TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

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 (504)	**Transportation Pooled Fund Program - Report Period:** ☐ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☒ Quarter 4 (October 1 – December 31)
TPF Study Number and Title: TPF-5 (504) – Continuous Bituminous Pavement Stripping Assessment Through Non-Destructive Testing	

Lead Agency Contact: Eyoab Zegeye	**Lead Agency Phone Number:** 651-366-5517 (work)	**Lead Agency E-Mail** eyoab.zegeye@state.mn.us
Lead Agency Project ID: TPF1550	**Other Project ID (i.e., contract #):**	**Project Start Date:** May 1, 2023 – Start date
Original Project Start Date:	**Original Project End Date:**	**If Extension has been requested, updated project End Date:**

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
$1,075,000	$	%

Project Description:
Stripping is a critical pavement subsurface distress affecting the performance and durability of asphalt pavement systems: full-depth asphalt, recycled, or composite. In full-depth asphalt pavements, stripping can be caused by moisture infiltration in the pavement system, leading to the loss of bond between the aggregate particles and the asphalt binder composing the mixture. The bond failure leads to the formation of an unbonded mixture and ultimately reduces the pavement bearing capacity. In asphalt overlays over concrete (composite), stripping is generally caused by moisture trapped in the interface above the concrete. Stripping leads to the formation of potholes, cracking, slippage cracking, tearing, and ultimately reduced strength and serviceability of pavements if not detected and addressed early.

Over the years, substantial progress has been made in developing bituminous mixtures less prone to stripping, thanks mainly to improved material selection tools, anti-stripping additives, modified asphalt binders, and improved drainage practices. However, stripping continues to be a dominant issue in pavement design and scoping processes for various reasons. To cite a few examples: a) placing new stripping-resistant mixtures on top of old bituminous mixtures that are likely to be affected by stripping; b) increased use of recycled and multi-recycled materials; and c) asphalt overlays on concrete and d) quality control-related section or spot failures (i.e., binder content deficiency).

The most challenging aspect of stripping is that it initiates at the bottom or middle of bituminous layers and propagates upward. Hence, it is almost impossible to detect and quantify at early stages through visual inspections or traditional pavement forensic investigation tools. Once the problem manifests itself on the top surface of the pavement, it is generally too late for minor localized treatments. The lack of appropriate diagnostic tools for stripping makes developing proper pavement rehabilitation plans challenging. For instance, without knowing the stripping's extent, severity, and depth, it becomes challenging to select an appropriate mill depth for a new overlay or a proper rehabilitation strategy (i.e., full reconstruction, mill and overlay, cold recycling).

Fortunately, new advanced non-destructive evaluation (NDE) technologies are becoming increasingly accessible and suitable for solving complex pavement issues. The Strategic Highway Research Program 2 (SHRP2) study R06D (Heitzman, et al. 2012) vetted the capability of several NDE technologies to evaluate pavements affected by delamination: stripping and debonding. Debonding is a similar failure that occurs when the tacking between the pavement layers (lifts) is inadequate. However, the affected layers generally remain physically quasi-intact in debonding, while the layers exhibit full or partial deterioration in stripping. Out of eight (8) vetted tools, two (2) provided promising results for identifying and quantifying stripping: the 3D-Ground Penetrating Radar (3D-GPR), an air-launched antenna array with frequency sweep measurements and the Impact Echo/Spectral Analysis of Surface Waves (IE/SASW) scanning system. Among these two technologies, 3D-GPR provided the added advantage of continuous full-lane width data collection in a single pass at safe traffic traveling speeds. Furthermore, the ability of 3D-GPR to scan full-lane width resulted in higher chances of detecting stripping locations than more traditional single-channel 2D-GPR systems. While in the case of debonding, 3D-GPR was less effective and offered good information only in wet conditions. The IE/SASW was most effective at identifying discontinuities when the pavement was cold and stiff. However, it required lane closure and did not provide continuous full-lane coverage.

After the R06D study, several states (FL, TX, NM, CA, KY and MN) participated in an Implementation Assistance Program (IAP) sponsored by FHWA and AASHTO, aimed at determining if the 3D-GPR and the IE/SASW technologies met "proof of concept" and were ready for national implementation. The study concluded that the 3D-GPR system met the criteria for high-speed data collection. The IE/SASW system significantly improved data collection speed but still requires lane closure. The IAP identified several drawbacks and concerns that need to be addressed to effectively use 3D-GPR in detecting stripping at project and network levels. The recommended needs for improvements are listed below:

- Develop standard practices for testing pavement using 3D-GPR and other companion NDE technologies such as Traffic Speed Deflectometer and Falling Weight Deflectometer
- Establish proper equipment calibration and data quality verification (i.e., coring locations and numbers) procedures to improve the accuracy of the output
- Develop a standard algorithm for automated processing of 3D-GPR data and detection of stripping. At present, identifying stripping in the bituminous layers is accomplished through a visual examination of the GPR images. This process is significantly dependent on the person's experience interpreting the images, time-consuming and labor-intensive, and difficult to adopt in state agencies' practices.
- Determine the need and benefits of linking the 3D-GPR data to other NDE technologies. 3D-GPR alone cannot identify stripping all the time and at all subsurface moisture conditions. In addition, 3D-GPR is only readily available to some road agencies. Hence, it is important to continue evaluating other NDE technologies that could fill in the blank spots of 3D-GPR. The other NDE technologies proposed for this study are TSD, FWD, 1D-GPR, IE/SASW, and PASP.
- Develop specifications and implementation plans and promote the use of 3D-GPR for testing stripping
- Facilitate communication between vendors and agencies to enable vendors to make improvements to their hardware and software
- Establish a national user group to provide a venue for experts in NDE technologies to advance GPR and other NDE technologies in local and national road authorities.

In September 2021, FHWA sponsored a well-attended Virtual Peer Exchange to gather updates on Post-R06D advancements from state agencies, universities, research institutions, consultants and vendor perspectives. The meeting noted that several state transportation agencies, including the Minnesota Department of Transportation (MNDOT), are working toward incorporating 3D-GPR in their project scoping process and addressing stripping and other subsurface pavement issues in their roadways. The group reiterated the need to address the IAP recommendations through a national pool fund study. MnDOT was selected to lead and manage the pool fund study efforts, including drafting and

advancing the present proposal. MnDOT recognizes the opportunities and challenges of this effort and believes they are best addressed in collaboration with other agencies and stakeholders.

