



## Transportation Consortium of South-Central States

*Solving Emerging Transportation Resiliency, Sustainability, and Economic Challenges through the Use of Innovative Materials and Construction Methods: From Research to Implementation*

### Semi-Annual Progress Report #5

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# 1. Accomplishments

## Major Goals and Objectives of the Program

The **Vision** of Tran-SET is to “address the accelerated deterioration of the transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes”.

The **Mission** of Tran-SET is to “conduct all phases of research, technology transfer, education, workforce development, and outreach activities as to solve transportation challenges in Region 6 and support implementation”.

The following 14 objectives are at the heart of *all* Tran-SET activities<sup>1</sup>:

Table 1. Major Objectives of Tran-SET.

ID <sup>1</sup>	Objective
<b>RESEARCH</b>	
R1	Improve the durability and extend the service life of transportation infrastructure [IF2, IN1 <sup>2</sup> ]
R2	Preserve the environment [IF1, IN1]
R3	Preserve the existing transportation system [IF2, IN1]
R4	Address immediate transportation priorities in Region 6 [S1, IF2, IF3, IF4, IN1]
<b>TECHNOLOGY TRANSFER</b>	
TT1	Ensure that scientific and technological developments are accessible, disseminated, and transferred to a wide range of users including state agencies, universities, and industries [IN2]
TT2	Ensure that scientific and technological developments have long-term research value and significant impact to the transportation industry by direct collaboration with all levels of government and nonprofit institutions [IN2]
<b>EDUCATION</b>	
E1	Improve and support existing academic programs at Tran-SET’s partnering institutions [IF4, A2]
E2	Improve and support transportation non-degree programs at Tran-SET’s partnering institutions (architectural, business, mechanical, electrical, industrial engineering, etc.) [IF4, A2]
<b>WORKFORCE DEVELOPMENT</b>	
WF1	Ensure research outcomes are disseminated through educational and workforce development activities by supporting the development of seminars, workshops, and training courses [IF4, A2]
<b>EMPHASIS AREAS</b>	
EL1	Develop the next generation of leaders and graduate students of the transportation field by supporting mentoring, networking, training, and other development activities [IF4, A2]
EL2	Provide leadership to regional stakeholders and communities (state agencies, universities, and industries) and provide national leadership to applicable research communities [IN1, IN2]
EC1	Encourage and foster collaboration between partnering institutions and external stakeholders as to: (1) maximize sharing of human expertise and facilities among partners and stakeholders, (2) tackle transportation challenges only solvable by multi-disciplinary teams, (3) facilitate knowledge transfer among the team institutions and stakeholders, and (4) minimize duplicative research to optimize the use of available funds [IN2, A2]
ED1	Integrate diversity-related activities into Tran-SET’s efforts as to increase participation of underrepresented students in STEM fields, particularly the transportation field [IF4, A2]
<b>MANAGEMENT</b>	
M1	Operate and manage Tran-SET as to ensure the highest degree of accountability, cost-efficiency, and optimum use of available funds, facilities, and capabilities [A2]

<sup>1</sup>All activities, outputs, outcomes, and impacts are categorized under Tran-SET’s objectives (in blue).

<sup>2</sup>All Tran-SET objectives, activities, outputs, outcomes, and impacts are categorized under objectives of the US DOT Strategic Plan for FY2018-2022 (in green). Regarding ID abbreviations: S refers to Safety, IF refers to Infrastructure, IN refers to Innovation, and A refers to Accountability objectives, respectively.

## Accomplishments (During this Reporting Period)

### RESEARCH

**Award of Third-Cycle Projects:** 36 proposals were reviewed by national subject matter experts (Apr. 2019), solicited for revisions by the PIs (May 2019), and finalized (Jun. 2019). Ultimately, 33 projects were selected for award and started on **Aug. 15, 2019**. Figures 1a and 1b show the distribution of projects by research objective and transportation area, respectively. Detailed information can be found in Appendix A [R1, R2, R3, R4, S1, IF2, IF3, IF4, IN1].

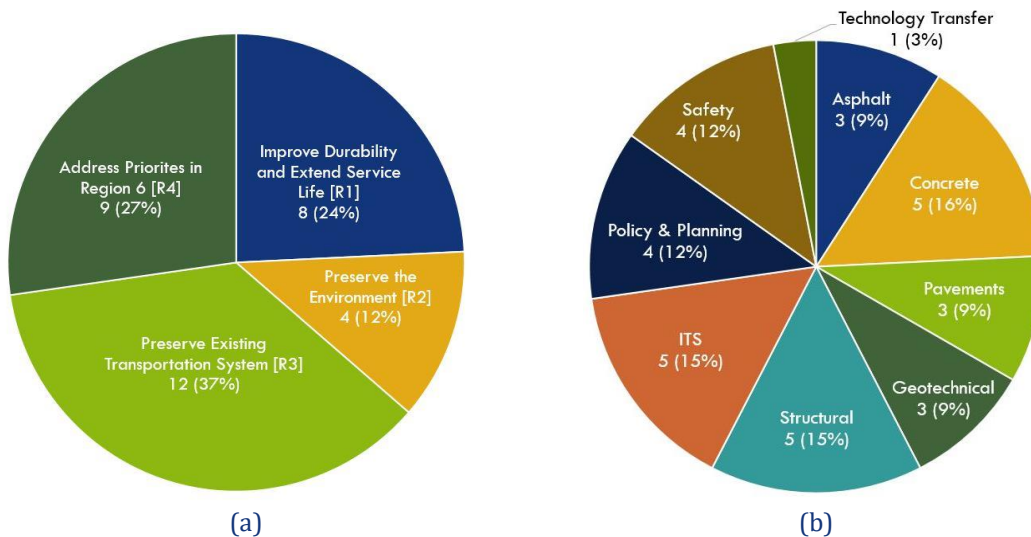


Figure 1. Third-Cycle Projects Categorized by: (a) Research Objective and (b) Transportation Area.

**Problem Statements for Fourth-Cycle Projects:** Tran-SET issued a call for problem statements (May 2019) for their fourth-cycle of research projects. A total of 96 problem statements (a record high) were received from 15 institutions in Region 6 (Aug. 2019). 17 problem statements were collaborative, involving multiple partnering institutions. Problem statements are categorized below. Problem statements are currently in review and being ranked by regional transportation leaders/experts. [R1, R2, R3, R4, S1, IF2, IF3, IF4, IN1]

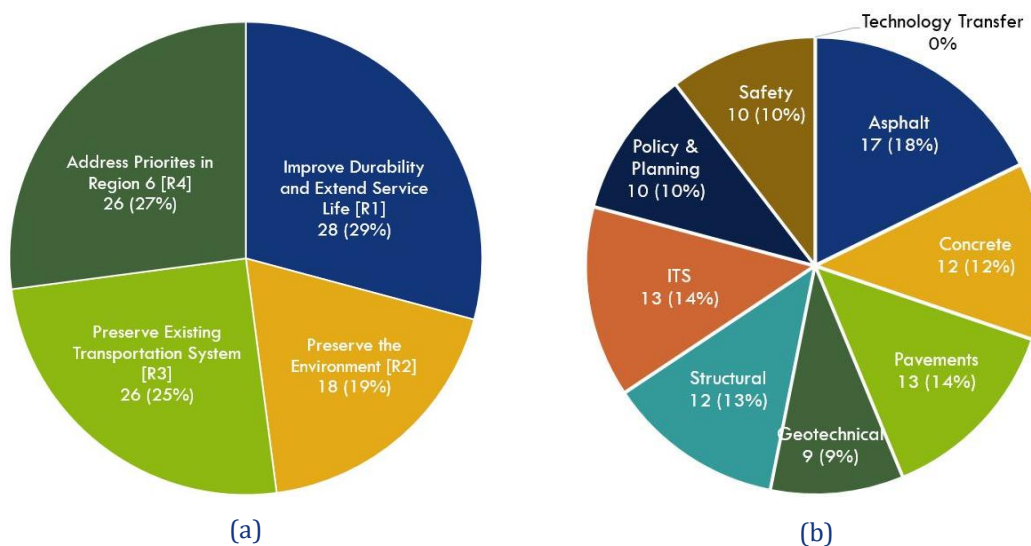


Figure 2. Fourth-Cycle Problem Statements Categorized by: (a) Research Objective and (b) Transportation Area.

