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This is a report of research, innovation implementation, and technology transfer efforts carried out by the Pennsylvania Department of Transportation through the State Planning and Research Program of the Federal Highway Administration, U.S. Department of Transportation, and the Pennsylvania Motor License Fund. The report describes activities during state fiscal year 2020-2021, covering July 1, 2020 through June 30, 2021.
INTRODUCTION

Dear Colleagues:

I am pleased to present the Fiscal Year (F.Y.) 2020-2021 Research Program Activities Report, which details the efforts accomplished over the year in Pennsylvania-focused research projects, transportation pooled fund studies, technology transfer and program management, and PennDOT’s Local Technical Assistance Program (LTAP).

PennDOT is committed to moving Pennsylvania forward by investing in research project activities that attempt to solve real-world transportation issues addressing construction, design, maintenance, operations and safety, planning and policy, and technology transfer. This report will demonstrate the broad diversity in the size, scope, and content of the various research projects initiated under PennDOT’s Research Program.

As another successful year ends, we look forward to F.Y. 2021-2022 where the Research Program Management Section (RPMS) will continue to initiate research projects that will move Pennsylvania forward and enable PennDOT to meet its strategic goals while identifying projects that will build upon one another.

Andrea Bahoric, Bureau Director
Bureau of Planning & Research
Research Division Vision
To build relationships throughout the Department so that the Research Division is the go-to unit for research studies and innovation implementation.

Research Division Mission
The Research Division manages and coordinates research, education and technology transfer programs and projects on behalf of PennDOT. The Research Division strives to support PennDOT’s strategic agenda by addressing vital transportation needs of the Commonwealth.

Research Program Overview
The Research Program Management Section (RPMS) of the Research Division located in the Bureau of Planning and Research is responsible for the development, administration, and management of PennDOT’s Bi-Annual Research Program.

This report covers F.Y. 2020-2021 research activities which accounts for the second year of PennDOT’s Bi-Annual Research Program.

The RPMS staff works with the Bureau Directors, District Executives and Deputy Secretaries to prioritize all received Research Innovations Deserving Exploration and Analysis (IDEA) forms. From the amount of funding available to initiate new research projects, the staff ensures that the projects selected, and initiated support PennDOT’s key focus areas and that the Department obtains usable results from the projects as they are completed.

In F.Y. 2020-2021, the RPMS staff actively managed thirty (30) projects. Also, the RPMS staff evaluated research projects that were previously submitted for consideration. This evaluation considered:

- Were all approved F.Y. 2019-2020 projects initiated?
- Were any approved F.Y. 2019-2020 projects deferred to a future fiscal year research program?
- Were any approved F.Y. 2019-2020 projects removed?
- Were any of the proposed F.Y. 2020-2021 projects moved to F.Y. 2019-2020?

For F.Y. 2020-2021, approximately $3.4 million were provided to fund important research projects that addressed the vital transportation needs of Pennsylvania in the areas of construction, design, maintenance, operations and safety, planning and policy and technology transfer.

*These investments are detailed on the following pages.*
## RESEARCH PROJECTS: F.Y. 2020-2021

### Request for Proposal (RFP)

<table>
<thead>
<tr>
<th>Project Name</th>
<th>PennDOT Technical Advisor (TA)</th>
<th>Principal Investigator (PI)</th>
<th>F.Y. 2020-2021 Funds</th>
<th>Start Date</th>
<th>End Date</th>
</tr>
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<tr>
<td>PennDOT Local Technical Assistance Program (LTAP)</td>
<td>Brian Wall</td>
<td>Karen Atkinson</td>
<td>$1,108,090.68</td>
<td>12/29/19</td>
<td>03/28/21</td>
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<td>PennDOT Local Technical Assistance Program (LTAP)</td>
<td>Chris Metka</td>
<td>Karen Atkinson</td>
<td>$243,844.18</td>
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<td>03/28/26</td>
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<td>Stormwater Control Measures</td>
<td>Daryl St. Clair</td>
<td>Kara Kalupson</td>
<td>$27,413.00</td>
<td>08/03/20</td>
<td>07/14/22</td>
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### Department of General Services (DGS) University Master Agreements