Project Objectives:
The primary objective of the proposed pooled-fund project is to establish a research consortium focused on addressing the R06D and IAP recommendations. As per the IAP and R06D findings and recommendations, particular emphasis will be placed on using 3D-GPR, which is particularly suitable for high-speed continuous and lane-width data collection and is already being incorporated in project scoping processes for thickness determination. Nevertheless, other NDE technologies, such as FWD and TSD, will also be considered to complement, evaluate, verify and validate the 3D-GPR findings. Similarly, recognizing that 3D-GPR alone cannot identify stripping all the time and at all subsurface moisture conditions, the study will also investigate using IE/SASW, MIRA, and Thermal Imaging for localized spot verifications. Furthermore, the proposed pool fund study will include contemporary 2D and 3D-GPR testing on limited projects to compare and identify advantages and disadvantages. The tools (i.e., equipment, testing procedures, data processing algorithms, specifications) advanced through this project will assist state transportation agencies in rapidly and confidently detecting the extent, depth, and severity of stripping in their roads. The set goals are to be accomplished by:

- Developing a methodology for rapid and automatic stripping detection based on 3D-GPR and other NDE technologies such as Falling Weight Deflectometer (FWD) and Traffic Speed Deflectometer (TSD). The development will be based on the experience and needs of participants so that the developed methodology can effectively and efficiently support their pavement evaluation program.
- Developing a software for automated processing of 3D-GPR data and detection of stripping
- Verifying and validating the developed methodology on projects selected by the participating agencies. The more states, the stronger the methodology
- Providing participating agencies guidelines on data collection and analysis protocols
- Drafting AASHTO specification.
- Facilitating and supporting communication between experts in NDE technologies, state engineers and vendors to advance the use of GPR for inspecting pavement subsurface issues
- Providing training and technical assistance that includes providing support for specification development and strategies for agency full implementation
- Conducting technology promotion for the technologies

Recognizing that 3D-GPR and TSD may only be readily available to some participating states, the study will allocate a portion of the pool fund to hire consulting firms for 3D-GPR and TSD surveys on the projects considered in this study.

Scope of Work:
The work plan was ~~will be~~ finalized and approved by the pool fund panel. While the details and scope of the objectives will be further defined during the first task of the project, it is anticipated that the project will include the followings:

- Task 1 – Finalizing the Scope of Work
- Task 2 – Survey and Literature Review
- Task 3 – Building GPR Signal Stripping Signature Database
- Task 4 – Building and Evaluating Artificially Stripped Section in MN ROAD
- Task 5 – Development of a Software for Automated Detection and Quantification of Stripping
- Task 6 – Data collection on Roads from Participant States
- Task 7- Review, Analysis, Data Fusion, and Interpretation of the collected data
- Task 8 – Development of AASHTO Specification - Testing and Analysis Procedures
- Task 9 – Training and Technical Assistance
- Task 10 – Support and Communication
- Task 11 – Strategic Technology Promotion

A summary of the technical and non-technical project activities is given in the complete workplan (See website)

The pool fund study accomplishments since its beginning are listed next. The accomplishments of the current quarter are highlighted below in yellow.

Task 1 – Finalizing the scope of work

Q1 (2023)	• Account set up(April, 2023):The lead agency, MnDOT, obtained final approval from the FHWA Division on March 23, 2023. Soon after, MnDOT's financial office assigned a proper project ID to the study, an official indication to start working on the items proposed in the work plan. Therefore, although the work did not start until April 2023, the lead agency conducted essential preparation works listed below: • Approval of workplan / Project Kick-Off Meeting (January 6, 2023): A two-hour-long online project kick-off meeting was held on January 6, 2023. The meeting was exclusively for state agencies. The objective was to discuss and approve the work plan that was shared with all the study partners well before the meeting. The meeting was for state agency and FHWA members alone and was well attended. Detailed meeting minutes can be found on the TPF website
Q2 (2023)	• New member: Welcomed Georgia to the pool fund study. The agency contact is Ian Rish
Q3 (2023)	
Q4 (2023)	• New member: Welcomed Florida Department of Transportation (FDOT) to the pool fund study. The agency contact is Charles Holzschuher • New member: Welcomed Kentucky Transportation Cabinet to the pool fund study. The agency contact is Brad Fraizer

Task 2 – Survey and Literature Review

Q1 (2023)	
Q2 (2023)	Drafting survey questionaries: MnDOT team, building on the work that started during the R06D final virtual meeting with QES, selected and finalized survey questions that would benefit the study. The questionnaires were sent out to all the partners and friends of the study for further discussion and deliberation. The final version of the questionnaires will come out from the August 11, 2023, virtual meeting. The meeting will also determine on how to share the questions and how to collect and analyze the responses.
Q3 (2023)	Distributing survey and gathering results: In Q2 2023, the survey questionnaires were finalized, approved during the August 11, 2023 meeting, and transformed into an online format in collaboration with MnDOT's *Lauren Dao*. The online survey included structured multiple-choice and open-ended questions targeted at individuals knowledgeable about pavement project scoping challenges and tools. Shared with 40 members of the pool fund study and AASHTO COMP, it received 29 detailed responses. Currently analyzing these responses, the plan for Q4 includes compiling a report and publishing it on the TPF website. Key insights from responses will be used to enhance our project activities.
Q4 (2023)	Analysis and synthesis of the survey results: The responses to the survey questionnaire were meticulously analyzed, yielding results highly pertinent to the objectives of the pooled fund study. These findings were presented at the fall first in-person meeting (Nov 2023), providing valuable insights. The data obtained from the questionnaires play a critical role in elucidating and directing the scope of our research effort, ensuring alignment with the study's overarching goals. The survey results are now being incorporated in the literature survey report that will be finalized in the next quarter. A synthesis of the survey result is uploaded in the website

Task 3 – Building GPR Signal Stripping Signature Database

Q1 (2023)	
Q2 (2023)	
Q3 (2023)	
Q4 (2023)	

