Jean-Louis Briaud were named recipients of The Texas A&M University System's Regents Fellow Service Award during a ceremony Feb. 11. The Regents Fellow Service Award is reserved for those A&M System employees "who have provided exemplary professional service to society that has created large and lasting benefits to Texas and beyond."

Fitzpatrick, a senior research engineer and manager of TTI's Roadway Design Program, is internationally recognized for her research involving transportation safety. During her 26-year career with TTI, she has led 40 different research projects and authored 260 publications, receiving accolades from colleagues and professional organizations alike.

"Working with other researchers at TTI, I have been fortunate to have the opportunity to pursue my passion for reducing crashes and to improve traffic operations, especially for pedestrians," Fitzpatrick said after receiving the prestigious award. "Being recognized as a Regents Fellow is a huge honor and is indeed a highpoint of my career."

Briaud is the Buchanan Chair professor in Texas A&M University's Zachry Department of Civil Engineering and manages TTI's Geotechnical and Geoenvironmental Program. He is also a Distinguished Member of the American Society of Civil Engineers and president of the Federation of International Geoengineering Societies.

Among his contributions to the field of engineering, Briaud's work on foundation engineering, bridge scour and soil erosion, and vehicle crash protection truly stands out, and his research has led to the publication of two books, on "the pressuremeter" in 1992 and on "geotechnical engineering: unsaturated and saturated soils" in 2013. He received tenure and promotion to Halliburton Associate Professor in 1983, and in 1986 became one of the youngest faculty members promoted to the rank of full professor. In 2002, he was awarded the Buchanan Chair. ■



## Kuhn Appointed Chair of ITE Coordinating Council



Kuhn

**T**TI System Management Division Head and Senior Research Engineer Beverly Kuhn was recently appointed chair of the Institute of Transportation Engineers (ITE) Coordinating Council. Kuhn's appointment began on Jan. 1.

The coordinating council organizes the activities of the professional, technical and employer-type councils of ITE and oversees more than 70 council projects currently under way. These projects include the development of standards and recommended practices for the profession, informational reports, technical sessions and awards. As chair, Kuhn will be attending all the coordinating council meetings held during the year. ■

## Pourteau Appointed Editor, Atchison Managing Editor of *Researcher*

**C**hris Pourteau, managing editor for the *Texas Transportation Researcher* since 2008, has been appointed editor beginning with this issue. Samantha Atchison, managing editor of TTI's *SafetyNet* newsletter, will now serve as managing editor for the publication. Kelly West, who served as editor for 12 years, is taking on a new management focus to expand TTI's editorial, graphic design and video services, and to increase project and proposal support Institute-wide. ■

## Spiegelman Named AAAS Fellow



Spiegelman

**E**lected by his peers, TTI Senior Research Scientist Cliff Spiegelman has been named Fellow of the American Association for the Advancement of Science (AAAS). It's an honor established in 1874 that highlights AAAS members' contributions to innovation, education and scientific leadership.

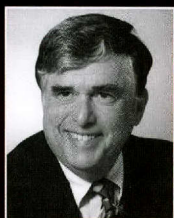
Spiegelman, who is an expert in statistical and environmental forensics, is considered one of the founders of chemometrics — the science of using data to extract information from chemical systems. In addition to his work at TTI, Spiegelman is a distinguished professor of statistics in the College of Science at Texas A&M University.

AAAS acknowledges Spiegelman "for leadership in addressing complex, real-world problems, especially in chemometrics, transportation, forensics and social program evaluation through the development, application and communication of innovative statistical methodology."

"It is great that the collaborative transportation work with so many colleagues at TTI is recognized. It is heartwarming that Dr. Herb Richardson, a colleague and fellow distinguished professor, went way out of his way to help make this honor happen," Spiegelman says. ■

For more information about TTI News, contact **Rick Davenport** at (979) 862-3763 or [r-davenport@tamu.edu](mailto:r-davenport@tamu.edu).