#### University of Pittsburgh (PITT) Projects

<table>
<thead>
<tr>
<th>Project Description</th>
<th>Principal Investigator (PI)</th>
<th>F.Y. 2020-2021 Funds</th>
<th>Start Date</th>
<th>End Date</th>
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<tbody>
<tr>
<td>Identification of Factors Controlling the Development of Subsidence Impacts</td>
<td>Roy Painter</td>
<td>$288,524.61</td>
<td>10/03/18</td>
<td>02/26/21</td>
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<td>Forecasting Methodology to the I-70 Alignment over Longwall Mining of the Tunnel Ridge Mine, Washington County</td>
<td>Tony Iannacchione</td>
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<td>Superload Effect on Pavement Life</td>
<td>Jeffrey Oswalt</td>
<td>$102,102.39</td>
<td>10/15/18</td>
<td>12/31/21</td>
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<td>Carbon Nanotubes for Structural Highway Concrete</td>
<td>Steve Hurlbert</td>
<td>$96,061.57</td>
<td>10/31/18</td>
<td>12/31/20</td>
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<tr>
<td>Faulting Model Improvements for MEPDG</td>
<td>Lydia Peddicord</td>
<td>$202,846.85</td>
<td>07/01/19</td>
<td>08/31/21</td>
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<td>Data Management, Mining, and Inference for Bridge Monitoring</td>
<td>Patricia Kiehl</td>
<td>$103,622.98</td>
<td>12/04/19</td>
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<td></td>
<td>Piervincenzo Rizzo</td>
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<td>Project Name</td>
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<td>Depth to Bedrock Seismic Measuring Device</td>
<td>Jason Daley</td>
<td>Steven Sachs</td>
<td>$18,990.14</td>
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<tr>
<td>Corrosion Repair Strategies for Steel Girder Ends Using High Performance and Traditional Materials</td>
<td>Kristin Langer</td>
<td>Kent Harries</td>
<td>$68,771.28</td>
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**Temple University (TEM) Projects**

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<th>Project Name</th>
<th>PennDOT Technical Advisor (TA)</th>
<th>Principal Investigator (PI)</th>
<th>F.Y. 2020-2021 Funds</th>
<th>Start Date</th>
<th>End Date</th>
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<tbody>
<tr>
<td>Electronic Construction Model Definition</td>
<td>Leroy Posey / Allen Melley</td>
<td>Joseph Coe</td>
<td>$190,568.74</td>
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<td>Joint and Full Waveform Inversion to Improve Evaluation of Sinkholes and Karst Features</td>
<td>Sarah McInnes</td>
<td>Joseph Coe</td>
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<td>Lightweight and Sustainable Materials in Engineered Fills</td>
<td>Sarah McInnes</td>
<td>Joseph Coe</td>
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<td>Cross Asset Management Tools</td>
<td>Justin Brunner</td>
<td>Julie Drzymalski</td>
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**Penn State University (PSU) Projects**

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<tr>
<td>Characterization of Reclaimed Asphalt Pavement (RAP) Asphalt Binder Properties Using Impact Resonance Test (IRT)</td>
<td>Tim Ramirez</td>
<td>Mansour Solaimanian</td>
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<td>Optimizing Use of Crumb Rubber Modifier (CRM) with PA Asphalt Mixes</td>
<td>Tim Ramirez</td>
<td>Mansour Solaimanian</td>
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<td>03/01/19</td>
<td>06/30/21</td>
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<td>Evaluating Testing, Protocols and Limits for Asphalt Rejuvenating Agents in PA</td>
<td>Neal Fannin</td>
<td>Mansour Solaimanian</td>
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<td>09/30/19</td>
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<td>Serviceability of Staged Bridges</td>
<td>Katherine Schopman</td>
<td>Aleksandra Radlinska</td>
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<td>Adopt &amp; Beautify Pollinator/Monarch Habitat Credit Program</td>
<td>John (Drew) Ames</td>
<td>Carolyn Mahan</td>
<td>$67,569.75</td>
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<td>03/16/21</td>
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<tr>
<td>A Study of PennDOT-Approved Specifications &amp; Materials Used in Concrete &amp; Asphalt Project in District 4</td>
<td>Brian Wall</td>
<td>Farshad Rajabipour</td>
<td>$19,874.21</td>
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Other Contracting Mechanism