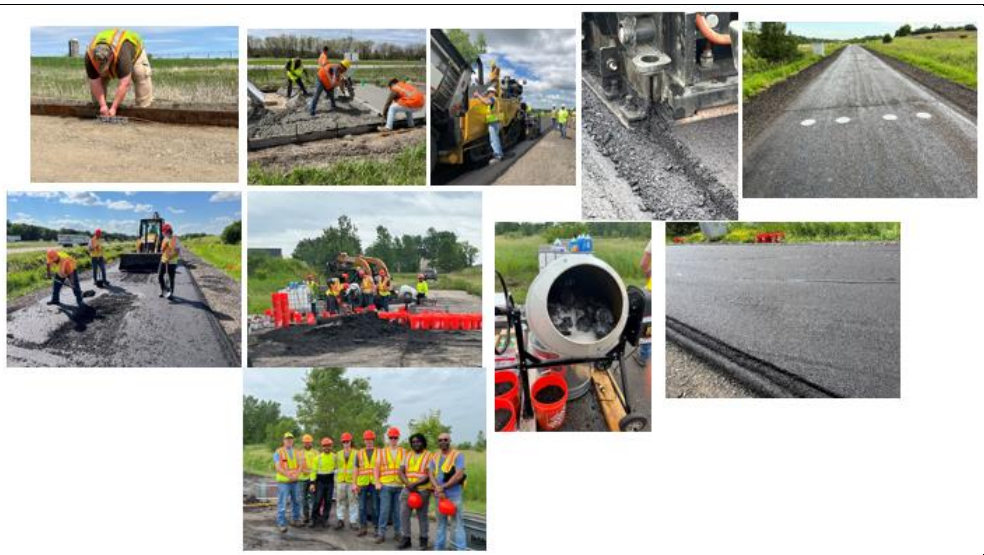
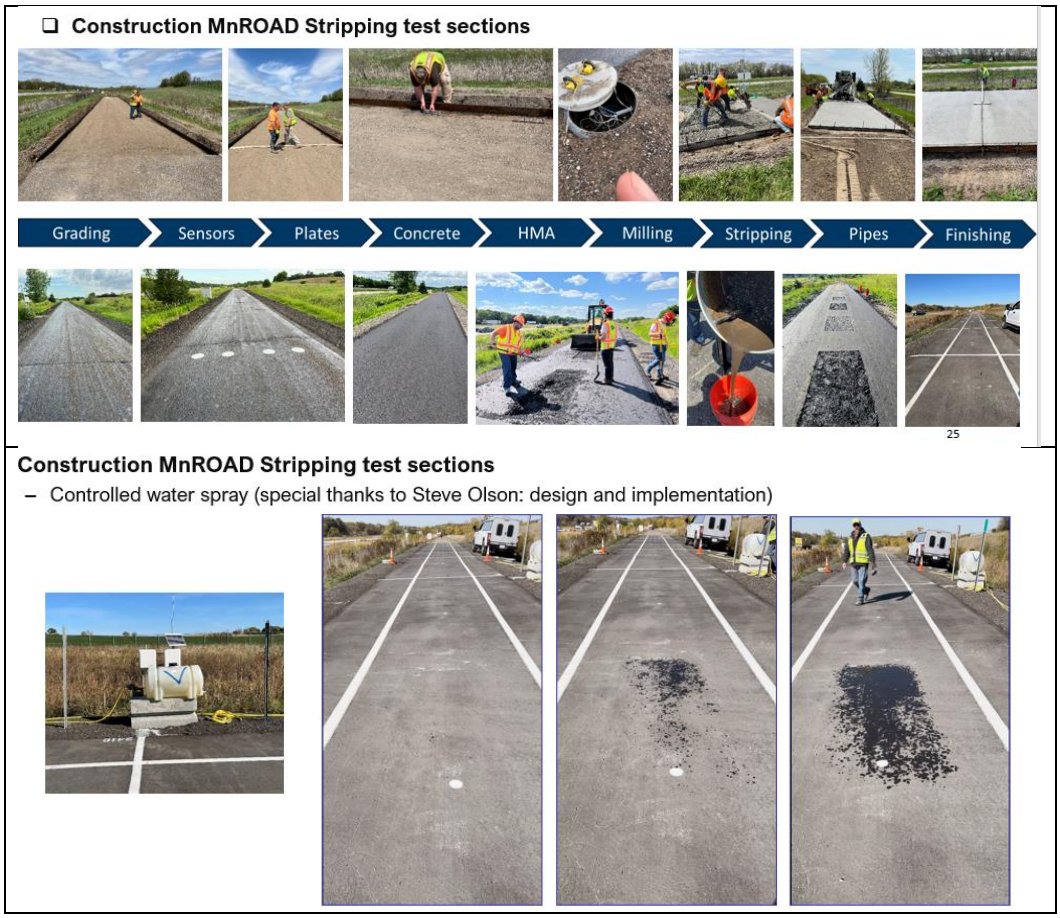
Task 4 – Building and Evaluating Artificially Stripped Section in MN ROAD

Q1 (2023)	• Meetings with subject matter experts: Meeting with Mike Heitzman (February 15, 2023): Mike Hetzman was the Principal Investigator (PI) on the R06D delamination study, a precursor to the current study. In two hours long discussion, Mike graciously shared information on the success and the challenges of the R06D. He elaborated on the challenges of construction test cells at NCAT and identified areas that worked well, and that did not. He recommended staying away from laboratory experiments and to emphasis field testing. He also shared documents and

	pictures from the NCAT construction and testing activities. He reiterated his interest in supporting the pool fund study • Identifying location for the construction of test cells at MnROAD. The project coordinator has been working with MnROAD managers and engineers to identify real estate for constructing the stripping test section proposed in the work plan. As a result, the group identified an existing service road located at the western end of MnROAD's Low Volume Road testing loop, adjacent to the I94 Mainline test sections that will be repurposed for the construction of the cells for TPF-5(504). The service road was originally built as a gravel road on top of a clay subgrade. In 1999, a portion of the road, approximately 1500 feet long, was replaced with Hot Mix Asphalt (HMA) mix. Four (4) inches of HMA mix was placed on top of the existing surfacing aggregate. The section served as a test section to establish paving techniques and develop a rolling pattern before placing the HMA on the LVR sections
Q2 (2023)	Detailed draft construction plans/drawings: The pool fund study aims to recreate typical full-depth bituminous and bituminous overlayed concrete pavements affected by stripping originating at the interfaces. The study envisions accomplishing the stated objective by identifying, producing and installing materials or mixes that closely simulate the conditions of stripping in actual pavements: failure of bonds between the binder and aggregate particles, loss of fine particles, continuously increasing void contents, loss of bearing capacity and deterioration etc. To accomplish this, the MnDOT team responsible for the TPF-5(504) pool fund study: • Reviewed the previous R06D study to assess its benefits, challenges, and lessons learned. Additionally, the team engaged in an extensive and productive discussion with Mike Heinzman, the principal investigator of the R06D study, who graciously shared valuable insights regarding the successes and failures encountered during the construction and testing of field and laboratory samples in the previous study. • Performed a concise literature review to identify the factors contributing to pavement stripping and how this phenomenon manifests itself. • Conducted forensic investigations of the site considered for constructing a new test section. The investigation included GPR and FWD surveys and analyses to evaluate the conditions of the existing road to determine whether to build or completely replace it with new layers. • Afterward, the MnDOT team developed preliminary drawings and plans, which underwent rigorous review, modification, and discussion in multiple meetings involving experts from various backgrounds, including MROAD construction operations, pavement design, materials, flexible pavement, and rigid pavement expertise. The documents containing the proposed construction plan, along with a detailed description of the factors considered and the works expected during the construction, can be found on the website. The documents also include a list of the people consulted in developing and reviewing the construction plan. • Following internal deliberation on the feasibility and constructability of the proposed plans, the MnDOT team is now circulating the plan documents to the state members, manufacturers, and supporters of the pool fund study to gather additional feedback, suggestions for adding or removing factors, and a consensus on proceeding with the construction of the test sections. The plan will be officially discussed, amended and approved on the August 11, 2023, virtual meeting. All partners and friends of the study are invited to provide feedback
Q3 (2023)	Refining construction plans: In Q2 2023, the preliminary construction plan for the MnROAD stripping test section received approval from TPF members during the August 11, 2023 meeting. A small working task group was also formed to develop this plan further and iron out the details. This task group includes senior engineers from MnROAD operations who will oversee the construction phase, ensuring a seamless transition from planning to implementation. Over the next few months, the working group will collaborate with MnROAD to refine the plan. Subsequently, preparations for contracting the jobs will commence, involving identifying contractors and materials required for the project. • MnROAD test section working task group meeting August 30, 2023. The meeting included a small group of individuals who volunteered to iron out details and finalize the approved construction plan for the MnROAD stripping test section. The group comprises Eyoab Zegeye (MnDOT), Shongtao Dai (MnDOT) Stephen Cooper (FHWA), Jeff Brunner (MnDOT), Jia Xiaoyang (TNDOT), Mike Heitzman (Kontour), Rami Chkaiban (ARA), Thomas Calhoon (MnDOT), Mike Vrtis (MnDOT/MnROAD), Jacob Calvert (MnDOT/MnROAD) and Ben Worel (MnDOT/MnROAD). The followings were discussed: ○ Precise start and end points for the test sections ○ Design of ramps before and after the test sections ○ Mix designs for concrete and host AC mixtures