**Final Reports and Project Datasets for Second-Cycle Projects:** Tran-SET staff conducted an initial review of submitted second-cycle final reports (Apr. 2019), requested revisions, received revisions (May 2019), coordinated review of each report by their respective project review committee (Jun. 2019), and finalized reports (Sep. 2019). Corresponding project datasets were also received and finalized (Sep. 2019). **26** final reports and corresponding project datasets have been archived and disseminated per UTC reporting requirements (Sep. 2019). They can be accessed from [Tran-SET's website](#). [TT1, IN2]

**Project Closeout of Second-Cycle Projects:** Tran-SET's second-cycle projects ended their implementation phase, submitted their implementation reports, and were successfully completed/closed out (Sep. 2019). [M1, A2]

## TECHNOLOGY TRANSFER

**2019 Tran-SET Conference:** Tran-SET held its second annual Conference on **Apr. 11-12, 2019** in San Antonio, TX. The program included: **2** keynote speakers, **2** additional guest speakers, **68** lectern presentations (covering all second-cycle projects), and **38** student posters. The Conference also included a Business Meeting with center advisory board (CAB) members. To enhance the international presence of Tran-SET, Professor Hainian Wang, Assistant Dean at Chang'an University, Xi'an (China) attended the Conference and joined Tran-SET's CAB. The Conference had over **110** attendees and provided a unique opportunity to network directly with Region 6 stakeholders and communicate how Tran-SET research can solve regional challenges. The Conference Program and published Conference Proceedings is available on [Tran-SET's website](#). The Conference was co-sponsored by the ASCE Transportation and Development Institute (T&DI). [TT1, TT2, EL2, IN2]

**2020 Tran-SET Conference:** Tran-SET will hold its third annual Conference on **Apr. 2-3, 2020** in Albuquerque, NM. The Conference is co-sponsored by the ASCE Construction Institute and hosted by the University of New Mexico (UNM) and New Mexico State University (NMSU). The Conference theme is "enhancing durability of service life of infrastructure: materials, methods, and technology." Many activities have occurred during this reporting period in preparation: established Conference Planning Committee (Apr. 2019), selected venue and date (May 2019), created Conference website (May 2019), solicited call for papers/presentations (Jul. 2019), contracted publisher (Aug. 2019), and collected/organized abstract submissions (Aug. 2019). In total, **52** abstracts were received. More information is available on [Tran-SET's website](#). [TT1, TT2, EL2, IN2]

**Joint Tran-SET Webinar Series:** Tran-SET continued its quarterly webinar series with its fourth (Jun. 2019) and fifth webinars (Sep. 2019). Both webinars were on the topic of "Innovative Technology, Techniques, and Processes in Transportation Infrastructure Inspection." The webinars were offered in collaboration with Region 2 UTC, Region 7 UTC, New Jersey DOT, and Nebraska DOT. Recorded webinars and other outreach materials are available on [Tran-SET's website](#). [TT1, TT2, EL1, EL2, EC1, IF4, IN2, A2]

**Newsletter:** Tran-SET continued to develop and disseminate its quarterly newsletter with the summer 2019 issue (Jul. 2019). Newsletters are disseminated via Tran-SET's listserv. Current and past newsletters are available on [Tran-SET's website](#). [TT1, IN2]

**Technology Transfer (T2) Plan:** Tran-SET continues to implement our T2 plan, specifically: requiring third-cycle proposals to include project-specific T2 plans and utilizing these plans in the review/selection process (Apr. 2019), establishing project review committees (PRCs) for each third-cycle project (Jul. 2019), and facilitating meetings between each research team and their respective PRC (Sep. 2019). These meetings have proven effective: providing needed guidance to the research, creating an engaged PRC, and identifying allies to champion T2 activities. [TT1, TT2, EC1, IN2, A2]

## EDUCATION

**Navajo Technical University Internship:** Tran-SET hosted their second annual Internship supporting Navajo Technical University (NTU) students to participate in Tran-SET-funded research at Louisiana State University (LSU). The Internship took place on **June 3-28, 2019** and included two Navajo students: Mr. Seth Dennison and Ms. Samantha Francis. The students were exposed to a variety of transportation topics and professions, including: a site visit to the FHWA LA Division Office, a local construction site visit, a site visit to the Capital Region Planning Commission, and an on-site presentation from Louisiana DOTD. More information is available on [Tran-SET's website](#). Due to the small pool of applicable NTU students, Tran-SET will open future Internships to Native American students at all partnering institutions. [E1, EL1, EC1, ED1, IF4, A2]

**Project-Level STEM Events:** Tran-SET and its affiliates sponsored, organized, and participated in several STEM events. Illustrative examples are listed below. [E1, E2, EL1, IF4, A2]

- *Summer Transportation Institute* – Dr. Fernando Moreu (PI) exposed high school students to advances in transportation infrastructure inspection with hands-on activities involving vibration sensors at UNM's Summer Transportation Institute (Jun. 2019).
- *Arrowhead High School* – Dr. Craig Newston (Associate Director) presented advances in concrete technology and its transportation applications to a student group at Arrowhead High School in Las Cruces, NM (Sep. 2019).
- *B.I.G. Girl Scout Event* – Tran-SET exhibited a booth at the B.I.G. Event held by the Louisiana East Girl Scouts (Sep. 2019). Mr. Christopher Melson (Program Manager), with several graduate students, demonstrated how concrete and asphalt are made, used in roadways, and how Tran-SET research is improving these materials. Over 2,000 Girl Scouts attended.

## WORKFORCE DEVELOPMENT

**Project-Level Involvement:** Tran-SET has sponsored, organized, and participated in various workshops, developed and presented revised course materials, and contributed to several professional societies. Illustrative examples are listed below. [WF1, TT1, TT2, EL2, IF4, A2, IN2]

- *Hosted Seminar* – Tran-SET hosted a seminar entitled “Pushing the Limits of Recycled Pavements: Total Recycle Mixtures” presented by the Chicago Testing Laboratory (CTL) (Aug. 2019). CTL is a CAB member and past financial sponsor of the Tran-SET Conference. The presentation discussed roadway mixtures designed with only recycled aggregate, recycled asphalt binder, and minimal new asphalt binder.
- *Structural Engineering Association of Texas* – Dr. Adolfo Montoya (PI) presented research findings at the 2019 Annual State Conference organized by the Structural Association of Texas (Sep. 2019). The presentation educated structural engineers on the interaction between bridges and waves during extreme weather events (Project No. 18STTSA04).
- *WTS Louisiana* – Tran-SET hosted WTS Louisiana on the campus of LSU for their August Luncheon. Mr. Christopher Melson (Program Manager) briefly gave an overview of Tran-SET and led a tour of several transportation-related laboratories (Aug. 2019). Tran-SET plans to continually work with WTS Louisiana and jointly host regular activities.