Engineering & Construction Management System (ECMS) Projects

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<th>Implementation</th>
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<tr>
<td>The Effect of Post-Consumer Recycled Asphalt Shingles (PCRAS) on Pavement Performance</td>
<td>Neal Fannin</td>
<td>Penn State University</td>
<td>Mansour Solaimanian</td>
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<td>Double Chip Seal on Paving Fabric</td>
<td>Tom Welker</td>
<td>Penn State University</td>
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<td>Bridge Resiliency in Rain Events</td>
<td>Tim Carre</td>
<td>Michael Baker, Jr.</td>
<td>Lehigh University</td>
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<td>Best Practice/Potential Solutions for Commercial Vehicle Navigation</td>
<td>Jerome Frederick</td>
<td>Michael Baker, Jr.</td>
<td>Todd Trautz</td>
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<td>02/10/20</td>
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<td>Testing Fibers in Microsurfacing</td>
<td>Tom Welker</td>
<td>Penn State University</td>
<td>Mansour Solaimanian</td>
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<td>SMART Intersections</td>
<td>Jeffrey Roecker</td>
<td>Kittelson &amp; Associates,</td>
<td>Inc. Shannon Warchol</td>
<td>$120,068.87</td>
<td>10/20/20</td>
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<tr>
<td>Project Name</td>
<td>PennDOT Technical Advisor (TA)</td>
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<td>Innovation and Development Deployment</td>
<td>Daryl St. Clair</td>
<td>Pennoni Associates, Inc.</td>
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<td>09/25/25</td>
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</table>
RESEARCH PROJECTS SPOTLIGHT

PUB 447: Approved Products for Low Volume Local Roads - Using Fibers in Microsurface Pavement Preservation Treatments

Microsurfacing is widely used to resurface existing roadways to extend their life cycles. It places a thin layer of new material over existing roadways, which allows better traction, sealing of cracks and other deficiencies. The Microsurfacing material is a composition of emulsified asphalt, cement, and a fine aggregate which is smoothed onto the road surface by a specialty mechanized machine. It generally extends the life of the road surface by five (5) plus years.

This research will determine whether adding small special fibers will extend the pavement life by seven (7) or eight (8) years. It is believed that these fibers will increase the durability of the product and help prevent cracking in the surface.

Laboratory testing and the monitoring of a municipal roadway project will be evaluated to determine if the extra cost of adding fibers will justify its use.

Source: Kenneth Road in West Manchester Township, York County

Tom Welker, PennDOT
Lightweight and Sustainable Materials in Engineered Fills

Lightweight materials with varying ranges in material properties have been in production for decades as alternatives to traditional engineered fills using soils. These materials can offer several advantages, including reduction of loads and induced settlements. Some projects may also realize lower costs and accelerated construction times when lightweight fill materials are used, particularly when compared to costly alternatives such as ground improvement techniques or the use of deep foundations. Additionally, the increasing use of sustainable or recycled products in lightweight fill materials has the added benefit of decreasing the carbon footprint of a project and promoting the application of sustainable materials for construction.

The purpose of this research project was to provide guidelines regarding appropriate implementation of lightweight and sustainable fill materials for use on PennDOT District 6-0 projects based on a comprehensive literature review and a review of recent case histories where such materials have been implemented.

In lightweight fill materials like Geofoam (RCPS), Cellular Concrete, Wood Fiber, Tire Shreds, Expanded Shale, Clay, Slate, Fly Ash, Boiler Slag, and Expanded Air-Cooled Slag were evaluated against more often used backfill products such as Flowable Concrete Fill, earthen material, including soils, aggregate, rock, and/or crushed paving materials.

