FY 2016 RESEARCH PROGRAM

RESEARCH AND TECHNOLOGY IMPLEMENTATION OFFICE

Texas Department of Transportation

March 2016

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Institutions Active in TxDOT's 2016 Research Program

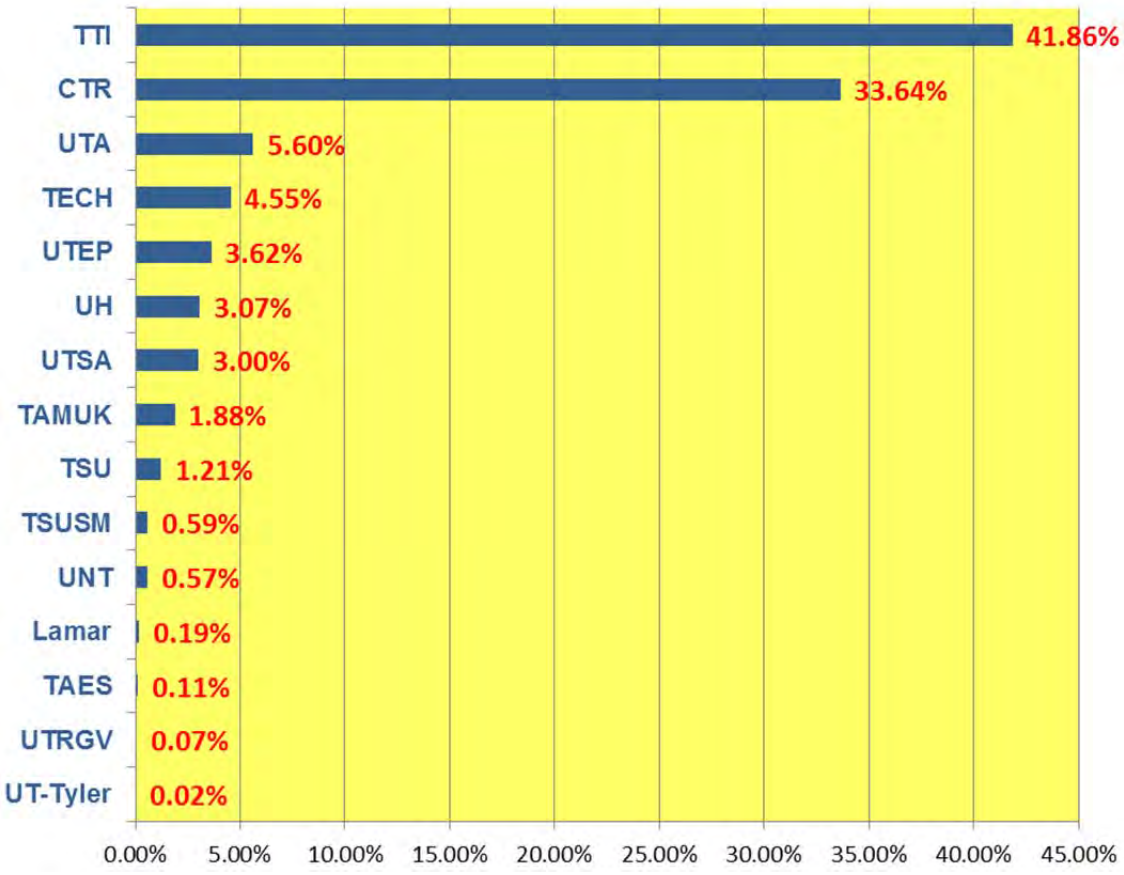
Acronym	University/Research Institution
CTR	Center for Transportation Research, The University of Texas at Austin
Lamar	Lamar University
TAES	Texas A&M AgriLife Extension Service
TAMUK	Texas A&M University–Kingsville
TECH	Center for Multidisciplinary Research in Transportation, Texas Tech University
TSU	Texas Southern University
TSUSM	Texas State University–San Marcos
TTI	Texas A&M Transportation Institute, Texas A&M University
UH	University of Houston
UNT	University of North Texas
UTA	The University of Texas at Arlington
UTEP	The University of Texas at El Paso
UTRGV	The University of Texas Rio Grande Valley
UTSA	The University of Texas at San Antonio
UT-Tyler	The University of Texas at Tyler

Fiscal Year 2016 Research Program

University Participation

TxDOT's fiscal year 2016 research program consists of 134 projects, with budgets totaling $26.5 million. This work is contracted to 15 Texas state-supported universities. The figure below shows project agreement percentages by university/research institution as of February 20, 2016.

University/Research Institution Participation in TxDOT FY 2016 Research



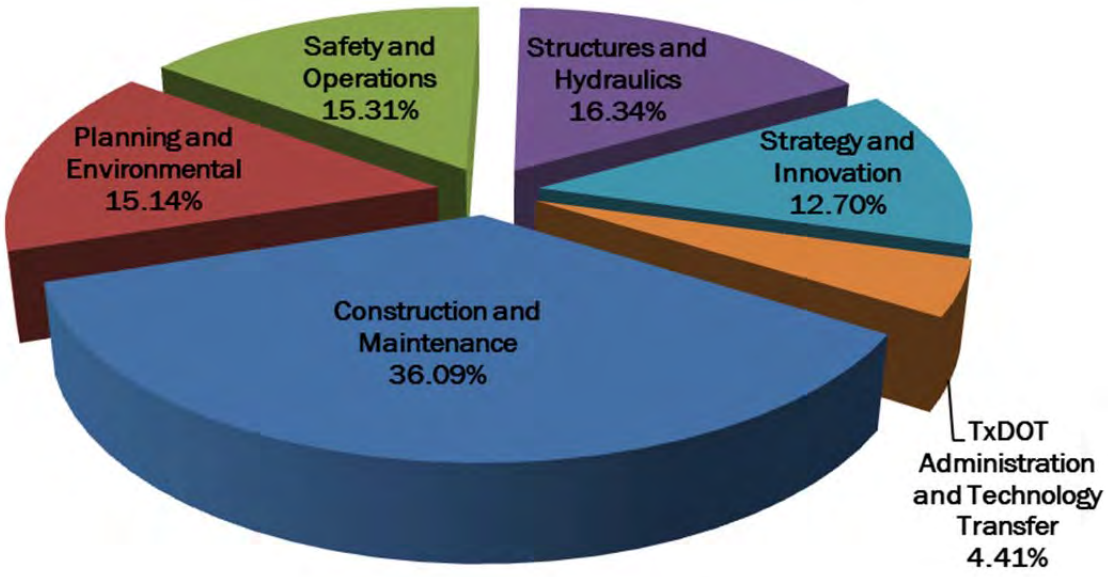
Funding

The table below shows a summary by functional area of the number of continuing/new projects and total funding for fiscal year 2016.

Functional Area	Number of Continuing Projects	Number of New Projects	Total Project Funding
Construction and Maintenance	41	13	$9,573,998
Strategy and Innovation	6	1	$3,370,815
Planning and Environmental	18	7	$4,018,043
Safety and Operations	11	10	$4,062,278
Structures and Hydraulics	13	11	$4,335,495
TxDOT Administration and Technology Transfer	2	1	$1,170,915
Total	91	43	$26,531,544

The figure below shows each functional area's proportion of the total fiscal year 2016 program.

Fiscal Year 2016 Program by Functional Area
Total = $26,531,544



Construction and Maintenance

Project	Title	Start Date	Page
0-6656-01	Further Validation of ASR Testing and Approach for Formulating ASR Resistant Mix	3/10/2015	9
0-6665	TxDOT Native Plant Integration Program for South, Central and West Texas	9/1/2010	10
0-6674-01	Improving Fracture Resistance Measurements in Asphalt Binder Specifications with Verification on Asphalt Mixtures Cracking Performance	12/5/2014	11
0-6808	Quantification of the Impact of a Road's Condition on Emissions	7/29/2014	13
0-6812	Updated Testing Procedures for Long Life Heavy Duty Stabilized Bases	4/25/2014	14
0-6813	Evaluation of ASTM C 494 Procedures for Polycarboxylate Admixtures Used in Precast Concrete Elements	8/15/2014	15
0-6814	Performance Evaluation, Specifications and Implementation of Non-tracking Tack Coat	5/8/2014	16
0-6815	Improved Overlay Tester for Fatigue Cracking Resistance of Asphalt Mixtures	6/30/2014	18
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0-6819	Designing Quieter Pavement Surfaces	2/10/2014	21
0-6826	Research on Joint Seal Materials to Improve Installation and Performance	7/11/2014	22
0-6832	Improved Crack Sealant Application Methods	9/30/2014	23
0-6833	Use of Geocells in Pavement Design	10/10/2014	24
0-6834	Optimization of the Design of Flexible Pavements with Unbounded Bases Reinforced with Geogrids Using APT	9/1/2015	25
0-6835	Test Procedure for Validation of Automated Distress Data	1/9/2015	27

Project	Title	Start Date	Page
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0-6843	Evaluating Use of Sub-grade Drains with PFC for Stormwater Drainage	2/17/2015	29
0-6853	Improvements to Ride Specifications	1/23/2015	30
0-6854	Engineering the Properties of Asphalt Mixtures Using Carbon Nanotubes	2/2/2015	31
0-6855	Validation of RAP and/or RAS in Hydraulic Cement Concrete	1/28/2015	32
0-6856	Sustainable Perpetual Asphalt Pavements and Comparative Analysis of Lifecycle Cost to Traditional 20-Year Pavement Design	1/27/2015	33
0-6857	Cost Effective Alternatives to Seal Coats	1/29/2015	34
0-6858	Evaluating Limestone Cements Containing Greater than 15% Limestone	1/16/2015	35
0-6860	Develop Metrics for Tire Debris on Texas Highways	1/29/2015	36
0-6868	Novel Material Systems for the Next Generation Flexible Pavement Structures	3/16/2015	37
0-6874	Develop Nondestructive Rapid Pavement Quality Assurance/Quality Control Evaluation Test Methods and Supporting Technology	4/23/2015	38
0-6878	Accelerating Innovation in Partnered Pavement Preservation	3/27/2015	39
0-6880	Full Depth Reclamation in Maintenance Operations Using Emerging Technologies	7/24/2015	40
0-6881	Recycled Engine Oil Bottoms and Polyphosphoric Acid in Texas Binders	9/1/2015	41
0-6883	Compaction of Soils and Base Materials Using Superpave Gyratory Compactors	9/1/2015	42
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Project	Title	Start Date	Page
0-6889	Rolling Density Meter to Ensure Long Term Performance of Flexible Pavements	9/1/2015	45
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0-6908	Comparative Analysis of Tack Coat, Underseal Membrane, and Underseal Technologies	1/1/2016	50
0-6910	Development of Proper Overlay Type and Designs for PCC Pavement	1/1/2016	51
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5-4687-03	Implementing Rubblization Techniques on Severely Distressed Concrete Pavements	9/1/2015	53
5-4829-03	Implementation of Geosynthetic-Reinforced Unbound Base Courses	8/28/2014	55
5-5598-05	Continued Implementation of High Performance Thin Overlays in Texas Districts	2/19/2014	56
5-6048-03	Implementation of Centrifuge Technology for Pavement Design on Expansive Clays	10/23/2013	57
5-6271-03	Using Small Sample Sizes in Full Depth Reclamation (FDR) Laboratory Mix Designs	7/11/2014	58
5-6271-05	Implementing Full Depth Reclamation (FDR) to Repair Roads Damaged in the Energy Sector	8/28/2014	59
5-6610-01	Implementation of Defect Correction Assessment Methodology on TxDOT Ride Quality Projects	6/22/2015	60

0-6656-01—Further Validation of ASR Testing and Approach for Formulating ASR Resistant Mix

Start Date: 3/10/2015 End Date: 2/28/2018

Project Objectives

The main objectives of this project are to further validate the aggregate-solution method and the accelerated concrete cylinder testing (ACCT) and validate the approach (developed in Research Project 06656) of developing alkali-silica reaction (ASR) resistant concrete mix. Developing ASR resistant mix is a combined approach of aggregate-solution testing measuring each activation energy and threshold alkalinity (THA) and concrete testing. The specific objectives are as follows:

Project Manager

Darrin Jensen, RTI

Project Supervisor

Anol Mukhopadhyay, TTI

1. Validate the usefulness of threshold alkalinity in determining alkali loading for different aggregate sources that could potentially be used to modify mix design Option 7. In Option 7 of TxDOT Item 421, it is recommended that the total alkali contribution from cement in the concrete should not exceed 3.5 lb per cubic yard of concrete when using hydraulic cement alone. With the eventual loss of Class F fly ash sources, the department needs to investigate other methods to determine potential reactivity of aggregates in terms of alkali threshold (current test methods are not appropriate for this analysis) in order to be prepared in the event Class F fly ash is no longer readily available.
2. Further validation of ACCT (testing period, expansion limits, level of alkali loadings, appropriate level of soak solution chemistry, suitable specimen dimension, etc.) method—Use the TxDOT field exposure block data to calibrate the ACCT method.
3. Suitability of ACCT to test job mix.
4. Validation of the combined approach using both aggregate-solution and concrete testing for formulating ASR resistant mix.

Total Project Budget	*Research University*	*FY 2016 Budget*
$1,835,487	Texas A&M Transportation Institute	$147,000

0-6665—TxDOT Native Plant Integration Program for South, Central and West Texas

Start Date: 9/1/2010 ***End Date: 8/31/2018***

Project Objectives

This project shall work to collect, evaluate, and release native seed sources for use by TxDOT in Central, West, and South Texas. Project seed collectors shall obtain seeds from target native plant species throughout these regions. Evaluation plantings shall be made using these seeds at numerous locations throughout the project area, and plant performance of the various species and collections shall be assessed. Following evaluation and testing, the most suitable species and collections shall be increased in field-scale production fields, and seeds harvested from these fields shall be distributed to commercial growers to make well-tested, adapted native plants and seeds readily available for use by TxDOT for right-of-way vegetation management and restoration.

Project Manager

Wade Odell, RTI

Project Supervisor

Forrest Smith, TAMUK

Total Project Budget	*Research University*	*FY 2016 Budget*
$3,250,000	Texas A&M University–Kingsville	$500,000

0-6674-01—Improving Fracture Resistance Measurements in Asphalt Binder Specifications with Verification on Asphalt Mixtures Cracking Performance

Start Date: 12/5/2014 End Date: 8/31/2018

Project Objectives

The current performance grading (PG) specification for asphalt binders was developed during the Strategic Highway Research Program (SHRP). The PG was based primarily on the study of unmodified asphalt binders. Over the years, experience has proven that the PG system, while good for ensuring overall quality, fails in some cases to guarantee good rutting and cracking performance, particularly as it applies to today's binders modified in a variety of unknown ways. Specifically, recent studies on mixes with highly polymer-modified binders from Minnesota found that the road mixes have substantially improved cold weather cracking properties over mixes currently used in Texas and still pass TxDOT's Hamburg rutting requirements.

Project Manager

Darrin Jensen, RTI

Project Supervisor

Fujie Zhou, TTI

Under Project 0-6674, researchers investigated these softer but highly modified binders in the laboratory and built 11 field test sections in northern districts of Texas for validation. (Note that softer binders are often referring to the PGXX-28 and PGXX-34 binders, with regular binders being PGXX-22 binders and stiffer binders being PG76-X_N binders.) The 11 test sections are four on SH 15 north of Amarillo, three on US 62 at Childress, and four on Loop 820 at Fort Worth. These projects were monitored for a maximum of 12 months, which is too short of a time to draw definite conclusions. Also in Project 0-6674, a statewide binder selection catalog was developed based on the results of laboratory tests and performance simulations of numerous overlay projects. Further work is needed to validate these recommendations.

The major objectives of Project 0-6674-01 are to:

1. Continue monitoring the 11 field test sections constructed under Project 0-6674 for the duration of 0-6674-01. This shall provide the research team with a total of five years of performance data, which should be adequate to validate the benefits of these softer binders in the colder areas of Texas.
2. Validate the statewide binder selection catalog building field test sections in West, South, and East Texas districts. The specific locations shall be selected in coordination with the project team and TxDOT districts.

3. Perform 40-year life cycle cost analyses with true cost and performance data on all field test sections to evaluate the benefit of using softer but highly modified binders.
4. Update the statewide binder selection catalog previously developed under Project 0-6674.
5. Evaluate 10 most often used asphalt binders recently engineered with a variety of modification techniques using the asphalt binder tests previously recommended by Project 0-6674.

Total Project Budget	*Research University*	*FY 2016 Budget*
$494,485	Texas A&M Transportation Institute	$106,979

0-6808—Quantification of the Impact of a Road's Condition on Emissions

Start Date: 7/29/2014 End Date: 8/31/2016

Project Objectives

The scope of this project involves quantifying the impact of roadway conditions on vehicular emissions and developing detailed guidance to assist TxDOT in improving maintenance strategies to reduce these emissions. The researchers shall quantify the vehicular emissions associated with different conditions of flexible pavement, continuously reinforced concrete pavement (CRCP), and jointed concrete pavement (JCP), and evaluate the effectiveness of different maintenance strategies in reducing emissions on these roadways. The researchers shall use this information to develop a model to identify roadway sections that will qualify for Congestion Mitigation and Air Quality Improvement (CMAQ) Program funds on maintenance projects.

Project Manager

Wade Odell, RTI

Project Supervisor

Carlos M. Chang, UTEP

Total Project Budget	*Research University*	*FY 2016 Budget*
$288,879	The University of Texas at El Paso	$59,055
	Texas Southern University	$68,912

0-6812—Updated Testing Procedures for Long Life Heavy Duty Stabilized Bases

Start Date: 4/25/2014 End Date: 8/31/2016

Project Objectives

TxDOT is in the process of evaluating new approaches and laboratory test methods for characterization of the fatigue performance of the cement treated base layers. The new approach is required to be all inclusive for statewide application and incorporation into the new *Texas Mechanistic Empirical Design Guide* (TexME). The three-point bending beam fatigue test is currently used for the determination of the modulus of rupture of the cement-treated mixes. This test proved to be impractical for lightly stabilized systems because the specimen tends to disintegrate during transportation to the test setup. Additionally, discrepancies associated with specimen preparation and non-uniform density distribution in large samples were found to be an added concern that greatly jeopardizes the accuracy of the performance prediction models. Therefore, there is an urgent need for a simple and practical fatigue test that provides inputs to the TexME structural design program. This research project provides an alternative laboratory testing protocol for mechanistic characterization of the cement treated base layers to meet the need.

Project Manager

Kevin Pete, RTI

Project Supervisor

Reza Ashtiani, UTEP

Total Project Budget	*Research University*	*FY 2016 Budget*
$297,000	The University of Texas at El Paso	$63,000

0-6813—Evaluation of ASTM C 494 Procedures for Polycarboxylate Admixtures Used in Precast Concrete Elements

Start Date: 8/15/2014 End Date: 12/31/2016

Project Objectives

This project shall provide TxDOT with revised tests, specifications, and recommended practices to use and inspect precast concrete (conventional and SCC) containing polycarboxylate admixtures (PC). An overarching objective of this project is to increase the understanding of the effect of polycarboxylate high-range water-reducers (HRWRs) on the performance of concrete mixtures, with a special focus on concrete mixtures that will be used in precast concrete beam applications. The project shall leverage the results of Interagency Contract (IAC) No. 46-3MTIAO34: Evaluation of Long-Term Durability of Concrete, which addresses potential mechanisms for cracking in girders cast at Texas precast plants, typically appearing 18–24 months after casting.

Project Manager

Sonya Badgley, RTI

Project Supervisor

Raissa Ferron, CTR

Total Project Budget	*Research University*	*FY 2016 Budget*
$266,442	Center for Transportation Research, The University of Texas at Austin	$106,696

0-6814—Performance Evaluation, Specifications and Implementation of Non-tracking Tack Coat

Start Date: 5/8/2014 *End Date: 4/30/2016*

Project Objectives

Non-tracking tacks, recently introduced to the paving industry, bond asphalt layers together while avoiding the tracking problems associated with traditional tacks. Initially, there was only one supplier in Texas, but now multiple producers are bringing new products to the market.

Project Manager

Darrin Jensen, RTI

Project Supervisor

Bryan Wilson, TTI

Performance to date has been good, but there have been no objective evaluations on short- and long-term performance. Furthermore, there are no established methods in TxDOT to test tackiness and tracking resistance of current and new products or to test the strength of bonded layers. Key to this project is developing new test procedures and specifications to measure and specify the properties of tracking and tack. “Non-tracking” refers to the amount of time required before it is possible to drive on the material. “Tack” refers to the bond strength provided by the material.

The objectives of this study are to:

1. Understand the impact of different types and quantities of non-tracking tack on engineering properties of pavements, including bonding and cracking resistance.
2. Identify limits on the non-tracking tack stiffness and application rate that negatively impacts engineering properties.
3. Validate laboratory findings with field data from test sections.
4. Incorporate this work into a set of specifications that includes new test procedures and criteria.
5. Formulate plans to practically demonstrate and implement the new procedures with the industry.

In the work plan, the research team shall:

1. Conduct a literature review of tack tracking and bonding issues and associated tests.
2. Characterize different non-tracking tacks and traditional tacks available in Texas.
3. Identify the best test procedure to measure tackiness and tracking resistance in the lab and verify results in the field.

4. Identify the best test procedure to measure bond strength in the lab and verify results in the field. Identify limits of stiffness and application rate that negatively impact bond strength and fatigue resistance.
5. Demonstrate non-tracking tack specifications in field projects and laboratory workshops. Develop specifications, write a comprehensive report of methods and findings, and share information via webinar to division and district personnel.

Total Project Budget	*Research University*	*FY 2016 Budget*
$308,870	Texas A&M Transportation Institute	$34,573

0-6815—Improved Overlay Tester for Fatigue Cracking Resistance of Asphalt Mixtures

Start Date: 6/30/2014 End Date: 6/30/2016

Project Objectives

This project shall focus on evaluating the previous work attempting to modify the current Overlay Tester (OT) to measure and characterize the fatigue properties of hot mix asphalt (HMA) laid down by the districts. This project shall select a modified test method and create corresponding specifications for OT that rank the fatigue cracking potential of HMA mixes and provide their fatigue properties in a timely manner and with few technical complications.

Project Manager

Kevin Pete, RTI

Project Supervisor

Soheil Nazarian, UTEP

Premature fatigue cracking is a major distress that deteriorates the pavement structure under the combined action of traffic loads and environmental impacts at a rapid rate. The present OT characterizes the cracking resistance of asphalt mixes by evaluating the number of cycles to failure of a specimen. The number of cycles to failure is not sufficient to capture and predict the fatigue properties of asphalt mixtures. Through appropriate instrumentation, interpretation, and analyses, the fatigue properties of the specimen can be obtained from the OT results. This goal cannot be achieved until the high degree of uncertainty in OT results, especially in dense-graded mixtures, is addressed.

Fatigue cracking of hot mix asphalt continues to be a recurring problem in Texas. Pavements with fatigue cracking deteriorate rapidly under the combination of traffic, moisture, and aging of the asphalt layer. Similar to the Hamburg Wheel Tracking Device (HWTD) for rutting potential, TxDOT has implemented the OT to evaluate the cracking susceptibility and resistance to reflective cracking of HMA. The OT is a relatively simple empirical laboratory method. Despite several previous attempts to improve OT so that parameters related to quantify resistance to fatigue cracking can be measured, additional work in that area is required. Recent studies have brought about some concerns about the utility of the OT in dense graded HMA mixes such as Types C and D, which make up about 75 percent of all HMAs used in Texas. The use of the OT to measure resistance to fatigue cracking of HMA reliably in a robust manner is greatly needed for all mixture types and HMA specifications.

Through a systematic approach, full consideration of the previous work on the subject, and in consultation with the manufacturers, the research team shall evaluate and improve the hardware and software, laboratory test procedures, and

specifications of the OT to allow direct measurement of fatigue properties of asphalt mixtures with much less variation.

Total Project Budget	*Research University*	*FY 2016 Budget*
$325,500	The University of Texas at El Paso	$142,000

0-6817—Review and Evaluation of Current Gross Vehicle Weights and Axle Load Limits

Start Date: 7/29/2014 End Date: 5/31/2016

Project Objectives

The researchers shall review and extend the work done under Project 0-6736, Rider 36, OS/OW Vehicles Permit Fee Structure, and other similar efforts currently underway in Texas and other states and at the federal and international level to evaluate the effects of single-, tandem-, tridem-, and quad-axle configurations on bridges and pavements, and develop guidelines for more infrastructure-friendly vehicle configurations. In addition, the researchers shall develop a cost-recovery structure that adequately funds repairs to roads utilized by overweight trucks. For consistency, this methodology shall be compatible with that proposed for the determination of fees with oversize/overweight (OS/OW) vehicles.