## MANAGEMENT

**Section 508/Accessibility:** Tran-SET has been working diligently to ensure all public facing content (submitted to NTL and all content residing on the Tran-SET website) is 508 compliant. Completed content includes: **30** previously submitted first-cycle final reports and project datasets (Jul. 2019), **225** documents on Tran-SET's website (Aug. 2019), all other information on Tran-SET's website and social media page (Aug. 2019), and **18** hours of video content (75% complete). [M1, A2]

## Dissemination of Results

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Please see the “Technology Transfer” subsections of Sections 1 (above) and 3 (below) documenting Tran-SET’s main outreach activities. More generally, results have been disseminated via: social media ([Tran-SET website](#), [LinkedIn](#), [Twitter](#), and [YouTube](#)), newsletters, other promotional documents (i.e., project briefs), conferences, educational materials, and peer-reviewed publications.

## Activities Planned (for Next Reporting Period)

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### RESEARCH

- Archive and finalize remaining second-cycle project deliverables (Oct. 2019). [TT1, IN2]
- Review/rank fourth-cycle problem statements (Dec. 2019), develop request for proposals for selected problem statements (Jan. 2020), and finalize review of proposals (Mar. 2020). [R1, R2, R3, R4, S1, IF2, IF3, IF4, IN1]

### TECHNOLOGY TRANSFER

- Develop and disseminate Tran-SET newsletter for fall 2019 (Oct. 2019), winter 2019 (Dec. 2019), and spring 2020 (Mar. 2020). [TT1, IN2]
- Promote and disseminate second-cycle reports and project datasets via Tran-SET listserv and social media (Nov. 2019). [TT1, IN2]
- Organize and jointly host two webinars in the “Joint-Tran-SET Webinar Series” (Dec. 2019, Mar. 2020). [TT1, TT2, EL1, EL2, EC1, IF4, IN2, A2]
- Continue planning activities for the 2020 Tran-SET Conference, including: finalize the registration process/mechanism (Oct. 2019), open registration (Nov. 2019), collect papers for review (Nov. 2019), review and select papers (Dec. 2019), finalize program and speakers (Jan. 2020), and prepare all other materials (Mar. 2020). [TT1, TT2, EL2, IN2]
- Begin planning activities for the 2021 Tran-SET Conference, including: establishing Conference Planning Committee (Feb. 2020) and selecting a venue and date (Mar. 2020). [TT1, TT2, EL2, IN2]

### EDUCATION

- Continue to develop revamped “Native American Transportation Internship”, including: developing new applicant processes and instructions (Jan. 2020), hosting webinar to explain and promote Internship (Feb. 2020), begin working with Native American organizations at partnering institutions to find applicants (Feb. 2020), and begin developing Internship program and application selection (Mar. 2020). [E1, EL1, EC1, ED1, IF4, A2]
- Continue to offer the Tran-SET Scholarship for Veterans, disseminate, and award to two recipients in the 2020 spring or fall semester (Jan. 2020). [E1, EL1, EC1, ED1, IF4, A2]
- Plan and conduct a jointly sponsored STEM event with WTS Louisiana – aimed at exposing diverse LSU undergraduate and graduate students to the transportation field and possible transportation-related careers (Mar. 2020). [E1, E2, EL1, IF4, A2]
- Continue sponsoring, organizing, and participating in STEM events (on-going). [E1, IF4, A2]

### WORKFORCE DEVELOPMENT

- Integrate developed educational modules and revised courses into the recently created LSU Construction Management online programs: B.S., Post Baccalaureate Certification, and M.S. degree programs (on-going). [WF1, TT1, TT2, EL2, IF4, A2, IN2]
- Continue sponsoring, organizing, and participating in workshops, developing and presenting revised course materials, and involvement in professional society activities (on-going). [WF1, TT1, TT2, EL2, IF4, A2, IN2]

## MANAGEMENT

- Organize and host an in-person, mid-year meeting with Associate Directors, Program Directors, and CAB members to discuss the management/operation of Tran-SET and ways to improve our processes (Jan. 2020). [M1, all, A2]
- Provide 508 compliant captions for remaining video content (Dec. 2019). [M1, A2]

## 2. Participants & Collaborating Organizations

During this reporting period, Tran-SET partnered with **74** organizations (23 academic institutions, 19 government agencies, 28 industrial firms, and 4 nonprofits) to accomplish and oversee its research, T2, education, and workforce development activities. Please see Table 2 for details.

Tran-SET collaborated with **16** organizations/individuals (from 9 academic institutions, 3 government agencies, 2 industrial firms, and 2 nonprofits.). Since this reporting period only covered the implementation phase of second-cycle projects and beginning of third-cycle projects, the collaborations mainly involved T2 activities (see Table 3).

### Partners

Table 2. Tran-SET Partners.

Organization Name	Type	Location	Description of Contribution [Tran-SET Affiliation]
Advanced Infrastructure Design	Industrial firm	Township, NJ	Collaborative research [PRC]
AECOM	Industrial firm	Los Angeles, CA	Collaborative research [PRC]
Alliance Safety Council	Nonprofit	Baton Rouge, LA	Collaborative research [CAB]
APS Engineering and Testing	Industrial firm	Baton Rouge, LA	Collaborative research [PRC]
Arcadis	Industrial firm	Baton Rouge, LA	Collaborative research [PRC]
Arkansas Department of Transportation	State government	Little Rock, AR	In-kind support; collaborative research [CAB; second-, third-cycle]
AZZ	Industrial firm	Fort Worth, TX	In-kind support [third-cycle]
Barriere Construction Co.	Industrial firm	Baton Rouge, LA	Collaborative research [CAB]
Bechtel Power Corporation	Industrial firm	Frederick, MD	Collaborative research [PRC]
Bernalillo County Public Works	Local government	Albuquerque, NM	Collaborative research [PRC]
Boeing	Industrial firm	Chicago, IL	Collaborative research [PRC]
Boise State University	Academic institution	Boise, ID	Collaborative research [PRC]
Boral CM Services	Industrial firm	Cape Coral, FL	In-kind support [third-cycle]
Bradley University	Academic institution	Peoria, IL	In-kind support [third-cycle]
Capitol Regional Planning Commission	Local government	Baton Rouge, LA	Collaborative research; in-kind support [CAB; third-cycle]
Carmeuse Lime and Stone	Industrial firm	Baton Rouge, LA	Collaborative research [CAB]
Chang'an University	Academic institution	Xi'an, China	Collaborative research [CAB]
Chicago Testing Laboratory, Inc.	Industrial firm	Warrenville, IL	Collaborative research [CAB, PRC]
City of Albuquerque	Local government	Albuquerque, NM	Collaborative research [PRC]
City of Arlington	Local government	Arlington, TX	Collaborative research [PRC]
City of Houston	Local government	Houston, TX	Collaborative research [PRC]
City of Jonesboro	Local government	Jonesboro, AR	Collaborative research [PRC]