The fills used on highway projects must:

- Provide adequate strength to support any overlying structures
- Appropriate gradation or use of filter fabric to prevent migration of native soils into the fill
- Adequate permeability to allow free drainage of any water accumulated in the fill
- Must not deteriorate in water
- Capable of being placed in a controlled and consistent manner for compaction
- Compatible with any overlying structures and/or native soils based on corrosion potential and chemical content.

Consequently, the selection of appropriate engineered fill and embankment materials is governed by specifications developed by FHWA, AASHTO, and state departments of transportation. Additionally, PennDOT’s Publication 408 highlights construction specifications for PennDOT projects and notes specific criteria for embankments and structural fills from various classes of excavations on a project.

Lightweight fill materials can be used for highway-related infrastructure when specific site conditions demand decreased applied loads, reductions in settlements, elimination, or reduction of the need for surcharge loading, reductions in lateral loads, and reductions in construction time.
AASHTO Research “Sweet Sixteen” Award

The Bureau of Planning and Research’s Research Program Management Section was recognized as one of AASHTO’s High Value Research Project Sweet Sixteen winners. The project was featured in AASHTO events and other publications such as the “Research Makes a Difference” brochure and was also the subject of a poster session at the Transportation Research Board (TRB) Annual Meeting.

The winning project was “Regionalized Urban/Suburban Collector Road Safety Performance Functions (SPFs).” Heather Sorce served as the project manager and was responsible for the project submission. Jason Hershock and Bob Ranieri (BOMO) were the PennDOT technical advisors. The Pennsylvania State University conducted the research. The objective of this project was to develop regionalized SPFs for urban-suburban collector roadways in Pennsylvania that are consistent with those in the Highway Safety Manual (HSM) for other facility types but reflect local conditions. Previously, collector roads could not be properly evaluated using HSM methods, since there weren’t any collector roadway SPFs. Pennsylvania is currently the only state that has SPFs for urban/suburban collector roads, which will lead to much more accurate safety assessments.

More information on the nationally recognized project may be found at:
### TRANSPORTATION POOLED FUND PROJECTS: F.Y. 2020-2021