Project Manager

Sonya Badgley, RTI

Project Supervisor

C. Michael Walton, CTR

Total Project Budget	*Research University*	*FY 2016 Budget*
$538,237	Center for Transportation Research, The University of Texas at Austin	$73,216
	The University of Texas at San Antonio	$0

0-6819—Designing Quieter Pavement Surfaces

Start Date: 2/10/2014 End Date: 1/31/2016

Project Objectives

This project outlines a work plan for designing quieter asphalt and concrete pavements. A literature review shall determine the state of the art in designing quieter pavements and contributing factors. An extensive pavement-noise database shall be compiled, comprising a variety of asphalt and concrete surfaces with corresponding noise measurements over time. This database shall be analyzed using statistical techniques and shall focus on identifying all relevant design parameters influencing noise. Laboratory design procedures to evaluate noise shall be developed and correlated against mixture design parameters for a range of different asphalt mixtures. Close proximity and far-field noise tests in the field on both asphalt and concrete pavements shall be correlated against laboratory measures toward establishing laboratory test procedures. Following these tasks, a set of preliminary guidelines shall be developed to provide the districts with recommendations on and assistance in selecting appropriate candidate projects for low-noise surfaces and for designing surfaces to provide long-term noise reductions. A case study shall be completed to recommend strategies for addressing noise complaints in an urban setting. In addition, a number of new and existing pavements across Texas shall be monitored. Results from the case study and field tests shall be used to validate and refine the district guidelines.

Project Manager

Kevin Pete, RTI

Project Supervisor

Jorge Prozzi, CTR

Total Project Budget	*Research University*	*FY 2016 Budget*
$341,958	Center for Transportation Research, The University of Texas at Austin	$53,673

0-6826—Research on Joint Seal Materials to Improve Installation and Performance

Start Date: 7/11/2014 End Date: 1/31/2016

Project Objectives

Joints in Portland cement concrete (PCC) pavement are sealed with proper sealant materials to prevent intrusion of water and incompressible materials. Intrusion of water could result in corrosion of dowels or tie bars in CPCD, and tie bars or longitudinal steel in CRCP. Intrusion and collection of incompressible materials could cause surface spalling. Another important failure mechanism in PCC pavement in Texas is erosion of base materials caused by water infiltration along longitudinal joints between the outside concrete lane and asphalt shoulder. To improve the performance of PCC pavement, it is important to keep the joint seals in a good condition so that water and incompressible materials cannot get into joints. There are three elements associated with joint seal performance: (1) proper joint design, (2) quality of joint seal materials, and (3) proper installations. Currently, joint design is dictated in the joint design standards, JS-94. Joint seal material quality is controlled by DMS-6310. Joint sealant installation is governed by Item 438. There are discrepancies between TxDOT requirements and actual practice, potentially compromising the effectiveness of joint performance. The discrepancies need to be identified and design standards or specifications revised or field practices modified.

Project Manager

Kevin Pete, RTI

Project Supervisor

Moon Won, TECH

Total Project Budget	*Research University*	*FY 2016 Budget*
$203,285	Center for Multidisciplinary Research in Transportation, Texas Tech University	$37,166

0-6832—Improved Crack Sealant Application Methods

Start Date: 9/30/2014 End Date: 8/31/2017

Project Objectives

The research team shall determine the routing standard for Texas pavements by performing a comprehensive review of all the known literature for routing as it pertains to crack sealing, as well as those factors impacting sealant performance. Surveys shall yield data for Texas' methods, as well as other states' practices and preferences. The installation and monitoring of five test sites shall provide data from installation through normal use over two years. The data gathered by the research team shall be assessed against current knowledge on the performance of sealed cracks under various traffic, climate, and existing pavement conditions; the performance of sealant under various crack routing configurations; and the effects of these methods on pavement roughness, user perception, and estimated future maintenance and rehabilitation costs. The research team shall present all of this information in a comprehensive final report, along with a simple comparison chart of sealant types and methods highlighting short- and long-term costs and benefits of routing prior to crack sealing.

Project Manager

Sonya Badgley, RTI

Project Supervisor

Soon Jae Lee, TSUSM

Total Project Budget	*Research University*	*FY 2016 Budget*
$229,640	Texas State University–San Marcos	$63,475

0-6833—Use of Geocells in Pavement Design

Start Date: 10/10/2014 End Date: 8/31/2016

Project Objectives

In recent years, a new construction technology known as "geocells" has been developed and increases the bearing capacity of supporting layers with no to minimal increase in cost of construction. However, the benefits (performance and cost) from using geocells in pavement design, particularly in locations where good quality base material is not readily available, are not well understood or documented. Researchers shall determine and document the benefits that derive from the use of the newer generation of geocells in pavement design/construction especially in terms of reducing base layer thicknesses even though low quality base material is being used. Researchers shall focus on evaluating feasibility of using lower/marginal quality base and/or sub-base material in the pavements constructed with geocell systems, which has become essential due to unavailability of good quality base material in many regions of Texas. In this project, the research team shall (1) characterize the mechanisms for improved support, (2) quantify the type of comparatively low quality material that can be used as infill of geocells, and (3) quantify the comparatively smaller thickness that could be used in bases or sub-bases when incorporating the use of geocells in pavement design.

Project Manager

Sonya Badgley, RTI

Project Supervisor

Vivek Tandon, UTEP

Total Project Budget	*Research University*	*FY 2016 Budget*
$251,671	The University of Texas at El Paso	$140,703

0-6834—Optimization of the Design of Flexible Pavements with Unbounded Bases Reinforced with Geogrids Using APT

Start Date: 9/1/2015 *End Date: 12/31/2017*

Project Objectives

Base reinforcement results from the addition of a geogrid at the bottom of or within an unbound base course to increase the structural or load-carrying capacity of a pavement system. TxDOT has significant experience in the use of geogrids to mitigate detrimental effects caused by expansive clay subgrades on flexible pavements. In the national arena, the main motivation to use geogrids in the design of unbound bases has been to resist traffic loads, rather than environmental loads. In these cases, the objectives have been to increase the design life of a pavement (for a given base thickness) or to decrease the required thickness of its base course (for a given design life). Many field-monitored projects, including accelerated pavement testing (APT) projects, have involved geogrid-reinforced pavements (GRPs). Yet, while previously collected field data are certainly valuable, the overall focus has been on quantifying how much improvement the geogrids can add to a pavement base course rather than on understanding why GRPs behave as they do. This focus may have precluded incorporating this promising technology into a rational methodology for pavement design.

Project Manager

Sonya Badgley, RTI

Project Supervisor

Jorge Zornberg, CTR

This project's objective is to determine the actual contribution of geogrids to the performance of flexible pavements and incorporate this understanding into tools that allow a rational design of GRPs. Achieving the objective requires overcoming key hurdles: (1) understanding the behavior of GRPs, (2) capitalizing on this understanding to identify the material properties that govern GRP performance, and (3) incorporating this understanding and properties into a robust design framework. Accordingly, an innovative work plan has been conceived that includes both the long-term pavement performance (LTPP) of field sections as well as a comprehensive APT program on geogrid-reinforced pavement sections.

The significant volume of field and experimental data collected in this project shall yield key project deliverables: comprehensive reports, geogrid selection criteria, documentation of geogrid testing protocols with threshold values for accepting properties, and modification of the Flexible Pavement Design System 19 (FPS-19) program to account for the presence of geogrid reinforcement in unbound bases. In addition, a set of special specifications shall update TxDOT's DMS-6240, easing the selection of geogrids for the reinforcement of unbound bases. Finally, to facilitate implementation, a pilot short course shall be offered to TxDOT personnel to discuss

the best practices for using geogrids in pavement design as well as the associated costs and benefits.

Total Project Budget	*Research University*	*FY 2016 Budget*
$468,937	Center for Transportation Research, The University of Texas at Austin	$210,642

0-6835—Test Procedure for Validation of Automated Distress Data

Start Date: 1/9/2015 *End Date: 8/31/2016*

Project Objectives

TxDOT currently has several contractors to collect distress data over the state highway network at a cost of over $2,000,000 annually. This survey is conducted by driving along the shoulder, in the lane, or in the grass adjacent to the roadway. The survey is labor intensive, takes about four months to complete, and exposes the survey crew as well as the driving public to accident risks. Clearly, the need exists to examine the use of automated systems to collect pavement condition for the department's pavement management information system (PMIS) as well as other roadway geometric information for managing other elements of the state highway infrastructure. This project shall develop a performance-based specification for automated distress data collection systems and assist TxDOT in preparing a detailed scope of work or specifications to procure equipment and services. To this end, a three-phase project shall be conducted to:

Project Manager

Sonya Badgley, RTI

Project Supervisor

Andrew Wimsatt, TTI

1. Develop a pilot performance-based specification on automated distress survey systems.
2. Assist TxDOT in preparing a detailed scope of work or specifications to procure equipment and services.
3. Validate the pilot specification and revise as necessary to deliver the final performance-based specification from this project.

Total Project Budget	*Research University*	*FY 2016 Budget*
$418,197	Texas A&M Transportation Institute	$180,000

0-6839—Designing Pavements to Support the Heavy Loads in the Energy Development

Start Date: 1/1/2015 *End Date: 11/30/2017*

Project Objectives

Many innovative and automated freight delivery strategies and technologies have been proposed to address the future freight needs of Texas' growing population. TxDOT and local transportation planners need to evaluate operational changes or technology applications to ensure continued, timely flow of commercial freight through the Texas transportation system. Emerging freight delivery technologies, such as automated freight vehicles or airborne small package delivery, and innovative operational freight strategies, such as nighttime off-peak hour deliveries or conversion of managed lanes to truck-only use during high port traffic periods, are potential ways to better use existing infrastructure. Changes in buying habits of consumer goods toward direct home package delivery also could dramatically shift distribution patterns and increase the number of intercity and local delivery trucks on TxDOT roadways.

Project Manager

Darrin Jensen, RTI

Project Supervisor

Fujie Zhou, TTI

The primary objective of this project is to establish a process to evaluate freight operational changes or technology applications in order to ensure continued timely flow of commercial freight through the Texas transportation system. This project shall develop and adapt the necessary evaluation metrics for future use. This project shall also access several currently proposed freight strategies and technologies to determine which of these should be further evaluated for implementation on the Texas transportation system in future project phases.

Total Project Budget	*Research University*	*FY 2016 Budget*
$638,559	Texas A&M Transportation Institute	$213,587

0-6843—Evaluating Use of Sub-grade Drains with PFC for Stormwater Drainage

Start Date: 2/17/2015 End Date: 1/31/2017

Project Objectives

Water standing on pavements is a major safety concern. Water accumulation on roadways leads to splash, spray, and hydroplaning, which contribute significantly to auto accidents. This project shall develop a design method for the underdrains of porous friction course (PFC) to eliminate standing water on roadway surfaces, especially difficult drain segments. The project includes both large-scale testing and numerical modeling of storm water drainage. The large-scale testing involves testing a few pavement sections and measuring water surface within and on the PFC. The numerical model shall couple the run-off on the PFC surface with the seepage within the PFC to avoid the limitations of existing numerical models. After calibrated by the test data, the numerical model shall be used to simulate the dynamic process of infiltration, run-off, and seepage for various pavement conditions under different rainfall events. With the results from the numerical modeling, the effect of underdrains on removing standing water on PFC shall be quantified and a number of design charts, equations, or similar tools shall be developed to assist in determining the size, spacing, and configuration of the underdrains. Researchers shall provide these design charts, which will be used for regular segments as well as difficult drainage segments, to TxDOT.

Project Manager

Sonya Badgley, RTI

Project Supervisor

Jie Huang, UTSA

Total Project Budget	*Research University*	*FY 2016 Budget*
$276,293	The University of Texas at San Antonio	$52,080
	Center for Multidisciplinary Research in Transportation, Texas Tech University	$71,570

0-6853—Improvements to Ride Specifications

Start Date: 1/23/2015 End Date: 7/31/2016

Project Objectives

The purpose of this research project is to develop an objective, rational, economically, and financially justifiable ride pay adjustment system that incorporates new versus existing ride quality and a methodology to tailor the existing techniques to measure ride quality using Surface Test Type B or inertial profilers on short projects. The objective of this research is to develop a comprehensive database that links TxDOT's site manager to the Design and Construction Information System (DCIS) and Pavement Management Information System (PMIS) databases.

Project Manager

Joe Adams, RTI

Project Supervisor

Jorge Prozzi, CTR

The deliverables of this research shall improve the existing pay adjustment factors and the evaluation of roughness measurements on short projects used by TxDOT.

Total Project Budget	*Research University*	*FY 2016 Budget*
$149,961	Center for Transportation Research, The University of Texas at Austin	$84,841

0-6854—Engineering the Properties of Asphalt Mixtures Using Carbon Nanotubes

Start Date: 2/2/2015 *End Date: 2/28/2017*

Project Objectives

Traditional polymer modified binders are typically used to achieve a target performance grade (PG) and also to enhance resistance of the binder to distresses, such as rutting, fatigue cracking, and low-temperature cracking. Conventional modifiers used with asphalt binders are often expensive and are not very effective to improve the low-temperature properties.

Project Manager

Wade Odell, RTI

Project Supervisor

Navid Saleh, CTR

Recent advances in nanotechnology have allowed for the development of novel materials that can be tailored to deliver improvements in both high- and low-temperature properties of the modified composite. Carbon nanotubes (CNTs) are one of the most promising classes of materials to show reduced rutting at high temperatures. However, simultaneous improvements in low-temperature properties can only be achieved if the CNTs are surface modified to effectively disperse in the binder and break the viscosity building molecular associations at low temperatures. The research team shall evaluate an innovative and novel method to deliver CNTs into the binder via water, used in the production of foamed WMA.

Total Project Budget	*Research University*	*FY 2016 Budget*
$265,438	Center for Transportation Research, The University of Texas at Austin	$136,546
	The University of Texas Rio Grande Valley	$19,888

0-6855—Validation of RAP and/or RAS in Hydraulic Cement Concrete

Start Date: 1/28/2015 End Date: 1/31/2017

Project Objectives

Reclaimed or recycled asphalt pavement (RAP) and recycled asphalt shingles (RAS) have been widely used in hot mix asphalt (HMA) in Texas. However, a high volume of RAP is still available in a form of stockpiles along TxDOT's highways or at hot mix asphalt concrete (HMAC) producers' plants, in spite of their use by the asphalt industries. Ground RAS from manufacturers and post-consumer uses are also available. The possible use of RAP and RAS in Portland cement concrete (PCC) not only would help dispose of excess RAP and RAS but also provide a cost reduction for aggregates in hydraulic cement concrete with additional benefits of improvement in concrete performance.

Project Manager

Wade Odell, RTI

Project Supervisor

Anol Mukhopadhyay, TTI

Previous research has indicated that the use of RAP as aggregate replacement in concrete paving mix appears to not only be feasible but also offer the possibility of improving the performance of concrete pavement. Therefore, it is very important to validate the earlier findings, i.e., that the addition of RAP and RAS will actually enhance the performance of concrete belonging to different classes while allowing recyclable products to be used.

Total Project Budget	*Research University*	*FY 2016 Budget*
$317,614	Texas A&M Transportation Institute	$149,273

0-6856—Sustainable Perpetual Asphalt Pavements and Comparative Analysis of Lifecycle Cost to Traditional 20-Year Pavement Design

Start Date: 1/27/2015 End Date: 11/30/2017

Project Objectives

Since 2001, the State of Texas has been designing and constructing perpetual pavements on heavily trafficked highways where the estimated 18 kip equivalent single axle loads (ESALs) exceed 30 million after a 20-year design period. Perpetual pavements, also commonly known as full-depth asphalt pavements, are pavement structures designed not to have major structural rehabilitation or reconstruction work, but requiring only minor periodic surface renewals for at least 50 years. To date, there are 10 perpetual pavement sections in service within Texas. With the oldest section having a service life of over 12 years, there is an opportunity to review the existing perpetual pavement design and construction practices with a view of modifying the design procedures and recommending the best construction practices to meet current traffic demands. The concern regarding these perpetual pavements was cost, and it was suggested that they were excessively thick and that their multiple lifts of different mixes made perpetual pavements difficult and expensive to construct. A critical review of field performance is warranted with recommendations on how to make these pavements cost competitive with both conventional 20-year flexible pavements and rigid concrete pavements.

Project Manager

Wade Odell, RTI

Project Supervisor

Lubinda Walubita, TTI

Total Project Budget	*Research University*	*FY 2016 Budget*
$618,825	Texas A&M Transportation Institute	$185,901

0-6857—Cost Effective Alternatives to Seal Coats

Start Date: 1/29/2015 End Date: 8/31/2017

Project Objectives

The primary focus of this project is the development of a mix design procedure and construction guidelines for an ultra-thin hot mix asphalt (HMA) alternative to seal coats. This project shall develop performance tests and implementation guidelines for ultra-thin (approximately 0.5 inch thick or less) asphalt layers intended as an alternative to seal coats (with similar or lower lifecycle cost). The project shall also address the mix design and testing of ultra-thin layer mixes both in the field and in the laboratory toward the selection of appropriate performance tests to evaluate the life expectancy, aggregate loss, and ride quality of new ultra-thin asphalt overlays and estimated lifecycle cost. Products of this project shall be the designing and monitoring of demonstration projects for ultra-thin asphalt layers, curriculum for a training program that introduces TxDOT personnel to ultra-thin asphalt overlays, technical memoranda and a research report that documents the materials and construction specification for ultra-thin overlays, and a project summary report.

Project Manager

Darrin Jensen, RTI

Project Supervisor

Amit Bhasin, CTR

Total Project Budget	*Research University*	*FY 2016 Budget*
$448,765	Center for Transportation Research, The University of Texas at Austin	$105,279
	The University of Texas at El Paso	$53,414

0-6858—Evaluating Limestone Cements Containing Greater than 15% Limestone

Start Date: 1/16/2015 End Date: 12/31/2017

Project Objectives

The primary objective of this project is to collect materials and pavement performance data on a minimum of a 100 highway test sections around the state of Texas. As well as being used to calibrate and validate mechanistic-empirical (M-E) design models, the data will also serve as an ongoing reference data source and/or diagnostic tool for TxDOT engineers and other transportation professionals. Some of the M-E models to be calibrated under this research project include the Flexible Pavement Design System design procedure, the Texas M-E, the Texas overlay design system, and the *Mechanistic-Empirical Pavement Design Guide*. The scope of work to accomplish these objectives shall include the following activities:

Project Manager

Darrin Jensen , RTI

Project Supervisor

Kevin Folliard, CTR

- Selection of field test sections across the state.
- Extensive laboratory and field testing.
- Literature review of M-E models and evaluation of existing databases.
- M-E model calibration and validation.
- Demonstration workshop of the data collected.

A plan for data collection and material testing (lab and field), a plan for data analysis, and a plan for model calibration shall be developed during the first months of this research project and, after TxDOT approval, shall be implemented by the research team. A minimum of 100 sections (representing different pavement types, material types, climatic regions, traffic levels, and ages [new and old]) shall be targeted.

Total Project Budget	*Research University*	*FY 2016 Budget*
$516,950	Center for Transportation Research, The University of Texas at Austin	$168,000

0-6860—Develop Metrics for Tire Debris on Texas Highways

Start Date: 1/29/2015 End Date: 6/30/2016

Project Objectives

Tire debris is one of the most common and prominent types of waste that can be observed on roadways. However, the extent and implications of this type of debris remain largely unknown, particularly in Texas, where there is a perception among the public that tire debris may represent safety, congestion, and maintenance concerns.

Project Manager

Sonya Badgley, RTI

Project Supervisor

Raul Avelar, TTI

Currently, traffic activity generates tire debris on Texas highways at an unknown rate. This debris must be removed as part of programs run by state and local agencies, such as maintenance or roadside emergency response. The costs associated with these operations are undetermined to a large extent. The true extent of the process of debris generation and the safety, operational, and economic ramifications are also unknown.

Researchers shall survey, collect field data, and review crash records in order to produce essential information on the following points: (1) the volume of tire debris that is generated on Texas highways each year, (2) the cost to state and local stakeholders of collecting and disposing of this type of debris, and (3) the safety and economic impacts to Texas road users associated with tire debris. In summary, the objective of this project is to develop statewide metrics of the volume, rate of generation, economic implications, and safety impacts of tire debris on Texas highways.

Total Project Budget	*Research University*	*FY 2016 Budget*
$192,475	Texas A&M Transportation Institute	$106,295

0-6868—Novel Material Systems for the Next Generation Flexible Pavement Structures

Start Date: 3/16/2015 End Date: 8/31/2016

Project Objectives

The Infrastructure Report Card published by the American Society of Civil Engineers indicates that US highway infrastructure is in need of a significant upgrade. The numerous challenges to fund such a mammoth undertaking are compounded by demands placed on the highway system from extreme climate patterns and the desire to develop highway systems that are more sustainable. On the other hand, this challenge provides an opportunity to develop a novel approach to design pavement systems and to integrate viable advanced technologies into the process. Researchers shall investigate and demonstrate novel material systems for flexible highway pavements that will be significantly more sustainable than what is used today, and will also provide longer performance life cycles that will help the bottom line. This is a multidisciplinary research effort executed by a diverse team of experts in chemical processing, molecular material simulation, construction process/cost engineering, sustainable life-cycle assessment, thermal systems, geotechnical engineering, and pavement engineering. Researchers shall evaluate factory precast asphalt concrete slabs containing embedded systems for feasibility in Phase I of the research and hope to implement them in a large scale laboratory setting in Phase II and in a field-scale setting in Phase III.

Project Manager

Chris Glancy, RTI

Project Supervisor

Sanjaya Senadheera, TECH

Total Project Budget	*Research University*	*FY 2016 Budget*
$1,532,332	Center for Multidisciplinary Research in Transportation, Texas Tech University	$935,896

0-6874—Develop Nondestructive Rapid Pavement Quality Assurance/Quality Control Evaluation Test Methods and Supporting Technology

Start Date: 4/23/2015 End Date: 8/31/2016

Project Objectives

Construction variability and isolated defects can be the limiting factors in a pavement's life. Ensuring quality construction of pavements currently uses small sample sizes, often missing defect areas. New innovations are needed to ensure attainment of specification requirements over the entire newly constructed pavement area while minimizing disruption to traffic. Researchers shall determine new innovative methods for characterizing pavement materials to ensure specification compliance using nondestructive technologies. Such technologies allow for minimal traffic disruption, an increased level of testing coverage, and the potential for increased pavement life.

Project Manager

Sonya Badgley, RTI

Project Supervisor

Stephen Sebesta, TTI

The research team shall research technologies to address elements of both flexible and rigid pavement construction. Researchers shall also verify the compacted material density and mechanical properties of a flexible base course using nondestructive testing and mechanical-based models. This project shall include rapid quality measurements during asphalt mixture compaction. This project shall include roller-based and post-compaction nondestructive tests to quantify roller compaction effort applied and evaluate final in-place density.

For rigid pavements, this project shall explore nondestructive techniques for evaluating effective curing of the concrete mixture. The focus elements included in this project, if demonstrated to be feasible and implementable, shall make assuring quality pavement construction more timely and reliable with minimal disruption to traffic

Total Project Budget	*Research University*	*FY 2016 Budget*
$1,191,206	Texas A&M Transportation Institute	$786,251

0-6878—Accelerating Innovation in Partnered Pavement Preservation

Start Date: 3/27/2015 End Date: 8/31/2019

Project Objectives

This project shall provide TxDOT with innovative highway pavement preservation materials, technologies, and procedures to provide a new platform for accelerating innovation in highway pavement preservation. The research results shall lead directly to their implementation. In each fiscal year of the project, pavement preservation needs shall be identified and prioritized for investigation. The research team shall select identified needs that shall be evaluated and addressed with a separate work plan, and the results shall be presented in an individual mid-fiscal year technical memorandum and end of fiscal year research report on an annual fiscal year basis. The technical memorandums and research reports shall include findings and recommendations that can support the implementation of the new guidelines or policies, as appropriate.

Project Manager

Wade Odell, RTI

Project Supervisor

Jorge Prozzi, CTR

Total Project Budget	*Research University*	*FY 2016 Budget*
$1,350,000	Center for Transportation Research, The University of Texas at Austin	$300,000

0-6880—Full Depth Reclamation in Maintenance Operations Using Emerging Technologies

Start Date: 7/24/2015 End Date: 1/31/2019

Project Objectives

As documented in the initial Project 0-6271, full depth recycling (FDR) is the main approach used all over Texas to rehabilitate thin roadways that are structurally damaged. In the FDR process, the existing surface and base materials are pulverized and mixed together and treated with a stabilizer. The type and amount of stabilizer to add is designed in the laboratory to provide sufficient strength and moisture resistance. The compacted treated base then receives a thin surfacing. This project shall identify and use these emerging FDR technologies in maintenance operations of districts to design and construct experimental sections with a range of new stabilizers, most notably cement slurries, foamed asphalt, and engineered emulsions. These sections shall typically be short distressed high profile roadways in TxDOT districts in which the research team can work with the TxDOT district lab and construction personnel to design, construct, and monitor the experimental FDR sections with these emerging technologies. Guidelines for using these emerging FDR technologies in maintenance operations shall also be developed.