Organization Name	Type	Location	Description of Contribution [Tran-SET Affiliation]
City of San Antonio	Local government	San Antonio, TX	Financial support; in-kind support [second-cycle, PRC]
Colorado State University	Academic institution	Fort Collins, CO	Collaborative research [PRC]
Con Edison	Industrial firm	New York, NY	In-kind support [third-cycle]
Costello, Inc.	Industrial firm	Houston, TX	Collaborative research [PRC]
ESPOL University	Academic institution	Guayaquil, Ecuador	In-kind support [third-cycle]
Federal Highway Administration	US government	Washington, D.C.	Collaborative research [PRC]
Fehr and Peers	Industrial firm	Walnut Creek, CA	Collaborative research [PRC]
Len Technologies	Industrial firm	Oak Hill, VA	Collaborative research [PRC]
Florida Atlantic University	Academic institution	Boca Raton, FL	Collaborative research [PRC]
Fort Wayne Metals	Industrial firm	Fort Wayne, IN	Collaborative research [PRC]
Greater Baton Rouge Industry Alliance	Nonprofit	Baton Rouge, LA	Collaborative research [CAB]
HDR Engineering	Industrial firm	Omaha, NE	Collaborative research [PRC]
HVJ Associates	Industrial firm	Houston, TX	Collaborative research [CAB]
Lawrence Technological University	Academic institution	Southfield, MI	Collaborative research [PRC]
Louisiana Community and Technical College System	Academic institution	Baton Rouge, LA	Collaborative research [CAB]
Louisiana Department of Transportation	State government	Baton Rouge, LA	Collaborative research [CAB]
Louisiana Economic Development	State government	Baton Rouge, LA	Collaborative research [CAB]
Louisiana Workforce Commission	State government	Baton Rouge, LA	Collaborative research [CAB]
Manhattan College	Academic institution	New York, NY	Collaborative research [PRC]
Marathon Petroleum Company	Industrial firm	Findlay, OH	Collaborative research [PRC]
NASA	US government	Washington, DC	Collaborative research [PRC]
NEAR Ready Mix Concrete	Industrial firm	Brookland, AR	In-kind support [third-cycle]
New Mexico Department of Transportation	State government	Albuquerque, NM	Financial support; in-kind support; collaborative research [CAB; PRC; third-cycle]
New Orleans Regional Planning	Local government	New Orleans, LA	Collaborative research [PRC]
North Central Texas Council of Governments	Local government	Arlington, TX	Collaborative research [PRC]
Oklahoma Department of Transportation	State government	Oklahoma City, OK	Collaborative research [CAB]
Pavetex	Industrial firm	Lubbock, TX	Collaborative research [CAB]
Ports Association of Louisiana	Nonprofit	Baton Rouge, LA	Collaborative research [CAB]
PTV Group	Industrial firm	Arlington, VA	In-kind support [third-cycle]
Quality Concrete	Industrial firm	Baton Rouge, LA	Collaborative research [PRC]
Quality Counts	Industrial firm	Raleigh, NC	Collaborative research [PRC]
Razorback Concrete Company	Industrial firm	Alexander, AR	Collaborative research [PRC]
Temple University	Academic institution	Philadelphia, PA	Collaborative research [PRC]
Terracon	Industrial firm	Oklahoma City, OK	Collaborative research [PRC]
Texas Department of Transportation	State government	Austin, TX	Collaborative research [CAB; PRC]



Organization Name	Type	Location	Description of Contribution [Tran-SET Affiliation]
Texas Local Technical Assistance Program	State government	Arlington, TX	Collaborative research [CAB]
Texas State University	Academic institution	San Marcos, TX	Collaborative research [PRC]
University of Akron	Academic institution	Akron, OH	Collaborative research [PRC]
University of Cincinnati	Academic institution	Cincinnati, OH	In-kind support [third-cycle]
University of Houston	Academic institution	Houston, TX	Collaborative research [PRC]
University of Louisiana at Lafayette	Academic institution	Lafayette, LA	In-kind support [second-cycle]
University of New Orleans	Academic institution	New Orleans, LA	In-kind support [third-cycle]
Utah State University	Academic institution	Logan, UT	Collaborative research [PRC]
Valmont Structures	Industrial firm	Valley, NE	Collaborative research [PRC]
Wood	Industrial firm	Baton Rouge, LA	Collaborative research [PRC]
Worcester Polytechnic Institute	Academic institution	Worcester, MA	Collaborative research [PRC]

## Collaborators

Table 3. Tran-SET Collaborators.

Organization/Name	Type	Description of Collaboration [Tran-SET Affiliation]
Center for Advanced Infrastructure and Transportation – Rutgers University Dr. Jie Gong	Academic institution	Speaker at sponsored webinar
Chang’an University Dr. Hainian Wang	Academic institution	Speaker at sponsored conference
Chicago Testing Laboratory Mr. Ahmad El Khatib	Industrial firm	Speaker at sponsored seminar
HDR, Inc. Mr. Danton Beam	Industrial firm	Speaker at sponsored seminar
Louisiana Department of Transportation and Development - Dr. Shawn Wilson	State government	Speaker at sponsored conference
Louisiana State University - Department of Veterans Affairs	Academic institution	Advocate, aided Tran-SET in establishing scholarship program for US veterans
Mid-America Transportation Center – Iowa State University Dr. Salam Rahmattala	Academic institution	Speaker at sponsored webinar
New Jersey DOT Dr. Giri Venkiteela	State government	Speaker at sponsored webinar
South East University	Academic institution	Discussed future collaborations on augmented reality (AR) for infrastructure inspection
SimCap Louisiana	Nonprofit	Identified research needs in area of simulation and capacity analysis, coordinated outreach
Texas A&M University Dr. Dallas Little	Academic institution	Speaker at sponsored conference
Texas DOT – Pavement Asset Management Dr. Magdy Mikhail	State government	Speaker at sponsored conference
University of Connecticut Dr. Alexandra Hain, Dr. Arash Zaghi	Academic institution	Speaker at sponsored webinar
University of Nebraska-Lincoln Dr. Jinying Zhu, Dr. Ece Erdogmus	Academic institution	Speaker at sponsored webinar
University of Texas at Tyler Dr. Michael McGinnis	Academic institution	Speaker at sponsored seminar
WTS Louisiana	Nonprofit	Organized luncheon and upcoming STEM event

### 3. Outputs

Performance metrics and targets for outputs, outcomes, and impacts of Tran-SET’s research, T2, education, and workforce development programs are discussed below.

#### RESEARCH

Table 4 lists Tran-SET’s performance metrics for research-related outputs. In total, **5** new technologies/techniques were developed. They are briefly summarized below.

Table 4. Research Performance Metrics: Outputs.

ID	Objective ID	Metric	Value <sup>1</sup>	Ann. Value <sup>2</sup>	Ann. Target <sup>3</sup>	Percent Compl. <sup>4</sup>
R-01	R4, S1, IF2, IF3, IF4, IN1	Number of projects specifically addressing regional challenges: Metropolitan growth and congestion	6	6	5	120%
R-02		Future transportation challenges	8	8	15	53%
R-03		Declining public revenues	3	3	3	100%
R-04		Underserved communities	2	2	2	100%
R-05		Safety	4	4	5	80%
R-06	EC1	Number of collaborative (multi-institution) projects	8	8	11	73%
R-07	R1, R2, R3, R4, IN1	Number of new technologies or techniques developed	5	8	15	53%

<sup>1</sup>Metric value for reporting period; <sup>2</sup>Best estimate for annualized metric value; <sup>3</sup>Annual, per funding cycle, target;

<sup>4</sup>Percent completion of annual target; same column definitions for Tables 4 – 13.

#### Developed Technologies or Techniques

1. Drs. Fernando Moreu and Chris Lippitt (PIs) developed: (1) a human-machine interface for transportation infrastructure inspection using augmented reality (AR) and (2) an AR field application with the ability to connect to structural dynamics (i.e., sensors) in real-time (Project No. 18STUNM03).
2. Drs. Gabriel Arce, Marwa Hassan, Tyson Rupnow, and Susan Bogus (PIs) developed a jointless whitetopping overlay material and system utilizing engineered cementitious composites (ECC) (Project No. 18CLUS01).
3. Drs. Changbum Ahn and Chao Wang (PIs) developed a model to predict road damage type based on supplied vehicle vibration data (Project No. 18PLSU08).
4. Dr. Shih-Ho Chao (PI) developed a new ductile-concrete strong-reinforcement (DCSR) design technique utilizing ultra-high-performance fiber-reinforced concrete (UHP-FRC) and corrosion-resistant high-strength fiber-reinforced polymer (FRP) bars (Project No. 18STUTA01).

#### TECHNOLOGY TRANSFER

Table 5 lists Tran-SET’s performance metrics for T2-related outputs. In total, **9** journal publications, **65** conference papers/presentations, **45** other presentations, and **8** webinars were published/delivered. Please see the selected output examples below.

Table 5. Technology Transfer Performance Metrics: Outputs.