<table>
<thead>
<tr>
<th>Project Name</th>
<th>PennDOT Technical Advisor (TA)</th>
<th>Lead Agency</th>
<th>F.Y. 2020-2021 Funding</th>
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<tbody>
<tr>
<td>Continuous Asphalt Mixture Compaction Assessment Using Density Profiling System (DPS)</td>
<td>Neal Fannin</td>
<td>Minnesota</td>
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<tr>
<td>Connected Vehicle Pooled Fund Study</td>
<td>Gunnar Rhone</td>
<td>Virginia</td>
<td>$50,000.00</td>
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<tr>
<td>Support for Urban Mobility Analyses (SUBPART A FUNDS)</td>
<td>Ryan McNary</td>
<td>Texas</td>
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<tr>
<td>Pavement Structural Evaluation with Traffic Speed Deflection Devices (TSDDs)</td>
<td>Janice Arellano</td>
<td>Virginia</td>
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<tr>
<td>National Partnership to Determine the Life Extending Benefit Curves of Pavement Preservation Techniques (MnROAD/NCAT Joint Study – Phase II)</td>
<td>Halley Cole</td>
<td>Minnesota</td>
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<tr>
<td>Building Information Modeling (BIM) for Bridges and Structures</td>
<td>Guozhou Li</td>
<td>Iowa</td>
<td>$20,000.00</td>
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<tr>
<td>Performance Engineered Concrete Paving Mixtures</td>
<td>Patricia Baer</td>
<td>Iowa</td>
<td>$15,000.00</td>
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<tr>
<td>Improving the Quality of Highway Profile Measurement</td>
<td>Colin McClenahen</td>
<td>South Dakota</td>
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<td>Clear Roads Phase II</td>
<td>Jon Fleming</td>
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<td>Roadside Safety Research for MASH Implementation</td>
<td>Hassan Raza</td>
<td>Washington</td>
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<td>Transportation Management Center (TMC)</td>
<td>Ryan McNary</td>
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<td>Evaluation of Low-Cost Safety Improvements</td>
<td>Jason Hershock</td>
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<td>Traffic Control Device (TCD) Consortium</td>
<td>Justin Smith</td>
<td>FHWA</td>
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<td>Technology Transfer Concrete Consortium (FY20-FY24)</td>
<td>Neal Fannin</td>
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<td>Improving the Quality of Pavement Surface Distress and Transverse Profile Data Collection and Analysis – Phase II</td>
<td>John Van Sickle</td>
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<td>Aurora Program (FY20-24)</td>
<td>Jason Norville</td>
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<td>Development of Criteria to Assess the Effects of Pack-out Corrosion in Build-Up Steel Members</td>
<td>Tim Carre</td>
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<td>Integrating Construction Practices and Weather into Freeze Thaw Specifications</td>
<td>Patricia Baer</td>
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<td>Automated Vehicle Pooled Fund Study</td>
<td>Mark Kopko</td>
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<td>Soil and Erosion Testing Services for Bridge Scour Evaluations</td>
<td>Dennis Neff</td>
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<td>Pavement Surface Properties Consortium: Phase III - Managing the Pavement Properties for Improved Safety</td>
<td>Octavio Acevedo</td>
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<td>Hydrologic and Hydraulic Software Enhancements (SMS, WMS, Hydraulic Toolbox, and HY-8)</td>
<td>Nick Vivian</td>
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<td>Structural Behavior of Ultra-High-Performance Concrete</td>
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<td>Demonstration to Advance New Pavement Technologies Pooled Fund</td>
<td>Halley Cole</td>
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TRANSPORTATION POOLED FUND PROJECT SPOTLIGHT

Clear Roads – Phase II

The Clear Roads Winter Highway Operations Pooled Fund is a national research consortium of 36 state members that pools funding to develop, advance, test and promote methods, materials, and equipment for winter highway maintenance activities. Currently, 14 research projects running 1 to 2 years in duration are in active research status. Over $4 million in projects have been either developed or are in process starting in 2017. PennDOT is an active member of this pooled fund and contributes to the selection of projects and research that we could not individually sustain for our annual contributions. In addition to being a voting member and introducing research projects, PennDOT also sits on the committees who oversee the research and direct the researchers to a product that meets the intent and final deliverables of the project. As these projects are completed, they are available on the Clear Roads website for states to utilize - www.clearroads.org.

Past and current projects’ deliverables and progress can be accessed from this website. The final deliverables are available for states to access as well as the project documentation and final presentations by the researchers. This allows PennDOT county and district staff to access the research and review the outcomes at their own pace and to review subjects of specific interest to them. Clear Roads projects range from snowplow blades research to environmental concerns of applying salt material. Clear Roads also promotes safe driving with a website available for all states to link to for driver’s awareness of winter conditions, driving tips, and safety messages.

Clear Roads recently completed a 2-year project to develop 22 training modules which can be used by DOTs to train new operators. This project includes PowerPoint presentations, instructor guides, student evaluations as well as video and other winter related activities for student learning. The modules can be edited for DOT-specific information and can be used as a complete package or individual parts to supplement existing training. PennDOT elected to use parts of this training packet to upgrade and refresh our current training package. We estimate the project has saved PennDOT approximately $50,000 to $75,000 in costs that would have been necessary to “update” our current training with video and updated student handouts.

PennDOT has and relies on in-house instructors to teach new employees as well as certify employees to receive their CDL and operate plow trucks. The new rules and regulations are very specific on how training must be rolled out, and on the content of the training. Clear Roads members voted to develop a research project to deliver a comprehensive training packet to meet the new Federal requirements. This training includes a Train the Trainer (TtT) seminar so states are prepared for the new changes and can continue to develop and certify new CDL drivers without having to send them to private CDL schools.
PennDOT did not estimate how much this new Federal ruling would have cost, but it would have been extremely expensive to develop our own training in-house and to develop/deliver the TtT packets. However, it is safe to say this project saved PennDOT at least $100,000 and several years utilizing consultant assistance to prepare and develop a concise product to assure the training packets would meet Federal requirements.