	○ Dimensions and locations of test sections, stripped elements, and plates ○ Material specifics for creating the stripped section ○ Placement and compaction of the stripped elements (Mike) ○ Design of moisture induction (Mike) ○ Potential sensor deployment ○ Construction timelines (are we ready to begin the construction works) ○ Schedule to commence contracting and construction work
Q4 (2023)	• Preparation for the construction of the MnROAD stripping test sections: Throughout this quarter, progress has been made in preparing for the upcoming MNROAD testing construction, scheduled to commence in May 2024, following the winter season's conclusion. Key activities included ongoing meetings, discussions, and the development of detailed drawings. During this period, the MnDOT team successfully identified lead personnel for various critical components of the construction effort. These key areas encompassed a range of activities: contracting and outsourcing specific construction tasks, designing and fabricating systems for water inlet under the stripping element, sourcing and procuring necessary materials, and preparing the construction site for the upcoming work. These strategic preparations are integral to ensuring a smooth and efficient construction process for the MNROAD testing, aligning with our projected timeline and quality standards • Meeting with Mike Vrtis and Steve Olson (Nov 28 and December 14 2023) ○ Discussed in length the option for building a system for controlled water injection in two stripping section. Agreed to build a system made of PVC pipelines feeding from a water tank aide by small motor pumps. The pipelines will be buried but will be instered after the compaction to avoid damage. A drawing will be prepared ○ Discuss and agreed the need to shift the test section further north to avoid milling the asphalt layer for the construction of concrete slabs. This way the concrete slab will be place on top of the existing gravel road and milling asphalt layer want be necessary. The drawing will be updated •
Q1 (2024)	Commencement of construction of MnROAD Test Sections. Construction of the test sections in MnROAD has commenced as part of Task 4. Below are some of the key activities and progress made so far. • Planning and Approval**:** In 2023 Q4, the pooled fund study members and collaborators extensively discussed and identified the key elements for the MnROAD striping test sections. The finalized plans and drawings were reviewed and approved at an in-person meeting in November 2023. Following approval, all drawings and relevant information were handed over to the MnROAD team for implementation. MnDOT TPF representatives (Eyoab, Dai and Thomas Calhoon) held regular weekly and bi-weekly meetings with the MnROAD teams and MnDOT TPF representatives to ensure smooth progress. • Implementation**:** The MnROAD team, including Ben Worel, Mike Vrtis, Steve Olson, Jacob Calvert, Dan Roushar, and Jeff Taberry, began executing the plan. Key activities included: • Clearing the project site • Estimating quantities • Building the water pipe system • Installing sensors and wiring • Hiring contractors • Purchasing tools and materials • Conducting laboratory and field experiments to produce stripping-simulating mixtures • Running demo operations • Preparing detailed drawings • Coordinating and scheduling construction operations • Consulting with various subject matter experts (Tim Anderson, Allen Gallistel, John Garrity, Tom Burnham, Greg Johnson, Chelsea Bennet and Mike Skurdalsvold) to validate and optimize plans • Contracting and Material Procurement**:** MnROAD initiated the contracting process, securing agreements with two contractors: Paragon for constructing concrete slabs and CAT for paving the asphalt layer. Paragon was selected due to its established working relationship with MnROAD, while CAT included these test sections through a partnership agreement. Local

	suppliers, already certified by MnDOT, such as Martin Marietta, were specially arranged to provide materials. • Site Preparation and Sensor Installation**:** MnROAD has cleared the site and installed essential sensors, including thermocouples. • Mixtures simulating stripping: Tim Anderson (MnDOT Pavement Design Engineer) and Allen Gallistel (MnDOT Chemist) proposed using vegetable oil to break the bonds between the binder and aggregates to simulate different levels of stripping effect. Mike Vrtis, aided by Thomas Calshoon and Eyoab Zegeye, conducted several laboratory and field experiments to verify this proposition and to find the right amount of vegetable oil and the most effective way to handle and wash the mixture with soap after blending it with vegetable oil. Other important considerations tested were how to accomplish this on 12 test cells and dispose of the waste in an environmentally considerate manner. Accordingly, the final plan for level 1 stripping will consist of milling from newly placed lifts, screening to retain the coarse particles (simulate losing fine particles), washing the retained material with oil and soap to decay the bond between binder and particles, replacing and loosely compacting the mixture in the designated test sections and finally place new AC lift on top. The level 2 stripping simulating mixture will consist of loosely compacted coarse aggregate from the same AC mixture used for the paving sprayed with a binder film on the top. • Presentation and Current Status**:** Mike Vrtis presented and described all the preparation works and plans to the pool fund member states during the virtual meeting held on March 2024. Current status: Paragon built the concrete slab in the first week of April 2024 (see picture below). The test sections are expected to be completed in the first three weeks of June 2024. More information will be included in the next progress report. • 
Q2 (2024)	• The construction of the 12 test sections continued during this period. MnDOT focused on identifying and contracting local asphalt mixture producers and paving contractors. The plan involved purchasing the mixture, paving the test sections, and milling certain portions of the segments to create artificially stripped sections. The milled material was then to be transported back to the plant for screening and removal of fine particles.
Q3 (2024	• The construction of the 12 MnROAD test sections continued during this period, with MnDOT completing the construction of all 12 sections, including the installation of sensors at select locations. The remaining tasks include finalizing the pipe system for the test sections with controlled water inlets, adding striping paint, and collaborating with Infrasense and MnDOT to develop a comprehensive testing plan. Below are some pictures documenting this progresses and tasks.

	
Q4 (2024)	• The construction of the MnROAD test sections was completed. The planning and construction details were presented and thoroughly discussed by MnROAD engineers and managers, including Ben Worel, Chris Herr, Eyoab Zegeye and Ken Maser(at the September ISIC 2024 Conference) and Mike Vrtis (at the second in-person meeting) held in Minnesota. 