Project Manager

Chris Glancy, RTI

Project Supervisor

Tom Scullion, TTI

Total Project Budget	*Research University*	*FY 2016 Budget*
$2,183,250	Texas A&M Transportation Institute	$383,372

0-6881—Recycled Engine Oil Bottoms and Polyphosphoric Acid in Texas Binders

Start Date: 9/1/2015 *End Date: 10/31/2017*

Project Objectives

In the past year, TxDOT has become increasingly aware that some binder modification activities have negatively impacted the performance of asphalt mixtures, and in turn, expected pavement life. Recent studies have documented the increased use of recycled engine oil bottoms (REOBs) and polyphosphoric acid (PPA) in Texas binders. In the last six months, REOBs have become a subject of national concern. Many state departments of transportation (DOTs) in the northeast have placed a complete ban on ROEBs' use in asphalt binders. This could be an over-reaction to the problems encountered since REOBs have been used in a small amount by the asphalt industry in the last 30 years. Thus, the key question is what is the maximum level of REOB and PPA that can be permitted without reducing performance?

Project Manager

Chris Glancy, RTI

Project Supervisor

Fujie Zhou, TTI

This is a critical study for TxDOT. Based on the problem statement and discussions at the pre-proposal meeting, the major project objectives of this study are:

1. Purchase handheld test equipment for accurately determining REOB and PPA content in the field and develop implementation recommendations.
2. Use control samples to develop test procedures and interpretation guidelines to accurately detect and quantify the levels of REOBs and PPA both in the laboratory and the field. Use a minimum of 50 combinations of different sources of asphalt binders and five different sources of REOBs.
3. Recommend maximum allowable level of REOBs for use in asphalt binders through evaluating the engineering properties of standard TxDOT mixes.
4. Conduct a study of the level of REOB currently used in hot applied seal coat binders in Texas.
5. Recommend a maximum allowable level of REOBs for use in hot applied seal coat binders through evaluating engineering properties of standard TxDOT seal coats.

Total Project Budget	*Research University*	*FY 2016 Budget*
$510,000	Texas A&M Transportation Institute	$295,000

0-6883—Compaction of Soils and Base Materials Using Superpave Gyratory Compactors

Start Date: 9/1/2015 *End Date: 8/31/2017*

Project Objectives

TxDOT employs impact hammer compaction in test procedures Tex-113-E and Tex-114-E to develop moisture-density relationships and fabricate specimens for strength testing. Although recent modifications to the test procedure enabled improvements in the precision of specimen molded moisture content and dry density, the precision of compressive strength remains a problem. This poor precision of compressive strength can result in conflicting test results regarding whether a material meets specification requirements, resulting in project delays and potentially large implications on the dollar value of a material source. This project shall use the Superpave gyratory compactor (SGC) to analyze whether SGC compaction enables improved precision of compressive strength tests for unbound materials; this project also shall examine use of the SGC in generation of moisture-density curves. Successful use of the SGC for soils and base materials will better represent field compaction in the lab, achieve more uniform compaction of test specimens, and most importantly reduce the variability of strength results.

Project Manager

Joe Adams, RTI

Project Supervisor

Stephen Sebesta, TTI

Total Project Budget	*Research University*	*FY 2016 Budget*
$449,601	Texas A&M Transportation Institute	$228,352

0-6888—Audible Lane Departure Warning for Seal Coat Surfaces

Start Date: 9/1/2015 *End Date: 4/30/2017*

Project Objectives

In an effort to reduce the number of single vehicle run-off-road and two-lane two-way crossover crashes, TxDOT has implemented various audible lane departure warning systems on seal coat road surfaces. These audible lane departure warning systems are typically profiled pavement markings but have recently included rumble bars. These countermeasures are typically used on seal coat road surfaces where milled rumble strips cannot be utilized or on roadways where shoulders are too narrow for milled rumble strips. While these treatments are mostly intended for seal coat road surfaces, they are being used on concrete and asphalt surfaces as well.

Project Manager

Joe Adams, RTI

Project Supervisor

Adam Pike, TTI

Currently, contractors and material producers are using slightly different designs to meet current specifications, which may yield varying levels of performance. Project plans are also calling for different spacing criteria and combinations of treatments. The effectiveness of these treatments from a cost/benefit, safety, increased wet-night visibility, sound level, and vibration level standpoint has not been thoroughly evaluated.

This research shall study the effectiveness of these treatments so that moving forward, the best system(s) can be implemented. Researchers shall study existing installations of these treatments to evaluate their performance. Researchers shall also design/develop and install new test areas to evaluate specific designs of these markings and bars that are not currently being used by TxDOT. These new test areas may change the size, spacing, materials, or other properties of the systems. Researchers shall also evaluate the sound and vibration performance of treatments after they have been seal coated over to determine if any performance is maintained after resurfacing.

This project shall gather information to evaluate the effectiveness of audible lane departure warning treatments by addressing the following objectives:

- What are the safety benefits?
- What is the delivered performance (sound, vibration, visibility)?
- What are the costs?
- What is (are) the best design(s)?

- When and where should audible lane departure warning treatments be implemented?
- What level of performance remains after the treatments are seal coated over?

Total Project Budget	*Research University*	*FY 2016 Budget*
$256,259	Texas A&M Transportation Institute	$156,679

0-6889—Rolling Density Meter to Ensure Long Term Performance of Flexible Pavements

Start Date: 9/1/2015 *End Date: 12/31/2017*

Project Objectives

Proper compaction of asphalt mixtures remains a key factor in achieving long term pavement performance. Traditional localized spot density tests provide little testing coverage, resulting in high producer and consumer risks; such testing also can miss localized defect areas, which eventually govern the pavement life. This project shall employ a rolling density meter to collect measurements at 6 inch spacing over newly constructed asphalt mixtures focusing on two applications: full lane testing coverage, and longitudinal joint density. With the advent of thin and ultra-thin mixtures, rolling density meter technology will provide much value since traditional coring can prove difficult with thin lifts. This project shall analyze the precision of the rolling density meter, perform an initial accuracy evaluation, and shadow test the rolling density meter on construction projects. Cores shall serve to provide reference values. For comparison, this project shall evaluate a new license-free non-nuclear density gauge and perform limited evaluation of an emerging 32-channel rolling density meter.

Project Manager

Joe Adams, RTI

Project Supervisor

Stephen Sebesta, TTI

Total Project Budget	*Research University*	*FY 2016 Budget*
$360,684	Texas A&M Transportation Institute	$146,803

0-6896—Developing a Surface Drainage Rating for Inclusion in TxDOT's Asset Management System

Start Date: 9/1/2015 *End Date: 8/31/2017*

Project Objectives

Drainage assets along the Texas roadway network play a pivotal role in its overall performance. These roadway and roadside assets are diverse, and the role each asset plays in a section's drainage is as diverse as the assets themselves. To develop a drainage rating system, elements such as cross-slope and ditch depth, along with restricted flow through a driveway pipe, provide just one example of drainage assets that must be considered in a rating. As the Moving Ahead for Progress in the 21st Century Act (MAP-21) pushes agencies toward comprehensive asset management, it is imperative to better understand and rate all assets. While MAP-21 only requires this for pavements and bridges, TxDOT is embarking on a proactive path as it seeks to capture its drainage assets and their current health. This shall be done by developing a drainage rating system aided by the collection of data through automated means. In a forward thinking move, TxDOT understands that laser scanning technology has evolved to a point where it can greatly assist in the collection of infrastructure data. The Texas A&M Transportation Institute (TTI) shall use its laser scanning data collector to not only develop a drainage rating system for the network level but also further evaluate automated collection techniques for use at the project level.

Project Manager

Joe Adams, RTI

Project Supervisor

Charles Gurganus, TTI

Total Project Budget	*Research University*	*FY 2016 Budget*
$341,294	Texas A&M Transportation Institute	$171,489

0-6903—Assess Deflection-Based Field Testing for Project Acceptance

Start Date: 1/16/2016 End Date: 7/31/2018

Project Objectives

TxDOT's current practice for field compaction quality control and acceptance for base, subbase, and soil layers is to determine the compacted density and sometimes moisture content by nuclear density gauge (NDG). TxDOT has also considered several stiffness-based devices to replace the NDG because stiffness parameters are more relevant to pavement design. Since spot tests cannot represent the uniformity of the compaction in a continuous manner, less stiff areas can be easily missed.

Project Manager

Sonya Badgley, RTI

Project Supervisor

Soheil Nazarian, UTEP

For design-build projects, an additional challenging step is the design verification. The current process based on laboratory resilient modulus tests is tedious and marginally representative of the in situ properties. Even though modulus-based nondestructive testing (e.g., with FWD, LWD, or DCP) can be conceptually considered as a straightforward solution to this problem, a recent NCHRP study has shown the level of detail that needs to be considered for obtaining meaningful values from the modulus-based devices. One cannot simply extrapolate the use of the FWD on existing roads to the design verification using FWD or other devices.

Our primary goal is to improve the process of design verification of compacted materials to ensure quality, performance, and durability using a combination of proof rolling (with or without intelligent compaction) and modulus-based devices. In close collaboration with our TxDOT partners, the researchers shall utilize their expertise gained from several recent and ongoing intelligent compaction projects and their involvement in an NCHRP project on the effective use of the modulus-based devices to develop practical test protocols and specifications to improve the design verification during construction.

Total Project Budget	*Research University*	*FY 2016 Budget*
$323,500	The University of Texas at El Paso	$60,000

0-6904—Develop New Methods for Material Acceptance on Design-Build Projects

Start Date: 1/1/2016 *End Date: 8/31/2017*

Project Objectives

The Federal Highway Administration (FHWA) has allowed state departments of transportation (DOTs) to use contractor material tests for acceptance, as long as they are validated by owner tests in accordance with FHWA Technical Advisory T6120.3, Use of Contractor Test Results in the Acceptance Decision, Recommended Quality Measures, and the Identification of Contractor/Department Risks, which is based on 23 CFR 637—Construction Inspection and Approval. On design-build projects, this process has led to a very complicated quality assurance program that requires contractor quality control and quality assurance (QC/QA) material testing laboratories and owner verification, independent assurance, and referee labs. The current process is time consuming, expensive, and reveals little about the quality of the product. This project shall expand on previous related work by the research team and:

Project Manager

Joe Adams, RTI

Project Supervisor

John Walewski, TTI

- Conduct a review of past and current studies for construction material acceptance.
- Identify current practices and innovative strategies or methods for construction material acceptance on design-build projects.
- Identify benefits, costs, and risks to highway agencies, contractors, and the traveling public for not having appropriate construction material acceptance on design-build projects.
- Evaluate the various strategies and methods for accepting materials on design-build projects based on risk and manpower limitations.
- Develop new strategies or methods for construction materials acceptance on design-build projects.
- Incorporate the results of this project into TxDOT's process on material acceptance and the training of project managers and other staff.
- Conduct a Material Acceptance for Design-Build Enhancement Workshop to facilitate implementation of research results.

Total Project Budget	*Research University*	*FY 2016 Budget*
$305,433	Texas A&M Transportation Institute	$141,781

0-6906—Chemical Solutions to Concrete Durability Problems

Start Date: 1/1/2016 ***End Date: 12/31/2018***

Project Objectives

The state of Texas has been plagued by various durability-related issues in recent years, including deterioration from alkali-silica reaction, delayed ettringite formation, corrosion of reinforcing steel, and volume changes (plastic shrinkage, drying shrinkage, thermal effects, etc.), just to name a few. These durability-related issues, coupled with other factors, contribute to reductions in service life (e.g., service loads and defects). For many of these problems, fly ash (primarily Class F) has been the remedy of choice; however, with changes in fly ash quality and quantity spurred by new emissions standards, there is a major concern that fly ash will not be able to fill these needs in the long term. The goal of this project is to evaluate chemical alternatives to fly ash, such as the use of chemical admixtures aimed at specifically improving concrete durability.

Project Manager

Chris Glancy, RTI

Project Supervisor

Kevin Folliard, CTR

Total Project Budget	*Research University*	*FY 2016 Budget*
$498,500	Center for Transportation Research, The University of Texas at Austin	$119,166

0-6908—Comparative Analysis of Tack Coat, Underseal Membrane, and Underseal Technologies

Start Date: 1/1/2016 *End Date: 1/31/2018*

Project Objectives

Several options are available for preparing a surface prior to an asphalt overlay. These include traditional tack coats, non-tracking tack coats, thicker spray-applied underseal membranes, and traditional underseals. Tack coats, with a shot rate between 0.04 and 0.14 gallon (gal)/square yard (sy), are expected to provide better bonding. Underseal membranes (0.13–0.3 gal/sy) and underseals (>0.3 gal/sy with rock) are expected to reduce moisture infiltration and reflective cracking. However, these benefits have not been sufficiently quantified, and neither has an overall impact on the asphalt overlay service life. Some of these approaches can have considerably higher costs of materials and equipment. Currently, it is unknown whether the added benefits of these technologies (potentially longer service life) result in cost savings to TxDOT.

Project Manager

Sonya Badgley, RTI

Project Supervisor

Bryan Wilson, TTI

The objective of this study is to evaluate the performance of asphalt overlays achieved with different tacking and sealing technologies, namely:

- Traditional tack coats.
- Non-tracking tack coats.
- Underseal membranes from a spray paver.
- Traditional underseals.

In the work plan, the research team shall evaluate each technology with respect to:

1. Layer bonding.
2. Sealing against moisture.
3. Resistance to reflection cracking.
4. General overlay condition.

Total Project Budget	*Research University*	*FY 2016 Budget*
$405,803	Texas A&M Transportation Institute	$129,966

0-6910—Development of Proper Overlay Type and Designs for PCC Pavement

Start Date: 1/1/2016 *End Date: 2/28/2018*

Project Objectives

Currently, guidelines on Portland cement concrete (PCC) pavement overlay on PCC pavement are more focused on overlay slab thickness determination for mostly jointed concrete pavement (CPCD), but do not provide clear directions on (1) whether existing PCC pavement is a good candidate for concrete overlay, or (2) if it is, which overlay type—bonded concrete overlay (BCO) or unbonded concrete overlay (UBCO)—is appropriate. This deficiency in currently available guidelines is primarily due to insufficient information on the structural responses and performance of PCC overlays built on PCC pavements at various structural conditions. Very few existing design guidelines address CRCP overlays because other states have not built CRCP as much as Texas has. As of 2014, TxDOT manages a total of 17,300 lane miles of PCC pavement, which represents an important asset to TxDOT. As PCC pavements in Texas built in the 1960s through 1980s have already exceeded or are approaching the end of their design lives, many of these projects will require rehabilitations in one form or another. This is especially true for the projects built prior to 1986, when TxDOT changed the pavement design period from 20 to 30 years. Those projects built or designed prior to 1986 have a deficiency in slab thickness from today's truck traffic volumes. Sound guidelines are needed for the selection of an optimum overlay type, especially for CRCP overlays, which could extend the performance period of structurally deficient PCC pavements in Texas at a reasonable cost.

Project Manager

Sonya Badgley, RTI

Project Supervisor

Moon Won, TECH

Total Project Budget	*Research University*	*FY 2016 Budget*
$271,633	Center for Multidisciplinary Research in Transportation, Texas Tech University	$76,332

0-6921—Use of Lasers for Laboratory Measurements of Aggregate Shape, Angularity, and Texture

Start Date: 1/1/2016 *End Date: 12/31/2017*

Project Objectives

Aggregate shape, texture, and angularity are considered crucial for the development of high quality adhesive systems with asphalt binder, and a good quality aggregate skeleton in asphalt and concrete mixtures. These properties are currently measured using the aggregate image measurement system (AIMS), which is based on analyzing images of aggregate samples taken with a digital camera to determine aggregate shape, angularity, and texture. TxDOT owns and operates the current camera-based imaging system. However, the current system may provide misleading results when scanning aggregates of dissimilar surface color. This shortcoming is significant because it may lead to erroneous rankings of materials. In practice, texture measurements are commonly made using lasers for in-service pavements, and for specimens compacted in the laboratory or taken from field sections. Indeed, specifications used in practice to measure texture are based on laser measurements. There is a need to investigate the application of these optical sensors for measuring aggregate profiles to determine shape, angularity, and texture, and to compare these measurements with those from the AIMS and from other advanced scanning techniques to improve the current image analysis method.

Project Manager

Joe Adams, RTI

Project Supervisor

Roger Walker, UTA

Total Project Budget	*Research University*	*FY 2016 Budget*
$665,573	The University of Texas at Arlington	$112,699
	Texas A&M Transportation Institute	$184,700

5-4687-03—Implementing Rubblization Techniques on Severely Distressed Concrete Pavements

Start Date: 9/1/2015 *End Date: 8/31/2018*

Project Objectives

One major pavement rehabilitation problem in Texas and across the United States is how to economically repair jointed concrete pavements (JCPs) that have substantially exceeded their design life and are currently in very poor condition. These roadways are often very rough and have multiple joint failures and broken slabs. TxDOT Study 0-4687, "Rubblization and Crack and Seat as Major Rehabilitation for Concrete Pavements," evaluated the potential for using the rubblization process, which has shown promise in other states.

Project Manager

Joe Adams, RTI

Project Supervisor

Tom Scullion, TTI

Rubblization is a unique means of rehabilitating concrete pavements by in-place conversion of the old concrete pavement into a useable base. Rubblization employs machinery that will break apart the concrete in place and leave pieces small enough that reflective cracking problems are significantly reduced or eliminated. Study 0-4687 developed a series of field investigation techniques that will be performed to evaluate any project's suitability for rubblization. It followed both the construction and performance evaluations of two rubblization projects in Texas. Based on these experiences, Study 0-4687 developed a non-invasive field test procedure to evaluate projects to determine if there is adequate support for rubblization, identified methodologies for detecting subsurface water that must be removed by means of retrofitted edge drains, developed thickness design procedures for rubblization projects, and construction specification appropriate for Texas conditions.

JCPs were very popular in Texas up to the late 1960s when the move to continuously reinforced pavements was accelerated. Consequently, many of the remaining JCPs are currently 40 to 50 years old and are buried beneath thin hot mix asphalt (HMA) layers. Most districts have several miles of these pavements, and many in the Paris, Dallas, Childress, and Beaumont Districts are still in service on major roadways. The study shall not be restricted to jointed pavements; consideration shall be given to sections of continuously reinforced concrete pavement (CRCP) that have reached the end of their design lives.

The purpose of this implementation project is to implement the findings of Project 0-4687. Two test sections shall be constructed as part of this study. The first shall be on a heavily damaged section of US 75 in the Paris District. The techniques in 0-4687 shall be used to design, construct, and monitor a test section on this

roadway. In this rehabilitation effort, all efforts shall be made to minimize inconvenience to the traveling public; where needed, construction activities shall only occur at night. At least three other districts shall participate in this study to determine if rubblization is an appropriate treatment for sections of JCP in their district. A second test section shall be constructed in one of the other districts.

Training schools shall be developed and taught in a minimum of four districts. The results shall be available for presentation at the TxDOT Annual Construction and Maintenance Conference. Rubblization techniques have been used with great success in Louisiana and Arkansas. It has been claimed that rubblization costs one-half as much as full reconstruction and takes less than one-third of the time. A recent project in New Jersey of an 11 mile section of badly distressed pavement was completed in 57 days when rubblization and innovative construction incentives were employed. These types of savings in time and money can be realized here in Texas.

Total Project Budget	*Research University*	*FY 2016 Budget*
$442,000	Texas A&M Transportation Institute	$162,000

5-4829-03—Implementation of Geosynthetic-Reinforced Unbound Base Courses

Start Date: 8/28/2014 End Date: 8/31/2017

Project Objectives

This project shall establish material specifications for geosynthetics used to reinforce unbound base courses, particularly for those placed on subgrades comprised of expansive clays. This project includes the following: (1) producing material property data using the small pullout equipment developed in 0-4829 to establish specifications, (2) collecting field performance data to establish limits of acceptable material property values, (3) developing guidance documents for proper selection and inspection, and (4) providing support and training to TxDOT personnel for the use of geosynthetic-reinforced pavements.

Project Manager

Joe Adams, RTI

Project Supervisor

Jorge Zornberg, CTR

Total Project Budget	*Research University*	*FY 2016 Budget*
$496,976	Center for Transportation Research, The University of Texas at Austin	$165,874

5-5598-05—Continued Implementation of High Performance Thin Overlays in Texas Districts

Start Date: 2/19/2014 End Date: 8/31/2016

Project Objectives

Under Research Project 0-5598, guidelines and specifications were developed on how a district could design and construct long life overlays using the concept of the balance mix design. The purpose of this project is to expand the implementation of high performance thin overlays to the Paris, Houston, and Odessa Districts. A series of sections shall be designed and constructed in each of the three districts. Training materials and specifications shall be updated, and workshops shall be conducted to widely distribute the implementation results. Additionally, the results shall be available for presentation at the TxDOT Annual Construction and Maintenance Conference

Project Manager

Joe Adams, RTI

Project Supervisor

Tom Scullion, TTI

Total Project Budget	*Research University*	*FY 2016 Budget*
$210,000	Texas A&M Transportation Institute	$120,000

5-6048-03—Implementation of Centrifuge Technology for Pavement Design on Expansive Clays

Start Date: 10/23/2013 End Date: 8/31/2016

Project Objectives

The overall objective of this implementation project is to capitalize on the successful centrifuge characterization of expansive clays by implementing these data into a pavement design approach. The specific objectives of this project include (1) implementing the use of undisturbed expansive clay samples into the centrifuge testing environment to allow field testing of clay specimens collected directly in project sites, (2) extending the generation of swell data to the locations of multiple additional projects in the Austin District, (3) implementing a field monitoring program involving the long-term quantification of vertical raise and associated changes in soil moisture, (4) incorporating the centrifuge swell test results into the current PVR design methodology and demonstrating it using field monitoring data, and (5) developing a training program suitable to all TxDOT engineers.

Project Manager

Joe Adams, RTI

Project Supervisor

Jorge Zornberg, CTR

Total Project Budget	*Research University*	*FY 2016 Budget*
$426,446	Center for Transportation Research, The University of Texas at Austin	$150,581

5-6271-03—Using Small Sample Sizes in Full Depth Reclamation (FDR) Laboratory Mix Designs

Start Date: 7/11/2014 End Date: 8/31/2016

Project Objectives

Currently, single laboratory full depth reclamation (FDR) design takes 300–400 lb of existing highway material for sampling, leaving patches requiring future maintenance. It also limits the ability to perform dual stabilizer treatments and test multiple locations. Additionally, the current test methods for a single design take a significant period of time to complete (1 month in some situations). This project shall utilize small sample test procedures on planned FDR projects to demonstrate that these procedures can remedy the previously mentioned issues and provide results that meet specifications. Additionally, the new procedures allow for readily available TxDOT owner equipment to be used, eliminating the need for major equipment expenditures.

Project Manager

Joe Adams, RTI

Project Supervisor

Tom Scullion, TTI

Total Project Budget	*Research University*	*FY 2016 Budget*
$135,000	Texas A&M Transportation Institute	$40,000

5-6271-05—Implementing Full Depth Reclamation (FDR) to Repair Roads Damaged in the Energy Sector

Start Date: 8/28/2014 End Date: 8/31/2017

Project Objectives

The purpose of this implementation project is to provide districts impacted by the energy sector with clear guidelines on how to take existing roadways through the FDR process to make long lasting, structurally adequate roadways able to carry overloaded vehicles. A minimum of five test sections shall be built in different districts around Texas. Workshops shall be developed and taught in a minimum of four districts. The results shall also be available for presentation at the TxDOT Annual Construction and Maintenance Conference.

Project Manager

Joe Adams, RTI

Project Supervisor

Tom Scullion, TTI

Total Project Budget	*Research University*	*FY 2016 Budget*
$922,000	Texas A&M Transportation Institute	$350,000

5-6610-01—Implementation of Defect Correction Assessment Methodology on TxDOT Ride Quality Projects

Start Date: 6/22/2015 End Date: 6/30/2017

Project Objectives

Project 0-6610, "Impact of Changes in Profile Measurement Technology on QA Testing of Pavement Smoothness," which terminated August 31, 2013, developed a defect correction index (DCI) based on correlating defect characteristics to the need for corrections using data from bump rating panel surveys. The researchers shall conduct a pilot implementation of the defect correction assessment methodology from Project 0-6610 to verify the methodology on TxDOT projects, introduce refinements as needed, automate the methodology for practical applications, and provide training. Implementation shall provide consistency in quality assurance testing of pavement smoothness. In addition, this can be used to assess the need for corrective treatments on existing pavements to consider improvements in ride quality, among other factors, when planning rehabilitation projects.

