

TRANSPORTATION POOLED FUND PROGRAM QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Indiana Department of Transportation

INSTRUCTIONS:

Lead Agency contacts should complete a quarterly progress report for each calendar quarter during which the projects are active. Please provide a project schedule status of the research activities tied to each task that is defined in the proposal; a percentage completion of each task; a concise discussion (2 or 3 sentences) of the current status, including accomplishments and problems encountered, if any. List all tasks, even if no work was done during this period.

Transportation Pooled Fund Program Project # TPF-5(514)	Transportation Pooled Fund Program - Report Period: <input checked="" type="checkbox"/> Quarter 1 (January 1 – March 31) <input type="checkbox"/> Quarter 2 (April 1 – June 30) <input type="checkbox"/> Quarter 3 (July 1 – September 30) <input type="checkbox"/> Quarter 4 (October 1 – December 31)	
TPF Study Number and Title: TPF-5(514) Work Zone Analytics		
Lead Agency Contact: John McGregor	Lead Agency Phone Number 317 899-8617	Lead Agency E-Mail jmcgregor@indot.in.gov
Lead Agency Project ID: TPF-5(514)	Other Project ID (i.e., contract #):	Project Start Date: July 1, 2023
Original Project Start Date: July 1, 2023	Original Project End Date: 6/30/2026	If Extension has been requested, updated project End Date: 12/31/2026

Project schedule status:

- On schedule
 On revised schedule
 Ahead of schedule
 Behind schedule

Overall Project Statistics:

Total Project Budget	Total Funds Expended This Quarter	Percentage of Work Completed to Date
\$743,000	\$72,834.92	80%

Project Description:

Background & Impact

For the past 3 years, Purdue University and the Indiana Department of transportation have been monitoring congestion and hard braking data across all 2600 miles of Indiana Interstates using connected vehicle data. Hard braking data has been found to a modern day surrogate for looking for skid marks on the road and predicting potential areas of concern for crashes.

These hard braking events can be used to identify specific locations along a road that should be looked at further by comparing the before construction with the connected vehicle hard braking data during construction.

Research Needs

These reports have evolved over the past 3 years in Indiana and there is a need to develop a multi-state consensus on the most effective reports. This will provide a framework to formalize the reporting models, data reduction processes and decision making process so these techniques can be scaled to other states so they can pro-actively identify emerging safety concerns in their work zones, conduct effective after action reviews of past work zones, and ultimately identify best practices for future work zones that minimize congestion, hard braking and ultimately crashes.

Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):

April 1 – June 30, 2023

The solicitation for TPF-5(514) was posted in Spring 2023.

The following agencies have committed a total of \$380,000 to TPF-5(514) as of June 30, 2023.

FHWA
Pennsylvania
Texas

The project has a start date of July 1, 2023, and will be funded incrementally by Purdue University as funds from the participating states are transferred.

July 1 – September 30, 2023

Webinar with panel members to obtain feedback on the project scope were held on August 10, 2023, with participation from FHWA, Texas, Pennsylvania, and Purdue.

During the past quarter, Michigan DOT and Wisconsin DOT have indicated their intention to join TPF-5(514).

The Purdue team has adapted some of the Indiana analytics to Interstate routes in PA and TX

To date, \$30,000 in funding for TPF-5(514) has been received by Purdue University. Significant work on the PFS project is pending additional transfer of funds from the partner states.

October 1 – December 30, 2023

Webinars to obtain feedback on the project scope were held on October 3 and October 23, 2023, with participation from FHWA, Indiana, Texas, Pennsylvania, Michigan, Wisconsin, and Purdue. In addition, an update was provided to the Work Zone ITS Subcommittee at the ATSSA Mid-year meeting in Chicago to generate interest among other states.

During the past quarter, Illinois, Michigan, Utah and Wisconsin committed to TPF-5(514). The Work Zone Analytics study team now includes the following:

FHWA
Illinois
Indiana
Michigan

Pennsylvania
Texas
Utah
Wisconsin

During this quarter, the Purdue research team has been seeking to identify an alternative connected vehicle data source other than Wejo (which suspended operations on June 1, 2023) as well as developing a tutorial on how to read heatmaps.