Task 5 – Development of a Software for Automated Detection and Quantification of Stripping

Q1 (2023)	
Q2 (2023)	

Q3 (2023)	Closed (only member agencies) meeting September 29, 2023. The meeting, which was attended by representatives of the member agencies only, discussed in depth plans for the development of software/algorithms for automated stripping detection and quantification. The attendants were Eyoab Zegeye (MnDOT), Shongtao Dai (MnDOT), Hung-Wen Chung (FLDOT), Brin Hill (ILDOT), Ian Rish (GADOT)Jia XiaoYang (TNDOT), Cindy Smith (MSDOT), Stephen Cooper (FHWA), Jeff Brunner (MNDOT), Jonathan Varner (MODOT), John Senger (ILDOT), Hoda Azar (FHWA) and Guangming Wang (FLDOT). In the meeting, the group discussed Task 5's project plan in depth. In particular, the group debated on the the following key points:
	• What features should the analysis tool include?
	• Should it be a stand-alone application or an embedded feature in other commercially available software applications?
	• Who should be tasked to develop these tools?
	• How should we identify and assign a team?
	• What type of 3D-GPR data will be utilized for this purpose?
	  ○ Direct: data collected using the geoscope, i.e. *.rda
	  ○ Indirect: data pre-processed in the Examiner, i.e., VOL, ASCII exports etc.
	• Are there any restriction to using the data
	• Data synching and fusion with other NDT data (i.e., FWD, TSD)
	As a result of these discussions, the group agreed to seek a qualified team responsible for accomplishing Task 5 through an RFP. *Eyoab Zegeye* and *Ian Rish* were entrusted with the responsibility of formulating an RFP that encapsulated the crucial points discussed during the meeting, aligning with the project work plan. Subsequently, the RFP was promptly drafted and circulated among representatives from member states for their input and endorsement before sharing it with the larger group. Upon receiving and addressing the group's comments and suggestions, the RFP was sent out to MnDOT's accounting and contracting office to start the contracting process. Eventually, the RFP will be posted to the general public to ensure broader participation.

Q4 (2023)	Official posting of RFP (December 21, 2023) MnDOT's team worked with MnDOT's research office to finalize the developed and endorsed RFP. The RFP was officially posted on the last week of December 2023. For detailed information about the RFP and the scope of work, please visit the P/T Notices - Professional Technical Consultant Services - MnDOT (state.mn.us) section on the MnDOT website. The project is listed under the title: "**Continuous Bituminous Pavement Stripping Assessment through Non-Destructive Testing**." The RFP seeks to identify a highly qualified team for a critical project that involves the development of testing protocols and analysis tools for automated detection, mapping, and rating of subsurface pavement defects, such as stripping 3D-GPR data. The posted documents include comprehensive explanations of the project, instructions for submitting queries, and critical submission dates. The team awarded for the project is expected, to collaborate with the TPF members and fulfill the objectives outlined in the RFP
Q1 (2024)	Task 5: Selection of a Team for Developing an Automated Algorithm for Detecting Stripping from GPR and Other NDT Technologies. Over the past year, we have made considerable progress in selecting a team to develop a robust automated algorithm for detecting stripping using GPR and other NDT technologies. This process was comprehensive and involved extensive discussions, deliberations, and evaluations. The process for selecting the team included the following steps: • Discussion and deliberations**:** The pool fund study members and friends engaged in over a year of discussions and debates to identify critical features and capabilities, the types of NDT technologies and data sources to use, and the final desired product and approach for selecting a team responsible for accomplishing this task • Closed (members-only) sessions: The pool fund study members conducted further discussions in closed sessions. During these sessions, a small technical workgroup comprised of Eyoab Zegeye (MnDOT), Ian (GADOT), Dai Shongtao (MnDOT), Jeff Brunner (MnDOT) and Jia Xiaoyang (TnDOT) was tasked with developing an RFP, working with the MnDOT research office to create a contract, reviewing proposals, and ultimately selecting the most fitting team. • Proposal Review and Team Selection: The selection committee received three strong proposals from consulting firms, GPR manufacturers, and universities. Although all proposals were robust and had important elements, the proposal submitted by a team composed of Infrasense, Hayat Consulting, Nichols Consulting Engineers, and Kontur US was found to be most aligned with the TPF's objectives and timeline. The other teams were a) Advanced Infrastructure Design Inc. (AID) and Kontur US and b) Michigan Technological University.

	• Final Endorsement and Workplan Development: The selected team's Principal Investigator (PI) and collaborators were invited to present their proposal to representatives of all member agencies for final endorsement. The team then produced a work plan based on the proposal and the comments received in the final meeting. • Current Status: The team is currently awaiting MnDOT Research Services' finalization of the contract and the issuance of a notice to proceed.
Q2 (2024)	• Contract finalization and signing: During this period, MnDOT Research Office and Research Services worked with Infrasense to finalize MnDOT contract No. 1055223: Continuous Bituminous Pavement Stripping Assessment through Non-Destructive Testing. The contract and supporting documents, including certificate of insurance, conflict of interest and DBE provision, were signed by Infrasense CEO on 6/25/2024 and returned to MnDOT.
Q3 (2024)	• Ken Maser (Infrasense) will begin to collect data from states and develop a framework for analysis. Data collection at MnROAD can begin once the test sections are complete.
Q4 (2024)	• Commencement of data collection on MnROAD test sections: With the construction of the MnROAD test sections complete, Ken Maser's team has begun collecting pavement data. MnDOT is regularly gathering 3D GPR and FWD data and sharing it with the team. During the second in-person meeting, Ken Maser (Infrasense), Jacopo Sala (Kontur), and Pat Miller (Olson) traveled to MnROAD in Minnesota to collect additional data using various equipment, including PASP and IE/SASW. Some preliminary results were presented and discussed at the meeting. During the meeting MnROAD and MnDOT engineers provide a 4 hours tour of the entire MnROAD testing facility and history to the participants.   •

Task 6 – Data collection on Roads from Participant States

Q1 (2023)	Meetings with subject matter experts: Meeting with Kare Sloth Jensen (April 12, 2023): Two hours meeting with the president of Measure, a company that developed a new lighter Traffic Speed Deflectometer (TSD) device. Kare introduced and explained the device to MnDOT researchers. The group agreed that the device would fit the testing activities proposed in the work plan. Most of the state

<table>
<tr><td></td><td>partners are in the TSD pool fund study. This new device would be a good fit for project-level short testing. Kare will explore ways to bring the device to the USA. If that occurs, we will schedule a meeting with all the state members to discuss including the device in our testing.</td></tr>
<tr><td>Q2 (2023)</td><td>MnDOT joined the TPF-5 (385) pool fund study. The MnDOT team worked with MnDOT's leadership and Research Steering Committee to secure funds (separate from the fund allocated for the TPF-5 (504)) to join the TPF-5 (385) pool fund study. The team also worked with the states pavement engineers to select several MN roads to be tested using the TSD device. Multiple of these roads are known to be affected by stripping and will be considered for the stripping pool fund study. Data collection is expected to occur in August 2023 and will include approximately 300 miles of roads</td></tr>
<tr><td>Q3 (2023)</td><td>• MnDOT TSD data collection: In August 2023, under the TPF-5 (385) pool fund study, MnDOT collected data using the Traffic Speed Deflectometer Device (TSDD) data along an approximately 300-mile continuous route. Nine roads were surveyed, including a few known to be impacted by stripping, earmarked for the stripping pool fund study.
• Selection of roads for the TPF-5(504): The group initiated identifying two roads per state suspected of stripping for inclusion in the study. MnDOT has distributed a project information request form (in spreadsheet format) to each participating state. Agency contacts are working with their agency to identify the roads and provide the requested information. Once this spreadsheet is completed, the group will determine and coordinate 3D-GPR and other testing. Already available data will be considered in determining the need for new data collection</td></tr>
<tr><td>Q4 (2023)</td><td>• Delivery of TSD Data (November 21. 2023): Under the TPF-5(385) pooled fund study, ARRB has successfully gathered approximately 300 miles of Traffic Speed Deflectometer (TSD) data on various Minnesota roadways. To finalize this project phase, ARRB delegates, Jerry Daleiden and Eric Botting, visited MnDOT's research office in Maplewood, MN, to hand over the collected data. This visit presented an invaluable opportunity for the MnDOT team to gain deeper insights into the system and the acquired data. Notably, a portion of this data was sourced from roadways earmarked for the stripping study, such as TH71. On this specific road, MnDOT had requested and subsequently received more detailed data, collected at more frequent intervals than usual. To coordinate a meeting involving both MnDOT and external stakeholders connected to the study or who would be end-users of the data, a doodle schedule survey was circulated. This aimed to identify a suitable time for all parties. The meeting was organized to accommodate both in-person and online participants. Attendees included the following individuals.