Project Manager

Joe Adams, RTI

Project Supervisor

Emmanuel Fernando, TTI

Total Project Budget	*Research University*	*FY 2016 Budget*
$272,018	Texas A&M Transportation Institute	$111,249

5-6614-01—Implementation of RAS Best Practices and Piloting Rejuvenators in Key Districts

Start Date: 8/22/2014 End Date: 8/31/2017

Project Objectives

Under Research Project 0-6614, researchers developed a best practices guide for processing, mix design, production, and construction of mixes using recycled asphalt shingles (RAS) 6902.

Additionally, researchers identified three rejuvenators that improve cracking resistance and performance, cost less, and preserve the environment.

The purpose of this implementation project is to demonstrate the benefits of the three rejuvenators in key TxDOT districts and to develop and present training workshop materials in four TxDOT regions.

Project Manager

Joe Adams, RTI

Project Supervisor

Fujie Zhou, TTI

Total Project Budget	*Research University*	*FY 2016 Budget*
$220,000	Texas A&M Transportation Institute	$90,000

5-6616-01—Statewide Implementation of the Surface Performance-Graded (SPG) Specification for Seal Coat Binders in Service

Start Date: 10/8/2013 End Date: 8/31/2017

Project Objectives

A surface performance-graded (SPG) specification for seal coat binders in service was developed and validated in TxDOT Research Projects 0-1710 and 0-6616 using binder properties measured in the laboratory and visual performances of 75 highway sections. This project shall implement the SPG specification statewide through adoption of the SPG specification and associated emulsion residue recovery method by TxDOT. Technical briefings shall be provided to TxDOT and industry to complement the technical memos, products, and technical report. Additional education efforts include a revised chapter of the Seal Coat Manual and Seal Coat Short Course. Also, the results shall be summarized in journal and conference publications and presentations to the Emulsion Task Force of the FHWA Perpetual Pavement Expert Task Group to aid in national adoption.

Project Manager

Joe Adams, RTI

Project Supervisor

Amy Epps Martin, TTI

Total Project Budget	*Research University*	*FY 2016 Budget*
$652,500	Texas A&M Transportation Institute	$155,198

5-6618-01—Mitigation of High Sulfate Soils in Texas

Start Date: 9/5/2014 *End Date: 10/31/2016*

Project Objectives

This project shall demonstrate two new treatment methods to mitigate high sulfate-induced soil heave on US 82 in the Paris District. Three test sections consisting of one control and two test sections were constructed on US 82 near Bells in Grayson County. The control section (Test Section 3) consists of lime treated soil in normal practice. The other two sections (Test Sections 1 and 2) are lime fly ash treated and lime treated sections. Both sections were constructed with an extended mellowing period of 7 days. Many districts have to partially or completely rehabilitate these pavements built on high sulfate soils within a few months to three to four years after original construction; in many cases, the repairs will include a complete restoration of the pavement lanes for several miles, which can be translated to losses of entire pavement infrastructure for those miles of pavement.

Project Manager

Joe Adams, RTI

Project Supervisor

Anand Puppala, UTA

Total Project Budget	*Research University*	*FY 2016 Budget*
$150,208	The University of Texas at Arlington	$75,111

5-6622-01—Field Implementation of the Texas Mechanistic-Empirical Pavement Design Process in Six TxDOT Districts

Start Date: 4/23/2015 End Date: 8/31/2018

Project Objectives

The purpose of this project is to expedite the implementation of the Texas Mechanistic-Empirical (TxME) Pavement Design Program recently developed in Project 0-6622—Implementation of a Texas Mechanistic-Empirical Thickness Design System (TexME)—completed in August 2013. This new system provides more realistic and longer lasting pavement designs. This project shall familiarize the districts with the complete ME design process that entails enhanced material inputs, as well as enhanced traffic, climate, and reliability inputs. Additionally, it shall demonstrate the advantages of using enhanced design inputs to show variations in performance life when premium materials, load spectrum, and local climate data are used. Researchers shall use these experiences to develop training workshop materials and present a pilot training workshop to the project team and the six selected districts incorporating the enhanced training materials.

Project Manager

Joe Adams, RTI

Project Supervisor

Sheng Hu, TTI

Total Project Budget	*Research University*	*FY 2016 Budget*
$392,350	Texas A&M Transportation Institute	$88,071

5-6717-01—Implementation: Investigation of Alternative Supplementary Cementing Materials (SCMs)

Start Date: 9/1/2015 ***End Date: 8/31/2017***

Project Objectives

Supplementary cementing materials (SCMs) provide many benefits to concrete mixtures in terms of cost, long-term strength, and durability. Class F fly ash is the most widely used SCM in Texas, but its availability is dwindling. Given the importance of Class F fly ash as a means to improve concrete durability, it is important to find alternative materials that can maintain the high quality and durability of concrete in Texas. TxDOT Project 0-6717 identified sources of Class F fly ash alternatives that can be used in Texas concrete and developed best practices in testing these materials. New, lower cost sources of SCMs have become available that cannot be implemented in Texas concrete without testing. These materials present even better opportunities for Class F fly ash replacement than those initially tested due to their higher availability and lower cost. Implementation of the experimental protocols developed in Project 0-6717 on these new materials shall facilitate their use in Texas concrete. The work in this implementation project aims to (1) procure additional Class F fly ash alternatives not tested in the original project, including natural pozzolans, industrial byproducts, and reclaimed and remediated fly ashes; (2) chemically and physically characterize the materials; (3) determine optimum dosage amounts based on workability, reactivity/strength, and durability; (4) test performance in concrete mixtures; and (5) make recommendations regarding their suitability for use in Texas. The testing shall follow the recommendations from the original project, with attention paid in particular to workability, admixture interaction, early and long-term strength, and resistance to alkali silica reaction and sulfate attack.

Project Manager

Joe Adams, RTI

Project Supervisor

Maria Juenger, CTR

Total Project Budget	*Research University*	*FY 2016 Budget*
$315,402	Center for Transportation Research, The University of Texas at Austin	$156,971

5-6740-01—Implementation of Intelligent Compaction Technology for Improving Compaction Quality of Soil and Base in Texas

Start Date: 7/2/2014 ***End Date: 6/30/2017***

Project Objectives

The main objective of this project is to capitalize on the new intelligent compaction (IC) specification for implementation of IC technology developed through TxDOT Research Project 0-6740. The specific objectives of this project include (1) developing and deploying a training program for TxDOT engineers and inspectors, (2) supporting the districts in implementing the IC technology in their districts, (3) implementing a field monitoring program to quantify the long-term benefits of the IC technology, and (4) assisting the CST in evaluating and incorporating the new IC specification for inclusion in the new specification book.

Project Manager

Joe Adams, RTI

Project Supervisor

Soheil Nazarian, UTEP

Total Project Budget	*Research University*	*FY 2016 Budget*
$450,000	The University of Texas at El Paso	$167,000

5-6744-01—Implementation of the HMA Shear Test for Routine Mix Design and Screening

Start Date: 8/14/2015 End Date: 8/31/2018

Project Objectives

In Texas, rutting or permanent deformation continues to be a flexible pavement failure mode of concern. TxDOT Research Project 0-6744: New HMA Shear Resistance and Rutting Test for Texas Mixes proposed several key modifications to the testing protocols in the view of improving their ability to simulate field rutting conditions. In this project, the researchers shall perform the following objectives:

Project Manager

Joe Adams, RTI

Project Supervisor

Lubinda Walubita, TTI

1. Assist districts with routine mix-design screening and HMA shear strength testing.
2. Conduct a pilot implementation of the findings of Project 0-6744, assisting with HMA mix designs and mix screening using the new testing protocols.
3. Verify and refine the test procedures with field performance data from in-service highway test sections.

Total Project Budget	*Research University*	*FY 2016 Budget*
$404,044	Texas A&M Transportation Institute	$140,693

5-9046-03—Pre-construction and Next Generation Concrete Surface (NGCS) Noise Monitoring on US290 in Harris County

Start Date: 8/15/2014 End Date: 8/31/2016

Project Objectives

The main objective of this project is to demonstrate the effectiveness of next generation concrete surfaces in reducing pavement noise and improving skid resistivity and texture. The project includes analyzing data before and after construction/rehabilitation transversally tinned concrete pavement sections on US 290 in the Houston District. The project results shall be conveyed in the form of technical memos and reports and shall serve as a template for future next generation concrete surface projects.

Project Manager

Joe Adams, RTI

Project Supervisor

Joe Weissman, UTSA

Total Project Budget	*Research University*	*FY 2016 Budget*
$118,992	The University of Texas at San Antonio	$39,000

Strategy and Innovation

Project	Title	Start Date	Page
0-6837	Assessment of Innovative and Automated Freight Systems and Development of Evaluation Tools	1/30/2015	70
0-6838	Bringing Smart Transport to Texans: Ensuring the Benefit of a Connected and Autonomous Transport System in Texas	1/16/2015	71
0-6869	Advancing Innovative High-Speed Remote-Sensing Highway Infrastructure Assessment Using Emerging Technologies	3/10/2015	72
0-6871	Phase I: Development of Highway Sensing and Energy Conversion (HiSEC) Modules for Generating Power	3/17/2015	74
0-6873	True Road Surface Deflection Measuring Device	4/8/2015	76
0-6875	Automated and Connected Vehicle (AV/CV) Test Bed to Improve Transit, Bicycle, and Pedestrian Safety	4/21/2015	77
0-6902	Texas Technology Task Force	11/24/2015	78

0-6837—Assessment of Innovative and Automated Freight Systems and Development of Evaluation Tools

Start Date: 1/30/2015 End Date: 3/31/2016

Project Objectives

Many innovative and automated freight delivery strategies and technologies have been proposed to address the future freight needs of Texas' growing population. TxDOT and local transportation planners need to evaluate operational changes or technology applications to ensure continued, timely flow of commercial freight through the Texas transportation system. Emerging freight delivery technologies, such as automated freight vehicles or airborne small package delivery, and innovative operational freight strategies, such as nighttime off-peak hour deliveries or conversion of managed lanes to truck-only use during high port traffic periods, are potential ways to better use existing infrastructure. Changes in buying habits of consumer goods toward direct home package delivery also could dramatically shift distribution patterns and increase the number of intercity and local delivery trucks on TxDOT roadways.

Project Manager

Wade Odell, RTI

Project Supervisor

Curtis Morgan, TTI

The primary objective of this project is to establish a process to evaluate freight operational changes or technology applications in order to ensure continued timely flow of commercial freight through the Texas transportation system. This project shall develop and adapt the necessary evaluation metrics for future use. This project shall also assess several currently proposed freight strategies and technologies to determine which of these should be further evaluated for implementation on the Texas transportation system in future project phases.

Total Project Budget	*Research University*	*FY 2016 Budget*
$517,892	Texas A&M Transportation Institute	$129,600

0-6838—Bringing Smart Transport to Texans: Ensuring the Benefit of a Connected and Autonomous Transport System in Texas

Start Date: 1/16/2015 End Date: 6/30/2016

Project Objectives

This project shall develop and demonstrate a variety of smart-transport technologies and practices for Texas highways and freeways using automated vehicles (AVs), connected vehicles (CV5), smartphone, and related technologies, as well as TxDOT's Lonestar statewide software. The work's products shall enable more efficient intersection, ramp, and weaving section operations for connected and autonomous vehicle (CAV) operations, alongside a suite of behavioral and traffic-flow forecasts for Texas regions and networks under a variety of vehicle mixes (smartphone, conventional, semi-autonomous vs. fully autonomous, connected but not automated). The work shall develop and facilitate rigorous benefit-cost assessments of multiple strategies that TxDOT may pursue to bring smarter, safer, more connected, and more sustainable ground transportation systems to Texas, in concert with auto manufacturers, technologists, and the traveling public. The effort shall also support proactive policymaking on vehicle/occupant licensing, liability, and privacy standards, as technologies become available and travel behaviors change.

Project Manager

Darrin Jensen, RTI

Project Supervisor

Kara Kockelman, CTR

The project's Phase 1 demonstrations shall showcase Texas' 12-mile dedicated short range communication (DSRC)-instrumented highway in San Antonio for application of driver alerts, road-surface conditions, and traffic flow monitoring, as well as vehicle guidance (using inexpensive inertial measurement units and heads-up displays in CV5). The research team's innovative pod approach allows equipment to be moved between vehicles. Phase 1 shall include regional and statewide behavioral forecasts (for vehicle choices, vehicle-miles traveled [VMT], and traveler benefits, by location) and simulations/optimizations of smart ramp merge and smart intersection operations, under thousands of case settings, with calculated delay reductions, fuel savings, safety impacts, and emissions benefits.

Total Project Budget	*Research University*	*FY 2016 Budget*
$1,494,655	Center for Transportation Research, The University of Texas at Austin	$796,232

0-6869—Advancing Innovative High-Speed Remote-Sensing Highway Infrastructure Assessment Using Emerging Technologies

Start Date: 3/10/2015 End Date: 8/31/2016

Project Objectives

Asset management is a strategic approach to the optimal allocation of resources for the management, operation, maintenance, and preservation of transportation infrastructure. Asset management combines engineering and economic principles with sound business practices to support decision making at the strategic, network, and project levels.

Project Manager

Chris Glancy, RTI

Project Supervisor

Paul Carlson, TTI

One of the key aspects of the development of asset management is data collection. The way in which transportation agencies collect, store, and analyze data has evolved along with advances in technology, such as mobile computing (e.g., laptops, tablets), sensing (e.g., laser and digital cameras), and spatial technologies (e.g., global positioning systems [GPSs], geographic information systems [GISs], and spatially enabled database management systems). These technologies have enhanced the data collection and integration procedures necessary to support the comprehensive analyses and evaluation processes needed for asset management.

Data collection is costly. In determining what data to collect, agencies must weigh these costs against the potential benefits from better data. Traditional pavement and bridge management approaches are data intensive, requiring extensive data collection activities of most or all pavement and bridge assets on an annual or biannual basis. These efforts can be justified given the cost of agencies' pavement and bridge programs. However, depending on the level of technology needed and the associated costs, it may be difficult to justify similarly extensive data collection efforts for safety and operation assets.

While many of the technology innovations and improved data collection processes have been in the bridges and pavements area, there are emerging technologies in the safety and operations infrastructure areas that have yet to be applied to the transportation space. These technologies are driving the costs and efficiencies to the point that makes good sense in terms of the tradeoffs between fiscal responsibilities and advantages of having the data. Therefore, while this research covers all highway infrastructure areas, it includes an emphasis on technologies to assess safety and operations infrastructure. Ultimately, through the three-phased approach, the research shall bundle the best technologies that maximize sensors and computing

power in an effort to achieve the vision of one day having an all-in-one data collection system for infrastructure assessment. Initially, the focus shall be on highways, but it could be expanded to include other modes of transportation such as rail, air, and even maritime.

Total Project Budget	*Research University*	*FY 2016 Budget*
$1,735,671	Texas A&M Transportation Institute	$768,405

0-6871—Phase 1: Development of Highway Sensing and Energy Conversion (HiSEC) Modules for Generating Power

Start Date: 3/17/2015 End Date: 8/31/2016

Project Objectives

The transportation infrastructure serves a critical societal need to rapidly move goods and people across the nation. Using this infrastructure as a source of renewable energy by harvesting it from the roadway is a relatively novel idea that has not been fully explored yet. This project is aimed at exploring energy harvesting from the roadway infrastructure and harnessing it to generate electrical power. Millions of lane miles subjected to solar heat and vibrations, combined with repeated strains under normal working conditions, make the roadway infrastructure a very good candidate for energy harvesting. This energy can be transformed using efficient systems into usable electrical power.

Project Manager

Chris Glancy, RTI

Project Supervisor

Samer Dessouky, UTSA

Piezoelectric systems have shown promise for use in energy harvesting. The loads due to passing vehicles generate stresses that can activate these systems. High forces and dynamic motions by vehicles create a stream of impulses to the road structure that can be harnessed by road-embedded piezoelectric sensors to generate electric power. Incorporating these systems in pavement as energy harvesters is a challenging problem that has yet to be studied. Massive amounts of mechanical energy are wasted when millions of vehicles are moving on roadways. The piezoelectric systems can harvest that energy, feed it to the power grid, or save it in roadside batteries and utilize it to charge electric cars or power roadside or traffic lights. Furthermore, changes in the response of these sensors with time can be used as a means of monitoring the health of the pavement layers, where these sensors are installed.

Researchers shall develop piezoelectric systems to harvest useable energy from roadways. These systems also provide continuous monitoring of the roadways' conditions since they are embedded in flexible pavement layers. This monitoring shall provide engineering data to assist in identifying the need for maintenance. The monitoring can also enable a "smart" road by potentially gathering real-time information on vehicle weight, speed, and traffic volume. The proposed systems can be placed under asphalt layers during regularly scheduled repaving and would not affect the vehicles traveling on the road, in terms of "road feel," fuel efficiency, or emissions. These systems can also be embedded under rail tracks and runways, providing real-time information on the health conditions of these structures and hence improve traveler safety.

This project shall deliver a novel roadway energy harvesting system with the capabilities of storing electrical energy and also serve as an infrastructure monitoring mechanism. The outcome of this project shall assist TxDOT in overcoming the challenges of a rapidly growing population and declining fuel tax revenues.

The research team has multidisciplinary expertise covering material science, electronic systems, and mechanical and civil engineering. They shall develop piezoelectric systems and investigate the potential benefits and the feasibility of using these systems to (a) harvest energy to generate useful power, (b) monitor and diagnose roadway conditions, and (c) collect real-time traffic data.

Total Project Budget	*Research University*	*FY 2016 Budget*
$1,320,583	The University of Texas at San Antonio	$454,721
	Texas A&M Transportation Institute	$155,434

0-6873—True Road Surface Deflection Measuring Device

Start Date: 4/8/2015 ***End Date: 8/31/2016***

Project Objectives

The high-speed measurement of accurate pavement surface deflections under a moving wheel on the Texas roadway network (network level) remains a challenge in pavement engineering. This goal cannot be accomplished with stationary deflection-measuring devices, such as the falling weight deflectometer (FWD); nor with slow-moving (< 2 mph) and discontinuous profiling, such as the LaCroix deflectograph; nor with slow-moving (< 3 mph) but continuous profiling devices, such as the rolling dynamic deflectometer (RDD) or total pavement acceptance device (TPAD). Today, network level studies of pavement structure are being performed with three moving devices: the curviameter, which travels at about I l mph and employs stationary geophones to continuously measure pavement deflections, and the rolling wheel deflectometer (RWD) and traffic speed deflectometer (TSD), which travel at 40 mph to 60 mph and use laser-based sensors to continuously measure pavement deflections. The major limitation with the RWD and TSD is the lack of accurate measurements due to pavement texture and roughness, which leads to determination of average deflections over 50 ft. or more. That is, no true deflection is measured at any point; it is only an indicative measurement. The measurement accuracy of the curviameter is high, but the complexity of the continuous chain mechanism to locate the geophones inhibits improvements in testing speed and continuity of measurements. The work conducted in this research project shall be for Phase 1 only. The research team shall develop in this Phase I a device for measuring true surface deflections at the network level. The development of this device is based on extensive experience of the research team with non-destructive testing (NDT) technologies and also on recent advances over the past several decades in sensor technologies that can be applied to continuous deflection measurements. These advances include the developments of low-frequency accelerometers and wireless Bluetooth technology. Pavement deflections under a fully loaded full-scale axle shall be measured by sensors that are wireless and stationary on the pavement. This shall eliminate the negative effects of pavement texture and roughness, and permit accurate measurements.

Project Manager

Wade Odell, RTI

Project Supervisor

Jorge Prozzi, CTR

Total Project Budget	*Research University*	*FY 2016 Budget*
$948,124	Center for Transportation Research, The University of Texas at Austin	$458,623

0-6875—Automated and Connected Vehicle (AV/CV) Test Bed to Improve Transit, Bicycle, and Pedestrian Safety

Start Date: 4/21/2015 End Date: 4/30/2016

Project Objectives

Pedestrians and bicyclists represent a considerable portion of traffic injuries and deaths in the United States. In 2012, 4,743 pedestrians died in traffic crashes—a 6 percent increase from the number reported in 20l l. In 2012, 726 cyclists were killed, and an additional 49,000 were injured in motor vehicle traffic crashes. In Texas, one of the most frequent crash types at Dallas Area Rapid Transit crossings involves bicyclists and pedestrians. Currently available automated technologies in passenger vehicles can be integrated into transit vehicles to help reduce these crashes by automating human tasks. Researchers shall design and develop a concept-of-operations document to operate near-term applications at a transit, bicycle, and pedestrian test bed. The purpose of the test bed is to demonstrate and evaluate automated and connected vehicle (AV/CV) and infrastructure hardware and applications in a controlled environment to improve transit, bicycle, and pedestrian safety. This project shall enhance and inform those efforts by focusing on AV/CV applications that address safety for others.

Project Manager

Wade Odell, RTI

Project Supervisor

Katherine Turnbull, TTI

Total Project Budget	*Research University*	*FY 2016 Budget*
$504,500	Texas A&M Transportation Institute	$207,800

0-6902—Texas Technology Task Force

Start Date: 11/24/2015 End Date: 8/31/2018

Project Objectives

The Texas Technology Task Force (TTTF) was formed in 2013, encompassing a group of professionals with expertise from areas such as information and communications technologies, telematics, computing, economic and legal, public relations, and various emerging transportation technologies. The first three meetings of the TTTF took place during Phase 1 of work in the contract period for TxDOT Research Project 0-6803 and were held in Austin, Texas, from February 2013 through August 2013. These meetings focused on identifying new, transformational technologies that have potential to drastically change transport in Texas in the mid-to-long term. Work completed by the research team during this period resulted in the development and implementation of an evaluation framework for categorizing and selecting groups of emerging technologies for development and promotion. The second phase of TTTF of work under TxDOT Research Project 0-6803 took place from September 2013 through December 2013 and resulted in initial background work for the establishment of the Strategic Technology Business Plan (STBP). Chapters of the STBP were submitted to TxDOT as research report two (R2) for TxDOT Research Project 0-6801.

Project Manager

Sonya Badgley, RTI

Project Supervisor

C. Michael Walton, CTR

Finally, the third phase (terminated 8/31/15) completed during the contract period for TxDOT Research Project 0-6803-01 reconvened the task force to review and revise Phase 1 and 2 work and expanded the list of other highly transformational technologies or integrated systems. New technologies in the portfolio were evaluated using the framework developed in Phase 1 and new subject matter experts (SMEs) joined the task force to provide insights on new technologies. Finally, additional work toward the establishment of the Strategic Technology Business Plan were completed and submitted to TxDOT as draft chapters of the STBP (deliverable P5 of 0-6803-01).

This three-year work program shall enhance previously completed work by the TTTF and provide necessary supporting research on emerging technologies and their trial programs to form the basis of recommendations to TxDOT regarding the development of programs and initiatives for technology adoption and integration in Texas.

Total Project Budget	*Research University*	*FY 2016 Budget*
$1,200,00	Center for Transportation Research, The University of Texas at Austin	$400,000

Planning and Environmental

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0-6820	Develop a 2-Stage Process for Evaluating Overweight Truck Corridors Serving Coastal Port Regions and Border Port-of-Entry	7/25/2014	87
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0-6848	Transportation Planning Implications of Automated/Connected Vehicles on Texas Highways	2/6/2015	91
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0-6852	Framework for Implementing Performance Planning for Rural Planning Organizations	2/2/2015	94
0-6864	Investigate the Air Quality Benefits of Nighttime Construction in Non-attainment Counties	2/12/2015	96
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0-6898	Estimating Freight Value Moved on TxDOT-Maintained Roadways for Investment Decision-Making	9/1/2015	108
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5-6690-01	Impact to Texas' Multimodal Freight Networks: Panama Canal and South American Markets	7/10/2015	111

0-6636—Photocatalytic NO_x/HRVOC/O_3 Removal in Transportation Applications

Start Date: 9/1/2010 *End Date: 12/31/2016*

Project Objectives

The focus of the proposed research is intensive and thorough testing of two commercial photocatalytic coatings applied to Portland cement concrete to provide accurate data that are representative of highway applications. While published laboratory data suggest that TiO2-based materials can remove NO_x and VOCs from air samples, the tests have not been designed to be representative of outdoor air conditions. Laboratory tests have been designed for this proposal to emulate roadway conditions. The results of these data shall be used to model the effects of using photocatalytic materials in the Houston-Galveston and Dallas-Fort Worth areas, predict the impact on air pollutant concentrations, and provide a cost-per-ton of pollutant removal among other metrics. Long-term outdoor exposure tests have been designed to examine the performance of the materials in real near-roadway locations in three different locations with varying pollutant concentrations and environmental conditions. Another critical component of the testing shall be material evaluation, examining the effects of the concrete substrate on photocatalysis, the effect of the photocatalytic process on material degradation, and the longevity of the material.