An alternative data source, Solaris, has been identified and is scheduled to begin providing a reasonable trajectory data set on January 15, 2024, that can be used for monitoring work zones.

Scheduling is underway for a webinar with all partners during the first quarter of 2024 in order to further define the scope and prioritize future activities.

January 1 – March 31, 2024

A webinar was held on February 15, 2024 with representatives from FHWA and partner states (IL, IN, PA, TX, WI). The research team shared examples of weekly heatmaps using Omnitrac's connected truck data. Partner states were requested to submit interstate Workzones of interest for their states, with Sharepoint sites set up for each state to receive the weekly heatmaps.

Subsequent to the meeting, states submitted work zones of interest. Weekly heatmaps are being generated and distributed through the Sharepoint sites. A summary of the number of work zones of interest submitted by each state is shown below.

Partner State	# Work Zones of Interest
Illinois	6
Indiana	7
Michigan	4
Pennsylvania	4
Texas	5
Utah	6
Wisconsin	10
Total	42

The next webinar for partner states is scheduled for May 10, 2024. At that meeting, case studies of work zones of Interest will be shared.

April 1 – June 30, 2024

The Purdue Research team presented "Work Zone Analytics" at the Midwest Work Zone Roundtable on May 9, 2024, to share activities of TPF-5(514) with a broader audience.

Webinar with TPF-5(514) partners (FHWA, IL, IN, MI, PA, TX, UT, IN) was held on May 10, 2024. Agenda included review of the weekly heatmaps for the partner states and selected case studies for work zones of interest submitted by states.

Weekly heatmaps are generated for all interstates for each state that is part of the PF study along with heatmaps specific to work zones (43 total) submitted by states and are updated every Monday in a shared one-drive folder.

Publication of heatmap monograph entitled "Measuring and Visualizing Freeway Traffic Conditions: Using Connected Vehicle Data" that demonstrates approximately 50 use cases. Citation listed below in Significant Results.

July 1 – September 30, 2024

Beginning in July, the weekly heatmap distribution to partner states included commentary that identified the top 2 or top 3 noteworthy changes from the week before for each state.

Webinar with TPF-5(514) partners (FHWA, IL, IN, MI, PA, TX, UT, IN) was held on August 9, 2024. Agenda included review of the weekly heatmaps for the partner states and selected case studies for work zones of interest submitted by states. Dialog on available data sources to monitor work zones included the following:

- Truck data is more affordable, but in some cases passenger car data provides better coverage of work zones
- Potential application of Hard braking data to monitor work zones
- Use of Vizion truck dash cam images to monitor work zones conditions

Tactical webinars with individual states provided opportunities to discuss their work zones of interest, review associated heatmaps and noteworthy changes from previous weeks. State webinars were held as follows:

- July 29, 2024 Wisconsin
- July 31, 2024 Illinois
- Aug. 2, 2024 Texas
- Sept. 13, 2024 Illinois

October 1 – December 31, 2024

Distribution of weekly heatmaps to partner states continued during this quarter.

Maryland and Delaware joined the PFS during this quarter and weekly heatmaps were initiated for their states.

Webinar with TPF-5(514) partners was held on October 30, 2024. Discussion included the following:

- Fielding Tipton from INDOT explained how the agency is using heatmaps and hard braking data for agile monitoring on work zones in Indiana.
- Purdue team discussed select case studies from each state.
- Partners indicated strong interest in the commercial truck dashcam roadway imagery and the hard braking data.

Tactical webinar with Illinois was held on November 14, 2024 with their central office staff. Subsequently, they have initiated dialog with their district construction engineers. The Purdue team will do a day trip to Springfield, IL on Feb 18 to present to their district construction engineers.

Ingestion has been done on a new CV data source (CompassIoT) using a sample of data from Texas. Adding a second CV data source has two advantages: 1) Introduces redundancy if one of the data providers decides to suspend CV data and 2) Establishes market competition.