Source: Clear Roads website
LOCAL TECHNICAL ASSISTANCE PROGRAM (LTAP)

Since 1982, the Federal Highway Administration (FHWA) has supported local and rural road agencies across the US by providing training, technical assistance and technology transfer services to help them manage and maintain their roadway systems. The primary vehicle for this effort has been the Local Technical Assistance Program (LTAP), a network of 51 local Centers across the US and in Puerto Rico funded by FHWA.

Through LTAP, these local public agencies have received mission-critical services that filled vital needs on a traditionally underserved portion of the national roadway system. Often, LTAP training events and personalized assistance were the only source for locally relevant and compatible resources. Over the years LTAP has carved a significant niche in providing these services. The program, with its low- to no-cost model and practical accessibility, is a benefit to a local agency workforce challenged by limited access to training and technical assistance resources.

The Pennsylvania LTAP is housed in the Bureau of Planning and Research and has been in existence since 1983. PennDOT LTAP is designed to help Pennsylvania’s municipalities, which maintain over 78,000 miles of roadways, make the best use of their roadway maintenance dollars. Also, PennDOT LTAP was created to share transportation knowledge, improve road maintenance and safety skills, and put research and technology into practice at the municipal level.

On a yearly basis, the PennDOT LTAP training and technology transfer program, trains and assists municipal employees in effective and efficient maintenance procedures, essential safety practices and infrastructure management processes. Historically, PennDOT LTAP has augmented this training with one-on-one technical assistance sessions and the dissemination of pieces of information highlighting practical technological advances. PennDOT LTAP services include:

**Training:**

LTAP training takes many forms and is offered at no cost to municipalities. Training events include: Roads Scholar courses delivered on-site as an open course, a roadshow for group who requested the training, or through a virtual delivery. Considering the restrictions imposed due to the COVID pandemic, LTAP was able to seamlessly transition all classes to the virtual environment. LTAP will continue to offer classes virtually and in person moving forward to address the needs and preferences of all municipalities.

**Technical Assistance:**

LTAP Technical Experts are available by phone, email and in person to help municipalities troubleshoot specific maintenance and safety problems on their roadways.
Newsletters and Technical Information Sheets:
The PennDOT LTAP newsletter is distributed quarterly to Pennsylvania municipalities, PA House and Senate members, FHWA, metropolitan and rural planning organizations and other LTAP centers. The newsletter covers new programs, practices, technologies, legislation, reminders, and money-saving tips applicable to municipal maintenance and safety efforts.

Webinars:
LTAP provides webinars quarterly and has a catalog of on-demand webinars on the website.

Drop-In Sessions:
LTAP provides informal, one-hour sessions on a specific topic. LTAP staff will initiate the session with a short discussion/presentation, and then open-up the discussion to attendees. The past drop-in sessions are available on-demand on the website.

In F.Y. 2020-2021, PennDOT LTAP provided the following services to Pennsylvania municipalities:

- 1,802 individuals representing 591 Pennsylvania municipalities attended LTAP classes.
- 72 classes for 30 course titles were held throughout Pennsylvania.
- All classes were delivered virtually.
- 34 classes addressed maintenance topics and 102 addressed safety topics.
- 716 technical assistance sessions were provided.
- 4 newsletters.
- 4 new tech sheets, 11 updated.
- 10 webinars with 323 attendees.
- 13 drop-in sessions with 611 attendees.
Build a Better Mousetrap Competition

On a yearly basis, PennDOT LTAP holds a statewide Build a Better Mousetrap Competition. The statewide competition is open to all Pennsylvania municipal employees or crew who have designed and built an innovative gadget or developed an improved way to do a job. All entries are judged by a committee of municipal road employees in accordance with the following criteria:

- Cost savings/benefits to the community
- Ingenuity
- Transferability to others
- Effectiveness

Statewide winners were announced in the summer LTAP newsletter. The 2021 statewide 1st place winner was Penn Township, Lancaster County, for their Snow Fence Winder. This entry was advanced to the National Build a Better Mousetrap Competition to compete for national recognition.