Project Manager

Wade Odell, RTI

Project Supervisor

Maria Juenger, CTR

Total Project Budget	*Research University*	*FY 2016 Budget*
$1,394,190	Center for Transportation Research, The University of Texas at Austin	$127,957

0-6762-01—Maximizing Mitigation Benefits

Start Date: 4/30/2015 End Date: 5/31/2016

Project Objectives

Project Agreement 0-6762—Maximizing Mitigation Benefits (termination date 8/31/2014) identified the need to accurately estimate and track project costs resulting from environmental mitigation. Although the research identified mitigation costs found in the Right of Way Information System (ROWIS), this only captured compensatory mitigation costs associated with Section 404 of the Clean Water Act for wetland mitigation, or in-lieu-fee, a program within the regulations (33 CFR Parts 325 and 332) that allows payment (fee) instead of (in lieu of) actually mitigating a wetland purchase. Section 404 of the Clean Water Act regulates discharges into waters of the US including wetlands. US Army Corps of Engineers (USACE) regulates Section 404 for wetland mitigation/discharges (40 CFR Part 230). The term "Section 404" is commonly used by practitioners as wetland mitigation regulation. There are many other project-related mitigation costs, and there is no single TxDOT source or management system at TxDOT for capturing and/or estimating mitigation costs statewide.

Project Manager

Darrin Jensen, RTI

Project Supervisor

John Overman, TTI

During this continuation project, researchers shall:

- Assess environmental mitigation cost-tracking and estimating at TxDOT.
- Conduct a synthesis of mitigation cost-tracking and estimating at selected state departments of transportation (DOTs).
- Assess and identify potential benefits from improved mitigation cost tracking and cost estimating.

The research product shall be the framework for a guide to track and estimate mitigation costs. The project would complement and build upon other project cost-tracking efforts at TxDOT including cost-tracking forms developed in Project 0-6633—Best Practices for Utility Investigations in the TxDOT Project Development Process (termination date 8/31/2011) for utility cost practices, as well as Project Management Office (PMO) processes to develop a Total Project Cost Estimating Guide.

Total Project Budget	*Research University*	*FY 2016 Budget*
$87,000	Texas A&M Transportation Institute	$43,200

0-6804—Life Cycle Cost and Performance of Lightweight Noise Barrier Materials along Bridge Structures

Start Date: 1/29/2013 End Date: 8/31/2017

Project Objectives

The site of this study is on elevated eastbound sections of IH-30, west of downtown Dallas. They are located north of the Kessler Park Neighborhood where the CTR team conducted a major sound project in 2010/2011 on westbound sections of an extensive retaining wall.

Project Manager

Wade Odell, RTI

Project Supervisor

Manuel Trevino, CTR

Two locations in the Dallas District are segments between Sylvan Avenue and Edgefield Avenue, with an approximate length of 2,500 ft., possessing a concrete sound wall approximately 8 ft. in height. The second segment is from Sylvan Avenue to Beckley Avenue, which has a traditional safety barrier rather than a dedicated concrete reflective sound wall and is approximately 4,000-ft. long. The research team shall evaluate the performance of a light-weight traffic noise wall for both sections, which will extend the height of the existing walls, to both attenuate sound propagation and block the current line of sight from the adjacent neighborhood to the highway.

The CTR team shall conduct a feasibility study using Dallas District staff and industry contacts. This study shall develop the comprehensive work plan needed to answer the issues raised and identify the research components to integrate the research activities with the sound wall bidding, construction, and maintenance activities, which shall be managed separately by the Dallas District. It shall allow the subsequent study to capture sound measurements and life cycle impacts at key locations before and after the construction of the lightweight sound walls before fall 2013. The measurement of sound absorption or reflection (depending on the type selected by the Dallas team) needs to be undertaken during regular cycles of weather, including wind and temperature changes, starting in winter 2013.

Total Project Budget	*Research University*	*FY 2016 Budget*
$416,615	Center for Transportation Research, The University of Texas at Austin	$99,108

0-6818—Dynamic Ride Sharing, Car-Sharing, Bike-Sharing and State-Level Mobility

Start Date: 6/30/2014 End Date: 12/31/2015

Project Objectives

Texas is one of the fastest growing states in the nation, and its growth is expected to continue, supported by diversity in its economy, geography, and population. The challenge of prioritizing limited resources in this environment requires a proactive approach to travel demand management. This project provides guidance for TxDOT in its planning and mobility efforts and in understanding the viability of various alternative mobility programs.

Project Manager

Darrin Jensen, RTI

Project Supervisor

Tina Geiselbrecht, TTI
Stacey Bricka, TTI

There is not a one-size-fits-all approach to identifying the most appropriate mobility programs for a region. Identifying and understanding the role of key factors such as the agencies involved, the regulations in force, regional travel behavior characteristics, and the vendor criteria for program implementation are all critical components of this research. This research shall evaluate best practices and lessons learned from introducing mobility programs across a variety of settings. It shall use executive interviews, focus groups, and surveys to obtain details and document perspectives of the varying stakeholder groups. The research shall result in the development of a guidebook that shall aid TxDOT in determining how to best identify and implement alternative mobility programs in a given region as part of its planning and mobility efforts.

Total Project Budget	*Research University*	*FY 2016 Budget*
$269,000	Texas A&M Transportation Institute	$63,800

0-6820—Develop a 2-Stage Process for Evaluating Overweight Truck Corridors Serving Coastal Port Regions and Border Port-of-Entry

Start Date: 7/25/2014 End Date: 8/31/2016

Project Objectives

A process is needed to evaluate, designate, and manage routine permitted overweight truck corridors serving coastal ports in Texas. These corridors can potentially enhance the competitive edge of companies importing or exporting freight through Texas ports while creating a self-sustaining system through permit fees. The research team recognizes that successful development of this analysis methodology will require close coordination with TxDOT, port authorities, metropolitan planning organizations, regional mobility authorities, manufacturers, and the trucking industry.

Project Manager

Sonya Badgley, RTI

Project Supervisor

C. Michael Walton, CTR

The methodology shall account for current and projected freight flows and opportunities that utilize the full cargo capacities of trucks operating along each corridor. The methodology shall provide an economic analysis of candidate corridors that accounts for pavement and bridge infrastructure strengthening and adjustments in geometric features; long-term maintenance costs: right-of-way, utility, and environmental clearance timeframes and impacts; sustainability based on projected permit revenue; and safety, security, and law enforcement requirements. The methodology shall also account for current legal restrictions for certain route types that can carry permitted indivisible loads but are restricted from carrying permitted divisible loads.

The methodology shall be flexible and provide a means for examining each factor and factor weight and their contributions to the final economic assessment of each corridor.

Total Project Budget	*Research University*	*FY 2016 Budget*
$475,205	Center for Transportation Research, The University of Texas at Austin	$232,500
	The University of Texas at San Antonio	$56,530

0-6836—Commercial Truck Platooning (Level 2 Automation)

Start Date: 4/8/2015 *End Date: 8/31/2016*

Project Objectives

Existing studies indicate platooning offers major safety and fuel saving benefits, critical issues for fleet operators. Truck platooning is defined as electronically coupling two or more trucks where the following truck's longitudinal and lateral functions are automated to mimic the leading truck while maintaining a tight distance. Researchers shall document all of the specific research activities completed throughout the duration of the project and provide detailed results of the truck platooning system design, development, and demonstration. Researchers shall provide possible future countermeasures in order to mitigate, eliminate, or at least create awareness regarding some of the technical, operational, and regulatory or legislative roadblocks for implementation of platooning within commercial vehicle fleet; identify operational and technical challenges experienced from previous projects in order to consider countermeasures and mitigate the future risks; and identify truck platooning scenarios that can be technically, economically, and legally implemented on Texas highways. Researchers shall evaluate the alternatives for deploying a truck platooning system in Texas and identify and prioritize two potential future deployment corridors for more detailed concept of operations development. Task 5 shall focus on the groundwork and prepare the engineering analysis needed before integrating the platooning system and subsystems into the demonstration trucks. Researchers shall identify relevant data and information that shall be collected from the vehicle to enable analysis for fuel saving measurements and emission reductions as a result of truck platooning application. Researchers shall implement the actual integration of systems and components into the two vehicle demonstrators. The final task shall result in the official demonstration of two commercial trucks platooning.

Project Manager

Sonya Badgley, RTI

Project Supervisor

Beverly Kuhn, TTI

Total Project Budget	*Research University*	*FY 2016 Budget*
$1,181,094	Texas A&M Transportation Institute	$708,799

0-6844—Putting a Price Tag on International Trade Use of State Infrastructure

Start Date: 1/23/2015 End Date: 12/31/2016

Project Objectives

A price tag is defined as a label attached to a product indicating its price; in transportation infrastructure terms, a price tag is an indication of the infrastructure construction and maintenance costs. Researchers shall develop a utility-based methodological framework for assigning price tags to freight corridors. This project shall allow TxDOT to maintain freight corridors with high condition standards and prepare for the potential trade growth. Researchers shall also provide TxDOT with capabilities to communicate their decisions to policy makers so that the necessary funds can be obtained to retain Texas' economic competitiveness.

Project Manager

Joe Adams, RTI

Project Supervisor

Zhanmin Zhang, CTR

Total Project Budget	*Research University*	*FY 2016 Budget*
$324,976	Center for Transportation Research, The University of Texas at Austin	$158,650

0-6846—Identify Involved Agencies Addressing Safety When Freight Centers Are Planned and Developed

Start Date: 1/30/2015 End Date: 7/31/2016

Project Objectives

This project stems from an observed need to improve coordination and cooperation among various entities in the process of planning for developing safer and more efficient connections between intermodal facilities and the highway network. Coordination and cooperation are extremely important given the number of public agencies (local, regional, and state) and private companies (railroads, transportation, manufacturing, etc.) that become involved in planning. When a limited number of entities, public or private, are involved in the planning process, some vital stakeholder concerns may not be adequately considered. Guidance is needed to provide a consistent approach to involve all entities that should be part of the process. Excluding some entities, even unintentionally, could result in important facts, issues, and other considerations being left out of the process. Exclusions could result in project delays, increased costs, omitted project steps, or duplication of efforts.

Project Manager

Sonya Badgley, RTI

Project Supervisor

Bill Frawley, TTI

Researchers shall investigate previous and current freight planning efforts and identify lessons learned and best practices to be applied in Texas, to include the work and findings of TxDOT's Panama Canal Stakeholder Working Group. Researchers shall develop guidance that stakeholders in Texas can use in planning and coordinating intermodal freight facilities to improve freight movement, enhance safety, and minimize congestion. These stakeholders include metropolitan planning organizations, cities, counties, economic development corporations, TxDOT, freight and transportations companies, and intermodal freight center developers. Researchers shall identify short-term accessibility improvement opportunities that could be considered to address current roadway operational issues such as curb radius at intersections in the vicinity of multimodal facilities

Total Project Budget	*Research University*	*FY 2016 Budget*
$270,397	Texas A&M Transportation Institute	$162,587

0-6848—Transportation Planning Implications of Automated/Connected Vehicles on Texas Highways

Start Date: 2/6/2015 *End Date: 8/31/2016*

Project Objectives

This research explores the transportation planning implications of automated and connected vehicles (AV/CV) on Texas highways and includes an in-depth study of how travel modeling can assist in planning for AV/CV. The research team shall assess how these potentially transformative technologies can be included in transportation planning to assist in the decision-making process. Researchers shall also define AV/CV implementation along various scales of vehicle technology advancement, public acceptance and adoption, and infrastructure implementation.

Project Manager

Wade Odell, RTI

Project Supervisor

Thomas A. Williams, TTI

Total Project Budget	*Research University*	*FY 2016 Budget*
$276,242	Texas A&M Transportation Institute	$177,245

0-6850—Texas Transportation Planning for Future Renewable Energy Projects

Start Date: 1/15/2015 End Date: 8/31/2016

Project Objectives

There will be a significant increase in the number of renewable energy production facilities in Texas. The construction of wind farms requires the transport of wind turbine components that create increased loads on rural roads and bridges. These rural roads and bridges are typically not designed for such loads. This will result in a greater burden on the transportation infrastructure in Texas.

Project Manager

Wade Odell, RTI

Project Supervisor

Chandra Bhat, CTR

Given the upward trend in particular in wind energy production, TxDOT is looking to plan for the impacts of future renewable energy projects on roads while facilitating the development of new renewable projects in and around Texas. Researchers shall create an operational planning tool that can be used to propose route plans for wind turbine components passing along Texas routes and develop recommendations for planning construction of new wind farms as well as maintenance strategies for the roads.

Total Project Budget	*Research University*	*FY 2016 Budget*
$224,500	Center for Transportation Research, The University of Texas at Austin	$137,700

0-6851—Strategies for Managing Freight Traffic through Urban Areas

Start Date: 1/19/2015 End Date: 8/31/2018

Project Objectives

Existing studies indicate platooning offers major safety and fuel-saving benefits, critical issues for fleet operators. Truck platooning is defined as electronically coupling two or more trucks where the following truck's longitudinal and lateral functions are automated to mimic the leading truck while maintaining a tight distance. Researchers shall document all of the specific research activities completed throughout the duration of the project and provide detailed results of the truck platooning system design, development, and demonstration. Researchers shall provide possible future countermeasures in order to mitigate, eliminate, or at least create awareness regarding some of the technical, operational, and regulatory or legislative roadblocks for implementation of platooning within commercial vehicle fleets. Researchers shall identify operational and technical challenges experienced from previous projects in order to consider countermeasures and mitigate future risks. Researchers shall identify truck platooning scenarios that can be technically, economically, and legally implemented on Texas highways. Researchers shall evaluate the alternatives for deploying a truck platooning system in Texas and identify and prioritize two potential future deployment corridors for more detailed concept-of-operations development. Task 5 shall focus on the groundwork and prepare the engineering analysis needed before integrating the platooning system and subsystems into the demonstration trucks. Researchers shall identify relevant data and information that shall be collected from the vehicle to enable analysis for fuel-saving measurements and emission reductions as a result of truck platooning application. Researchers shall implement the actual integration of systems and components into the two vehicle demonstrators. The final task shall result in the official demonstration of two commercial trucks platooning.

Project Manager

Sonya Badgley, RTI

Project Supervisor

Jeff Shelton, TTI

Total Project Budget	*Research University*	*FY 2016 Budget*
$556,498	Texas A&M Transportation Institute	$100,930

0-6852—Framework for Implementing Performance Planning for Rural Planning Organizations

Start Date: 2/2/2015 *End Date: 7/31/2016*

Project Objectives

Moving Ahead for Progress in the 21st Century (MAP-21) places increased emphasis on performance-based management of the multimodal transportation system and requires the use of performance-based methods in state, metropolitan, and non-metropolitan transportation planning and programming. The MAP-21 emphasizes eight areas including safety, infrastructure condition, congestion reduction, system reliability, freight movement, and economic vitality. Establishing a common set of performance measures allows for the evaluation and comparison of different projects and transportation corridors for both current and future conditions, and translates data and statistics into a form that the public and decision makers can easily understand. The research team shall provide TxDOT with a framework, performance measures, tools, and guidance to conduct performance-based transportation planning and programming in non-metropolitan areas of the state and support rural transportation planning organizations (RTPOs or RPOs). Researchers shall conduct a national literature review, seeking information from state DOTs, rural planning organizations, regional planning commissions, councils of governments, and small MPOs. Researchers shall develop an organizational and technical framework and process that will allow TxDOT to establish performance-based transportation system assessment and monitoring and will support long-range planning and programming in rural counties, RTPOs, and TxDOT districts. Researchers shall provide performance measures that cover a broad range of goals and objectives, support the seven areas identified in MAP-21, and/or other areas identified in cooperation with TxDOT; develop a user-friendly tool that enables TxDOT's districts, RTPOs, individual counties, and TxDOT to support the rural performance-based transportation system assessment, monitoring, planning, and programming at the individual county, RPO, TxDOT district, and statewide levels; develop a user-friendly guidebook that directs the reader through a framework for conducting a rural transportation system assessment, monitoring progress, and improving project planning and programming based on individual goals and objectives and selected performance measures and weights; and develop and deliver one workshop presentation and materials for a TxDOT district and/or RTPO.

Project Manager

Sonya Badgley, RTI

Project Supervisor

John Overman, TTI

Total Project Budget	*Research University*	*FY 2016 Budget*
$228,200	Texas A&M Transportation Institute	$122,700

0-6864—Investigate the Air Quality Benefits of Nighttime Construction in Non-attainment Counties

Start Date: 2/12/2015 End Date: 4/30/2017

Project Objectives

Researchers shall provide TxDOT with a nighttime construction decision support framework as well as a quantified characterization of the expected changes of the emission from construction activity and affected traffic. This decision support framework shall help the stakeholders evaluate the various factors such as cost, safety, mobility, location, air quality impacts, local considerations, etc. on a systematic basis. A series of case studies and the development of a decision support tool shall provide TxDOT with practical, usable research results that can be applied to make appropriate decisions. The case studies shall include estimating emissions of construction site activities as well as the affected traffic. In addition to the main objective of the study in characterizing the changes of emission in the context of regional conformity, the emission estimates shall also be used in a high-level emission dispersion analysis. This analysis shall help to evaluate the impact of key meteorological factors on the concentrations of pollutant emissions and the resultant air quality at and around construction zones.

Project Manager

Sonya Badgley, RTI

Project Supervisor

Reza Farzaneh, TTI

Total Project Budget	*Research University*	*FY 2016 Budget*
$425,900	Texas A&M Transportation Institute	$234,740

0-6865—Cost Effective Mitigation Strategy for State Listed Freshwater Mussels

Start Date: 2/2/2015 *End Date: 7/31/2016*

Project Objectives

Transportation agencies continue to promote economic growth through infrastructure development; however, with this comes the responsibility of preserving important natural resources. When road and bridge construction is proposed, an environmental impact assessment is conducted to determine the potential threat that a given project has on sensitive species or ecological areas. For freshwater mussels, surveys are often performed to determine whether mussels are present and their distribution within the project area. If mussels of concern are found, a relocation plan is often implemented wherein mussels are moved to minimize impacts from construction activities. In Texas, there are no current standard protocols for establishing presence or absence of state-threatened, federally listed, or candidate species within a bridge construction project area or guidelines for when and how to conduct mussel relocations. The overall goal of this project is to provide TxDOT with guidelines for conducting freshwater mussel surveys and relocations.

Project Manager

Sonya Badgley, RTI

Project Supervisor

Charles Randklev, TAES

Total Project Budget	*Research University*	*FY 2016 Budget*
$60,000	Texas A&M AgriLife Extension Service	$29,139

0-6866—NEPA Reporting Synthesis of State Practices

Start Date: 1/23/2015 End Date: 12/31/2015

Project Objectives

Under the Surface Transportation Project Delivery Program created by SAFETEA-LU (23 United States Code 32701) and continued under MAP-21, federal transportation law has authorized delegating the NEPA review and approval processes to state departments of transportation (DOTs). This research shall assist TxDOT with its goals of shortening project review periods, developing a robust review process, and cutting costs where possible. Collectively, these accomplishments help TxDOT to achieve one of its strategic plan goals: "Become a best-in-class state agency." The objectives of this research study are to (a) review the effectiveness of practices for NEPA assignment in other states and provide recommendations on best practices; (b) assess challenges in conducting effective NEPA reports and approvals, including benefits and costs that have been quantified; (c) review the legal and case law landscape to identify any potential litigation trends and any legal impediments that may impact NEPA assignment; and (d) recommend process revisions and procedures for developing a robust NEPA assignment program within TxDOT.

Project Manager

Joe Adams, RTI

Project Supervisor

Lisa Loftus Otway, CTR

Total Project Budget	*Research University*	*FY 2016 Budget*
$137,095	Center for Transportation Research, The University of Texas at Austin	$32,289
	University of North Texas	$15,180

0-6870—Integrating Underground Freight Transportation into Existing Intermodal Systems

Start Date: 4/15/2015 End Date: 5/31/2016

Project Objectives

This research project shall investigate the feasibility to address the potential for employing underground freight technology. This concept includes construction of freight tubes (also called pneumatic capsule pipeline), a technology that can be used to transport most cargoes normally transported by trucks. Tube freight transportation is a class of unmanned transportation systems in which close-fitting capsules or trains of capsules carry freight through tubes between terminals. This project examines the use of underground freight tubes in congested urban environments. Enabling the State of Texas through public private partnerships (P3) could allow for the use of ground under the existing TxDOT right of way, especially interstate highways, for construction of such tubes.

Project Manager

Chris Glancy, RTI

Project Supervisor

Mohammad Najafi, UTA

Total Project Budget	*Research University*	*FY 2016 Budget*
$247,049	The University of Texas at Arlington	$147,429

0-6876—Understanding the Consequences and Cost of Climate Change to the Texas Transportation System

Start Date: 6/1/2015 *End Date: 5/31/2017*

Project Objectives

The consequences of climate change have the ability to create significant damage to the state's existing transportation infrastructure on a scale that will grow over time. The potential consequences include damage to highway pavements due to increased temperatures and more severe and frequent droughts; the inundation of roadways, bridges, and ferry infrastructure in low-lying coastal areas due to sea level rise; and stronger storm surges along the Texas Coast and the subsequent damage to bridges and roadways. TxDOT risks the possibility of spending hundreds of millions or even billions of dollars of state funds to maintain or replace damaged infrastructure due to climate change. TxDOT needs to determine the scale of the potential problem and its potential costs and the disruptions that may result from future climate change, which is the focus of this study. Researchers shall develop a framework to assist with avoiding any significant, unanticipated costs that would be imposed upon Texas taxpayers and industry due to damage or loss of the state's transportation infrastructure as a result of climate change.

Project Manager

Sonya Badgley, RTI

Project Supervisor

Vivek Tandon, UTEP

Total Project Budget	*Research University*	*FY 2016 Budget*
$249,903	The University of Texas at El Paso	$119,671

0-6884—Gulf Intracoastal Waterway Capacity Study

Start Date: 9/1/2015 ***End Date: 2/28/2017***

Project Objectives

It is in the long-term interest of TxDOT to encourage greater usage of the GIWW, particularly if cargoes being transported on the state's highway system can be diverted to barge. However, like all transportation infrastructure, the GIWW is at risk of reaching capacity constraints that could arise along entire segments of the waterway or at individual chokepoints. To date, there has not been a systematic, operational, data-driven approach by TxDOT to look at vessel movements along the entire GIWW to determine if and where capacity problems might exist. The proposed scope of work shall employ an existing database of historic vessel activity for locations along the GIWW to provide an overview of vessel movements, which shall be supplemented with interviews with key stakeholders. The research project shall synthesize background research and summarize existing data on vessel effects, as they relate to safety and navigation, and summarize current and future vessel activity along the GIWW, its tributary channels, and intersecting ship channels. Finally, the study shall outline a set of criteria for tracking conditions along the GIWW that identify specific triggers or milestones that would suggest improvements to the GIWW's future operations or infrastructure.

Project Manager

Wade Odell, RTI

Project Supervisor

Terrance Pohlen, UNT

Total Project Budget	*Research University*	*FY 2016 Budget*
$297,614	University of North Texas	$137,086
	Center for Transportation Research, The University of Texas at Austin	$81,067

0-6886—Engineering Guidelines for Installing Temporary Lines within the Right of Way

Start Date: 9/1/2015 *End Date: 8/31/2017*

Project Objectives

Moving the enormous amounts of water and other fluids needed for unconventional oil and gas energy developments requires considerable resources. Fluids can be transported by truck or by pipeline. For temporary pipelines, TxDOT issues permits that are usually valid for up to 90 days. In practice, districts have observed a wide range of practices related to the installation, operation, and maintenance of these facilities. The purpose of the research is to examine current practices and to develop engineering guidelines for permitting, installing, operating, and maintaining temporary pipelines within the state right of way. The research includes examining issues such as, but not limited to, public versus private uses, accommodation practices, construction and inspection procedures, structural configuration of aboveground temporary facilities, standards and specifications, materials, and preferred methods and best practices for installation, operation, and maintenance. The research also examines safety issues, environmental concerns, and protection of the transportation infrastructure and the traveling public. In addition to the report, research deliverables include (a) a guidebook for permitting, design, construction, operation, and maintenance of temporary lines; and (b) recommendations for changes to policy, manuals, procedures, and accommodation rules.

Project Manager

Kevin Pete, RTI

Project Supervisor

Cesar Quiroga, TTI

Total Project Budget	*Research University*	*FY 2016 Budget*
$340,000	Texas A&M Transportation Institute	$186,330

0-6890—Tools for Port TRZs and TRZs for Multimodal Applications

Start Date: 9/1/2015 *End Date: 11/30/2016*

Project Objectives

The Texas State Legislature has created one innovative transportation funding mechanism called the transportation reinvestment zone (TRZ), which allows local governments to set aside local match contributions for the transportation projects most critical to their communities. Since the original law enabling the creation of TRZs was enacted by the state legislature, the mechanism has attracted interest from a number of counties and municipalities, several of which have created their own TRZs. TRZs rely on tax increments to raise transportation project funds. Since TRZs cover large swaths of land, it is important to understand potential land development closely so as to develop more robust assessments of land development and value trends as well as property tax increment revenue flows.