ID	Objective ID	Metric	Value	Ann. Value	Ann. Target	Percent Compl.
TT-01	TT1, TT2, IN2	Number of stakeholders identified, specifically <sup>1</sup> : Early potential adopters	63	63	30	213%

ID	Objective ID	Metric	Value	Ann. Value	Ann. Target	Percent Compl.
TT-02		Late potential adopters	51	51	30	170%
	TT1, TT2, IN2	Number of times research products (technology) are disseminated via the following channels:				
TT-03		Featured in Tran-SET newsletter	6	18	25	72%
TT-04		Featured on Tran-SET social media	10	27	50	54%
TT-05		Peer-reviewed publications and presentations	181	260	130	200%
TT-06		Webinars	8	13	5	260%
	TT1, IN2	Tran-SET website traffic:				
TT-07		Number of visitors to website	16k	33k	30k	110%
TT-08		Number of visits to website	120k	244k	250k	98%
	TT1, TT2, IN2	Number of times disseminated research products have informed/been viewed:				
TT-09		Social media engagement levels(s)	5/1.6	5/1.6	4.5 <sup>2</sup> /2.5 <sup>3</sup>	111/64%
TT-010		Number of times reports (or related) are downloaded	1,159	2,435	2,500	97%
TT-011		Number of citations from publications	56	90	120	75%
TT-012		Presentation attendees or views	2,450	4,360	4,500	97%
	TT1, TT2, IN2	External funds:				
TT-013		Industrial partners providing funds	9	9	4	75%
TT-014		Public agency partners providing funds	7	7	10	90%
TT-015		Total funds from industrial partners	\$243k	\$243k	\$200k	122%
TT-016		Total funds from public agency partners	\$470k	\$470k	\$300k	157%

<sup>1</sup>Individual stakeholders as specified in second-cycle, project-specific T2 plans; may contain multiple (but distinct) stakeholders within same agency; <sup>2</sup>Average “calculated as clicks/impressions” (LinkedIn); <sup>3</sup>Average “engagement rate” (Twitter).

### Discussion of Performance Metrics: Building Audience and Creating Partnerships

- **Presentation Attendees or Views (TT-012):** The target for this metric was re-evaluated and raised to 4,500 (from 1,000). The increase is due to successful outreach activities conducted during the second-cycle projects’ implementation phase. Although not an “end-all” metric, this metric is useful in identifying appropriate venues to engage stakeholders. For example: 43% of reported attendees were from Center-supported activities, while 57% were from project-level activities (showcasing the importance of both).
- **External Funds (TT-013 – TT-016):** The number of private partners was raised from 3 to 9 and the funding amount from \$102k to \$243k (from the previous funding cycle), while the number of public agency partners and funding levels remained the same. Based on other metrics, Tran-SET is better engaging both of these groups (shown in the increase in private support); however, this highlights the difficulty and long-term approach needed to coordinate among public agency funding processes, timelines, and uncertainties.

### Peer-Reviewed Journal Publications (Selected)

1. Gholikhani, M., R. Nasouri, S. Legette, S. Tahami, S. Dessouky, and A. Montoya (2019). Harvesting kinetic energy from roadway pavement through an electromagnetic speed bump. *Journal of Applied Energy*, 250, 503-511. [Published] [Federal support acknowledged] [Accessible [here](#)]
2. Milla, J., M. Hassan, T. Rupnow, and W. Daly (2019). Measuring the crack-repair efficiency of steel fiber reinforced concrete beams with microencapsulated calcium nitrate. *Construction and Building Materials*, 201, 526-538. [Published] [Federal support acknowledged] [Accessible [here](#)]

3. Khandel, O. and M. Soliman (2019). Integrated framework for quantifying the effect of climate change on the risk of bridge failure due to floods and flood-induced scour. *Journal of Bridge Engineering*, 24(9), 04019090. [Published] [Federal support acknowledged] [Accessible [here](#)]
4. Loganathan, K., M. Isied, A.M. Coca, M. Souliman, S. Romanoschi, and S. Dessouky (2019). Development of comprehensive deflection parameters to evaluate the structural capacity of flexible pavements at the network level. *International Journal of Pavement Research and Technology*, 12(4), 347-355. [Published] [Federal support acknowledged] [Accessible [here](#)]
5. Baumgardner, G., Z. Hossain, and M. Alam (2019). Effects of aging on physicomechanical and chemical properties of chemically modified binders. *Journal of Testing and Evaluation*, 49(2). [Published] [Federal support acknowledged] [Accessible [here](#)]

### Conference Papers/Presentations (Selected)

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1. Karmacharya, A.J. Gamarra, and S. Chao (2019). "Use of ultra-high-performance fiber-reinforced concrete (UHP-FRC) for fast and sustainable repair of rigid pavements". In *Airfield and Highway Pavements 2019: Design, Construction, Condition Evaluation, and Management of Pavements*, 279-285, ASCE. [Published] [Federal support acknowledged] [Accessible [here](#)]
2. Saeidi, S., Z. Xu, Y. Zhu, S. Mukhopadhyay, and R. Gudishala (2019). "Application of virtual reality to investigate driver's route choice in an interstate freeway". In *Computing in Civil Engineering 2019: Visualization, Information Modeling, and Simulation*, June 2019, Atlanta, GA. [Published] [Federal support acknowledged] [Accessible [here](#)]
3. Javid, A.H. and R. Bulut (2019). "Evaluation equilibrium matric suctions under pavement system based on thornthwaite moisture index (TMI)". In *Airfield and Highway Pavements 2019: Testing and Characterization of Pavement Materials*, 511-521, ASCE. [Published] [Federal support acknowledged] [Accessible [here](#)]
4. Malone, N., P. Miller, H. Ozcan, J. Ma, J. Schaffer, and I. Karaman (2019). "Integrated health monitoring of transportation structures with magnetic Fe-SMA wires". In *MATEC Web of Conferences*, 271, 01008. [Published] [Federal support acknowledged] [Accessible [here](#)]
5. Loganathan, K., M. Isied, A.M. Coca, M. Souliman, S. Romanoschi, and S. Dessouky (2019). "Mechanistic empirical estimation of remaining service life of flexible pavements based on simple deflection parameters: A case study for the state of Texas". In *Airfield and Highway Pavements 2019: Design, Construction, Condition Evaluation, and Management of Pavements*, 279-285, ASCE. [Published] [Federal support acknowledged] [Accessible [here](#)]

### Websites or other Internet Sites (Selected)

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The [Tran-SET website](#), [LinkedIn](#), [Twitter](#), and [YouTube](#) pages are continuously leveraged for outreach initiatives and activities. Partnering institutions have also reported on Tran-SET-sponsored activities through their own outlets. Selected, demonstrative examples are shown below:

- [Article](#) from the University of New Mexico (UNM) documenting the partnership between Sandia Peak Tramway and Dr. Fernando Moreu (PI) and the installation of wireless smart sensors on the Sandia Peak Tramway (Project No. 17STUNM02);
- [Announcement](#) from AZZ Inc. on their research collaboration and hosted seminar with Dr. Homero Castaneda-Lopez (PI) on a corrosion management system for reinforced concrete bridges (Project No. 19STLSU10); and
- [Article](#) from Daily Commercial News and [article](#) from Greater Baton Rouge Business Report documenting Drs. Gabriel Arce's, Marwa Hassan's, Tyson Rupnow's, and Susan Bogus' field testing of engineered cementitious composites (ECC) (Project No. 18CLSU01).

### EDUCATION

Table 6 lists Tran-SET’s performance metrics for education-related outputs. In total, Tran-SET supported **99** students and produced **14** educational modules. Select modules are described below.

Table 6. Education Performance Metrics: Outputs.