Regional and National Presentations regarding work related to TPF-4(514) included the following:

- Ohio Traffic Engineering Conference on October 9, 2024
- Virtual National Work Zone Management Conference on October 22, 2024
- FHWA Advance Warning Workshop on October 30, 2024.

January 1 – March 31, 2025

Distribution of weekly heatmaps to partner states continued during this quarter.

Webinar with TPF-5(514) partners was held on February 5, 2025. Discussion included the following:

- Update on connected vehicle data from Omnitrac and emerging opportunities with CompassIoT.
- Workzone Safety and Mobility Rules Performance Measures that can be supported by work of the PFS. In preparation for our April webinar with partner states, the team is working on developing example performance measures.

Site Visit to Illinois for presentations during their Statewide Traffic Control Supervisor Meeting was done on February 18, 2025. Presentations included the following:

- Connected Vehicle Heatmap Demonstration
- Illinois Case Studies

Begin ingesting CompassIoT connected vehicle data to evaluate feasibility of incorporating this data into the weekly work zone reports and/or Workzone Safety and Mobility Rules Performance Measures.

Regional and National Presentations regarding work related to TPF-4(514) included the following:

- ATSSA Annual Conference (March 2, 2025): “Monitoring Work Zone Maintenance of Traffic Using Crowdsourced Dash Cameras”
- Center for Connected and Automated Transportation (CCAT) Global Symposium (March 28, 2025): “Methodologies for Monitoring Work Zone Performance Measures Across State Border Highways Using Connected Vehicle Data”
- 2025 Purdue Road School Transportation Conference and Expo (March 18-19, 2025)
 - Assessing the Coverage of Commercial Truck Dash Cam Images on Interstate Roads
 - In-Cab Alerts Impacts on Connected Truck Speed Reductions

April 1 – June 30, 2025

Distribution of weekly heatmaps to partner states continued during this quarter.

Webinar with TPF-5(514) partners was held on April 23, 2025. Discussion included the following:

- Data sources that can be used for calculating Safety and Mobility Performance Measures as part of 23 CFR Part 630 Subpart J
- In preparation for the construction season, collection of work zones from state partners for inclusion in the 2025 Work Zone Weekly heatmaps.

Webinar with TPF-5(514) partners was held on June 30, 2025. Discussion included the following:

- Weekly Heatmaps using Omnitrac data for Interstates and Work Zones will be posted to SharePoint site.
- Heatmaps using CompassIoT Data will be posted on SharePoint site as the data is available.
- Vizion dash cam images are now being stored on Google Cloud.
- Speed summaries are being distributed as part of the weekly reports.

July 1 – September 30, 2025

Distribution of weekly heatmaps to partner states continued during this quarter.

The following items are posted to SharePoint site on a weekly basis:

- Heatmaps using Omnitrac data for Interstates and Work Zones
- Heatmaps using CompassIoT Data as the data is available.
- Speed quartile summaries
- Prepared manuscript entitled “Workzone Performance Measures Derived from Connected Vehicle Data ” and submitted it to TRB. That paper has been accepted for presentation in January 2025 as Paper ID 26-02289

National Presentations regarding work related to TPF-4(514) at the ATSSA Mid-Year Meeting in Milwaukee, WI on August 22, 2025.

Tactical webinar with Texas DOT was held on September 24, 2025.

October 1 – December 31, 2025

Webinar with TPF-5(514) partners was held on October 1, 2025. Panel meeting discussion and continued activity during this quarter includes the following:

- Heatmaps using Omnitrac data for Interstates and Work Zones. Web links and QR codes are posted to the SharePoint site on a weekly basis.
- Virtual drives of work zones from Vizion images are distributed via YouTube unlisted playlists for each state on a weekly basis. States may request virtual drives for specific work zones and time periods as needed.
- One-on-one calls with states can be scheduled to review their respective work zones and reports.

The following publication was accepted for publication and is currently in press.

Sakhare, R, Desai, J., Overall, M., Mukai, J., Pava, J., McGregor, J., Bullock, D., Work Zone Performance Measures Derived from Connected Vehicle Data for Safety and Mobility Assessment. Future Transportation. In press, January 2026.