Project Manager

Chris Glancy, RTI

Project Supervisor

Rafael Aldrete, TTI

More recently, TRZ legislation was expanded to consider port authority TRZs as another method to fund infrastructure in these multimodal facilities. Under the legislation, port authority is defined as a port authority or navigation district created or operating under Section 52, Article III, or Section 59, Article XVI, Texas Constitution. While the processes for establishing a port authority TRZ are fundamentally the same as conventional TRZs, there are differences in the ways these funds may be utilized. A vital element of the development of such zones is also an understanding of land development to allow better tax increment revenue prediction models considering the inherent characteristics of port and navigation support infrastructure, as well as multimodal connections that the ports offer.

This project aims to (a) look at the processes for establishing these port and navigation TRZs, (b) document those agencies that have already made steps in that direction, (c) develop a more systematic understanding of the types of projects that are TRZ eligible in the context of port authority TRZs and the interactions of TRZ funding in the context of port funding/finance and how that may vary across ports types in Texas, (d) develop an understanding of land development in port jurisdictions, and then finally (e) develop tools to facilitate the implementation process of port TRZs.

Total Project Budget	*Research University*	*FY 2016 Budget*
$228,432	Texas A&M Transportation Institute	$182,168

0-6891—Using Public Transportation to Facilitate Last Mile Package Delivery

Start Date: 9/1/2015 *End Date: 8/31/2017*

Project Objectives

Rural transit districts and intercity bus carriers are an important link within Texas' multimodal transportation system. Without such service providers, many rural residents that are transit dependent would be forced to either relocate or find other means of transportation. However, provision of transit service (especially in rural areas because of large distances and limited ridership) is a costly endeavor. Alternative revenue streams offer rural transit operators the opportunity to operate more sustainably and potentially leverage additional state- and federal-level funding sources by providing funding for local match.

Project Manager

Sonya Badgley, RTI

Project Supervisor

Suzie Edrington, TTI

Continued growth of business to consumer e-commerce has increased demand for package shipping services. Rural areas face a particular challenge in finding efficient "last mile" delivery of goods (from freight drop to final destination). Rural transit districts operate demand response door-to-door service throughout Texas, providing critical connections to goods and services. The network of Texas rural transit districts may effectively bridge the last mile gap in package shipping from the freight drop point to the final destination by providing last mile package delivery services in cooperation with freight companies. Last mile package delivery service may present an opportunity for rural transit operators to diversify revenue sources and improve overall cost effectiveness while maintaining existing door-to-door service. Research is needed to address current gaps in existing package delivery service that may be filled by the network of intercity bus and rural transit districts in Texas.

TxDOT, as well as transit and freight stakeholders (such as regional package delivery companies, United Parcel Service [UPS], FedEx Corporation, and United States Postal Service) will benefit from knowledge of best practices, challenges, policy implications, and the potential for revenue generation. Furthermore, rural transit operators will benefit from the guidebook developed by this effort. The guidebook shall be designed to inform rural transit operators of how to implement a package delivery service and shall be tested by the research team (to ensure viability) during the implementation of a pilot package delivery service in partnership with a rural transit operator

Total Project Budget	*Research University*	*FY 2016 Budget*
$165,000	Texas A&M Transportation Institute	$110,000

0-6892—Integration of Right of Way Project Schedules for Decision-Making Purposes

Start Date: 9/1/2015 *End Date: 8/31/2016*

Project Objectives

There is a need for adequate tools to enhance right of way project planning and performance management in Texas. Recently completed National Cooperative Highway Research Program (NCHRP) Project 20-84 resulted in improved, integrated real property procedures and business practices in the project development and delivery process, as well as recommendations to improve property management practices. One of the NCHRP 20-84 products was a prototype, reference real property acquisition, and relocation assistance work schedule that enables dynamic evaluations of what-if scenarios that can be used for decision-making during project development and delivery. Another product was a set of strategies to address issues and challenges that affect the timely, effective delivery of real property interests to transportation agencies. This research compares the functionality of the project performance tools developed in NCHRP 20-84 against real property acquisition processes and schedules in Texas, expands the national research by including a risk-based approach for conducting what-if scenarios and sensitivity analysis, and tailors relevant strategies developed in NCHRP 20-84 with the goal to develop a management decision tool for real property acquisition management practices.

Project Manager

Sonya Badgley, RTI

Project Supervisor

Cesar Quiroga, TTI

Total Project Budget	*Research University*	*FY 2016 Budget*
$200,000	Texas A&M Transportation Institute	$200,000

0-6898—Estimating Freight Value Moved on TxDOT-Maintained Roadways for Investment Decision-Making

Start Date: 9/1/2015 *End Date: 8/31/2017*

Project Objectives

Supply chains have become more complex, and current models of freight travel rely on a clearly inadequate four-step modeling process, initially developed for passenger vehicle forecasting. The challenge lies in adequately capturing the numerous linkages involving shippers, carriers, third-party logistics agents, and customers as well as varying sizes, shapes, volumes, value, and weights of the commodities being moved. Unfortunately, modelers are limited by the availability of sufficiently disaggregate data. Secondary or public data are easily accessible but are available only in highly aggregate form and insufficient for model development. Primary data, which are collected by third-party firms, would be ideal but are proprietary in nature, and clients are unwilling to share information because of the competitive nature of the business.

Project Manager

Chris Glancy, RTI

Project Supervisor

C. Michael Walton, CTR

This 2-year study examines commodity flow estimation methods to provide the best assessment of the value of freight moved along Texas corridors using multiple data sources. This study shall examine commodity flow estimates from the various private- and public-sector databases and identify problems and limitations of each database. The study team shall then examine flow patterns for a number of commodities and test different modeling approaches to compare with estimates from the existing databases. This research work shall prepare TxDOT for subsequent studies relating to statewide commodity flow estimation and development of future scenarios. It shall also include recommendations on what modifications need to be made to existing databases to better reflect Texas commodity flows and the value of freight moved on TxDOT-maintained roadways.

Total Project Budget	*Research University*	*FY 2016 Budget*
$475,596	Center for Transportation Research, The University of Texas at Austin	$236,750

0-6900—Coordinating Consistency between Statewide and Regional Planning Models

Start Date: 9/1/2015 *End Date: 8/31/2017*

Project Objectives

In Texas, a statewide planning model is used for planning projects that shall have implications on transportation across the entire state, often pertaining to major freight corridors. At the same time, metropolitan planning organizations (MPOs) throughout Texas use planning models for individual urban regions. Currently, these models are maintained and updated independently. This project has two objectives: improve the synchronization of these models (increasing accuracy and consistency of results) and streamline the process of updating these models (reducing duplication of employee effort). These objectives are as follows:

Project Manager

Chris Glancy, RTI

Project Supervisor

Stephen Boyles, CTR

1. Create a workable definition of consistency that is practical, relevant, quantitative, well defined, and will express the degree of consistency, not just a yes/no answer. This definition will also reflect the distinction between input consistency and output consistency.
2. Identify potential options for coordinating statewide and regional models, based on the chosen definition of consistency. Researchers shall identify several options, which will vary as to the amount of implementation effort required and the degree to which consistency will be improved, reflecting effort and resource constraints for both TxDOT and Texas MPOs in the short and long term.

Researchers shall accomplish each of these objectives through a substantial and comprehensive set of model runs that will evaluate a number of candidate options. In particular, ultimate success in coordinating the statewide and regional models (the second objective) is critically dependent on choosing a proper definition of consistency (the first objective). Past research by the research team has shown the importance of understanding the relationships and connections between two models of different scale, and that superficial or intuitively obvious consistency definitions may not capture the most important interactions between statewide and regional models. The research plan thus allows a full year for developing a robust and well-tested consistency definition before proceeding to identify and test options in the second year.

To facilitate implementation, the research team shall (a) produce separate reports documenting the definition of consistency and potential options for improving

consistency; (b) provide a range of potential options for improving consistency to give TxDOT an accurate sense of the tradeoffs between effort involved in changing the models and the improvement in consistency; and (c) host a training workshop in the final year of the project.

Total Project Budget	*Research University*	*FY 2016 Budget*
$282,003	Center for Transportation Research, The University of Texas at Austin	$120,263

5-6690-01—Impact to Texas' Multimodal Freight Networks: Panama Canal and South American Markets

Start Date: 7/10/2015 End Date: 8/31/2017

Project Objectives

Texas deep-water ports, Beaumont, Galveston, and Houston, for example, have benefited from the growth in international trade, as Texas's position as the leading U.S. export state attests. Technical Report 0-6690-1, The Dynamics of U.S.-Asian-South American Waterborne Trade and the Panama Canal Expansion: Their Anticipated Impacts on Texas Ports and the State's Economy, identified a range of potential investments at the leading Texas ports, driven by exports, the growing Texas consumer market, and an enhanced Panama Canal (PC). Shippers moving Texas trade to and from Asia face two distinct choices: move freight by rail or truck to Southern Californian ports, or use Texas ports and the PC. In late 2015 or early 2016, a new lock system will open on the PC and allow ships that are substantially larger than the current designs (the PC's existing size limit specification for ships is termed "Panamax"). The use of post-Panamax ships will impact all bulk and containerized commodities passing through the canal and will lower shipping costs to the benefit of both Texas shippers and ports. Global shippers will have new choices to serve Texas based on commodities, routes, cost, and service. TxDOT will benefit from increased knowledge regarding the impacts of agricultural and energy exports as well as national product imports through the Port of Houston on landside access and freight corridor planning.

Project Manager

Joe Adams, RTI

Project Supervisor

Robert Harrison, CTR

Total Project Budget	*Research University*	*FY 2016 Budget*
$153,159	Center for Transportation Research, The University of Texas at Austin	$67,600

Safety and Operations

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0-6840—Analysis of the Shoulder Widening Need on the State Highway System

Start Date: 1/7/2015 *End Date: 11/30/2015*

Project Objectives

In many rural Texas areas, pedestrians and cyclists have limited trip options, and therefore travelers often use rural low speed highways for their trips. If these corridors do not have adequate roadway shoulders available, pedestrians and cyclists cannot travel on the shoulder and instead must occupy an active travel lane. The objective of this project is to define the criteria for roadway shoulder suitability for pedestrians and bicycles, apply these criteria to Texas highways to determine candidate locations that merit shoulder improvements, identify high use or high demand locations, and develop a list of target locations, coupled with the suitability criteria to be incorporated into a Strategic Corridor Development Plan.

Project Manager

Sonya Badgley, RTI

Project Supervisor

Karen Dixon, TTI

Total Project Budget	*Research University*	*FY 2016 Budget*
$163,853	Texas A&M Transportation Institute	$55,278

0-6845—Connected Vehicle Problems, Challenges, and Major Technologies

Start Date: 1/16/2015 End Date: 12/31/2016

Project Objectives

The objective of the project is to compare and evaluate existing and emerging VANET (vehicular ad-hoc network) technologies in connected vehicle environments, including, but not limited to, the architecture, routing protocols, and hardware of vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications. During this project, researchers shall:

1. Provide an up-to-date overview and comparison of existing and emerging VANET technologies and their applications.
2. Identify technical challenges and potential solutions associated with the system architecture, hardware, and software in VANET deployments.
3. Demonstrate secure V2I and V2V messaging via round trip timing and security-enhanced location sensors in a realistic attack scenario. This experiment shall be undertaken in a laboratory setting.
4. Provide guidelines for V2I and V2V applications in Texas roadway settings and identify opportunities for data collection through connected vehicle (CV) systems.

Project Manager

Darrin Jensen, RTI

Project Supervisor

Chandra Bhat, CTR

Total Project Budget	*Research University*	*FY 2016 Budget*
$335,000	Center for Transportation Research, The University of Texas at Austin	$167,500

0-6847—An Assessment of Autonomous Vehicles: Traffic Impacts and Infrastructure Needs

Start Date: 1/15/2015 End Date: 12/31/2016

Project Objectives

This research project shall survey Texans on vehicle and technology preferences and then anticipate the adoption rates of various levels of vehicle automation and connectivity under different pricing, demographic, regional, and other scenarios. This approach shall allow the research team and TxDOT to anticipate the benefits of such technologies for Texas households and businesses, at various levels of autonomous vehicle and connected vehicle (AV and CV) adoption, along with the economic impacts on different industry sectors (including vehicle repair and medical care industries), and the cost effectiveness of various TxDOT interventions and protocols in the design, management, and improvement of its transportation system. The project shall deliver an assessment of connected and autonomous vehicles' (CAVs') benefits, costs, and impacts for surface transportation systems; a detailed description of the adoption rates under multiple scenarios simulated; and recommended modifications for Texas transportation design, planning, and project evaluation practices to reflect AV impacts.

Project Manager

Darrin Jensen, RTI

Project Supervisor

Kara Kockelman, CTR

Total Project Budget	*Research University*	*FY 2016 Budget*
$341,388	Center for Transportation Research, The University of Texas at Austin	$165,303

0-6849—Implications of Automated Vehicles on Safety, Design and Operation of the Texas Highway

Start Date: 1/15/2015 End Date: 8/31/2016

Project Objectives

This project seeks to quantify crash-related gains of various vehicle automation and connectivity features by first documenting all demonstrated and emerging technologies, then anticipating Texans' adoption rates of such technologies (for both personal and commercial uses), and then simulating crash contexts under various technology, network design, and traffic management techniques. Researchers shall document the state of research and development in automated and connected vehicle (AV and CV) technologies and evolve the Texas fleet and its daily use under market (price, technology, demographics, and land use) scenarios. Researchers shall be able to anticipate the near-term and long-term impacts (e.g., those emerging in less than 15 years and those emerging over 25 years or more, respectively) on Texas crash counts and severities, and identify the spectrum of economic, institutional, and other outcomes that may come from a near-crashless roadway system. The team shall identify the best practices for TxDOT and other agencies to most cost-effectively facilitate Texas' adoption and use of top technologies. Researchers shall apply comprehensive benefit-cost analyses and provide TxDOT staff with training on the topics and project results and recommendations to facilitate project implementation.

Project Manager

Darrin Jensen, RTI

Project Supervisor

Kara Kockelman, CTR

Total Project Budget	*Research University*	*FY 2016 Budget*
$320,144	Center for Transportation Research, The University of Texas at Austin	$191,411

0-6859—Operational Analysis of Active Traffic Management Strategies

Start Date: 1/22/2015 End Date: 12/31/2016

Project Objectives

This project shall develop tools for analyzing the effectiveness of active traffic management (ATM) strategies, along with supporting methodologies. The ATM strategies studied in this project are ramp metering, variable speed limits, mainline gap metering, coordinated freeway-arterial operations, dynamic lane use control, dynamic shoulder lane (hard shoulder running), dynamic route guidance, junction control, travel time signs, overhead gantries, and queue warning. The supporting methodologies shall predict the effectiveness of these strategies based on traffic and other network data. These tools and methodologies address three related needs: using traffic data to perform bottleneck analyses, identifying locations where ATM implementation would relieve congestion, and identifying ATM decision rules to be applied in real time, including activation/deactivation thresholds and control rules.

Project Manager

Wade Odell, RTI

Project Supervisor

Stephen Boyles, CTR

The project approach is informed by the following principles:

- Multiple tools are needed to accommodate differences in data availability at various locations, as well as the availability of already-calibrated simulation and assignment models for other purposes. A “one size fits all” approach is insufficient.
- Bottlenecks are a property of a system, not a single facility. A network-based approach is needed to connect local improvements in traffic flow to broader congestion measures.
- Properly evaluating the long-term effects of ATM requires accounting for changes in habitual driving behavior. Improving flow along a corridor may attract additional vehicle demand from alternate routes and can reduce the benefits of ATM in reducing congestion.
- The last two factors are particularly critical, and failing to account for network effects and long-term behavior changes shall systematically overestimate the benefits of ATM. The tools developed in this project incorporate these effects, accurately evaluating ATM benefits.

Researchers shall develop four methodologies, including supporting tools, combining microsimulation for traffic realism and dynamic traffic assignment for vehicle re-routing and bottleneck analysis, and three frameworks that require only one, or

neither, of these models. For the latter frameworks, the research team shall replace unavailable models with much simpler methodologies (resembling the procedures in the Highway Capacity Manual), obtained from comprehensive simulation runs performed during the project. These latter methodologies shall be presented in spreadsheet form. All tools, spreadsheets, and supporting documentation shall be delivered to TxDOT, and a training workshop shall be scheduled.

Total Project Budget	*Research University*	*FY 2016 Budget*
$288,863	Center for Transportation Research, The University of Texas at Austin	$144,286

0-6861—Improving Safety and Efficiency of Signalized Intersections during Inclement Weather

Start Date: 2/12/2015 End Date: 12/31/2016

Project Objectives

Inclement weather, such as rain, snow, fog, and ice, create special operational challenges for traffic management agencies. This project shall provide TxDOT with technical guidance for improving safety and efficiency of signalized intersections during inclement weather. Researchers shall examine available technologies for detecting adverse weather at signalized intersections and provide technical guidance on strategies for modifying traffic signal operations during various types of weather events. The results of this project shall provide a realistic and practical architectural framework for collecting and disseminating weather information to improve signalized intersection operations. As part of this research effort, researchers shall assess existing TxDOT mechanisms for providing weather responsive traffic signal operations for different types of inclement weather events. Following this assessment, researchers shall provide TxDOT with practical and implementable guidelines for developing traffic signal timing plans and using specific traffic signal controller features for making significant improvements in safety and congestion at signalized intersection during weather events such as fog, rain, ice, snow, and high winds. Researchers shall provide guidance for operating traffic signals and developing traffic signal timing plans for large-scale evacuations, such as hurricane evacuations in coastal regions, in the form of revisions to TxDOT's Traffic Signal Operations Handbook. A one-day training module for implementing weather responsive traffic operations shall be developed by the research team and tested as part of this project.

Project Manager

Sonya Badgley, RTI

Project Supervisor

Kevin Balke, TTI

Total Project Budget	*Research University*	*FY 2016 Budget*
$343,735	Texas A&M Transportation Institute	$204,008

0-6867—Connected Vehicle Wrong-Way Driving Detection and Mitigation Demonstration

Start Date: 2/12/2015 End Date: 12/31/2015

Project Objectives

This project shall focus on developing a concept of operations and functional requirements for a connected vehicle test bed for wrong-way driving applications that will notify TxDOT and emergency response vehicles and personnel, including but not limited to law enforcement vehicles, about wrong-way driving events. More specifically, this project is a foundational systems engineering and planning effort focusing on:

Project Manager

Darrin Jensen, RTI

Project Supervisor

Melissa Finley, TTI

1. Identifying and selecting test bed locations.
2. Conducting needs assessments.
3. Developing a comprehensive concept of operations.
4. Engaging market suppliers to develop wrong-way driving connected vehicle cost information.
5. Creating financial requirements for test bed operations.
6. Designing and testing potential warning messaging for fixed signing and in-vehicle applications.
7. Outlining the system design for the selected wrong-way applications.

Total Project Budget	*Research University*	*FY 2016 Budget*
$591,554	Texas A&M Transportation Institute	$132,542

0-6877—Communications and Radar-Supported Transportation Operations and Planning (CAR-STOP)

Start Date: 3/27/2015 End Date: 6/30/2016

Project Objectives

The project's research activities shall focus on the advancement of the body of knowledge on the use of wireless technology (both communications and radar) to address the transportation safety challenges facing the state (for the purpose of this project, communications refers to the encoding of, and two-way talk of, relevant vehicle-related information, while radar refers to a non-informational sound signal sent by and received by a single vehicle to sense its surroundings). The emphasis shall be on both basic research and porting that basic research to applied research in the form of pilot implementation tests.

Project Manager

Darrin Jensen, RTI

Project Supervisor

Chandra Bhat, CTR

Total Project Budget	*Research University*	*FY 2016 Budget*
$881,377	Center for Transportation Research, The University of Texas at Austin	$618,930

0-6879—Cross-Border ITS Systems with Traffic Management Centers

Start Date: 4/30/2015 End Date: 5/31/2016

Project Objectives

The traffic management centers (TMCs) in Texas play a vital role in managing traffic operations in many of our major metropolitan areas. TMCs have deployed extensive detection, monitoring, and communication infrastructure to allow TxDOT operators to manage incidents and reduce collisions, provide traveler information through roadside assets, provide traffic status to broadcast media, and support work zone monitoring and construction information. Currently, there is no cross-border TMC or traveler data exchange along the Texas-Mexico border to inform the traveling public of the traffic conditions on the other side of the border; therefore, travelers do not have information regarding traveling conditions between border sister cities.

Project Manager

Darrin Jensen, RTI

Project Supervisor

Roberto Macias, TTI

Researchers shall evaluate the current state of the practice and future plans in Mexico to advance intelligent transportation systems (ITSs), develop a framework and an action plan for TxDOT to lead the deployment of cross-border TMCs, and share data to improve the traffic conditions along the Texas-Mexico border and adjacent border cities.

Total Project Budget	*Research University*	*FY 2016 Budget*
$130,102	Texas A&M Transportation Institute	$80,041

0-6887—Transportation and Economic Impact of Texas Shortline Railroads

Start Date: 9/1/2015 *End Date: 9/30/2016*

Project Objectives

While several recent studies have examined the role of Class I rail transportation on large cities, regions within the state, or provided even statewide analysis, this study shall analyze the transportation and economic impacts of the state's Class III/shortline railroads including their impacts upon smaller, rail-served communities.

Project Manager

Sonya Badgley, RTI

Project Supervisor

Fengxiang Qiao, TSU

Many shortline railroads service communities that only have one significant industry, and if that industry fails, the entire community would suffer economically as a result. Increasing truck traffic would both increase roadway maintenance requirements and potentially reduce safety of others using roadways where Class III rail service is lost or not available.

The study shall seek to identify direct and indirect customer bases of the railroads, conduct interviews with shortline railroad officials and their customers, and follow up with interviews of local community leaders (i.e., mayors, economic development directors, rural rail transportation district [RRTD] officials, etc.) to determine detailed roles and plans for the shortline network of the state. Data collected during the project shall then be analyzed to document the impacts of shortline railroad operations for the state and its local communities.

Total Project Budget	*Research University*	*FY 2016 Budget*
$297,252	Texas Southern University	$139,516
	University of Houston	$148,282

0-6894—Guidelines for Design and Operation of U-turns

Start Date: 9/1/2015 ***End Date: 8/31/2017***

Project Objectives

U-turn lanes are commonly provided at diamond interchanges to reduce delay for U-turning traffic and for the interchange as a whole; however, there are currently many unknowns related to their design, operation, and use. The project provides TxDOT with easy-to-use and implementable guidelines for designing and operating U-turn lanes at diamond interchanges. The project shall identify and investigate demand and capacity factors affecting U-turn lane use, determine the capacity of U-turn lanes under various geometric and operational conditions, and determine the anticipated effectiveness of proposed solutions to U-turn operational issues. These guidelines shall be structured appropriately for inclusion in the Roadway Design Manual and other manuals dealing with access management, design, and operations of facilities. This project shall also provide a cross-sectional safety analysis of existing U-turn configurations. The key product of the safety analysis is a self-calculating spreadsheet tool that can be used to predict U-turn safety performance under a variety of conditions.

Project Manager

Darrin Jensen, RTI

Project Supervisor

Jonathan Tydlacka, TTI

Total Project Budget	*Research University*	*FY 2016 Budget*
$292,665	Texas A&M Transportation Institute	$147,812

0-6895—Development of Low Maintenance Cost Median Barriers with Enhanced Safety Features

Start Date: 9/1/2015 *End Date: 2/28/2018*

Project Objectives

Median barriers are used as a separation between two opposing traffic lanes on divided highways. Typically, rigid median barriers are made of reinforced concrete using safety or single slope profiles. These barriers are positively constructed as an integral part of the roadway through starter bars or other construction means. A damaged rigid median barrier typically requires lane closures, which results in congestion, in addition to the costs associated with the repair of the damaged section.

Project Manager

Wade Odell, RTI

Project Supervisor

Akram Abu-Odeh, TTI

The research team shall design a new generation of median barriers for TxDOT through computer simulation and state-of-the-art optimization technologies in order to maximize the performance of the barrier in terms of safety, while incorporating low-maintenance cost features in the design. The research team shall review traditional and non-traditional construction material and technologies for use in this new design. Full-scale crash testing shall be conducted according to the latest version of AASHTO's Manual for Assessing Safety Hardware (MASH) standard to validate the crash worthiness of the system.