<table>
<tr><td>Zegeye, Eyoab (DOT)</td><td>In-person</td></tr>
<tr><td>Eric Botting</td><td>In-Person</td></tr>
<tr><td>Turgeon, Curt (DOT)</td><td>In-Person</td></tr>
<tr><td>Brunner, Jeffrey (DOT)</td><td>On-line</td></tr>
<tr><td>Dai, Shongtao (DOT)</td><td>In-person</td></tr>
<tr><td>Andersen, Timothy (DOT)</td><td>In-person</td></tr>
<tr><td>Cole, Melissa (DOT)</td><td>On-line</td></tr>
<tr><td>Henrichs, Steven (DOT)</td><td>On-line</td></tr>
<tr><td>Holzbauer, Micah (DOT)</td><td>On-line</td></tr>
<tr><td>Kosobud, Kevin (DOT)</td><td>Not sure</td></tr>
<tr><td>Van Deusen, David (DOT)</td><td>Not attending</td></tr>
<tr><td>Graham, Nancy (DOT)</td><td>Not attending</td></tr>
<tr><td>Johnson, Sara (DOT)</td><td>On-line</td></tr>
<tr><td>nazarian@utep.edu</td><td>Not attending</td></tr>
<tr><td>Bautista, Emil (He/Him/His) (DOT)</td><td>In-person</td></tr>
<tr><td>Burnham, Thomas (DOT)</td><td>Not attending</td></tr>
<tr><td>Lanotte, Michele</td><td>In-person</td></tr>
<tr><td>Podolsky, Joseph (He/Him/His) (DOT)</td><td>On-line</td></tr>
<tr><td>Sanchez-Pliego, Marcos (DOT)</td><td>Not attending</td></tr>
<tr><td>nschaefer@smoothroad.com</td><td>On-line</td></tr>
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</td></tr>
</table>

Sivaneswaran, Nadarajah (FHWA)	Not attending
maras002@umn.edu	Not attending
Worel, Benjamin (DOT)	In-person
Jerome Daleiden	In-person
ctirado@utep.edu	Not sure
Larson, Gregory (DOT)	On-line
Clark, Stephanie (DOT)	Not sure
Thorson, Amy (DOT)	On-line
Yuri Pillai	On-line

- MnDOT TSD data collection – 2nd round: MNDOT's team worked with MnODT's Research Steering Committee (RCS) to continue with the TSD pool fund study data collection for another 3 years. On October 6, 2023 MnDOT joined the second phase of the TSD pool fund study TPF-5 (518). In rge coming months, MnDOT will identify additional roads of which some will be included in the stripping pool fund study.

- Identifying agency roads for the study: During the preset quarter, several member agencies have actively collaborated within their respective Departments of Transportation (DOTs) to identify and nominate roads suspected of experiencing stripping for inclusion in the study. In the fourth quarter, six of the participating agencies put forward a total of 11 roads, all impacted by stripping. Essential details of these roads are outlined below. Additional crucial data shared includes precise road locations, lane counts, traffic conditions, pavement conditions, road age, and existing data availability. This information was collated using a standardized template (an Excel spreadsheet), developed and disseminated by MnDOT in the third quarter. The spreadsheet is accessible on the website under the title 'tpf-5(504)_agency roads.' Once this spreadsheet is fully populated, the team will assess and coordinate the deployment of 3D-GPR and other testing methodologies. The decision-making process will also consider any relevant data already available to gauge the necessity for new data collection.

Agency	Contact	Road Name	Type	Length, mi
MN	Eyoab Zegeye	TH71	Full depth bituminous	14
GADOT	Ian Rish	I-285	Full depth bituminous	6.5
GADOT	Ian Rish	I-59	Full depth bituminous	8.5
MS	Griffin Sullivan	US45 (NB)	Full depth bituminous	12.7
MS	Griffin Sullivan	US84 (EB)	Full depth bituminous	8.5
KY	Brad Fraizer	I-71	Bituminous overlay over concrete	3
KY	Brad Fraizer	US-42	Aggregate Base Pavements	1.4
TX	Ruben Carrasco	SH43	Full depth bituminous	19
TX	Ruben Carrasco	SH155	Full depth bituminous	9.5
TN	Xiaoyang Jia	SR68	Full depth bituminous	15.5
TN	Xiaoyang Jia	SR074	Full depth bituminous	12.73

Q1 (2024)

Task 6: Addition to the member-state roads suspected of stripping to be considered in the TPF study. Illinois sent information and coordinates of its state's roads suspected of stripping that will be considered in this study. So far, we have received feedback from all state members, except MODOT. (I may have missed the communication so please check this from your end, as well). Here is a short summary of the candidate roads. More details on these roads can be found on the TPF-5(504) website.

Agencies	Contact Person	Road Name	Type of Road
MN	Eyoab Zegeye	TH71	Full depth bituminous
GADOT	Ian Rish	I-285	Full depth bituminous
GADOT	Ian Rish	I-59	Full depth bituminous

	MS	Griffin Sullivan	US45 (NB)	Full depth bituminous	
	MS	Griffin Sullivan	US84 (EB)	Full depth bituminous	
	KY	Brad Fraizer	I-71	Bituminous overlay over concrete	
	KY	Brad Fraizer	US-42	Aggregate Base Pavements	
	TX	Ruben Carrasco	SH43	Full depth bituminous	
	TX	Ruben Carrasco	SH155	Full depth bituminous	
	TN	Xiaoyang Jia	SR68	Full depth bituminous	
	TN	Xiaoyang Jia	SR074	Full depth bituminous	
	IL	Brian Hill	I-270	Bituminous overlay over concrete	
	IL	Brian Hill	I-72	Full depth bituminous	
Q2 (2024)					
Q3 (2024)					

Q4 (2024)

- Gathering data from roads with known or suspected stripping issues is being gathered and analyzed. Ken Maser has started collecting and receiving GPR, TSD, coring, and historical information for these roads. Infrasense and the team will use a portion of this data to develop the automated stripping detection algorithm, while the rest will be used to validate the method and algorithm. A summary of the data made available to Ken Maser is shown below: Since October this list has been modified several times to include more data and remove data from roads that were deemed out of scope