The following manuscript was published.

Overall, M., Mukai, J., Sakhare, R., Desai, J., Horton, D. and Bullock, D. (2026) Applications of Commercial Truck Dash Cameras for Work Zone Inspection and Monitoring. *Journal of Transportation Technologies*, **16**, 95-114. <https://doi.org/10.4236/jtts.2026.161006>

January 1 – March 31, 2026

Webinar with TPF-5(514) partners was held on February 2, 2026. Panel meeting discussion and updates included the following:

- The research team is available to do one-on-one meetings as orientation to the project activities and output for partner states.
- New Heatmap tool was demonstrated and key points were discussed.
- States can submit 2026 Work zones for monitoring:
- The current project ends on June 30, 2026. Budget estimates indicate that commitments and available funds are sufficient to extend the project through the upcoming work zone season. Jawad Paracha agreed with proceeding with a no cost extension to December 31, 2026.

Regional and National Presentations regarding work related to TPF-4(514) included the following:

- 2026 Transportation Research Board (TRB) Presentation
 - Work Zone Performance Measures Derived from Connected Vehicle Data that Map into the FHWA Rule on Work Zone Safety and Mobility
 - Applications of Commercial Truck Dash Cameras for Work Zone Inspection and Monitoring
- 2026 ATSSA Annual Meeting in Houston, TX Presentation
 - Sunday, Feb. 22, 2026: Education Session entitled “Work Zone Safety and Mobility Metrics” featured case studies from partner states. Following the presentation, members who were present met for informal dialog and sharing of ideas.

Site Visit to Illinois during their Statewide Traffic Control Supervisor Meeting was done on March 25, 2026, for presentation entitled “Connected Vehicle Applications in Illinois Workzones”

The following manuscript was published.

Sakhare, R.S.; Desai, J.; Overall, M.; Mukai, J.; Pava, J.; McGregor, J.; Bullock, D.M. Work Zone Performance Measures Derived from Connected Vehicle Data for Safety and Mobility Assessment. *Future Transp.* **2026**, *6*, 12. <https://doi.org/10.3390/futuretransp6010012>

Anticipated work next quarter:

- Schedule panel meeting (webinar) in Spring 2026
- Updating list of workzones for monitoring from each partner state.
- Continued distribution of weekly heatmaps and virtual drives to partner states.
- One-on-one calls with states can be scheduled to review their respective work zones and reports.
- Share work related to TPF-5(514)
 - April 18, 2026 Presentation at Illinois Asphalt Pavement Association on Work Zone Analytics
 - April 30, 2026 Peer Exchange Webinar: Work Zone Safety & Mobility

Significant Results:

Sakhare, R. S., Desai, J., Mathew, J. K., McGregor, J., Kachler, M., & Bullock, D. M. (2024). *Measuring and visualizing freeway traffic conditions: Using connected vehicle data* (Joint Transportation Research Program No. TPF-5(514)). West Lafayette, IN: Purdue University. <https://doi.org/10.5703/1288284317751>

R. S. Sakhare, J. Desai, J. K. Mathew and D. M. Bullock, (2024) "Assessing the Interstate Coverage of Commercial Trucks Capable of Providing Roadway Imagery via On-Vehicle Dash Camera in the United States," in IEEE Access, <https://ieeexplore.ieee.org/document/10758643>

Overall, M., Mukai, J., Sakhare, R., Desai, J., Horton, D. and Bullock, D. (2026) Applications of Commercial Truck Dash Cameras for Work Zone Inspection and Monitoring. *Journal of Transportation Technologies*, 16, 95-114. <https://doi.org/10.4236/jtts.2026.161006>

Sakhare, R.S.; Desai, J.; Overall, M.; Mukai, J.; Pava, J.; McGregor, J.; Bullock, D.M. Work Zone Performance Measures Derived from Connected Vehicle Data for Safety and Mobility Assessment. *Future Transp.* **2026**, 6, 12. <https://doi.org/10.3390/futuretransp6010012>

Potential Implementation: N/A