Total Project Budget	*Research University*	*FY 2016 Budget*
$737,453	Texas A&M Transportation Institute	$122,859
	Center for Transportation Research, The University of Texas at Austin	$138,953

0-6899—Traffic Safety Challenges and Strategies in the Eagle Ford Shale Area

Start Date: 9/1/2015 *End Date: 8/31/2017*

Project Objectives

In the past few years, Texas has experienced a boom in energy-related activities, particularly in the extraction of shale oil and natural gas. Horizontal drilling and hydraulic fracturing, or fracking, in the Eagle Ford area has resulted in an economic boom that is benefiting rural and urban communities alike. The Eagle Ford Shale area covers more than 25 counties and seven councils of government in South Texas. Unfortunately, many short-term and long-term impacts on the state transportation infrastructure result from these activities, including a dramatic increase in truck traffic and crashes involving commercial vehicles. Although local, county, and state agencies are beginning to implement measures to boost safety, these efforts are not properly documented and their effectiveness has not been assessed. TxDOT has started to document some observed impacts of energy-related activities in the Eagle Ford Shale region on transportation infrastructure and transportation safety through the analysis of five-year crash records; however, a detailed analysis of the direct impact of these activities on transportation safety in the region is lacking.

Project Manager

Wade Odell, RTI

Project Supervisor

Hatim Sharif, UTSA

The research team shall perform a comprehensive evaluation of crash causes and risk factors to identify the root causes of the dramatic increase in crashes involving commercial vehicles on roadways in the Eagle Ford Shale region. The research team shall detail the main types (run-off-the-road, right angle, side-swipe, rear end) and causes of crashes in the region, effectiveness of safety enhancement measures, and the other additional interventions that can improve the current state of practice.

Total Project Budget	*Research University*	*FY 2016 Budget*
$266,603	The University of Texas at San Antonio	$121,490

0-6907—Communicating Information for Traveling on Managed Lane Networks

Start Date: 1/1/2016 ***End Date: 8/31/2017***

Project Objectives

Managed lane networks are complex, interconnected facilities that require advancements in traveler information to successfully serve the users of those facilities. Historically, managed lanes were typically developed for single, distinct corridors, providing preferential access for users who travel from one endpoint to another. The success of past managed lane projects have led to planned and constructed networks of managed lanes that expand the concept across most major freeways within a region. Currently, operators rely mostly on signage, websites, and social media to convey information related to pricing and operating rules. Existing communication methods will become ineffective as network complexity increases. New technology, including advancements in traveler information and connected vehicles, may provide a solution to the problem. This research shall conduct a state-of-the-practice review, facilitate focus groups, and administer a survey to investigate current national practice and assess user information needs. A technology assessment shall examine the practicality of harnessing advancements in communication techniques and connected vehicle technologies. Overall, this research project shall improve the traveler experience, which could lead to improved mobility and economic benefit for the state of Texas.

Project Manager

Darrin Jensen, RTI

Project Supervisor

Nick Wood, TTI

Total Project Budget	*Research University*	*FY 2016 Budget*
$304,287	Texas A&M Transportation Institute	$132,183

0-6911—Development of Systemic Large Truck Safety Analyses

Start Date: 1/1/2016 *End Date: 2/28/2017*

Project Objectives

Texas has the highest number of fatal crashes involving large trucks in the US since 1994, and this number in 2012 grew by 82 percent from 299 crashes in 2009. Due to the size and weight, crashes involving large trucks are usually more destructive. Although there is a significant impact on Texas traffic safety, there has been less concern and fewer analyses on the risk factors of large truck-involved crashes, as well as the effectiveness of countermeasures. The goals of this research are to analyze the risk factors of large truck-involved crashes; recommend low-cost, high-effective countermeasures; as well as determine about how many large truck crashes can be reduced by specific countermeasure implementation. To achieve the research goals, the research team shall (1) conduct a crash data analysis to identify the crash hot spots and contributing factors to the large truck-involved crashes; (2) conduct a risk assessment in order to prioritize the risk factors; (3) survey truck drivers to validate the identified crash risk factors; (4) identify potential effective countermeasures for preventing large truck-involved crashes; and (5) conduct a cost-benefit analysis and recommend the most cost-effective countermeasures.

Project Manager

Wade Odell, RTI

Project Supervisor

Yi Qi, TSU

Total Project Budget	*Research University*	*FY 2016 Budget*
$118,036	Texas Southern University	$59,458

0-6912—Innovative Tools and Techniques in Identifying Highway Safety Improvement Projects

Start Date: 1/1/2016 *End Date: 6/30/2017*

Project Objectives

Federal legislation established the Highway Safety Improvement Program (HSIP), which requires states to develop and implement a strategic highway safety plan (SHSP) that aims to address highway safety problems. As part of the SHSP, agencies are expected to establish priorities that will help to achieve reductions in fatal and serious injury crashes on all public roads. According to the Texas SHSP, TxDOT must process crash data, analyze highway safety problems, identify appropriate countermeasures, and prioritize proposed improvements. The current safety project selection process at TxDOT suffers from certain limitations such as lack of consistent site selection procedures, limited tools to systematically screen candidate sites for safety improvement, and large demands on staff manpower resources. This research shall develop innovative tools and techniques that will allow TxDOT not only to minimize the amount of time and resources required to identify highway safety projects but also to spend safety funds in the most cost-effective manner. To accomplish this goal, researchers shall develop a process of analyzing and visualizing crash data; generate a series of visualization products that will be used in the context of the 2016 and 2017 HSIPs; develop a framework that will encompass a suite of tools and techniques that are specifically targeted toward reliable and consistent safety project identification; test and evaluate the effectiveness of these tools; and develop implementation strategies.

Project Manager

Darrin Jensen, RTI

Project Supervisor

Ioannis Tsapakis, TTI

Total Project Budget	*Research University*	*FY 2016 Budget*
$299,946	Texas A&M Transportation Institute	$134,401

0-6913—MASH Test Level 2 (TL-2) Short Radius Guardrail Treatment for Texas Roadways

Start Date: 1/1/2016 *End Date: 2/28/2018*

Project Objectives

When a secondary road or driveway intersects a highway in close proximity to a bridge, it is difficult to fit the proper guardrail length along the primary roadway to properly protect motorists from hazards underlying the bridge. In such instances, the available right of way and constrained distance between the bridge and secondary roadway or driveway can severely limit the application of effective safety treatments. One solution is to apply a tight radius to the guardrail in order to turn it from the primary road to the secondary road. A crashworthy solution for a short radius guardrail treatment has eluded the roadside safety research community for two decades. The research team's innovative short radius guardrail system performance qualifies for implementation on high-speed roadways (62 miles per hour) and will undoubtedly represent a significant improvement in roadside safety; however, there are many sites that are even more restrictive than the new short radius guardrail treatment can accommodate. A large percentage of these sites exist along lower speed roadways. Hence, a shorter, more economical short radius guardrail system suitable for implementation on low speed roadways is needed. Low speed roadways are those that have 45 mph or less speed limits and thus the roadside safety features have to meet MASH TL-2 performance criteria.

Project Manager

Wade Odell, RTI

Project Supervisor

Akram Abu-Odeh, TTI

Total Project Budget	*Research University*	*FY 2016 Budget*
$525,558	Texas A&M Transportation Institute	$98,403

0-6915—Identify Project Criteria for ITS Deployment in Work Zone

Start Date: 2/9/2016 *End Date: 2/28/2017*

Project Objectives

Intelligent transportation systems (ITSs) have become a widely accepted and trusted part of the surface transportation system, and the extent of their deployment for work zone projects has increased in recent years. In a fiscally constrained environment, however, highway agencies will be unable to meet the full demand of work zone ITS deployment. It is therefore desirable to establish guidelines to help TxDOT to systematically identify the work zone ITS locations as funding becomes available. The guidelines shall allow the work zone ITS infrastructure to yield the highest potential benefit or rate of return by deploying the system in the most efficient and productive locations. The objective of this project is to develop a selection methodology to assist project designers in assessing whether a particular project should be considered for work zone ITS deployment, based on identification of specific user or traveler needs for that project. If so, the assessment would also assist the designer in determining the system characteristics that would be most appropriate for that project. This assessment would also assist the designer in quantifying the expected or possible benefits of the system in terms of amount of reduced crash costs and reduction in work zone-induced delay to compare against expected costs of the system. The final product of this project shall be implementation-oriented guidelines for immediate use by TxDOT's Traffic Operation Division.

Project Manager

Darrin Jensen, RTI

Project Supervisor

Mehdi Azimi, TSU

Total Project Budget	*Research University*	*FY 2016 Budget*
$153,667	Texas Southern University	$54,444
	The University of Texas at El Paso	$33,667

0-6920—Proactive Traffic Signal Timing and Coordination for Congestion Mitigation on Arterial Roads

Start Date: 1/1/2016 *End Date: 12/31/2016*

Project Objectives

The rapid growth of urban passenger cars and freight volumes results in serious traffic congestion in many cities of Texas. The congestion not only causes more delay in daily commutes but also increases risk of incidents, as well as greenhouse gas emissions and fuel consumption. Recently, signal phasing and time control on arterial roads has attracted intensive research and implementation attention due to its advancement on direct traffic management and coordination. With precise loop-detecting technologies and/or increasing numbers of connected vehicles, signals are now able to interact with real-time traffic conditions and to be operated more proactively with traffic prediction models to mitigate road congestion and enhance the transportation network efficiency. The proposed innovation entails integrating traffic signals with various participants and infrastructures to develop a fully collaborative signal control system to maximize the network performance and minimize road congestion in the vicinities of intersections. The research leverages signal controls with recent advances in communications among detectors, connected vehicles, and signals to develop a proactive signal control system. The levers consider the following components: (a) network monitoring and prediction, (b) individual signal operation, and (c) signal coordination. The contractor anticipates that the project will save travel costs due to congestion of over $5.5 million in the next 10 years.

Project Manager

Darrin Jensen, RTI

Project Supervisor

Xing Wu, Lamar

Total Project Budget	Research University	FY 2016 Budget
$60,861	Lamar University	$51,511

9-1001-14—Traffic Control Device Evaluation Program

Start Date: 9/1/2013 ***End Date: 8/31/2016***

Project Objectives

This project shall provide TxDOT a mechanism to quickly and effectively conduct high-priority, limited-scope evaluations of traffic control devices (TCD) including policies and specifications. The TCD issues to be evaluated in this project may represent new devices or technologies, new applications of an existing device or technology, traffic control device material performance, or changes in TxDOT practices regarding a TCD. Examples of various evaluations include safety effects, visibility assessments, and cost/benefit analyses. The activities conducted through this project shall support the development of TCD related policy, standards, guidelines, handbooks, and training.

Project Manager

Wade Odell, RTI

Project Supervisor

Paul Carlson, TTI

The research activities of this project are specifically oriented to provide results that will lead directly to implementation. In each year of the project, TCD issues shall be identified and prioritized for investigation. The selected issues shall be evaluated and addressed with a separate work plan, and the results shall be presented in an individual technical memorandum. The technical memorandums shall include findings and recommendations that can support the implementation of the new guidelines or policy, as appropriate.

Total Project Budget	*Research University*	*FY 2016 Budget*
$994,929	Texas A&M Transportation Institute	$320,000

9-1002-15—Roadside Safety Device Crash Testing Program

Start Date: 9/4/2014 *End Date: 8/31/2017*

Project Objectives

This project provides TxDOT with a mechanism to quickly and effectively evaluate high-priority issues related to roadside safety devices. Roadside safety devices shield motorists from roadside hazards, such as non-traversable terrain and fixed objects. To maintain the safety of the motoring public, these safety devices must be designed to accommodate a variety of site conditions, placement locations, and a changing vehicle fleet. As changes are made or in-service problems encountered, there is a need to assess the compliance of existing safety devices with current vehicle testing criteria and to develop new devices with enhanced performance.

Project Manager

Wade Odell, RTI

Project Supervisor

Roger Bligh, TTI

This project is set up to provide quick response to identified roadside safety needs and produce research results that will be immediately implemented. Implementation efforts shall occur each year throughout the life of the project. The project shall result in new or improved safety features that will be implemented through new or revised standard detail sheets. It shall support the roadside safety needs of the Bridge, Design, Maintenance, and Traffic Operations Divisions.

Total Project Budget	*Research University*	*FY 2016 Budget*
$1,800,000	Texas A&M Transportation Institute	$600,000

Structures and Hydraulics

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0-6731—Repair Systems for Deteriorated Bridge Piles

Start Date: 9/1/2011 *End Date: 12/31/2015*

Project Objectives

The objective of the research project is to develop a durable repair system for deteriorated steel bridge piles that can be implemented without the need for dewatering. A rigorous survey of the relevant practice nationwide shall be conducted to inform and direct the remaining research efforts. The current state-of-practice shall be critically reviewed and the most promising alternatives shall be identified for detailed investigation. The structural performance, constructability, and economy of the existing systems shall be considered. A simplified but reliable framework for assessing the condition of deteriorated piles shall be developed. The framework shall be used to direct the full-scale testing of artificially deteriorated and repaired piles. Accelerated environmental exposure tests shall also be conducted to evaluate the durability of the different repair systems. The results of the full-scale tests and the environmental durability tests shall be used to direct a life-cycle cost analysis to identify the most economical repair systems based on initial costs, life-cycle costs, agency costs, and user costs. To evaluate the performance of the repair systems in real applications, field testing and long-term monitoring shall be conducted at two bridge sites. Based on the research findings, guidelines for the design, construction, and maintenance of the systems shall be developed to facilitate transfer of the technology to TxDOT bridge maintenance operations. The successful completion of the research project is expected to lead to the development of a new method and guidelines for repair of steel bridge piles that will significantly enhance the safety and economy of existing bridge infrastructure throughout the state.

Project Manager

Wade Odell, RTI

Project Supervisor

Mina Dawood, UH

Total Project Budget	*Research University*	*FY 2016 Budget*
$642,309	University of Houston	$9,900
	Center for Multidisciplinary Research in Transportation, Texas Tech University	$1,100

0-6783—Bi-directional Application of Carbon Fiber Reinforced Polymer (CFRP) with CFRP Anchors for Shear-Strengthening and Design Recommendations/Quality Control Procedures for CFRP Anchors

Start Date: 9/1/2012 *End Date: 12/31/2015*

Project Objectives

The Texas highway system is handling larger volumes of traffic and heavier loads than were expected when many bridges were designed. It may be necessary to reroute some loads to avoid overloading bridges of questionable strength. Texas bridges are largely constructed with pre-stressed concrete beams. CFRP strengthening to repair damage in critical locations or to remedy insufficient capacity for permitted overloads would be a valuable addition to structural preservation and life extension techniques.

Project Manager

Darrin Jensen, RTI

Project Supervisor

James Jirsa, CTR

The objective of the study is to demonstrate the feasibility of using bi-directional CFRP for shear strengthening of large bridge I- and U-beams. This project is an outgrowth of Project 0-6306 in which it was demonstrated that uni-directional CFRP strips and CFRP anchors could be used to improve the shear strength of reinforced concrete elements. The prime objective of that study was to evaluate the role of CFRP anchors. The tests showed that without anchors, the CFRP strips debonded and there was no significant improvement in the shear capacity. With CFRP anchors, it was possible to achieve a 40–50 percent increase in shear capacity. Tests of four 54 in. deep I-beams with both uni-directional and bi-directional CFRP strips indicated that the use of bi-directional strips led to significantly greater increases in shear capacity. It would not have been possible to strengthen the I-beams without the use of anchors to prevent debonding of the CFRP at reentrant corners of the cross section. Because the data on the bi-directional layout of CFRP were limited, additional work is needed to understand the behavior of the CFRP in strengthening thin webs subjected to large shear forces.

Since the anchor installation is a key element of the strengthening technique, there is a need for quality control procedures to make sure that the materials are used properly and the installation meets the design requirements. At present there are no quality control procedures available for CFRP anchors.

Total Project Budget	*Research University*	*FY 2016 Budget*
$995,026	Center for Transportation Research, The University of Texas at Austin	$42,320

0-6816—Partial Depth Precast Concrete Deck Panels on Curved Bridges

Start Date: 7/11/2014 End Date: 12/31/2015

Project Objectives

The primary objective of this research is to extend the use of precast concrete panels (PCPs) to curved girder systems. The focus of the study includes steel I-girder systems, steel tub girder systems, and spliced prestressed concrete U-beams, which are currently being considered for use in some Texas bridges. The research methods that are to be employed in this study consist of full-scale laboratory testing and parametric finite element modeling of the PCPs and the corresponding curved girder systems.

Project Manager

Wade Odell, RTI

Project Supervisor

Todd Helwig, CTR

Total Project Budget	*Research University*	*FY 2016 Budget*
$1,414,137	Center for Transportation Research, The University of Texas at Austin	$456,442

0-6829—Fatigue Resistance and Reliability of High Mast Illumination Poles (HMIPs) with Pre-existing Cracks (CTR)

Start Date: 8/22/2014 End Date: 3/31/2018

Project Objectives

High mast illumination poles (HMIPs) are used throughout Texas and the US to provide lighting along highways and at interchanges. Texas currently has about 5000 HMIPs, varying in height from 100 to 175 ft. In recent years, a number of HMIP collapses have been reported in other states. These collapses have been attributed to fatigue failures at the HMIP shaft-to-base plate connection.

Project Manager

Wade Odell, RTI

Project Supervisor

Michael Engelhardt, CTR

This project shall generate data and information to support a probabilistic-based assessment of the remaining life of pre-cracked HMIPs. Laboratory fatigue tests shall be conducted on pie-cracked galvanized HMIPs. In addition, field data shall be collected, and additional analyses shall be conducted to characterize the wind response of Texas HMIPs. Field and laboratory studies shall be supplemented by finite element studies simulating the global and local response of pie-cracked HMIPs. The results of the laboratory data, field studies, and analytical studies shall be combined in a reliability-based framework to provide a probabilistic assessment of the fatigue life of in-service pre-cracked HMIPs. Finally, additional information shall be developed on options for mitigating risk associated with cracked HMIPs, such as increased inspection and monitoring, repair techniques, and methods to reduce vortex shedding.

Total Project Budget	*Research University*	*FY 2016 Budget*
$1,437,727	Center for Transportation Research, The University of Texas at Austin	$508,387

0-6830—Fatigue Resistance and Reliability of High Mast Illumination Poles (HMIPs) with Pre-existing Cracks

Start Date: 9/3/2014 *End Date: 8/31/2016*

Project Objectives

This research project shall evaluate the safe and serviceable lives and probability-based life cycle costs of TxDOT high mast illumination poles (HMIPs). The research includes a unique high-cycle resonant bending fatigue testing plan, which will enable testing of HMIP base connections up to 100 million cycles within 6 weeks. The research team shall also conduct a detailed wind analysis based on a field monitoring campaign. The field measurements shall be used to develop new and detailed wind loading models to minimize the uncertainty associated with wind loading of these structures. The dynamic response of the poles and the corresponding stress ranges shall be modeled through a finite element analysis approach. A probabilistic life-cycle analysis shall be used to evaluate the probability of failure of the poles and the benefit/cost ratio of various intervention techniques. The findings of the research project will serve as a state-of-the-art reference for TxDOT engineers and decision makers to allocate resources, minimize risk, and maximize benefit/cost ratios associated with maintenance of high mast poles.

Project Manager

Wade Odell, RTI

Project Supervisor

Mina Dawood, UH

Total Project Budget	*Research University*	*FY 2016 Budget*
$587,917	University of Houston	$210,872
	Center for Multidisciplinary Research in Transportation, Texas Tech University	$65,587

0-6831—End Region Behavior of Pretensioned Concrete Beams with 0.7-Inch Prestressing Strands

Start Date: 7/31/2014 End Date: 8/31/2017

Project Objectives

While future implementation of 0.7-inch prestressing strands may reduce fabrication costs and extend the working range of pretensioned concrete beams, the limits of the technology have yet to be defined. An innovative combination of analytical and experimental methods shall be used to resolve the primary technical challenges to the fabrication of sate serviceable TX girders with 0.7-inch strands.

Project Manager

Wade Odell, RTI

Project Supervisor

Oguzhan Bayrak, CTR

- *End Region Serviceability*—Effective doubling of the stress imposed by each strand within a standard (2-inch by 2-inch) grid is expected to have a dramatic effect on the performance of current end region details. Practical modifications to the prestressing and end region reinforcement schemes shall be experimentally evaluated and refined to obtain serviceable behavior.
- *Ultimate Shear Strength*—The unique end region stresses imposed by 0.7-inch strands may influence the failure mode and ultimate strength of shear-dominated TX girders. Full-scale shear tests shall be completed to identify the controlling shear failure mechanisms and assess the conservation of the corresponding shear capacities estimated through application of the AASHTO LRFD shear design provisions.
- Implementation of 0.7-inch strands through application of the research findings shall be greatly facilitated by continuum TxDOT and industry stakeholder involvement throughout the course of the project.

Total Project Budget	*Research University*	*FY 2016 Budget*
$835,000	Center for Transportation Research, The University of Texas at Austin	$282,595

0-6841—Modeling a Change in Flowrate through Detention or Additional Pavement on the Receiving System

Start Date: 1/15/2015 End Date: 12/31/2015

Project Objectives

The addition or removal of flow from a stream affects the water surface downstream and possibly upstream. The extent of such effects is only known by modeling the receiving stream—a vital component of such modeling is where to locate boundaries in such a model. Rapid model development to assess incremental changes in flowrate from incremental changes in pavement coverage or detention benefits TxDOT by reducing the time required to assess the hydraulic impact. Researchers shall develop guidance that concisely describes how far upstream or downstream a hydraulic model needs to extend to fully describe those effects, and shall support rapid model construction to assess changes in anticipated discharge.

Project Manager

Wade Odell, RTI

Project Supervisor

Ted Cleveland, TECH

Total Project Budget	*Research University*	*FY 2016 Budget*
$59,945	Center for Multidisciplinary Research in Transportation, Texas Tech University	$22,147

0-6842—Analysis of Curb Inlets in the New TxDOT Standard Inlet and Manhole Program

Start Date: 1/15/2015 End Date: 2/28/2017

Project Objectives

This project shall provide design guidance for the flow performance of the new TxDOT standard on-grade type PCO precast curb inlet. The new curb inlet uses flush slab supports for inlets longer than 5 ft., which is required in Texas due to small road slopes and intense rainfall rates. The flush slab supports are thought to cause a substantial decrease in the curb inlet capacity, but there are no examples of inlet experiments in the literature that can be used to quantify the effect of the slab supports. Without new guidance on inlet capacity with slab supports, roadway designers must resort to making rough estimates of probable drainage effects, which could result in significant over- or under-capacity designs.

Project Manager

Wade Odell, RTI

Project Supervisor

Ben R. Hodges, CTR

The research team shall conduct full-scale experiments using the existing UT Roadway Physical Model and analyze the experimental results to provide a set of flow equations for inlet behavior that can be used in standard design software (for example, GeoPak Drainage). The research team shall test the new inlet design both with and without slab supports with the standard opening sizes (5, 9.5, 14 ft.) over a variety of roadway longitudinal and cross slopes at different flow rates and roadway roughness.

This research team shall determine how the new precast curb inlet will behave, which is critical to making best use of the new standards.

Total Project Budget	*Research University*	*FY 2016 Budget*
$307,551	Center for Transportation Research, The University of Texas at Austin	$137,261

0-6862—Improved Tub Girder Details

Start Date: 1/23/2015 End Date: 12/31/2018

Project Objectives

Steel trapezoidal box girders, generally referred to as tub girders, have been widely used on a number of bridges throughout the state of Texas. The smooth profile of the girder systems provides an aesthetically appealing bridge that also possesses several structural advantages compared to other girder types. Due to the high torsional stiffness of the closed box section, the girders are a popular choice in horizontally curved systems where the bridge geometry leads to large torsional moments. The girders have also been used on a number of straight girder systems throughout the state leading to improved bridge aesthetics. While tub girders have primarily been used on bridges with longer spans where concrete girders are not viable, an application of relatively shallow steel tub girders was recently utilized in the TxDOT Waco District on a bridge with span lengths normally reserved for concrete girder systems. The resulting bridge provided an aesthetically appealing structure that satisfied a demanding vertical clearance requirement and was cost comparable with precast concrete girders. This shallow tub girder application demonstrates that steel trapezoidal box girders offer a viable alternative that should be considered for a wider variety of bridge applications. However, to augment the viability of tub girders, improved details need to be considered to further enhance their economic and structural advantages. Modifications in the girder geometry can provide more efficient systems. Researchers shall conduct the research that consists of large-scale laboratory testing as well as parametric finite element analyses. The project shall result in improved details for tub girders as well as design methodologies for the girders and bracing components.