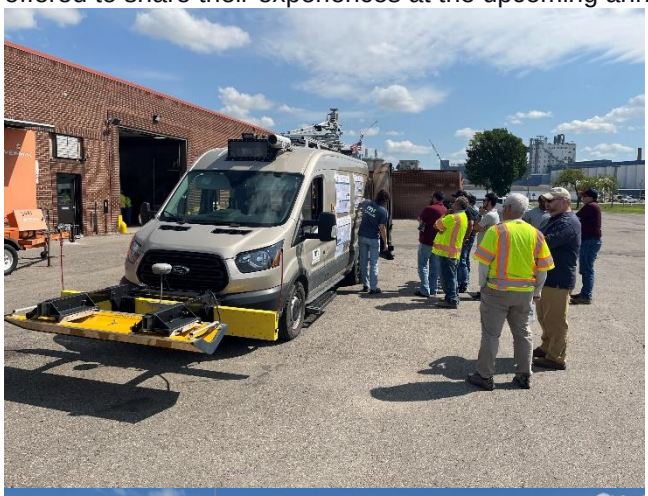
Road	State	Nearby Town	Cores	FWD	TSD	3DGPR	Stripping	Contacts
TH71	MN	Bemidji	Yes	Yes	Yes	Yes	Yes	Eyoab/Nancy
I285	GA	Chamblee	Yes	Yes	Yes	Yes	?	Ian Rish
I59	GA	Trenton	Yes	Yes	Yes	Yes	?	Ian Rish
US45(NB)	MS	Amory	Yes	Yes	Yes	Yes	Yes	Griffin/Jim
US84 (EB)	MS	McComb	Yes	Yes	Yes	Yes	Yes	Griffin/Jim
I-270	IL	Alton	Yes		Yes	?		Brian
I-72	IL	East Hannibal	TBD		Yes	?		Brian
SH155	TX	Daingerfield	Yes	Yes	Yes	Yes	Yes	Ruben/Tom Scullion
SH43	TX	Henderson						Ruben/Tom Scullion
I29	MO	St Joseph	Yes			No		Jonathan
Route 13	MO	Warrensburg	Yes			No		Jonathan
SR-60	FL	Vero Beach				Yes		Guangming
SR-8 (I-10)	FL	Milton				Yes	Rublizzed Concrete	Guangming
I64	KY	Rowan	Yes	Yes (Dynatest)		Yes		Kean
I-71	KY	Williamstown	Yes	Yes (JILs)		Yes		Kean
US2	ND	Grand Forks	Yes			Yes	Yes/Rublizzed Concrete	Curt
US93N	NV	Rachel	Yes	Yes	Yes	Yes	Yes	Peter

Task 9, 10 & 11 – Support and Communication & Strategic Technology Promotion

Q1 (2023)	• Project Kick-Off Meeting (January 6, 2023): A two-hour-long online project kick-off meeting was held on January 6, 2023. The meeting was exclusively for state agencies. The objective was to discuss and approve the work plan that was shared with all the study partners well before the meeting. The meeting was for state agency and FHWA members alone and was well attended. Detailed meeting minutes can be found on the TPF website. • Designing website: MnDOT started building and maintaining a website for the pool fund study. The website is hosted on the MnDOT website and will store important documentation, share calendars, events and training materials, and publish results and reports of various formats. The link for the website is here: http://www.dot.state.mn.us/materials/nde-stripping-evaluation/index.html
Q2 (2023)	• Building website: The MnDOT team created a website dedicated to supporting the pool fund study. You can access the website here: https://www.dot.state.mn.us/materials/nde-stripping-evaluation/. The website will serve as a repository for various resources, including documents, papers, videos, imagery, meeting notes, presentations, calendars, manuals, lists of manufacturers and equipment involved in the study, and information about organizations supporting the study. These materials are

	important to the understanding and promotion of the NDT (Non-Destructive Testing) technologies investigated in the pool fund study • Call for virtual meeting: Virtual meeting called for August 11, 2023. The date was selected based on a widely participated Doodle survey.
Q3 (2023)	• Virtual meeting August 11, 2023. The meeting, which was attended by 60 individuals (members and friends of the study) discussed the followings: o Introduction to the website o Review and discuss the proposed plan for controlled field Pavement test sections o Discussion on the development of software/algorithms for automated stripping detection and quantification o Discussing proposed survey questions on stripping and use of GPR and other NDT: draft survey developed in collaboration with QES, Inc. (Steve Koser and Dennis Morian) during the last virtual meeting (pre-pool fund study) has been attached to this email for your consideration. o Updated from the state members: o Discuss plans and topics for the first TPF5-504 In-Person meeting • Planning for upcoming Joint fall Meeting TPF-5(504) and TPF-5 (443): Preparations for the upcoming collaborative fall meeting between TPF-5(504) and TPF-5 (443) involved close collaboration among the managers and teams overseeing these pooled fund studies, working in tandem with MnDOT. The purpose was to plan and coordinate a joint project update and peer exchange event. Key tasks encompassed: o Crafting a comprehensive meeting agenda. o Strategizing optimal dates for the meeting, scheduled to take place in the Twin Cities, Minnesota. o Identifying and inviting speakers to provide updates on advancements in Non-Destructive Testing (NDT) technologies pertinent to the pooled fund studies. o Facilitating travel authorization and managing reimbursement paperwork for attending members. o Securing suitable meeting venues and configuring online meeting capabilities.
Q4 (2023)	• First in-person meeting November 8th, 2023. The first in-person meeting for the TPF-5(504) Project Update and Peer Exchange Meeting was held jointly with the DPS pool fund study. The TPF-5 (504) took place on Wednesday, November 8th, 2023, from 7:45 AM to 5:00 PM (CTS). This well-attended meeting included in-person and online participants, featuring representatives from various state Departments of Transportation (DOTs), the Federal Highway Administration (FHWA), and multiple private sector and academic institutions. A more detailed meeting minute is uploaded on the website. Below are key Discussions and Highlights from the meeting: o Opening and Background: ▪ Jeff Brunner (MnDOT) and Steve Cooper (FHWA) initiated the meeting, discussing the Road Doctor initiative, MnDOT's leadership in the pooled fund, and the SHRP effort. ▪ Dai Shongtao (MnDOT) highlighted the importance of continuous pavement measurements and the integration of 3D Radar and Kontur data with TSD sections. ▪ Project Overview and Progress: ▪ Eyoab Zegeye (MnDOT) presented the TPF-5 (504) project's objectives, progress, and budget overview. He emphasized the challenges in using NDE technology and the need for a broader approach in the pooled fund study. The meeting also covered the construction of AC Stripping Test Sections at MnROAD. o Development of Analysis Tools: ▪ The discussion focused on developing automated detection tools for hidden defects in pavements. The RFP was developed by the state members, as discussed, to create a tool for detecting and rating stripping using 3DGPR and other NDT data. The key topics were the RFP process, objectives, desired features, budget, and funding. o Construction Plans for MnROAD Stripping Sections: ▪ Detailed planning and development strategies for constructing field test sections were discussed, including objectives, investigative approaches, and concerns such as ride quality, data collection challenges, and material selection. o Updates from Member States:

	▪ Representatives from various state DOTs shared experiences with roads affected by stripping, discussing identified roads for the pooled fund study and data collection efforts. o Afternoon Sessions and Presentations: ▪ Innovative NDT technologies were showcased, including a new Traffic Speed Deflectometer by Kare Sloth Jensen (Measure) and presentations on Impact Echo (IE) and Spectral Analysis of Surface Waves (SASW) by Monica Jurado. ▪ Paul Collins and Jacopo Sala (Kontur) provided insights into 3D-GPR technology. ▪ Soheil Nazarian (UTEP) discussed the NRRA awarded project's research scope, focusing on TSD use guidelines. • Open discussions involved various topics, including GPS accuracy, data analysis techniques, and nuances in GPR data interpretation. Overall, the meeting demonstrated a collaborative effort among various agencies and experts in the field of pavement assessment and technology. It highlighted strategic planning and the integration of innovative technologies and methodologies to enhance pavement analysis and research.
Q1 (2024)	Task 10-11: Contracting CTS to support communication and technology promotion. After several interviews and discussions, MnDOT, on behalf of the TPF study, created a contract (in progress) with CTS to help us with communication and strategic technology promotions, meeting facilitation, notes, etc. The collaboration work plan can be found on the TPF website. The funds for these efforts are coming from TASK 10 and Task 11. Task 9-10-11: Invitation to attend the International Society for Intelligent Construction (ISIC) 2024 Conference in Orlando, Florida, from September 10 to 12, 2024. Use this link to learn more about the conference. • Travel opportunities: The conference organizers noted the similarities between the Intelligent Construction technologies discussed at the conference and the NDT technologies considered in the TPF-5(504) pool fund study. Consequently, they have offered a time slot and room for conducting our scheduled technical meeting during the conference, allowing participants to learn more about the TPF-5(504) objectives and activities. The meeting will be held in a hybrid format. As discussed and agreed upon in the March online meeting, the pool fund study will cover the travel costs for up to three member agencies if they intend to send representatives to this conference. If you plan to attend, please inform Lisa Bilotta or Eyoab Zegeye (MnDOT) as soon as possible so that we can send you the necessary travel forms. • Paper and presentation: MnDOT has submitted a paper documenting the state's experience with 3D-GPR for project scoping and detailing the objectives of the TPF pool fund study. This study aims to improve and refine the use of 3D-GPR in severely deteriorated roads, which are often considered for scoping and rehabilitation. The paper has been accepted for publication and presentation at the upcoming conference. Task 10: Planning for the Annual Face-to-Face Meeting in Minnesota. We have begun preparations for the annual face-to-face user group meeting, scheduled to take place in Minnesota in October or November. In the coming week, you will receive a survey to help select the ideal dates for this joint meeting with the other GPR-related pool fund study led by MnDOT. Please respond as soon as possible and suggest topics you would like to see covered during the two—to three-day user-group workshop.
Q2 (2024)	Planning for in-person Technical Work Meeting (semi-annual): During this quarter, the chair of the ISIC reached out to MnDOT to inform them about the group's upcoming conference planned for September in Florida. The group primarily targets researchers, manufacturers, and contractors involved in advancing Intelligent Construction technologies. They expressed interest in hearing about the stripping and DPS pooled fund studies and invited us to conduct our technical work meeting as a workshop in their office. The TPF-5(504) members approved this plan as part of the pooled fund studies' effort to promote the technology. They also agreed to reimburse travel, meals, and registration costs for member states planning to attend in person. For those unable to travel, online access was provided. MnDOT collaborated with the administrator of the MnDOT Research Office to compile a list of members traveling and ensure all travel authorizations and arrangements were finalized. Additionally, MnDOT, along with Eyoab and the panel, worked together to develop the agenda for the meeting, which is scheduled for Tuesday, September 10, 2024.

Q3 (2024)	• The pooled fund held its first in-person meeting in Orlando, Florida in conjunction with the International Society for Intelligent Construction (ISIC) conference. This meeting included a discussion of the pooled fund's work plan, an update on the construction of the test sections at MnROAD, and a proposed agenda for the fall meeting. • Planning also continued for a fall 2024 in-person meeting to be held jointly with the Continuous Asphalt Mixture Compaction Assessment Using Density Profiling System pooled fund (TPF-5(443)), which MnDOT also leads. This meeting would be held at MnROAD, and include a tour of the newly constructed test sections. • The MnDOT Road Doctor Team traveled to North Dakota with the Road Doctor Survey Van to discuss and demonstrate the capabilities of 3D GPR for pavement scoping with NDOT engineers. NDOT engineers, who are considering joining the pooled fund study, sought to learn more about the group's objectives and mission. MnDOT also assisted in collecting and analyzing GPR data for NDOT. In return, NDOT compiled all historical information, coring and related to this work and offered to share their experiences at the upcoming annual in-person meeting  • 
Q4 (2024)	• The contract for communications and meeting support was awarded to CTC & Associates LLC. • The pooled fund's in-person fall meeting was held at MnROAD in October 2024. An agenda and notes from the participants' discussion are available on the pooled fund's website.

Anticipated work next quarter:
The project activities that are expected to occur or start in the next quarter include:

- **Task 4**: Finalize costs and expenses for the construction of MnROAD test sections
- **Task 5**: Coordinate 3D-GPR and TSD testing on state roads selected for the study
- **Task 5:** Progress of the data analysis and algorithm development
- **Task 6:** Summary of data sent from state members to Infrasense
-

Significant Results:

- Help first in-person project update and peer-exchange meeting
- Officially posted the RFP for developing tools for automated detection and rating of stripping
- Finalized construction plans from MnROAD stipping test section
- Obtained TSD data on MnDOT roads suspected of stripping
- Held two in-person meeting in Minnesota and one in Florida in conjunction with ISIC and DPS pool fund study
- Hired Infrasense and team to develop the software for automated stripping detection
- Hired CTC & associtates to support communication and strategic technology promotion
- Started collecting data on MnROAD and gathering data from state members to support the development of the automated software
- Early GPR, FWD, IE/SASW and PASB result very promising

Circumstance affecting project or budget. (Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints set forth in the agreement, along with recommended solutions to those problems).

The planning and preparation phase, although slightly extended, facilitated in-depth discussions and thorough deliberations proving beneficial for the project in the long run. The construction commencement of the MnROAD test sections was rescheduled to Spring 2024 due to considerations regarding the winter season and the comprehensive level of detail incorporated into the plan. Apart from this adjustment, the project continues to progress forward

Potential Implementation:

The final objective of the pool fund study is to develop testing procedures and algorithms (software) that can reliably and automatically detect stripping and other moisture-related damages from 3D-GPR images of bituminous and composite pavements. This will significantly improve the use of 3D-GPR in project scoping practices beyond just measuring the layer thickness. State engineers will have data that can better support their rehabilitation selection processes and will be able to quickly identify sections of the road that require particular attention and thus avoid one-solution-fits-all approaches