Details on PennDOT LTAP Build a Better Mousetrap 2021 statewide winner are listed below.

Pennsylvania LTAP - Build a Better Mousetrap 2021 Winner – 1st Place

Problem Statement:
The township has an aging workforce, making getting on hands and knees difficult for staff members when rolling up snow fence. Additionally, rolling up the snow fence in higher grass and corn stalks is also a challenge.
Discussion of Solution:
The public works crew felt there was a need to come up with some way to roll snow fence up tighter and not be bent over or on their knees to do it. They came up with a way to roll snow fence tighter and utilized the hydraulics on their small dump truck. Once the snow fence is wound, the winder bar is lifted out of a cradle and the snow fence roll is slid off the shaft. Two crew members then throw the roll onto the truck.

Labor, Equipment, Materials Used:
A used stone pan from the back of the dump truck supplied the framework for the new tool. The crew removed the floor of the pan and welded on a platform to hold the hydraulic valve and controls. Additionally, the crew used some hoes, a couple universal joints, and some scrap materials that the department had on hand.

Cost:
The snow fence winder was built for $520.

Savings/Benefit to the Community:
The new equipment has increased the efficiency of rolling the snow fence into tighter rolls for storage. Also, the winder saves countless hours and time spent by crew on hands and knees manually rolling the snow fence.
Impactful Resilient Infrastructure Science and Engineering (IRSAE) Consortium

IRSAE Consortium F.Y. 2020-2021 activities included the following:

- Ongoing Monthly Steering Committee Meetings
- Conducted the 2021 IRSAE Annual Meeting
- Reviewed and Approved the Year 4 Annual Program
- Reviewed and Approved the Year 4 Scopes of Works and Budgets

The following IRSAE projects are on-going:

**Early Opening of Concrete Pavements to Traffic** - The purpose of this project is to develop a strategy that can be implemented by IRSAE members for the optimal timing of the opening of new concrete pavements to traffic.

**Improving Bridge Assessments** – The purpose of this project is to establish a framework capable of leveraging emerging Structural Health Monitoring (SHM) and Non-Destructive Evaluation (NDE) techniques to provide improved performance assessment of bridges. In particular, the proposed framework would focus on addressing the principal challenges associated with studying the service life of bridge structures, which are related to (a) the long-time scales (which requires accelerated aging), and (b) the diverse outputs related to bridge condition (in terms of data collected through SHM Data (SHMD), NDE and visual inspection). The primary focus would be on identifying the synergies among bridge degradation remaining service life, and the results taken from the multimodal sensing technologies (such as SHMD & NDE).

The following IRSAE projects were initiated during F.Y. 2020-2021:

**Preliminary Evaluation of Pavement Surface Distresses Related to Pavement Markings** - The purpose of this project is to investigate if pavement markings cause pavement surface deterioration in Pennsylvania and, if so, to develop approaches for mitigation of this problem.

**Remote-Controlled Technology Assessment for Safer Pavement Construction and QA/QC** - The purpose of this project is to identify and review new and emerging remote-controlled processes with focus on pavement QA/QC, testing and evaluation recently developed in the U.S. and abroad that can potentially be implemented by the IRSAE members. The project will inform the IRSAE members on the latest developments and facilitate implementation of the emerging pavement technologies to develop safer and more effective pavement construction and evaluation methodologies.
Joint Design Optimization - The purpose of this project is to evaluate the type, reservoir design, construction practices and performance of joint sealant in Pennsylvania and provide guidance on strategies for optimizing joint performance. The scope of research also includes incorporating the consideration of the potential for dowel corrosion into models for predicting faulting.