ID	Objective ID	Metric	Value	Ann. Value	Ann. Target	Percent Compl.
E-01 E-02 E-03	E1, E2, EL1, IF4, A2	Number of students supported from Tran-SET research:				
		Undergraduate students	30	30	25	120%
		Masters students	26	26	25	104%
E-03		Doctoral students	43	43	25	172%
E-04 E-05	E1, E2, EL1, ED1, IF4, A2	Number of research opportunities for under-representative groups:				
		Undergraduate students	25	25	15	167%
E-05		Graduate students	18	18	15	120%
E-06	E1, E2, EL1, ED1, IF4, A2	Total budgeted costs for women and minorities	\$0.168M	\$0.168M	\$1.1M	15% <sup>1</sup>
E-07	E1, E2, EL1, IF4, A2	Number of new transportation-related educational modules delivered	14	30	35	86%
E-08	E1, E2, EL1, IF4, A2	Number of STEM events sponsored by Tran-SET or that participated in	12	24	15	160%

<sup>1</sup>Tran-SET recognizes the low completion of this target; Tran-SET strives to better engage such students through existing partnerships (with BRCC and NTU on third-cycle projects) and to establish new partnerships: engaging additional, diverse institutions in our research (specifically Southern University near LSU).

### Educational Modules (Selected)

1. An educational module on lifecycle environmental impacts was added to course “CVEG5183: Energy and Environmental Sustainability” at Prairie View A&M University (PVAMU) (Project No. 18PPPVU01).
2. An educational module on augmented reality (AR) and new technologies related to infrastructure inspection was developed for high school students as part of UNM’s Summer Transportation Institute (Project No. 18STUNM03).
3. An educational module on fully softened shear strength measurement and application was developed for LSU courses “CE4780: Coastal Geotechnics” and “CE7310: Advances Geotechnics II” (Project No. 18GTLSU06).
4. A series of hands-on educational modules was developed for Oklahoma State University (OSU) freshman students involving light-wave sensing and communication (Project No. 18ITSOKS01).
5. An educational module on ultra-high-performance concrete was developed for LSU course “CM4206: Advance Concrete Material” (Project No. 18CNMS01).

### WORKFORCE DEVELOPMENT

Table 7 lists Tran-SET’s performance metrics for workforce development-related outputs. During this reporting period, **13** revised courses and **10** seminars/workshops were delivered.

Table 7. Workforce Development Performance Metrics: Outputs.

ID	Objective ID	Metric	Value	Ann. Value	Ann. Target	Percent Compl.
WF-01	WF1, IF4, A2	Number of new or revised transportation-related courses	13	21	25	84%

ID	Objective ID	Metric	Value	Ann. Value	Ann. Target	Percent Compl.
WF-02	WF1, IF4, A2	Number of seminars/workshops presented	10	14	15	93%
WF-03	WF1, IF4, A2	Number of professional society-related events <sup>1</sup> sponsored or participated in	9	24	15	160%

<sup>1</sup>Events include local and regional meetings of various professional societies (e.g., AASHTO, ASCE, ITE, SAE, etc.); Tran-SET believes these local groups are a critical link in developing the transportation workforce.

### Seminars/Workshops (Selected)

1. Hossain, Z. and K.T. Islam. “Rice Husk Ash (RHA) Modified Concrete”. Apr. 1, 2019. Stuttgart, AR. [Federal support acknowledged]
2. Weldon, B. and C. Newton. “Workforce Development Symposium on Ultra-High Performance Concrete (UHPC)”. April 23, 2019. Las Cruces, NM. [Federal support acknowledged]
3. Zhang, S., S. Baros, and S. Bogus. “Sinkhole Extractor Tool Tutorial”. Jun. 4, 2019. Albuquerque, NM. [Federal support acknowledged]
4. Arce, G. “Application of Engineered Cementitious Composites (ECC) for Jointless Ultrathin Whitetopping Overlay”. May 10, 2019. Baton Rouge, LA. [Federal support acknowledged]
5. Moreu, F. “Augmented Reality for Structural Inspection”. Sep. 5, 2019. Nanjing, China. [Federal support acknowledged]

## 4. Outcomes

Given the necessary time to realize true outcomes, the following subsections detail how current efforts are driving select outputs towards implementation and towards future, meaningful outcomes.

### TECHNOLOGY TRANSFER

Table 8 lists Tran-SET’s performance metrics for T2-related outcomes. Tran-SET re-evaluated targets for each metric below and increased them significantly (200%) from the previous reporting period.

Table 8. Technology Transfer Performance Metrics: Outcomes.

ID	Objective ID	Metric	Value	Ann. Value	Ann. Target	Percent Compl.
TT-C1 TT-C2	TT1, TT2, IN2	External, derivative initiatives spurred by research products <sup>1</sup>				
		Number of additional research projects	3	4	2	200%
		Total funding of additional research projects	\$3.86M	\$3.99M	\$1.00M	399%
TT-C3	TT1, TT2, IN2	Number of commercialized/patented/licensed research products	3	4	2	200%
TT-C4	TT1, TT2, IN2	Number of stakeholders MOUs	3	4	2	200%
TT-C5 TT-C6	TT1, TT2, IN2	Number of stakeholders who have:				
		Committed to adopt research products	3	5	4	125%
		Adopted research products	1	3	2	150%

<sup>1</sup>Sponsored research projects (external to Tran-SET) initiated as a direct result of research products developed from a Tran-SET-sponsored project.

### Discussion of Performance Metrics: Further Development and Adoption of Research Products

- **Number of Additional Research Projects (TT-C1, TT-C2):** Three previous project teams received grants from Texas DOT and the City of San Antonio (COA) to improve products

developed from previous Tran-SET projects. The [two COSA funded projects](#) are particularly well-connected to previous Tran-SET research (Project Nos. 18HSTSA01 and 18SATSA05) as COSA staff served on their respective PRCs.

- **Number of Stakeholder MOUs (TT-C4):** Tran-SET has identified **8** viable opportunities for MOUs involving second-cycle projects. As an example: an MOU may be pursued with Alma Plantation LLC for the implementation (at a large scale) of the optimized bagasse ash production process (Project No. 18CLSU03). Tran-SET will support and work with respective PIs to pursue these MOUs as outlined in the T2 Plan.

### **New Policies, Regulations, Rulemaking, or Legislation (Selected)**

- New hydrologic models for the Leon Creek and Upper San Antonio watersheds in Texas were developed and utilized to investigate flood mitigation strategies (Project No. 18HSTSA02). These findings may lead to better-informed flood emergency policies in these areas.
- An optimization model and decision support tool was developed to prioritize needs for accelerated construction of transportation infrastructure after disaster events (Project No. 18PPLSU04). The decision support tool may lead to more efficient construction (and related procedures/policies) after hurricane and flooding events.

### **Adoption of New Technology, Techniques, or Practices (Selected)**

- A model to estimate the corrosion potential of metal culverts was developed (Project No. 18GTASU01), and results of the model were utilized to create GIS-based metal culvert corrosion risk maps for the state of Arkansas. The developed maps will help Arkansas DOT engineers assess corrosion potential of metal pipes prior to new construction and repair – and to select proper culvert and cross drain materials.
- A robust toolset that utilizes airborne LiDAR data to detect and map sinkholes is publicly available and can be downloaded from [GitHub](#) (Project No. 18GTUNM01). The research team also prepared a [recorded tutorial](#) that details the tool requirements, initial setup, optional DEM creator, sinkhole extractor, and acknowledgements.

## **EDUCATION**

Table 9 lists Tran-SET’s performance metrics for education-related outcomes. In total, **134** students participated in Tran-SET-sponsored research.

Table 9. Education Performance Metrics: Outcomes.