## In Memoriam



Heil



Lanier

**Larry Heil — former McDonald Transit CEO, founding director and president of the Southwest Transit Association and vice president of the American Public Transportation Association. Heil was chair of the TTI Advisory Council from 1994 to 2002. He was inducted into the Texas Transportation Hall of Honor in 2008.**

**Bob Lanier — former mayor of the city of Houston and chairman of the Texas Highway Commission. He helped initiate both the Adopt-a-Highway program and the "Don't Mess with Texas" campaign. He also chaired the Metropolitan Transit Authority. Lanier was inducted into the Texas Transportation Hall of Honor in 2002. ■**



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## PUBLICATIONS

A full catalog of TTI publications and other products is online at <http://tti.tamu.edu/> publications. You can find the publications by searching for either the title or publication number listed here. Most of these publications are available as free downloads in portable document format (PDF).

Printed, bound versions of these reports are also available through the URL above.

### RESEARCH VIDEOS

Access the research topics listed below via the URLs shown.

*Sharing Information Is Key to Solving Transportation Problems:*  
<https://vimeo.com/123663113>

*TTI's Public Engagement Program:*  
<https://vimeo.com/120101589>

*TTI's Flexible Pavements Program:*  
<https://vimeo.com/118643727>

*Most Texans Support More Funding for Transportation, New Poll Shows:*  
<https://vimeo.com/114683447>

*TTI Partners with the U.S. State Department to Protect Americans Worldwide:*  
<https://vimeo.com/106825832>

*Connected Cars, Smarter Roads, Safer Texas:*  
<https://vimeo.com/97270483>

### TECHNICAL REPORTS

*Accounting for Electric Vehicles in Air Quality Conformity — Final Report*, by Joe Zietsman, **0-6763-1**, December 2, 2014.

*Assessment of the Effectiveness of Wrong Way Driving Countermeasures and Mitigation Methods*, by Melisa Finley, **0-6769-1**, December 4, 2014.

*Development of Delineator Testing Standard*, by Dusty Arrington, **0-6772-1**, March 4, 2015.

*Development of NTCIP-Based Portable Traffic Signal Evaluation System*, by Nadeem Chaudhary, **0-6775-1**, October 29, 2014.

*HMA Shear Resistance, Permanent Deformation, and Rutting Tests for Texas Mixes: Final Year 2 Report*, by Lubinda Walubita, **0-6744-2**, November 25, 2014.

*Maximizing Mitigation Benefits — Making a Difference with Strategic Inter-resource Agency Planning: Year Two Technical Report*, by John Overman, **0-6762-2**, December 1, 2014.

*Skid-Mounted Support System for Temporary Guide Signs*, by Roger Bligh, **0-6782-2**, December 2, 2014.

### PROJECT SUMMARY REPORTS AND PRODUCTS

*Determine the Cost for TxDOT to Process/Review/Approve Utility and Driveway Permits*, by Cesar Quiroga, **0-6756-S**, October 31, 2014.

*Develop a Pavement Project Evaluation Index to Support the 4-Year Pavement Management Plan*, by Nasir Gharaibeh, **0-6683-S**, November 13, 2014.

*Developing a Mixture-Based Specification for Flexible Base*, by Jon Epps, **0-6621-S**, March 16, 2015.

*Development of Design Standards for Mounting Temporary Large Guide Signs*, by Roger Bligh, **0-6782-S**, October 30, 2014.

*Development of New Delineator Material and Impact Testing Standard to Prevent Premature Failures Specific to Installation Application*, by Dusty Arrington, **0-6772-S**, October 30, 2014.

*Implementation Workshops for Best Practices for Managing Operating Costs for Rural and Small Urban Transportation Systems, Task 3, Finalized Workshop Materials and Presentations*, by Suzie Edrington, **5-6694-01-P3**, October 16, 2014.

*Introductory Guide to Integrated Ecological Framework*, by John Overman, **0-6762-P1**, October 30, 2014.

*Lap Splice and Development Length Performance in ASR and/or DEF Damaged Concrete Elements*, by Joe Bracci, **0-5722-S**, March 16, 2015.

*Maximizing Mitigation Benefits — Making a Difference with Strategic Inter-resource Agency Planning*, by John Overman, **0-6762-S**, October 28, 2014.

*Partially Populated Catalogue of Measured Properties of Field Sections*, by Fujie Zhou, **0-6674-P3**, October 29, 2014.

*Presentation for New Binder Tests and Specification Change Workshop*, by Fujie Zhou, **0-6674-P2**, October 29, 2014.

**Teens in the Driver Seat**  
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May 17-19, 2015  
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[www.t-driver.com/TDSSummit15/](http://www.t-driver.com/TDSSummit15/)

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