Developing Methodologies to Predict and Quantify the Benefits that Create Durable and Longer Lasting Highway Infrastructure - The purpose of this project is to develop methodologies and apply them to the research results developed for several highway infrastructure projects to predict and quantify the benefits. The scope of work also involves tasks to be performed to evaluate current methodologies used to predict changes in highway infrastructure relative to longevity and resulting cost reductions.

Material Compatible Repairs Evaluation - The purpose of this project is to assess the performance of partial depth repairs made using the recommendations in the research in comparison with partial repairs made using other methods in similar settings.

Three-Dimensional (3-D) Micro-mechanical Characterization of the Effect of Vibration and Compaction in Concrete Pavements - The purpose of this project is to formally quantify the effect of vibration and compaction as a function of the mix workability and the ambient temperature and humidity on the overall paving process. The findings will serve as the base for the definition of novel guidelines to allow for the optimized construction of concrete pavements in different conditions.
Center for Integrated Asset Management for Multi-Modal Transportation Infrastructure Systems (CIAMTIS)

For F.Y. 2020-2021 the following project was initiated:

**Development of a Fatigue Testing Protocol for Supporting Integrated Design of Asphalt Pavement** –
The purpose of this project is to develop a laboratory fatigue testing protocol for asphalt mixtures using the Hamburg Wheel Tracking Device, evaluate the repeatability and reliability of the testing protocol for characterizing various types of asphalt mixtures, and develop a draft testing protocol for use by state highway agencies.

During F.Y. 2020-2021, the PennDOT Technical Advisors worked with the PSU Principal Investigators to craft scopes of work for the following proposed CIAMTIS projects:

**Artificial Intelligence (AI) for Building a Landslide Inventory & Advanced Landslide Warning System in Pennsylvania** – The purpose of the project is to develop AI models for advance warning of rainfall-induced landslides for unstable slopes above or below state-maintained roadways in Pennsylvania. The average annual direct and indirect cost of landslides is in the tens of millions of dollars in the state. Landslides cause damage to utilities, buildings, and transportation routes, which, in turn, creates travel delays and other side effects. As more land is being developed and with more frequent extreme rainfalls associated with the climate change, an increased frequency of rainfall-induced landslides is likely in the coming decades. Roadway reconstruction costs, travel delays, and other side effects could be significantly reduced if an advanced warning system of rainfall-induced landslides could be developed. By providing an advanced warning system to transportation officials, it would allow them to address rainfall-induced landslides before they affect the safety, inconvenience, and cost to the public.

**Reducing the Cost and Facilitating Broader Adoption of Ultra-High-Performance Concrete (UHPC) in Pennsylvania Bridges** - The purpose of this project is to develop cost-effective, non-proprietary UHPC mixtures that meet target mechanical performance for ready mix and precast applications. Also, this project will develop a bridge beam application that can be readily adopted by the precast concrete industry.

**Improving Freeze-Thaw Resistance and Fatigue Resistance of Recycled Aggregate Concrete** - The purpose of this project is to evaluate the use of silane emulsion to prevent strength loss due to water adsorption and improve the durability and freeze-thaw resistance of recycled aggregate concrete (RCA). The hypothesis of this project is the surface treated RCA can be utilized to design high-quality, freeze-thaw-resistant pavement concrete and reduce maintenance needs and costs of transportation infrastructure.
Quantifying the Impact of Data Unavailability, Inaccuracies and Uncertainty on Deterioration Modeling and Infrastructure Asset Management Policies - The purpose of this project is to improve upon existing performance and condition prediction models for bridge decks or pavements. This will be accomplished by using statistical and machine learning enabled data analysis methods, addressing data uncertainties and incompleteness. Overall, this project can significantly enhance currently used tools for infrastructure asset management, offering more accurate predictions, increased safety, and considerable savings of resources, and can provide a framework for DOTs as to how inspection and monitoring resources should be prioritized and selected.

Economic Impacts of Transportation Infrastructure Investments - The purpose of this project is to identify optimal transportation investment strategies that maximize the economic returns for the entire Mid-Atlantic region, considering both traditional and technological investments.
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