<b>ID</b>	<b>Objective ID</b>	<b>Metric</b>	<b>Value</b>	<b>Ann. Value</b>	<b>Ann. Target</b>	<b>Percent Compl.</b>
E-C1 E-C2	E1, E2, EL1, ED1, IN4, A2	Number of students participating in Tran-SET research:				
		Undergraduate students	48	48	75	64%
		Graduate students	86	86	100	86%
E-C3	E1, E2, EL1, IN4, A2	Number of times educational modules have been viewed	291	591	700	84%
E-C4	E1, E2, EL1, ED1, IN4, A2	Number of students attending sponsored or involved STEM events	805	1,025	1,000	103%

### **Increased Body of Scientific Knowledge (Selected)**

- The NTU Internship attracted two diverse, promising individuals to the transportation field and provided unique experiences to better prepare them for the workforce. The *actual*

outcome of such a program in yet to be assessed; however, the aim is to develop the next generation of transportation leaders and to advance the transportation workforce in needed communities (i.e., the Navajo Nation).

- Dr. Sabit Ekin (PI) and his research team developed “do-it-yourself” light-wave sensing and communication kits for high school students (Project No. 18ITSOKS01). The objective of the kit and corresponding educational module is to teach students the basics of communication and sensing. Such activities provide information, exposure, and positive experiences at an influential stage in students’ career trajectory.

## WORKFORCE DEVELOPMENT

Table 10 lists Tran-SET’s performance metrics for workforce development-related outcomes. In total, **808** attendees participated in new/revised transportation-related courses, seminars, or workshops.

Table 10. Workforce Development Performance Metrics: Outcomes.

ID	Objective ID	Metric	Value	Ann. Value	Ann. Target	Percent Compl.
WD-C1	WF1, IF4, A2	Number attending offered new or revised courses	248	292	500	58%
WD-C2	WF1, IF4, A2	Number attending presented seminars/workshops	560	640	500	128%
WD-C3	WF1, IF4, A2	Sponsorship: Number of stakeholders sponsoring seminars/workshops/conferences	4	8	3	267%
WD-C4		Total funds of sponsorship	\$7.5k	\$10.5k	\$15k	70%

## Enlargement of Trained Transportation Workforce (Selected)

- Drs. Brad Weldon and Craig Newtonson (PIs) conducted a pre-bid meeting for an upcoming ultra-high performance concrete (UHPC) project let by New Mexico DOT (NMDOT) (Project No. 18TTNMS01). The Meeting provided necessary information for contractors, designers, and NMDOT to successfully place an UHPC overlay. Multiple bids on the project indicate the success and confidence provided through the training, and it is expected the Meeting will help promote the adoption of UHPC in the region.

## 5. Impacts

As with outcomes, project impacts will be updated as they become available. The following subsections detail how select project outcomes are *envisioned to impact* the transportation system and workforce.

### TECHNOLOGY TRANSFER

Table 11 lists Tran-SET’s performance metrics for T2-related impacts. These metrics are as described in the previous reporting period and cover related products from second-cycle projects. Estimated impacts will be updated with third-cycle products once their technical phase ends (Aug. 2020).

Table 11. Technology Transfer Performance Metrics: Impacts.

ID	Objective ID	Metric	Value	Ann. Value	Ann. Target	Percent Compl.
TT-I1	TT1, TT2, R1, IF2, IN1, IN2	Improve the durability and service life of transportation infrastructure <sup>1</sup>	-	35%	20%	175%



ID	Objective ID	Metric	Value	Ann. Value	Ann. Target	Percent Compl.
TT-I2	TT1, TT2, IN2	Reduce costs associated with repair and upgrade of transportation infrastructure <sup>2</sup>	-	\$75k	\$10k	750%

<sup>1</sup>Represents the average percent improvement to service life estimated by second-cycle project PIs of their specific infrastructure component of study, assuming a full-scale implementation and all other factors constant; <sup>2</sup>Represents the average cost savings per lane-mile estimated by second-cycle PIs associated with repairs using their specific infrastructure component of study, assuming all other factors constant.

### Discussion of Performance Metrics: Impact on Effectiveness of the Transportation System

- Improve the Durability and Service Life of Transportation Infrastructure (TT-I1):** This metric comprises of **23** applicable products. For example:
  - Implementation of developed methods to effectively synthesize geopolymer cement (GPC) for soil stabilization may improve performance of roadway sublayers by 15-20% (Project No. 18CTAM03); and
  - Better characterization of asphalt binders can reduce premature pavement failures, potentially increasing the service life of asphalt pavement (with modified binders) by 25% (Project No. 18BASU02).
- Reduce Costs Associated with Repair and Upgrade of Transportation Infrastructure (TT-I2):** This metric comprises of **9** of applicable products. For example:
  - Improved understanding of how recurring cycles of wetting and drying impact soil strength may reduce the frequency of shallow embankment failures, and based on failure frequency rates in Louisiana, may produce a cost savings of \$50k/mile (Project No. 18GTLSU06).
  - Accurately detecting and mapping sinkholes can assist engineers in identifying causes and repairing sinkholes before they significantly damage transportation infrastructure (Project No. 18GTUNM01). In the scenario of gradual subsidence, a road section may be gradually damaged, and repairs in New Mexico can be approximated as \$100k/mile (will vary based on the type of damage incurred).

### Impact on Adoption of New Practices and Commercialization (Selected)

- The developed method to produce iron-based shape memory alloy rods suitable for structural transportation applications and non-destructive sensing/monitoring is viable for commercialization (Project No. 18STTAM02). Fort Wayne Metals has been engaged in the research and is a suitable partner to adopt such methods at their production facility.
- Two patents have been filed related to using augmented reality (AR) for transportation infrastructure inspection (Project No. 18STUNM03). This technology was demonstrated to several private/public organizations and is expected to lead to an MOU to further demonstrate its benefits in a field setting.

### EDUCATION

Table 12 lists Tran-SET’s performance metrics for education-related impacts. As shown, funded projects have led to the graduation of a number of students that will effectively contribute to the transportation workforce.

Table 12. Education Performance Metrics: Impacts.

ID	Objective ID	Metric	Value	Ann. Value	Ann. Target	Percent Compl.
E-I1	EL1, EL2, IF4, A2	Number of graduated, supported students entering the transportation field	8	9	30	30%

ID	Objective ID	Metric	Value	Ann. Value	Ann. Target	Percent Compl.
E-I2	EL1, EL2, IF4, A2	Feedback <sup>1</sup> of graduated, supported students who've entered the transportation field	Good	Good	Excellent	-

<sup>1</sup>Feedback solicited from in-person discussions; <sup>2</sup>Scale: Excellent, Good, Average, Unsatisfactory, Average; same definitions for Table 13

### Impact on Scientific Knowledge (Selected)

- Project No. 18CNMS01 was one of the first attempts to use ultra-high performance concrete (UHPC) as grout for bridge superstructure shear keys and one of the first studies to include corresponding full-scale laboratory testing. Development of this technology expands the body of scientific knowledge in bridge engineering and may lead to other novel applications of UHPC or new practices for grouting shear keys.
- Project No. 18STOKS02 developed a model to compute life-cycle costs of bridge decks considering direct and indirect maintenance attributes. The developed approach is applicable to (and may improve assessment of) other types of long-life infrastructure systems, such as: offshore structures, roads, and culverts.

### WORKFORCE DEVELOPMENT

Table 13 lists Tran-SET's performance metrics for workforce development-related impacts.

Table 13. Workforce Development Metrics: Impacts.