Project Manager

Wade Odell, RTI

Project Supervisor

Todd Helwig, CTR

Total Project Budget	Research University	FY 2016 Budget
$988,485	Center for Transportation Research, The University of Texas at Austin	$298,295

0-6863—Develop Strong and Serviceable Details for Precast, Prestressed Concrete Bent Cap Standards That Can Be Implemented on Everyday Bridge Construction Projects

Start Date: 1/27/2015 End Date: 11/30/2017

Project Objectives

This project shall enable TxDOT to use pre-tensioned, precast bent caps through a comprehensive investigation that shall include a literature search, review of design considerations, numerical modeling, and experimental verification. The specific objectives are to:

1. Develop strong and serviceable details for precast, pretensioned concrete bent cap standards that can be implemented in the TxDOT Bridge Standard.
2. Develop serviceable details for the overhang portion of the bent cap where the longitudinal prestressing force is less likely to be fully effective.
3. Evaluate the use of interior voids to reduce precast unit weight and enhance constructability.

Project Manager

Darrin Jensen, RTI

Project Supervisor

Anna Birely, TTI

Total Project Budget	*Research University*	*FY 2016 Budget*
$686,356	Texas A&M Transportation Institute	$300,394

0-6872—Use of Geothermal Energy for De-icing Approach Pavement Slabs and Bridge Decks

Start Date: 3/27/2015 End Date: 8/31/2016

Project Objectives

Deicing using geothermal energy can provide TxDOT a better alternative than the existing method of using deicing with sands and/or salts. This research project shall address this topic with a primary focus of comprehensive synthesis study. As a part of this synthesis, the available literature on geothermal energy along with success application case studies in the world on the use of geothermal energy for bridge decks and pavement deicing applications shall be compiled. The review of geothermal underground structures shall be focused on underground thermal energy storage (UTES), which is used to inject or extract heat into/from underground soil for seasonal cooling and heating needs. A preliminary finite element analysis of bridge deicing using geothermal energy shall also be performed using typical Texas soil and climate conditions to demonstrate feasibility along with potential cost-benefit analysis of the recommended geothermal deicing system for field application. Recommendations shall be made on candidate geothermal structures and bridge deck/pavement heating systems for field demonstration studies as a part of follow-up validation studies.

Project Manager

Sonya Badgley, RTI

Project Supervisor

Xinbao Yu, UTA

The main objectives of the synthesis project over a period of two fiscal years are:

1. Perform a synthesis study to investigate the current state of the art on the development of a geothermal system for Texas conditions to store and reuse the heat collected into an underground soil system to warm the bridge deck and approach pavement slabs above the freezing point.
2. Collect the available knowledge base including successful case studies in well-developed counties such as Switzerland and Germany on the UTES technology and determine their effectiveness in warming the bridge deck and pavement surfaces during freezing temperature conditions. Preliminary numerical modeling demonstrating thermal temperature distribution in the bridge deck/pavement systems along with cost-benefit studies using these technologies shall be performed and included as a part of the synthesis report.
3. Recommend geothermal structure, bridge deck, and approach pavement slab heating system model that can be implemented for field demonstration studies.

This project shall enhance the safety of the traveling public by alleviating treacherous road conditions during extreme winter conditions. Over the last three years, severe

winter conditions including snowstorm events have resulted in the closure of bridges and pavements due to icing conditions. These cold conditions have resulted in the closure of roads and bridges since icy road conditions result in accidents including human lives lost due to accidents. This geothermal technology can potentially alleviate this concern and enhance the safety of the traveling public by warming the roads and bridge decks so the surface conditions are much more conducive to safer traveling.

Total Project Budget	*Research University*	*FY 2016 Budget*
$193,063	The University of Texas at Arlington	$142,336

0-6882—Evaluating the Effectiveness of Freshwater Mussel Mitigation Strategies

Start Date: 9/1/2015 *End Date: 8/31/2018*

Project Objectives

Relocation of mussels is applied as a mitigation strategy for potential impacts on threatened mussel species resulting from bridge construction or repairs. Demonstrably efficient surveys are required to document the distribution and abundance of mussels within the potentially impacted area to enable relocation. Captive propagation of juvenile mussels could be an alternative mitigation strategy, with large numbers of juvenile mussels being released to augment populations.

Project Manager

Chris Glancy, RTI

Project Supervisor

Astrid Schwab, TSUSM

Researchers shall work in a collaborative effort among mussel experts, geneticists, and engineers to test currently applied relocation methods for mitigation, examine alternative options to provide the best ecological management approach, and test the capacity of captive propagation for population augmentation as an alternative mitigation strategy to relocation.

Total Project Budget	*Research University*	*FY 2016 Budget*
$266,442	Texas State University–San Marcos	$94,396

0-6893—Strengthening of Existing Inverted-Tee Bent Cap Ledges

Start Date: 9/1/2015 *End Date: 8/31/2018*

Project Objectives

Inverted-tee bent caps are used extensively throughout Texas to economically satisfy geometric constraints and to provide an aesthetically pleasing appearance. Over the decades, the design approach has changed in response to research prompted by observed cracking. With a change in design philosophy, many of the early inverted-tee ledges are deficient when evaluated against the current design approach. One example is the substructure supporting the IH-35 upper deck through downtown Austin.

Project Manager

Chris Glancy, RTI

Project Supervisor

Stefan Hurlebaus, TTI

The research objectives are:

1. Develop analysis procedure and evaluation criteria for existing inverted-tee bent cap ledges determined to have insufficient capacity based on current design methodologies.
2. Recommend technical concepts to retrofit ledges found to be deficient using current design methodologies.
3. Further develop the technical concepts based on various factors including design and constructability.
4. Validate the design concepts with full-scale testing.
5. Make recommendations for conditions where vertical clearance is controlled by the soffit of the inverted-tee ledge as well as locations where vertical clearance is not controlled by the inverted-tee ledge soffit.

A primary objective is to demonstrate and validate through experimental testing the satisfactory performance of strengthening existing inverted-tee bent cap ledges.

The solutions developed by this research shall provide increased capacity of existing substructure components on numerous direct connectors and other bridges including the highly congested IH-35 upper deck through downtown Austin.

Total Project Budget	*Research University*	*FY 2016 Budget*
$567,151	Texas A&M Transportation Institute	$125,697

0-6897—Evaluate Specialized Hauling Vehicles with Regard to Pavement and Bridge Deterioration and Posting Limit

Start Date: 9/1/2015 *End Date: 8/31/2017*

Project Objectives

The Federal Highway Administration (FHWA) requires a state to certify that it does not permit operation of specialized hauling vehicles (SHVs) or conducts bridge force effects load rating analyses consistent with the standard American Association of State Highway and Transportation Officials (AASHTO) HS20 or HL93 loads and applicable SHV loads based on five configurations.

Project Manager

Chris Glancy, RTI

Project Supervisor

C. Michael Walton, CTR

A single-unit truck is designed such that the engine, driver compartment, and the cargo are carried on the same truck chassis. An SHV is a modified single-unit truck with from 4 to 7 axles. The SHV is modified by adding from 1 to 4 liftable axles that can be raised once the cargo is delivered or, when the SHV is loaded, to make steering through an intersection easier though the potential for overturning might be increased. SHVs may be designed as dump trucks, construction trucks, ready mix trucks, solid waste trucks, and other types.

Researchers shall obtain field data to determine where SHVs operate in Texas; the numbers and types of SHV configurations; and axle loads, axle spacing, and gross vehicle weights. Researchers shall conduct pavement and bridge load rating analyses and shall determine load posting requirements. Researchers shall evaluate the deterioration (consumption) rates for pavements and bridges when all axles are on the ground and when axles are lifted to accommodate steering and other operations. Researchers shall evaluate safety by comparing the difference in SHV operating characteristics and crash history compared to common single unit and tractor-semi trailer truck configurations in Texas. Researchers shall prepare draft policy and legislation to manage SHV operations and load posting sign layouts for the Texas Manual on Uniform Traffic Control Devices (MUTCD).

Total Project Budget	*Research University*	*FY 2016 Budget*
$547,473	Center for Transportation Research, The University of Texas at Austin	$181,472
	The University of Texas at San Antonio	$75,433

0-6905—Performance of Skewed Reinforcing in Inverted-T Bridge Caps

Start Date: 1/1/2016 *End Date: 2/28/2019*

Project Objectives

Reinforced concrete inverted-T bridge caps are used extensively in Texas bridges. Many of these bridge structures must be skewed, some in excess of 45 degrees. Faster and easier construction could be obtained if skewed transverse reinforcing steel is utilized. Accordingly, there is a concern about whether using skewed transverse reinforcement will provide reasonable structural behavior for the skewed inverted-T bridge cap in terms of overall cracking occurrence and structural performance. The guidance in current AASHTO code and research of skewed inverted-T bridge caps are limited to only the design of typical normal skewed transverse reinforcement. Therefore, it is necessary to analyze the structural performance of the skewed inverted-T bridge caps with skewed transverse reinforcement and compare the performance to typical normal transverse reinforcement. This research project shall conduct the experimental and analytical investigation on the behavior of the skewed inverted-T bridge caps utilizing skewed transverse reinforcement emphasizing the following three aspects: (a) skewed angle, (b) detailing of transverse reinforcement, and (c) amount of transverse reinforcement. Design provisions of existing design codes, especially AASHTO LRFD code, shall be reevaluated through the experimental approach. Finally, a rational design method shall be established for the skewed inverted-T bridge caps with skewed transverse reinforcement.

Project Manager

Chris Glancy, RTI

Project Supervisor

Y. L. Mo, UH

Total Project Budget	*Research University*	*FY 2016 Budget*
$623,595	University of Houston	$203,832

0-6909—Designing for Deck Stress over Precast Panels in Negative Moment Regions

Start Date: 1/1/2016 *End Date: 12/31/2019*

Project Objectives

One of the leading causes contributing to structural deficiency in the United States Bridge Inventory is related to deterioration and durability issues with concrete bridge decks (NCHRP, 2004). The long-term costs associated with maintenance issues on bridges can quickly exceed the initial cost of the bridge. In 1999, Chase and Lamon estimated that more than $1 billion is spent annually repairing or replacing concrete decks on US bridges. The primary factor that can affect the durability of the concrete deck is cracking that provides a direct conduit for moisture and other corrosive agents to penetrate the concrete and attack the reinforcing steel. The area of the bridge where deck cracking is likely to be the most predominant is in the negative moment region where the concrete is subjected to tensile stresses from girder flexure. Therefore, controlling the size and distribution of the cracks in this region is of paramount importance. The size and distribution of cracks in the deck are controlled by the reinforcing steel that is provided. The distribution of the reinforcing steel that is used is often dependent on the forming system that is employed for the bridge deck. In 2002, Merrill estimated that partial depth precast concrete panels (PCPs) were used in approximately 85 percent of all Texas bridges. With wider usage on both steel and concrete girder systems, that number has likely grown and will continue to increase in the coming years. One of the problems faced by designers for continuous girder systems is the lack of clear guidance in the AASHTO LRFD specifications on the reinforcing requirements in the concrete deck. The specification does provide guidance on the deck steel requirements in the negative moment region of continuous steel girders and recommends the use of two layers of reinforcing. However, the AASHTO commentary recognizes the difficulty of fitting in two layers with PCPs and suggests the engineer of record make a decision on the best layout of the steel. For continuous prestressed concrete girders with PCPs, AASHTO does not provide any guidance on the layout of the steel in the negative moment region. The vague commentary language for continuous steel girders as well as the lack of provisions for continuous prestressed concrete girders results in a complicated situation for engineers that can create either overly conservative or unconservative conditions depending on how an engineer interprets the specification and commentary. Consequently, at one extreme, TxDOT may end up with inefficient and uneconomical structural systems that are difficult to build, and at the other, a poorly reinforced bridge deck that results in long-

Project Manager

Joe Adams, RTI

Project Supervisor

Todd Helwig, CTR

term maintenance issues that can prove very costly. The goal of the proposed research investigation is to develop comprehensive guidelines for deck reinforcing steel details in the negative moment regions of bridges utilizing PCPs. Although the primary focus of the investigation is on continuous prestressed concrete girder systems, improved guidance shall also be developed for continuous steel girder systems.

Total Project Budget	*Research University*	*FY 2016 Budget*
$994,832	Center for Transportation Research, The University of Texas at Austin	$119,269

0-6914—Non-contact Splices at Drilled Shaft to Bridge Column Interface

Start Date: 1/1/2016 *End Date: 2/28/2019*

Project Objectives

Use of the contact lap splices of the reinforcement is common for the construction of reinforced concrete structures. It is now often required to provide a reinforcing steel splicing arrangement with non-contact lap splices for the connection of non-circular bridge columns interfacing directly with circular drilled shafts. The general requirement of a splice is to transfer the forces from one rebar to another without spalling of surrounding concrete and large cracks. Accordingly, there is concern about whether the non-contact splices at drilled shaft to bridge column connections are safe and cost effective because the guidance in current AASHTO code and research for this type of connection is limited. This research project shall conduct the experimental and analytical investigation on the behavior of non-contact splices at geometrically dissimilar bridge column and drilled shaft interfaces with regards to the following parameters: (a) splice length, (b) splice spacing, (c) amount of confining reinforcement, (d) reinforcing steel ratio, and (e) strength of reinforcing bars. Design provisions of existing regulations, especially AASHTO LRFD code, shall be reevaluated through the experimental approach. Finally, a rational design method and appropriate construction practices shall be established for safe and serviceable non-contact splices at bridge column and drilled shaft connections.

Project Manager

Joe Adams, RTI

Project Supervisor

Y. L. Mo, UH

Total Project Budget	*Research University*	*FY 2016 Budget*
$616,995	University of Houston	$201,632

0-6916—Seismic Vulnerability and Post-Event Actions

Start Date: 1/1/2016 *End Date: 12/31/2017*

Project Objectives

Over the past five years, the number of earthquakes per year in Texas has increased significantly, particularly near the Dallas metropolitan area. This recent increase in Texas seismicity raises concerns over the seismic safety of bridge infrastructure in Texas, which has historically been designed with little to no consideration of seismic demands. This project shall address these concerns by generating new data to characterize the natural and potentially non-natural seismic hazards in Texas and to predict the levels of ground shaking that may be expected. Researchers shall provide a seismic hazard map of the state to identify areas of greatest risk for earthquakes. Researchers shall subject numerical models of bridges capable of simulating damage to a variety of earthquakes representative of those expected in the state of Texas. The researchers shall use results from this study to predict the likelihood of seismic damage in various types of bridges. This information shall help TxDOT evaluate its exposure to seismic risk and inform TxDOT of best practices in post-earthquake response. The project shall result in tools to inform targeted, immediate post-earthquake inspection of those bridges that are found to be at most risk for damage.

Project Manager

Joe Adams, RTI

Project Supervisor

Patricia Clayton, CTR

Total Project Budget	*Research University*	*FY 2016 Budget*
$539,631	Center for Transportation Research, The University of Texas at Austin	$194,559

0-6917—Synthesis of Concrete Bridge Piles Prestressed with CFRP Systems

Start Date: 1/1/2016 *End Date: 12/31/2016*

Project Objectives

The transportation infrastructure is aging and deteriorating mostly due to corrosion problems related to the prestressing steel strands. A corrosion-free material for reinforcement will create alternatives for bridge engineers to design long-lasting and safer bridge members. If not considered, corrosion will create additional maintenance and replacement costs for TxDOT. Furthermore, the loss of cross-section of the prestressing steel will result in lower load carrying capacity of the member, which may eventually lead to structural failure. This will cause a public safety issue.

Project Manager

Chris Glancy, RTI

Project Supervisor

Abdeldjelil Belarbi, UH

Prestressed concrete piles are exposed to aggressive environmental affects that cause corrosion of the internal prestressing steel. The loss of functionality due to corrosion of the prestressed reinforcement of the piles causes service interruptions or replacements and in most cases requires expensive interventions. A promising alternative to prestressing steel is the use of corrosion-free CFRP prestressing strands in prestressed concrete piles. The behavior of the CFRP prestressed concrete piles should be investigated as a possible component of bridges with much longer target design lives (exceeding 100 years).

Current investigations indicate that some DOTs are including pilot studies using CFRP in the design of prestressed piles. Most of these studies are not assessed through laboratory tests. Furthermore, there is a lack of design specifications and construction procedures to enable transportation engineers to adopt this innovative technology. As part of this synthesis study, the research team shall:

1. Conduct a comprehensive literature review of all existing, published and unpublished, investigations related to CFRP prestressed piles.
2. Identify the research and practice gaps.
3. Derive a research plan including experimental and analytical studies to complement existing knowledge.
4. Identify the set of design guidelines and construction specifications that needs to be developed for the use of these materials.

The synthesis study shall develop a plan for the required research and implementation plans to be adopted by TxDOT.

Total Project Budget	*Research University*	*FY 2016 Budget*
$60,000	University of Houston	$43,168
	The University of Texas at Tyler	$5,720

0-6919—Evaluation of Structural Cracking in Concrete

Start Date: 1/1/2016 ***End Date: 8/31/2018***

Project Objectives

Current procedures used for classifying the damage associated with visually observed cracking in reinforced and prestressed concrete structures generally consist of various rating criteria that are comprised of pre-established crack width limits. While such procedures can be useful for cataloguing damage progression, they typically provide very little information pertaining to the structural capacity implications of concrete cracking observed in the field. Thus, the development of reinforced concrete strength assessment procedures that employ visual crack measurement data as the primary basis for capacity assessment will better assist engineers in prioritizing rehabilitation and maintenance efforts and will serve as valuable tools that can be used in identifying strength-related deficiencies.

Project Manager

Chris Glancy, RTI

Project Supervisor

Trevor Hrynyk, CTR

Analytical studies shall be used to develop practical crack-based shear strength assessment procedures that are rooted in mechanical models and novel damage evaluation techniques. By way of their crack-based formulations, these procedures shall inherently incorporate influences associated with member scale, reinforcement details, and loading conditions. The procedures shall be evaluated and refined using test data pertaining to well-documented TxDOT relevant concrete infrastructure elements and subsequently shall be employed to develop crack inspection field aids that can be used by TxDOT personnel on site.

Total Project Budget	*Research University*	*FY 2016 Budget*
$497,102	Center for Transportation Research, The University of Texas at Austin	$128,075

0-6922—Evaluating Long-Term Durability/Performance of Prestressed Concrete Beam with Extensive Surface Cracking

Start Date: 1/1/2016 *End Date: 1/31/2019*

Project Objectives

This project focuses on the cracking of concrete beams that has been observed at most of the large precast plants in Texas in recent years. This cracking appears approximately 18–24 months after fabrication, and the exact nature of these cracks is not clearly understood. The overarching goal of this project is to use existing cracked beams to predict whether long-term durability issues will develop. The research team is uniquely equipped to conduct this project due to the expertise of its team and the ability to leverage the efforts of this project with relevant projects underway at CTR. The research team shall execute a comprehensive program consisting of non-destructive evaluations and core-based tests to determine the effect of the cracks on mechanical properties and durability. The research team shall develop a novel method to evaluate the extent to which the cracks contribute to corrosion of pre-stressing strands and conduct service life modeling to estimate the effect that the cracks have on the service life of the beams. Successful completion of this project shall result in the research team providing recommendations to TxDOT on the likelihood of long-term material and structural problems occurring from these cracks.

Project Manager

Chris Glancy, RTI

Project Supervisor

Raissa Ferron, CTR

Total Project Budget	Research University	FY 2016 Budget
$521,998	Center for Transportation Research, The University of Texas at Austin	$122,637

5-6022-03—Pilot Implementation Using Geofoam for Repair of Bridge Approach Slabs and Adjoining Roadway

Start Date: 4/29/2015 End Date: 8/31/2017

Project Objectives

The scope of this implementation project is to expand on the work completed in Project 5-6022-01 with continued demonstration of the longer-term performance of the EPS geofoam in the US 67 bridge over SH 174 in the Fort Worth District and the formulation of design charts for future use of EPS geofoam in other projects statewide and nationally.

Project Manager

Joe Adams, RTI

Project Supervisor

Anand Puppala, UTA

Total Project Budget	*Research University*	*FY 2016 Budget*
$336,370	The University Texas at Arlington	$90,497

5-6359-01—Implementation of New Specification Requirements for Coarse Backfill Materials for Mechanically Stabilized Earth (MSE) Walls

Start Date: 8/15/2015 End Date: 8/31/2018

Project Objectives

The objective of this implementation project is to establish material specifications for coarse aggregates (Item 423, Type A and D) used to construct MSE walls in Texas.

Project Manager

Joe Adams, RTI

Project Supervisor

Soheil Nazarian, UTEP

This project includes the following items:

1. Producing material property data using the field leach test procedures developed in Project 0-6359 and comparing with the data from traditional TxDOT methods.
2. Collecting field performance data to establish limits of acceptable material property values using method including electric impedance spectroscopy (EIS).
3. Developing guidance documents for proper selection and inspection of coarse aggregates used in constructing MSE walls.
4. Providing support and training to TxDOT personnel for the proper use of coarse aggregates in MSE backfill.

Total Project Budget	*Research University*	*FY 2016 Budget*
$365,000	The University of Texas at El Paso	$125,000

5-6719-01—Bridge Strengthening Design and Load Testing for a Continuous Steel Girder Bridge with Post-Installed Shear Connectors

Start Date: 12/17/2015 *End Date: 8/31/2016*

Project Objectives

A non-composite continuous steel girder bridge in Texas will be strengthened using techniques developed in Research Project 0-6719. The strengthening approach includes the use of post-installed shear connectors in positive moment regions and the allowance of limited flexural yielding in negative moment regions. The project shall demonstrate the strengthening technique, evaluate potential difficulties in design and construction and suggest solutions, and evaluate structural effectiveness and cost effectiveness of this bridge strengthening technique. This project shall include the selection of a non-composite continuous girder bridge in Texas for strengthening, detailed design of the strengthening system, detailed finite element analysis of the un-strengthened and strengthened bridge designs, and field load testing of the un-strengthened bridge to obtain baseline data on the behavior of the existing bridge for later comparison with field load testing data for the strengthened bridge.

Project Manager

Darrin Jensen, RTI

Project Supervisor

Michael Engelhardt, CTR

Total Project Budget	*Research University*	*FY 2016 Budget*
$146,472	Center for Transportation Research, The University of Texas at Austin	$146,472

TxDOT Administration and Technology Transfer

Project	Title	Start Date	Page
0-6806-CTR	TxDOT Administration Research	9/1/2014	168
0-6806-TTI	TxDOT Administration Research	9/1/2013	169
5-0575-16	Texas Local Technical Assistance Program (TxLTAP)	9/29/2015	170

0-6806-CTR—TxDOT Administration Research

Start Date: 9/1/2014 ***End Date: 8/31/2016***

Project Objectives

This project was established to allow TxDOT to receive results on short-term research efforts. The scope of this project allows for work requests to be identified and research conducted on, but not limited to, policy and legislative issues. This project shall also evaluate numerous transportation issues and develop findings and/or recommendations based on results.

Project Manager

Sonya Badgley, RTI

Project Supervisor

Khali Persad, CTR

Two of the most significant of these are that:

1. Transportation research needs are sometimes identified in a manner that necessitates a quick response that does not fit into the normal research program planning cycle.
2. Individual transportation research needs are not always sufficiently large enough to justify funding as a stand-alone research project, despite the fact that the issue may be an important one.

Total Project Budget	*Research University*	*FY 2016 Budget*
$375,000	Center for Transportation Research, The University of Texas at Austin	$124,999

0-6806-TTI—TxDOT Administration Research

Start Date: 9/1/2013 ***End Date: 8/31/2016***

Project Objectives

This project was established to allow TxDOT to receive results on short-term research efforts. The scope of this project allows for work requests to be identified and research conducted on, but not limited to, policy and legislative issues. This project shall also evaluate numerous transportation issues and develop findings and/or recommendations based on results.

Project Manager

Kevin Pete, RTI

Project Supervisor

Bill Stockton, TTI

Two of the most significant of these are that:

1. Transportation research needs are sometimes identified in a manner that necessitates a quick response that does not fit into the normal research program planning cycle.
2. Individual transportation research needs are not always sufficiently large enough to justify funding as a stand-alone research project, despite the fact that the issue may be an important one.

Total Project Budget	*Research University*	*FY 2016 Budget*
$375,000	Texas A&M Transportation Institute	$125,000

5-0575-16—Texas Local Technical Assistance Program (TxLTAP)

Start Date: 9/29/2015 End Date: 8/31/2017

Project Objectives

The objective of this program is to demonstrate a nationally recognized reputation of excellence for meeting the varied training and technical assistance needs of the large and diverse population of local city and county road agencies in Texas, aligning and presenting training and technical assistance services that meet those varied needs, and being widely known as the training and technical resource for local road agencies in Texas. The program shall focus on preserving and enhancing the local road system; delivering quality training and technical assistance to local city and county road agencies in Texas that assist the performance of their duties in a safe, efficient, environmentally sound, and cost effective manner; and simultaneously maximizing benefits from limited fiscal and staffing resources.

Project Manager

Joe Adams, RTI

Project Supervisor

Bryan Sims, UTA

Total Project Budget	*Research University*	*FY 2016 Budget*
$1,819,907	The University of Texas at Arlington	$920,916