ID	Objective ID	Metric	Value	Ann. Value	Ann. Target	Percent Compl.
	WF1, IF4, A2	Feedback of seminar/workshop/Conference attendees:				
WD-I1		Related to skills gained	Good	Good	Excellent	-
WD-I2		Related to improved practices	Excellent	Excellent	Excellent	-

### Impact on Transportation Workforce Development (Selected)

- The second workforce development symposium on ultra-high performance concrete (UHPC) successfully engaged a diverse audience of designers, NMDOT personnel, contractors, and industry suppliers (Project No. 18TTNMS02). The symposium successfully transferred knowledge and provided training to potential adopters of UHPC. The number of attendees, positive feedback, and post-symposium engagement indicate its success.
- Over 100 researchers attended a workshop on utilizing augmented reality (AR) for infrastructure inspection, providing exposure to the practical application of AR for industry and field decision-making (Project No. 18STUNM03). Positive feedback was received by the organizer (Stanford University) and may lead to development of a book chapter. Likewise, interest from the workshop may lead to future collaborations with the organizer.

## 6. Changes/Problems

Nothing to report.

## 7. Special Reporting Requirements

Not applicable.

## Appendix

Table 14. Awarded Third-Cycle Projects.

Project No.	Title	Total Cost	Leading Institution	Research Objective	Topical Area
19BASU02 <sup>1</sup>	Assessment of Compatibility of Mineral Aggregates and Binders	\$102,013	A-State	R3, IF2, IN1	Asphalt
19BLSU01 <sup>1</sup>	Enhancing the Performance of Asphalt Mixtures Containing High RAP Content with the Use of Different WMA Technologies	\$105,094	LSU	R1, IF2, IN1	Asphalt
19BLSU02 <sup>1</sup>	Evaluation of Asphalt Mixtures Resistance to Cement-Treated Base Reflective Cracking in the Laboratory	\$120,000	LSU	R1, IF2, IN1	Asphalt
19CASU03 <sup>1</sup>	Influence of Powder Activated Carbon (PAC) in Fly Ash on the Properties of Concrete	\$77,000	A-State	R1, IF2, IN1	Concrete
19CLSU03 <sup>2,3</sup>	Evaluation of Bagasse Ash as Cement and Sand Replacement for the Production of Engineered Cementitious Composites (ECC)	\$180,169	LSU	R2, IF1, IN1	Concrete
19CLSU04 <sup>2,3</sup>	Engineered Geopolymer Composites (EGC) for Sustainable Transportation Infrastructure	\$270,011	LSU	R2, IF1, IN1	Concrete
19CNMS01	Field Implementation and Monitoring of an Ultra-High Performance Concrete Bridge Deck Overlay	\$120,000	NMSU	R1, IF2, IN1	Concrete
19CTAM02 <sup>1</sup>	Development of Corrosion Inhibiting Geopolymers Based Cement for Transportation Infrastructure	\$120,000	TAMU	R1, IF2, IN1	Concrete
19GTASU01 <sup>1,2</sup>	Site-Specific Seismic Ground Motion Analyses for North-East Arkansas	\$100,015	A-State	R3, IF2, IN1	Geotech.
19GTLSU05 <sup>3</sup>	Coupling Novel Soil Moisture-Suction Sensors and UAV Photogrammetry Technology to the Performance of Highway Embankments	\$270,033	LSU	R3, IF2, IN1	Geotech.
19GUTA01 <sup>3</sup>	Eco-Friendly Stabilization of Sulfate-Rich Expansive Soils using Geopolymers for Transportation Infrastructure	\$212,000	UTA	R2, IF1, IN1	Geotech.
19ITSLSU06 <sup>1,2</sup>	Analysis, Modeling, and Simulation (AMS) Case Studies of Connected and Automated Vehicle (CAV) Implementations Specific to Region 6	\$90,000	LSU	R4, IF3, IF4, IN1	ITS
19ITSLSU07 <sup>3</sup>	Selecting the Most Feasible Construction Phasing Plans for Urban Highway Rehabilitation Projects	\$150,000	LSU	R3, IF2, IN1	ITS
19ITSOSU01	Real-Time Work Zone Traffic Management via Unmanned Air Vehicles	\$161,321	LSU	R4, IF1, IF3, IN1	ITS
19ITSUTA02	The Impact of Increased Adverse Weather Events on Freight Movement	\$110,000	UTA	R4, IF1, IF3, IN1	ITS
19ITSUTSA01 <sup>1</sup>	Development of a Self-Powered Weigh-in-Motion System	\$99,886	UTSA	R4, IF1, IF3, IN1	ITS
19PITSLSU14 <sup>1,2,3</sup>	Investigating the Impacts of Truck Platooning on Transportation Infrastructure in Region 6	\$365,894	LSU	R4, IF1, IF3, IN1	Pavement
19PLSU09	Advanced Modelling and Design Methodology for Pavements using Plasticity-based Shakedown Theory	\$135,038	LSU	R1, IF2, IN1	Pavement
19PLSU13 <sup>3</sup>	Holistic Network-level Assessment of Pavement Flood Damages using the FEMA's	\$120,000	LSU	R3, IF2, IN1	Pavement

Project No.	Title	Total Cost	Leading Institution	Research Objective	Topical Area
	Hazus Flood Models and Maintenance Cost Prediction				
19PPLSU11	Evaluation of Connections Between Light Rail Link Terminals in New Orleans and Baton Rouge and Existing Public Transportation Systems	\$150,000	UNO	R4, IF3, IF4, IN1	Policy & Planning
19PPLSU12	Development, Education, and Implementation of A Low-Cost Audio Sensor-based Autonomous Surveillance System for Smart and Connected Transportation Infrastructure Construction and Maintenance	\$75,000	LSU	R3, IF2, IN1	Policy & Planning
19PPPV01	Life Cycle Environmental Impact of Houston METRO System – Evaluation of Electric Alternatives	\$46,500	PVAMU	R2, IF1, IN1	Policy & Planning
19PPUNM01	ABQ Streets Project: Creating Alternative Residential Street Designs	\$100,000	UNM	R4, IF3, IN1	Policy & Planning
19SAUNM03	Enhancing Evaluation of Wildlife Detection Systems	\$80,000	UNM	R4, IF3, S	Safety
19SAUTA03	Real-Time Early Detection and Monitoring of Flooding Using Low-Cost Highly Sensitivity Ultrasonic Sensing of Water Level	\$116,000	UTA	R3, IF2, IN1, S	Safety
19SAUTA04	Detection and Estimation of Inundation and Associated Risks using Traffic Monitoring Cameras and High-resolution Flood Maps under Extreme Flooding Conditions	\$110,000	UTA	R3, IF2, IN1, S	Safety
19SAUTSA03	Development of a Low Power, Low Cost Rural Railway Intersection Smart Detection and Warning System	\$66,010	UTSA	R3, IF2, IN1, S	Safety
19STLSU10 <sup>2,3</sup>	Corrosion Management System of Regional Reinforced Concrete (RC) Bridges	\$224,001	LSU	R3, IF2, IN1	Structural
19STTAM03	Development of Low-Cost Multifunctional Materials for Near-Surface-Mounted (NSM) Strengthening of RC Bridge Beams and Columns	\$120,000	TAMU	R1, IF2, IN1	Structural
19STUNM02	Bridge Construction Monitoring using LIDAR for Quantified, Objective Quality-Control Quality-Assurance (QOQCQA)	\$150,000	UNM	R3, IF2, IN1	Structural
19STUNM04 <sup>2</sup>	Bridge Deck Inspection Using Small Unmanned Aircraft System Based Airborne Imaging Techniques			R3, IF2, IN1	Structural
19STUTSA02	Optimizing the Geometric Configuration and Manufacturing Process of High Mast Illumination Poles	\$100,017	UTSA	R1, IF2, IN1	Structural
19TTNTU01	Analysis of the Causes of Workforce Shortages: Create Guidelines for Education and Workforce Development in Transportation to Generate Future Careers for the Navajo Nation	\$20,000	NTU	R4, IF4, IN1	Tech. Transfer

<sup>1</sup>Industrial firm providing matching funds (public-private partnership); <sup>2</sup>Government agency providing matching funds (public-public partnership); <sup>3</sup>Multi-institution project